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

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

FOREWORD

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

It has been decided to amend the general title of the IEC 61850 series to *Communication networks and systems for power utility automation.* Henceforth, new editions within the IEC 61850 series will adopt this new general title.

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

FDIS	Report on voting
57/886/FDIS	57/905/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 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- withdrawn,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.

INTRODUCTION

The present standard includes all additional logical nodes, not included in IEC 61850-7-4:2003, required to represent the complete control and monitoring system of a hydropower plant.

Most of the Logical Nodes in IEC 61850-7-410 that are of general use, Logical Nodes the names of which do not start with the letter "H", will be transferred to the future Edition 2 of IEC 61850-7-4. In the same manner, all Common Data Classes specified in IEC 61850-7-410 will be transferred to future Edition 2 of IEC 61850-7-3.

Once future Editions 2 of IEC 61850-7-3 and IEC 61850-7-4 are published, IEC 61850-7-410 will be revised to include only those Logical Nodes that are specific to hydropower use.

Before Edition 2 of IEC 61850-7-410 is published, there will be a period where the Common Data Class (CDC) and Logical Node (LN) specifications will overlap with IEC 61850-7-3 (future Edition 2) and IEC 61850-7-4 (future Edition 2). During this time, the specifications in IEC 61850-7-3 (future Edition 2) and IEC 61850-7-4 (future Edition 2) will apply.

COMMUNICATION NETWORKS AND SYSTEMS FOR POWER UTILITY AUTOMATION –

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

1 Scope

IEC 61850-7-410 is part of the IEC 61850 series. 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.

The Logical Nodes and Data Objects defined in this part of IEC 61850 belong to the following fields of use:

- **Electrical functions**. This group includes LN and DO used for various control functions, essentially related to the excitation of the generator. New LN and DO defined within this group are not specific to hydropower plants; they are more or less general for all types of larger power plants.
- **Mechanical functions**. This group includes functions related to the turbine and associated equipment. The specifications of this document are intended for hydropower plants, modifications might be required for application to other types of generating plants. Some more generic functions are though defined under Logical Node group K.
- **Hydrological functions**. This group of functions includes objects related to water flow, control and management of reservoirs and dams. Although specific for hydropower plants, the LN and DO defined here can also be used for other types of utility water management systems.
- **Sensors**. A power plant will need sensors providing measurements of other than electrical data. With a few exceptions, such sensors are of general nature and not specific for hydropower plants.

NOTE All Logical Nodes with names not starting with the letter “H” will be included in a future edition 2 of IEC 61850-7-4. When that document is published, the Logical Nodes in IEC 61850-7-4 (Edition 2) will take precedence over Logical Nodes with the same name in this part IEC 61850-7-410.

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

IEC 61850-5, *Communication networks and systems in substations – Part 5: Communication requirements for functions and device models*

IEC 61850-6, *Communication networks and systems in substations – Part 6: Configuration description language for communication in electrical substations related to IEDs*

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

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

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

3 Terms and definitions

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

4 Abbreviations

In general, the abbreviations defined in IEC 61850-2 apply. The following abbreviations are repeated here for convenience.

ASG	Analogue setting
BSC	Binary controlled step position information
CDC	Common data class
CIM	Common information model (reference to IEC 61970-301)
CMV	Complex measured value
DO	Data object
DPC	Double point control
DPL	Device name-plate
DPS	Double point status information
HMI	Human machine interface
IED	Intelligent electronic device
INC	Controllable integer status
ING	Integer status setting
INS	Integer status
LD	Logical device
LN	Logical node
MV	Measured value
PD	Physical device
PID	Proportional – Integrating – Derivative regulator
SAV	Sampled analogue value
SMV	Sampled measured value
SPC	Single point control
SPS	Single point status

WYE Phase to ground related measured values of a three-phase system

5 Basic concepts for hydropower plant control and supervision

5.1 Functionality of a hydropower plant

Figure 1 below is based on the substation structure described in IEC 61850-6. A typical power plant will include a “substation” part that will be identical to what is described in the IEC 61850 series. The generating units with their related equipment are added to the basic structure.

A generating unit does consist of a turbine – generator set with auxiliary equipment and supporting functions. Generator transformers can be referenced as normal substation transformers; there is not always any one-to-one connection between generating units and transformers.

The dam is a different case. There is always one dam associated with a hydropower plant. There are however reservoirs that are not related to any specific power plant as well as there are power plants from which more than one dam are being controlled. While all other objects can be addressed through the power plant, dams might have to be addressed directly.

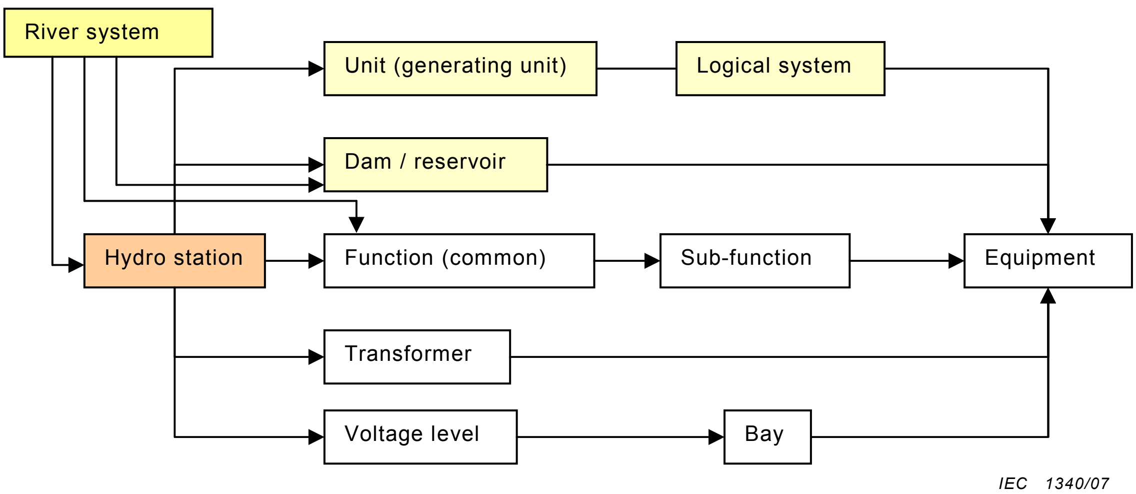


Figure 1 – Structure of a hydropower plant

There is, however, no standardised way of arranging overall control functions, the structure will depend on whether the plant is manned or remote operated, as well as traditions within the utility that owns the plant. In order to cover most arrangements, some of the Logical Nodes defined in this part of IEC 61850 more or less overlap. This will allow the user to arrange Logical Devices by selecting the most appropriate Logical Nodes that suits the actual design and methods of operation of the plant. Other Logical Nodes are very small, in order to provide simple building blocks that will allow as much freedom as possible in arranging the control system.

Some control functions do work more or less autonomously after being started and stopped by the start/stop sequencer. Such functions include the cooling system for the generator and the lubrication oil system for the bearings.

5.2 Principles for water control in a river system

5.2.1 General

The water control of river systems and hydropower plants can follow different strategies, depending on the external requirements put on the operation of the system.

a) Water flow control

In this type of control, the power production is roughly adapted to the water flow that is available at the moment. The rate of flow is the controlled while the water level is allowed to vary between high and low alarm levels in the dams. The dams are classified after the time over which the inflow and outflow shall add up (daily, weekly etc.).

b) Water level control

In some locations, there are strict limits imposed on the allowed variation of the water level of the dam. This might be due to maritime shipping or by other environmental requirements. In this case, the upper water level of the dam is the overriding concern, power production is adjusted by the water level control function to provide correct flow to maintain the water level.

c) Cascade control

In rivers with more than one power plant, the overall water flow in the river is coordinated between plants to ensure an optimal use of the water. Each individual plant can be operated according to the water level model or the water flow model as best suited, depending on the capacity of the local dam and allowed variation in water levels. The coordination is normally done at dispatch centre level, but power plants often have feed-forward functions that will automatically notify the next plant downstream if there is a sudden change of water flow.

Power plants with more than one generating unit and/or more than one dam gate, can be provided with a joint control function that controls the total water flow through the plant as well as the water level control.

5.2.2 Principles for electrical control of a hydropower plant

A power plant can be operated in different modes: active power production mode or condenser mode. The generator can be used as a pure synchronous condenser, without any active power production and with the runner spinning in air.

In a pumped storage plant, there is a motor mode for the generator. A generator in a pumped storage plant can also be used for voltage control in a synchronous condenser mode, in this case, normally with an empty turbine chamber.

The following steady states are defined for the unit:

a) *Excited, not connected* – Field current is applied and a voltage is generated, the generator is however not connected to any load, there is no significant stator current.
b) *Synchronised* – The generator is synchronised to an external network. This is the normal status of an operating generator.
c) *Synchronised in condenser mode* – The generator is synchronised. However it does not primarily produce active power. In condenser mode, it will produce or consume reactive power, in generation- or pump-direction (for pumped storage), it consumes active power.
d) *Island operation mode* – The external network has been separated and the power plant shall control the frequency.
e) *Local supply mode* – In the case of a larger disturbance of the external network, one or more generators in a power plant can be set at a minimum production to provide power for local supply only. This type of operation is common in thermal power plants to shorten the start-up time once the network is restored, but can also be used in hydropower plants for practical reasons.

5.3 Logical structure of a hydropower plant

Different devices handle active and reactive power control. The turbine governor provides the active power control by regulating the water flow through the turbine and thus the pole angle between the rotating magnetic flux and the rotor. The excitation system provides the reactive power control by regulating the voltage of the generator. The magnetic flux shall correspond to the shaft torque to keep the generator synchronised to the grid.

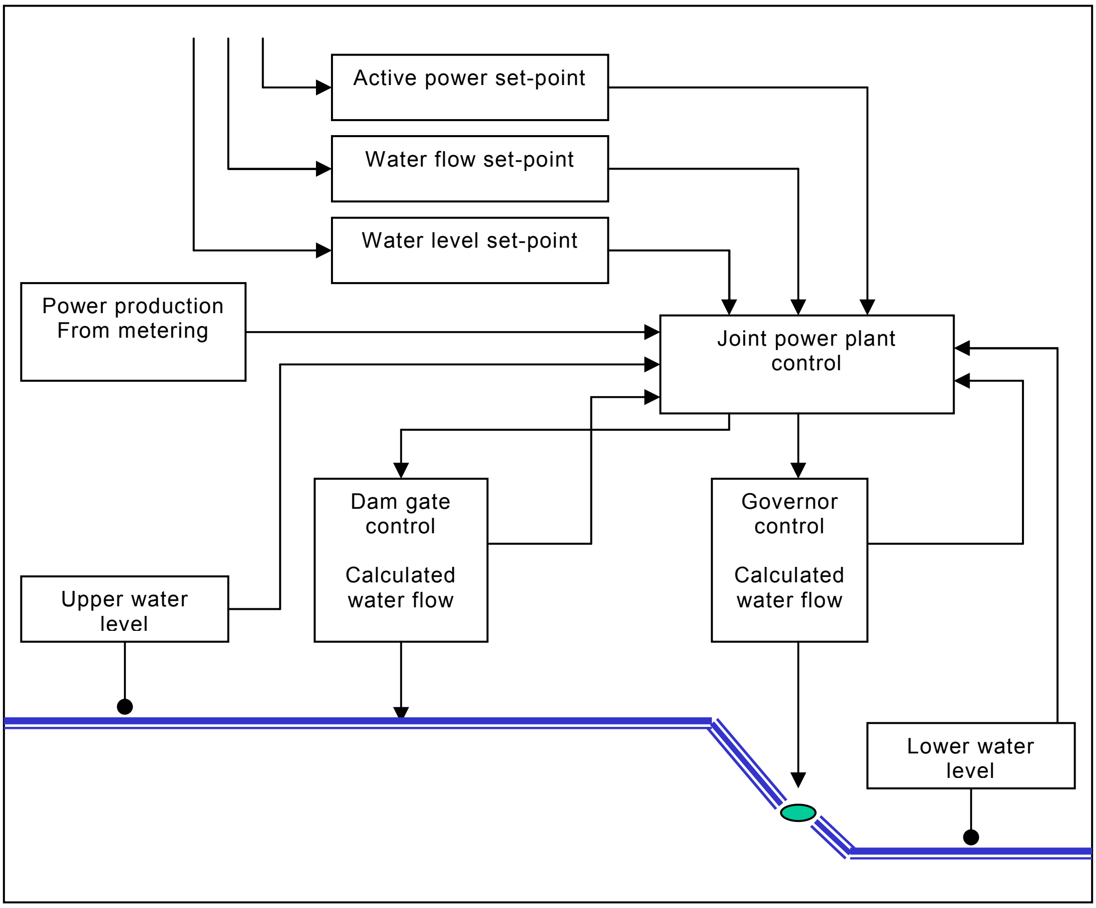


Figure 2 – Principles for the joint control function

Figure 2 shows an example of an arrangement including a joint control function. The set-points will be issued from a dispatch centre and could be one of three optional values. Therefore, the type of set-point that will be used depends on the water control mode that is used for the plant.

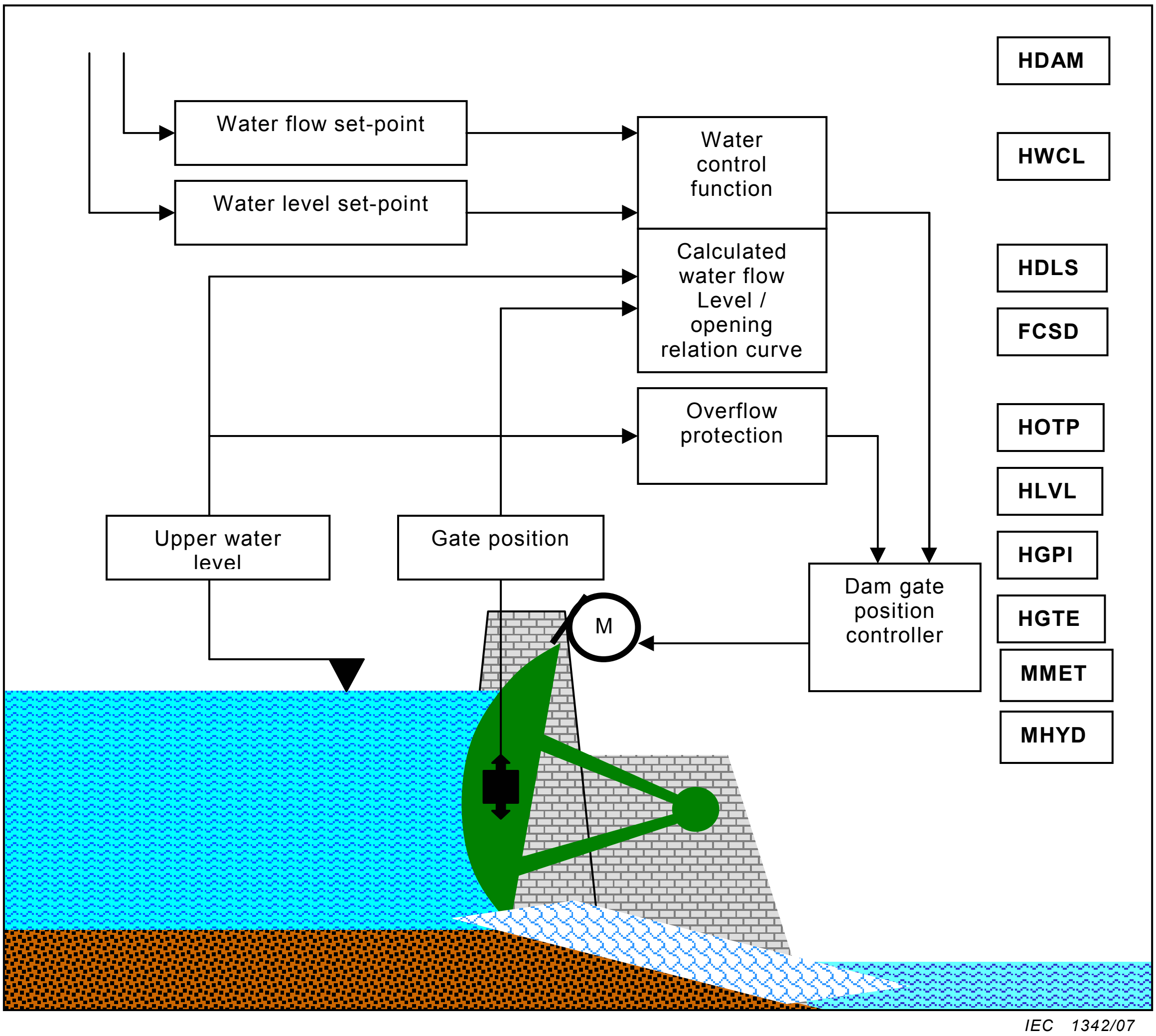


Figure 3 – Water control functions

Figure 3 is a typical example of water control functions of a dam. The overall water control of a hydropower plant will also include the water running through turbines. The overtopping protection (HOTP) is a safety function, acting independent of other control functions that will override normal spillway gate controls.

In the case of a reservoir without any power production, this water control function will get the set-points from a dispatch centre; in the case of a power plant it will be normally the joint control function that sets the values. The set-point will be either water level or water flow set-points.

The total water flow is the sum of flows through turbines and gates. The overall flow control shall also consider the flow through turbines. The turbine control system can, due to this, be provided with different set-points for the control:

- Water flow set-point. The control system will base the regulation on the given water flow level and try to optimise the production.
- Active power set-point. The control system will try to meet the active power, the water flow will be reported back to the overall water control system.

- Active power control with speed droop. This is the mode when the unit is contributing to the network frequency control. The active power set-point is balanced over the speed droop setting to obtain the desired power/frequency amplification.
- Frequency set-point. in the case of an islanded system or a power plant in peak load duty, the active power will be controlled to exactly meet the demand. This control mode is also used during start-up of the unit, up to the point when the generator is synchronised. Water flow will be reported.

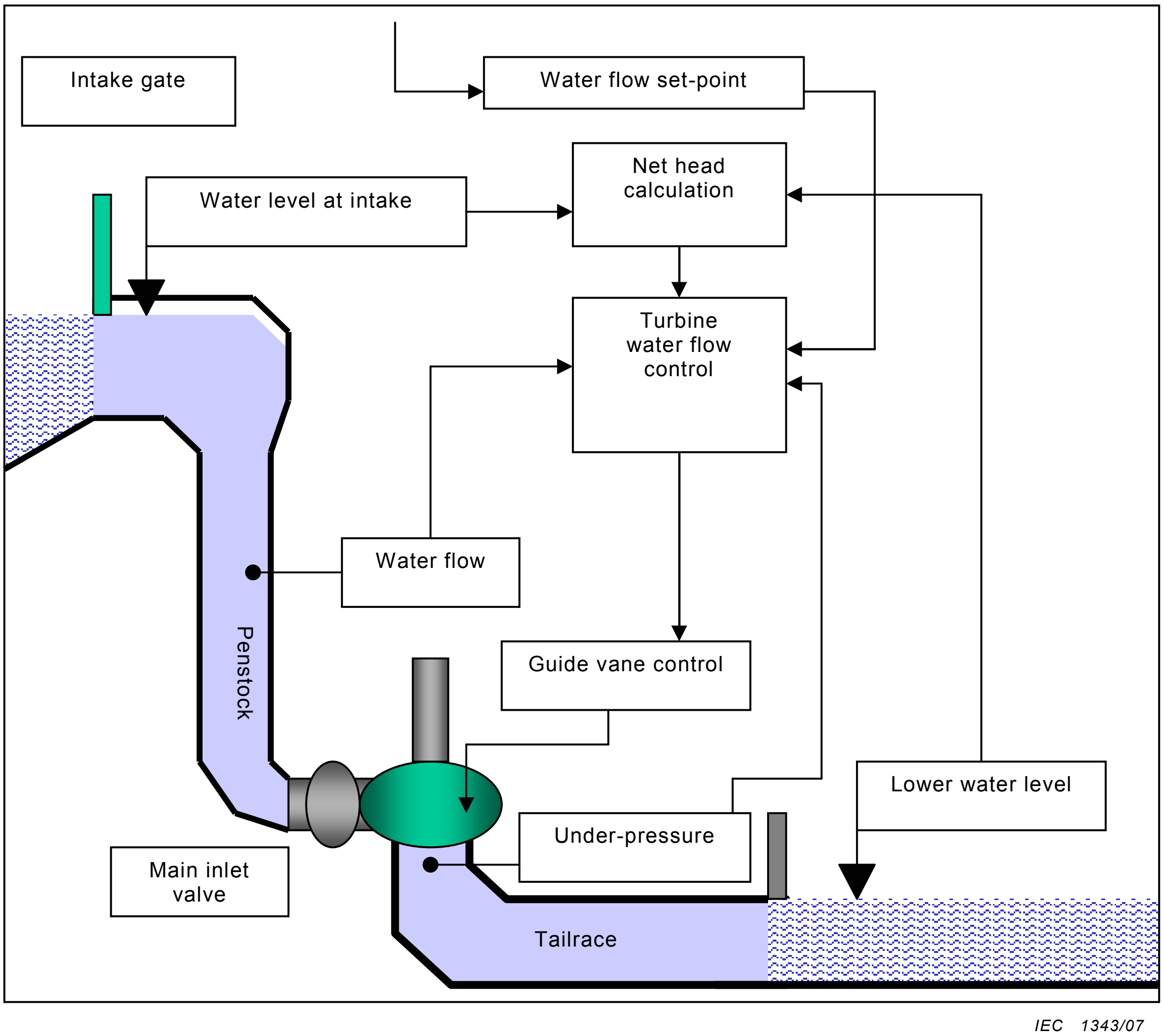


Figure 4 – Water flow control of a turbine

Figure 4 shows an example of water flow control of a turbine. Direct measurement of the water flow, as indicated in the figure, is less common. The flow is normally calculated, using the net head, the opening angle of the guide vanes and a correlation curve.

Main inlet valves to shut off the turbine chamber are used for pumped storage plants and power plants with high penstocks.

It is important to differentiate between the water levels of the dam and at the intake. Due to the intake design or if the turbine is running close to rated power, the water level at the intake might be considerably lower than the average for the dam.

The measurement of under-pressure below the turbine chamber is a safety measure, to ensure that the operation of the guide vanes does not cause any dangerous conditions in the tail-race part.

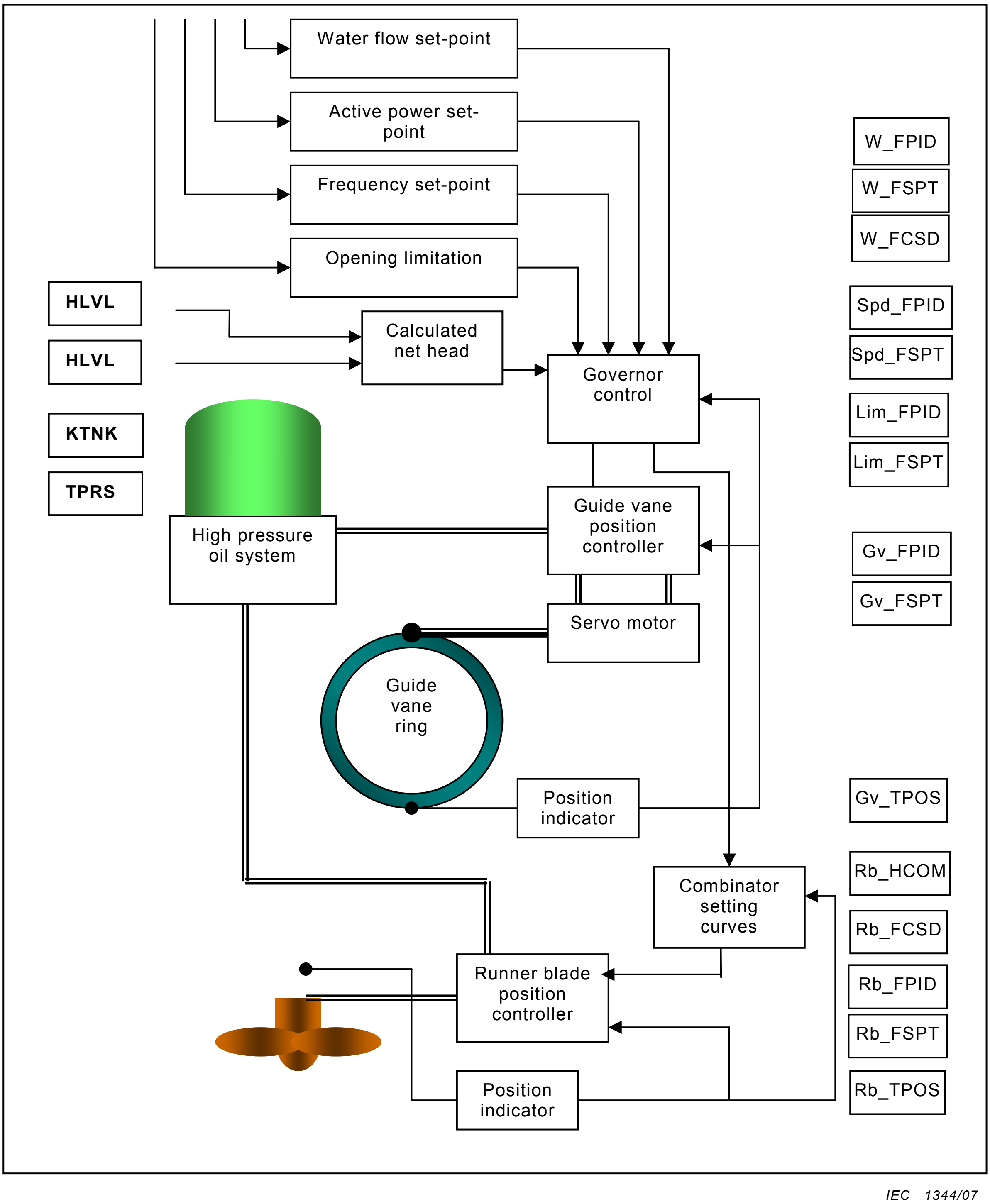


Figure 5 – Typical turbine control system

Figure 5 above shows an example of a turbine control system for a Kaplan turbine with moveable runner blades.

The frequency set-point and any opening (maximum power) limitation set-point are most likely to be given by dispatch centre (or locally).

The active power set-point can be given by dispatch centre, but in the case of overriding water control functions, it is given by the joint control function (HJCL). The water control set-point is almost always provided by the joint control function.

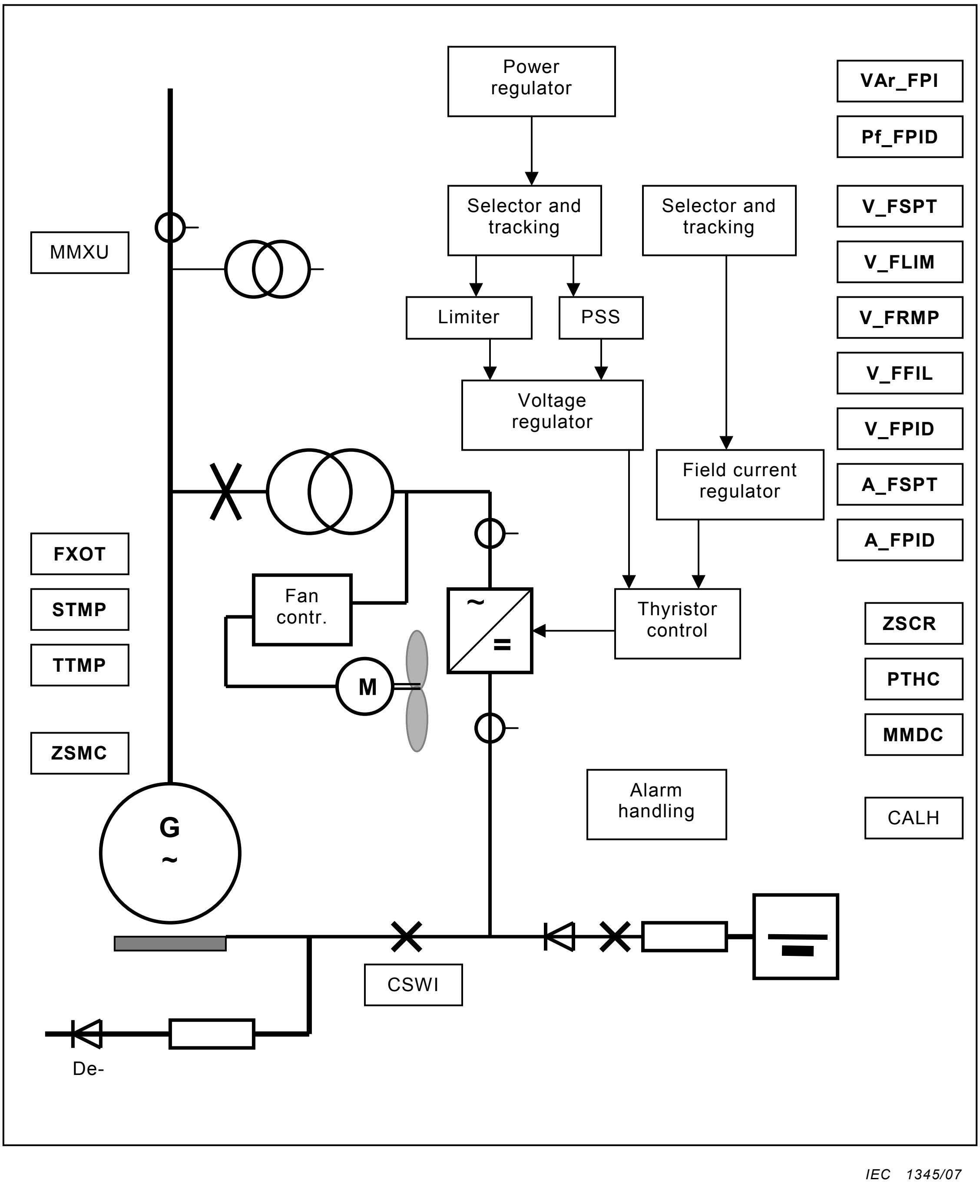


Figure 6 – Excitation system

Figure 6 shows an example of the excitation system for a generator. There are a number of different design principles for excitation systems; the figure does, however, include the most common functions. The synchronisation device can be included in the excitation system, in the turbine governor system, or it can be a separate device not being part of either.

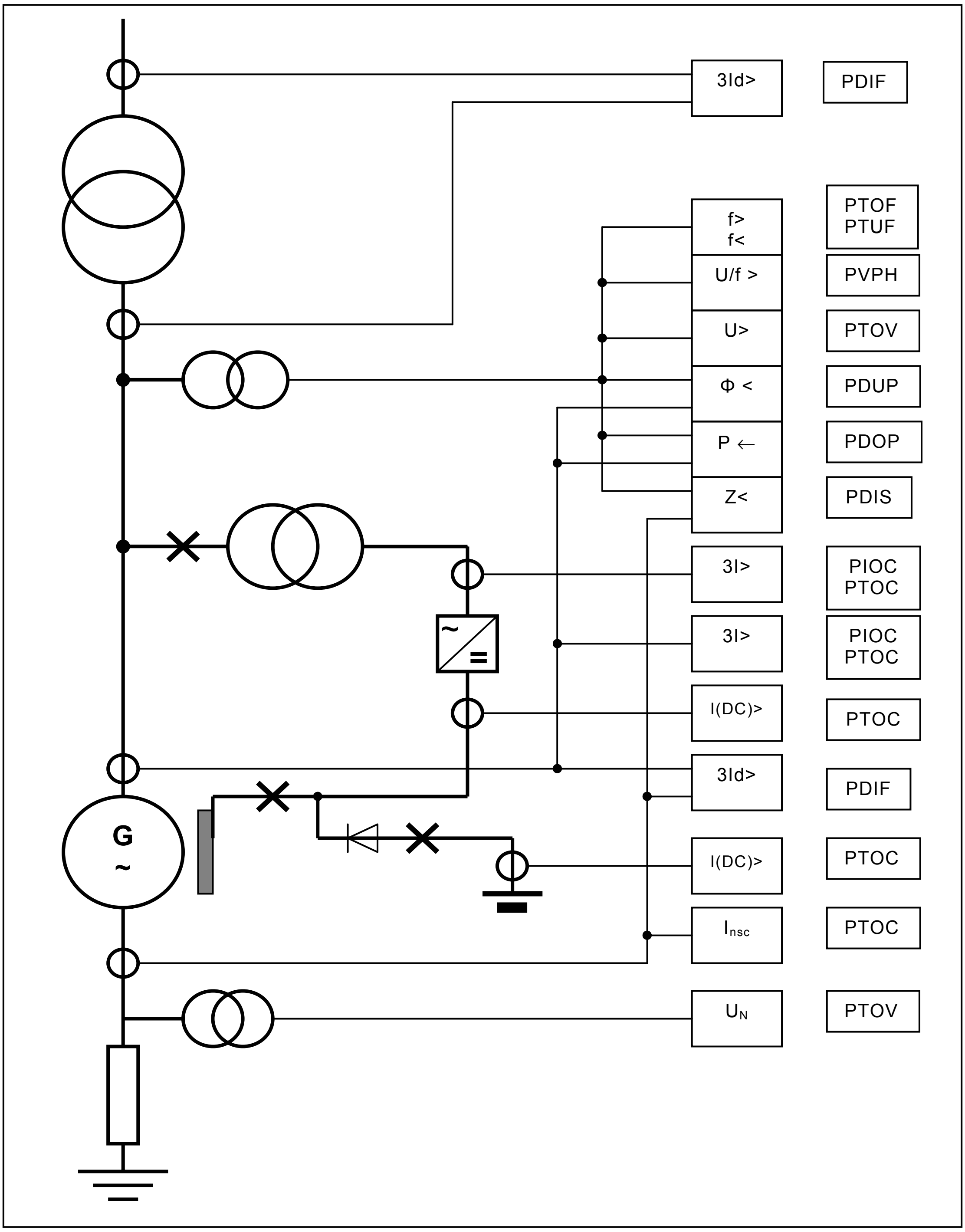


Figure 7 – Electrical protections of a generating unit

Figure 7 shows examples of electrical protections that are commonly used in hydropower applications. There might be other protections beside the ones shown here, such as shaft current protection. Another protection not included in the figure is a protection against unintentional energisation at stand-still; logical node name PZSU.

6 Modelling concepts and examples

6.1 The concept of Logical Devices

A Logical Device is a local definition of an entity that may contain an arbitrary number of Logical Nodes. Logical Devices are used to provide a common address for Logical Nodes that would normally be grouped together. The principle of how Logical Devices are used is described in IEC 61850-7-1. For the formal specification of Logical Devices, see IEC 61850-7-2, Clause 8. As an example, we can look at a simple over-current protection, a standard distribution type protection device. Even if being part of for example an excitation system, this protection will be a separate device, with a possible set-up according to Table 1. All logical nodes in this example are found in IEC 61850-7-4.

Table 1 – Example of Logical Device over-current protection

LOGICAL-DEVICE class		
Attribute name	**Attribute type**	**Value/value range/explanation**
SupplyOC	ObjectName	Incoming supply over-current protection
G1ExOCin	ObjectReference	Excitation system for G1, incoming over-current
LPHD	LOGICAL-NODE	Physical device data
LLN0	LOGICAL-NODE	Logical node zero
MMXU	LOGICAL-NODE	Three-phase measurement data
PIOC1	LOGICAL-NODE	First step, instantaneous
PTOC2	LOGICAL-NODE	Second step, time delayed
PTOC3	LOGICAL-NODE	Second step, time delayed *
RDIR1	LOGICAL-NODE	Directional element, linked to first step *
RBRF	LOGICAL-NODE	Breaker-failure function *
* Functions not required in the specific application can be disabled, in which case the corresponding logical nodes will not show in the Logical Device Directory.		

A real world excitation system would most likely be built up of a number of smaller logical (and physical) devices. The excitation system as such will then only be a part of the name reference string that identifies the various logical devices that together constitutes the overall function.

6.2 Logical nodes for sensors, transmitters, supervising and monitoring functions

This group of logical nodes are divided in two groups. Sensors and transmitters are listed within logical node group T. These devices will output a single sampled analogue value at a given sampling rate. Supervising and monitoring functions are grouped under S, these functions may convert the sampled values to measured values and perform checks against limits. Figure 8 shows the concept of how different data classes are used.

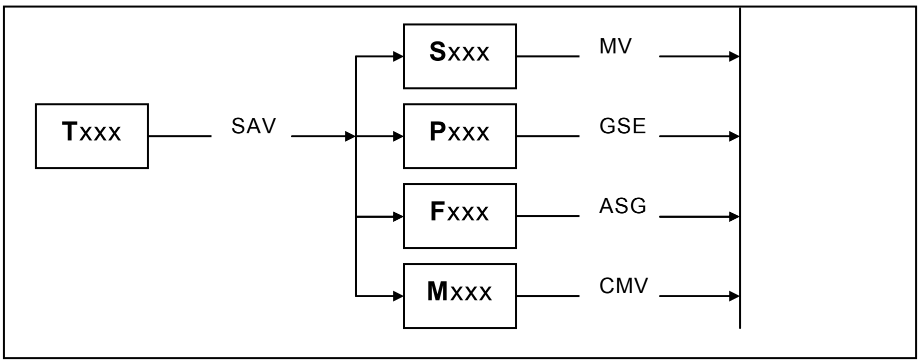


Figure 8 – Conceptual use of transmitters

6.3 Address strings

The utility is expected to provide the address, from top level and down to the Logical Device level. The naming conventions and format shall be as specified in IEC 61850-7-2, Clause 19.

The allowed format is basically as shown in Figure 9.

LD Name	LN Name			Data Name	Data Attribute Name
	LN Prefix	LN Class	LN Instance no		

IEC 1348/07

Figure 9 – Logical Device Name

The Logical Device name (**LDName**) may consist of up to 32 alphanumeric characters.

The Logical Node name (**LNName**) may consist of up to 11 alphanumeric characters, arranged as follows:

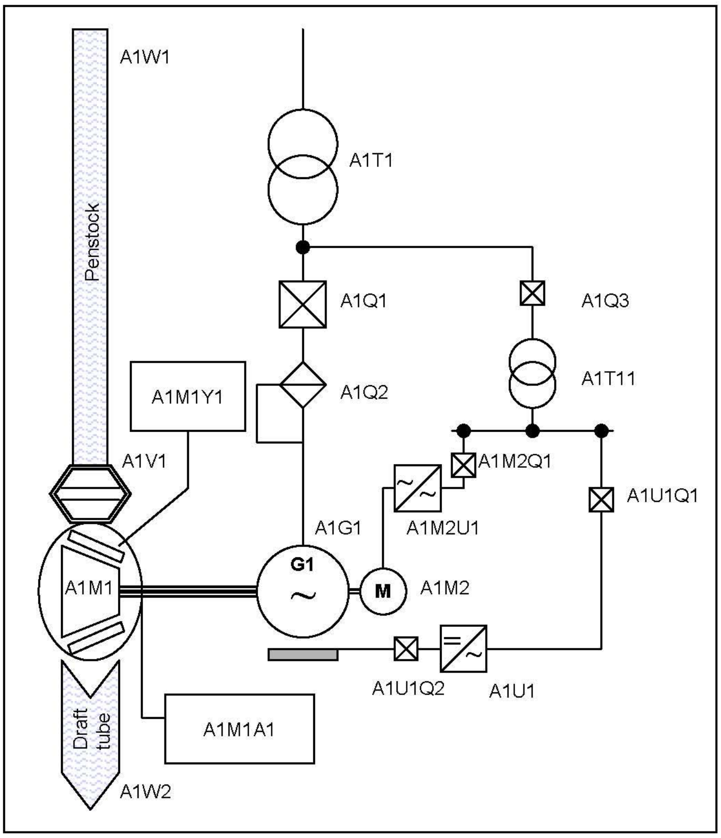
Logical Node prefix: m characters

Logical Node Class name: 4 characters (e.g. as specified in IEC 61850-7-4)

Logical Node instance number: n numeric characters

m + n may be up to 7 characters

A Data Name (DataName) may consist of 10 characters (e.g. as specified in IEC 61850-7-4). Figure 10 shows an example of possible LD name strings, using IEC 61346-1.



IEC 1349/07

A1	Generating unit 1
A1G1	Generator 1
A1M1	Turbine
A1M1Y1	Turbine governor
A1M1A1	Compressed air system for turbine chamber
A1M2	Start motor (pony motor)
A1M2U1	Motor start system
A1M2Q1	Start motor supply circuit-breaker
A1T1	Generator transformer
A1T11	Local services transformer
A1Q1	Generator circuit-breaker
A1Q2	Phase-shift switch
A1Q3	Local services switch
A1U1	Excitation system
A1U1Q1	Excitation supply switch
A1U1Q2	Field circuit-breaker
A1V1	Ball valve

Figure 10 – Example of naming structure, in a pumped storage plant, based on IEC 61346-1

6.4 Naming of logical nodes

Logical Nodes are grouped together with nodes of similar or related functions having the same first letter. The following letters are at present assigned to such groups of functions:

A Automatic control functions

C Control functions

D Functions specific to distributed energy resources (DER)

F Logical nodes representing functional blocks

G Generic references

H Functions specific to hydropower plants

I Interface and archiving functions

K Kinetic energy, mechanical devices and equipment

L Physical devices and common logical nodes

M Metering and measurement

P Electrical protections

R Protection related functions

S Supervision and monitoring

T Sensors and transmitters (including instrument transformers)

W Functions specific to wind power plants

X Switchgear

Y Power transformers

Z Power system equipment

6.5 Recommended naming structure for automatic control functions

In substations, the logical nodes representing functions are named after the purpose of the functions. In most cases, the algorithms used are hidden from the user and there is little point in indicating the type of algorithm of the function.

The design of control functions in power plants is, however, different. Most control structures are assembled from generic control blocks. The logical nodes for automatic control functions included in this document are named on a principle based on the algorithm used within the function, for example PID regulator, ramping control etc.

In order to indicate which logical nodes are used in the same overall control function, or what type of equipment is being controlled, prefixes can be used in a formalised manner. This is recommended for situations where one logical device might include more than one group of control functions. For example, a turbine governor control that includes both frequency and active power control functions, functions for correlating guide vane and runner blade settings as well as position control of operated devices.

As an example, a runner blade control function within the turbine governor, based on a PID regulator algorithm, may be identified as Rb_FPID. If there is more than one logical node of the same type, the instances shall be differentiated by suffix numbers.

Recommended logical node prefixes are listed in Table 2 below:

Table 2 – recommended LN prefixes

Name/description of function	Recommended LN prefix
Active power	W_
Actuator	Act_
Current	A_
Deflector	Dfl_
Droop	Drp_
Flow	Flw_
Frequency	Hz_
Guide vane	Gv_
Level	Lvl_
Limiter	Lim_
Needle	Ndl_
Position	Pos_
Power factor	Pf_
Pressure	Pa_
Reactive power	VAr_
Runner blade	Rb_
Speed	Spd_
Temperature	Tmp_
Voltage	V_

The prefixes in Table 2 are only recommendations, the user may decide on another method to identify the purpose of logical nodes for control functions. If a more specific definition is required, for example if a flow control function is intended for water flow or oil flow, this should be identified by the logical device namestring.

6.6 Summary of logical nodes to be used in hydropower plants

6.6.1 General

This part of IEC 61850 specifies the compatible Logical Node classes to be used in hydropower plants listed in the following Tables 3 to 16. Logical Node names shown in bold are the LN classes defined in this document. Logical Node names shown in plain text are defined in IEC 61850-7-4:2003, they are included in this list for easier reference.

6.6.2 Group C – Control functions

Table 3 – Logical nodes for control functions

LN Class	Description
CALH	Alarm handling. See IEC 61850-5 for a description of this LN.
CSWI	Switch controller. See IEC 61850-5 for a description of this LN.

6.6.3 Group F – Functional blocks

Table 4 – Logical nodes representing functional blocks

LN Class	Description
FCNT	**Counter function**. This LN represents a generic counter. It can be a separate physical device or be embedded in a more complex logical device. It basically counts incoming pulses that might represent anything that can be counted.
FCSD	**Curve shape description**. A logical node to hold a curve shape description used for correlation between measured values and metered values.
FFIL	**Filter function.** Basic filter function to modify a measured value.
FLIM	**Limiter function.** The function is used to set restrictions to output signals of other control functions.
FPID	**Proportional, integral and derivative regulator function.** Basic regulator function used in most controllers.
FRMP	**Ramp control function.** Ramp function to be used to modify e.g. a set-point value.
FSPT	**Setpoint control function.** Basic function used to modify inputs to regulators or other control functions.
FXOT	**Action at over threshold.** This logical node represents a function acting when the measured value increases above a given set value. It can typically be used whenever a protection, control or alarm function is based on other physical measurements than primary electric data.
FXUT	**Action at under threshold.** This logical node represents a function acting when the measured value decreases below a given set value. It can typically be used whenever a protection, control or alarm function is based on other physical measurements than primary electric data.

6.6.4 Group H – Hydropower specific logical nodes

Table 5 – 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.
HDLS	**Dam leakage supervision**. Represents a device that will supervise and give alarm in the case of dam leakage. The actual measurement can be based on water flow.
HGPI	**Gate position indicator**. A device that provides the position of a dam gate. The position is given either as an angular displacement in the case of sector gates or as distance from fully closed position in the 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.

Table 5 *(continued)*

LN Class	Description
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 to control a gate is to send a position set-point.
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	**Dam 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 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 the case of a risk for overflow. The protection will sometimes include its own water measurement device; hence an optional measured value for water level. Whether the protection shall trip a unit or not depends on the layout of the plant, if there is a risk of flooding if the dam overflows.
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.
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.
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 the case of a plant with a joint control function, the HJCL LN will provide the flow set-point to be used by HWCL.

6.6.5 Group I – Interface and archiving

Table 6 – Logical nodes for interface and archiving

LN Class	Description
IARC	Generic archiving function. See IEC 61850-5 for a description of this LN.
IHMI	Generic human – machine interface. See IEC 61850-5 for a description of this LN.
ISAF	Generic safety device. This logical node represents an alarm push-button or other device that will provide an alarm in the case of danger to persons or property.

6.6.6 Group K – Mechanical and non-electrical primary equipment

Table 7 – Logical nodes for mechanical and non-electric primary equipment

LN Class	Description
KFAN	**Fan.** The LN represents the physical device of a fan.
KFIL	**Filter.** The LN represents a filter for air, liquid or other media.
KPMP	**Pump.** The LN represents the physical device of a pump for gaseous or liquid media.
KTNK	**Tank**. This LN represents tanks of various types used in the plant, e.g. for water, hydraulic oil or pressurised air. It can be used for tanks that are pressurised.
KVLV	**Valve or aperture gate**. A valve or gate that can be operated between two end positions that can be given as a percentage of full open position. It would normally be assumed that the measured flow can be calculated directly based on the percent of opening.

6.6.7 Group L – Physical devices and common logical nodes

Table 8 – Logical nodes for physical devices and common LN

LN Class	Description
LLN0	Logical Node zero. Shall always be present in a logical device. See IEC 61850-7-4 for a description of this LN.
LPHD	Physical device information. Shall always be present in a physical device. See IEC 61850-7-4 for a description of this LN.

6.6.8 Group M – Metering and measurement

Table 9 – Logical nodes for metering and measurement

LN Class	Description
MDIF	Differential current measurement. See IEC 61850-5 for a description of this LN.
MENV	**Environmental data**. This LN is used to present various measurements of environmental data, outside what is provided by MHYD and MMET.
MHAI	Harmonics measurement. See IEC 61850-5 for a description of this LN.
MHYD	**Hydrological measurement.** This LN is used for measurements of hydrological data that is used to supply water level and flow data to various systems such as the power plant controller or to other agencies.
MMDC	**DC current and voltage measurement**. This LN is used for measurements in DC systems. It provides current (I), voltage (V), active power (P) and resistance (Ω). Since most DC systems in power plants are not connected to earth, the measurements of voltage and resistance is optionally provided between poles as well between each pole and earth.
MMET	**Meteorological measurement.** This LN is used for measurements of meteorological data elements that contribute to predict level and flow fluctuations in the river system.
MMXN	Single-phase measurement. See IEC 61850-5 for a description of this LN.
MMXU	Three-phase measurement. See IEC 61850-5 for a description of this LN.

6.6.9 Group P – Protection functions

NOTE Most of the logical nodes that represent protective functions are defined in the substation part of the IEC 61850 series.

Table 10 – Logical nodes for protections

LN Class	Description
PDIF	Generator differential, restricted earth-fault. See IEC 61850-5 for a description of this LN.
PDOP	Reverse power. See IEC 61850-5 for a description of this LN.
PDUP	Loss of field (excitation system failure). See IEC 61850-5 for a description of this LN.
PHIZ	Residual over-voltage. See IEC 61850-5 for a description of this LN.
PIOC	Phase over-current. See IEC 61850-5 for a description of this LN.
PPAM	Phase angle, out-of-step. See IEC 61850-5 for a description of this LN.
PRTR	**Rotor protection**. Field short-circuit protection using the 6th harmonic (300Hz).
PSDE	Directional earth-fault. See IEC 61850-5 for a description of this LN.
PTHF	**Thyristor failure protection**. Will provide alarm and tripping in the case of one or more thyristors fails.
PTOC	Time over-current, rotor earth-fault, bearing current, stator earth-fault.
PTOF	Over-frequency. See IEC 61850-5 for a description of this LN.
PTOV	Over-/under-voltage. See IEC 61850-5 for a description of this LN.
PTUF	Under-frequency. See IEC 61850-5 for a description of this LN.
PTTR	Overload. See IEC 61850-5 for a description of this LN.
PVOC	Under impedance. See IEC 61850-5 for a description of this LN.
PVPH	Over-fluxing. See IEC 61850-5 for a description of this LN.
PZSU	Energising at stand-still. See IEC 61850-5 for a description of this LN.

6.6.10 Group R – Protection related functions

Table 11 – Logical nodes for protection related functions

LN Class	Description
RBRF	Breaker-fail protection. See IEC 61850-5 for a description of this LN.
RPSB	Power swing detection. See IEC 61850-5 for a description of this LN.
RSYN	**Synchronizing**. Replacement specification of the LN of IEC 61850-7-4:2003. The existing specification in IEC 61850-7-4:2003 is incorrect for use in power generation.

6.6.11 Group S – Supervision and monitoring

Table 12 – Logical nodes for supervision and monitoring

LN Class	Description
SPDC	Partial discharge sensor. See IEC 61850-5 for a description of this LN.
STMP	**Temperature supervision**. This logical node represents a generic temperature supervision system that can provide alarm and trip signals. In an application, the LN shall be instantiated with one instance per temperature being measured.
SVBR	**Vibration supervision**. This logical node represents a generic vibration supervision system that can provide alarm and trip signals. In an application, the LN shall be instantiated with one instance per point being measured. The LN can be used to supervise either vibration or axial displacement or both values.

6.6.12 Group T – Transducers and instrument transformers

Table 13 – Logical nodes for sensors

LN Class	Description
TANG	**Angle**. This sensor LN returns the angle between two objects (° or rad).
TAXD	**Axial displacement**. A sensor that returns the axial displacement of a rotating shaft (mm).
TCTR	Current transformer. See IEC 61850-5 for a description of this LN.
TDIS	**Distance**. This sensor LN provides the distance between two objects (m).
TFLW	**Liquid flow**. A sensor LN that provides a flow rate value (m^3/s).
TFRQ	**Frequency**. This sensor LN provides a frequency value, measuring a non-electric quantity (Hz).
THUM	**Humidity**. A sensor LN that measures the water content in a media (%).
TLEV	**Media level**. A sensor LN that provides a level value, given as percentage of maximum content of the device being measured.
TMGF	**Magnetic field**. A sensor LN that provides a magnetic field value (T) measured at the place where the sensor is located.
TPOS	**Position indicator**. A sensor LN that provides the position of a mechanical device. The position is given as a percentage of full movement.
TPRS	**Pressure**. A sensor LN that provides a media pressure value (Pa)
TRTN	**Rotation**. A sensor LN that provides a value for rotational speed (r/s)
TSND	**Sound pressure**. This sensor LN returns a sound pressure value (dB)
TTMP	**Temperature**. A sensor LN that provides a temperature value (K)
TTNS	**Mechanical tension/stress**. A sensor LN that provides a value for mechanical tension (Pa)
TVBR	**Vibration sensor**. A sensor LN that provides a vibration value (mm/s).
TVTR	Voltage transformer. See IEC 61850-5 for a description of this LN.
TWPH	**Water acidity**. A sensor LN that returns the water pH level

6.6.13 Group X – Switchgear

Table 14 – Logical nodes for switchgear

LN Class	Description
XCBR	Circuit-breaker. See IEC 61850-5 for a description of this LN.
XSWI	Switch, disconnector, earth-switch. See IEC 61850-5 for a description of this LN.

6.6.14 Group Y – Power transformers

Table 15 – Logical nodes for power transformers

LN Class	Description
YPSH	Power shunt. See IEC 61850-5 for a description of this LN.
YPTR	Power transformer. See IEC 61850-5 for a description of this LN.

6.6.15 Group Z – Power system equipment

Table 16 – Logical nodes for power system equipment

LN Class	Description
ZAXN	Auxiliary network (power plant supply). See IEC 61850-5 for a description of this LN.
ZBAT	DC battery. See IEC 61850-5 for a description of this LN.
ZMOT	Motor. See IEC 61850-5 for a description of this LN.
ZREA	Reactor. See IEC 61850-5 for a description of this LN.
ZRES	**Neutral resistor**. This LN is basically a repository for the name-plate data of the neutral resistor; the resistor will normally not have any controllable functionality. A built-in switch shall be referenced by its own XSWI logical node.
ZSCR	**Semi-conductor controlled rectifier**. In this part of IEC 61850 used for example, to represent the rectifier within an excitation system.
ZSMC	**Synchronous machine.** LN to represent additional rating data of a synchronous machine.

7 Logical Node Classes

7.1 Abbreviations and definitions used in Logical Node tables

7.1.1 Interpretation of Logical Node tables

NOTE The following text is an extract from IEC 61850-7-4, repeated here for quick reference. See also IEC 61850-7-4:2003, subclause 5.2.

The interpretation of the headings for the logical node tables is presented in Table 17.

Table 17 – Interpretation of Logical Node tables

Column heading	Description
Attribute Name	**Name of the Data**
Attr. Type	Common Data Class that defines the structure of the data. 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. NOTE 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 Attribute Names (Data Names) are listed alphabetically in Clause 8. Despite some overlapping, the data in the Logical Nodes Classes are grouped for the convenience of the reader into some of the following categories.

a) 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.

b) 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.

c) 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.

d) 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.

e) 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 often than Settings.

f) Metered values

are analogue data representing quantities measured over time, for example energy. This information is produced locally and cannot be changed remotely unless substitution is applicable.

7.1.2 Abbreviated terms used in Attribute Names

The following terms are used to build concatenated Attribute Names. The list below only includes abbreviations for terms that are defined in this part of IEC 61850. For further abbreviations, see also IEC 61850-7-4 for terms that are reused in this part of IEC 61850.

Term	Description
Act	Action, active
Adj	Adjustment
Alg	Algorithm
Amb	Ambient
Ax	Axial
Brg	Bearing
Brk	Brake
C	Carbon
Cam	Cam
Cff	Coefficient
Cm	Centimeters
Cmpl	Completed, completion, complete
Cndct	Conductivity
CO	Carbon monoxide
CO2	Carbon dioxide
Credit	Credit
Crl	Correlation
Crp	Creeping, creepage
Cst	Constant
Cvr	Cover
D	Derivative
Dam	Dam
Defl	Deflector (used in Pelton turbines)
Dew	Dew, condensation
Dgr	Degrees
Dl	Delay, daylight
Dn	Down, below, downstream, downside
Insol	Insolation
K	Proportional gain constant
Lft	Left
Lkg	Leakage
Lub	Lubrication
Mag	Magnetic, magnetism
Msg	Message
Mvm	Moving, movement
Ndl	Needle (used in Pelton turbines)
NOX	Nitrogen oxides
O2	Oxygen
O3	Ozone
Operate	Operate order to a device
P	Proportional
Pc	Percent
PH	Acidity
Pt	Point
Rad	Radiation, radiants
Rb	Runner blade
Rect	Rectifier
Res	Reservoir
Rmp	Ramp
Rn	Rain
Rst	Restraint
Sat	Saturation
Slnt	Salinity, saline content
Snd	Sound, audible noise

Term	Description	Term	Description
Dsp	Displacement	Snw	Snow
Dust	Dust, particles suspended in air	SOX	Sulphur oxides
Dvc	Device	Spt	Process set-point
Err	Error	Srfc	Surface
Fil	Filter	Stat	Stator (also statistics)
Fld	Field (e.g. magnetic field)	Stl	Still, not moving
Fll	Fall	Stnd	Stand, standing
Flush	Flush, flushing	Stuck	Cannot move
Green	Green (e.g. green tag)	Tnk	Tank
Gte	Gate, dam gate	Tns	Tension, mechanical stress
Gust	Gust, (e.g. wind gust)	Trade	Trade
Hd	Head	Up	Up, above, upstream, upside
Hmdt	Humidity	Vbr	Vibration
Hor	Horizontal	Ver	Vertical
Hyd	Hydrological, hydro, water	Vlm	Volume
I	Integral	Wd	Wind
Inert	Inertia	Wet	Wet

7.2 Logical Nodes representing functional blocks — LN group F

7.2.1 Modelling remarks

This group of logical nodes represents various types of control function blocks. Logical Node classes of this type do include some form of control algorithm. The LN's will normally be part of a logical device providing overall functionality within the system.

NOTE Logical Nodes specified in 7.2 will be included the future Edition 2 of IEC 61850-7-4. When published, Logical Nodes specified IEC 61850-7-4 (future Edition 2) will take precedence over Logical Nodes in 7.2.

7.2.2 LN: Counter — Name: FCNT

Logical Node FCNT shall be used to count incoming pulses.

FCNT class				
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
EEHealth	INS	External equipment health		O
EEName	DPL	External equipment nameplate		O
Loc	SPS	Local operation		M
Status information				
Up	STS	Last count direction upward		O
Dn	STS	Last count direction downward		O
Measured values				
Out	BCR	Output value		M
Controls				
Blk	SPC	Block operation		O
CntRs	SPC	The counter is reset to 0		O

7.2.3 LN: Curve shape description — Name: FCSD

Logical Node FCSD shall comprise the data classes that represent the curve shaping output positions. The values can be dynamically modified online. The values entered in the table are based on statistical data obtained following a series of index tests.

The Logical Node is used to adapt an incoming value to a specified curve function. For example, it can be used 2-dimensionally to adjust nonlinear transmitters to the correct physical values or, by instantiation, used for 3-dimensional surface mapping.

FCSD class				
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
Measured Values				
Out	MV	Output		M
Settings				
Crv	CSD	Curve shape		M
Controls				
Blk	SPC	Block operation		O

7.2.4 LN: Generic Filter Name: FFIL

Logical Node FFIL shall be used to filter an incoming value. For a more detailed description of the functionality behind FFIL, see Annex A.

FFIL class				
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
Settings				
FilTyp	ING	Filter type: | Low pass | High pass | Bandpass | Bandstop (notch) |		
Kp	ASG	Proportional Gain		M
Kld	ASG	K lead		O
Klg	ASG	K lag		O
T1	INT	Time 1 [ms]		O
T1ld	INT	Time 1 (lead) [ms]		O
T2	INT	Time 2 [ms]		O
T2ld	INT	Time 2 (lead) [ms]		O
T3	INT	Time 3 [ms]		O
Measured values				
Out	MV	Output		M
ErrTerm	MV	Error term		O
Control				
Blk	SPC	Block operation		O

7.2.5 LN: Control function output limitation Name: FLIM

This logical node is used to set temporary or permanent operational limits to an output signal (MV) from a control function. The FLIM Logical Node should not be used to replace FXOT or FXUT.

FLIM class				
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
Status information				
HiLim	SPS	High limit reached (input signal equal to or above limit)		O
LoLim	SPS	Low limit reached (input signal equal to or below limit)		O
Measured values				
Out	MV	Output signal		M
Settings				
HiLimSpt	ASG	High limit setpoint		M
LoLimSpt	ASG	Minimum limit setpoint		O
Controls				
Blk	SPC	Block operation		O

7.2.6 LN: PID regulator Name: FPID

Logical Node FPID shall comprise the data classes that represent proportional, integral and derivative information for a PID controller. For a more detailed description of the functionality behind FPID, see Annex A.

FPID class				
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
Measured Values				
Out	MV	PID output		M
PAct	MV	Proportional action		C
IAct	MV	Integral action		C
DAct	MV	Derivative action		C
P	MV	P output		O
I	MV	I output		O
D	MV	D output		O
ErrTerm	MV	Error term		O
Settings				
PidAlg	ING	P|I|D|PI|PD|ID|PID|		M
Kp	ASG	Proportional gain		C
Ki	ASG	Integral Gain		C
Ti	ING	Integral time (ms)		C
Kd	ASG	Derivative gain		C
Td	ING	Derivative time (ms)		C
Tf	ING	Derivative time filter (ms)		C
Bias	ASG	Bias added to Process variable		O
Controls				
Blk	SPC	Block operation		O

The conditional attributes shown in the first column of Table 18 shall be linked with the corresponding PID algorithm selected.

Table 18 – Conditional attributes in FPID

	PidAlg (M-Mandatory, Blank-Not Used)						
Attribute Name	P	I	D	PI	PD	ID	PID
PAct	M			M	M		M
IAct		M		M		M	M
DAct			M		M	M	M
Kp	M			M	M		M
Ki		M		M		M	M
Ti		M		M		M	M
Kd			M		M	M	M
Td			M		M	M	M
Tf			M		M	M	M

7.2.7 LN: Ramp function Name: FRMP

Logical Node FRMP shall be used as a generic ramp. The LN is required due to the fact the data attributes of the ASG common data class does not contain all of the information required to achieved a full ramping function with divergent up and down trends.

FRMP class				
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
Measured Values				
Out	MV	Ramp Output		M
ErrTerm	MV	Error term		O
Status information				
AdjMsg	INS	Adjustment Message 0 Completed 1 Cancelled 2 New adjustments 3 Under way		O
Settings				
RmpUp	ASG	Ramping rate on a upward trend		M
RmpDn	ASG	Ramping rate on a downward trend		M
StepPs	ASG	Step size when turning from negative to positive direction		O
StepNg	ASG	Step size when turning from positive to negative direction		O
Controls				
Blk	SPC	Block operation		O

7.2.8 LN: Set-point control function Name: FSPT

Logical Node FSPT shall be used to provide the common characteristics found in all controller or regulator type Logical Nodes. The LN can be standalone or cascaded with other logical nodes to forma a complete controller.

FSPT class				
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
Controls				
SptR	SPC	Setpoint raise		O
SptL	SPC	Setpoint lower		O
Measured Values				
SptMem	MV	Setpoint in memory		M
ErrTerm	MV	Error term		O
Output	MV	Output		O
Status Information				
Auto	SPS	Automatic operation		O
SptDvAlm	SPS	Deviation alarm		O
SptUp	SPS	Setpoint going up (raising)		O
SptDn	SPS	Setpoint going up (Lowering)		O
SptDir	SPS	Setpoint direction		O
SptMsg	INS	End Message: 0 Ended normally 1 Ended with overshoot 2 Cancelled: measurement was deviating 3 Cancelled: loss of communication with dispatch centre 4 Cancelled: loss of communication with local area network 5 Cancelled: loss of communication with the local interface 6 Cancelled: timeout 7 Cancelled: voluntarily 8 Cancelled: noisy environments 9 Cancelled: material failure A Cancelled: new set-point request B Cancelled: improper environment (blockage) C Cancelled: stability time was reached D Cancelled: immobilisation time was reached E Cancelled: equipment was in the wrong mode F Unknown causes		O
AdjMsg	INS	Adjustment Message 0 Completed 1 Cancelled 2 New adjustments 3 Under way		O
Settings				
MaxRst	RST	Maximum restriction		O
MinRst	RST	Minimum restriction		O
DvAlm	ASG	Deviation Alarm		O
SptVal	APC	Setpoint		O
DeadB	ASG	Deadband		O
Controls				
Blk	SPC	Block operation		O

7.2.9 LN: Action at over threshold Name: FXOT

Logical Node FXOT shall be used to set a high-level threshold value to be used in control sequences. It optionally provides a second level signal that can be used provide a two-step action.

FXOT class				
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
EEHealth	INS	External equipment health		O
EEName	DPL	External equipment nameplate		O
Status information				
Op	SPS	Level of action reached	T	M
OpB	SPS	Second level of action reached	T	O
Settings				
StrVal	ASG	Start level set-point		C
StrValB	ASG	Second level of action setpoint		C
OpDlTmms	ING	Operate delay time [ms]		O
StrCrv	CSD	Start level curve		C
RsDlTmms	ING	Reset operate delay time [ms]		O
Controls				
Blk	SPC	Block operation		O

Condition: Start level shall be given as a singular point or as a curve.

7.2.10 LN: Action at under threshold Name: FXUT

Logical Node FXUT shall be used to set a low-level threshold value to be used in control sequences. It optionally provides a second level signal that can be used provide a two step action.

FXUT class				
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
EEHealth	INS	External equipment health		O
EEName	DPL	External equipment nameplate		O
Status information				
Op	SPS	Level of action reached	T	M
OpB	SPS	Second level of action reached	T	O
Settings				
StrVal	ASG	Start level set-point		C
StrValB	ASG	Second level of action setpoint		O
OpDlTmms	ING	Operate delay time [ms]		O
StrCrv	CRV	Start level curve		C
RsDlTmms	ING	Reset operate delay time [ms]		O
Controls				
Blk	SPC	Block operation		O

Condition: Start level shall be given as a singular point or as a curve.

7.3 Hydropower specific Logical Nodes LN group H

7.3.1 Modelling remarks

This group of Logical Nodes covers functions that are specific to hydropower plants. Some may also be used for utility water supply systems or other types of larger reservoirs.

7.3.2 LN: Turbine – generator shaft bearing Name: HBRG

Logical Node HBRG shall be used to represent the physical device bearing. It can be used to represent both thrust and guide bearings. One instance shall be used per bearing.

HBRG class				
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
EEHealth	INS	External equipment health		O
EEName	DPL	External equipment nameplate		O
OpTmh	INS	Operation time		O
Status information				
BrgTyp	INS	Type of bearing (enumerated list)		M
TmpAlm	SPS	Bearing temperature alarm		M
OilTmpHi	SPS	Lubrication oil temperature alarm		M

7.3.3 LN: Combinator Name: HCOM

Logical Node HCOM shall be used to represent the function that optimises the relation between net head, guide vane and runner blade positions in order to achieve best possible efficiency. It is normally a part of the governor logical device and the functionality is based on one or more 2-D curves. If more than one curve is defined, one instance shall be used per curve.

HCOM class				
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
EEHealth	INS	External equipment health		O
EEName	DPL	External equipment nameplate		O
Loc	SPS	Local operation		O
Status information				
CrlAlm	SPS	Correlation deviation alarm		O
RbPos	APC	Runner blade position setting		M
Settings				
CrvNum	ING	Number of setting curves		O
CrvSize	ING	Number of X/Y pairs in each curve		O
Controls				
Auto	SPC	Automatic or manual control		M
Blk	SPC	Block the function from operation		M

7.3.4 LN: Hydropower dam Name: HDAM

Logical Node HDAM shall be used to represent the dam of a hydropower plant. It is basically used to provide a reference tag for the dam holding basic design information. In case the functional aspect of the dam shall be represented, the Logical Node HRES shall be used, see 7.3.16.

HDAM class				
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
Status information				
DamTyp	INS	Type of dam (construction), enumerated list		O

7.3.5 LN: Dam leakage supervision Name: HDLS

Logical Node HDLS shall be used to represent a leakage supervision system for a dam.

HDLS class				
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
OpCnt	INS	Operation counter		O
Status information				
LkgAlm	SPS	Leakage alarm level reached		M
Settings				
LkgAlmVal	ASG	Alarm level setpoint for leakage		M
Measured values				
Flw	MV	Water flow at point of measurement [m^3/s]		O
Controls				
Blk	SPC	Block the function from operation		O

7.3.6 LN: Gate position indicator Name: HGPI

Logical Node HGPI shall be used to represent a physical device that provides the position of a gate. It shall be used for gates where the full open position (or fully closed position) is dependent on the actual upper water level of the dam. The position is given either as a distance for straight gates or as an angular displacement for sector gates.

HGPI class				
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
EEHealth	INS	External equipment health		O
EEName	DPL	External equipment nameplate		O
Status information				
PosUp	SPS	Upper end position reached		M
PosDn	SPS	Lower end position reached		M
Measured values				
GtePos	MV	Gate position given as angular displacement (1/20° or rad)		C
GtePosCm	MV	Gate position given as distance from full closed (cm)		C

7.3.7 LN: Dam gate Name: HGTE

Logical Node HGTE shall be used to represent a dam gate. It is intended for gates where the full open or full closed position is dependent on the water level of the dam. For gates inserted in a dam in such a way that the upper water level is always above the upper part of the gate, the valve logical node (KVLV) is recommended. For calculation of water flow, a FCSD logical node that holds the relation between water level, opening and flow, should be included in the same logical device.

HGTE class				
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
EEHealth	INS	External equipment health		O
EEName	DPL	External equipment nameplate		O
OpCnt	INS	Operation counter		O
Loc	SPS	Local operation selected		M
Status information				
PosUp	SPS	Upper end position reached (gate cannot move further)		M
PosDn	SPS	Lower end position reached (gate cannot move further)		M
Mvm	SPS	Gate is moving		O
GteBlk	SPS	Gate is blocked (cannot move from present position)		O
Settings				
GteUpLim	ASG	Upper limit of gate position (temporary restriction)		O
GteLoLim	ASG	Lower limit of gate position (temporary restriction)		O
Incr	ASG	Increment of position change for raise/lower commands		O
Measured values				
Flw	MV	Calculated water flow through the gate [m^3/s]		O
Controls				
Opn	SPC	Gate to full open position		O
Cls	SPC	Gate to full closed position		O
PosChg	INC	Change gate position (stop, raise, lower)		C
PosChgIncr	INC	Change gate position incrementally (stop, raise, lower)		C
BlkOpn	SPC	Block opening of the gate		O
BlkCls	SPC	Block closing of the gate		O

7.3.8 LN: Intake gate Name: HITG

Logical Node HITG shall be used to model the intake gates. If operated they will be either raised fully or lowered fully, mid positions are not used during continuous operation. However start sequencers might need to operate the gate at different speeds during different parts of the movement or keep the gate at a certain position for some time, before continuing movement. To cater for this, intake gates are often provided with position switches. In order to not limit the number of switches, the position switches are represented by an integer value (0 representing fully closed, 1 – n indicating steps passed, counting from the closed position).

HITG class				
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
EEHealth	INS	External equipment health		O
EEName	DPL	External equipment nameplate		O
OpCnt	INS	Operation counter		O
Loc	SPS	Local operation selected		M
Status information				
PosStep	INS	Integer representing the position, counting from lowest position		O
PosUp	SPS	Upper end position reached (gate cannot move further)		M
PosDn	SPS	Lower end position reached (gate cannot move further)		M
Mvm	SPS	Gate is moving		O
GteBlk	SPS	Gate is blocked (cannot move from present position)		O
Controls				
Opn	SPC	Gate to full open position		O
Cls	SPC	Gate to full closed position		O
BlkOpn	SPC	Block opening of the gate		O
BlkCls	SPC	Block closing of the gate		O

7.3.9 LN: Joint control Name: HJCL

Logical Node HJCL shall be used when a hydropower plant is operated in a constant water flow or a constant upper water level mode. That is, the power production level is subordinated the water control. The joint control logical node is used to co-ordinate the water flow through the plant, through turbines as well as gates. The joint control function will normally try to optimise the power output for a given flow. It can open or close gates that are not blocked from operation, it can increase or decrease the active power from turbines but it cannot start or stop a unit. The LN shall be instantiated to provide one instance per turbine and gate to be included in the joint control. Compare also with the HWCL logical node, which can be used to control a single object.

HJCL class				
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
EEHealth	INS	External equipment health		O
EEName	DPL	External equipment nameplate		O
Loc	SPS	Local operation		O
Status information				
TotFlwMax	SPS	Total maximum flow reached		O
TotFlwMin	SPS	Total minimum flow reached		O
FlwMax	SPS	Maximum flow through the controlled object (gate or turbine)		O
FlwMin	SPS	Minimum flow through the controlled object		O
FlwLevAlm	SPS	Flow and level control settings in conflict		O
PosChg	BSC	Change position of gate (stop – raise – lower)	T	O
ActPwrR	SPC	Increase active power (open guide vanes)	T	O
ActPwrL	SPC	Decrease active power (close guide vanes)	T	O
Settings				
TotFlwMxLm	ASG	Maximum flow limit (Maximum allowed flow)		O
TotFlwMnLm	ASG	Minimum flow limit (Minimum allowed flow) – can be 0.		O
FlwMaxLim	ASG	Maximum allowed flow through the controlled object		O
FlwMinLim	ASG	Minimum allowed flow through the controlled object		O
Measured values				
Flw	MV	Water flow through the controlled object (gate or turbine)		M
NetHd	MV	Net head (distance between upper and lower water levels)		O
TotFlw	MV	Total water flow through the plant		O
Controls				
HydrCtlMod	INC	The LN to operate in flow control or level control mode		O
FlwSpt	ASG	Total water flow set-point [m^3/s]		O
LevSpt	ASG	Upper water level set-point [m]		O
Blk	SPC	Block operation		O

7.3.10 LN: Leakage supervision Name: HLKG

Logical Node HLKG shall be used to represent a leakage supervision system for any purpose.

HLKG class				
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
EEHealth	INS	External equipment health		O
EEName	DPL	External equipment nameplate		O
OpCnt	INS	Operation counter		O
Status information				
LkgAlm	SPS	Leakage alarm		M
Settings				
LkgAlmVal	ASG	Alarm level for leakage		M
Measured values				
Flw	MV	Measured water (liquid) flow		O

7.3.11 LN: Water level indicator Name: HLVL

Logical Node HLVL shall be used to represent a water level indicator. The principles of measurement might vary, but the level will normally be given with an accuracy of 0,01 m. In order to compare different level measurements above and below the plant, an offset from a base level is added to the local measurement. The water level measurement is a typical example of situation where substitution of the measured value is commonly used, the measurement device is often blocked from operation for example by ice.

For a simple level measurement of for example a tank, where the level can be expressed as a percentage of full tank, the TLVL logical node should be used instead of HLVL.

HLVL class				
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
EEHealth	INS	External equipment health		O
EEName	DPL	External equipment nameplate		O
Status information				
Stuck	SPS	Alarm of measurement device not moving (stuck, frozen)		O
Settings				
LevOfs	ASG	Offset from power plant base level		O
Measured values				
LevM	MV	Water level at the point of measuring (including offset if given)		M

7.3.12 LN: Mechanical brake Name: HMBR

Logical Node HMBR shall be used to represent the physical device brake. The brake is used to stop the rotation of the shaft during power down of the unit.

HMBR class				
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
EEHealth	INS	External equipment health		O
EEName	DPL	External equipment nameplate		O
OpCntRs	INS	Reset-able operation counter		O
Status information				
BrkOn	SPS	Brakes are applied (on)		M
BrkOff	SPS	Brakes are disengaged (off)		M
Controls				
Pos	DPC	Change brake position (on/off)		M

7.3.13 LN: Needle control Name: HNDL

Logical Node HNDL shall be used to represent the control of turbine needles for Pelton type of turbines.

HNDL class				
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
EEHealth	INS	External equipment health		O
EEName	DPL	External equipment nameplate		O
OpCntRs	INS	Operation counter		O
Status information				
AOfsCam	SPS	A-servo Off CAM function is activated		O
Auto	SPS	Regulator in mode. TRUE = auto		O
DeflOpn	SPS	Pelton using ON /OFF deflector control. TRUE = open command active		O
NdlMan	SPS	Manual selection of number of needles is active		O
NdlErr	INS	Servo loop fault, Pelton turbine needle (needle number returned)		O
Settings				
NdlManNum	ING	Manual number of needles, when in manual needle control		O
Controls				
NdlAutSl	SPC	Auto selection of number of active needles, select		O
NdlManSl	SPC	Manual selection of number of active needles, select		O
OfsCamEna	SPC	Enable runner offset using Asp		O
Operate	SPC	Start command.		O
Stop	SPC	Stop command.		O

7.3.14 LN: Water net head data Name: HNHD

Logical Node HNHD shall be used to represent a function that calculates and presents net head data and some related information. The input measured values will, in most cases, be derived from logical nodes of class HLEV.

Separate logical nodes of HNHD class shall be used depending on the purpose of the net head value. The value used for control of a turbine will normally be based on measurements taken inside the intake gate and at the tail-race outlet. If a net head value is to be used for general water control, the measurements are taken at some distance from the power plant, both upstream and downstream.

HNHD class				
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
Status information				
Stuck	SPS	Alarm of measurement device not moving (stuck, frozen)		O
Settings				
LevOfs	ASG	Offset from power plant base level		O
Metered values				
NetHd	MV	Calculated Net head		M
DifPres	MV	Calculated Differential water pressure across trashrack		O

7.3.15 LN: Dam over-topping protection Name: HOTP

Logical Node HOTP shall be used to represent an over-topping protection for the dam. The normal action of the protection, when engaged, is to open one or more gates to full open position. One instance shall be provided for each gate that is to be controlled.

HOTP class				
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
EEHealth	INS	External equipment health		O
EEName	DPL	External equipment nameplate		O
OpCnt	INS	Reset-able operation counter		O
Status information				
OpLev	SPS	Operation level reached	T	M
Settings				
OpSpt	ASG	Operation level set-point		M
RsDlTmm	ING	Reset Operate delay time in minutes		O
Controls				
Blk	SPC	Block the function from operation		O

7.3.16 LN: Hydropower/water reservoir Name: HRES

Logical Node HRSV shall be used to represent the functional aspect of the reservoir in a hydropower plant. Note that the HRES Logical Node does not represent the physical aspect of the dam.

HRES class				
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
Settings				
Area	CSD	Area with respect to elevation		O
VlmCap	CSD	Volume with respect to elevation		O
Measured values				
Vlm	MV	Calculated volumetric content of the dam [m^3]		O

7.3.17 LN: Hydropower unit sequencer Name: HSEQ

Logical Node HSEQ shall be used to represent the unit sequencer. It will be part of the unit controller logical device. The LN will keep track of the unit operating status, i.e. what the generator and turbine is doing at the moment. This LN only represents a minimum of information required; in any actual implementation, the sequencer will have to address a large number of devices.

HSEQ class				
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
EEHealth	INS	External equipment health		O
EEName	DPL	External equipment nameplate		O
OpCntRs	INS	Reset-able operation counter		O
Loc	SPS	Local operation		O
Status information				
SeqStat	INS	Status of the sequencer		M
StepPos	INS	Active step	T	M
StrCmpl	SPS	Start sequence completed (unit synchronised at minimum load)	T	M
StopCmpl	SPS	Stop sequence completed (brakes released, no creeping)	T	M
Controls				
Auto	SPC	Automatic or manual		M
Operate	SPC	Start order to the sequencer		M
Stop	SPC	Stop order to the sequencer		M

7.3.18 LN: Speed monitoring Name: HSPD

Logical Node HSPD shall normally be part of a stand-alone logical device. It acts as a protective backup of the governor frequency control and also as a placeholder for various speed limits and set-points used by the start sequencer and other functions.

HSPD class				
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
EEHealth	INS	External equipment health		O
EEName	DPL	External equipment nameplate		O
Loc	SPS	Local operation		O
Status information				
StndStl	SPS	Stand still detection		O
SpdCrp	SPS	Creep detection		O
SpdBrk	SPS	Brake operation allowed		O
SpdLub	SPS	Set-point for operation of lubrication system		O
SpdLft	SPS	Set-point for operation of lift pump (high pressure oil system)		O
SpdRB	SPS	Set-point for setting of start angle for rotor blades		O
SpdExt	SPS	Set-point for operation of excitation system breaker		O
SpdSyn	SPS	Set-point for synchronising		O
SpdOvr	SPS	Over-speed detection and alarm		O
DirRot	SPS	Direction of rotation		O
Settings				
SetSpdCrp	ASG	Creep detection setting		O
SetSpdBrk	ASG	Braking allowed setting		O
SetSpdLub	ASG	Lubrication system operation setting		O
SetSpdLft	ASG	Lift pump operation setting		O
SetSpdRb	ASG	Start angle setting settting		O
SetSpdExt	ASG	Excitation breaker operation setting		O
SetSpdSyn	ASG	Synchronisation setting		O
SetSpdOv	ASG	Over-speed detection setting		O
Measured values				
Spd	MV	Rotational speed of the shaft [r/s]		M
Controls				
Blk	SPC	Block the function from operation		O

7.3.19 LN: Hydropower unit Name: HUNT

Logical Node HUNT shall be used to represent the physical device of a hydropower production unit, that is, a generator and turbine combination. It can be seen as an extended name-plate, which allows temporary settings of data. The logical node holds information about the present operational status of the unit.

HUNT class				
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
EEHealth	INS	External equipment health		O
EEName	DPL	External equipment nameplate		O
Inert	INS	Inertia of the unit [kgm^2]		O
OpTmh	INS	Operation time		O
Status information				
UntOpSt	INS	Status of the unit 1 = Blocked from operation (disabled) 2 = Stopped (needs control sequence to start) 3 = Starting (start-up in progress) 4 = Generator energised 5 = Synchronised, normal operation 6 = Stopping (shut-down in progress) 7 = Creeping (slow movement) 8 = Standby (stopped but ready for start)		M
UntOpMod	INS	Operating mode of the unit 1 = Generating mode 2 = Synchronous condenser mode 3 = Pumping mode (for pumped storage)		M
GridMod	INS	Grid mode e.g. the actual grid the unit meets when CB synchronises to the grid. 1 = Normal condition (normal frequency and voltage level) 2 = Island (varying frequency and/or voltage level) 3 = Local supply		O
GridOpSt	INS	Grid operational status, i.e. if there is a disturbance or not 1 = Normal conditions (no distrurbance) 2 = Disturbed (abnormal frequency and/or voltage level) 3 = PSS control		O
StopVlv	SPS	Stop valve position		M
Settings				
PwrRtgLim	ASG	Temporary limitation of power output		O
VRtgLim	ASG	Temporary limitation of operating voltage		
FlwRtg	ASG	Rated maximum water flow		O
SpdLim	ASG	Maximum allowed rotational speed		O
Controls				
Blk	SPC	Block the unit from operation		O

7.3.20 LN: Water control Name: HWCL

Logical Node HWCL shall be used to represent the control of one physical device, dam gate or turbine, which can modify the water flow through the plant. Compare also with the LN for joint control (HJCL) that can be used for combined control.

HWCL class				
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
EEHealth	INS	External equipment health		M
EEName	DPL	External equipment nameplate		O
Loc	SPS	Local operation		O
Status information				
Auto	SPS	Automatic control selected		M
FlwMax	SPS	Maximum flow reached		O
FlwMin	SPS	Minimum flow reached		O
HiLev	SPS	Upper water (dam) high level alarm		O
LoLev	SPS	Upper water (dam) low level alarm		O
HiLevDn	SPS	Lower water (tailrace) high level alarm		O
LoLevDn	SPS	Lower water (tailrace) low level alarm		O
FlwLevAlm	SPS	Flow and level control settings in conflict		O
PosChg	BSC	Change position of gate (stop – raise – lower)	T	C
ActPwrR	SPC	Increase active power (open guide vanes)	T	C
ActPwrL	SPC	Decrease active power (close guide vanes)	T	C
Settings				
FlwMaxLim	ASG	Maximum flow set-point		O
FlwMinLim	ASG	Minimum flow set-point		O
LevHiSet	ASG	Upper water (dam) high level alarm set-point		O
LevLoSet	ASG	Upper water (dam) low level alarm set-point		O
LevDnHiSt	ASG	Lower water (tailrace) high level alarm set-point		O
LevDnLoSt	ASG	Lower water (tailrace) low level alarm set-point		O
Measured values				
Flw	MV	Calculated water flow through the controlled object (m^3/s)		M
Controls				
HydCtlMod	DPC	The LN to operate in flow control or level control mode		M
FlwSet	APC	Water flow set-point (m^3/s)		C
LevSet	APC	Upper water level set-point (m)		C

NOTE The Logical Node will control either a gate (gate position) or a turbine (guide vane position).

7.4 Logical Nodes for interface and archiving LN group I

7.4.1 Modelling remarks

This group of Logical Nodes represents human interfaces and other generic interfaces towards external entities. IEC 61850-7-4 defines some LN for this purpose (IARC, IHMI, ITCI and ITMI). This document defines one LN for general safety alarm interfaces.

NOTE Logical Nodes specified in 7.4 will be included in Edition 2 of IEC 61850-7-4. When published, Logical Nodes specified IEC 61850-7-4 (Edition 2) shall take precedence over Logical Nodes in 7.4.

7.4.2 LN: Safety alarm function Name: ISAF

Logical Node ISAF shall be used to represent an alarm push-button or any other device that is used to provide an alarm in the case of danger to persons or property

ISAF class				
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
Status information				
Alm	SPS	Safety alarm (1=On, 0=Off)	T	M
Controls				
AlmRs	SPC	Alarm signal reset		O

7.5 Logical Nodes for mechanical and non-electric primary equipment LN group K

7.5.1 Modelling remarks

This group of logical nodes represents various devices that can be supervised, controlled or operated but that are not primarily of electrical nature. This group includes devices like tanks, valves, fans etc.

NOTE Logical Nodes specified in 7.5 will be included the future Edition 2 of IEC 61850-7-4. When published, Logical Nodes specified IEC 61850-7-4 (future Edition 2) will l take precedence over Logical Nodes in 7.5.

7.5.2 LN: Fan Name: KFAN

Logical Node KFAN shall be used to represent a fan. It can be seen as an extended nameplate that allows the temporary setting of data.

KFAN class				
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
EEHealth	INS	External equipment health		O
EEName	DPL	External equipment nameplate		O
OpTmh	INS	Operation time		O
Status information				
ACAlm	SPS	AC supply failure (fuse or other problem)		O
MotPro	SPS	Motor protection tripped		O
Blocked	SPS	The fan is blocked from operation		O
Settings				
MinOpTmm	ING	Minimum operation time in minutes		O
MaxOpTmm	ING	Maximum operation time in minutes		O
Measured values				
Spd	MV	Rotational speed of the fan		O
Controls				
Operate	DPC	Operate fan		M
SpdSpt	APC	Speed set-point (in the case of speed regulated motor)		O

7.5.3 LN: Filter Name: KFIL

Logical Node KFIL shall be used to represent a (mechanical) filter. It can be seen as an extended nameplate that allows the temporary setting of data.

KFIL class				
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
EEHealth	INS	External equipment health		O
EEName	DPL	External equipment nameplate		O
OpTmh	INS	Operation time		O
Status information				
ACAlm	SPS	AC supply failure (fuse or other problem)		O
MotPro	SPS	Motor protection tripped		O
Flush	SPS	Filter flushing		O
FlushCnt	INC	Filter flushing counter (reset-able)		O
FilAlm	SPS	Filter alarm		O
Settings				
DifPresHi	ASG	Alarm level set-point		O
Measured values				
DifPresHi	MV	Differential pressure over the filter		O
Controls				
Operate	DPC	Operate filter		O

7.5.4 LN: Pump Name: KPMP

Logical Node KPMP shall be used to represent a pump. It can be seen as an extended nameplate that allows the temporary setting of data.

KPMP class				
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
EEHealth	INS	External equipment health		O
EEName	DPL	External equipment nameplate		O
OpTmh	INS	Operation time		O
Status information				
ACAlm	SPS	AC supply failure (fuse or other problem)		O
MotPro	SPS	Motor protection tripped		O
BlkSt	SPS	The pump is blocked from operation		O
Settings				
MinOpTmm	ING	Minimum operation time in minutes		O
MaxOpTmm	ING	Maximum operation time in minutes		O
Measured values				
Spd	MV	Rotational speed of the pump		O
Controls				
Operate	DPC	Operate pump		M
SpdSpt	APC	Speed set-point (in the case of speed regulated motor)		O

7.5.5 LN: Tank Name: KTNK

Logical Node KTNK shall be used to represent the physical device of a tank, such as a hydraulic oil tank. The tank can be pressurised or not. If used to represent a tank for pressurised gas, only the pressure MV will be used. If used for an oil sump, only the level MV will be used. For a simple level sensor, the SLVL logical node can be used instead.

KTNK class				
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
EEHealth	INS	External equipment health		O
EEName	DPL	External equipment nameplate		O
Loc	SPS	Local operation		O
Status information				
TnkTyp	INS	Type of tank (pressure only, level only, both pressure and level)		M
Settings				
VlmCap	AsG	Total volume capacity		O
Measured values				
Pres	MV	Pressure in the tank		O
LevPc	MV	Level in the tank (as percentage of full tank level)		O
Vlm	MV	Volume of media in tank		O
Tmp	MV	Temperature of the media in the tank		O

7.5.6 LN: Valve control Name: KVLV

Logical Node KVLV shall be used torepresent a valve or gate where the position can be given as a percentage of full open position (optionally the angle (0 to 90) ° may be used). In the case of dam gates where either open or closed position depends on the water level of the dam, the HGTE LN should be used.

KVLV class				
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
EEHealth	INS	External equipment health		O
EEName	DPL	External equipment nameplate		O
OpCnt	INS	Operation counter		O
Loc	SPS	Local operation selected		M
Status information				
ClsPos	SPS	Closed end position reached (valve cannot move further)		C[1]
OpnPos	SPS	Open end position reached (valve cannot move further)		C[1]
Mvm	SPS	Valve is moving		O
Stuck	SPS	Valve is blocked (cannot move from present position)		O
Settings				
OpnLim	ASG	Opening limit of valve position (temporary restriction)		O
ClsLim	ASG	Closing limit of valve position (temporary restriction)		O
Incr	ASG	Increment of position change for open/close commands		O
Measured values				
PosPc	MV	Valve position given as (0 to 100) %		C[2]
PosDeg	MV	Valve position given as (0 to 90) °		C[2]
Flw	MV	Calculated liquid flow through the valve [m^3/s]		O
Controls				
PosSpt	APC	Valve position set-point		O
Opn	DPC	Valve to full open position		O
Cls	DPC	Valve to full closed position		O
PosChg	INC	Change valve position (stop, raise, lower)		C[2]
PosChgIncr	INC	Incremental change of position		C[2]
BlkOpn	SPC	Block opening of the valve		O
BlkCls	SPC	Block closing of the valve		O

NOTE For data attributes with conditions C^1, one or both may be used, however the use of at least one is mandatory. Data attributes with conditions C^2 are optional, but if used, only one can be selected.

7.6 Logical Nodes for metering and measurement LN group M

7.6.1 Modelling remarks

This group of logical nodes represents sensors for electric measurements. IEC 61850-7-4 defines a number of LN for AC measurements (MMXU, MMXN, MMTR, MMSTA, MHAI, MHAN and MDIF). This document defines three LNs: MENV, MHYD, MMDC, MMET.

NOTE Logical Nodes specified in 7.6 will be included the future Edition 2 of IEC 61850-7-4. When published, Logical Nodes specified IEC 61850-7-4 (future Edition 2) will take precedence over Logical Nodes in 7.6.

7.6.2 LN: Environmental information Name: MENV

Logical Node MENV shall be used for modelling the characteristics of environmental conditions such as emissions, and other key environmental data. In addition, many of the environmental sensors may be located remotely from the instantiated logical node. This logical node may therefore represent a collection of environmental information from many sources. It does however not include basic meteorological and hydrological data. For such information, see MHYD and MMET logical node classes.

MENV Class				
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
EEHealth	INS	External equipment health		O
EEName	DPL	External equipment nameplate		O
Measured Values				
CO2	MV	CO_2 emissions		O
CO	MV	CO emissions		O
NOx	MV	NO_x emissions		O
SOx	MV	SO_x emissions		O
Dust	MV	Dust particles suspended in air		O
Snd	MV	Sound pressure level		O
O2	MV	Oxygen in combustion gases		O
O3	MV	Ozone in air		O
Settings				
DvcOwner	DOO	Owner and operator of device		O
CTrade	INS	Involved in carbon trading		O
CCredit	MV	Carbon production credit value		O
GreenTag	INS	Green tag information		O

7.6.3 LN: Hydrological information Name: MHYD

Logical Node MHYD shall comprise the data classes that represent hydrological information such as river, lake, pond, or oceanic water related information.

This logical node may represent a collection of meteorological information from many sources.

MHYD class				
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
EEHealth	INS	External equipment health		O
EEName	DPL	External equipment nameplate		O
Status Information				
FishCnt	MV	Fish counter reading		O
Lev	MV	Water level [m]		O
Flw	MV	River, Stream, Canal Volumetric Flow [m^3/s]		O
SpdSrfc	MV	Surface speed of water flow [m/s]		O
Tmp	MV	Temperature of water [°C]		O
Cndct	MV	Electrical conductivity of water [S/cm^2]		O
HydPH	MV	pH of water (0 to 14)		O
SInt	MV	Saline content of water [g/l]		O

7.6.4 LN: DC measurement Name: MMDC

Logical Node MMDC shall be used to represent measurements in a DC system: current, voltage, power and resistance.

MMDC class				
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
EEHealth	INS	External equipment health		O
Measured values				
Watt	MV	Power		O
Amp	MV	Current (DC current)		O
Vol	MV	Voltage (DC voltage) between poles		O
VolPsGnd	MV	Voltage between positive pole and earth		O
VolNgGnd	MV	Voltage between negative pole and earth		O
Ris	MV	Resistance in DC circuit		O
RisPsGnd	MV	Resistance between positive pole and earth		O
RisNgGnd	MV	Resistance between negative pole and earth		O

7.6.5 LN: Meteorological information Name: MMET

Logical Node MMET shall comprise the data classes that represent meteorological information.

The data classes as shown in the following table focus on meteorological station information. MMET may in reality represent a collection of meteorological information from many sources, that is, from sensors located at different places. This logical node is a superset of the WMET LN defined in IEC 61400-25-2; information about precipitation and insolation is added.

MMET class				
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
EEHealth	INS	External equipment health		O
EEName	DPL	External equipment nameplate		O
Status Information				
AmbTmp	MV	Ambient temperature		O
WetBlbTmp	MV	Wet bulb temperature [°C]		O
CloudCvr	MV	Cloud cover level		O
Hmdt	MV	Humidity		O
DewPt	MV	Dew point		O
DifInsol	MV	Diffuse insolation [W/m^2]		O
DirInsol	MV	Direct normal insolation [W/m^2]		O
DlDur	MV	Daylight Duration (time elapsed between sunrise and sunset)		O
HorInsol	MV	Total Horizontal Insolation [W/m^2]		O
HorWdDir	MV	Horizontal Wind direction		O
HorWdSpd	MV	Average Horizontal Wind speed [m/s]		O
VerWdDir	MV	Vertical Wind Direction		O
VerWdSpd	MV	Average Vertical Wind speed [m/s]		O
WdGustSpd	MV	Max Wind gust speed [m/s]		O
Pres	MV	Barometric pressure		O
RnFll	MV	Rainfall (mm)		O
SnwDen	MV	Density of snowfall (g/cm^3)		O
SnwTmp	MV	Temperature of snowfall (°C)		O
SnwCvr	MV	Snowcover (mm)		O
SnwFll	MV	Snowfall (mm)		O
SnwEq	MV	Water equivalent of snowfall (mm)		O

7.7 Logical Nodes for protection functions LN group P

7.7.1 Modelling remarks

This group of logical nodes represents electrical protections. IEC 61850-7-4 defines most of the electrical protections used in any type of plant, including hydropower. This part of IEC 61850 defines two specific logical nodes, rotor protection (PRTR) and thyristor failure protection (PTHF).

NOTE Logical Nodes specified in 7.7 will be included the future Edition 2 of IEC 61850-7-4. When published, Logical Nodes specified IEC 61850-7-4 (future Edition 2) will take precedence over Logical Nodes in 7.7.

7.7.2 LN: Rotor protection Name: PRTR

Logical Node PRTR shall be used to represent a field short-circuit protection using the 6th harmonic. The protection is normally included in the excitation system.

PRTR class				
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
OpCntRs	INC	Reset-able operation counter		O
Status information				
Str	ACD	Start		M
Op	ACT	Operate (trips both field CB and generator CB)	T	M
Settings				
StrVal	ASG	Start value		O

7.7.3 LN: Thyristor protection Name: PTHF

Logical Node PTHF shall be used to represent a thyristor (thyristor valve) protection. In a power plant, this protection will typically be included in the excitation system.

PTHF class				
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
OpCntRs	INC	Reset-able operation counter		O
Status information				
Str	ACD	Start		M
Op	ACT	Operate (trips both field CB and generator CB)	T	M
Settings				
StrVal	ASG	Start value		O

7.8 Logical nodes for protection related functions LN Group R

7.8.1 Modelling remarks

LN group R of logical nodes represents functions that are related to electrical protections.

NOTE The Logical Node specified below in 7.8 will be included the future Edition 2 of IEC 61850-7-4. When published, Logical Nodes specified IEC 61850-7-4 (future Edition 2) will take precedence over Logical Nodes in 7.8.

7.8.2 LN: synchronising or synchro-check device Name: RSYN

This version of RSYN shall superseed the RSYN LN of IEC 61850-7-4:2003 when used for power generation purposes. It can optionally be used to represent synchro-check devices in substations.

RSYN class				
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O/C**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
Controls				
StrSynPrg	SPC	Start synchronising process		O
StopSynPrg	SPC	Stop synchronising process		O
RelDeaBus	SPC	Releasing Dead Bus/Dead Line function		O
BlkSyn	SPC	Enable writing parameters to synchronizer		O
RsSyn	SPC	Reset synchroniser (in error condition)		O
Status Information				
Rel	SPS	Release cmd (M in the case of synchrocheck)		C
Cmd	SPS	Command (M in the case of Autosynchronising)		C
RV	SPS	Raise Voltage		C
LV	SPS	Lower Voltage		C
RHz	SPS	Raise frequency (increase speed)		C
LHz	SPS	Lower frequency (lower speed)		C
VInd	SPS	Voltage Difference Indicator		O
AngInd	SPS	Angle Difference Indicator		O
HzInd	SPS	Frequency Difference Indicator		O
SynPrg	SPS	Synchronising in progress		O
SynFlt	SPS	Synchroniser in error status		O
SynRdy	SPS	Synchroniser ready to synchronise		O
SynSetMod	SPS	Synchroniser in setting mode (blocked)		O
Measured values				
DifVClc	MV	Calculated Difference in Voltage (amplitude value)		O
DifHzClc	MV	Calculated Difference in Frequency		O
DifHzClcHi	MV	Calculated Difference in Frequency (high resolution)		O
DifAngClc	MV	Calculated Difference of Phase Angle		O
V1Clc	MV	Amplitude value U1		O
V2Clc	MV	Amplitude value U2		O
Hz1Clc	MV	Frequency f1		O
Hz2Clc	MV	Frequency f2		O
AccClc	MV	Acceleration		O
Settings				
VNomV	ING	Nominal secondary voltage		O
HzNom	ASG	Nominal frequency		O
VAdpFact	ASG	Adaptation factor U1/U2		O
AdpAngDeg	ING	Adaptation angle (e.g. setting group compensation)		O
BkrTmms	ING	Closing Time of breaker		O
PlsTmms	ING	Close Pulse Time		O
DlTms	ING	Supervision time for paralleling		O
MltCmd	SPG	Multiple Command generation		O
DifVNg	ASG	Difference Voltage (amplitude value) negative		O
DifVPs	ASG	Difference Voltage (amplitude value) positive		O
DifHzNg	ASG	Difference Frequency negative		O
DifHzPs	ASG	Difference Frequency positive		O
DifAngNg	ASG	Difference Phase Angle negative		O
DifAngPs	ASG	Difference Phase Angle positive		O
MinVSyn	ASG	Minimum voltage for live synchronisation		O
MaxVSyn	ASG	Maximum voltage for live synchronisation		O
DetSyn	ASG	Detection of synchronism		O
LivDeaMod	ING	Live Dead Mode		O
DeaLinVal	ASG	Dead Line Value		O
LivLinVal	ASG	Live Line Value		O
DeaBusVal	ASG	Dead Bus Value		O
LivBusVal	ASG	Live Bus Value		O
VAdj	SPG	Voltage matcher ON/OFF		O
VChr	ASG	Voltage adjustment characteristic		O
VInvTms	ING	Voltage adjustment pulse interval		O
MinVTms	ING	Minimum voltage adjustment pulse time		O
MaxVTms	ING	Maximum voltage adjustment pulse time		O
HzAdj	SPG	Frequency matcher ON/OFF		O
HzChr	ASG	Frequency adjustment characteristic		O
HzInvTms	ING	Frequency adjustment pulse interval		O
MinHzTms	ING	Minimum frequency adjustment pulse time		O
MaxHzTms	ING	Maximum frequency adjustment pulse time		O
HzTgtVal	ASG	Frequency matcher target value		O
KckPls	SPG	Kicker pulse ON/OFF		O
TmTot	ASG	Total time of synchronising process		O

7.9 Logical Nodes for supervision and monitoring LN group S

7.9.1 Modelling remarks

This group of logical nodes represents:

a) functions that are related to electrical protections although not protections in themselves and

b) protective functions that act on other physical measurements than electrical for their function.

The logical nodes in this group will normally provide an alarm signal if the measured level passes a set value. They can optionally provide a trip signal.

NOTE Logical Nodes specified in 7.9 will be included the future Edition 2 of IEC 61850-7-4. When published, Logical Nodes specified IEC 61850-7-4 (future Edition 2) will take precedence over Logical Nodes in 7.9.

7.9.2 LN: temperature supervision Name: STMP

Logical Node STMP shall be used to represent various devices that supervise the temperatures of major plant objects. It provides alarm and trip/shutdown functions. If more than one sensor (LN TTMP) is connected the LN STMP shall be instantiated for each sensor.

STMP class				
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
EEHealth	INS	External equipment health		O
EEName	DPL	External equipment nameplate		O
Loc	SPS	Local operation		O
Status information				
Alm	SPS	Temperature alarm level reached		M
Trip	SPS	Temperature trip level reached		O
Settings				
TmpAlmSpt	ASG	Temperature alarm level set-point		M
TmpTrSpt	ASG	Temperature trip level set-point		O
Measured values				
Tmp	MV	Temperature		O

7.9.3 LN: vibration supervision Name: SVBR

Logical Node SVBR shall be used to represent various devices that supervise the vibrations in rotating plant objects such as shafts, turbines, generators etc. It provides alarm and trip/shutdown functions. If more than one sensor (LN TVBR) is connected, the LN SVBR shall be instantiated for each sensor

SVBR class				
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
EEHealth	INS	External equipment health		O
EEName	DPL	External equipment nameplate		O
Loc	SPS	Local operation		O
Status information				
Alm	SPS	Vibration alarm level reached		M
Trip	SPS	Vibration trip level reached		O
Settings				
VbrAlmSpt	ASG	Vibration alarm level set-point		M
VbrTrSpt	ASG	Vibration trip level set-point		O

AxDpAlmSpt	ASG	Axial displacement alarm level set-point		O
AxDpTrpSpt	ASG	Axial displacement trip level set-point		O
Measured values				
Vbr	MV	Vibration level [mm/s^2]		O
AxDsp	MV	Total axial displacement [mm]		O

7.10 Logical Nodes for instrument transformers and sensors LN group T

7.10.1 Modelling remarks

This group of logical nodes represents various sensors that provide sampled values (raw data). In most cases, each sensor physical device provides a single measurement. It is important to note that the logical node does not need to be located in the actual sensor. In most cases sensors will be connected to transducers, merging units or monitoring equipment. In such cases, the sensor logical nodes may reside in device to which the physical sensors are connected.

It shall be noted, that substitution (see substitution model in IEC 61850-7-2) is not allowed for the SAV common data class. A sensor, whose design allows substitution, shall not be modelled in the T group of logical nodes. Compare the two level measurement logical nodes specified this document, TLVL and HLVL. HLVL is intended for a dam water level indicator (that is prone to freezing up during winters), while TLVL is intended for any type of level measurement. HLVL returns a MV common data class where substitution is allowed.

NOTE Logical Nodes specified in 7.10 will be included the future Edition 2 of IEC 61850-7-4. When published, Logical Nodes specified IEC 61850-7-4 (future Edition 2) will take precedence over Logical Nodes in 7.10.

7.10.2 LN: Angle sensor Name: TANG

Logical Node TANG shall be used to represent a measurement of an angle between two objects (one of which might be a theoretical vertical or horizontal line). The measurement can be returned optionally as degrees or radians (° or rad). Compare also with the specific gate position indicator (HGPI) of this part of IEC 61850.

TANG class				
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
SmpRteRng	ING	Available sampling rate range		O
Measured values				
AngRad	SAV	Angle given as (rad)		C
AngDgr	SAV	Angle given as (°)		C
Settings				
SmpRte	ING	Sampling rate setting		O

7.10.3 LN: Axial displacement sensor Name: TAXD

Logical Node TAXD shall be used to represent an axial displacement value. The axial displacement can, depending on the application, be either longitudinal or transverse to the shaft. This sensor is often used together with vibration sensors as input to a vibration monitoring system.

TAXD class				
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
SmpRteRng	ING	Available sampling rate range		O
Measured values				

AxDsp	SAV	Total axial displacement (mm)		M
Settings				
SmpRteSet	ING	Sampling rate setting		O

7.10.4 LN: Distance sensor Name: TDST

Logical Node TDST shall be used to represent a measurement of the distance to an object that can move. It is intended to provide a measurement between a fixed location and a movable object.

TDST class				
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
SmpRteRng	ING	Available sampling rate range		O
Measured values				
Dis	SAV	Distance [m]		M
Settings				
SmpRte	ING	Sampling rate setting		O

7.10.5 LN: Flow sensor Name: TFLW

Logical Node TFLW shall be used to represent a measurement of media flow rate through the device where it is located.

TFLW class				
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
SmpRteRng	ING	Available sampling rate range		O
Measured values				
Flw	SAV	Liquid flow rate (m^3/s)		M
Settings				
SmpRte	ING	Sampling rate setting		O

7.10.6 LN: Frequency sensor Name: TFRQ

Logical Node TFRQ shall be used to represent a measurement of frequency. It is intended for any frequency that is not related to electrical ac measurements. It can be used for example for sound measurements, vibrations and timing of repeated occurrences. If a pure vibration is to be measured, where the movement rather than the frequency is of interest, the TVBR logical node is recommended.

TFRQ class				
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
SmpRteRng	ING	Available sampling rate range		O
Measured values				
Hz	SAV	Frequency (Hz)		M
Settings				
SmpRte	ING	Sampling rate setting		O

7.10.7 LN: Humidity sensor Name: THUM

Logical Node THUM shall be used to represent a measurement of humidity in the media that is monitored. The result is given in percent of maximum possible humidity.

THUM class				
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
SmpRteRng	ING	Available sampling rate range		O
Measured values				
Hmdt	SAV	Humidity (%)		M
Settings				
SmpRte	ING	Sampling rate setting		O

7.10.8 LN: Level sensor Name: TLEV

Logical Node TLEV shall be used to represent a measurement of the media level in the container where it is located. The level is expressed as a percentage of full container. For a measurement given as a distance from a base level, the HLEV logical node shall be used.

TLEV class				
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
SmpRteRng	ING	Available sampling rate range		O
Measured values				
LevPc	SAV	Level (%)		M
Settings				
SmpRteSet	ING	Sampling rate setting		O

7.10.9 LN: Magnetic field sensor Name: TMGF

Logical Node TMGF shall be used to represent a measurement of the magnetic field strength at the place where it is located.

TMGF class				
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
SmpRteRng	ING	Available sampling rate range		O
Measured values				
MagFld	SAV	Magnetic field strength/flux density (T)		M
Settings				
SmpRte	ING	Sampling rate setting		O

7.10.10 LN: Movement sensor Name: TMVM

Logical Node TMVM shall be used to represent a measurement of movement or speed. It is intended to provide a measurement of the speed, in m/s, with which two objects (one of which may be fixed) are moving in relation to each other.

TMVM class				
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
SmpRteRng	ING	Available sampling rate range		O
Measured values				
MvmRte	SAV	Movement rate [m/s]		M
Settings				
SmpRte	ING	Sampling rate setting		O

7.10.11 LN: Position indicator Name: TPOS

Logical Node TPOS shall be used to represent the position of a movable device, actuator or similar. The position is given as a percentage of the full movement of the device being monitored. Compare with TDST that returns the distance in m.

TPOS class				
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
SmpRteRng	ING	Available sampling rate range		O
Measured values				
PosPc	SAV	Position given as percentage of full movement (%)		M
Settings				
SmpRte	ING	Sampling rate setting		O

7.10.12 LN: Pressure sensor Name: TPRS

Logical Node TPRS shall be used to represent the absolute pressure of a medium. The medium might be air, water, oil, steam or any other substance, the pressure of which needs to be supervised.

TPRS class				
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
SmpRteRng	ING	Available sampling rate range		O
Measured values				
Pres	SAV	Pressure of media [Pa]		M
Settings				
SmpRte	ING	Sampling rate setting		O

7.10.13 LN: Rotation transmitter Name: TRTN

Logical Node TRTN shall be used to represent the rotational speed of a rotating device. Different measurement principles may be used, the presented result is however the same.

TRTN class				
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
SmpRteRng	ING	Available sampling rate range		O
Measured values				
Spd	SAV	Rotational speed [r/s]		M
Settings				
SmpRte	ING	Sampling rate setting		O

7.10.14 LN: Sound pressure sensor Name: TSND

Logical Node TSND shall be used to represent the sound pressure level at the location where the sensor is located.

TSND class				
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
SmpRteRng	ING	Available sampling rate range		O
Measured values				
Snd	SAV	Sound pressure level [dB]		M
Settings				
SmpRte	ING	Sampling rate setting		O

7.10.15 LN: Temperature sensor Name: TTMP

Logical Node TTMP shall be used to represent a single temperature measurement.

TTMP class				
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
SmpRteRng	ING	Available sampling rate range		O
Measured values				
Tmp	SAV	Temperature [°C]		M
Settings				
SmpRte	ING	Sampling rate setting		O

7.10.16 LN: Mechanical tension /stress sensor Name: TTNS

Logical Node TTNS shall be used to represent a measurement of the mechanical tension in an object.

TTNS class				
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
SmpRteRng	ING	Available sampling rate range		O
Measured values				
Tns	SAV	Mechanical stress [N]		M
Settings				
SmpRte	ING	Sampling rate setting		O

7.10.17 LN: Vibration sensor Name: TVBR

Logical Node TVBR shall be used to represent a vibration level value. In the case where the vibration can be defined as a frequency, the TFRQ logical node could be used instead.

TVBR class				
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
SmpRteRng	ING	Available sampling rate range		O
Measured values				
Vbr	SAV	Vibration [mm/s^2]		M
Settings				
SmpRte	ING	Sampling rate setting		O

7.10.18 LN: Water pH sensor Name: TWPH

Logical Node TWPH shall be used to represent a water pH level value.

TWPH class				
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
SmpRteRng	ING	Available sampling rate range		O
Measured values				
HydPh	SAV	Water pH level (0 to 14)		M
Settings				
SmpRte	ING	Sampling rate setting		O

7.11 Logical Nodes for power system equipment LN group Z

7.11.1 Modelling remarks

The generator model in this document is a modification of the generator model of IEC 61850-7-4:2003. The reason for the modification is that a number of data objects in the model of 61850-7-4 are found in other LN of this document.

NOTE Logical Nodes specified in 7.11 will be included the future Edition 2 of IEC 61850-7-4. When published, Logical Nodes specified IEC 61850-7-4 (future Edition 2) will take precedence over Logical Nodes in 7.11.

7.11.2 LN: Neutral resistor Name: ZRES

Logical Node ZRES shall be used to represent a neutral resistor. The resistor is normally not controlled; this LN is a placeholder for rating plate data.

ZRES class				
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
EEHealth	INS	External equipment health		O
EEName	DPL	External equipment nameplate		O
OpTmh	INS	Operation time		O

7.11.3 LN: Semiconductor rectifier controller Name: ZSCR

Logical Node ZSCR shall be used to represent a controllable rectifier. A typical use is to provide the controllable DC current within an excitation system.

ZSCR class				
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
EEHealth	INS	External equipment health		O
EEName	DPL	External equipment nameplate		O
OpTmh	INS	Operation time		O
Status information				
Alm	SPS	Control function alarm		M
Settings				
SetA	ASG	Current setting (if operating to a fixed current)		*Note*
SetV	ASG	Voltage setting (if operating to a fixed voltage)		*Note*
Controls				
OpModRect	ING	Control mode setting (A, V, W)		*Note*
AmpSpt	APC	Current target set-point		*Note*
VolSpt	APC	Voltage target set-point		*Note*

NOTE The rectifier can be used to provide a fixed voltage and controllable current, to provide a fixed current and a controllable voltage or have both current and voltage controllable. If either voltage or current is fixed, the set-point should be given as a setting.

7.11.4 LN: Synchronous machine Name: ZSMC

Logical Node ZSMC shall be used to represent any type of synchronous machine. The logical node only includes rating data, all controls and operational status information is found in other logical nodes in this part of IEC 61850, compare for example the logical node HUNT.

ZSMC class				
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
EEHealth	INS	External equipment health		O
EEName	DPL	External equipment nameplate		O
OpTmh	INS	Operation time		O
Status information				
PwrRtg	INS	S_N – Rated apparent power [VA]		M
VRtg	INS	U_N – Rated voltage [V]		M
ARtg	INS	I_N – Rated stator current [A]		M
PFRtg	ASG	Rated power factor		M
Inertia	ASG	Synchronous machine moment of inertia J [kgm^2]		O
RotDir	SPS	Field rotation direction (TRUE = clockwise)		O
SpdRtg	INS	Synchronous machine rated speed [s^{-1}]		M
SpdCrit	INS	Synchronous machine critical speed of the generator [s^{-1}]		O
FldAmpRtg	ASG	Rated field current IF_N[A]		O
FldAmpRtgO	ASG	No-load field current for rated stator voltage IFo [A]		O
FldRis	ASG	Field resistance RF[ohm]		O
StatRis	ASG	Stator resistance [ohm]		O
FldRisTmp	INS	Reference temperature for field resistance [°C]		O
StatRisTmp	INS	Reference temperature for stator resistance [°C]		O
BaseImp	ASG	Base p.u. impedance [ohm /phase] (U_N^2/S_N)		O
StatLReact	ASG	Stator leakage reactance [p.u.]		O
ReactXd	ASG	D-axis synchronous reactance X_d [p.u.] (unsaturated)		O
ReactXdP	ASG	D-axis transient synchronous reactance X_d' [p.u.] (unsaturated)		O
ReactXdS	ASG	D-axis Reactance X_d'' [p.u.] (unsaturated)		O
ReactXq	ASG	Q-axis synchronous reactance X_q [p.u.] (unsaturated)		O
ReactXqP	ASG	Q-axis transient reactance X_q' [p.u.] (unsaturated)		O
ReactXqS	ASG	Q-axis sub-transient reactance X_q'' [p.u.] (unsaturated)		O
ReactX0	ASG	Zero sequence Reactance X_0 [p.u.] (unsaturated)		O
ReactX2	ASG	Negative sequence Reactance X_2 [p.u.] (unsaturated)		O
TmCstTdP	ASG	D-axis short circuit transient time constant T_d' [s] (unsaturated)		O
TmCstTdS	ASG	D-axis short-circuit sub-transient time constant T_d'' [s] (unsaturated)		O
TmCstTd0P	ASG	D-axis open circuit transient time constant T_{d0}' [s] (unsaturated)		O
TmCstTd0S	ASG	D-axis open circuit sub-transient time constant T_{d0}'' [s] (unsaturated)		O
TmCstTqP	ASG	Q-axis short circuit transient time constant T_q' [s] (unsaturated)		O
TmCstTqS	ASG	Q-axis short circuit sub-transient time constant T_q'' [s] (unsaturated)		O
TmCstTq0P	ASG	Q-axis open circuit transient time constant T_{q0}' [s] (unsaturated)		O
TmCstTq0S	ASG	Q-axis open circuit sub-transient time constant T_{q0}'' [s] (unsaturated)		O
TmCstTa	ASG	Armature time constant T_a [s] (unsaturated)		O
SatCffS10	ASG	Saturation coefficient $S_{1.0}$		O
SatCffS12	ASG	Saturation coefficient $S_{1.2}$		O

8 Data name semantics

In Table 19, the data names used in Clause 7 are described. The meaning of Boolean values are FALSE = 0, TRUE = 1. Data names used in this document, that already are listed in IEC 61850-7-4, are repeated here for easier reference. In such cases, a reference is inserted in parentheses.

Table 19 – Description of data

<table>
<tr><th>Data Name</th><th>Semantics</th></tr>
<tr><td>AccClc</td><td>Acceleration (change of rate of frequency difference)</td></tr>
<tr><td>ActPwrL</td><td>Lower active power production</td></tr>
<tr><td>ActPwrR</td><td>Raise active power production</td></tr>
<tr><td>AdjMsg</td><td>Adjustment message:
<table>
<tr><th>Message</th><th>Value</th></tr>
<tr><td>Completed</td><td>0</td></tr>
<tr><td>Cancelled</td><td>1</td></tr>
<tr><td>New adjustments</td><td>2</td></tr>
<tr><td>Under way</td><td>3</td></tr>
</table></td></tr>
<tr><td>AdpAngDeg</td><td>Adaptation angle (e.g. connection group compensation)</td></tr>
<tr><td>ACAlm</td><td>Detection of fault in the AC supply system to a device. (FALSE = normal, TRUE = alert)</td></tr>
<tr><td>Alm</td><td>General single alarm (IEC 61850-7-4)</td></tr>
<tr><td>AlmRs</td><td>Alarm signal reset</td></tr>
<tr><td>AlmVal</td><td>Alarm Value is the pre-set value for a measurand that when reached will result in an alarm. (IEC 61850-7-4)</td></tr>
<tr><td>AmbTmp</td><td>Ambient temperature [°C]</td></tr>
<tr><td>Amp</td><td>Current of a non-three-phase circuit (IEC 61850-7-4). Here used for DC current.</td></tr>
<tr><td>AmpSpt</td><td>Current set-point</td></tr>
<tr><td>AngDeg</td><td>Measured angle value given as degrees (°)</td></tr>
<tr><td>AngRad</td><td>Measured angle value given as radians (rad)</td></tr>
<tr><td>AOffCam</td><td>A-servo off, CAM function is activated</td></tr>
<tr><td>Area</td><td>Area of a given surface [m^2]</td></tr>
<tr><td>ARtg</td><td>I_N - Rated current, intrinsic property of the device, which cannot be set/changed from remote. (IEC 61850-7-4)</td></tr>
<tr><td>Auto</td><td>This Data is responsible for the enabling or disabling of the output circuit of the automatic controller; automatic (TRUE) = output circuit is enabled, not automatic (FALSE) = output circuit is disabled. (IEC 61850-7-4)</td></tr>
<tr><td>AxDsp</td><td>Total axial displacement [mm]</td></tr>
<tr><td>AxDpAlmSpt</td><td>Axial displacement alarm level set-point</td></tr>
<tr><td>AxDpTrpSpt</td><td>Axial displacement trip level set-point</td></tr>
<tr><td>BaseImp</td><td>U_N^2/S_N – Base p.u. impedance [Ω/phase]</td></tr>
<tr><td>Bias</td><td>Bias added to process value</td></tr>
<tr><td>Blk</td><td>This data is used to block the function from operation (TRUE = block)</td></tr>
<tr><td>BlkCls</td><td>This Data is used to block ‘close operation’ from another logical node. (IEC 61850-7-4)</td></tr>
<tr><td>BlkOpn</td><td>This Data is used to block ‘open operation’ from another logical node. (IEC 61850-7-4)</td></tr>
<tr><td>BlkSt</td><td>The function or device represented by the LN is blocked from operation (TRUE = blocked)</td></tr>
</table>

Table 19 *(continued)*

<table>
<tr><th>Data Name</th><th>Semantics</th></tr>
<tr><td>BlkSyn</td><td>Block synchronisation (enable writing of parameters to synchronizer)</td></tr>
<tr><td>BrgTyp</td><td>Type of bearing:
<table>
<tr><th>Bearing type</th><th>Value</th></tr>
<tr><td>Generator thrust</td><td>1</td></tr>
<tr><td>Generator guide</td><td>2</td></tr>
<tr><td>Turbine thrust</td><td>3</td></tr>
<tr><td>Turbine guide</td><td>4</td></tr>
<tr><td>Combined guide and thrust</td><td>5</td></tr>
<tr><td>Gear-box</td><td>6</td></tr>
<tr><td>Clutch</td><td>7</td></tr>
</table>
A value of ‘0’ indicates a “general” bearing without any specifics</td></tr>
<tr><td>BrkOff</td><td>Brakes are disengaged</td></tr>
<tr><td>BrkOn</td><td>Brakes are applied</td></tr>
<tr><td>CCredit</td><td>Carbon production credit value</td></tr>
<tr><td>CloudCvr</td><td>Cloud cover level (%)</td></tr>
<tr><td>Cls</td><td>This Data represents a command to move the controlled object to a fully closed position</td></tr>
<tr><td>ClsLim</td><td>This data represents a limitation on closing of a device (% of full opening)</td></tr>
<tr><td>ClsPos</td><td>Closed position indication of a device.</td></tr>
<tr><td>Cmd</td><td>Command</td></tr>
<tr><td>Cndct</td><td>Conductivity [S/m]</td></tr>
<tr><td>CntRs</td><td>Reset command to counter (the counter is set to 0)</td></tr>
<tr><td>CO</td><td>CO emission measurement</td></tr>
<tr><td>CO2</td><td>CO_2 emission measurement</td></tr>
<tr><td>CrlAlm</td><td>Correlation deviation alarm</td></tr>
<tr><td>Crv</td><td>Curve (using the curve shape definition common data class)</td></tr>
<tr><td>CrvNum</td><td>Number of setting curves available for the function</td></tr>
<tr><td>CrvSize</td><td>Number of X/Y data pairs in a setting curve</td></tr>
<tr><td>Ctrade</td><td>Main object is involved in carbon trading</td></tr>
<tr><td>D</td><td>Derivative output from a PID regulator</td></tr>
<tr><td>Dact</td><td>Derivative action, action by the derivative part of a PID regulator</td></tr>
<tr><td>DamTyp</td><td>Type of dam or reservoir (type of design):
<table>
<tr><td>Concrete structure</td><td>1</td></tr>
<tr><td>Stone core</td><td>2</td></tr>
<tr><td>Earth core</td><td>3</td></tr>
<tr><td>Mixed or special design</td><td>4</td></tr>
</table></td></tr>
<tr><td>DeadB</td><td>Deadband value</td></tr>
<tr><td>DeflOpn</td><td>Pelton turbine deflector control. (TRUE = open command active)</td></tr>
<tr><td>DetSyn</td><td>Frequency difference level for detection synchronism (below this level, the measured objects are treated as synchronous)</td></tr>
<tr><td>DewPt</td><td>Dew point</td></tr>
</table>

Table 19 *(continued)*

Data Name	Semantics
DifAngNg	Negative phase angle difference
DifAngPs	Positive phase angle difference
DifHzClcHi	Calculated frequency difference (high resolution), used to detect synchronism
DifHzNg	Negative frequency difference
DifHzPs	Positive frequency difference
DifInsol	Diffuse insolation [W/m^2]
DifPres	Differential pressure, e.g. across a filter
DifPresHi	Differential pressure high alarm level setting
DifVNg	Negative voltage (amplitude) difference
DifVPs	Positive voltage (amplitude) difference
DirInsol	Direct insolation [W/m^2]
Dis	Distance to measured object, linear distance [m]
DlDur	Daylight duration (time between sunrise and sunset) [min]
DlTms	Delay time (supervision time) for paralleling of synchronous lines
Dust	Measurement of dust particles suspended in air
DvAlm	Deviation alarm
DvcOwner	Owner and operator of physical device (additional tag of CDC type DOO)
Dn	Downwards (decreasing)
EEHealth	This information reflects the state of external equipment, for example circuit-breaker controlled by the logical node XCBR. The values are the same as for Health. (*IEC 61850-7-4*)
EEName	This information reflects the name plate of external equipment, for example the circuit-breaker XCBR controlled by the logical node CSWI. (*IEC 61850-7-4*)
ErrTerm	Error term
FilTyp	Filter function type, enumerated: | Low pass | High pass | Bandpass | Bandstop (notch) |
FishCnt	Fish counter reading (e.g. counting fish passing a fish ladder system)
FldAmpRtg	IF_N – Rated field current [A]
FldAmpRtgO	IF_0 – No-load field current at rated stator voltage [A]
FldRis	RF – Field resistance [Ω]
FldRisTmp	Reference temperature for field resistance [°C]
FilAlm	Filter alarm, can be indicated by too high or too low differential pressure
Flush	Filter flushing in progress
FlushCnt	Filter flushing counter (resettable)
Flw	Flow rate of water or other liquid [m^3/s]
FlwLevAlm	This Data is used to indicate that there is a conflict between liquid flow control setting limits and liquid level setting limits.
FlwMax	Maximum liquid flow through the controlled object
FlwMaxLim	(Temporary) limitation of maximum liquid flow
FlwMin	Minimum liquid flow through the controlled object (used if not zero)
FlwMinLim	(Temporary) limitation of minimum liquid flow
FlwRtg	Rated flow (media flow) [m^3/s]
FlwSpt	Operational set-point for a flow control algorithm [m^3/s]
GreenTag	Green tag information

Table 19 *(continued)*

<table>
<tr><th>Data Name</th><th>Semantics</th></tr>
<tr><td>GridMod</td><td>Grid mode status, the operating condition of the external grid that the generator will meet when the circuit-breaker synchronises onto the grid.
<table>
<tr><th>Grid mode</th><th>Value</th></tr>
<tr><td>Normal conditions (normal frequency and voltage)</td><td>1</td></tr>
<tr><td>Islanded (varying frequency and/or voltage)</td><td>2</td></tr>
<tr><td>Local supply (no external network available)</td><td>3</td></tr>
</table></td></tr>
<tr><td>GridOpSt</td><td>Operational status of the external grid; i.e if it is disturbed or not.
<table>
<tr><th>Grid operational status</th><th>Value</th></tr>
<tr><td>Normal conditions (no disturbance)</td><td>1</td></tr>
<tr><td>Disturbed (abnormal frequency and/or voltage level)</td><td>2</td></tr>
<tr><td>PSS control (PSS controller override)</td><td>3</td></tr>
</table></td></tr>
<tr><td>GteBlk</td><td>Gate is blocked (cannot move from the present position)</td></tr>
<tr><td>GteLoLim</td><td>Low limit of gate movement (temporary restriction)</td></tr>
<tr><td>GtePos</td><td>Gate position given as angular displacement (typical for sector gates) from closed position [1/20° or rad]</td></tr>
<tr><td>GtePosCm</td><td>Gate position given as distance from closed position [cm]</td></tr>
<tr><td>GteUpLim</td><td>Upper limit of gate movement (temporary restriction)</td></tr>
<tr><td>Health</td><td>This information reflects the state of the logical node related HW and SW. More detailed information related to the source of the problem may be provided by specific Data. For LLN0, this Data reflects the worst value of “Health” of the logical nodes that are part of the logical device associated with LLN0.
<table>
<tr><th>Health state</th><th>Value</th></tr>
<tr><td>Ok (“green”) – no problems, normal operation</td><td>1</td></tr>
<tr><td>Warning (“yellow”) – minor problems but in safe operation mode</td><td>2</td></tr>
<tr><td>Alarm (“red”) – severe problem, no operation possible</td><td>3</td></tr>
</table>
Health states 1 (“green”) and 3 (“red”) are unambiguous by definition. The detailed meaning of Health state 2 (“yellow”) is a local issue depending from the dedicated function/device. (IEC 61850-7-4)</td></tr>
<tr><td>HiLev</td><td>High (water) level alarm (upstream)</td></tr>
<tr><td>HiLevDn</td><td>High (water) level alarm downstream (tailrace)</td></tr>
<tr><td>HiLim</td><td>High limit reached</td></tr>
<tr><td>HiLimSpt</td><td>High limit setpoint</td></tr>
<tr><td>Hmdt</td><td>Humidity [%]</td></tr>
<tr><td>HorInsol</td><td>Horizontal insolation [W/m^2]</td></tr>
<tr><td>HorWdDir</td><td>Horizontal wind direction</td></tr>
<tr><td>HorWdSpd</td><td>Average horizontal wind speed (m/s)</td></tr>
<tr><td>HydCtlMod</td><td>This data is used to define what mode the joint control logical node (HJCL) shall operate in.
<table>
<tr><th>Operating mode</th><th>Value</th></tr>
<tr><td>Off (no joint control)</td><td>1</td></tr>
<tr><td>Upper water level set-point control mode</td><td>2</td></tr>
<tr><td>Total flow set-point control mode</td><td>3</td></tr>
</table></td></tr>
<tr><td>HydPH</td><td>Water pH value (0 to 14)</td></tr>
</table>

Table 19 *(continued)*

Data Name	Semantics
Hz	*(The frequency of a power system in Hz. IEC 61850-7-4*). In the context of this part of IEC 61850, the frequency of any repeated occurancy (vibration, sound etc.) that can be expressed in Hz.
Hz1Clc	Calculated value of frequency 1
Hz2Clc	Calculated value of frequency 2
HzAdj	Frequency matcher (TRUE=ON)
HzChr	Frequency adjustment characteristic
HzInvTms	Frequency adjustment pulse interval
HzNom	Nominal frequency
HzTgtVal	Frequency matcher target value
I	Integral output from a PID regulator
Iact	Integral action, action by the integral part of a PID regulator
Inertia	J – synchronous machine moment of inertia [kgm^2]
Incr	This data represent an incremental movement set-point, i.e. how much a controlled object shall move if an incremental position change (PosChgIncr) command is given
KckPls	Kicker pulse (TRUE=ON)
Kd	Derivative gain constant
Ki	Integral gain constant
Kld	Filter constant K lead
Klg	Filter constant K lag
Kp	Proportional gain constant
Lev	Level above ground, media level in a container, general
LevDnHi	Downstream (tailrace) high water level alarm setting [m]
LevDnHiAlm	Downstream (tailrace) high water level alarm
LevDnLo	Downstream (tailrace) low water level alarm set-point [m]
LevDnLoAlm	Downstream (tailrace) low water level alarm
LevHi	Upper water (dam) high level setting [m]
LevHiAlm	Upper water (dam) high level alarm
LevLo	Upper water (dam) low level setting [m]
LevLoAlm	Upper water (dam) low level alarm
LevM	Level, such as water level, expressed as distance from a base level [m]
LevOfs	Base value from which a level is measured, addition to sensor reading in order to get distance from plant base level. [m]
LevPc	Level, such as a tank level, expressed as a percentage of full level (%)
LevSpt	Level set-point for a level control function [m]
LkgAlm	Leakage alarm
LkgAlmVal	Alarm level set-point for leakage
Loc	This changeover is always done locally with a physical key or toggle switch. The physical key or toggle switch may have a set of contacts from which the position can be read. This Data indicates the switchover between local and remote operation; local = TRUE, remote = FALSE. At bay level, 'local' means operation from the bay unit and 'remote' means operation from a station unit. At process level, 'local' means operation direct on the process device, for example on a circuit-breaker and 'remote' means operation from the bay unit. If in a Logical Device the Loc of LLN0 is in contradiction to the Loc of any contained LN. 'local' is always dominant. (*IEC 61850-7-4*)

Table 19 *(continued)*

Data Name	Semantics
LoLev	Low (water) level alarm (upstream)
LoLevDn	Low (water) level alarm downstream (tailrace)
LoLim	Low limit reached
LoLimSpt	Low limit setpoint
MagFld	Magnetic field strength/flux density (T)
MaxHzTms	Maximum frequency adjustment pulse time
MaxOpTmm	Maximum operational time in minutes (the device shall not operate longer than this time)
MaxRst	Maximum restriction
MaxVSyn	Maximum voltage for live synchronisation
MaxVTms	Maximum voltage adjustment pulse time
MinHzTms	Minimum frequency adjustment pulse time
MinOpTmm	Minimum operational time in minutes (if started, the device shall run at least this time)
MinRst	Minimum restriction
MinVSyn	Minimum voltage for live synchronisation
MinVTms	Minimum voltage adjustment pulse time
MltCmd	Multiple command generation (TRUE=multiple command). Used to distinguish between single command and multiple command modes of an automatic synchroniser

Table 19 *(continued)*

<table>
<tr><th>Data Name</th><th>Semantics</th></tr>
<tr><td>Mod</td><td>
<table>
<tr><th>Mode and behaviour</th><th>Value</th></tr>
<tr><td>ON (enabled)
Function active
Outputs (to process) generated
Reporting (to client)
Control services (from client) accepted
Functional (process related) data visible
Configuration (capability) data visible
(Normal state)</td><td>1</td></tr>
<tr><td>BLOCKED
Function active
No outputs (to process) generated
No reporting (to client)
Control services (from client) rejected
Functional (process related) data visible
Configuration (capability) data visible
(Process is passively supervised)</td><td>2</td></tr>
<tr><td>TEST
Function active
Outputs (to process) generated
Reporting (to client) flagged as test
Control services (from client)accepted
Functional (process related) data visible
Configuration (capability) data visible
(Function is operated but results are flagged as test results)</td><td>3</td></tr>
<tr><td>TEST/BLOCKED
Function active
No outputs (to process) generated
Reporting (to client) flagged as test
Control services (from client) accepted
Functional (process related) data visible
Configuration (capability) data visible
(Function is operated in test mode with no impact to the process)</td><td>4</td></tr>
<tr><td>OFF (disabled)
Function not active
No outputs (to process) generated
No reporting (to client)
Control services (from client) rejected
Functional (process related) data not visible
Configuration (capability) data visible
(Process is inactive but shows its configuration capability)</td><td>5</td></tr>
</table>
(IEC 61850-7-4)</td></tr>
<tr><td>MotPro</td><td>Motor protection of the physical device has tripped (TRUE = tripped)</td></tr>
<tr><td>Mvm</td><td>The controlled object is moving</td></tr>
<tr><td>MvmRte</td><td>Movement rate [m/s]</td></tr>
<tr><td>NdlErr</td><td>Pelton turbine needle, servo loop fault. The integer number indicates what loop is faulty</td></tr>
<tr><td>NdlMan</td><td>Pelton turbine manual selection of number of active needles (TRUE = manual mode)</td></tr>
<tr><td>NdlManNum</td><td>Pelton turbine manual selection of number of needles – selected number (1 to 6)</td></tr>
<tr><td>NetHd</td><td>Net head – distance between upper and lower water levels [m]</td></tr>
<tr><td>Nox</td><td>NO_x emission measurement</td></tr>
<tr><td>O2</td><td>Measurement of oxygen in flue gases</td></tr>
</table>

Table 19 *(continued)*

<table>
<tr><th>Data Name</th><th>Semantics</th></tr>
<tr><td>O3</td><td>Measurement of ozone in air</td></tr>
<tr><td>OfsCamEna</td><td>Enable runner offset using Asp</td></tr>
<tr><td>OilTmpHi</td><td>Oil temperature high alarm</td></tr>
<tr><td>Op</td><td>Operate (Common Data Class ACT) indicates the trip decision of a protection function. (IEC 61850-7-4)</td></tr>
<tr><td>OpB</td><td>Operate at level B (in the case of a second level with a different action)</td></tr>
<tr><td>OpCnt</td><td>This data represents a count of operations that is not resettable. The counter shall not be reset from remote, it might though be reset locally. (IEC 61850-7-4)</td></tr>
<tr><td>OpCntrRs</td><td>This data represents a reset-able LN operations counter. The use of the INC Common Data Class permits setting the counter to something other than “0”. (IEC 61850-7-4)</td></tr>
<tr><td>OpSpt</td><td>Operate level set-point</td></tr>
<tr><td>OpDlTmm</td><td>Time delay in minutes before operating once operate conditions have been met</td></tr>
<tr><td>OpDlTmms</td><td>Time delay in ms before operating once operate conditions have been met. (IEC 61850-7-4)</td></tr>
<tr><td>Operate</td><td>Command to operate a device (motor, pump, fan or similar) that will continue running until the command is negated. Common data class SPC or DPC depending on application</td></tr>
<tr><td>OpLev</td><td>Level of operation reached, e.g. for device started by a level indication</td></tr>
<tr><td>OpModRect</td><td>This data is used to define what mode a controllable rectifier shall operate in.
<table>
<tr><th>Operating mode</th><th>Value</th></tr>
<tr><td>Current control mode</td><td>1</td></tr>
<tr><td>Voltage control mode</td><td>2</td></tr>
<tr><td>Active power control pode</td><td>3</td></tr>
</table></td></tr>
<tr><td>Opn</td><td>This data represents a command to move the controlled device to full open position</td></tr>
<tr><td>OpNdlAuto</td><td>Automatic selection of number of active needles, select</td></tr>
<tr><td>OpNdlMan</td><td>Manual selection of number of active needles, select</td></tr>
<tr><td>OpnLim</td><td>Open position limitation, temporary limitation of maximum opening of valve, actuator or other device.</td></tr>
<tr><td>OpnPos</td><td>Open position indication. Indicates that the controlled device has reached a fully open position</td></tr>
<tr><td>OpTmh</td><td>This Data indicates the operation time in h of a physical device since start of operation. Details are LN specific. (IEC 61850-7-4)</td></tr>
<tr><td>Out</td><td>Generic analogue output data from a controller</td></tr>
<tr><td>P</td><td>Proportional output from a PID regulator</td></tr>
<tr><td>Pact</td><td>Proportional action</td></tr>
<tr><td>PFRtg</td><td>Rated power factor</td></tr>
<tr><td>PidAlg</td><td>Selection of PID algorithm
<table>
<tr><th>Algorithm</th><th>Value</th></tr>
<tr><td>P</td><td>1</td></tr>
<tr><td>I</td><td>2</td></tr>
<tr><td>D</td><td>3</td></tr>
<tr><td>PI</td><td>4</td></tr>
<tr><td>PD</td><td>5</td></tr>
<tr><td>ID</td><td>6</td></tr>
<tr><td>PID</td><td>7</td></tr>
</table></td></tr>
</table>

Table 19 *(continued)*

<table>
<tr><th>Data Name</th><th>Semantics</th></tr>
<tr><td>Pos</td><td>This Data is accessed when performing a switch command or to verify the switch status or position. (IEC 61850-7-4)</td></tr>
<tr><td>PosChg</td><td>Change position of the controlled device.</td></tr>
<tr><td>PosChgInc</td><td>If PsnChg command 2 or 3 is given, the device will continue moving until stop command is received.
If PsnChgInc command 2 or 3 is given, the device will move a given distance. How much the device will move is given by the increment setting
<table>
<tr><th>Action</th><th>Value</th></tr>
<tr><td>Stop movement</td><td>1</td></tr>
<tr><td>Raise/Increase</td><td>2</td></tr>
<tr><td>Lower/decrease</td><td>3</td></tr>
</table></td></tr>
<tr><td>PosDn</td><td>Lower end position reached</td></tr>
<tr><td>PosStep</td><td>Integer representing the position of a device that can be moved in defined steps. The value is counted from the lowest position.</td></tr>
<tr><td>PosUp</td><td>Upper end position reached</td></tr>
<tr><td>PosDeg</td><td>Position of a device, e.g. a valve, given as opening angle [0 to 90 °]</td></tr>
<tr><td>PosPc</td><td>Position of a device given as percentage of full movement [0 to 100 %]</td></tr>
<tr><td>PosSpt</td><td>Position set-point</td></tr>
<tr><td>Pres</td><td>Pressure in a specific volume. (IEC 61850-7-4) [Pa]</td></tr>
<tr><td>PwrRtg</td><td>S_N – Rated Power (IEC 61850-7-4)</td></tr>
<tr><td>PwrRtgLim</td><td>Temporary limitation of rated power</td></tr>
<tr><td>RbPos</td><td>Runner blade position [%]</td></tr>
<tr><td>ReactX0</td><td>Zero sequence reactance X_0 (unsaturated) [p.u.]</td></tr>
<tr><td>ReactX2</td><td>Negative sequence reactance X_2 (unsaturated) [p.u.]</td></tr>
<tr><td>ReactXd</td><td>D-axis synchronous reactance X_d (unsaturated) [p.u.]</td></tr>
<tr><td>ReactXdP</td><td>D-axis transient synchronous reactance X_d’ (unsaturated) [p.u.]</td></tr>
<tr><td>ReactXdS</td><td>D-axis reactance X_d’’ (unsaturated) [p.u.]</td></tr>
<tr><td>ReactXq</td><td>Q-axis synchronous reactance X_q (unsaturated) [p.u.]</td></tr>
<tr><td>ReactXqP</td><td>Q-axis transient reactance X_q’ (unsaturated) [p.u.]</td></tr>
<tr><td>ReactXqS</td><td>Q-axis sub-transient reactance X_q’’ (unsaturated) [p.u.]</td></tr>
<tr><td>RelDeaBus</td><td>Releasing dead bus/dead line function</td></tr>
<tr><td>Ris</td><td>Resistance in a circuit, DC resistance [Ω]</td></tr>
<tr><td>RisNgGnd</td><td>Resistance between negative pole and ground [Ω]</td></tr>
<tr><td>RisPsGnd</td><td>Resistance between positive pole and ground [Ω]</td></tr>
<tr><td>RmpDn</td><td>Ramping rate at a downward trend</td></tr>
<tr><td>RmpUp</td><td>Ramping rate at an upward trend</td></tr>
<tr><td>RnFll</td><td>Rainfall [mm]</td></tr>
<tr><td>RotDir</td><td>Field rotation direction (TRUE= clockwise)</td></tr>
<tr><td>RsDlTmm</td><td>Time delay in minutes before reset once reset conditions have been met</td></tr>
</table>

Table 19 *(continued)*

Data Name	Semantics
RsDlTmms	Time delay in ms before reset once reset conditions have been met. (*IEC 61850-7-4*)
RsSyn	Reset synchroniser (in error condition)
SatCff10	Saturation coefficient $S_{1.0}$
SatCff12	Saturation coefficient $S_{1.2}$
SeqStat	Status of a sequencer device
SetA	Current setting
SetSpdBrk	Setting of brake operation speed
SetSpdCrp	Setting of creep speed limit
SetSpdExt	Setting of speed limit for excitation
SetSpdLft	Setting for lift-pump insertion limit
SetSpdLub	Setting for speed limit of lubrication system
SetSpdOv	Setting for over-speed indication
SetSpdRb	Setting for rotor blade start angle speed limit
SetSpdSyn	Setting for synchronisation speed limit
SetV	Votage setting
Slnt	Saline content of water [g/l]
SmpRteRng	Available sampling rate range
SmpRte	Sampling rate setting
Snd	Sound pressure level [dB]
SnwCvr	Snow cover [mm]
SnwDen	Density of snowfall [g/m^3]
SnwEq	Water equivalent of snowfall [mm]
SnwFll	Snowfall [mm]
SnwTmp	Snow temperature [°C]
Sox	SO_x emission measurement
Spd	Rotational speed [s^{-1}]
SpdBrk	Indication that the speed is low enough to allow application of brakes on the generator shaft.
SpdCrit	Synchronous machine critical speed [s^{-1}]
SpdCrp	Detection of turbine creeping (slow movement). (TRUE = creeping detected)
SpdExt	Indication that speed is high enough to allow operation of excitation system
SpdLft	Indication used for insertion of high pressure lubrication system (lift pumps)
SpdLim	Design limit for (rotational) speed [s^{-1}]
SpdLub	Indication used for operation of bearing lubrication system
SpdOvr	Over-speed indication (TRUE = Over-speed limit passed)
SpdRb	Indication used for speed at which rotor blades shall be set at start angle
SpdRtg	Rated (rotational) speed [s^{-1}]
SpdSpt	(Rotational) speed set-point [s^{-1}]
SpdSrfc	Surface speed, linear speed [m/s]
SpdSyn	Indication that speed is within limits to allow synchronisation
SptDir	Set-point direction

Table 19 *(continued)*

<table>
<tr><th>Data Name</th><th>Semantics</th></tr>
<tr><td>SptDn</td><td>Set-point going down (lowering) activated</td></tr>
<tr><td>SptDvAlm</td><td>Set-point deviation alarm</td></tr>
<tr><td>SptL</td><td>Set-point lower (decreasing)</td></tr>
<tr><td>SptMem</td><td>Set-point in memory</td></tr>
<tr><td>SptMsg</td><td>Set-point controller function completion message:
<table>
<tr><th>Message</th><th>Value</th></tr>
<tr><td>Ended normally</td><td>0</td></tr>
<tr><td>Ended with over-shoot</td><td>1</td></tr>
<tr><td>Cancelled: measurement was deviating</td><td>2</td></tr>
<tr><td>Cancelled: loss of communication with issuing device</td><td>3</td></tr>
<tr><td>Cancelled: loss of contact with network</td><td>4</td></tr>
<tr><td>Cancelled: loss of communication with local interface</td><td>5</td></tr>
<tr><td>Cancelled: time-out</td><td>6</td></tr>
<tr><td>Cancelled: voluntary</td><td>7</td></tr>
<tr><td>Cancelled: noisy environment</td><td>8</td></tr>
<tr><td>Cancelled: equipment failure</td><td>9</td></tr>
<tr><td>Cancelled: new set-point request</td><td>A</td></tr>
<tr><td>Cancelled: improper environment (blockage)</td><td>B</td></tr>
<tr><td>Cancelled: stability time was reached</td><td>C</td></tr>
<tr><td>Cancelled: immobilisation time was reached</td><td>D</td></tr>
<tr><td>Cancelled: equipment in wrong mode (manual)</td><td>E</td></tr>
<tr><td>Unknown causes</td><td>F</td></tr>
</table>
</td></tr>
<tr><td>SptR</td><td>Set-point raise (increasing)</td></tr>
<tr><td>SptUp</td><td>Set-point going up (raising) activated</td></tr>
<tr><td>SptVal</td><td>Set-point value. An analogue value that is either input as control to a function or generated by a controlling function.</td></tr>
<tr><td>StatLReact</td><td>Stator leakage reactance [p.u.]</td></tr>
<tr><td>StatRis</td><td>Stator resistance [Ω]</td></tr>
<tr><td>StatRisTmp</td><td>Refernce temperature for stator resistance [°C]</td></tr>
<tr><td>StepNg</td><td>Step size when changing from positive to negative direction</td></tr>
<tr><td>StepPos</td><td>Active step, of a sequencer or device that acts step-wise</td></tr>
<tr><td>StepPs</td><td>Step size when changing from negative to positive direction</td></tr>
<tr><td>StndStl</td><td>This Data is used to indicate that a generator is at standstill.</td></tr>
<tr><td>Stop</td><td>Stop command to a sequencer, controller or other automatic device</td></tr>
<tr><td>StopCmpl</td><td>Stop sequence completed, brakes released, no creepining, roll-out time passed.</td></tr>
<tr><td>StopSynPrg</td><td>Stop synchronising process</td></tr>
<tr><td>StopVlv</td><td>This Data is responsible for control and indication of the valve that stops the generator driving forces. TRUE = valve closed. (IEC 61850-7-4). This Data can also represent a solenoid or any similar device, it identifies that the generator is formally stopped.</td></tr>
</table>

Table 19 *(continued)*

Data Name	Semantics
Str	Start (Common data class ACT) indicates the detection of a fault or an unacceptable condition. Str may contain phase and directional information. (*IEC 61850-7-4*)
StrCmpl	Start sequence completed
StrCrv	Start level curve
StrSynPrg	Start synchronising process
StrVal	Level of the supervised value, which starts a dedicated action of the related function. (*IEC 61850-7-4*)
StrValB	Second level set-point (in the case of two separate actions)
Stuck	Device is blocked through external influence (can not operate or move)
SynFlt	Synchroniser in fault state
SynRdy	Synchroniser in ready state
SynSetMod	Synchrinser in setting mode (blocked from operation)
T1	Time constant 1 [ms]
T1ld	Time constant 1 (lead) [ms]
T2	Time constant 2 [ms]
T2ld	Time constant 2 (lead) [ms]
T3	Time constant 3 [ms]
T3ld	Time constant 3 (lead) [ms]
Td	Derivative time constant [ms]
Tf	Derivative time filter constant [ms]
Ti	Integral time constant [ms]
TmCstTa	Armature time constant T_a (unsaturated) [ms]
TmCstTd0P	D-axis open circuit transient time constant T_{d0}’ (unsaturated) [ms]
TmCstTd0S	D-axis open circuit sub-transient time constant T_{d0}’’ (unsaturated) [ms]
TmCstTdP	D-axis short-circuit transient time constant T_d’ (unsaturated) [ms]
TmCstTdS	D-axis short-circuit sub-transient time constant T_d’’ (unsaturated) [ms]
TmCstTq0P	Q-axis open circuit transient time constant T_{q0}’ (unsaturated) [ms]
TmCstTq0S	Q-axis open circuit sub-transient time constant T_{q0}’’ (unsaturated) [ms]
TmCstTqP	Q-axis short-circuit transient time constant T_q’ (unsaturated) [ms]
TmCstTqS	Q-axis short-circuit sub-transient time constant T_q’’ (unsaturated) [ms]
Tmp	The temperature of a specified component or in a specified volume [°C]. (*IEC 61850-7-4*)
TmpAlm	Temperature alarm because of an abnormal condition (FALSE = normal, TRUE = alert). (*IEC 61850-7-4*)
TmpAlmSpt	Set-point for temperature alarm level [°C]
TmpTrSpt	Set-point for temperature trip level [°C]
TmTot	Total operation time of the process
TnkTyp	Type of tank (e.g. type of data representing the tank fill status) <table><tr><th>*Type of measurements*</th><th>*Value*</th></tr><tr><td>Pressure only</td><td>1</td></tr><tr><td>Level only</td><td>2</td></tr><tr><td>Both pressure and level</td><td>3</td></tr></table>

Table 19 *(continued)*

<table>
<tr><th>Data Name</th><th>Semantics</th></tr>
<tr><td>Tns</td><td>Tension, mechanical stress in a measured object [N]</td></tr>
<tr><td>TotFlw</td><td>Total water flow through a plant [m³/s]</td></tr>
<tr><td>TotFlwMax</td><td>Total flow maximum reached</td></tr>
<tr><td>TotFlwMaxLm</td><td>(Temporary) limit to maximum allowed total flow</td></tr>
<tr><td>TotFlwMn</td><td>Total flow minimum reached</td></tr>
<tr><td>TotFlwMnLm</td><td>(Temporary) limit to minimum allowed total flow</td></tr>
<tr><td>Trip</td><td>General trip or stop command (TRUE = trip condition reached)</td></tr>
<tr><td>UntOpMod</td><td>Operational mode of the generating unit
<table>
<tr><th>Operational mode</th><th>Value</th></tr>
<tr><td>Generating mode</td><td>1</td></tr>
<tr><td>Synchronous condenser mode</td><td>2</td></tr>
<tr><td>Pumping mode</td><td>3</td></tr>
</table></td></tr>
<tr><td>UntOpSt</td><td>Operational status of the generating unit
<table>
<tr><th>Operational condition</th><th>Value</th></tr>
<tr><td>Blocked from operation (disabled)</td><td>1</td></tr>
<tr><td>Stopped (needs control sequence to start)</td><td>2</td></tr>
<tr><td>Starting (start-up in progress)</td><td>3</td></tr>
<tr><td>Generator energised</td><td>4</td></tr>
<tr><td>Synchronised, normal conditions</td><td>5</td></tr>
<tr><td>Stopping (shut-down in progress)</td><td>6</td></tr>
<tr><td>Creeping (slow movement)</td><td>7</td></tr>
<tr><td>Standby (stopped but ready for start)</td><td>8</td></tr>
</table></td></tr>
<tr><td>Up</td><td>Direction upwards (increasing)</td></tr>
<tr><td>V1Clc</td><td>Calculated amplitude of voltage 1</td></tr>
<tr><td>V2Clc</td><td>Calculated amplitude of voltage 2</td></tr>
<tr><td>Vadj</td><td>Voltage matcher on/off (TRUE=ON)</td></tr>
<tr><td>Vbr</td><td>Vibration level [mm/s²]</td></tr>
<tr><td>VbrAlmSpt</td><td>Vibration alarm level set-point</td></tr>
<tr><td>VbrTrpSpt</td><td>Vibration trip level set-point</td></tr>
<tr><td>VChr</td><td>Voltage adjustment characteristic</td></tr>
<tr><td>VcompFact</td><td>Compensation factor U1/U2. Used to compensate for amplitude between the two measured voltages in the case of different measuring transformer behaviour</td></tr>
<tr><td>Vol</td><td>Voltage non-phase related (IEC 61850-7-4). Here used for DC voltage</td></tr>
<tr><td>VerWdDir</td><td>Vertical wind direction</td></tr>
<tr><td>VerWdSpd</td><td>Average vertical wind speed [m/s]</td></tr>
<tr><td>VinvTms</td><td>Voltage adjustment time interval</td></tr>
<tr><td>Vlm</td><td>Volumetric content of a container, reservoir, dam or tank [m³]</td></tr>
<tr><td>VlmCap</td><td>Maximum volume oto which container can be filled</td></tr>
<tr><td>VnomV</td><td>Nominal secondary voltage</td></tr>
<tr><td>VolStp</td><td>Voltage control set-point</td></tr>
</table>

Table 19 *(continued)*

Data Name	Semantics
VolPsGnd	DC voltage between negative pole and earth
VolNgGnd	DC voltage between positive pole and earth
VRtg	U_N - Rated Voltage, intrinsic property of the device, which cannot be set/changed from remote. (*IEC 61850-7-4*)
VRtgLim	Temporary limit of rated operating voltage
Watt	Real power in a non-three-phase circuit (*IEC 61850-7-4*)
WetBlbTmp	Wet bulb temperature [°C]
WdGustSpd	Maximum wind gust speed [m/s]

9 Common data classes

9.1 General

Common data classes are defined in IEC 61850-7-3. For explanation of the layout of the data class tables, see IEC 61850-7-3.

9.2 Device ownership and operator (DOO)

Clause 7.9.2 of IEC 61850-7-3 defines the device name-plate information, including the vendor, the device, and its location. However, in many cases, for example when a plant is co-owned by more than one utility, the ownership of a specific device is also important, along with the entity responsible for operations. Common Data Class DOO shall be used for general information as well as part of access management.

DOO Class					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataName	Inherited from Data Class (see IEC 61850-7-2)				
DataAttribute					
		description			
owner	VISIBLE STRING255	DC			M
site	VISIBLE STRING255	DC			O
psName	VISIBLE STRING255	DC			O
role	VISIBLE STRING255	DC			O
primOpr	VISIBLE STRING255	DC			O
secOpr	VISIBLE STRING255	DC			O
cdcNs	VISIBLE STRING255	EX			AC_DLNDA_M
cdcName	VISIBLE STRING255	EX			AC_DLNDA_M
dataNs	VISIBLE STRING255	EX			AC_DLN_M

9.3 Maintenance and operational tag (TAG)

Common Data Class TAG shall be used to represent the operational and maintenance tag that can be logically affixed to primary equipment that is temporary taken out of operation.

TAG class					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value range**	**M/O/C**
DataName	Inherited from Data Class (see IEC 61850-7-2)				
DataAttribute					
		control and status			
ctlVal	BOOLEAN	CO		off (FALSE) | on (TRUE)	AC_CO_M
operTm	TimeStamp	CO			AC_CO_O
origin	Originator	CO, ST			AC_CO_O
ctlNum	INT8U	CO, ST		0…255	AC_CO_ST
stVal	BOOLEAN	ST	dchg	FALSE | TRUE	AC_ST
q	Quality	ST	qchg		AC_ST
t	TimeStamp	ST			AC_ST
stSeld	BOOLEAN	ST	dchg		AC_CO_O
		substitution			
subEna	BOOLEAN	SV			PICS_SUBST
subVal	BOOLEAN	SV		FALSE | TRUE	PICS_SUBST
subQ	Quality	SV			PICS_SUBST
subID	VISIBLE STRING64	SV			PICS_SUBST
		configuration, description and extension			
id	VISIBLE STRING 255				O
tagType	ENUM			Out (of service); Hold; Local; Out+Local; Hold+Local	M
startTime	VISIBLE STRING255				O
stopTime	VISIBLE STRING255				O
ctlModel	CtlModels	CF			M
sboTimeout	INT32U	CF			AC_CO_O
sboClass	SboClasses	CF			AC_CO_O
d	VISIBLE STRING255	DC		Text	O
dU	UNICODE STRING255	DC			O
cdcNs	VISIBLE STRING255	EX			AC_DLNDA_M
cdcName	VISIBLE STRING255	EX			AC_DLNDA_M
dataNs	VISIBLE STRING255	EX			AC_DLN_M

9.4 Operational restriction (RST)

Common Data Class RST comprises attribute data that represent operational restriction on primary equipment.

RST class					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value range**	**M/O/C**
DataName	Inherited from Data Class (see IEC 61850-7-2)				
DataAttribute					
		setting			
setMag	AnalogueValue	SP			AC_NSG_M
setMag	AnalogueValue	SG, SE			AC_SG_M
		configuration, description and extension			
id	VISIBLE STRING 255				O
val	FLOAT32				O
units	Unit	CF			O
sVC	ScaledValueConfig	CF			AC_SCAV
minVal	AnalogueValue	CF			O
maxVal	AnalogueValue	CF			O
stepSize	AnalogueValue	CF		1 … (maxVal – minVal)	O
d	VISIBLE STRING255	DC		Text	O
dU	UNICODE STRING255	DC			O
cdcNs	VISIBLE STRING255	EX			AC_DLNDA_M
cdcName	VISIBLE STRING255	EX			AC_DLNDA_M
dataNs	VISIBLE STRING255	EX			AC_DLN_M

10 Data attribute semantics

In Table 20, the data attributes used in Clause 9 are described. In the case that a data attribute name is used in IEC 61850-7-3, the semantic is repeated here for easier reference.

Table 20 – Semantics of data attributes

<table>
<tr><th>Data attribute name</th><th>Semantics</th></tr>
<tr><td>cdcName</td><td>Name of the common data class. Used together with cdcNs, for details, see IEC 61850-7-1. (IEC 61850-7-3)</td></tr>
<tr><td>cdcNs</td><td>Common data class name space. For details, see IEC 61850-7-1. (IEC 61850-7-3)</td></tr>
<tr><td>ctlModel</td><td></td></tr>
<tr><td>ctlNum</td><td>If the change of the status was caused by a control, the content shall show the control sequence number of the control service. All service primitives belonging to one control sequence shall be identified by the same control sequence number. The use of ctlNum is an issue of the client. The only thing the server shall do with ctlNum is to include it in the responses to the control model and in the reports about a status change that is caused by a command. (IEC 61850-7-3)</td></tr>
<tr><td>ctlVal</td><td>Determines the control activity. TRUE = operational tag active, FALSE = tag inactive.</td></tr>
<tr><td>d</td><td>Textual description of the data (IEC 61850-7-3).</td></tr>
<tr><td>dataNs</td><td>Data name space. For details, see IEC 61850-7-1. (IEC 61850-7-3)</td></tr>
<tr><td>dU</td><td>Textual description of the data using Unicode characters. (IEC 61850-7-3)</td></tr>
<tr><td>id</td><td>Name or identification of person responsible for inserting or activating the data. For the CDCs in this part of IEC 61850, id refers to:
<table>
<tr><th>CDC</th><th>Data attribute id refers to</th></tr>
<tr><td>TAG</td><td>Person responsible for setting TAG to TRUE</td></tr>
<tr><td>RST</td><td>Person responsible for inserting an operational restriction</td></tr>
</table></td></tr>
<tr><td>operTm</td><td>If the service TimeActivatedOperate is performed, then this attribute shall specify the absolute time when the command shall be executed. (IEC 61850-7-3)</td></tr>
<tr><td>origin</td><td>Contains information related to the originator of the last change of the controllable value of the data. (IEC 61850-7-3)</td></tr>
<tr><td>owner</td><td>Owner of physical device that the common data class relates to</td></tr>
<tr><td>primOpr</td><td>Primary operator of physical device</td></tr>
<tr><td>psName</td><td>Name of power system (grid or section) the physical device is connected to</td></tr>
<tr><td>q</td><td>Quality of the attribute(s) representing the value of the data. For the different CDCs, q applies to the following data attributes:
<table>
<tr><th>CDC</th><th>Data attribute q applies to</th></tr>
<tr><td>TAG</td><td>stVal</td></tr>
</table>
(text from IEC 61850-7-3)</td></tr>
<tr><td>role</td><td>The role (or purpose) of the physical device within the overall system structure</td></tr>
<tr><td>secOpr</td><td>Secondary operator of physical device</td></tr>
<tr><td>site</td><td>The name of the site where the physical device is located</td></tr>
<tr><td>startTime</td><td>Time when the operational tag is set (or will come into effect)</td></tr>
<tr><td>stopTime</td><td>Time when the operational tag is planned to be removed. Note that the stop time is for information only; this does not imply that the tag will be automatically removed when the time is reached. The tag shall always be removed by the person who originally set it</td></tr>
<tr><td>stVal</td><td>Status value of the data (IEC 61850-7-3)</td></tr>
<tr><td>stSeld</td><td>The controllable data is in the status “selected”. (IEC 61850-7-3)</td></tr>
</table>

Table 20 *(continued)*

<table>
<tr><th>Data attribute name</th><th>Semantics</th></tr>
<tr><td>subEna</td><td>Used to enable substitution. If this attribute is set to true, the attribute(s) representing the value of the data instance shall always be set to the same value as the attribute(s) used to store the substitution value of the data. If this attribute is set to false, the attribute(s) representing the value of the data instance shall be based on the process value (the value found in the IED). For the different CDCs q applies to the following data attributes:
<table>
<tr><th>CDC</th><th>Data attribute q applies to</th></tr>
<tr><td>TAG</td><td>StVal and subVal, q and subQ</td></tr>
</table>
It is the responsibility of the client application, in particular in the case of multiple attributes to be substituted, to set all relevant substaitution values before enabling substitution.
(text from IEC 61850-7-3)</td></tr>
<tr><td>subID</td><td>Shows the address of the device that made the substitution. The value of null shall be used if subEna is false or the device is not known. (IEC 61850-7-3)</td></tr>
<tr><td>subQ</td><td>Value used to substitute the data attribute q. (IEC 61850-7-3)</td></tr>
<tr><td>subVal</td><td>Value used to substitute the attribute representing the value of the data instance. For the different CDCs, subVal is used to substitute the following data attributes:
<table>
<tr><th>CDC</th><th>Data attribute q applies to</th></tr>
<tr><td>TAG</td><td>stVal</td></tr>
</table>
(text from IEC 61850-7-3)</td></tr>
<tr><td>t</td><td>Timestamp of the last change in one of the attribute(s) representing the value of the data or in the q attribute. For the different CDCs t applies to the following data attributes:
<table>
<tr><th>CDC</th><th>Data attribute q applies to</th></tr>
<tr><td>TAG</td><td>stVal</td></tr>
</table>
(text from IEC 61850-7-3)</td></tr>
<tr><td>tagType</td><td>Type of maintenance tag. The values are:
<table>
<tr><th>value</th><th></th></tr>
<tr><td>1</td><td>Out (- of service)</td></tr>
<tr><td>2</td><td>Hold (do not operate)</td></tr>
<tr><td>3</td><td>Local (- operation selected)</td></tr>
<tr><td>4</td><td>Out + Local</td></tr>
<tr><td>5</td><td>Hold + Local</td></tr>
</table>
</td></tr>
</table>

Annex A
(informative)

Algorithms used in logical nodes for automatic control

A.1 General

A number of logical nodes for control functions are based on the algorithms used rather than the allocation in a functional structure. This annex provides more detailed information on the functional content behind the formal Logical Node definitions.

The following Logical Nodes are described in this annex:

- FCSD – Curve shape description function
- FPID – PID regulator function
- FFIL – Filter function
- FRMP – Set-point ramping function
- FSPT – Set-point control function

A.2 Logical Node FCSD (Curve shape description)

The logical node is used to adapt an incoming value to a specific curve function. As an example, it can be used to adjust non-linear transmitters to the correct physical values. The curve is two-dimensional in nature, however a three-dimensional curve can be achieved by using several instances of the FCSD LN.

In Figure A.1, an example of a 2 dimensional curve used for shaping a Flow Value based on the gate position is given. The values entered in the table are based on statistical data obtained following a series of index tests.

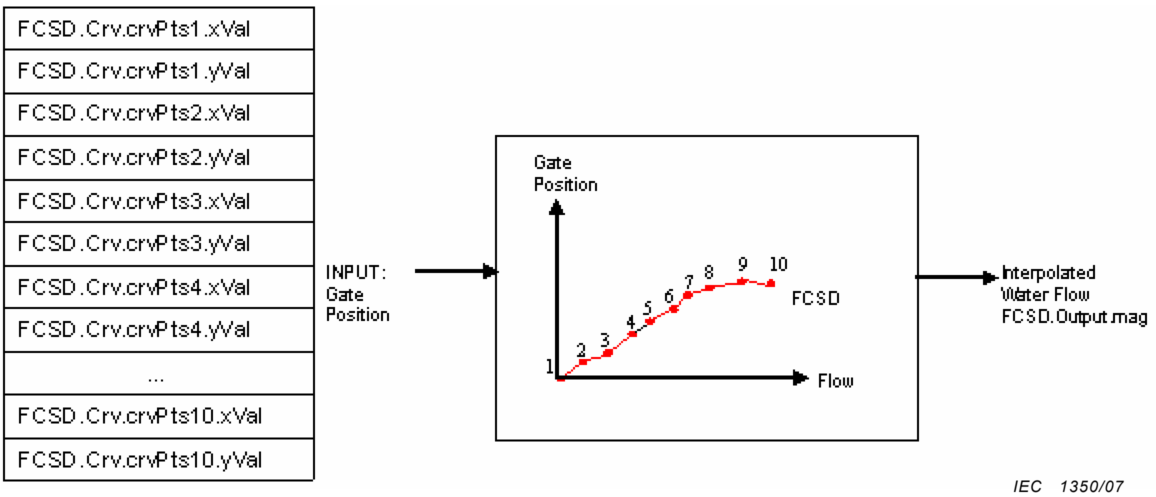


Figure A.1 – Example of curve based on an indexed gate position providing water flow

A.3 Logical Node FCSD (Curve shape group)

The logical node is used to adapt an incoming value to a specific curve function. As an example it can be used to adjust non-linear transmitters to the correct physical values. The curve is two-dimensional in nature, however a three-dimensional curve can be achieved by using several instances of the FCSG LN. The logical node is similar to FCSD with the exception that they modifiable online.

In Figure A.2, an example of a three-dimensional curve used for defining a runner blade position based on two variables: net head and guide vane position is given. To achieve such a function five logical nodes are required.

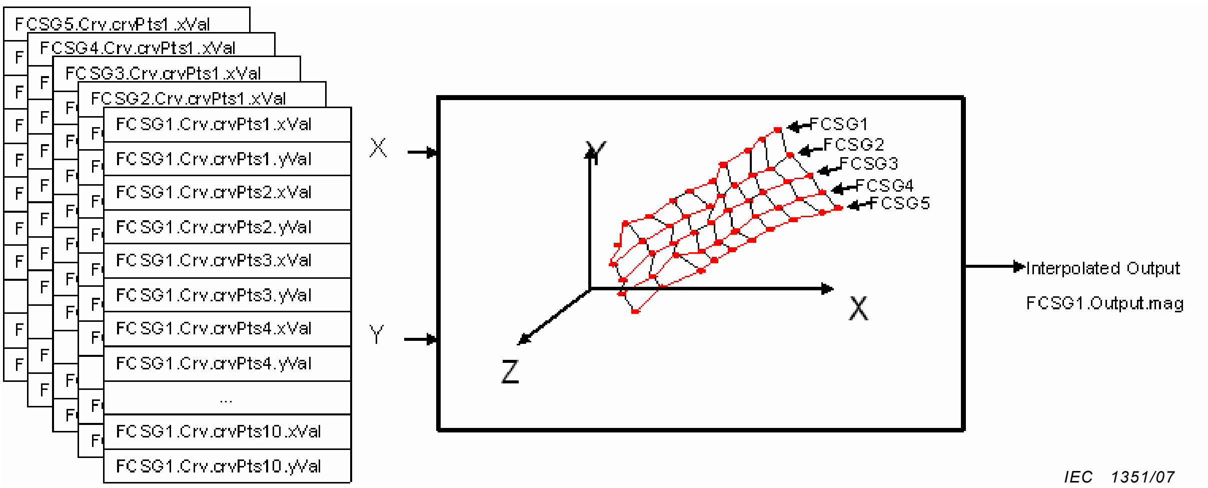


Figure A.2 – Example of curve based on an indexed guide vane position (X axis) versus net head (Y axis) giving an interpolated Runner Blade position (Z axis)

A.4 Logical Node FPID (PID regulator function)

The PID logical node comprises the following basic functions:

– The Proportional function

This logical node is used to amplify an incoming value.

$$Output(t) = K_p \times Input(t); \qquad G(s) = \frac{Output(s)}{Input(s)} = K_p$$

– The Integral function

This logical node is used to integrate an incoming value.

$$Output(t) = \frac{K}{Ti} \times \int_t Input \times dt\,; \qquad G(s) = \frac{Output(s)}{Input(s)} = K \times \frac{1}{s \times Ti}$$

– The Differential function

This logical node is used to adapt an incoming value to a specified function.

$$Output(t) = Input(t) \times K \times \frac{Td}{Tf} \times e^{\frac{-t}{Tf}} \qquad ; \; G(s) = \frac{Output(s)}{Input(s)} = K \times \frac{s \times Td}{1 + s \times Tf}$$

In Figure A.3, a typical proportional-Integral-Derivate controller is shown. All of the control algorithm parameters are mapped to the Logical Node FPID data attributes. The process value can originate from a sensor or a cascaded controller. The set-point normally will originate from a cascaded controller or a manual command.

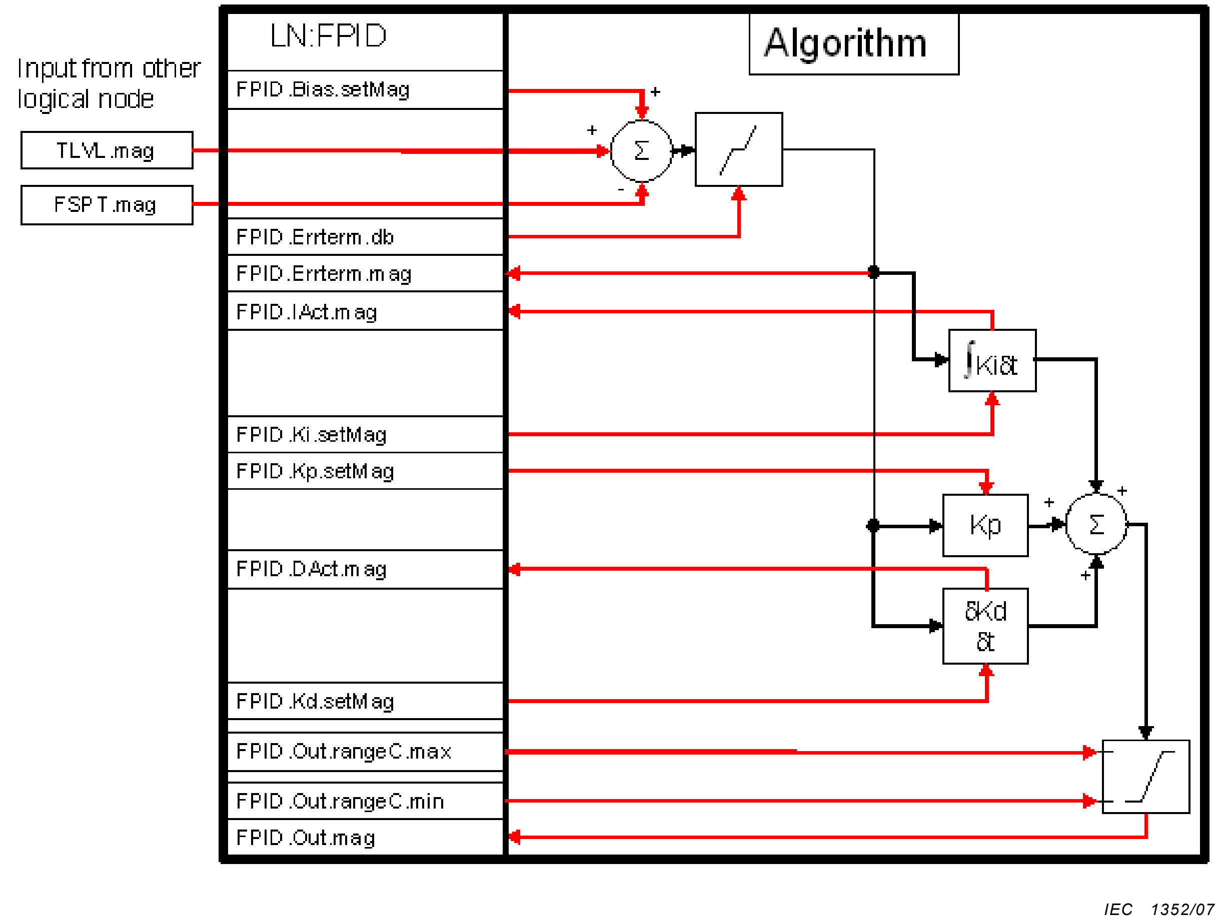


Figure A.3 – Example of a proportional-integral-derivate controller

A.5 Logical Node FFIL (Filter function)

The logical node is used to filter an incoming value.

$$G(s) = \frac{Output(s)}{Input(s)} = K \times \frac{(1 + s \times T1)}{\left(1 + s \times T3 + (s \times T2)^2\right)}$$

More complex logical devices such as Power stabilisation systems make a multiple use of Filters – see Figure A.4.

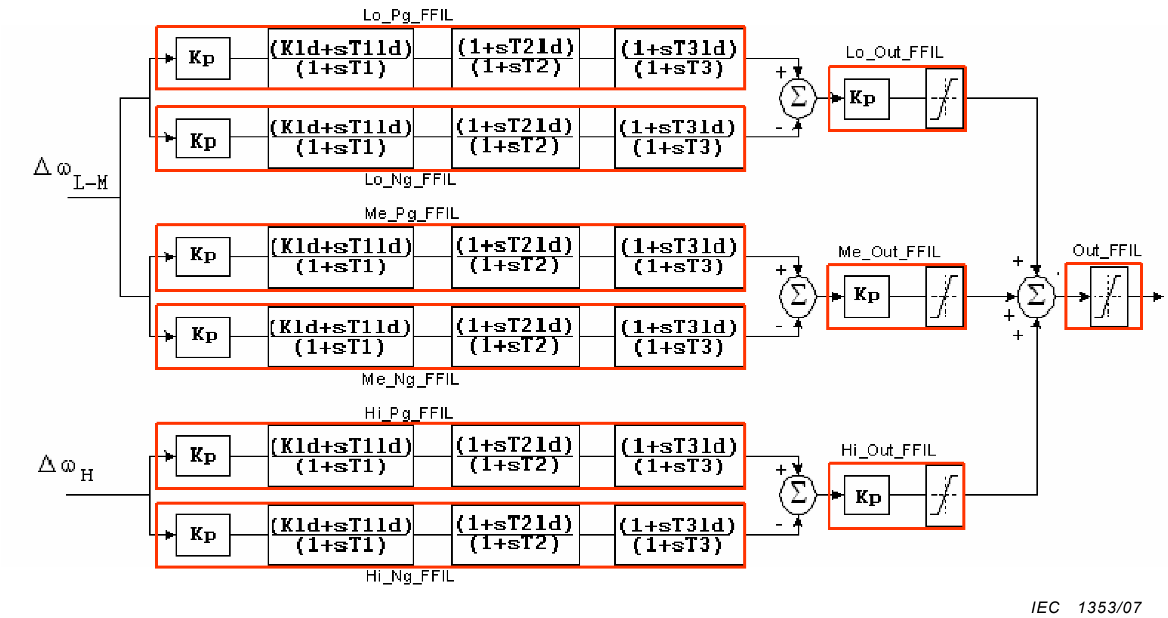


Figure A.4 – Example of a Power stabilisation system

A.6 Logical Node FRMP (Set-point ramping function)

In the example given in Figure A.5, the set-point is being ramped according to two different ramp set levels (FRMP1.RmpUp.stVal ≠ FRMP1.RmpDn.stVal). The time cycle for each increment is given by the defined sample rate (FRMP1.Output.smpRate).

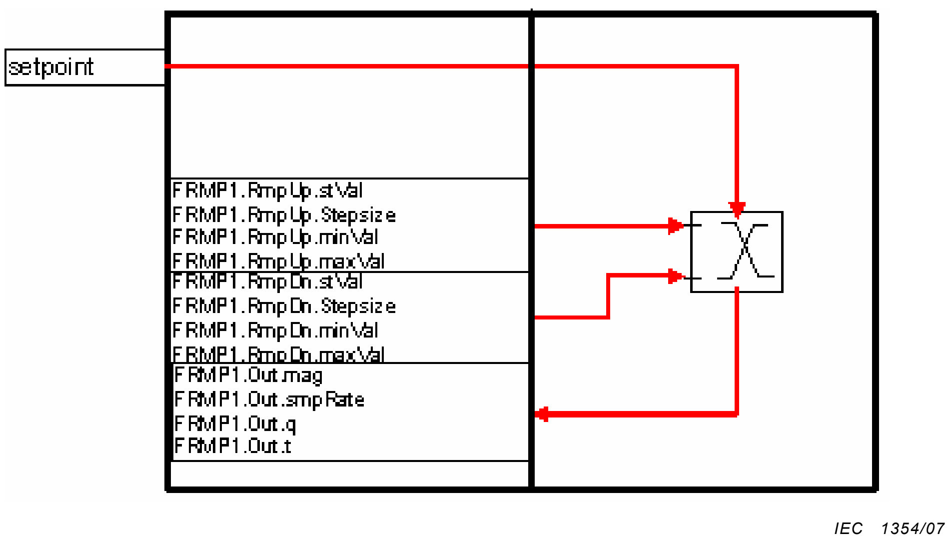


Figure A.5 – Example of a ramp generator

A.7 Logical Node FSPT (Set-point control function)

The Logical Node covers some common characteristics that are used in most automatic control or regulator functions. The ASPT LN can be used as a stand-alone function but will normally be cascaded with other control logical nodes.

The example given in Figure A.6 shows a set-point control interface with a field set-point positioning device.

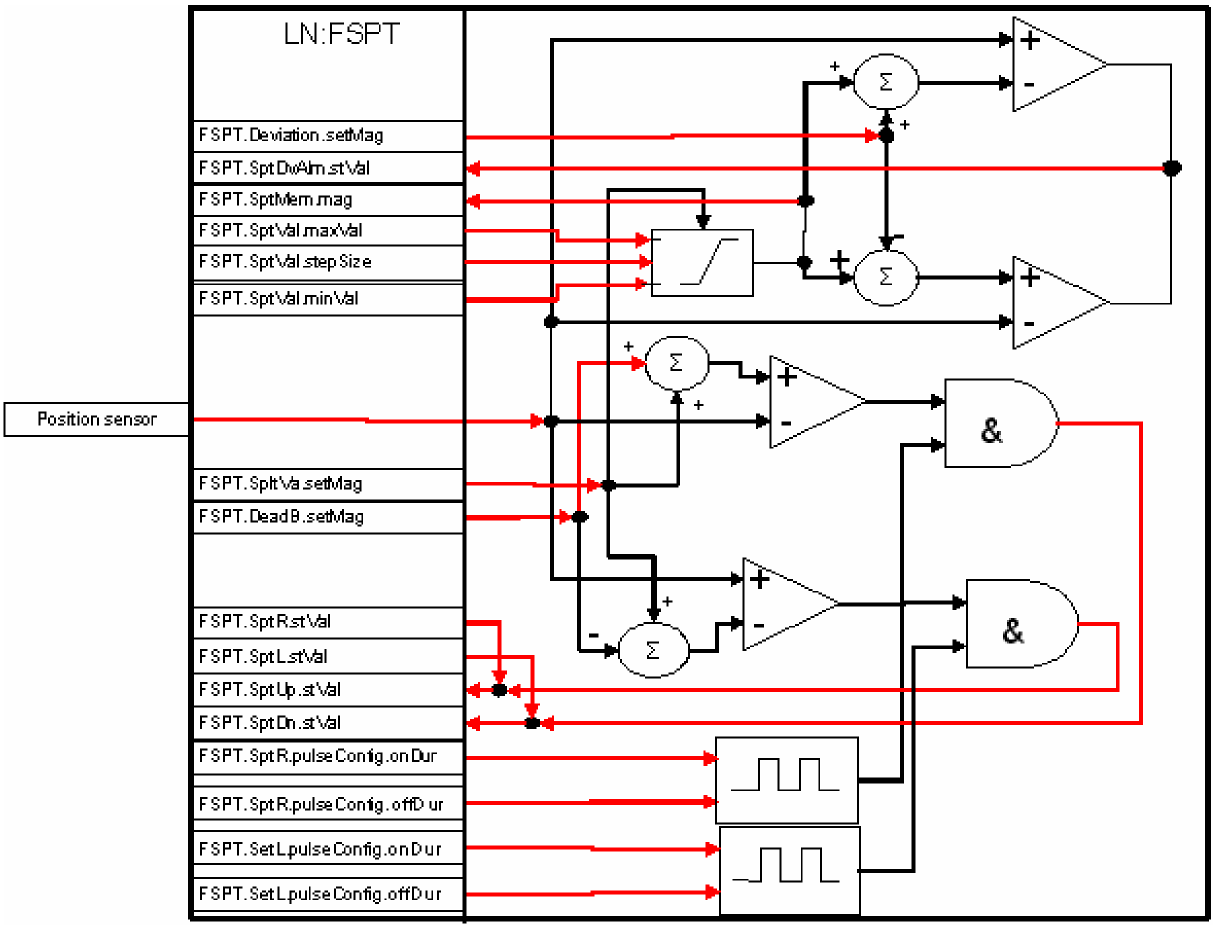


Figure A.6 – Example of an interface with a set-point algorithm

The example given in Figure A.7 shows a physical interface with a motorised potentiometer or a rheostat. Such designs are quite often used to provide an external set-point for analogue controllers.

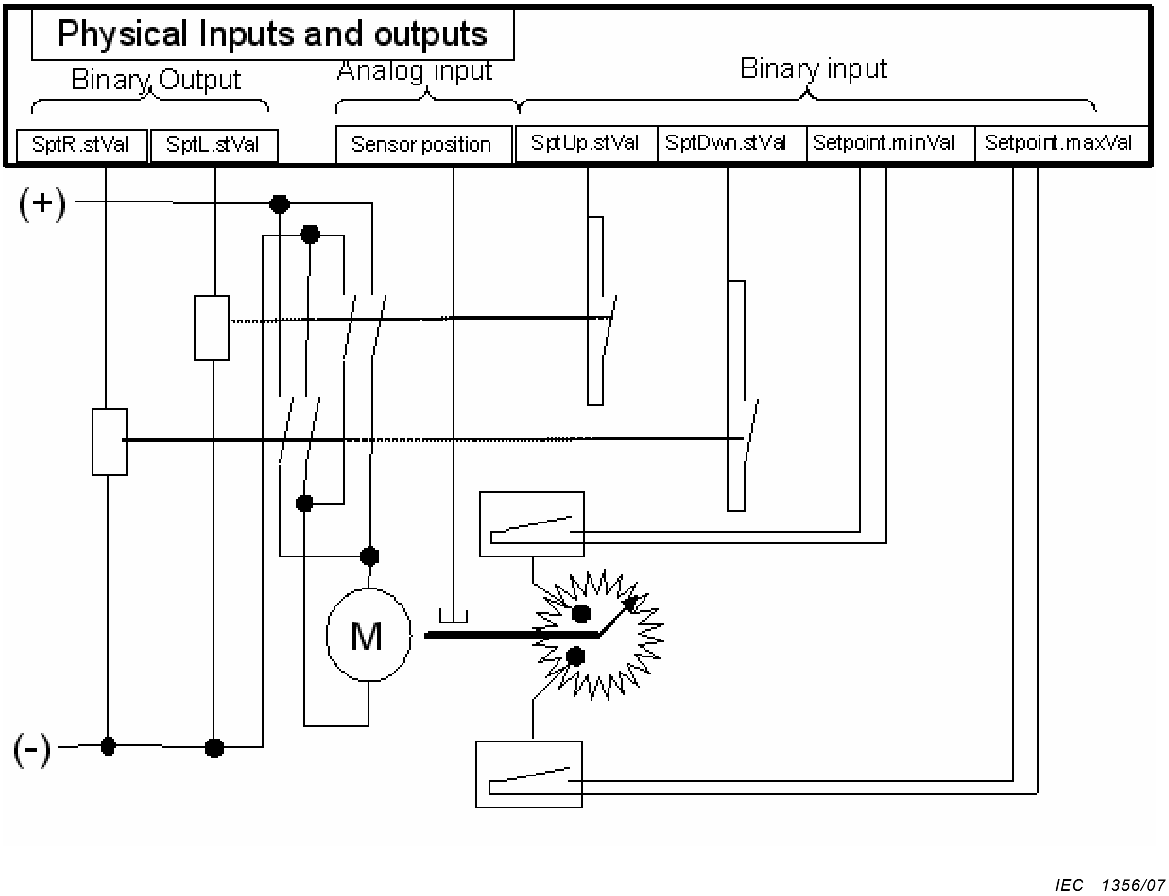


Figure A.7 – Example of a physical connection to a set-point device

Bibliography

Further information and reading on control structures in power plants can be found in the documents listed below:

IEC 61362, Guide to specification of hydraulic turbine control systems

IEC 61400-25-2, *Wind turbines – Part 25-2: Communications for monitoring and control of wind power plants – Information models*

IEC 61850-7-1, *Communication networks and systems in substations – Part 7-1: Basic communication structure for substation and feeder equipment – Principles and models*

IEC 61850-10, *Communication networks and systems in substations – Part 10: Conformance testing*

IEC 61970-301, *Energy management system application program interface (EMS-API) – Part 301: Common Information Model (CIM) base*

IEC 62270, *Hydroelectric power plant automation – Guide for computer-based control*

IEEE P421.5, *IEEE Recommended Practice for Excitation System Models for Power System Stability Studies*

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