

TECHNICAL REPORT



**Communication networks and systems for power utility automation –
Part 7-510: Basic communication structure – Hydroelectric power plants –
Modelling concepts and guidelines**

IEC/TR 61850-7-510:2012

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INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 33.200

ISBN 978-2-8322-0046-9

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CONTENTS

FOREWORD.....	6
INTRODUCTION.....	8
1 Scope.....	9
2 Normative references	9
3 Overall communication structure in a hydropower plant	10
3.1 Abstract communication structure.....	10
3.2 Communication network	10
3.3 Operational modes	12
3.4 Fundamental control strategies	13
3.5 Hydro power plant specific information	14
4 Structuring control systems	16
4.1 Basic use of logical nodes	16
4.2 Logical device modelling	16
4.3 Example of application for an excitation system	19
4.3.1 General	19
4.3.2 Voltage regulation example	22
4.3.3 PSS example.....	24
4.4 Example of application for a turbine governor system.....	25
4.4.1 Conditions of this example.....	25
4.4.2 Signal hierarchy	25
4.4.3 Basic overview	26
4.4.4 Detailed description of used structure	28
4.5 Examples of how to reference a start / stop sequencer of a unit	34
4.5.1 General	34
4.5.2 Unit sequences definition with IEC 61850	34
4.5.3 Start sequence from a state “stopped” to a state “speed no load not excited” (included in LD named “SEQ_SnINexStr”)	35
4.5.4 Start sequence from state “speed no load not excited” to state “generation” (included in LD named “SEQ_SnIExcStr” and “SEQ_GenStr”).....	37
4.5.5 Stop sequence from state “generator” to state “speed no load not excited” (included in LD named “SEQ_GridFaultStop”)	38
4.5.6 Shutdown sequence from state “generator” to state “stopped” (SEQ_NormalStop).....	40
4.5.7 Quick shutdown sequence from state “generator” to state “stopped” (SEQ_QuickStop)	42
4.5.8 Emergency shutdown sequence from state “generator” to state “stopped” (SEQ_EmgStop)	45
5 Variable speed system example	47
5.1 Example of block diagrams and logical nodes of variable speed pumped storage system.....	47
5.2 Example of application for an excitation system of variable speed pumped storage.....	49
5.2.1 General	49
5.2.2 Automatic power regulator example.....	49

5.2.3	Power detector example	50
5.2.4	Gate pulse generator example	50
5.3	Example of governor system	51
5.3.1	Guide vane opening function example	51
5.3.2	Guide vane controller example	52
5.3.3	Speed controller example	53
5.3.4	Optimum speed function example	53
5.4	Example of how to reference a start / stop sequencer for variable speed pumped storage system	54
5.4.1	Unit sequences definition for conventional and variable speed pumped storage	54
5.4.2	Start sequence from a state "Stopped" to a state "Synchronous Condenser (SC) mode in pump direction"	55
5.4.3	Start sequence from a state "Synchronous Condenser (SC) mode in Pump direction" to a state "Pumping"	56
5.4.4	Mode Transition sequence from a state "Pumping" to a state "Synchronous Condenser (SC) mode in Pump direction"	57
5.4.5	Sequence from a state "pumping" to a state "stopped"	58
5.4.6	Emergency shutdown sequence from a state "pumping" to a state "stopped"	60
5.4.7	Shutdown sequence from a state "Synchronous Condenser (SC) mode in pump direction" to a state "stopped"	61
5.4.8	Emergency shutdown sequence from a state "Synchronous Condenser (SC) mode in pump direction" to a state "stopped"	62
6	Pump start priorities of a high pressure oil system	64
6.1	Example of a pump start priority for high pressure oil system	64
6.1.1	General	64
6.1.2	Sequence to manage a pump start priorities	64
6.1.3	Sequence to manage a pump	67
7	Addressing structures, examples of mapping	68
7.1	Basic principles (IEC 61850-6)	68
7.2	Decentralised ICD file management	68
7.3	Centralised ICD file management	69
7.4	Power plant structure – ISO/TS 16952-10 (Reference Designation System – Power Plants)	70
7.4.1	ISO/TS 16952-10 (Reference Designation System – Power Plants)	70
7.4.2	Example 1: Wicket gate indications	73
7.4.3	Example 2: 3 Phase Measurement	74
7.4.4	Example 3: Speed Controller	74
7.4.5	Example 4: Speed measurement with some thresholds	75
7.4.6	Example 5: Common turbine information	76
8	Examples of how to use various types of curves and curve shape descriptions	76
9	Examples of voltage matching function	80
	Bibliography	82
	Figure 1 – Structure of a hydropower plant	10
	Figure 2 – Simplified network of a hydropower plant	12
	Figure 3 – Principles for the joint control function	14
	Figure 4 – Water flow control of a turbine	15

Figure 5 – Pressurised oil systems with LD suffix and with LN prefix.....	18
Figure 6 – Examples of logical nodes used in an excitation system.....	19
Figure 7 – Example of logical devices of the regulation part of an excitation system	21
Figure 8 – AVR basic regulator	22
Figure 9 – Superimposed regulators, power factor regulator	22
Figure 10 – Superimposed regulators, over-excitation limiter	23
Figure 11 – Superimposed regulators, under-excitation limiter	23
Figure 12 – Superimposed regulators, follow up.....	24
Figure 13 – Power system stabilizer function	24
Figure 14 – Signal hierarchy	25
Figure 15 – Use of Logical Node HGOV	27
Figure 16 – Governor control	29
Figure 17 – Flow control	30
Figure 18 – Level control	31
Figure 19 – Speed control.....	32
Figure 20 – Limitations	33
Figure 21 – Actuator control.....	33
Figure 22 – Sequencer overview.....	34
Figure 23 – Typical block diagram in pumping operation.....	47
Figure 24 – Typical block diagram in generating operation.....	48
Figure 25 – Typical block diagram in synchronous condenser mode	48
Figure 26 – Automatic power regulator.....	49
Figure 27 – Power detector.....	50
Figure 28 – Gate pulse generator.....	50
Figure 29 – Guide vane opening function.....	51
Figure 30 – Guide vane controller.....	52
Figure 31 – Speed controller.....	53
Figure 32 – Optimum speed function.....	53
Figure 33 – Sequencer overview.....	54
Figure 34 – Graphical representation of the high pressure oil pumping unit.....	64
Figure 35 – Example of pump priority start logic sequence.....	66
Figure 36 – Example of pump start logic sequence	68
Figure 37 – Exchange of ICD files between system configurators	69
Figure 38 – Static Data exchange with vendor's configuration tool	70
Figure 39 – Tree structure of a system using RDS-PP	72
Figure 40 – Hydraulic correlation curve.....	77
Figure 41 – Turbine correlation curve	80
Figure 42 – Example of traditional voltage adjusting pulses	80
Figure 43 – Example of mapping of the pulse time in IEC 61850.....	80
Figure 44 – Example of an IEC 61850 voltage adjusting command	81
Table 1 – IED within a simplified single unit power plant	11
Table 2 – Recommended LN prefixes	16

Table 3 – Logical device structure.....	20
Table 4 – Logical device names for functions.....	26
Table 5 – Typical sequences.....	35
Table 6 – Logical device names for sequence function groups.....	54
Table 7 – RDS-PP designation codes for Hydropower use.....	71

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COMMUNICATION NETWORKS AND SYSTEMS FOR POWER UTILITY AUTOMATION –

Part 7-510: Basic communication structure – Hydroelectric power plants – Modelling concepts and guidelines

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IEC 61850-7-510, which is a technical report, has been prepared by IEC technical committee 57: Power systems management and associated information exchange.

The text of this technical report is based on the following documents:

Enquiry draft	Report on voting
57/1143/DTR	57/1203/RVC

Full information on the voting for the approval of this technical report 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 stability date indicated on the IEC web site under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication will be

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- amended.

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

INTRODUCTION

This Technical Report is connected with IEC 61850-7-410, as well as IEC 61850-7-4:2010, explaining how the control system and other functions in a hydropower plant can use logical nodes and information exchange services within the complete IEC 61850 package to specify the information needed and generated by, and exchanged between functions.

The dynamic exchange of values by using polling, GOOSE, Reporting or Sampled Values is beyond the scope of this report. This data flow is specified in the engineering work flow defined in IEC 61850-5; this part of IEC 61850 applies also to applications in hydro power plants.

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COMMUNICATION NETWORKS AND SYSTEMS FOR POWER UTILITY AUTOMATION –

Part 7-510: Basic communication structure – Hydroelectric power plants – Modelling concepts and guidelines

1 Scope

This part of IEC 61850 is intended to provide explanations on how to use the Logical Nodes defined in IEC 61850-7-410 as well as other documents in the IEC 61850 series to model complex control functions in power plants, including variable speed pumped storage power plants.

IEC 61850-7-410 introduced the general modelling concepts of IEC 61850 to hydroelectric power plants. It is however not obvious from the standard how the modelling concepts can be implemented in actual power plants.

2 Normative references

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

IEC 60870-5-104, *Telecontrol equipment and systems – Part 5-104: Transmission protocols – Network access for IEC 60870-5-101 using standard transport profiles*

IEC 61850-5:2003, *Communication networks and systems in substations – Part 5: Communication requirements for functions and device models*

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

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

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

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

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

IEC 61850-8-1, *Communication networks and systems for power utility automation – Part 8-1: Specific communication service mapping (SCSM) – Mappings to MMS (ISO 9506-1 and ISO 9506-2) and to ISO/IEC 8802-3*

IEC 61850-9-2, *Communication networks and systems for power utility automation – Part 9-2: Specific communication service mapping (SCSM) – Sampled values over ISO/IEC 8802-3*

ISO/TS 16952-10, *Technical product documentation – Reference designation system – Part 10: Power plants*

3 Overall communication structure in a hydropower plant

3.1 Abstract communication structure

Figure 1 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 consists 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 at least one dam associated with a hydropower plant. There are however reservoirs that are not related to any specific power plant, equally there are power plants from which more than one dam is being controlled. There can also be dams with more than one hydropower plant. While all other objects can be addressed through a specific power plant, dams might have to be addressed directly.

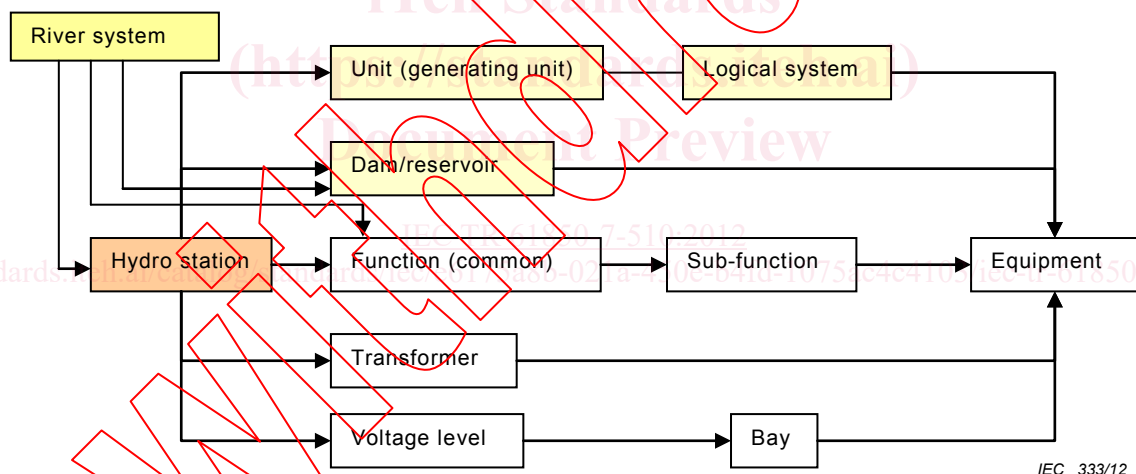


Figure 1 – Structure of a hydropower plant

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 document are more or less overlapping. 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.

3.2 Communication network

Defining a station communication network is one of the primary steps for defining how the logical devices will be distributed among IEDs. The decision of where to nest the logical device is relative to the physical connection of an IED and the field instrumentation. Table 1 lists an example of physical devices used for control of a small hydropower plant.

Table 1 – IED within a simplified single unit power plant

Intelligent electronic device	Description	Example of types of logical Devices nested in an IED
IED1	Intake valve controller	Valve {A, B}
IED2	Turbine controller and speed governor	Actuators, Controllers, Turbine information
IED3	High pressure oil system controller	Tank, Pump A, Pump B
IED4	Generator monitoring system	Phase Windings{A,B,C}, Eccentricity
IED5	Excitation system	Logical device group reference: Regulation, Controls, Field Breaker, Protection
IED6	Bearing monitoring system	Thrust bearing, guide bearing, and generator bearing
IED7	Dam monitoring system	Spillway gate{1,2} and dam
Unit IED	Unit acquisition and control	Logical device group reference: sequences and Alarm grouping
Common IED	Remote terminal unit	Nil
Merging unit 1	Current- and voltage measurements at generator	Merging Unit
Merging unit 2	Current- and voltage measurements in MV	Merging Unit
Merging unit 3	Current- and voltage measurements in HV	Merging Unit
PROT1 T	Primary transformer protection	Protection, measurement
PROT2 T	Secondary transformer protection	Protection, measurement
PROT1 G	Primary generator protection	Protection, measurement
PROT2 G	Secondary generator protection	Protection, measurement

The following example in Figure 2 shows a simplified network of a single unit power plant. The IEDs exchange information and control commands using MMS (IEC 61850-8-1), send trip commands via GOOSE messaging (IEC 61850-9-2) and get information instantaneous current and voltage reading via sample value (IEC 61850-9-2). The logical devices are distributed among IEDs along functional groupings. The information is pushed to the dispatch centre via a data concentrator which is the remote terminal unit using IEC 60870-5-104.

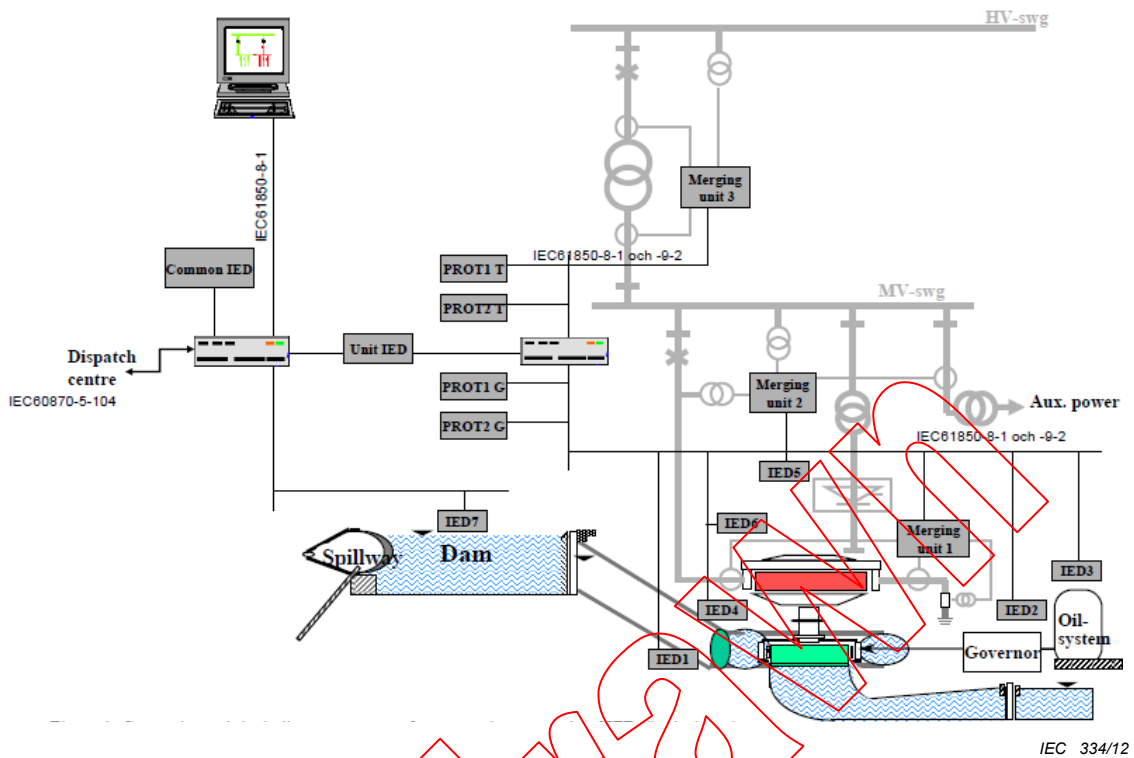


Figure 2 – Simplified network of a hydropower plant

3.3 Operational modes

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:

Stopped – Unit is at standstill

Speed no load, not excited – No field current is applied, no voltage is generated; the generator is running at rated speed but not connected to any external load.

Speed no load, excited – Field current is applied and a voltage is generated, the generator is however not connected to any external load, there is no significant stator current.

Synchronised – The generator is synchronised to an external network. This is the normal status of an operating generator.

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.

Island operation mode – The external network has been separated and the power plant shall control the frequency.