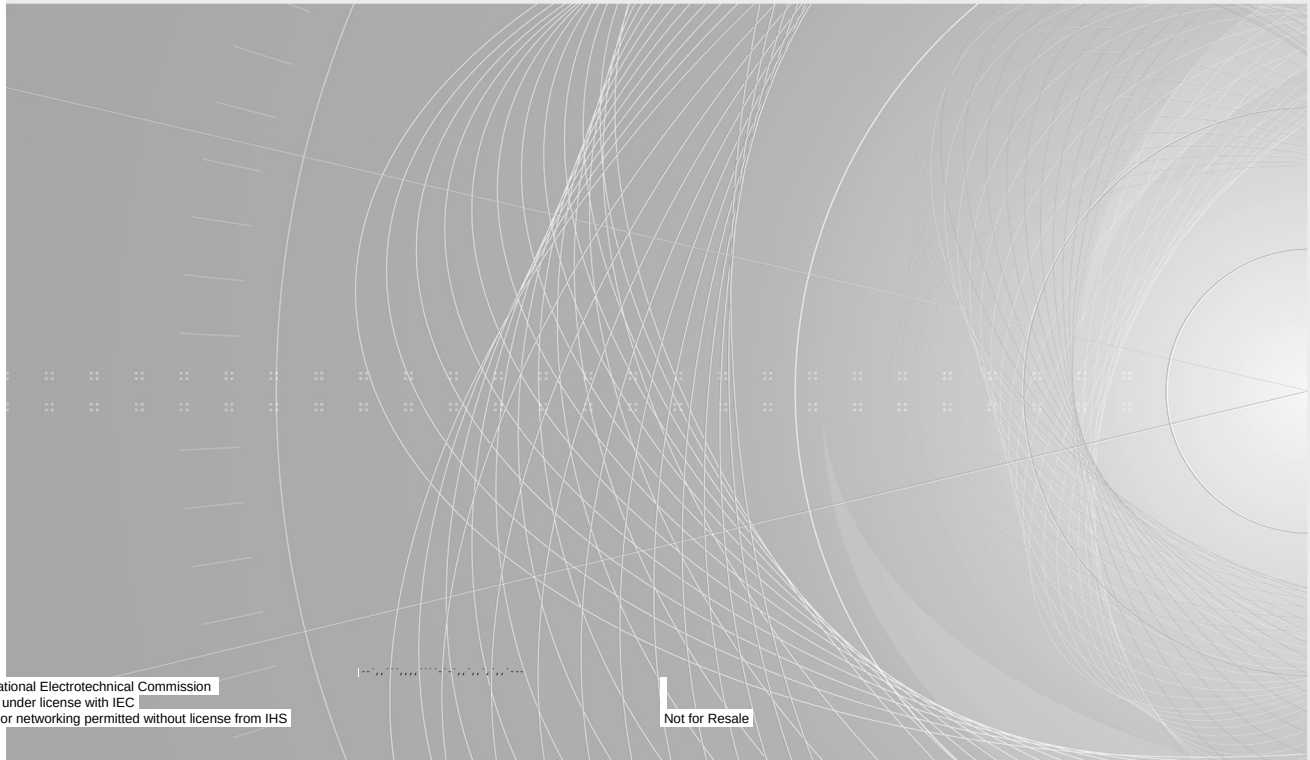
IEC 61850-7-4

Edition 2.0 2010-03

INTERNATIONAL STANDARD

colour inside

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



IEC 61850-7-4:2010(E)

IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland
Email: inmail@iec.ch
Web: www.iec.ch

About the IEC

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

About IEC publications

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

- Catalogue of IEC publications: www.iec.ch/searchpub

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 It also gives information on projects, withdrawn and replaced publications.

- IEC Just Published: www.iec.ch/online_news/justpub

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

- Electropedia: www.electropedia.org

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

- Customer Service Centre: www.iec.ch/webstore/custserv

If you wish to give us your feedback on this publication or need further assistance, please visit the Customer Service Centre FAQ or contact us:

Email: csc@iec.ch
Tel.: +41 22 919 02 11
Fax: +41 22 919 03 00

IEC 61850-7-4

Edition 2.0 2010-03

INTERNATIONAL STANDARD

colour inside

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

INTERNATIONAL ELECTROTECHNICAL COMMISSION

PRICE CODE XH

ICS 33.200

ISBN 2-8318-1082-0

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

COMMUNICATION NETWORKS AND SYSTEMS FOR POWER UTILITY AUTOMATION –

Part 7-4: Basic communication structure – Compatible logical node classes and data object classes

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
6) All users should ensure that they have the latest edition of this publication.
7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 61850-7-4 has been prepared by IEC technical committee 57: Power systems management and associated information exchange.

This second edition cancels and replaces the first edition published in 2003. It constitutes a technical revision.

Future standards in this series will carry the new general title as cited above. Titles of existing standards in this series will be updated at the time of the next edition.

The major technical changes with regard to the previous edition are as follows:

- corrections and clarifications according to information letter "IEC 61850-technical issues by the IEC TC 57" (see document 57/963/INF, 2008-07-18);
- extensions for new logical nodes for the power quality domain;

- extensions for the model for statistical and historical statistical data;
- extensions regarding IEC 61850-90-1 (substation-substation communication);
- extensions for new logical nodes for monitoring functions according to IEC 62271;
- new logical nodes from IEC 61850-7-410 and IEC 61850-7-420 of general interest.

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

FDIS	Report on voting
57/1045/FDIS	57/1051/RVD

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

The content of this part of IEC 61850 is based on existing or emerging standards and applications. In particular the definitions are based upon:

- the specific data objects types defined in IEC 60870-5-101 and IEC 60870-5-103;
- the common class definitions from the Utility Communication Architecture 2.0: Generic Object Models for Substation and Feeder Equipment (GOMSFE) (IEEE TR 1550);
- CIGRE Report 34-03, Communication requirements in terms of data flow within substations, December 1996.

A list of all parts of the IEC 61850 series under the general title *Communication networks and systems in substations*, 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

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

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

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

INTRODUCTION

This part of IEC 61850 is part of a set of standards, the IEC 61850 series. IEC 61850 defines communication networks and systems for power utility automation, and more specially the communication architecture for subsystems such as substation automation systems. The sum of all subsystems may result also in the description of the communication architecture for the overall power system management. The defined architecture provided in specific parts of IEC 61850-7-x gives both a power utility specific data model and a substation domain specific data model with abstract definitions of data objects classes and services independently from the specific protocol stacks, implementations, and operating systems. The mapping of these abstract classes and services to communication stacks is outside the scope of IEC 61850-7-x and may be found in IEC 61850-8-x and in IEC 61850-9-x.

IEC 61850-7-1 gives an overview of the basic communication architecture to be used for all applications in the power system domain. IEC 61850-7-3 defines common attribute types and common data classes related to all applications in the power system domain. The attributes of the common data classes may be accessed using services defined in IEC 61850-7-2. These common data classes are used in this part to define the compatible data object classes.

To reach interoperability, all data objects in the data model need a strong definition with regard to syntax and semantics. The semantics of the data objects is mainly provided by names assigned to common logical nodes defined in this part and the data objects they contain, as defined in this basic part, and dedicated logical nodes defined in domain specific parts such as for hydro power control systems. Interoperability is easiest if as much as possible of the data objects are defined as mandatory. Because of different approaches and technical features, some data objects, especially settings, were declared as optional in this edition of the standard. There are also data objects which were declared as conditional, i.e. they will become mandatory under some well-defined conditions. After some experience has been gained with this standard, this decision may be reviewed in the next edition of this part.

It should be noted that data objects with full semantics are only one of the elements required to achieve interoperability. The standardized access to the data objects is defined in compatible, power utility and domain specific services (see IEC 61850-7-2). Since data objects and services are hosted by devices (IED), a proper device model is also needed. To describe both the device capabilities and the interaction of the devices in the related system, a configuration language is also needed, as defined in IEC 61850-6 by the substation configuration description language (SCL).

The compatible logical node name and data object name definitions found in this part and the associated semantics are fixed. The syntax of the type definitions of all data objects classes is governed by abstract definitions provided in IEC 61850-7-2 and IEC 61850-7-3. Not all features of logical nodes are listed in this part; for example, data sets and logs are covered in IEC 61850-7-2.

COMMUNICATION NETWORKS AND SYSTEMS FOR POWER UTILITY AUTOMATION –

Part 7-4: Basic communication structure – Compatible logical node classes and data object classes

1 Scope

This part of IEC 61850 specifies the information model of devices and functions generally related to common use regarding applications in systems for power utility automation. It also contains the information model of devices and function-related applications in substations. In particular, it specifies the compatible logical node names and data object names for communication between intelligent electronic devices (IED). This includes the relationship between logical nodes and data objects.

The logical node names and data object names defined in this document are part of the class model introduced in IEC 61850-7-1 and defined in IEC 61850-7-2. The names defined in this document are used to build the hierarchical object references applied for communicating with IEDs in systems for power utility automation and, especially, with IEDs in substations and on distribution feeders. The naming conventions of IEC 61850-7-2 are applied in this part.

To avoid private, incompatible extensions, this part specifies normative naming rules for multiple instances and private, compatible extensions of logical node (LN) classes and data object names. Any definition is based on IEC 61850 or on referenced well identified public documents.

This part does not provide tutorial material. It is recommended to read parts IEC 61850-5 and IEC 61850-7-1 first, in conjunction with IEC 61850-7-3, and IEC 61850-7-2.

This standard is applicable to describe device models and functions of substation and feeder equipment. The concepts defined in this standard are also applied to describe device models and functions for:

- substation-to-substation information exchange,
- substation-to-control centre information exchange,
- power plant-to-control centre information exchange,
- information exchange for distributed generation,
- information exchange for distributed automation, or
- information exchange for metering.

Figure 1 provides a general overview of this standard. The groups of logical nodes defined in this standard are shown in Figure 1, ordered according to some semantic meaning, for instance different control levels such as plant level, unit level, etc. For convenience, the logical nodes are defined below in alphabetical order.

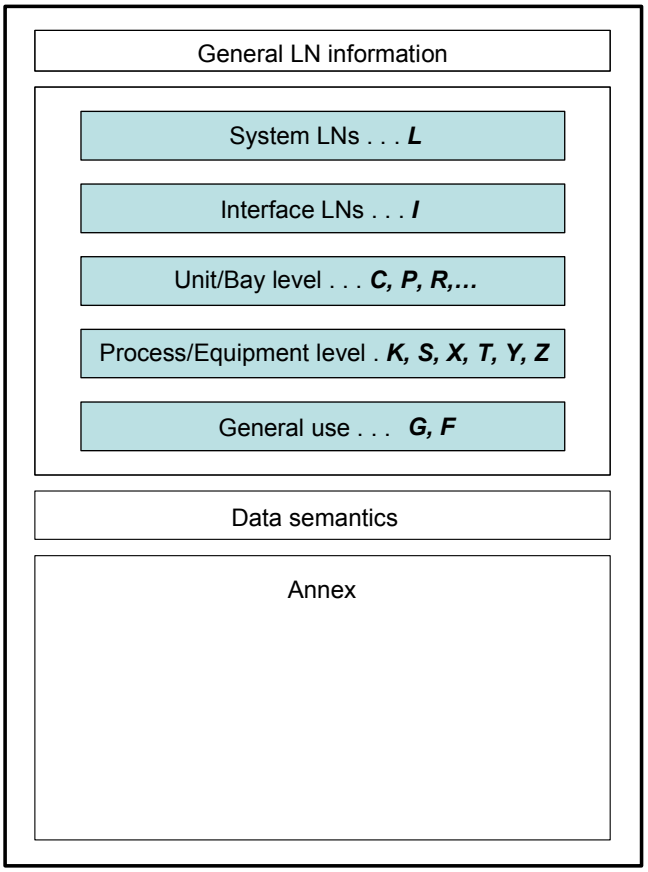


Figure 1 – Overview of this standard

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 60270:2000, *High-voltage test techniques – Partial discharge measurements*

IEC 61000-4-7:2002, *Electromagnetic compatibility (EMC) – Part 4-7: Testing and measurement techniques – General guide on harmonics and interharmonics measurements and instrumentation, for power supply systems and equipment connected thereto*

IEC 61000-4-15, *Electromagnetic compatibility (EMC) – Part 4-15: Testing and measurement techniques – Flickermeter – Functional and design specifications*

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

---

1 To be published.

IEC 61850-7-2:___ [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:___ [3], *Communication networks and systems for power utility automation – Part 7-3: Basic communication structure – Common data classes*

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*

IEEE C37.111:1999, *IEEE Standard Common Format for Transient Data Exchange (COMTRADE) for Power Systems*

IEEE 519:1992, *IEEE Recommended Practises and Requirements for Harmonic Control in Electrical Power Systems*

IEEE C37.2:1996, *Electrical Power System Device Function Numbers and Contact Designation*

IEEE 1459:2000, *IEEE Trial-Use Standard Definitions for the Measurement of Electric Power Quantities Under Sinusoidal, Nonsinusoidal, Balanced, or Unbalanced Conditions*

IEEE 1588, *Precision clock synchronization protocol for networked measurement and control systems*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 61850-2 and IEC 61850-7-2 apply.

4 Abbreviated terms

The following terms are used to build concatenated data object names. For example, ChNum is constructed by using two terms "Ch" which stands for "Channel" and "Num" which stands for "Number". Thus the concatenated name represents a "channel number".

Term	Description	Term	Description
A	Current	Alm	Alarm
Acs	Access	Amp	Current non-phase-related
Abr	Abrasion	An	Analogue
Abs	Absolute	Ang	Angle
AC	AC, alternating current	Ap	Access point
Acc	Accuracy	App	Apparent
Act	Action, activity	Arc	Arc
Acu	Acoustic	Area	Area
Adj	Adjustment	Auth	Authorisation
Adp	Adapter, adaptation	Auto	Automatic
Age	Ageing	Aux	Auxiliary
Air	Air	Av	Average
Alg	Algorithm	AWatt	Wattmetric component of current

[2] To be published.

[3] To be published.

Term	Description
Ax	Axial
B	Bushing
Base	Base
Bat	Battery
Beh	Behaviour
Ber	Bit error rate
Bias	Bias
Bin	Binary
Blb	Bulb
Blk	Block, blocked
Bnd	Band
Bo	Bottom
Bst	Boost
Bus	Bus
C	Carbon
C2H2	Acetylene
C2H4	Ethylene
C2H6	Ethane
Cap	Capability
Capac	Capacitance
Car	Carrier
CB	Circuit breaker
Cdt	Credit
CE	Cooling equipment
Cel	Cell
Cf	Crest factor
Cff	Coefficient
Cfg	Configuration
CG	Core ground
Ch	Channel
CH4	Methane
Cha	Charger
Chg	Change
Chk	Check
Chr	Characteristic
Circ	Circulating, circuit
Clc	Calculate, calculated
Clk	Clock, clockwise
Cloud	Cloud
Clr	Clear
Cls	Close
Cndct	Conductivity
Cnt	Counter
Cmbu	Combustible, combustion
Cmd	Command
CO	Carbon monoxide
CO2	Carbon dioxide
Col	Coil
Conf	Configuration
Cons	Constant
Con	Contact
Cor	Correction
Core	Core
Crd	Coordination
Crit	Critical
Crv	Curve
CT	Current transducer
Ctl	Control
Ctr	Center
Cur	Current
Cvr	Cover, cover level
Cyc	Cycle
D	Derivate
Day	Day
dB	Decibel
Dct	Direct
Dea	Dead
Den	Density
Det	Detected
Detun	Detuning
DExt	De-excitation
Dew	Dew
Dff	Diffuse
Dgr	Degree
Diag	Diagnostics
Dif	Differential, difference
Dip	Dip
Dir	Direction
Dis	Distance
Dsp	Displacement
Dl	Delay
Dlt	Delete
Dmd	Demand
Dn	Down
DPCSO	Double point controllable status output
DQ0	Direct, quadrature, and zero axis quantities
Drag	Drag hand
Day	Day
Drv	Drive
DS	Device state

Term	Description
Dsc	Discrepancy
Dsch	Discharge
Dur	Duration
Dv	Deviation
EC	Earth Coil
Echo	Echo
EE	External equipment
EF	Earth fault
Emg	Emergency
Ems	Emissions
En	Energy
Ena	Enabled
End	End
Env	Environment
Eq	Equalization, equal
Err	Error
Ev	Evaluation
Evt	Event
Ex	External
Exc	Exceeded
Excl	Exclusion
Exp	Expired
Ext	Excitation
F	Float
FA	Fault arc
Fact	Factor
Fail	Failure
Fan	Fan
Fer	Frame error rate
Fil	Filter, filtration
Fish	Fish
Fld	Field
Fll	Fall
Flood	Flood
Flt	Fault
Flush	Flush
Flw	Flow
FPF	Forward power flow
Fu	Fuse
Full	Full
Fwd	Forward
Gas	Gas
Gen	General
Go	Goose
GoCBRef	Goose control block reference (see IEC 61850-7-2)
Gn	Generator
Gnd	Ground
Gr	Group
Grd	Guard
Grn	Green
Gri	Grid
Gust	Gust
H	Harmonics (phase-related)
H2	Hydrogen
H2O	Water
Ha	Harmonics (non-phase-related)
Health	Health
Heat	Heater, heating
Hi	High, highest
Hor	Horizontal
HP	Hot point
Hum	Humidity
Hy	Hydraulics, hydraulic system
Hyd	Hydrological, hydro, water
Hz	Frequency
I	Integral
Imb	Imbalance
Imp	Impedance non-phase-related
In	Input
Ina	Inactivity
Iner	Inertia
Incr	Increment
Ind	Indication
Inh	Inhibit
Ins	Insulation
Insol	Insolation
Int	Integer
Intr	Interrupt, interruption
Intv	Interval
ISCSO	Integer status controllable status output
K	Constant
Kck	Kicker
Key	Key
km	Kilometre
L	Lower
Last	Last
Ld	Lead
LD	Logical device
LDC	Line drop compensation
LDCR	Line drop compensation resistance

Term	Description
LDCX	Line drop compensation reactance
LDCZ	Line drop compensation impedance
Leak	Leakage
LED	Light-emitting diode
Len	Length
Lev	Level
Lg	Lag
Lim	Limit
Lin	Line
Liv	Live
LN	Logical node
Lo	Low
LO	Lockout
Loc	Local
Lod	Load, loading
Lok	Locked
Loop	Loop
Los	Loss
Lst	List
LTC	Load tap changer
M	Minutes
M/O/C	Data object is mandatory or optional or conditional
Made	Made
Mag	Magnetic, magnitude
Max	Maximum
Mbr	Membrane
Mem	Memory
Min	Minimum
Mir	Mirror
Mlt	Multiplier, multiple
Mod	Mode
Month	Month
Mot	Motor
Ms	Milliseconds
Mst	Moisture
MT	Main tank
Mth	Method
Mvm	Movement, moving
N2	Nitrogen dioxide
Nam	Name
Name	Name (see Note)
NdsCom	Needs commissioning (see IEC 61850-7-2)
Net	Net sum
Neut	Neutral
Nit	Nitrogen
Ng	Negative
Nom	Nominal, normalising
Num	Number
NSQ	Average partial discharge current
O2	Oxygen
O3	Ozon, trioxygen
Ofs	Offset
Oil	Oil
Oo	Out of
Op	Operate, operating
Opn	Open
Out	Output
Ov	Over, override, overflow
Ovl	Overload
P	Proportional
Pa	Partial
Pap	Paper
Par	Parallel
Pct	Percent, percentage
Per	Periodic, period
PF	Power factor
Ph	Phase
PH	Acidity, value of pH
PhsA	Phase L1
PhsB	Phase L2
PhsC	Phase L3
PNV	Phase-to-neutral voltage
Phy	Physical
Pi	Instantaneous P
Pls	Pulse
Plt	Plate, long-term flicker severity
Pmp	Pump
Po	Polar
Pol	Polarizing
Pos	Position
PosA	Position phase L1
PosB	Position phase L2
PosC	Position phase L3
Pot	Potentiometer
POW	Point on wave switching
PP	Phase to phase
ppm	Parts per million
PPV	Phase to phase voltage
Pre	Pre-

Term	Description
Pres	Pressure
Prg	Progress, in progress
Pri	Primary
Pro	Protection
Proxy	Proxy
Prt	Parts, part
Ps	Positive
Pst	Post, short-term flicker severity
Pt	Point
Pwr	Power
Qty	Quantity
R	Raise
R0	Zero sequence resistance
Rat	Ratio
Rcd	Record, recording
Rch	Reach
Rcl	Reclaim
Rct	Reaction
Rdy	Ready
Re	Retry
React	Reactance, reactive
Rec	Reclose
Rect	Rectifier
Red	Reduction, redundant
Ref	Reference
Rel	Release
Rem	Remote
Res	Residual
Reso	Resonance
Rev	Revision
Rf	Refreshment
Ris	Resistance
Rl	Relation, relative
Rmp	Ramping, ramp
RMS	Root mean square
Rnbk	Runback
Rot	Rotation, rotor
Rs	Reset, resetable
Rsl	Result
Rst	Restraint, restriction
Rsv	Reserve
Rte	Rate
Rtg	Rating
Rv	Reverse
Rx	Receive, received
S1	Step one
S10	coefficient $S_{1.0}$
S12	coefficient $S_{1.2}$
S2	Step two
Sar	Surge arrestor
Sat	Saturation
Sbs	Subscription
Sch	Scheme
Sco	Supply change over
SCSM	Specific communication service mapping
Sec	Security
Sel	Select
Seq	Sequence
Set	Setting
Sig	Signal
Sign	Sign
Sim	Simulation, simulated
Sh	Shunt
Slnt	Salinity, saline content
Smok	Smoke
Snr	Signal to noise ratio
Snw	Snow
Spd	Speed
Spec	Spectra
SPl	Single pole
SPCSO	Single point controllable status output
Spt	Setpoint
Src	Source
St	Status, state
Sta	Station
Step	Step
Sto	Storage e.g. activity of storing data
Stat	Statistics
Stop	Stop
Std	Standard
Stk	Stroke
Str	Start
Stuck	Stuck
Sup	Supply
Svc	Service
SvCBRef	SV control block reference (see IEC 61850-7-2)
Sw	Switch, switched
Swg	Swing
Syn	Synchronisation
Tap	Tap

Term	Description
Td	Total distortion
Tdf	Transformer derating factor
Tdp	Td’
Td0P	Td0’
Td0S	Td0’’
Tds	Td’’
Term	Termination
Test	Test
Tgt	Target
Thd	Total harmonic distortion
Thm	Thermal
TiF	Telephone influence factor
Tm	Time Tmh = Time in h Tmm = Time in min Tms = Time in s Tmms = Time in ms
Tmp	Temperature (°C)
Tnk	Tank
To	Top
Tot	Total
TP	Three pole
Tpc	Teleprotection
Tqp	Tq’
Tq0p	Tq0’
Tq0s	Tq0’’
Tqs	Tq ’’
Tr	Trip
Trd	Trade
Trip	Trip
Trg	Trigger
Trk	Track, tracking
Trs	Transient
Ts	Total signed
Tu	Total unsigned
Tun	
Tx	Transmit, transmitted
Typ	Type
Uhf	Ultra-high-frequency
Un	Under
Up	Up, upwards
V	Voltage
VA	Volt amperes
Va	Variation
Vac	Vacuum
Val	Value
VAr	Volt amperes reactive

Term	Description
Ver	Vertical
Vbr	Vibration
Viol	Violation
Visc	Viscosity
Vlm	Volume
Vlv	Valve
Vol	Voltage non-phase-related
Volts	Voltage
VT	Voltage transducer
W	Active power
Wac	Watchdog
Watt	Active power non-phase-related
Wav	Wave, waveform
Wd	Wind
Week	Week
Wei	Weak end infeed
Wh	Watt hours
Wid	Width
Win	Window
Wrm	Warm
Wrn	Warning
X0	Zero sequence reactance
X1	Positive sequence reactance
X2	Negative sequence reactance X2
Xd	synchronous reactance Xd
Xdp	transient synchronous reactance Xd’
Xds	Reactance Xd’’
Xq	synchronous reactance Xq
Xqp	transient reactance
Xqs	sub-transient reactance Xq’’
Year	Year
Z	Impedance
Z0	Zero sequence impedance
Z1	Positive sequence impedance
Zer	Zero
Zn	Zone
Zro	Zero sequence method

NOTE The abbreviation “Name” should only be used in data object EEName and LNName.

5 Logical node classes

5.1 Logical node groups

Logical nodes are grouped according to the logical node groups listed in Table 1. The names of logical nodes shall begin with the character representing the group to which the logical node belongs. For modelling per phase (for example switches or instrument transformers), one instance per phase shall be created; for modelling protection per zone or level, one instance per zone or level shall be created also.

Table 1 – List of logical node groups

Group indicator	Logical node groups
A	Automatic control
B	Reserved
C	Supervisory control
D	Distributed energy resources
E	Reserved
F	Functional blocks
G	Generic function references
H	Hydro power
I	Interfacing and archiving
J	Reserved
K[a]	Mechanical and non-electrical primary equipment
L	System logical nodes
M	Metering and measurement
N	Reserved
O	Reserved
P	Protection functions
Q	Power quality events detection related
R	Protection related functions
S[a]	Supervision and monitoring
T[a]	Instrument transformer and sensors
U	Reserved
V	Reserved
W	Wind power
X[a]	Switchgear
Y[a]	Power transformer and related functions
Z[a]	Further (power system) equipment

[a] LNs of this group exist in dedicated IEDs if a process bus is used. Without a process bus, LNs of this group are the I/Os in the hardwired IED one level higher (for example in a bay unit) representing the external device by its inputs and outputs (process image).

5.2 Interpretation of logical node tables

The interpretation of the headings for the logical node tables is presented in Table 2.

Table 2 – Interpretation of logical node tables

Column heading	Description
Data object name	Name of the data object
Common data class	Common data class that defines the structure of the data object. See IEC 61850-7-3. For common data classes regarding the service tracking logical node (LTRK), see IEC 61850-7-2.
Explanation	Short explanation of the data object and how it is used.
T	Transient data objects – the status of data objects with this designation is momentary and must 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 OBJECTS only applies to BOOLEAN process data attributes (FC=ST) of that DATA OBJECTS. A transient DATA OBJECT is identical to normal DATA OBJECT, except that for the process state change from TRUE to FALSE no event may be generated for reporting and for logging. For transient data objects, the falling edge is not reported if the transient attribute is set to true in the SCL-ICD file. It is recommended to report both states (TRUE to FALSE, and FALSE to TRUE), i.e. not to set the transient attribute in the SCL-ICD file for those DOs, and that the clients filter the transitions that are not "desired".
M/O/C	This column defines whether a data object is mandatory (M) or optional (O) or conditional (C) for an instance of a specific logical node. When a data object is marked mandatory (M), it shall be contained in the instance of the logical node. When a data object is marked optional (O), it may be contained in the instance of the logical node; the decision if the data object is contained or not is outside the scope of this standard. The entry C is an indication that a condition exists for this data object, given in a note under the LN table. The condition decides what conditional data objects get mandatory. C may have an index to handle multiple conditions. NOTE1 Procurement specifications may require specific data objects marked optional to be provided for a particular project. The amount of optional information to be provided needs to be negotiated. NOTE 2 The attributes for data objects that are instantiated may also be mandatory or optional based on the CDC (attribute type) definition in IEC 61850-7-3.

The LNName attribute is inherited from Logical-Node class (see IEC 61850-7-2). The LN class names are individually given in the logical node tables. The LN instance name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.

All data object names are listed alphabetically in Clause 6. Despite some overlapping, the data objects in the logical node classes are grouped for the convenience of the reader into the following categories:

– Status information
  Status information contains data object, which show either the status of the process or of the function allocated to the LN class. This information is produced locally and cannot be changed via communication for operational reasons unless substitution is applicable. Data objects such as “start” or “trip” are listed in this category. Most of these data objects are mandatory.

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

– Controls
Controls contain data objects which are changed by commands such as switchgear state (ON/OFF), tap changer position or resettable counters. They are typically changed remotely, and are changed during operation much more often than settings.

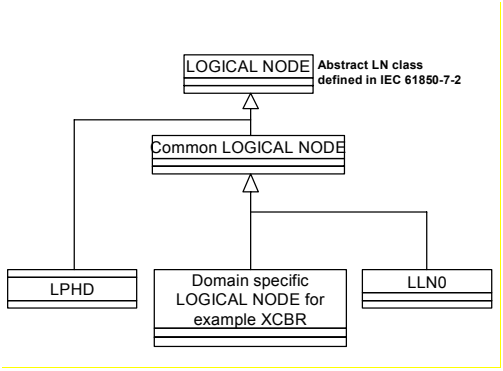
– Settings
Settings are data objects which configure the function for its operation. Since many settings are dependent on the implementation of the function, only a commonly agreed minimum is standardised. They may be changed from remote, but normally not very often.

– Descriptions
Descriptions are data objects, which give information about the LN itself or an allocated device. This information consists of identification information and general properties like configuration revision, hard and software revisions, etc.

5.3 System logical nodes LN group: L

5.3.1 LN relationships

In this subclause, the system specific information is defined. This includes common logical node information (for example logical node behaviour, nameplate information, operation counters) as well as information related to the physical device (LPHD) implementing the logical devices and logical nodes. These logical nodes (LPHD and common LN) are independent of the application domain. All other logical nodes are domain specific, but inherit mandatory and optional data objects from the common logical node.



IEC 1103/03

Figure 2 – LOGICAL NODE relationships

All logical node classes defined in this document inherit their structure from the GenLogicalNodeClass (LN, see Figure 2) defined in IEC 61850-7-2. Apart from the logical node class ‘Physical Device Information’ (LPHD), all logical node classes (LLN0 and domain specific LNs) defined in this document inherit at least the mandatory data objects of the common logical node (Common LN).

NOTE Common logical node will never be instantiated.

5.3.2 LN: Physical device information Name: LPHD

This LN is introduced in this part to model common issues for physical devices.

LPHD class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
Data objects				
Descriptions				
PhyNam	DPL	Physical device name plate		M
Status information				
PhyHealth	ENS	Physical device health		M
OutOv	SPS	Output communications buffer overflow		O
Proxy	SPS	Indicates if this LN is a proxy		M
InOv	SPS	Input communications buffer overflow		O
NumPwrUp	INS	Number of power-ups		O
WrmStr	INS	Number of warm starts		O
WacTrg	INS	Number of watchdog device resets detected		O
PwrUp	SPS	Power-up detected		O
PwrDn	SPS	Power-down detected		O
PwrSupAlm	SPS	External power supply alarm		O
Controls				
RsStat	SPC	Reset device statistics	T	O
Sim	SPC	Receive simulated GOOSE or simulated SV		O
Settings				
Data sets (see IEC 61850-7-2)				
Inherited and specialised from logical node class (see IEC 61850-7-2)				
BufferedReportControlBlock (see IEC 61850-7-2)				
Inherited and specialised from logical node class (see IEC 61850-7-2)				
UnbufferedReportControlBlock (see IEC 61850-7-2)				
Inherited and specialised from logical node class (see IEC 61850-7-2)				
Services (see IEC 61850-7-2)				
Inherited and specialised from logical node class (see IEC 61850-7-2)				

5.3.3 LN: common logical node Name: Common LN

The common logical node class provides data objects which are mandatory or conditional to all dedicated LN classes. It contains also data which may be used in all dedicated logical node classes, such as input references and data objects for the statistical calculation methods (refer to Annex F).

Common LN class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
Data objects				
Mandatory and conditional logical node information (shall be inherited by ALL LN but LPHD)				
Descriptions				
NamPlt	LPL	Name plate		C1
Status information				
Beh	ENS	Behaviour		M
Health	ENS	Health		C1
Blk	SPS	Dynamic blocking of function described by the LN		O
Controls				
Mod	ENC	Mode		C1

Common LN class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
Data objects				
CmdBlk	SPC	Blocking of control sequences and action triggers of controllable data objects		C2
Settings				
InRef1	ORG	General input reference		O
BlkRef1	ORG	Blocking reference shows the receiving of dynamically blocking signal		O
Logical node information (statistical calculation specific – refer to Annex F)				
Status information				
ClcExp	SPS	Calculation period expired	T	C3
Controls				
ClcStr	SPC	Enables the calculation start at time operTm from the control model (if set) or immediately		O
Settings				
ClcMth	ENG	Calculation method of statistical data objects		C3
ClcMod	ENG	Calculation mode. Allowed values: TOTAL, PERIOD, SLIDING		C4
ClcIntvTyp	ENG	Calculation interval type		C4
ClcIntvPer	ING	In case ClcIntvTyp equals to MS, PER-CYCLE, CYCLE, DAY, WEEK, MONTH, YEAR, number of units to consider to calculate the calculation interval duration		C4
NumSubIntv	ING	The number of sub-intervals a calculation period interval duration contains		O
ClcRfTyp	ENG	Refreshment interval type		O
ClcRfPer	ING	In case ClcIntvTyp equals to MS, PER-CYCLE, CYCLE, DAY, WEEK, MONTH, YEAR, number of units to consider to calculate the refreshment interval duration		O
ClcSrc	ORG	Object reference to source logical node		C5
ClcNxTmms	ING	Remaining time up to the end of the current calculation interval – expressed in milliseconds		O
InSyn	ORG	Object reference to the source of the external synchronization signal for the calculation interval		O
Data sets (see IEC 61850-7-2)				
Inherited and specialised from logical node class (see IEC 61850-7-2)				
BufferedReportControlBlock (see IEC 61850-7-2)				
Inherited and specialised from logical node class (see IEC 61850-7-2)				
UnbufferedReportControlBlock (see IEC 61850-7-2)				
Inherited and specialised from logical node class (see IEC 61850-7-2)				
Services (see IEC 61850-7-2)				
Inherited and specialised from logical node class (see IEC 61850-7-2)				
Condition C1: Mod, Health and NamPlt shall be inherited by LLN0 of the root LD of a hierarchy as mandatory and by all other LN as optional. Condition C2: CmdBlk shall be inherited as optional data object by all LNs which contain controllable data objects additionally to Mod, if there is no BlkOpn/BlkCls available (like in XCBR). Condition C3: This data object is optional but mandatory when considering statistical calculation, especially the MMXU, MMXN LN. Condition C4: These data objects are mandatory, except when ClcMth equals UNSPECIFIED. Condition C5: This data object is mandatory, if the considered LN is performing statistical calculation derived from another LN.				

All dedicated LN classes shall inherit all data objects, data objects sets, control blocks and services from this common logical node class, if applicable. The data object beh shall be inherited in any case as mandatory.

5.3.4 LN: Logical node zero Name: LLN0

This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.

LLNO class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
Data objects				
Status information				
OpTmh	INS	Operation time		O
LocKey	SPS	Local operation for complete logical device		O
Loc	SPS	Local control behaviour		O
Controls				
LocSta	SPC	Switching authority at station level		O
Diag	SPC	Run diagnostics		O
LEDRs	SPC	LED reset	T	O
Settings				
GrRef	ORG	Reference to a higher level logical device		O
MltLev	SPG	Select mode of authority for local control (True – control from multiple levels is allowed, False – no other control level allowed) (see Annex B)		O
SettingGroupControlBlock [0..1] (see IEC 61850-7-2)				
Inherited and specialised from logical node class (see IEC 61850-7-2)				
Log [0..n](see IEC 61850-7-2)				
Inherited and specialised from logical node class (see IEC 61850-7-2)				
LogControlBlock [0..n] (see IEC 61850-7-2)				
Inherited and specialised from logical node class (see IEC 61850-7-2)				
GOOSEControlBlock [0..n] (see IEC 61850-7-2)				
Inherited and specialised from logical node class (see IEC 61850-7-2)				
MulticastSampledValueControlBlock [0..n] (see IEC 61850-7-2)				
Inherited and specialised from logical node class (see IEC 61850-7-2)				
UnicastSampledValueControlBlock [0..n] (see IEC 61850-7-2)				
Inherited and specialised from logical node class (see IEC 61850-7-2)				

5.3.5 LN: Physical communication channel supervision Name: LCCH

This LN is introduced in this part to model common issues for physical communication channels. It is instantiated for each physical channel or each pair of link level redundant physical channels.

LCCH class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data Objects				
Status information				
ChLiv	SPS	Physical channel status; true, if channel receives telegrams within a specified time interval.		M
RedChLiv	SPS	Physical channel status of redundant channel		C
OutOv	SPS	Output communications buffer overflow		O
InOv	SPS	Input communications buffer overflow		O

LCCH class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/ C**
Fer	INS	Frame error rate on this channel; count of erroneous (or missed, in case of redundancy) messages for each 1 000 messages forwarded to the application.		O
RedFer	INS	Frame error rate on redundant channel; count of missed messages on this channel for each 1 000 messages forwarded to the application.		O
Measured and metered values				
RxCnt	BCR	Number of received messages		O
RedRxCnt	BCR	Number of received messages on redundant channel		O
TxCnt	BCR	Number of sent messages		O
Settings				
ApNam	VSG	Access point name to which this channel belongs; only needed, if more than one access point and more than one physical channel exist.		O
ChLivTms	ING	Timeout time for channel live supervision; default 5 s		O
NOTE If channel redundancy with duplicate remove is used, the number of lost messages can be calculated as 'messages forwarded to application as result of both channels – messages received on this channel'. In this case, the FER is calculated by counting the received messages per channel, until 1 000 messages are forwarded to the application, and then using above formula per channel. Observe that in PRP any message received for a wrong channel is also forwarded to the application. Thus a wrong connection of cables to ports can be detected, if Fer and RedFer have a value around 500 (1 000 messages with wrong channel identification forwarded to application, 500 messages with wrong channel identification received on each channel). Condition C: is mandatory, if channel redundancy is used.				

5.3.6 LN: GOOSE subscription Name: LGOS

The LN LGOS shall be used monitoring of GOOSE messages. There shall be one instance of LGOS per GOOSE subscription for a given GOOSE source. It allows for instance to diagnose the subscription state of a GOOSE message.

LGOS class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/ C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Status information				
NdsCom	SPS	Subscription needs commissioning		O
St	SPS	Status of the subscription (True = active, False=not active)		M
SimSt	SPS	Status showing that really Sim messages are received and accepted		O
LastStNum	INS	Last state number received		O
ConfRevNum	INS	Expected configuration revision number		O
Settings				
GoCBRef	ORG	Reference to the subscribed GOOSE control block		O

5.3.7 LN: Sampled value subscription Name: LSVS

The LN LSVS shall be used for diagnose and monitoring supervision of sampled value messages. There shall be one instance of LSVS per SV subscription for a given server. It allows for instance to diagnose the subscription of a SV message (status of subscription).

LSVS class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Status information				
NdsCom	SPS	Subscription needs commissioning		O
St	SPS	Status of the subscription (True = active, False = not active)		O
SimSt	SPS	Status showing that really Sim messages are received and accepted		O
LastStNum	INS	Last state number received		O
ConfRevNum	INS	Expected configuration revision number		O
Settings				
SvCBRef	ORG	Reference to the subscribed SV control block		O

5.3.8 LN: Time management Name: LTIM

The LN LTIM shall be use for diverse configurations regarding the local time of an IED.

LTIM class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Status information				
TmDT	SPS	Indicating if for this location daylight saving time is in effect now		M
Settings				
TmOfsTmm	ING	Offset of local time from UTC in minutes		M
TmUseDT	SPG	Flag indicating if this location is using daylight saving time		M
TmChgDayTm	TSG	Local time of next change to daylight saving time		O
TmChgStdTm	TSG	Local time of next change to standard time		O
StrWeekDay	ENG	Day of the start of the local week for statistical calculation (Monday (default) | Tuesday | Wednesday | Thursday | Friday | Saturday | Sunday)		O

5.3.9 LN: Time master supervision Name: LTMS

The LN LTMS shall be used for the configuration and supervision of the time synchronization function in an IED.

LTMS class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Status information				
TmAcc	INS	Number of significant bits in the Fraction Of Second in the time accuracy part of the time stamp. See IEC 61850-7-2.		O
TmSrc	VSS	Current time source		M
TmSyn	ENS	Time synchronized according to IEC 61850-9-2		O
TmChSt1	SPS	Time channel status (up/down)		O
Settings				
TmSrcSet1	VSG	Time source setting (“1588” in case the time source is a IEEE 1588 source or dotted IP-address)		O

5.3.10 LN: Service tracking Name: LTRK

The LN LTRK allows to track service parameters. With this tracking, service parameters will stay visible after the execution of service. For this purpose, common data classes are needed which contain the parameters of the services according to IEC 61850-7-2.

LTRK class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Control and access service tracking				
SpcTrk	CTS	Control service tracking for controllable single point		O
DpcTrk	CTS	Control service tracking for controllable double point		O
IncTrk	CTS	Control service tracking for controllable Integer		O
EncTrk1	CTS	Control service tracking for enumerated controllable		O
ApcFTrk	CTS	Control service tracking for controllable analogue set point with float command		O
ApcIntTrk	CTS	Control service tracking for controllable analogue set point with Integer command		O
BscTrk	CTS	Control service tracking for binary controlled step position information		O
IscTrk	CTS	Control service tracking for integer controlled step position information		O
BacTrk	CTS	Control service tracking for binary controlled analogue process value		O
GenTrk	CST	Common service tracking for all services for which no specific tracking data exists		O
UrcbTrk	UTS	Access service tracking for unbuffered report control block		O
BrcbTrk	BTS	Access service tracking for buffered report control block		O
LocbTrk	LTS	Access service tracking for log control block		O
GocbTrk	GTS	Access service tracking for goose control block		O
MsvcbTrk	MTS	Access service tracking for multicast sampled values control block		O
UsvcbTrk	NTS	Access service tracking for unicast sampled values control block		O
SgcbTrk	STS	Access service tracking for setting group control block		O
NOTE The common data classes for the data objects in LTRK are specified in IEC 61850-7-2.				

5.4 Logical nodes for automatic control LN Group: A

5.4.1 Modelling remarks

Table 3 – Relation between IEC 61850-5 and IEC 61850-7-4 for automatic control LNs

Functionality	Defined in IEC 61850-5 by LN	Modelled in IEC 61850-7-4 by LN	Comments
Zero voltage tripping	AZVT	PTUV	The start value has to discriminate between live and dead. The delay time has to be reasonably long to discriminate between a transient voltage zero or a permanent switched off line.
Automatic neutral (starpoint) control	ANCR	ANCR ARIS	Automatic control of suppression (Petersen) coil Automatic wattmetric increase with thermal supervision

5.4.2 LN: Neutral current regulator Name: ANCR

For a description of this LN, see IEC 61850-5. This LN shall be used for regulation of suppression coils (ASC / Petersen coil) as tap coils and plunger core coils.

ANCR class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Status information				
LocKey	SPS	Local or remote key		O
Loc	SPS	Local control behaviour		M
HiColPos	INS	High coil position		O
LoColPos	INS	Low coil position		O
ColOpR	SPS	Change coil position rise		O
ColOpL	SPS	Change coil position lower		O
ColChgOp	SPS	Change coil position in operation		O
StFixCol	SPS	Status of external fixcoil (True – fixcoil is connected, False – not connected)		O
StClcTun	ENS	Result of tuning: not tuned , tuned, tuned but not compensated, Umax,Umax_nC(Umax- but not compensated), Umax_not compensated due to U continuous limitation		O
PotAlm	SPS	Potentiometer alarm		O
MotAlm	SPS	Motor drive alarm due to no movement		O
MotWrn	SPS	Motor for Petersen coil operating time exceeded		O
ClcSeqWrn	SPS	Number of calculation sequence exceeded in automatic/manual mode		O
Measured and metered values				
ColPosA	MV	Coil position (usually as current in Ampere)		O
AResoPt	MV	Current at the resonance-point		O
AWatt	MV	Wattmetric part of the residual current at the fault location		O
ADetun	MV	Detuning due to the actual coil position		O
Damp	MV	Damping of the network		O
CapacImb	MV	Capacitive imbalance of the network		O
VolResoPt	CMV	Value of the voltage at the resonance point		O
NeutVol	CMV	Neutral to ground voltage		O
Controls				
OpCntRs	INC	Resettable operation counter		O
LocSta	SPC	Switching authority at station level		O
TapChg	BSC	Change tap position (stop, higher, lower)		C1
ColTapPos	ISC	Move coil to specified discrete coil position		C1
ColPos	APC	Move coil to specified continuous coil position		C1
RCol	SPC	Raise plunger coil position		M
LCol	SPC	Lower plunger coil position		M
Auto	SPC	Automatic / manual operation		M
StrClc	SPC	Start calculation sequence		O
ParOp	SPC	Parallel/Independent operation (True – parallel, False – independent)		O
FixCol	APC	Size of external fix coil		O
Settings				
ParColMod	ENG	Mode of parallel operation of Petersen coil (Master/ Slave | Master/ Slave with fixed slave coil position | Master/ Slave with variable slave coil position | Parallel operation without communication)		M
ParMod	ENG	Set current regulator mode during control (master, slave, independent)		O

ANCR class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
ADetunSpt	ASG	Setpoint for the detuning of the suppression coil		O
BndWid	ASG	Band width voltage as voltage or percent of nominal voltage		O
Condition C1: at least one of the described attributes shall be used (either TapChg or ColTapPos) for controlling YEFN as a tap coil.				

5.4.3 LN: Reactive power control Name: ARCO

For a description of this LN, see IEC 61850-5. This LN shall be used for a reactive controller independent of the control method being used.

ARCO class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Status information				
LocKey	SPS	Local or remote key		O
Loc	SPS	Local control behaviour		M
VOvSt	SPS	Voltage override status		O
NeutAlm	SPS	Neutral alarm is present		O
DschBlk	SPS	Bank switch close blocked due to discharge	T	O
Controls				
OpCntRs	INC	Resettable operation counter		O
LocSta	SPC	Switching authority at station level		O
TapChg	BSC	Change reactive power (stop, higher, lower)		M
Auto	SPC	Automatic operation		O

5.4.4 LN: Resistor control Name: ARIS

For a description of this LN, see IEC 61850-5. This LN should be used for the automatic wattmetric increase with thermal supervision.

ARIS class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Status information				
LocKey	SPS	Local or remote key		O
Loc	SPS	Local control behaviour		M
ZBlk	SPS	Blocked		O
TmpAlm	SPS	Thermal alarm		O
Controls				
OpCntRs	INC	Resettable operation counter		O
LocSta	SPC	Switching authority at station level		O

ARIS class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
Auto	SPC	Parallel/Independent operation		O
StrSeq	SPC	Start sequence		M
Measured an metered values				
NeutVol	CMV	Neutral to ground voltage		O
RisTmp	MV	Resistance temperature for wattmetric increase		O
RisTmpClc	MV	Resistance temperature calculated		O

5.4.5 LN: Automatic tap changer controller Name: ATCC

For a description of this LN, see IEC 61850-5.

ATCC class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Status information				
LocKey	SPS	Local or remote key		O
Loc	SPS	Local control behaviour		O
HiTapPos	INS	High tap position		O
LoTapPos	INS	Low tap position		O
TapOpR	SPS	Change tap position raise	T	O
TapOpL	SPS	Change tap position lower	T	O
TapOpStop	SPS	Change tap position stop	T	O
TapOpErr	SPS	Tap change error or tap indication error (e.g. wrong BCD code)		O
LTCBlkVLo	SPS	LTC inhibit due to under voltage		O
LTCBlkVHi	SPS	LTC inhibit due to over voltage		O
LTCBlkAHi	SPS	LTC inhibit due to over current		O
EndPosR	SPS	End position raise or highest allowed tap position reached		O
EndPosL	SPS	End position lower or lowest allowed tap position reached		O
ErrPar	SPS	Error of parallel operation		O
Measured and metered values				
CtlV	MV	Control voltage		M
LodA	MV	Load current (total transformer secondary current)		O
CircA	MV	Circulating current		O
PhAng	MV	Phase angle of LodA relative to CtlV at 1.0 power factor, FPF		O
HiCtlV	MV	Highest control voltage		O
LoCtlV	MV	Lowest control voltage		O
HiDmdA	MV	High current demand (load current demand)		O
Controls				
OpCntRs	INC	Resettable operation counter		O
LocSta	SPC	Switching authority at station level		O
TapChg	BSC	Change tap position (stop, higher, lower)		C1
TapPos	ISC	Set tap position		C1
BndCtrChg	BAC	Band centre change (raise, lower), no status		O

ATCC class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
ParOp	SPC	Parallel/Independent operation		M
LTCBlk	SPC	Block (Inhibit) automatic control		O
LTCDragRs	SPC	Reset LTC drag hands	T	O
Auto	SPC	Automatic/Manual operation		O
VRed1	SPC	Voltage reduction step 1		O
Settings				
BndCtr	ASG	Band center voltage (FPF presumed)		O
BndWid	ASG	Band width voltage (as voltage or percent of nominal voltage, FPF presumed)		O
CtlDlTmms	ING	Control intentional time delay (FPF presumed)		O
LDCR	ASG	Line drop voltage due to line resistance component		O
LDCX	ASG	Line drop voltage due to line reactance component		O
BlkLV	ASG	Control voltage below which auto lower commands blocked		O
BlkRV	ASG	Control voltage above which auto raise commands blocked		O
BlkVLo	ASG	Control voltage below which auto raise commands are blocked		O
BlkVHi	ASG	Control voltage above which auto lower commands are blocked		O
RnbkRV	ASG	Runback raise voltage		O
LimLodA	ASG	Limit load current (LTC block load current)		O
LDC	SPG	Line drop compensation is R&X or Z model		O
ParTraMod	ENG	Parallel transformer mode		O
TmDlChr	SPG	Time delay linear or inverse characteristic		O
LDCZ	ASG	Line impedance for line drop compensation		O
VRedVal	ASG	Reduction of band centre (percent) when voltage reduction step is active		O
TapBlkR	ING	Tap position of load tap changer where automatic raise commands are blocked		O
TapBlkL	ING	Tap position of load tap changer where automatic lower commands are blocked		O
Condition C1: depending on the tap-change method, at least one of the two controls, TapChg or TapPos shall be used for manual operation. BndCtrChg may be optionally used to change the value of BndCtr by commands.				

5.4.6 LN: Voltage control Name: AVCO

For a description of this LN, see IEC 61850-5. This LN shall be used for a voltage controller independent of the control method being used.

AVCO class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Status information				
LocKey	SPS	Local or remote key		O
Loc	SPS	Local control behaviour		M
BlkEF	SPS	Blocked by earth fault		O
BlkAOv	SPS	Blocked by current limit overflow		O
BlkVOv	SPS	Blocked by voltage limit overflow		O
Controls				
OpCntRs	INC	Resettable operation counter		O

AVCO class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LocSta	SPC	Switching authority at station level		O
TapChg	BSC	Change voltage (stop, higher, lower)		M
SptVol	APC	Voltage setpoint		O
Auto	SPC	Automatic operation		O
Settings				
LimAOv	ASG	Current limit for overflow blocking		O
LimVOv	ASG	Voltage limit for overflow blocking		O

5.5 Logical nodes for control LN Group: C

5.5.1 Modelling remarks

Table 4 – Relation between IEC 61850-5 and IEC 61850-7-4 for control LNs

Functionality	Defined in IEC 61850-5 by LN	Modelled in IEC 61850-7-4 by LN	Comments
Transformer including cooling	YPTR	CCGR	Dedicated cooling group control split off from YPTR

5.5.2 LN: Alarm handling Name: CALH

For a description of this LN, see IEC 61850-5. CALH allows the creation of group warnings, group indications and group alarms. The individual alarms, which are used to calculate the group indications/alarms/warnings, are subscribed from elsewhere. The calculation is a local issue, usually performed by a logic scheme.

CALH class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Status information				
GrAlm	SPS	Group alarm		C
GrWrn	SPS	Group warning		C
GrInd	SPS	Group indication		C
AlmLstOv	SPS	Alarm list overflow		O
Condition C: At least one data object shall be modelled.				

5.5.3 LN: Cooling group control Name: CCGR

This LN class shall be used to control the cooling equipment. One instance per cooling group shall be used.

CCGR class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Status information				
OpTmh	INS	Operation time		O

CCGR class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
FanOvCur	SPS	Fan overcurrent trip		O
PmpOvCur	SPS	Pump overcurrent trip		O
PmpAlm	SPS	Loss of pump		O
Measured and metered values				
EnvTmp	MV	Temperature of environment		O
OilTmpIn	MV	Oil temperature cooler in		O
OilTmpOut	MV	Oil temperature cooler out		O
OilMotA	MV	Oil circulation motor drive current		O
FanFlw	MV	Air flow in fan		O
CETmpIn	MV	Temperature of secondary cooling medium in		O
CETmpOut	MV	Temperature of secondary cooling medium out		O
CEPres	MV	Pressure of secondary cooling medium		O
CEFlw	MV	Flow of secondary cooling medium		O
FanA	MV	Motor drive current fan		O
Controls				
CEBlk	SPC	Control of automatic / manual operation (blocking)		O
CECtl	SPC	Control of complete cooling group (pumps and fans)		O
PmpCtlGen	ENC	Control of all pumps		O
PmpCtl	ENC	Control of a single pump		O
FanCtlGen	ENC	Control of all fans		O
FanCtl	ENC	Control of a single fan		O
Auto	SPC	Automatic or manual		O
Settings				
OilTmpSet	ASG	Set point for oil temperature		O

5.5.4 LN: Interlocking Name: CILO

For a description of this LN, see IEC 61850-5. This LN shall be used to “enable” a switching operation if the interlocking conditions are fulfilled. One instance per switching device is needed. At least all related switchgear positions have to be subscribed. The interlocking algorithm is a local issue.

CILO class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Status information				
EnaOpn	SPS	Enable Open		M
EnaCls	SPS	Enable Close		M

5.5.5 LN: Point-on-wave switching Name: CPOW

For a description of this LN, see IEC 61850-5. This LN shall be used if the circuit breaker is able to perform point-on-wave switching. In this case, the start signal for CPOW is OpOpn or OpCls to be subscribed from CSWI. Then CPOW shall perform its entire dedicated algorithm using data objects from the allocated TCTR or local and remote TVTR (local issue) and shall then release a “Time Activated Control” (see IEC 61850-7-2) to XCBR. OpOpn and OpCls shall be used if no “Time Activated Control” services is available between CPOW and XCBR. Alternatively, CPOW may be started by a control service acting on data object Pos.

CPOW class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22		
Data objects				
Status information				
TmExc	SPS	Maximum allowed time exceeded		M
StrPOW	SPS	CPOW started		O
OpOpn	ACT	Open switch	T	O
OpCls	ACT	Close switch	T	O
Controls				
Pos	DPC	Switch, general		O
PosA	DPC	Switch L1		O
PosB	DPC	Switch L2		O
PosC	DPC	Switch L3		O
Settings				
MaxDlTmms	ING	Maximum allowed delay time		O

5.5.6 LN: Switch controller Name: CSWI

For a description of this LN, see IEC 61850-5. This LN class shall be used to control all switching conditions above process level. CSWI shall subscribe the data object POWCap ("point-on-wave switching capability") from XCBR if applicable. If a switching command (for example Select-before-Operate) arrives and point-on-wave switching capability" is supported by the breaker, the command shall be passed to CPOW. OpOpn and OpCls shall be used if no Control Service is available between CSWI and XCBR (see GSE in IEC 61850-7-2).

CSWI class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Status information				
LocKey	SPS	Local or remote key		O
Loc	SPS	Local control behaviour		O
OpOpn	ACT	Operation "Open switch"	T	O
SelOpn	SPS	Selection "Open switch"		O
OpCls	ACT	Operation "Close switch"	T	O
SelCls	SPS	Selection "Close switch"		O
Controls				
OpCntRs	INC	Resettable operation counter		O
LocSta	SPC	Switching authority at station level		O
Pos	DPC	Switch, general		M
PosA	DPC	Switch L1		O
PosB	DPC	Switch L2		O
PosC	DPC	Switch L3		O

5.5.7 LN: Synchronizer controller Name: CSYN

For a description of this LN, see IEC 61850-5. This LN class shall be used to control the synchronizing conditions i.e. voltage, frequency and phase.

CSYN class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22		
Data objects				
Status information				
LocKey	SPS	Local or remote key		O
Loc	SPS	Local control behaviour		O
Cmd	SPS	Breaker closing command		C
Rel	SPS	Breaker closing command released		C
RV	SPS	Raise voltage		O
LV	SPS	Lower voltage		O
RHz	SPS	Raise frequency (increase speed)		O
LHz	SPS	Lower frequency (lower speed)		O
VInd	SPS	Voltage difference indicator		O
AngInd	SPS	Angle difference indicator		O
HzInd	SPS	Frequency difference indicator		O
RotDir	ENS	Rotational direction (Clockwise | Counter-clockwise | Unknown)		O
Measured and metered values				
DifVClc	MV	Calculated difference in voltage (amplitude value)		O
DifHzClc	MV	Calculated difference in frequency		O
DifAngClc	MV	Calculated difference of phase angle		O
V1Clc	MV	Amplitude value U_1		O
V2Clc	MV	Amplitude value U_2		O
Hz1Clc	MV	Frequency f_1		O
Hz2Clc	MV	Frequency f_2		O
AccClc	MV	Acceleration		O
AccClcDev	MV	Acceleration deviation		O
Controls				
OpCntRs	INC	Resettable operation counter		O
LocSta	SPC	Switching authority at station level		O
SynPrg	SPC	Start and stop synchronising progress		O
RelDeaBus	SPC	Releasing dead bus / dead line function		O
OpModSyn	ENC	Operating mode selection (Automatic-synchronizing |Automatic-paralleling | Manual | Test)		O
Settings				
VNom	ASG	Nominal secondary voltage		O
HzNom	ASG	Nominal frequency		O
VAdpFact	ASG	Adaptation factor U_1/ U_2		O
AdpAngDeg	ASG	Adaptation angle (e.g. setting group compensation)		O
DlTmms	ING	Supervision time for paralleling (delay time)		O
MltCmd	SPG	Multiple command generation		O
DifVNg	ASG	Difference voltage (amplitude value) negative		O
DifVPs	ASG	Difference voltage (amplitude value) positive		O

CSYN class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
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 (Δf)		O
LivDeaMod	ENG	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
VInvTmms	ING	Voltage adjustment pulse interval		O
MinVTmms	ING	Minimum voltage adjustment pulse time		O
MaxVTmms	ING	Maximum voltage adjustment pulse time		O
HzAdj	SPG	Frequency matcher ON / OFF		O
HzChr	ASG	Frequency adjustment characteristic		O
HzIntvTmms	ING	Frequency adjustment pulse interval		O
MinHzTmms	ING	Minimum frequency adjustment pulse time		O
MaxHzTmms	ING	Maximum frequency adjustment pulse time		O
HzTgtVal	ASG	Frequency matcher target value		O
KckPls	SPG	Kicker pulse ON / OFF		O
DlSynTmms	ING	Delay of synchronization process after start signal		O
TotTmms	ING	Total time of synchronising process		O
Condition C: at least one of the data objects (Cmd, Rel) shall be used.				

5.6 Logical nodes for functional blocks LN group F

5.6.1 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 LNs will normally be part of a logical device providing overall functionality within the system. Therefore, no description and requirements for the logical nodes of group F are given in IEC 61850-5. The LNs of the F-group are never located at the border to the process.

The LN classes of the F-group shall be used only if another LN class from other groups does not fit to the semantic and function to be modelled.

5.6.2 LN: Counter Name: FCNT

Logical node FCNT shall be used to count incoming pulses not related to the electrical network.

FCNT class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Status information				
Up	SPS	Last count direction upward		O
Dn	SPS	Last count direction downward		O
Measured and metered values				
CntRs	BCR	Counter		M

5.6.3 LN: Curve shape description Name: FCSD

Logical node FCSD shall comprise the data object classes that represent curve shaped output values. The values can be dynamically modified online. The curves entered in the table can be based on statistics 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, can be used for 3-dimensional surface mapping.

FCSD class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Measured and metered values				
Out	MV	Output		M
Settings				
Crv	CSG	Curve shape		M

5.6.4 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 of IEC 61850-7-410.

FFIL class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Measured and metered values				
Out	MV	Output		M
ErrTerm	MV	Control loop termination error value		O
Settings				
FilTyp	ENG	Filter type		M
KP	ASG	Proportional gain		O
KLd	ASG	K lead		O
KLg	ASG	K lag		O
Tm1ms	ING	Time 1 [ms]		O
Tm1ldms	ING	Time 1 (lead) [ms]		O
Tm2ms	ING	Time 2 [ms]		O

FFIL class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
Tm2ldms	ING	Time 2 (lead) [ms]		O
Tm3ms	ING	Time 3 [ms]		O
DeaBnd	ASG	Deadband		O

5.6.5 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				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
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 and metered values				
Out	MV	Output signal		M
Settings				
HiLimSpt	ASG	High limit setpoint		O
LoLimSpt	ASG	Minimum limit setpoint		O

5.6.6 LN: PID regulator Name: FPID

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

FPID class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Measured and metered values				
Out	MV	PID output		M
PAct	MV	Proportional action		C
IAct	MV	Integral action		C
DAct	MV	Derivative action		C
ErrTerm	MV	Control loop termination error value		O
Settings				
PIDAlg	ENG	P|I|D|PI|PD|ID|PID|		M
KP	ASG	Proportional gain		C
KI	ASG	Integral gain		C
ITmms	ING	Integral time (ms)		C
KD	ASG	Derivative gain		C
DTmms	ING	Derivative time (ms)		C

FPID class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
DFilTmms	ING	Derivative time filter (ms)		C
Bias	ASG	Bias added to process variable		O
ILim	ASG	Anti-windup integral limit		O
Droop	ASG	Percent change in effective setpoint at maximum action		O
Condition: The conditional data objects shown in the first column of Table 5 shall be linked with the corresponding PID algorithm selected.				

Table 5 – Conditional attributes in FPID

	PIDAlg (M-Mandatory, O-Optional, Blank-Not Used)						
Data Objects Name	P	I	D	PI	PD	ID	PID
PAct	O			O	O		O
IAct		O		O		O	O
DAct			O		O	O	O
KP	M			M	M		M
KI		M		M		M	M
ITmms		M		M		M	M
KD			M		M	M	M
DTmms			M		M	M	M
DFILTmms			M		M	M	M

5.6.7 LN: Ramp function Name: FRMP

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

FRMP class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Status information				
AdjSt	ENS	State of adjustment process		O
Measured and metered values				
Out	MV	Ramp output		M
ErrTerm	MV	Control loop termination error value		O
Settings				
RmpUp	ASG	Ramping rate on a upward trend		O
RmpDn	ASG	Ramping rate on a downward trend		O
StepPs	ASG	Step size when turning from negative to positive direction		O
StepNg	ASG	Step size when turning from positive to negative direction		O

5.6.8 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 form a complete controller.

FSPT class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Status information				
Loc	SPS	Local control behaviour		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
SptEndSt	ENS	End status of set-point control		O
AdjSt	ENS	Adjustment status		O
Measured Values				
SptMem	MV	Setpoint in memory		M
ErrTerm	MV	Control loop termination error value		O
Out	MV	Output		O
Controls				
SptChg	BAC	Setpoint change (raise, lower)		O
SptVal	APC	Setpoint		M
Auto	SPC	Automatic operation		O
Settings				
MaxRst	ASG	Maximum restriction		O
MinRst	ASG	Minimum restriction		O
DvAlm	ASG	Deviation alarm		O

5.6.9 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. If a second level is necessary, a second instance can be modelled. FXOT can typically be used whenever a protection, control or alarm function is based on other physical measurements than primary electrical data.

FXOT class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Status information				
Op	ACT	Level of action reached	T	M
Settings				
StrVal	ASG	Start level set-point		C
OpDlTmms	ING	Operate delay time [ms]		O
StrCrv	CSG	Start level curve		C
RsDlTmms	ING	Reset operate delay time [ms]		O
Condition: Start level shall be given as a singular point or as a curve.				

5.6.10 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. If a second level is necessary, a second instance can be modelled. FXUT can

typically be used whenever a protection, control or alarm function is based on other physical measurements than primary electric data.

FXUT class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Status information				
Op	ACT	Level of action reached	T	M
Settings				
StrVal	ASG	Start level set-point		C
OpDlTmms	ING	Operate delay time [ms]		O
StrCrv	CSG	Start level curve		C
RsDlTmms	ING	Reset operate delay time [ms]		O
Condition: Start level shall be given as a singular point or as a curve.				

5.7 Logical nodes for generic references LN Group: G

5.7.1 Modelling remarks

The logical nodes of group G shall be used only for modelling functions without a dedicated logical node with appropriate semantics. Therefore, no description and requirements for the logical nodes of group G are given in IEC 61850-5.

5.7.2 LN: Generic automatic process control Name: GAPC

This node shall be used only to model in a generic way the processing/automation of functions that are not predefined by one of the groups A, C, M, P, or R. If needed, all data objects listed in Clause 6 of this standard can be used single or multiple for a dedicated application of LN GAPC. Data objects with proper semantic meaning should be preferred. The extension rules according to IEC 61850-7-1, Clause 14 shall be followed.

GAPC class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Status information				
LocKey	SPS	Local or remote key		O
Loc	SPS	Local control behaviour		O
Auto	SPC	Automatic operation		O
Str1	ACD	Start		O
Op1	ACT	Operate	T	O
Alm1	SPS	Generic single alarm		O
Wrn1	SPS	Generic single warning		O
Ind1	SPS	Generic single indication		O
Controls				
OpCntRs	INC	Resettable operation counter		O
LocSta	SPC	Switching authority at station level		O
SPCSO1	SPC	Single point controllable status output		O
DPCSO1	DPC	Double point controllable status output		O

GAPC class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
ISCSO1	INC	Integer status controllable status output		O
Settings				
StrVal1	ASG	Start value		O

5.7.3 LN: Generic process I/O Name: GGIO

This node shall be used only to model in a generic way process devices that are not predefined by the groups S, T, X, Y, or Z. If needed, all data objects listed in Clause 6 can be used single or multiple for a dedicated application of LN GGIO. Data objects with proper semantic meaning should be preferred. The extension rules according to IEC 61850-7-1, Clause 14 shall be followed.

GGIO class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Descriptions				
EEName	DPL	External equipment name plate		O
Status information				
EEHealth	ENS	External equipment health		O
LocKey	SPS	Local or remote key		O
Loc	SPS	Local control behaviour		O
IntIn1	INS	Integer status input		O
Alm1	SPS	General single alarm		O
Wrn1	SPS	General single warning		O
Ind1	SPS	General indication (binary input)		O
Measured and metered values				
AnIn1	MV	Analogue input		O
AnOut1	APC	Controllable analogue output		O
CntRs1	BCR	Counter, resettable		O
Controls				
OpCntRs	INC	Resettable operation counter		O
LocSta	SPC	Switching authority at station level		O
SPCSO1	SPC	Single point controllable status output		O
DPCSO1	DPC	Double point controllable status output		O
ISCSO1	INC	Integer status controllable status output		O

5.7.4 LN: Generic log Name: GLOG

The LN GLOG refers to a function which allows to log not only changed data itself but also any related data being defined in the settings of LN GLOG. The logging is started by the changed data object (TrgRef1) or by the operator (LogTrg). The logged data are identified by the references to the related source data objects in the data model.

GLOG class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Logged Status information, Measured and metered values, Controls, Settings				
Access via LOG only		Included value assigned to InRef1		O
Controls				
OpCntRs	INC	Counts the events logged (resettable)		O
LogTrg	SPC	Trigger logging by operator		O
Settings				
LogRef	ORG	Reference to Log		O
TrgRef1	ORG	Trigger reference shows the receiving trigger signal		O
InRef1	ORG	Reference to data objects / data attributes to include in LOG according to IEC 61850-7-2, when the configured trigger was active		O

5.7.5 LN: Generic security application Name: GSAL

This node shall be used to monitor security violations regarding authorisation, access control, service privileges and inactive associations.

GSAL class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Status information				
AuthFail	SEC	Authorisation failures		M
AcsCtlFail	SEC	Access control failures detected		M
SvcViol	SEC	Service privilege violations		M
Ina	SEC	Inactive associations		M
NumCntRs	INS	Number of counter resets		O
Controls				
OpCntRs	INC	Resettable operation counter		M
NOTE An operation in the context of this logical node is a security violation.				

5.8 Logical nodes for interfacing and archiving LN Group: I

5.8.1 Modelling remarks

The Logical Nodes of group I shall be used at the border of the IEC 61850 modelled system with the exception of the process interface (e.g. to operator by IHMI, to external communication system by ITCI) or where the modelling level is changed (proxy).

5.8.2 LN: Archiving Name: IARC

For a description of this LN, see IEC 61850-5.

IARC class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Status information				
MemOv	SPS	Memory overflow		M
MemUsed	INS	Memory used in %		O
NumRcd	INS	Actual number of records		O
Settings				
InTrg1	ORG	Reference to trigger		O
InLog1	ORG	Reference to data objects		O
MaxNumRcd	ING	Maximum number of records		O
RcdMod	ENG	Recorder operation mode (saturation, overwrite)		O
MemFull	ING	Memory full level		O

5.8.3 LN: Human machine interface Name: IHMI

For a description of this LN, see IEC 61850-5.

IHMI class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Descriptions				
EEName	DPL	External equipment name plate		O
Status information				
EEHealth	ENS	External equipment health		O
LocKey	SPS	Local or remote key		O
Loc	SPS	Local control behaviour		O
Controls				
LocSta	SPC	Switching authority at station level		O

5.8.4 LN: Safety alarm function Name: ISAF

For a description of this LN, see IEC 61850-5. Logical node ISAF shall be used to represent an alarm push-button or any other device that is used to provide an alarm in case of danger to persons or property.

ISAF class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Descriptions				
EEName	DPL	External equipment name plate		O

ISAF class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
Status information				
EEHealth	ENS	External equipment health		O
Alm	SPS	Safety alarm (True=On, False=Off)		M
Controls				
OpCntRs	INC	Resettable operation counter		O
AlmReset	SPC	Alarm signal reset		O

5.8.5 LN: Telecontrol interface Name: ITCI

For a description of this LN, see IEC 61850-5.

ITCI class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Descriptions				
EEName	DPL	External equipment name plate		O
Status information				
EEHealth	ENS	External equipment health		O
Loc	SPS	Local control behaviour		O
Alm1	SPS	Alarm signal		O
Controls				
LocSta	SPC	Switching authority at station level		O

5.8.6 LN: Telemonitoring interface Name: ITMI

For a description of this LN, see IEC 61850-5.

ITMI class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Descriptions				
EEName	DPL	External equipment name plate		O
Status information				
EEHealth	ENS	External equipment health		O

5.8.7 LN: Teleprotection communication interfaces Name: ITPC

For a description of this LN, see IEC 61850-5. The LN ITPC comprises all information for communication channel setting and supervision. ITPC is not intended to generate direct process data objects. Thus, it does not contain the input and output data objects to be transmitted and it has no ‘operate’ data objects object.

ITPC class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		

ITPC class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
Data objects				
Descriptions				
EEName	DPL	External equipment nameplate		O
Status information				
EEHealth	ENS	External equipment health		O
GrdRxCmdRx	SPS	Alarm situation: Guard received together with the command, may indicate interference on the channel. Used in case of an analogue communication channel.		O
LosSig	SPS	Alarm situation: No signal received, indicates a channel problem		O
TxCmdCnt1	INS	For diagnostics: Transmitted commands counters (for each command)		O
RxCmdCnt1	INS	For diagnostics: Received commands counters (for each command)		O
LosSyn	SPS	Alarm situation: Loss of synchronism. Indicates that there is no synchronization between the transmitter and the receiver, i.e., no communication is possible. Used in case of a digital communication channel.		O
Measured and metered values				
Ber	MV	Bit error rate of the communication channel. Used in case of a digital communication channel		O
Fer	MV	Frame error rate of the communication channel. Used in case of a digital communication channel. May be vendor specific		O
CarLev	MV	Power of received signal in case of an analogue communication channel		O
Snr	MV	Signal to noise ratio (in dB), used in case of analogue communication		O
LoopTestTm	MV	Time measured at last loop test		O
Settings				
NumTxCmd	ING	Number of used binary transmit commands		O
NumRxCmd	ING	Number of used binary receive commands		O
TpcTxMod1	ENG	Teleprotection application mode in transmit direction for each command (Unused, Blocking, Permissive, Direct, Unblocking, Status)		O
TpcRxMod1	ENG	Teleprotection application mode in receive direction for each command (Unused, Blocking, Permissive, Direct, Unblocking, Status)		O
SecTmms	ING	Pickup security timer on loss of carrier guard signal: if a command is received within SecTmms after the guard has disappeared, this command is considered valid, used in case of an analogue communication channel.		O
BstRat	ASG	Level of increased power during the transmission of a command in dB. Used in case of an analogue communication channel		O
TxPwr	ASG	Transmit power (peak envelope power) in dBm. Used in case of an analogue communication channel		O
TxCtrHz	ASG	Transmit center frequency. Used in case of an analogue communication channel		O
RxCtrHz	ASG	Receive center frequency. Used in case of an analogue communication channel		O
TxBndWid	ASG	Transmit bandwidth. Used in case of an analogue communication channel		O
RxBndWid	ASG	Receive bandwidth. Used in case of an analogue communication channel		O
NOTE EEHealth is used to indicate the state of the communication channel, whereas PhyHealth is used to indicate the state of the (physical) communication device. If ITPC receives a GOOSE message with quality attribute “invalid" or “questionable" or no GOOSE message at all within Tmax, it will set PhyHealth to “Warning". Other actions are a local issue.				

5.9 Logical nodes for mechanical and non-electric primary equipment LN group K

5.9.1 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. Therefore, description and requirements are given in IEC 61850-5 with different level of detail.

5.9.2 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 object.

KFAN class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Descriptions				
EEName	DPL	External equipment nameplate		O
Status information				
EEHealth	ENS	External equipment health		O
Loc	SPS	Local control behaviour		O
LocKey	SPS	Local or remote key		O
OpTmh	INS	Operation time		O
Measured and metered values				
Spd	MV	Rotational speed of the fan		O
Controls				
OpCtl	SPC	Operate fan		C
SpdSpt	APC	Speed set-point (in case of speed regulated motor)		C
LocSta	SPC	Switching authority at station level		O
Settings				
MinOpTmm	ING	Minimum operation time in minutes		O
MaxOpTmm	ING	Maximum operation time in minutes		O
C: Condition: only one data object should be applied.				

5.9.3 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 object.

KFIL class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Descriptions				
EEName	DPL	External equipment nameplate		O
Status information				
EEHealth	ENS	External equipment health		O
OpTmh	INS	Operation time		O
Loc	SPS	Local control behaviour		O
LocKey	SPS	Local-remote key		O
ACAlm	SPS	AC supply failure (fuse or other problem)		O
MotPro	SPS	Motor protection tripped		O
Flush	SPS	Filter flushing		O

KFIL class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
FilAlm	SPS	Filter alarm		O
Measured and metered values				
DifPresHi	MV	Differential pressure over the filter		O
Controls				
FlushCnt	INC	Filter flushing counter (resettable)		O
OpCtl	SPC	Operate filter		O
LocSta	SPC	Switching authority at station level		O
Settings				
AlmSpt	ASG	Alarm level set-point		O

5.9.4 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 objects.

KPMP class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Descriptions				
EEName	DPL	External equipment nameplate		O
Status information				
EEHealth	ENS	External equipment health		O
Loc	SPS	Local control behaviour		O
LocKey	SPS	Local-remote key		O
OpTmh	INS	Operation time		O
Measured and metered values				
Spd	MV	Rotational speed of the pump		O
Controls				
OpCtl	SPC	Operate pump		C
SpdSpt	APC	Speed set-point (in case of speed regulated motor)		C
LocSta	SPC	Switching authority at station level		O
Settings				
MinOpTmm	ING	Minimum operation time in minutes		O
MaxOpTmm	ING	Maximum operation time in minutes		O
C: Condition: only one data object should be applied.				

5.9.5 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				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		

KTNK class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
Data objects				
Descriptions				
EEName	DPL	External equipment nameplate		O
Status information				
EEHealth	ENS	External equipment health		O
Measured and metered values				
LevPct	MV	Level in the tank (as percentage of full tank level)		O
Vlm	MV	Volume of media in tank		O
Settings				
VlmCap	ASG	Total volume capacity		O
TnkTyp	ENG	Type of data representing the tank fill status (pressure only, level only, both pressure and level)		M

5.9.6 LN: Valve control Name: KVLV

Logical node KVLV shall be used to represent a valve or gate where the position can be given as a percentage of full open position (optionally, the angle 0°-90° may be used). In 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				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Descriptions				
EEName	DPL	External equipment nameplate		O
Status information				
EEHealth	ENS	External equipment health		O
OpCnt	INS	Operation counter		O
Loc	SPS	Local control behaviour		O
LocKey	SPS	Local-remote key		O
ClsPos	SPS	Closed end position reached (valve cannot move further)		C1
OpnPos	SPS	Open end position reached (valve cannot move further)		C1
Mvm	SPS	Valve is moving		O
Stuck	SPS	Valve is blocked (cannot move from present position)		O
Measured and metered values				
PosVlv	MV	Valve position		O
Flw	MV	Calculated liquid flow through the valve		O
Controls				
PosSpt	APC	Valve position set-point		O
Pos	DPC	Valve to full open or closed position		O
PosChg	BSC	Change valve position (stop, raise, lower)		C2
PosChgIncr	INC	Incremental change of position		C2
BlkOpn	SPC	Block opening of the valve		O
BlkCls	SPC	Block closing of the valve		O
LocSta	SPC	Switching authority at station level		O

KVLV class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
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
Condition C1: At least one of the data objects shall be used. The use of both data objects is optional. Condition C2: The use of the data objects is optional, but if used, only one shall be selected.				

5.10 Logical nodes for metering and measurement LN Group: M

5.10.1 Modelling remarks

Table 6 – Relation between IEC 61850-5 and IEC 61850-7-4 for metering and measurement LNs

Functionality	Defined in IEC 61850-5 by LN	Modelled in IEC 61850-7-4 by LN	Comments
Measurement	MMXU	MMXU	Three-phase version
		MMXN	Non-phase-related version (single phase)
		MMDC	DC-related version
Metering (three-phase)	MMTR	MMTR	Metering (three-phase values)
		MMTN	Metering (single-phase values)
		MSTA	Metering (statistics) – obsolete, moved to annex
Harmonics and interharmonics	MHAI	MHAI	Three-phase version
		MHAN	Non-phase-related version (single phase)
Environmental measurement	MENV	MENV	Environmental data objects
		MMET	Meteorological data objects

5.10.2 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 objects. 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 objects. For such information, see MHYD and MMET logical node classes.

MENV class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Status information				
SmokAlm	SPS	Smoke alarm		O
FloodAlm	SPS	Flood alarm		O
Measured and metered values				
CO2Ems	MV	CO_2 emissions		O
COEms	MV	CO emissions		O
NOxEms	MV	NO_x emissions		O

MENV class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
SOxEms	MV	SO_x emissions		O
Dust	MV	Dust particles suspended in air		O
Snd	MV	Sound pressure level		O
O2CmbuGas	MV	Oxygen in combustion gases		O
O3Air	MV	Ozone in air		O
Settings				
CTrd	SPG	Involved in carbon trading		O
CCdt	ASG	Carbon production credit value		O
GrnTag	SPG	Green tag information		O
PartSens	ASG	Sensitivity to particulates		O
FloodLev	ASG	Flood alarm level		O

5.10.3 LN: Flicker measurement name Name: MFLK

This LN shall be used for calculation of flicker inducing voltage fluctuations according to IEC 61000-4-15. The main use is for operative applications.

MFLK class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Measured and metered values				
PPPst	DEL	Short-term flicker severity of last complete interval for phase to phase measurements		O
PhPst	WYE	Short-term flicker severity of last complete interval for phase to ground measurements		O
PPPlt	DEL	Long-term flicker severity of last complete interval for phase to phase measurements		O
PhPlt	WYE	Long-term flicker severity of last complete interval for phase to ground measurements		O
PPPiMax	DEL	Output 5 – Instantaneous peak P value for phase to phase measurements		O
PhPiMax	DEL	Output 5 – Instantaneous peak P value for phase to ground measurements		O
PPPiLoFil	DEL	Output 4 – 1 min average of output 5 for phase to phase measurements		O
PhPiLoFil	DEL	Output 4 – 1 min average of output 5 for phase to ground measurements		O
PPPiRoot	DEL	Output 3 – Square root of output 5 for phase to phase measurements		O
PhPiRoot	DEL	Output 3 – Square root of output 5 for phase to ground measurements		O
PPPcbLs	HST	Classifier bins of last complete short interval for phase to phase (AB, BC, CA)		O
PhPcbLs	HST	Classifier bins of last complete short interval for phase to ground (A, B, C)		O
PPPcbLl	HST	Classifier bins of last complete long interval for phase to phase (AB, BC, CA)		O
PhPcbLl	HST	Classifier bins of last complete long interval for phase to ground (A, B, C)		O
PPPdmWav	HDEL	Real time demodulated waveform for phase to phase (AB, BC, CA)		O
PhPdmWav	HWYE	Real time demodulated waveform for phase to ground (A, B, C)		O

MFLK class				
Data object name	Common data class	Explanation	T	M/O/C
PPPdmSpec	HDEL	Real time demodulated waveform spectra for phase to phase (AB, BC, CA)		O
PhPdmSpec	HWYE	Real time demodulated waveform spectra for phase to ground (A, B, C)		O

5.10.4 LN: Harmonics or interharmonics Name: MHAI

For a description of this LN, see IEC 61850-5. This LN shall be used for calculation of harmonics or interharmonics in a three-phase system. Instances either for harmonics (including subharmonics and multiples) or interharmonics are possible depending on the value of the basic settings, i.e.:

- frequency *f* (“Hz”);
- evaluation window Δt (“EvTmms”).

The frequency may either be given (HzSet) or calculated (Hz).

Both harmonics and interharmonics carry power and produce distortions. There are different methods to calculate disturbances. For more information and definitions, see IEC 61000-4-7 (2002), IEEE 519-1992, and IEEE 1459-2000.

MHAI class				
Data object name	Common data class	Explanation	T	M/O/C
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Measured and metered values				
Hz	MV	Basic frequency		C
HA	HWYE	Sequence of harmonics or interharmonics current		O
HPhV	HWYE	Sequence of harmonics or interharmonics phase to ground voltages		O
HPPV	HDEL	Sequence of harmonics or interharmonics phase to phase voltages		O
HW	HWYE	Sequence of harmonics or interharmonics active power		O
HVAr	HWYE	Sequence of harmonics or interharmonics reactive power		O
HVA	HWYE	Sequence of harmonics or interharmonics apparent power		O
HRmsA	WYE	Current RMS harmonic or interharmonics (un-normalized total harmonic distortion, Thd)		O
HRmsPhV	WYE	Voltage RMS harmonic or interharmonics (un-normalized Thd) for phase to ground		O
HRmsPPV	DEL	Voltage RMS harmonic or interharmonics (un-normalized Thd) for phase to phase		O
HTuW	WYE	Total phase harmonic or interharmonics active power (no fundamental) unsigned sum		O
HTsW	WYE	Total phase harmonic or interharmonic active power (no fundamental) signed sum		O
HATm	WYE	Current time product		O
HKf	WYE	K factor		O
HTdf	WYE	Transformer derating factor		O
ThdA	WYE	Current total harmonic or interharmonic distortion (different methods)		O
ThdOddA	WYE	Current total harmonic or interharmonic distortion (different methods – odd components)		O
ThdEvnA	WYE	Current total harmonic or interharmonic distortion (different methods – even components)		O

MHAI class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
TddA	WYE	Current total demand distortion per IEEE 519		O
TddOddA	WYE	Current total demand distortion per IEEE 519 (odd components)		O
TddEvnA	WYE	Current total demand distortion per IEEE 519 (even components)		O
ThdPhV	WYE	Voltage total harmonic or Interharmonic Distortion (different methods) for phase to ground		O
ThdOddPhV	WYE	Voltage total harmonic or interharmonic distortion (different methods) for phase to ground (odd components)		O
ThdEvnPhV	WYE	Voltage total harmonic or interharmonic distortion (different methods) for phase to ground (even components)		O
ThdPPV	DEL	Voltage total harmonic or interharmonic distortion (different methods) for phase to phase		O
ThdOddPPV	DEL	Voltage total harmonic or interharmonic distortion (different methods) for phase to phase (odd components)		O
ThdEvnPPV	DEL	Voltage total harmonic or interharmonic distortion (different methods) for phase to phase (even components)		O
HCfPhV	WYE	Voltage crest factors (peak waveform value/sqrt(2)/fundamental) for phase to ground		O
HCfPPV	DEL	Voltage crest factors (peak waveform value/sqrt(2)/fundamental) for phase to phase		O
HCfA	WYE	Current crest factors (peak waveform value/sqrt(2)/fundamental)		O
HTif	WYE	Voltage telephone influence factor		O
Settings				
HzSet	ASG	Basic frequency		C
EvTmms	ING	Evaluation time (time window) determines the lowest frequency		O
NumCyc	ING	Number of cycles of the basic frequency		O
ThdAVal	ASG	ThdA alarm setting – value entered in %		O
ThdVVal	ASG	ThdPhV / ThdPPV alarm setting – value entered in %		O
ThdATmms	ING	ThdA alarm time delay in ms		O
ThdVTmms	ING	ThdPhV / ThdPPV alarm time delay in ms		O
NomA	ASG	Normalising demand current used in IEEE 519 TDD calculation		O
Condition C: Hz and HzSet are exclusive.				

5.10.5 LN: Non-phase-related harmonics or interharmonics Name: MHAN

This LN shall be used for calculation of harmonics or interharmonics in a single-phase system, i.e. a single line with no phase relations. Instances either for harmonics (including subharmonics and multiples) or interharmonics are possible depending on the value of the basic settings, i.e.:

- frequency f (“Hz”);
- evaluation window Δt (“EvTmms”).

The frequency may either be given or calculated by means such as a phase-locked loop (only possible for a dominant frequency like the basic power frequency). For the settings for harmonics and interharmonics instances, see MHAI.

MHAN class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Measured and metered values				
Hz	MV	Basic frequency		C
HaAmp	HMV	Sequence of harmonics or interharmonics for current		O
HaVol	HMV	Sequence of harmonics or interharmonics for voltages		O
HaWatt	HMV	Sequence of harmonics or interharmonics for active power		O
HaVolAmpr	HMV	Sequence of harmonics or interharmonics for reactive power		O
HaVolAmp	HMV	Sequence of harmonics or interharmonics for apparent power		O
HaRmsAmp	MV	Current RMS harmonic or interharmonic (un-normalized Thd)		O
HaRmsVol	MV	Voltage RMS harmonic or interharmonic (un-normalized Thd)		O
HaTuWatt	MV	Total harmonic or interharmonic active power (no fundamental) unsigned sum		O
HaTsWatt	MV	Total harmonic or interharmonic active power (no fundamental) signed sum		O
HaAmpTm	MV	Current time product		O
HaKFact	MV	K factor		O
HaTdFact	MV	Transformer derating factor		O
ThdAmp	MV	Current total harmonic or Interharmonic distortion (different methods)		O
ThdOddAmp	MV	Current total harmonic or Interharmonic distortion (different methods – odd components)		O
ThdEvnAmp	MV	Current total harmonic or interharmonic distortion (different methods – even components)		O
TddAmp	MV	Current total demand distortion per IEEE 519		O
TddOddAmp	MV	Current total demand distortion per IEEE 519 (odd components)		O
TddEvnAmp	MV	Current total demand distortion per IEEE 519 (even components)		O
ThdVol	MV	Voltage total harmonic or Interharmonic distortion (different methods)		O
ThdOddVol	MV	Voltage total harmonic or interharmonic distortion (different methods – odd components)		O
ThdEvnVol	MV	Voltage total harmonic or Interharmonic distortion (different methods-even components)		O
HaCfAmp	MV	Current crest factors (peak waveform value/sqrt(2)/fundamental)		O
HaCfVol	MV	Voltage crest factors (peak waveform value/sqrt(2)/fundamental)		O
HaTiFact	MV	Voltage telephone influence factor		O
Settings				
HzSet	ASG	Basic frequency		C
EvTmms	ING	Evaluation time (time window) determines the lowest frequency		O
NumCyc	ING	Number of cycles of the basic frequency		O
ThdAVal	ASG	ThdA alarm setting – value entered in %		O
ThdVVal	ASG	ThdV alarm setting – value entered in %		O
ThdATmms	ING	ThdA alarm time delay in ms		O
ThdVTmms	ING	ThdV alarm time delay in ms		O
NomA	ASG	Normalising demand current used in IEEE 519 TDD calculation		O
Condition C: Hz and HzSet are exclusive.				

5.10.6 LN: Hydrological information Name: MHYD

Logical node MHYD shall comprise the data objects 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				
Data object Name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Measured and metered values				
Lev	MV	Water level		O
Flw	MV	River, stream, canal volumetric flow		O
SpdSrfc	MV	Surface speed of water flow		O
Tmp	MV	Temperature of water		O
Cndct	MV	Electrical conductivity of water		O
HydPH	MV	Acidity of water (0-14)		O
SInt	MV	Saline content of water [g/l]		O
FishCnt	BCR	Fish counter reading		O

5.10.7 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				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Measured and metered 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

5.10.8 LN: Meteorological information Name: MMET

Logical node MMET shall comprise the data objects that represent meteorological information.

The data objects 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.

MMET class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Measured and metered values				
EnvTmp	MV	Ambient temperature		O
WetBlbTmp	MV	Wet bulb temperature		O
CloudCvr	MV	Cloud cover level		O
EnvHum	MV	Humidity		O
DewPt	MV	Dew point		O
DffInsol	MV	Diffuse insolation		O
DctInsol	MV	Direct normal insolation		O
DlDur	MV	Daylight duration (time elapsed between sunrise and sunset)		O
HorInsol	MV	Total horizontal insolation		O
HorWdDir	MV	Horizontal wind direction		O
HorWdSpd	MV	Horizontal wind speed		O
VerWdDir	MV	Vertical wind direction		O
VerWdSpd	MV	Vertical wind speed		O
WdGustSpd	MV	Wind gust speed		O
EnvPres	MV	Barometric pressure		O
RnFll	MV	Rainfall		O
SnwDen	MV	Density of snowfall		O
SnwTmp	MV	Temperature of snowfall		O
SnwCvr	MV	Snow cover		O
SnwFll	MV	Snowfall		O
SnwEq	MV	Water equivalent of snowfall		O

5.10.9 LN: Metering Single Phase Name: MMTN

For a description of this LN, see IEC 61850-5. This LN shall be used for calculation of energy in a single-phase system. The main use is for billing purposes.

MMTN class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Measured and metered values				
TotVAh	BCR	Net apparent energy		O
TotWh	BCR	Net real energy		O
TotVArh	BCR	Net reactive energy		O
SupWh	BCR	Real energy supply (default supply direction: energy flow towards busbar)		O
SupVArh	BCR	Reactive energy supply (default supply direction: energy flow towards busbar)		O
DmdWh	BCR	Real energy demand (default demand direction: energy flow from busbar away)		O
DmdVArh	BCR	Reactive energy demand (default demand direction: energy flow from busbar away)		O

5.10.10 LN: Metering 3 Phase Name: MMTR

For a description of this LN, see IEC 61850-5. This LN shall be used for calculation of energy in a three-phase system. The main use is for billing purposes.

MMTR class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Measured and metered values				
TotVAh	BCR	Net apparent energy		O
TotWh	BCR	Net real energy		O
TotVArh	BCR	Net reactive energy		O
SupWh	BCR	Real energy supply (default supply direction: energy flow towards busbar)		O
SupVArh	BCR	Reactive energy supply (default supply direction: energy flow towards busbar)		O
DmdWh	BCR	Real energy demand (default demand direction: energy flow from busbar away)		O
DmdVArh	BCR	Reactive energy demand (default demand direction: energy flow from busbar away)		O

5.10.11 LN: Non-phase-related measurement Name: MMXN

This LN shall be used for calculation of currents, voltages, powers and impedances in a single-phase system, i.e. in a system where voltages and currents are not phase-related. The main use is for operative applications.

MMXN class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Measured and metered values				
Amp	MV	Current I not allocated to a phase		O
Vol	MV	Voltage V not allocated to a phase		O
Watt	MV	Power (*P*) not allocated to a phase		O
VolAmpr	MV	Reactive power (*Q*) not allocated to a phase		O
VolAmp	MV	Apparent power (*S*) not allocated to a phase		O
PwrFact	MV	Power factor not allocated to a phase		O
Imp	CMV	Impedance		O
Hz	MV	Frequency		O

5.10.12 LN: Measurement Name: MMXU

For a description of this LN, see IEC 61850-5. This LN shall be used for calculation of currents, voltages, powers and impedances in a three-phase system. The main use is for operative applications.

MMXU class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		

MMXU class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
Data objects				
Measured and metered values				
TotW	MV	Total active power (total *P*)		O
TotVAr	MV	Total reactive power (total *Q*)		O
TotVA	MV	Total apparent power (total *S*)		O
TotPF	MV	Average power factor (total *PF*)		O
Hz	MV	Frequency		O
PPV	DEL	Phase to phase voltages (*VL*1,*VL*2, …)		O
PNV	WYE	Phase to neutral voltage		O
PhV	WYE	Phase to ground voltages (*VL*1ER, …)		O
A	WYE	Phase currents (*IL*1, *IL*2, *IL*3)		O
W	WYE	Phase active power (*P*)		O
VAr	WYE	Phase reactive power (*Q*)		O
VA	WYE	Phase apparent power (*S*)		O
PF	WYE	Phase power factor		O
Z	WYE	Phase impedance		O
AvAPhs	MV	Arithmetic average of the magnitude of current of the 3 phases. Average(Ia,Ib,Ic)		O
AvPPVPhs	MV	Arithmetic average of the magnitude of phase to phase voltage of the 3 phases. Average(PPVa, PPVb, PPVc)		O
AvPhVPhs	MV	Arithmetic average of the magnitude of phase to reference voltage of the 3 phases. Average(PhVa, PhVb, PhVc)		O
AvWPhs	MV	Arithmetic average of the magnitude of active power of the 3 phases. Average(Wa, Wb, Wc)		O
AvVAPhs	MV	Arithmetic average of the magnitude of apparent power of the 3 phases. Average(VAa, VAb, VAc)		O
AvVArPhs	MV	Arithmetic average of the magnitude of reactive power of the 3 phases. Average(VAra, VArb, VArc)		O
AvPFPhs	MV	Arithmetic average of the magnitude of power factor of the 3 phases. Average(PFa, PFb, PFc)		O
AvZPhs	MV	Arithmetic average of the magnitude of impedance of the 3 phases. Average(Za, Zb, Zc)		O
MaxAPhs	MV	Maximum magnitude of current of the 3 phases. Max(Ia,Ib,Ic)		O
MaxPPVPhs	MV	Maximum magnitude of phase to phase voltage of the 3 phases. Max(PPVa, PPVb, PPVc)		O
MaxPhVPhs	MV	Maximum magnitude of phase to reference voltage of the 3 phases. Max(PhVa, PhVb, PhVc)		O
MaxWPhs	MV	Maximum magnitude of active power of the 3 phases. Max(Wa, Wb, Wc)		O
MaxVAPhs	MV	Maximum magnitude of apparent power of the 3 phases. Max(VAa, VAb, VAc)		O
MaxVArPhs	MV	Maximum magnitude of reactive power of the 3 phases. Max(VAra, VArb, VArc)		O
MaxPFPhs	MV	Maximum magnitude of power factor of the 3 phases. Max(PFa, PFb, PFc)		O
MaxZPhs	MV	Maximum magnitude of impedance of the 3 phases. Max(Za, Zb, Zc)		O

MMXU class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/ C**
MinAPhs	MV	Minimum magnitude of current of the 3 phases. Min(Ia,Ib,Ic)		O
MinPPVPhs	MV	Minimum magnitude of phase to phase voltage of the 3 phases. Min(PPVa, PPVb, PPVc)		O
MinPhVPhs	MV	Minimum magnitude of phase to reference voltage of the 3 phases. Min(PhVa, PhVb, PhVc)		O
MinWPhs	MV	Minimum magnitude of active power of the 3 phases. Min(Wa, Wb, Wc)		O
MinVAPhs	MV	Minimum magnitude of apparent power of the 3 phases. Min(VAra, VArb, VArc)		O
MinVArPhs	MV	Minimum magnitude of reactive power of the 3 phases. Min(VAra, VArb, VArc)		O
MinPFPhs	MV	Minimum magnitude of power factor of the 3 phases. Min(PFa, PFb, PFc)		O
MinZPhs	MV	Minimum magnitude of impedance of the 3 phases. Min(Za, Zb, Zc)		O
Settings				
ClcTotVA	ENG	Calculation method used for total apparent power (TotVA)		O
PFSign	ENG	Sign convention for VAr and power factor (PF)		O

5.10.13 LN: Sequence and imbalance Name: MSQI

For a description of this LN, see IEC 61850-5.

MSQI class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/ C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Measured and metered values				
SeqA	SEQ	Positive, negative and zero sequence current		C
SeqV	SEQ	Positive, negative and zero sequence voltage		C
DQ0Seq	SEQ	DQ0 sequence		O
ImbA	WYE	Imbalance current		O
ImbNgA	MV	Imbalance negative sequence current		O
ImbNgV	MV	Imbalance negative sequence voltage		O
ImbPPV	DEL	Imbalance phase-phase voltage		O
ImbV	WYE	Imbalance voltage		O
ImbZroA	MV	Imbalance zero sequence current		O
ImbZroV	MV	Imbalance zero sequence voltage		O
MaxImbA	MV	Maximum imbalance current		O
MaxImbPPV	MV	Maximum imbalance phase-phase voltage		O
MaxImbV	MV	Maximum imbalance voltage		O
Condition C: At least one of either data object shall be used.				

5.10.14 LN: Metering statistics Name: MSTA

This LN is moved to Annex C because it includes the calculation methods MAX, MIN, AVG etc. and is therefore obsolete for this edition of the IEC 61850.

5.11 Logical nodes for protection functions LN Group: P

5.11.1 Modelling remarks

This subclause refers to modelling of protection and protection related logical nodes and shows the relation (see Table 7) between IEC 61850-5 and the logical node class definitions according to this standard.

- If there are several stages to one function (i.e. for multi-zone relay), each stage shall be a separate instance of the LN. Examples are PDIS (n zones) or PTOV (2 stages).
- Multiple instances shall be used if LNs of the same LN class are operating with different settings in parallel.
- If different measuring principles such as phase or ground are required, each shall be represented by an instance of the same basic function. An example is PTOC (used for phase or ground in dedicated instances).
- The logical nodes are defined in IEC 61850-5 from protection requirements (see Table 7), however, for modelling purposes, some logical nodes have been split (see Table 7).
- Logical nodes from IEC 61850-5 are modelled using combinations of the LNs defined in this standard (see Table 6).
- Other logical nodes have been added to model complex protection devices and schemes (see the following subclauses). As an example, line protection uses LN PSCH to combine the outputs from multiple protection LNs.
- The protection functions provide (if applicable) the data object Str (Start) with direction information. In the case of a protection function which provides no direction information, the direction “unknown” shall be transmitted. The data object Str is summarised by LN PTRC.
- If the fault direction is provided in Str (Start), the directional protection may be modelled without the directional element LN RDIR. If any of the settings provided by LN RDIR are needed, the LN RDIR shall be used.
- The protection functions provide (if applicable) the data object Op (Operate) without direction information. The data object Op is conditioned by LN PTRC resulting in the data object Tr (Real Trip), that is between every protection LN and the circuit breaker node XCBR shall be a LN PTRC.

Table 7 – Relation between IEC 61850-5 and IEC 61850-7-4 (this standard) for protection LNs

Functionality	IEEE C37.2 reference	Defined in IEC 61850-5	Modelled in IEC 61850-7-4	Comments
Distance	21	PDIS	PDIS PSCH	Use one instance per zone. To build line protection schemes
Directional power /reverse power	32	PDPR	PDOP or PDUP	Directional over power Directional under power Reverse power modelled by PDOP plus directional mode “reverse”
Undercurrent/underpower	37	PUCP	PTUC PDUP	Undercurrent Underpower
Loss of field/underexcitation	40	PUEX	PDUP PDIS	Directional under power Underimpedance protection

Functionality	IEEE C37.2 reference	Defined in IEC 61850-5	Modelled in IEC 61850-7-4	Comments
Reverse phase or phase balance current	46	PPBR	PTOC	Time overcurrent (PTOC) with three-phase information with sequence current as an input or even ratio of negative and positive sequence currents
Phase sequence voltage	47	PPBV	PTOV	Three-phase information and processing
Rotor thermal overload	49R	PROL	PTTR	Thermal overload
Stator thermal overload	49S	PSOL	PTTR	Thermal overload
Power factor	55	PPFR	POPF PUPF	Over power factor Under power factor
DC-overvoltage	59DC	PDOV	PTOV	Both for DC and AC
Voltage or current balance	60	PVCB	PTOV PTOC	Overvoltage or overcurrent regarding the magnitude of the difference
Rotor earth fault	64R	PREF	PTOC PHIZ	Time overcurrent
Stator earth fault	64S	PSEF	PTOC PHIZ	Time overcurrent
Interturn fault	64W	PITF	PTOC	Time overcurrent
AC directional overcurrent	67	PDOC	PTOC	Time overcurrent
Directional earth fault	67N	PDEF	PTOC	Time overcurrent
DC time overcurrent	76	PDCO	PTOC	Time overcurrent for AC and DC
Frequency	81	PFRQ	PTOF PTUF PFRC	Over frequency Under frequency Rate of change of frequency
Carrier or pilot wire protection	85	RCPW	PSCH	PSCH is used for line protection schemes instead of RCPW
Phase comparison	87P	PPDF	PDIF	
Differential line	87L	PLDF	PDIF	
Restricted earth fault	87N	PNDF	PDIF	
Differential transformer	87T	PTDF	PDIF PHAR	Differential transformer Harmonic restraint
Busbar	87B	PBDF	PDIF or PDIR	Busbar differential or fault direction comparison
Motor differential	87M	PMDF	PDIF	
Generator differential	87G	PGDF	PDIF	
Motor startup	49R, 66 48, 51LR	PMSU	PMRI PMSS	Motor restart inhibition Motor starting time supervision
Rotor protection	64 / 59AC	PROT	PRTR	Field short-circuit protection using the 6th harmonic (300 Hz).

5.11.2 LN: Differential Name: PDIF

See IEC 61850-5 (LNs PLDF, PNDF, PTDF, PBDF, PMDF, and PPDF). This LN shall be used for all kinds of current differential protection. Proper current samples for the dedicated application shall be subscribed.

PDIF class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/ C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Status information				
Str	ACD	Start		O
Op	ACT	Operate	T	M
TmASt	CSD	Active curve characteristic		O
Measured and metered values				
DifAClc	WYE	Differential current		O
RstA	WYE	Restraint current		O
Controls				
OpCntRs	INC	Resettable operation counter		O
Settings				
LinCapac	ASG	Line capacitance (for load currents)		O
LoSet	ASG	Low operate value, percentage of the nominal current		C
HiSet	ASG	High operate value, percentage of the nominal current		C
MinOpTmms	ING	Minimum operate time		O
MaxOpTmms	ING	Maximum operate time		O
RstMod	ENG	Restraint mode		O
RsDlTmms	ING	Reset delay time		O
TmACrv	CURVE	Operating curve type		O
TmAChr33	CSG	Multiline curve characteristic definition		O
Condition C: These data objects are conditional, and if used only one data object should be applied.				
NOTE TmAChr33 refers to the attribute TmACrv.setCharact = 33 etc.				

5.11.3 LN: Direction comparison Name: PDIR

For a description of this LN, see IEC 61850-5. The operate decision is based on an agreement of the fault direction signals from all directional fault sensors (for example directional relays) surrounding the fault. The directional comparison for lines is made with PSCH.

PDIR class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/ C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Status information				
Str	ACD	Start (appearance of the first related fault direction)		M
Op	ACT	Operate (decision from all sensors that the surrounded object is faulted)	T	M
Controls				
OpCntRs	INC	Resettable operation counter		O
Settings				
RsDlTmms	ING	Reset delay time		O

5.11.4 LN: Distance Name: PDIS

For a description of this LN, see IEC 61850-5. The phase start value and ground start value are minimum thresholds to release the impedance measurements depending on the distance function characteristic given by the algorithm and defined by the settings. The settings replace the data object curve as used for the characteristic on some other protection LNs. One instance of PDIS per zone shall be used.

PDIS class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Status information				
Str	ACD	Start		M
Op	ACT	Operate	T	M
Controls				
OpCntRs	INC	Resettable operation counter		O
Settings				
PoRch	ASG	Polar reach is the diameter of the Mho diagram		O
PhStr	ASG	Phase start value		O
GndStr	ASG	Ground start value		O
DirMod	ENG	Directional mode		O
PctRch	ASG	Percent reach		O
Ofs	ASG	Offset		O
PctOfs	ASG	Percent offset		O
RisLod	ASG	Resistive reach for load area		O
AngLod	ASG	Angle for load area		O
TmDlMod	SPG	Operate time delay mode		O
OpDlTmms	ING	Operate time delay		O
PhDlMod	SPG	Operate time delay multiphase mode		O
PhDlTmms	ING	Operate time delay for multiphase faults		O
GndDlMod	SPG	Operate time delay for single phase ground mode		O
GndDlTmms	ING	Operate time delay for single phase ground faults		O
X1	ASG	Positive sequence line (reach) reactance		O
LinAng	ASG	Line angle		O
RisGndRch	ASG	Resistive ground reach		O
RisPhRch	ASG	Resistive phase reach		O
K0Fact	ASG	Residual compensation factor K_0		O
K0FactAng	ASG	Residual compensation factor angle		O
RsDlTmms	ING	Reset time delay		O

5.11.5 LN: Directional overpower Name: PDOP

For a description of this LN, see IEC 61850-5 (LN PDPR). This LN shall be used for the overpower part of PDPR. Additionally, PDOP is used to model a reverse overpower function (IEEE device function number 32R, from IEEE C37.2:1996) when the DirMod is set to reverse.

PDOP class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Status information				
Str	ACD	Start		M
Op	ACT	Operate	T	M
Controls				
OpCntRs	INC	Resettable operation counter		O
Settings				
DirMod	ENG	Directional mode		O
StrVal	ASG	Start value		O
OpDlTmms	ING	Operate delay time		O
RsDlTmms	ING	Reset delay time		O

5.11.6 LN: Directional underpower Name: PDUP

For a description of this LN, see IEC 61850-5 (LN PDPR). This LN shall be used for the underpower part of PDPR.

PDUP class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Status information				
Str	ACD	Start		M
Op	ACT	Operate	T	M
Controls				
OpCntRs	INC	Resettable operation counter		O
Settings				
StrVal	ASG	Start value		O
OpDlTmms	ING	Operate delay time		O
RsDlTmms	ING	Reset delay time		O
DirMod	ENG	Directional mode		O

5.11.7 LN: Rate of change of frequency Name: PFRC

For a description of this LN, see IEC 61850-5 (LN PFRQ). This LN shall be used to model the rate of frequency change of PFRQ. One instance shall be used per stage.

PFRC class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Status information				
Str	ACD	Start		M
Op	ACT	Operate	T	M
BlkV	SPS	Blocked because of voltage		O

PFRC class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
Controls				
OpCntRs	INC	Resettable operation counter		O
Settings				
StrVal	ASG	Start value df/dt		O
BlkVal	ASG	Voltage block value		O
OpDlTmms	ING	Operate delay time		O
RsDlTmms	ING	Reset delay time		O

5.11.8 LN: Harmonic restraint Name: PHAR

This LN shall be used to represent the harmonic restraint data object of the transformer differential protection (see PDIF) in a dedicated node. There may be multiple instantiations of this LN with different settings, especially with different data object HaRst.

PHAR class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Status information				
Str	ACD	Start (active when restraint is needed)		M
Controls				
OpCntRs	INC	Resettable operation counter		O
Settings				
HaRst	ING	Number of harmonic restrained		O
PhStr	ASG	Start value		O
PhStop	ASG	Stop value		O
OpDlTmms	ING	Operate delay time		O
RsDlTmms	ING	Reset delay time		O

5.11.9 LN: Ground detector Name: PHIZ

For a description of this LN, see IEC 61850-5. This LN shall be used for high-impedance isolation faults only.

PHIZ class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Status information				
Str	ACD	Start		M
Op	ACT	Operate	T	M
Controls				
OpCntRs	INC	Resettable operation counter		O
Settings				
AStr	ASG	Current start value		O
VStr	ASG	Voltage start value		O
HVStr	ASG	Third harmonic voltage start value		O

PHIZ class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
OpDlTmms	ING	Operate delay time		O
RsDlTmms	ING	Reset delay time		O

5.11.10 LN: Instantaneous overcurrent Name: PIOC

For a description of this LN, see IEC 61850-5. This LN shall be used for instantaneous overcurrent protection only.

PIOC class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Status information				
Str	ACD	Start		O
Op	ACT	Operate	T	M
Controls				
OpCntRs	INC	Resettable operation counter		O
Settings				
StrVal	ASG	Start value		O

5.11.11 LN: Motor restart inhibition Name: PMRI

For a description of this LN, see IEC 61850-5 (LN PMSU). This LN shall be used to model in a dedicated LN the part from LN PMSU which protects a motor against thermal overload during start-up.

PMRI class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Status information				
Op	ACT	Operate	T	O
StrInh	SPS	Restart inhibited		O
StrInhTmm	INS	Restart inhibition time		O
Controls				
OpCntRs	INC	Resettable operation counter		O
Settings				
SetA	ASG	Current setting for motor start-up		O
SetTms	ING	Time setting for motor start-up		O
MaxNumStr	ING	Maximum number of starts (also for cold starts)		O
MaxWrmStr	ING	Maximum warm starts, permissible number of warm starts		O
MaxStrTmm	ING	Time period for the maximum number of starts		O
EqTmm	ING	Temperature equalisation time		O
InhTmm	ING	Restart inhibit time		O

5.11.12 LN: Motor starting time supervision Name: PMSS

For a description of this LN, see IEC 61850-5 (LN PMSU). This LN shall be used to model from LN PMSU the part which protects a motor against excessive starting time/locked rotor during start-up in a dedicated LN.

PMSS class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Status information				
Str	ACD	Start		O
Op	ACT	Operate	T	O
Controls				
OpCntRs	INC	Resettable operation counter		O
Settings				
SetA	ASG	Current setting for motor start-up		O
SetTms	ING	Time setting for motor start-up		O
MotStr	ASG	Motor startup (current pickup value of motor starting)		O
LokRotTms	ING	Lock rotor time, permissible locked rotor time		O

5.11.13 LN: Over power factor Name: POPF

For a description of this LN, see IEC 61850-5 (LN PPFR). This LN shall be used for the over power factor part of PPFR.

POPF class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Status information				
Str	ACD	Start		M
Op	ACT	Operate	T	M
BlkA	SPS	Blocked below minimum operating current		O
BlkV	SPS	Blocked below minimum operating voltage		O
Controls				
OpCntRs	INC	Resettable operation counter		O
Settings				
StrVal	ASG	Start value		O
OpDlTmms	ING	Operate delay time		O
RsDlTmms	ING	Reset delay time		O
BlkValA	ASG	Block value (minimum operating current)		O
BlkValV	ASG	Block value (minimum operating voltage)		O

5.11.14 LN: Phase angle measuring Name: PPAM

For a description of this LN, see IEC 61850-5. This function shall be used to model “out-of-step” protection of generators.

PPAM class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Status information				
Str	ACD	Start		M
Op	ACT	Operate	T	M
Controls				
OpCntRs	INC	Resettable operation counter		O
Settings				
StrVal	ASG	Start value		O

5.11.15 LN: Rotor protection Name: PRTR

For a description of this LN, see IEC 61850-5. Logical Node PRTR shall be used to represent a field short-circuit protection using the 6^{th} harmonic (300 Hz). The protection is normally included in the excitation system.

PRTR class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Status information				
Str	ACD	Start		M
Op	ACT	Operate (trips both field CB and generator CB)	T	M
Controls				
OpCntRs	INC	Resettable operation counter		O
Settings				
StrVal	ASG	Start value		O

5.11.16 LN: Protection scheme Name: PSCH

This LN shall be used to model the logic scheme for line protection function co-ordination. The protection scheme allows the exchange of the “operate” outputs of different protection functions and conditions for line protection schemes. It includes data objects for teleprotection if applicable. In this case, all appropriate data objects shall be subscribed.

PSCH class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Status Information				
TxPrm	ACT	Permissive information to be transmitted to the other side (teleprotection permissive signal)	T	O
TxBlk	ACT	Blocking information to be transmitted to the other side (teleprotection blocking signal)	T	O
TxTr	ACT	Direct trip information to be transmitted to the other side	T	O
RxPrm1	ACT	Activation information RxPrm1 received from the other side(s), for logging purposes (teleprotection permissive signal received)	T	O

PSCH class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
RxBlk1	ACT	Activation information RxBlk1 received from the other side(s), for logging purposes (teleprotection blocking signal received)	T	O
RxTr1	ACT	Activation information RxTr1 received from the other side(s), for logging purposes (direct trip signal received)		O
Op	ACT	Operate	T	M
EchoWei	SPS	TxPrm is being sent as echo signal or in case of weak end infeed	T	O
EchoWeiOp	SPS	Additional indication that Op is the operate from the weak end infeed or echo function (typically with undervoltage control)	T	O
Controls				
OpCntRs	INC	Resettable operation counter		O
Settings				
RxSrc1	ORG	Source for activation information RxPrm or RxBlk, must refer to data of type ACT		O
RxSrcTr1	ORG	Source for activation information RxTr, must refer to data of type ACT		O
OpDlTmms	ING	Operate delay time		O
CrdTmms	ING	Co-ordination timer for blocking scheme		O
DurTmms	ING	Minimum duration of TxPerm in case of operate of PSCH		O
UnBlkMod	ENG	Unblock function mode for scheme type		O
UnBlkTmms	ING	Unblocking time		O
WeiMod	ENG	Mode of weak end infeed function		O
WeiTmms	ING	Co-ordination time for weak end infeed function		O

5.11.17 LN: Sensitive directional earthfault Name: PSDE

For a general description of directed earth fault protection, see IEC 61850-5. This LN is used for directional earthfault handling in compensated and isolated networks. The use of “operate” is optional and depends both on protection philosophy and on instrument transformer capabilities. For compensated networks, this function is often called wattmetric directional earthfault. The very high accuracy needed for fault current measurement in compensated networks may require phase angle compensation. This shall be realised by the related LN TCTR.

PSDE class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Status information				
Str	ACD	Start		M
Op	ACT	Operate	T	O
Controls				
OpCntRs	INC	Resettable operation counter		O
FltIndRs	SPC	Earthfault indication, resettable		O
Settings				
Ang	ASG	Angle between voltage (U_0) and current (I_0)		O
GndStr	ASG	Ground start value (3 U_0)		O
GndOp	ASG	Ground operate value (3 I_0)		O
StrDlTmms	ING	Start delay time		O
OpDlTmms	ING	Operate delay time		O
DirMod	ENG	Directional mode		O

5.11.18 LN: Transient earth fault Name: PTEF

For a description of this LN, see IEC 61850-5. This LN shall be used to detect (“start”) transient earth fault in compensated networks.

PTEF class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Status information				
Str	ACD	Start (transient earth fault)		C
Op	ACT	Operate (transient earth fault)	T	C
Controls				
OpCntRs	INC	Resettable operation counter		O
FltIndRs	SPC	Earthfault indication, resettable		O
Settings				
GndStr	ASG	Ground start value		O
DirMod	ENG	Directional mode		O
Condition C: at least one of the two status information (Str, Op) shall be used.				

5.11.19 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				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Status information				
Str	ACD	Start		M
Op	ACT	Operate (trips both field CB and generator CB)	T	M
Controls				
OpCntRs	INC	Resettable operation counter		O
Settings				
StrVal	ASG	Start value		O

5.11.20 LN: Time overcurrent Name: PTOC

For a description of this LN, see IEC 61850-5 (LN PTOC). This LN shall also be used to model the directional time overcurrent (PDOC/IEEE device function number 67, from IEEE C37.2:1996). The Definite Time overcurrent (also PTOC/IEEE device function number 51, from IEEE C37.2:1996) shall be modelled by use of PTOC and selecting the related curve.

PTOC class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Status information				
Str	ACD	Start		M

PTOC class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/ C**
Op	ACT	Operate	T	M
Controls				
OpCntRs	INC	Resettable operation counter		O
Settings				
TmACrv	CURVE	Operating curve type		O
TmAChr33	CSG	Multiline curve characteristic definition		C
TmASt	CSD	Active curve characteristic		O
StrVal	ASG	Start value		O
TmMult	ASG	Time dial multiplier		O
MinOpTmms	ING	Minimum operate time		O
MaxOpTmms	ING	Maximum operate time		O
OpDlTmms	ING	Operate delay time		O
TypRsCrv	ENG	Type of reset curve		O
RsDlTmms	ING	Reset delay time		O
DirMod	ENG	Directional mode		O
NOTE TmAChr33 refers to the attribute TmACrv.setCharact = 33 etc.				

5.11.21 LN: Overfrequency Name: PTOF

For a description of this LN, see IEC 61850-5 (LN PFRQ). This LN shall be used to model the overfrequency part of PFRQ. One instance shall be used per stage.

PTOF class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/ C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Status information				
Str	ACD	Start		M
Op	ACT	Operate	T	M
BlkV	SPS	Blocked because of voltage		O
Controls				
OpCntRs	INC	Resettable operation counter		O
Settings				
StrVal	ASG	Start value (frequency)		O
BlkVal	ASG	Voltage block value		O
OpDlTmms	ING	Operate delay time		O
RsDlTmms	ING	Reset delay time		O

5.11.22 LN: Overvoltage Name: PTOV

For a description of this LN, see IEC 61850-5. For some applications such as transformer star-point or delta supervision, “operate” may not be used.

PTOV class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Status information				
Str	ACD	Start		M
Op	ACT	Operate	T	O
Controls				
OpCntRs	INC	Resettable operation counter		O
Settings				
TmVCrv	CURVE	Operating curve type		O
TmVChr33	CSG	Multiline curve characteristic definition		C
TmVSt	CSD	Active curve characteristic		O
StrVal	ASG	Start value		O
TmMult	ASG	Time dial multiplier		O
MinOpTmms	ING	Minimum operate time		O
MaxOpTmms	ING	Maximum operate time		O
OpDlTmms	ING	Operate delay time		O
RsDlTmms	ING	Reset delay time		O
NOTE TmVChr33 refers to the attribute TmVCrv.setCharact = 33 etc.				

5.11.23 LN: Protection trip conditioning Name: PTRC

This LN shall be used to connect the “operate” outputs of one or more protection functions to a common “trip” to be transmitted to XCBR. In addition, or alternatively, any combination of “operate” outputs of the protection functions may be combined to a new “operate” of PTRC.

PTRC class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Status information				
Tr	ACT	Trip		C
Op	ACT	Operate (combination of subscribed Op from protection functions)		C
Str	ACD	Start (combination of subscribed Str from protection functions)		O
Controls				
OpCntRs	INC	Resettable operation counter		O
Settings				
TrMod	ENG	Trip mode		O
TrPlsTmms	ING	Trip pulse time		O
Condition C: At least one of the two status informations (Tr, Op) shall be used.				

5.11.24 LN: Thermal overload Name: PTTR

For a description of this LN, see IEC 61850-5 (LNs PROL, PSOL). PTTR shall be used for all thermal overload functions. Depending on the algorithm, the LN describes either a temperature or a current (thermal model). Temperature data objects are also provided by other LNs. Examples are the hot spot temperature in LN YPTR or the isolation gas temperature in LN SIMG.

PTTR class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Status information				
Str	ACD	Start		O
Op	ACT	Operate	T	M
AlmThm	SPS	Thermal alarm		O
BlkThm	SPS	Block closing command for circuit breaker because of thermal condition		O
Measured and metered values				
Amp	MV	Current for thermal load model		O
Tmp	MV	Temperature for thermal load		O
TmpRl	MV	Relation between temperature and maximum temperature		O
LodRsvAlm	MV	Load reserve to alarm		O
LodRsvTr	MV	Load reserve to trip		O
Controls				
OpCntRs	INC	Resettable operation counter		O
Settings				
TmTmpCrv	CURVE	Characteristic curve for temperature measurement		O
TmTmpChr33	CSG	Multiline curve characteristic definition		C
TmACrv	CURVE	Characteristic curve for current measurement /Thermal model		O
TmAChr33	CSG	Multiline curve characteristic definition		C
TmTmpSt	CSD	Active curve characteristic		O
TmASt	CSD	Active curve characteristic		O
TmpMax	ASG	Maximum allowed temperature		O
StrVal	ASG	Start value		O
OpDlTmms	ING	Operate delay time		O
MinOpTmms	ING	Minimum operate time		O
MaxOpTmms	ING	Maximum operate time		O
RsDlTmms	ING	Reset delay time		O
ConsTms1	ING	Time constant of the thermal model		O
AlmVal	ASG	Alarm value		O
DropoutVal	ASG	Dropout value for blocking closing command		O
NOTE TmAChr33 refers to the attribute TmACrv.setCharact = 33 etc. TmTmpChr33 refers to the attribute TmTmpCrv.setCharact = 33 etc.				

5.11.25 LN: Undercurrent Name: PTUC

For a description of this LN, see IEC 61850-5 (LN PUCP). This LN shall be used for the undercurrent part of PUCP. The underpower part of LN PUCP is covered by PDUP. Different instances shall be used for phase and ground.

PTUC class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Status information				
Str	ACD	Start		M
Op	ACT	Operate	T	M
Controls				
OpCntRs	INC	Resettable operation counter		O
Settings				
TmACrv	CURVE	Operating curve type		O
TmAChr33	CSG	Multiline curve characteristic definition		C
TmASt	CSD	Active curve characteristic		O
StrVal	ASG	Start value		O
OpDlTmms	ING	Operate delay time		O
TmMult	ASG	Time dial multiplier		O
MinOpTmms	ING	Minimum operate time		O
MaxOpTmms	ING	Maximum operate time		O
TypRsCrv	ENG	Type of reset curve		O
RsDlTmms	ING	Reset delay time		O
DirMod	ENG	Directional mode		O
NOTE TmAChr33 refers to the attribute TmACrv.setCharact = 33 etc.				

5.11.26 LN: Underfrequency Name: PTUF

For a description of this LN, see IEC 61850-5 (LN PFRQ). This LN shall be used to model the underfrequency part of PFRQ. One instance shall be used per stage.

PTUF class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Status information				
Str	ACD	Start		M
Op	ACT	Operate	T	M
BlkV	SPS	Blocked because of voltage		O
Controls				
OpCntRs	INC	Resettable operation counter		O
Settings				
StrVal	ASG	Start value (frequency)		O
BlkVal	ASG	Voltage block value		O
OpDlTmms	ING	Operate delay time		O
RsDlTmms	ING	Reset delay time		O

5.11.27 LN: Undervoltage Name: PTUV

For a description of this LN, see IEC 61850-5. With an appropriate low operating curve, PTUV works also as zero voltage relay.

PTUV class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Status information				
Str	ACD	Start		M
Op	ACT	Operate	T	M
Controls				
OpCntRs	INC	Resettable operation counter		O
Settings				
TmVCrv	CURVE	Operating curve type		O
TmVChr33	CSG	Multiline curve characteristic definition		C
TmVSt	CSD	Active curve characteristic		O
StrVal	ASG	Start value		O
TmMult	ASG	Time dial multiplier		O
MinOpTmms	ING	Minimum operate time		O
MaxOpTmms	ING	Maximum operate time		O
OpDlTmms	ING	Operate delay time		O
RsDlTmms	ING	Reset delay time		O
NOTE TmVChr33 refers to the attribute TmVCrv.setCharact = 33 etc.				

5.11.28 LN: Underpower factor Name: PUPF

For a description of this LN, see IEC 61850-5 (LN PPFR). This LN shall be used for the underpower factor part of PPFR.

PUPF class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Status information				
Str	ACD	Start		M
Op	ACT	Operate	T	M
BlkA	SPS	Blocked below minimum operating current		O
BlkV	SPS	Blocked below minimum operating voltage		O
Controls				
OpCntRs	INC	Resettable operation counter		O
Settings				
StrVal	ASG	Start value		O
OpDlTmms	ING	Operate delay time		O
RsDlTmms	ING	Reset delay time		O
BlkValA	ASG	Block value (minimum operating current)		O
BlkValV	ASG	Block value (minimum operating voltage)		O

5.11.29 LN: Voltage controlled time overcurrent Name: PVOC

For a description of this LN, see IEC 61850-5.

PVOC class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Status information				
Str	ACD	Start		M
Op	ACT	Operate	T	M
Controls				
OpCntRs	INC	Resettable operation counter		O
Settings				
AVCrv	CURVE	Operating curve type (for voltage controlled current curve)		O
AVChr33	CSG	Multiline curve characteristic definition		C
TmACrv	CURVE	Operating curve type (for current)		O
TmAChr33	CSG	Multiline curve characteristic definition		C
AVSt	CSD	Active curve characteristic		O
TmASt	CSD	Active curve characteristic		O
TmMult	ASG	Time dial multiplier		O
MinOpTmms	ING	Minimum operate time		O
MaxOpTmms	ING	Maximum operate time		O
OpDlTmms	ING	Operate delay time		O
TypRsCrv	ENG	Type of reset curve		O
RsDlTmms	ING	Reset delay time		O
NOTE AVChr33 refers to the attribute AVCrv.setCharact = 33 etc. TmAChr33 refers to the attribute TmACrv.setCharact = 33 etc.				

5.11.30 LN: Volts per Hz Name: PVPH

For a description of this LN, see IEC 61850-5. One instance of PVPH shall be used per protection stage.

PVPH class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Status information				
Str	ACD	Start		M
Op	ACT	Operate	T	M
Controls				
OpCntRs	INC	Resettable operation counter		O
Settings				
VHzCrv	CURVE	Operating curve type		O
VHzChr33	CSG	Multiline curve characteristic definition		C
VHzSt	CSD	Active curve characteristic		O
StrVal	ASG	Volts per hertz start value		O
OpDlTmms	ING	Operate delay time		O
TypRsCrv	ENG	Type of reset curve		O
RsDlTmms	ING	Reset delay time		O

PVPH class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
TmMult	ASG	Time dial multiplier		O
MinOpTmms	ING	Minimum operate time		O
MaxOpTmms	ING	Maximum operate time		O
NOTE VHzChr33 refers to the attribute VHzCrv.setCharact = 33 etc.				

5.11.31 LN: Zero speed or underspeed Name: PZSU

For a description of this LN, see IEC 61850-5.

PZSU class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Status information				
Str	ACD	Start		M
Op	ACT	Operate	T	M
Controls				
OpCntRs	INC	Resettable operation counter		O
Settings				
StrVal	ASG	Start value (speed)		O
OpDlTmms	ING	Operate delay time		O
RsDlTmms	ING	Reset delay time		O

5.12 Logical nodes for power quality events LN Group: Q

5.12.1 Modelling remarks

This group of logical nodes refers to the modelling of power quality events detection and analysis functions. The models are based on the principles used for modelling protection functions.

There is a one-to-one relationship between the power quality event logical nodes in IEC 61850-5 and the logical node class definitions in this standard.

5.12.2 LN: Frequency variation Name: QFVR

For a description of this LN, see IEC 61850-5.

QFVR class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Status information				
VarStr	SPS	Start of the frequency variation event		M
UnHzStr	SPS	Start (underfrequency variation event in progress)		O
OvHzStr	SPS	Start (overfrequency variation event in progress)		O
VarEnd	SPS	Event finished but not reset	T	O

QFVR class				
Data object name	Common data class	Explanation	T	M/O/C
Measured and metered values				
HzVaTm	MV	Frequency variation duration of the last completed event		O
HzVaMag	MV	Frequency variation magnitude of the last completed event		O
EvtCnt	HST	Event counter histogram (HzVaTm, HzVaMag)		O
Controls				
OpCntRs	INC	Resettable counter operation		O
Settings				
UnHzStrVal	ASG	Underfrequency set point		O
OvHzStrVal	ASG	Overfrequency set point		O

5.12.3 LN: Current transient Name: QITR

For a description of this LN, see IEC 61850-5.

QITR class				
Data object name	Common data class	Explanation	T	M/O/C
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Status information				
VarStr	SPS	Start of the event		M
VarEnd	SPS	Event finished but not reset	T	O
Measured and metered values				
ATrsTm	MV	Current transient duration		O
MaxATrs	MV	Maximum current transient value		O
EvtCnt	HST	Event counter histogram (ATrsTm, MaxATrs)		O
Controls				
OpCntRs	INC	Resettable counter operation		O
Settings				
StrVal	ASG	Current transient start value		O

5.12.4 LN: Current unbalance variation Name: QIUB

For a description of this LN, see IEC 61850-5.

QIUB class				
Data object name	Common data class	Explanation	T	M/O/C
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Status information				
VarStr	SPS	Start of the event		M
VarEnd	SPS	Event finished but not reset	T	O
Measured and metered values				
AVaTm	MV	Current unbalance variation duration		O
MaxAVa	MV	Maximum unbalance deviation value		O
EvtCnt	HST	Event counter histogram		O

QIUB class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
Controls				
OpCntRs	INC	Resettable counter operation		O
Settings				
UnbDetMth	ENG	Unbalance detection method		O
StrVal	ASG	Current unbalance start value		O

5.12.5 LN: Voltage transient Name: QVTR

For a description of this LN, see IEC 61850-5.

QVTR class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Status information				
VarStr	SPS	Start of the event		M
VarEnd	SPS	Event finished but not reset	T	O
Measured and metered values				
VTrsTm	MV	Voltage transient duration		O
MaxVTrs	MV	Maximum voltage transient value		O
EvtCnt	HST	Event counter histogram		O
Controls				
OpCntRs	INC	Resettable counter operation		O
Settings				
StrVal	ASG	Voltage transient start value		O

5.12.6 LN: Voltage unbalance variation Name: QVUB

For a description of this LN, see IEC 61850-5.

QVUB class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Status information				
VarStr	SPS	Start of the event		M
VarEnd	SPS	Event finished but not reset	T	O
Measured and metered values				
VVaTm	MV	Voltage unbalance variation duration		O
MaxVVa	MV	Maximum unbalance deviation value		O
EvtCnt	HST	Event counter histogram		O
Controls				
OpCntRs	INC	Resettable counter operation		O
Settings				
UnbDetMth	ENG	Unbalance detection method		M
StrVal	ASG	Voltage unbalance start value		M

5.12.7 LN: Voltage variation Name: QVVR

For a description of this LN, see IEC 61850-5. This LN refers to one phase only.

QVVR class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Status information				
VarStr	SPS	Start (voltage variation event in progress)		M
DipStr	SPS	Start (voltage dip event in progress)		O
SwlStr	SPS	Start (voltage swell event in progress)		O
IntrStr	SPS	Start (voltage interruption event in progress)		O
VarEnd	SPS	Event finished but not reset	T	O
Measured and metered values				
VVa	MV	Voltage variation magnitude of the last completed event		O
EvtCnt	HST	Event counter histogram		O
VVaTm	MV	Voltage variation duration of the last completed event		O
Controls				
OpCntRs	INC	Resettable counter operation		O
Settings				
DipStrVal	ASG	Voltage dip set point		O
SwlStrVal	ASG	Voltage swell set point		O
IntrStrVal	ASG	Voltage Interruption set point		O
IntrDetMth	ENG	Interruption detection method		O

5.13 Logical nodes for protection related functions LN Group: R

5.13.1 Modelling remarks

Table 8 gives the relation between IEC 61850-5 and this standard for protection related LNs.

Table 8 – Relation between IEC 61850-5 and IEC 61850-7-4 for protection related LN

Functionality	IEEE reference	Defined in IEC 61850-5 by LN	Modelled in IEC 61850-7-4 by LN	Comments
Carrier or pilot line wire protection	85	RCPW	PSCH	PSCH is used for line protection schemes instead of RCPW
Directional element			RDIR	Directional element for modelling directed protection with Pxyz nodes
Disturbance recording (acquisition)		RDRE	RDRE RADR RBDR	Basic functionality Analogue channel Binary channel

5.13.2 LN: Disturbance recorder channel analogue Name: RADR

In addition to the channel number, all attributes needed for the COMTRADE file (IEEE C37.111:1999) are provided either by data objects from the TVTR or TCTR or by attributes of the measured value (samples subscribed from TVTR or TCTR) itself or by data objects from pseudo channels (calculated values, derived values of power quality devices). The "circuit component" and "phase identification" is provided by the instance identification of the LN RADR. Channels "1" to "*n*" are created by "1" to "*n*" instances.

RADR class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Status information				
ChTrg	SPS	Channel triggered		M
Measured and metered values				
Access via COMTRADE only		Analogue input channel		M
Controls				
OpCntRs	INC	Resettable operation counter		O
Settings				
ChNum1	ING	Channel number		C
TrgMod	ENG	Trigger mode (internal trigger, external or both)		O
LevMod	ENG	Level trigger mode		O
HiTrgLev	ASG	High (positive) trigger level		O
LoTrgLev	ASG	Low (negative) trigger level		O
PreTmms	ING	Pre-trigger time		O
PstTmms	ING	Post-trigger time		O
SrcRef	ORG	Reference to the IEC 61850 source data object		O
Condition C: multiple instances of ChNum are only allowed in case of compound data types (e.g. WYE). The order of these shall be the same as in the referenced data object.				

5.13.3 LN: Disturbance recorder channel binary Name: RBDR

In addition to the channel number, all attributes needed for the COMTRADE file (IEEE C37.111:1999) are provided by attributes of the binary input (subscribed from another LN). The "circuit component" and "phase identification" is provided by the instance identification of the LN RBDR. Channels "1" to "*n*" are created by "1" to "*n*" instances.

RBDR class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Status information				
ChTrg	SPS	Channel triggered		M
Access via COMTRADE only		Binary input channel		M
Controls				
OpCntRs	INC	Resettable operation counter		O
Settings				
ChNum1	ING	Channel number		O
TrgMod	ENG	Trigger mode (internal trigger, external or both)		O

RBDR class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LevMod	ENG	Level trigger mode		O
PreTmms	ING	Pre-trigger time		O
PstTmms	ING	Post-trigger time		O
SrcRef	ORG	Reference to the IEC 61850 source data object		O
Condition C: multiple instances of ChNum are only allowed in case of compound data types (e.g. double indication). The order of these shall be the same as in the referenced data object.				

5.13.4 LN: Breaker failure Name: RBRF

For a description of this LN, see IEC 61850-5.

RBRF class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Status information				
Str	ACD	Start, timer running		O
OpEx	ACT	Breaker failure trip (“external trip”)	T	C
OpIn	ACT	Operate, retrip (“internal trip”)	T	C
Controls				
OpCntRs	INC	Resettable operation counter		O
Settings				
FailMod	ENG	Breaker failure detection mode		O
FailTmms	ING	Breaker failure time delay for bus bar trip		O
SPITrTmms	ING	Single pole retrip time delay		O
TPTrTmms	ING	Three pole retrip time delay		O
DetValA	ASG	Current detector value		O
ReTrMod	ENG	Retrip mode		O
Condition C: At least one of either data objects shall be used depending on the applied tripping schema.				

5.13.5 LN: Directional element Name: RDIR

This LN shall be used to represent all directional data objects in a dedicated LN used for directional relay settings. The protection function itself is modelled by the dedicated protection LN. LN RDIR may be used with functions 21, 32 or 67 according to IEEE device function number designation.

RDIR class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Status information				
Dir	ACD	Direction		M
Settings				
ChrAng	ASG	Characteristic angle		O
MinFwdAng	ASG	Minimum phase angle in forward direction		O

RDIR class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
MinRvAng	ASG	Minimum phase angle in reverse direction		O
MaxFwdAng	ASG	Maximum phase angle in forward direction		O
MaxRvAng	ASG	Maximum phase angle in reverse direction		O
BlkValA	ASG	Minimum operating current		O
BlkValV	ASG	Minimum operating voltage		O
PolQty	ENG	Polarizing quantity		O
MinPPV	ASG	Min phase-phase voltage		O

5.13.6 LN: Disturbance recorder function Name: RDRE

For consistent modelling, the disturbance recorder function described as a requirement in IEC 61850-5 is decomposed into one LN class for analogue channels (RADR) and another LN class for binary channels (RBDR). The output refers to the “IEEE Standard Format for transient data exchange (COMTRADE) for power systems” (see IEEE C37.111:1999). Disturbance recorders are logical devices built up with one instance of LN RADR or LN RBDR per channel. Since the content of logical devices (LD) are not standardised, other LNs may be inside the LD “disturbance recorder” if applicable. All enabled channels are included in the recording, independently of the trigger mode (TrgMod).

RDRE class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Status information				
RcdMade	SPS	Recording made		M
FltNum	INS	Fault number		M
GriFltNum	INS	Grid fault number		O
RcdStr	SPS	Recording started		O
MemUsed	INS	Memory used in %		O
Controls				
RcdTrg	SPC	Trigger recorder		O
MemRs	SPC	Reset recorder memory (set the pointer of memory start to the beginning)	T	O
MemClr	SPC	Clear memory (erase all content of the memory)	T	O
OpCntRs	INC	Resettable operation counter		O
Settings				
TrgMod	ENG	Trigger mode (internal trigger, external or both)		O
LevMod	ENG	Level trigger mode		O
PreTmms	ING	Pre-trigger time		O
PstTmms	ING	Post-trigger time		O
MemFull	ING	Memory full level		O
MaxNumRcd	ING	Maximum number of records		O
ReTrgMod	SPG	Retrigger mode		O
PerTrgTms	ING	Periodic trigger time in s		O
ExclTmms	ING	Exclusion time		O
RcdMod	ENG	Recorder operation mode (saturation, overwrite)		O
StoRte	ING	Storage rate, i.e. sampling rate of the disturbance recorder		O

RDRE class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
NOTE 1 The trigger modes (TrgMod) of RDRE, RADR and RBDR are not independent. If the trigger mode of RDRE is external, the trigger modes of RADR and RBDR may be external (no extension of trigger possibilities) or internal (extension of the external trigger mode). If the trigger mode of RDRE is internal, the trigger modes of RADR and RBDR should also be internal because otherwise, no trigger possibility is provided. NOTE 2 The source of the external trigger is a local issue. It may be a contact or a signal from another logical node. NOTE 3 The source of the internal trigger is an event detected by the supervision of the channel. It may, for analogue channels, be a limit violation or it may, for binary channels, be a status change. The trigger levels (high/low) for analogue channels for internal triggering have to be set per channel. NOTE 4 Since in case of sensors providing the analogue data as samples, the sampling rate at the source (TVTR and TCTR) as defined in IEC 61850-7-3 as data attribute, smpRate may be different from the sampling rate of the recording unit. Therefore, in line with Table 8, the sampling rate of the RDRE is a data object called StoRte meaning storage rate.				

5.13.7 LN: Disturbance record handling Name: RDRS

For a description of this LN, see IEC 61850-5. This LN shall handle the disturbance records acquired by some local function. This LN is normally located at station level.

RDRS class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Controls				
AutoUpLod	SPC	Automatic upload		O
DltRcd	SPC	Delete record		O

5.13.8 LN: Fault locator Name: RFLO

For a description of this LN, see IEC 61850-5. In case of a fault, the fault location is calculated in Ω.

RFLO class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Status information				
FltLoop	ENS	Fault loop		O
Measured and metered values				
FltZ	CMV	Fault impedance		M
FltDiskm	MV	Fault distance		O
Controls				
OpCntRs	INC	Resettable operation counter		O

5.13.9 LN: Differential measurements Name: RMXU

This LN shall be used to provide locally calculated process values (phasors calculated out of samples or the samples itself) representing the local current values which are sent to the remote end and which are used for the local differential protection function (PDIF). Therefore, the LN RMXU together with LN PDIF models the core functionality of the differential protection function number 87 according to the IEEE designation (C37.2). In addition, the LNs RMXU on both sides of the line represents also the function to synchronize the samples. Therefore, also the samples sent from the local TCTR to the local PDIF are routed through the function represented by RMXU. The local RMXU is therefore the source

of synchronized samples or phasors from the local current sensor, which sends its information to the local PDIF and to all required remote PDIF nodes.

RMXU class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Measured and metered values				
ALoc	WYE	Current (phasor) of the local current measurement		C
AmpLocPhsA	SAV	Current (sampled value) of the local current measurement (phase L1)		C
AmpLocPhsB	SAV	Current (sampled value) of the local current measurement (phase L2)		C
AmpLocPhsC	SAV	Current (sampled value) of the local current measurement (phase L3)		C
AmpLocRes	SAV	Current (sampled value) of the local current measurement (residual current)		O
Condition C: Either ALoc or AmpLocPhA…AmpLocPhC shall be used.				

5.13.10 LN: Power swing detection/blocking Name: RPSB

For a description of this LN, see IEC 61850-5. The power swing is characterised by slow periodic changing of measured impedance. Such a moderate impedance change is tolerated, but may result in tripping of the distance protection function. If the generator is out of step (pole slipping), transient changes of impedance (one per slip) are measured. After a small number of slips (MaxNumSlp) in a dedicated time window (EvTmms), the generator shall be tripped to avoid mechanical damage (out of step tripping). The actual number of slips shall be reset either by the trip or by the end of evaluation time.

RPSB class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Status information				
Str	ACD	Start (power swing detected)		C1
Op	ACT	Operate (out of step tripping)	T	C2
BlkZn	SPS	Blocking of PDIS zone		C1
Controls				
OpCntRs	INC	Resettable operation counter		O
Settings				
ZeroEna	SPG	Zero enable		O
NgEna	SPG	Negative sequence current supervision enabled		O
MaxEna	SPG	Maximum current supervision enabled		O
SwgVal	ASG	Power swing delta		O
SwgRis	ASG	Power swing delta R		O
SwgReact	ASG	Power swing delta X		O
SwgTmms	ING	Power swing time		O
UnBlkTmms	ING	Unblocking time		O
MaxNumSlp	ING	Maximum number of pole slips until tripping (Op, out of step tripping)		O
EvTmms	ING	Evaluation time (time window, out of step tripping)		O
Condition C1: Mandatory if RPSB is used for “Power swing blocking”. Condition C2: Mandatory if RPSB is used for “Out of step tripping”.				

5.13.11 LN: Autoreclosing Name: RREC

For a description of this LN, see IEC 61850-5. The number of trigger modes (CycTrMod *i*) and reclose times (RecTmms*i*) is equal to the maximum allowed number of reclose cycles (MaxCyc). The trigger for the activation of RREC can be the start signal of PTRC, or the report "breaker open" of the circuit breaker, or any other signals and combination of signals. If different types of protections are involved in the autoreclosing process, all relevant data objects have to be published and subscribed by the allocated protection LNs. A principal diagram of RREC is given in Annex G.

RREC class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Status information				
TrBeh	ENS	Defines single or three pole tripping (mostly resulting from combination CycTrMod[n] and RecCyc) for the next trip to be subscribed by the protection		O
RecCyc	INS	Actual reclose cycle (number between 1 and UseCyc)		O
OpCls	ACT	Operation "close switch" issued to close the XCBR		M
AutoRecSt	ENS	Auto reclosing status		M
Settings				
CycTrMod1	ENG	Indicates if single pole tripping allowed or three pole tripping always requested in the cycle indicated by the DO index		O
MaxCyc	ING	Maximum number of reclose cycles		O
UseCyc	ING	Used actual set maximum number of reclose cycles		O
MaxTmms	ING	Maximum time after fault detection during which autoreclosing is permitted		O
Rec1Tmms1	ING	Reclose time for 1-phase faults i.e. time to reclose command after trip in the cycle indicated by the DO index		O
Rec13Tmms1	ING	Reclose time for evolving faults		O
Rec3Tmms1	ING	Reclose time for 3-phase faults		O
RclTmms	ING	Reclaim time		O
RdyTmms	ING	Time between successful and ready state		O

All settings with an index higher than 1 up to MaxCyc will appear if MaxCyc is higher than 1.

For the number of actual permitted (used) cycles holds: UseCyc ≤ MaxCyc.

5.13.12 LN: Synchronism-check Name: RSYN

For a description of this LN, see IEC 61850-5. The voltage phasor difference from both sides of an open breaker is calculated and compared with predefined switching conditions (synchrocheck). Included is the case that one side is dead (example: energising a dead line).

RSYN class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Status information				
Rel	SPS	Release		M
VInd	SPS	Voltage difference indicator		O
AngInd	SPS	Angle difference indicator		O

RSYN class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
HzInd	SPS	Frequency difference indicator		O
Measured and metered values				
DifVClc	MV	Calculated difference in voltage		O
DifHzClc	MV	Calculated difference in frequency		O
DifAngClc	MV	Calculated difference of phase angle		O
Controls				
SynPrg	SPC	Start and stop synchrocheck progress		O
Settings				
DifV	ASG	Difference voltage		O
DifHz	ASG	Difference frequency		O
DifAng	ASG	Difference phase angle		O
LivDeaMod	ENG	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
TotTmms	ING	Total time of synchronising process		O

5.14 Logical nodes for supervision and monitoring LN Group: S

5.14.1 Modelling remarks

Table 9 gives the relation between IEC 61850-5 and this standard for supervision and monitoring LNs.

Table 9 – Relation between IEC 61850-5 and IEC 61850-7-4 for supervision and monitoring LNs

Functionality	Defined in IEC 61850-5 by LN	Modelled in IEC 61850-7-4 by LN	Comments
Insulation medium supervision	SIMS	SIML SIMG	Insulation liquid such as oil Insulation gas such as SF_6
Tap changer supervision	YLTC	SLTC	Drive supervision part of XCBR and XSWI
Supervision of operating mechanism	XCBR XSWI	SOPM	Drive supervision part of XCBR and XSWI
Power transformer supervision	YPTR	SPTR	Supervision part of YPTR
Switch supervision	CSWI	SSWI	Supervision part of CSWI
Circuit breaker supervision	XCBR	SCBR	Supervision part of XCBR

5.14.2 LN: Monitoring and diagnostics for arcs Name: SARC

For a description of this LN, see IEC 61850-5.

SARC class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Status information				
FADet	SPS	Fault arc detected		M
SwArcDet	SPS	Switch arc detected		O
Controls				
OpCntRs	INC	Resettable operation counter (switch and fault arcs)		O
FACntRs	INC	Fault arc counter		M
ArcCntRs	INC	Switch arc counter		O

5.14.3 LN: Circuit breaker supervision Name: SCBR

For a description of this LN, see IEC 61850-5. This LN is used for supervision of circuit breakers. Operating a breaker and especially tripping a short circuit causes always some abrasion (or erosion) of the breaker contacts. The supervision is per phase since each phase has its own contact.

SCBR class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Status information				
ColOpn	SPS	Open command of trip coil		M
AbrAlm	SPS	Contact abrasion alarm		O
AbrWrn	SPS	Contact abrasion warning		O
MechHealth	ENS	Mechanical behaviour alarm		O
OpTmAlm	SPS	Switch operating time exceeded		O
ColAlm	SPS	Coil alarm		O
OpCntAlm	SPS	Number of operations (modelled in the XCBR) has exceeded the alarm level for number of operations		O
OpCntWrn	SPS	Number of operations (modelled in the XCBR) exceeds the warning limit		O
OpTmWrn	SPS	Warning when operation time reaches the warning level		O
OpTmh	INS	Time since installation or last maintenance in hours		O
Measured and metered values				
AccAbr	MV	Cumulated abrasion		O
SwA	MV	Current that was interrupted during last open operation		O
ActAbr	MV	Abrasion of last open operation		O
AuxSwTmOpn	MV	Auxiliary switches timing open		O
AuxSwTmCls	MV	Auxiliary switches timing close		O
RctTmOpn	MV	Reaction time measurement open		O
RctTmCls	MV	Reaction time measurement close		O
OpSpdOpn	MV	Operation speed open		O

SCBR class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
OpSpdCls	MV	Operation speed close		O
OpTmOpn	MV	Operation time open		O
OpTmCls	MV	Operation time close		O
Stk	MV	Contact stroke		O
OvStkOpn	MV	Overstroke open		O
OvStkCls	MV	Overstroke close		O
ColA	MV	Coil current		O
Tmp	MV	Temperature e.g. inside drive mechanism		O
Controls				
OpCntRs	INC	Resettable operation counter		O
Settings				
AbrAlmLev	ASG	Abrasion sum threshold for alarm state		O
AbrWrnLev	ASG	Abrasion sum threshold for warning state		O
OpAlmTmh	ING	Alarm level for operation time in hours		O
OpWrnTmh	ING	Warning level for operation time in hours		O
OpAlmNum	ING	Alarm level for number of operations		O
OpWrnNum	ING	Warning level for number of operations		O

5.14.4 LN: Insulation medium supervision (gas) Name: SIMG

For a general description of this LN, see IEC 61850-5. Insulation medium is gas, for example SF6 in gas isolated devices. For other measuring objects related to the same IED, a new instance of SIMG may be used. If the new measuring point(s) is/are related to a new IED, in this new IED a new instance of SIMG shall be used.

SIMG class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Status information				
InsAlm	SPS	Insulation gas critical (refill isolation medium)		M
InsBlk	SPS	Insulation gas not safe (block device operation)		O
InsTr	SPS	Insulation gas dangerous (trip for device isolation)		O
PresAlm	SPS	Insulation gas pressure alarm		C
DenAlm	SPS	Insulation gas density alarm		C
TmpAlm	SPS	Insulation gas temperature alarm		C
InsLevMax	SPS	Insulation gas level maximum (relates to predefined filling value)		O
InsLevMin	SPS	Insulation gas level minimum (relates to predefined filling value)		O
Measured values				
Pres	MV	Insulation gas pressure		O
Den	MV	Insulation gas density		O
Tmp	MV	Insulation gas temperature		O
InsBlkTmh	INS	Calculated time till blocking level is reached, corresponds to leakage of gas compartment		O

SIMG class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
Controls				
OpCntRs	INC	Resettable operation counter		O
Condition C: depending on the supervised properties of the liquid, at least one status information shall be used.				

5.14.5 LN: Insulation medium supervision (liquid) Name: SIML

For a description of this LN, see IEC 61850-5. The insulation medium is a liquid such as oil, like that used for example for some transformers and tap changers. For other measuring objects related to the same IED, a new instance of SIML may be used. If the new measuring point(s) is/are related to a new IED a new instance of SIML shall be used.

SIML class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Status information				
InsAlm	SPS	Insulation liquid critical (refill insulation medium)		M
InsBlk	SPS	Insulation liquid not safe (block device operation)		O
InsTr	SPS	Insulation liquid dangerous (trip for device isolation)		O
TmpAlm	SPS	Insulation liquid temperature alarm		O
GasInsAlm	SPS	Gas in insulation liquid alarm (may be used for Buchholz alarm)		O
GasInsTr	SPS	Gas in insulation liquid trip (may be used for Buchholz trip)		O
GasFlwTr	SPS	Insulation liquid flow trip because of gas (may be used for Buchholz trip)		O
InsLevMax	SPS	Insulation liquid level maximum		O
InsLevMin	SPS	Insulation liquid level minimum		O
H2Alm	SPS	H_2 alarm		O
H2Wrn	SPS	H_2 warning level		O
MstAlm	SPS	Moisture alarm		O
MstWrn	SPS	Moisture warning		O
Measured and metered values				
Tmp	MV	Insulation liquid temperature		O
Lev	MV	Insulation liquid level (usually in m)		O
Pres	MV	Insulation liquid pressure		O
H2O	MV	Relative saturation of moisture in insulating liquid (in %)		O
H2OPap	MV	Relative saturation of moisture in insulating paper (in %)		O
H2OAir	MV	Relative saturation of moisture in air in expansion volume (in %)		O
H2OTmp	MV	Temperature of insulating liquid at point of H_2O measurement		O
H2ppm	MV	Measurement of Hydrogen (H_2 in ppm)		O
N2ppm	MV	Measurement of N_2 in ppm		O
COppm	MV	Measurement of CO in ppm		O
CO2ppm	MV	Measurement of CO_2 in ppm		O
CH4ppm	MV	Measurement of CH_4 in ppm		O
C2H2ppm	MV	Measurement of C_2H_2 in ppm		O
C2H4ppm	MV	Measurement of C_2H_4 in ppm		O

SIML class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
C2H6ppm	MV	Measurement of C_2H_6 in ppm		O
O2ppm	MV	Measurement of O_2 in ppm		O
CmbuGas	MV	Measurement of total dissolved combustible gases (TDCG)		O
FltGas	MV	Fault gas volume in Buchholz relay		O
Controls				
OpCntRs	INC	Resettable operation counter		O

5.14.6 LN: Tap changer supervision Name: SLTC

This LN is used for supervision of tap changer. It is used to assess the condition of the tap changer.

SLTC class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Status information				
OilFil	SPS	Oil filtration running		O
MotDrvBlk	SPS	Motor drive overcurrent blocking		O
VacCelAlm	SPS	Circuit status of vacuum cell (ANSI)		O
OilFilTr	SPS	Oil filter unit trip		O
Measured and metered values				
Torq	MV	Drive torque		O
MotDrvA	MV	Motor drive current		O
AbrPrt	MV	Abrasion (in %) of parts subject to wear		O
Controls				
OpCntRs	INC	Resettable operation counter		O

5.14.7 LN: Supervision of operating mechanism Name: SOPM

This LN is used for supervision of operating mechanism for switches. It is used to assess the condition of the operating mechanism and can be used to indicate a possible malfunction in the future.

Today, different technologies for operating mechanisms are available. Typically operating mechanisms for circuit breakers contain an energy storage to provide the required switching energy within a short time. Examples for today's storage medias are springs or compressed gas. To operate the switch, the energy is transferred by means of a mechanical or hydraulical linkage. A charger motor is used to compensate energy losses due to leakages or to recharge the storage after a switch operation.

The proposed attributes cover the status of the relevant components both of the hydraulic system and the spring system. Depending on the used technology, some of the attributes are not applicable. This LN can also be used for simple operating mechanisms that are directly driven by a motor.

SOPM class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Status information				
MotOp	SPS	Indicates if the motor is running		O
MotStrAlm	SPS	Alarm for number of motor starts exceeds MotAlmNum		O
HyAlm	SPS	Hydraulic alarm		O
HyBlk	SPS	Block of operation due to hydraulic		O
EnBlk	SPS	Energy block		O
EnAlm	SPS	Energy alarm		O
MotAlm	SPS	Motor operating time exceeded		O
HeatAlm	SPS	Heater alarm		O
ChaIntvTms	INS	Time interval between last two charging operations		O
MotStr	INS	Number of motor starts		O
Measured and metered values				
En	MV	Stored energy (e.g. stored energy or remaining energy)		O
HyPres	MV	Hydraulic pressure		O
HyTmp	MV	Hydraulic temperature		O
MotTm	MV	Operating time of the motor		O
MotA	MV	Motor current		O
Tmp	MV	Temperature inside the drive cubicle		O
Controls				
OpCntRs	INC	Resettable operation counter		O
Settings				
MotAlmTms	ING	Alarm level for motor run time in s		O
MotStrNum	ING	Alarm level for number of motor starts		O
MotStrTms	ING	Time interval for acquisition of motor starts		O

5.14.8 LN: Monitoring and diagnostics for partial discharges Name: SPDC

For a description of this LN, see IEC 61850-5. IEC 60270 should be applied.

SPDC class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Status information				
PaDschAlm	SPS	Partial discharge alarm		C
OpCnt	INS	Operation counter		M
Measured and metered values				
AcuPaDsch	MV	Acoustic level of partial discharge		C

SPDC class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
AppPaDsch	MV	Apparent charge of partial discharge, peak level (PD)		C
NQS	MV	Average discharge current		C
UhfPaDsch	MV	UHF level of partial discharge		C
Controls				
OpCntRs	INC	Resettable operation counter		O
Settings				
CtrHz	ASG	Center frequency of measurement unit according to IEC 60270		O
BndWid	ASG	Bandwidth of measurement unit according to IEC 60270		O
Condition C: depending on the functionality, at least one of the data objects AcuPaDsch, UHFPaDch, NQS, AppPaDsch or PaDschAlm shall be used.				

5.14.9 LN: Power transformer supervision Name: SPTR

This LN is used for supervision of power transformer. It is used to asses the condition of the power transformer.

SPTR class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Status information				
HPTmpAlm	SPS	Winding hotspot temperature alarm		O
HPTmpOp	SPS	Winding hotspot temperature operate		O
HPTmpTr	SPS	Winding hotspot temperature trip	T	O
MbrAlm	SPS	Leakage supervision alarm of tank conservator membrane		O
CGAlm	SPS	Core ground alarm		O
HeatAlm	SPS	Heater alarm		O
Measured and metered values				
AgeRte	MV	Aging rate		O
BotTmp	MV	Bottom oil temperature		O
CoreTmp	MV	Core temperature		O
HPTmpClc	MV	Calculated winding hotspot temperature		O
Controls				
OpCntRs	INC	Resettable operation counter		O

5.14.10 LN: Circuit switch supervision Name: SSWI

This LN is used for supervision of all switches, such as disconnectors, earthing switches, etc. except circuit breakers. It is used to assess the condition of the switch and is closely related to LN SOPM. Most attributes are used to supervise the operation time of the switch and contact movement. Deviations from nominal values can be used to indicate a possible malfunction of the switch in the future. Abrasion of parts gives an indication when to maintain the switch. For the special requirements of a circuit breaker, the abrasion, etc. is defined in LN SCBR. The supervision SSWI is per phase.

SSWI class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Status information				
OpTmAlm	SPS	Switch operating time exceeded		O
OpCntAlm	SPS	Number of operations (modelled in XSWI) has exceeded the alarm level for number of operations		O
OpCntWrn	SPS	Number of operations (modelled in XSWI) exceeds the warning limit		O
OpTmWrn	SPS	Warning when operation time reaches the warning level		O
OpTmh	INS	Time since installation or last maintenance in hours		O
MechHealth	ENS	Mechanical behaviour alarm		O
Measured and metered values				
AccAbr	MV	Cumulated abrasion of parts subject to wear		O
AuxSwTmOpn	MV	Auxiliary switches timing open		O
AuxSwTmCls	MV	Auxiliary switches timing close		O
RctTmOpn	MV	Reaction time measurement open		O
RctTmCls	MV	Reaction time measurement close		O
OpSpdOpn	MV	Operation speed open		O
OpSpdCls	MV	Operation speed close		O
OpTmOpn	MV	Operation time open		O
OpTmCls	MV	Operation time close		O
Stk	MV	Contact stroke		O
OvStkOpn	MV	Overstroke open		O
OvStkCls	MV	Overstroke close		O
ColA	MV	Coil current		O
Tmp	MV	Temperature e.g. inside drive mechanism		O
Controls				
OpCntRs	INC	Resettable operation counter		O
Settings				
OpAlmTmh	ING	Alarm level for operation time in hours		O
OpWrnTmh	ING	Warning level for operation time in hours		O
OpAlmNum	ING	Alarm level for number of operations		O
OpWrnNum	ING	Warning level for number of operations		O

5.14.11 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				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Descriptions				
EEName	DPL	External equipment nameplate		O
Status information				
EEHealth	ENS	External equipment health		O
Alm	SPS	Temperature alarm level reached		O
Trip	SPS	Temperature trip level reached		O
Measured and metered values				
Tmp	MV	Temperature		O
Controls				
OpCntRs	INC	Resettable operation counter		O
Settings				
TmpAlmSpt	ASG	Temperature alarm level set-point		O
TmpTripSpt	ASG	Temperature trip level set-point		O

5.14.12 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				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Status information				
Alm	SPS	Vibration alarm level reached		M
Trip	SPS	Vibration trip level reached		O
Measured and metered values				
Vbr	MV	Vibration level		O
AxDsp	MV	Total axial displacement		O
Controls				
OpCntRs	INC	Resettable operation counter		O
Settings				
VbrAlmSpt	ASG	Vibration alarm level set-point		O
VbrTripSpt	ASG	Vibration trip level set-point		O
AxDAlmSpt	ASG	Axial displacement alarm level set-point		O
AxDTripSpt	ASG	Axial displacement trip level set-point		O

5.15 Logical nodes for instrument transformers and sensors LN Group: T

5.15.1 Modelling remarks

This group of logical nodes represents the sensors for all the different values which have to be continuously sampled for monitoring their behaviour over time. These samples are used either by dedicated processing logical node classes as for protection (see LN Group P) or by the related supervision logical node classes (see LN group S). The sampling rate defines the time resolution of the resulting figures of the processing logical node classes (group P, group S). The modelling of samples are conditional since they are not exposed to communication in any case, as T and S nodes may be implemented in the same IED.

5.15.2 LN: Angle 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).

TANG class				
Data object name	**Common data class**	**Explanation**	**T**	**M/ O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Descriptions				
EEName	DPL	External equipment name plate		O
Status information				
EEHealth	ENS	External equipment health		O
Measured and metered values				
AngSv	SAV	Angle		C
Settings				
SmpRte	ING	Sampling rate setting		O
Condition C: The data object is mandatory if the data object is transmitted over a communication link and therefore it is visible.				

5.15.3 LN: Axial displacement 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				
Data object name	**Common data class**	**Explanation**	**T**	**M/ O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Descriptions				
EEName	DPL	External equipment name plate		O
Status information				
EEHealth	ENS	External equipment health		O
Measured and metered values				
AxDspSv	SAV	Total axial displacement		C

Settings				
SmpRte	ING	Sampling rate setting		O
Condition C: The data object is mandatory if the data object is transmitted over a communication link and therefore gets no updated values (values are frozen). It is visible.				

5.15.4 LN: Current transformer Name: TCTR

For a description of this LN, see IEC 61850-5. The current is delivered as sampled values. The sampled values are transmitted as engineering values, i.e. as “true” (corrected) primary current values. Therefore, the transformer ratio and the correction factors are of no interest for the transmitted samples, but for maintenance purposes of an external conventional (magnetic) transducer only. In addition, status information is provided and some other settings are accepted from the LN TCTR.

TCTR class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Descriptions				
EEName	DPL	External equipment name plate		O
Status information				
EEHealth	ENS	External equipment health		O
OpTmh	INS	Operation time		O
Measured and metered values				
AmpSv	SAV	Current (sampled value)		C1
Settings				
ARtg	ASG	Rated current		O
HzRtg	ASG	Rated frequency		O
Rat	ASG	Winding ratio of an external current transformer (transducer) if applicable		O
Cor	ASG	Current phasor magnitude correction of an external current transformer		C2
AngCor	ASG	Current phasor angle correction of an external current transformer		C2
CorCrv	CSG	Curve phasor magnitude and angle correction		C2
Condition C1: The data object is mandatory if the data object is transmitted over a communication link and therefore it is visible. Condition C2: If there are two or more correction pairs necessary, CorCrv should be used.				

5.15.5 LN: Distance 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				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Descriptions				
EEName	DPL	External equipment name plate		O
Status information				

TDST class				
Data object name	**Common data class**	**Explanation**	**T**	**M/ O/C**
EEHealth	ENS	External equipment health		O
Measured and metered values				
DisSv	SAV	Distance [m]		C
Settings				
SmpRte	ING	Sampling rate setting		O
Condition C: The data object is mandatory if the data object is transmitted over a communication link and therefore it is visible.				

5.15.6 LN: Liquid flow 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				
Data object name	**Common data class**	**Explanation**	**T**	**M/ O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Descriptions				
EEName	DPL	External equipment name plate		O
Status information				
EEHealth	ENS	External equipment health		O
Measured and metered values				
FlwSv	SAV	Liquid flow rate [m3/s]		C
Settings				
SmpRte	ING	Sampling rate setting		O
Condition C: The data object is mandatory if the data object is transmitted over a communication link and therefore it is visible.				

5.15.7 LN: Frequency 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 a.c. 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				
Data object name	**Common data class**	**Explanation**	**T**	**M/ O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Descriptions				
EEName	DPL	External equipment name plate		O
Status information				
EEHealth	ENS	External equipment health		O
Measured and metered values				
HzSv	SAV	Frequency [Hz] related to non-electrical values		C

TFRQ class				
Data object name	**Common data class**	**Explanation**	**T**	**M/ O/C**
Settings				
SmpRte	ING	Sampling rate setting		O
Condition C: The data object is mandatory if the data object is transmitted over a communication link and therefore it is visible.				

5.15.8 LN: Generic sensor Name: TGSN

Logical node TGSN shall be used to represent a generic sensor if there is no specific sensor available. It can also be used for modeling the health and name of an external equipment (sensor).

TGSN class				
Data object name	**Common data class**	**Explanation**	**T**	**M/ O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Descriptions				
EEName	DPL	External equipment name plate		O
Status information				
EEHealth	ENS	External equipment health		O
Measured and metered values				
GenSv	SAV	Generic sampled value		C
Settings				
SmpRte	ING	Sampling rate setting		O
Condition C: The data object is mandatory if the data object is transmitted over a communication link and therefore it is visible.				

5.15.9 LN: Humidity 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				
Data object name	**Common data class**	**Explanation**	**T**	**M/ O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Descriptions				
EEName	DPL	External equipment name plate		O
Status information				
EEHealth	ENS	External equipment health		O
Measured and metered values				
HumSv	SAV	Humidity [%]		C
Settings				
SmpRte	ING	Sampling rate setting		O
Condition C: The data object is mandatory if the data object is transmitted over a communication link and therefore it is visible.				

5.15.10 LN: Media level Name: TLVL

Logical node TLVL 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 HLVL logical node shall be used.

TLVL class				
Data object name	**Common data class**	**Explanation**	**T**	**M/ O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Descriptions				
EEName	DPL	External equipment name plate		O
Status information				
EEHealth	ENS	External equipment health		O
Measured and metered values				
LevPctSv	SAV	Level [%]		C
Settings				
SmpRte	ING	Sampling rate setting		O
Condition C: The data object is mandatory if the data objects are transmitted over a communication link and therefore they are visible.				

5.15.11 LN: Magnetic field 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				
Data object name	**Common data class**	**Explanation**	**T**	**M/ O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Descriptions				
EEName	DPL	External equipment name plate		O
Status information				
EEHealth	ENS	External equipment health		O
Measured and metered values				
MagFldSv	SAV	Magnetic field strength / flux density (T)		C
Settings				
SmpRte	ING	Sampling rate setting		O
Condition C: The data object is mandatory if the data object is transmitted over a communication link and therefore it is visible.				

5.15.12 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				
Data object name	**Common data class**	**Explanation**	**T**	**M/ O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Descriptions				
EEName	DPL	External equipment name plate		O
Status information				
EEHealth	ENS	External equipment health		O
Measured and metered values				
MvmRteSv	SAV	Movement rate [m/s]		C
Settings				
SmpRte	ING	Sampling rate setting		O
Condition C: The data object is mandatory if the data object is transmitted over a communication link and therefore it is visible.				

5.15.13 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				
Data object name	**Common data class**	**Explanation**	**T**	**M/ O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Descriptions				
EEName	DPL	External equipment name plate		O
Status information				
EEHealth	ENS	External equipment health		O
Measured and metered values				
PosPctSv	SAV	Position given as percentage of full movement [%]		C
Settings				
SmpRte	ING	Sampling rate setting		O
Condition C: The data object is mandatory if the data object is transmitted over a communication link and therefore it is visible.				

5.15.14 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				
Data object name	**Common data class**	**Explanation**	**T**	**M/ O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		

TPRS class				
Data object name	**Common data class**	**Explanation**	**T**	**M/ O/C**
Data objects				
Descriptions				
EEName	DPL	External equipment name plate		O
Status information				
EEHealth	ENS	External equipment health		O
Measured and metered values				
PresSv	SAV	Pressure of media [Pa]		C
Settings				
SmpRte	ING	Sampling rate setting		O
Condition C: The data object is mandatory if the data object is transmitted over a communication link and therefore it is visible.				

5.15.15 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				
Data object name	**Common data class**	**Explanation**	**T**	**M/ O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Descriptions				
EEName	DPL	External equipment name plate		O
Status information				
EEHealth	ENS	External equipment health		O
Measured and metered values				
RotSpdSv	SAV	Rotational speed [1/s]		C
Settings				
SmpRte	ING	Sampling rate setting		O
Condition C: The data object is mandatory if the data object is transmitted over a communication link and therefore it is visible.				

5.15.16 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				
Data object name	**Common data class**	**Explanation**	**T**	**M/ O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Descriptions				
EEName	DPL	External equipment name plate		O
Status information				
EEHealth	ENS	External equipment health		O

TSND class				
Data object name	**Common data class**	**Explanation**	**T**	**M/ O/C**
Measured and metered values				
SndSv	SAV	Sound pressure level [dB]		C
Settings				
SmpRte	ING	Sampling rate setting		O
Condition C: The data object is mandatory if the data object is transmitted over a communication link and therefore it is visible.				

5.15.17 LN: Temperature sensor Name: TTMP

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

TTMP class				
Data object name	**Common data class**	**Explanation**	**T**	**M/ O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Descriptions				
EEName	DPL	External equipment name plate		O
Status information				
EEHealth	ENS	External equipment health		O
Measured and metered values				
TmpSv	SAV	Temperature [°C]		C
Settings				
SmpRte	ING	Sampling rate setting		O
Condition C: The data object is mandatory if the data object is transmitted over a communication link and therefore it is visible.				

5.15.18 LN: Mechanical tension / stress Name: TTNS

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

TTNS class				
Data object name	**Common data class**	**Explanation**	**T**	**M/ O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Descriptions				
EEName	DPL	External equipment name plate		O
Status information				
EEHealth	ENS	External equipment health		O
Measured and metered values				
TnsSv	SAV	Mechanical stress [N]		C
Settings				
SmpRte	ING	Sampling rate setting		O
Condition C: The data object is mandatory if the data object is transmitted over a communication link and therefore it is visible.				

5.15.19 LN: Vibration sensor Name: TVBR

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

TVBR class				
Data object name	**Common data class**	**Explanation**	**T**	**M/ O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Descriptions				
EEName	DPL	External equipment name plate		O
Status information				
EEHealth	ENS	External equipment health		O
Measured and metered values				
VbrSv	SAV	Vibration [mm/s^2]		C
Settings				
SmpRte	ING	Sampling rate setting		O
Condition C: The data object is mandatory if the data object is transmitted over a communication link and therefore it is visible.				

5.15.20 LN: Voltage transformer Name: TVTR

For a description of this LN, see IEC 61850-5. The voltage is delivered as sampled values. The sampled values are transmitted as engineering values, that is as “true” (corrected) primary voltage values. Therefore, the transformer ratio and the correction factors are of no interest for the transmitted samples but for maintenance purposes of an external conventional (magnetic) transducer only. In addition, status information is provided and some other settings are accepted from the LN TVTR.

TVTR class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/ C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Descriptions				
EEName	DPL	External equipment name plate		O
Status information				
EEHealth	ENS	External equipment health		O
OpTmh	INS	Operation time		O
FuFail	SPS	TVTR fuse failure		O
Measured and metered values				
VolSv	SAV	Voltage (sampled value)		C1
Settings				
VRtg	ASG	Rated voltage		O
HzRtg	ASG	Rated frequency		O
Rat	ASG	Winding ratio of external voltage transformer (transducer) if applicable		O
Cor	ASG	Voltage phasor magnitude correction of external voltage transformer		O
AngCor	ASG	Voltage phasor angle correction of external voltage transformer		C2
CorCrv	CSG	Curve phasor magnitude and angle correction		C2
Condition C1: The data object is mandatory if the data object is transmitted over a communication link and therefore it is visible. Condition C2: If there are two or more correction pairs necessary, CorCrv should be used.				

5.15.21 LN: Water acidity Name: TWPH

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

TWPH class				
Data object name	**Common data class**	**Explanation**	**T**	**M/ O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Descriptions				
EEName	DPL	External equipment name plate		O
Status information				
EEHealth	ENS	External equipment health		O
Measured and metered values				
H2OPhSv	SAV	Water pH level (0-14)		C
Settings				
SmpRte	ING	Sampling rate setting		O
Condition C: The data object is mandatory if the data object is transmitted over a communication link and therefore it is visible.				

5.16 Logical nodes for switchgear LN Group: X

5.16.1 Modelling remarks

The logical nodes of this group provide data which are needed to represent the related switchgear equipment in the automation system. There are only two logical nodes (XCBR, XSWI) since all not current breaking switches are modelled by XSWI. Each logical node has companion logical nodes in group S (like SCBR, SSWI) providing the detailed supervision information if needed.

5.16.2 LN: Circuit breaker Name: XCBR

This LN is used for modelling switches with short circuit breaking capability. Additional LNs, for example SIMS, etc. may be required to complete the logical modelling for the breaker being represented. The closing and opening commands shall be subscribed from CSWI or CPOW if applicable. If no “time activated control” service is available between CSWI or CPOW and XCBR, the opening and closing commands shall be performed with a GSE-message (see IEC 61850-7-2).

XCBR class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/ C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Descriptions				
EEName	DPL	External equipment name plate		O
Status information				
EEHealth	ENS	External equipment health		O
LocKey	SPS	Local or remote key (local means without substation automation communication, hardwired direct control)		O
Loc	SPS	Local control behaviour		M
OpCnt	INS	Operation counter		M

XCBR class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/ C**
CBOpCap	ENS	Circuit breaker operating capability		O
POWCap	ENS	Point on wave switching capability		O
MaxOpCap	INS	Circuit breaker operating capability when fully charged		O
Dsc	SPS	Discrepancy		O
Measured and metered values				
SumSwARs	BCR	Sum of switched amperes, resettable		O
Controls				
LocSta	SPC	Switching authority at station level		O
Pos	DPC	Switch position		M
BlkOpn	SPC	Block opening		M
BlkCls	SPC	Block closing		M
ChaMotEna	SPC	Charger motor enabled		O
Settings				
CBTmms	ING	Closing time of breaker		O

5.16.3 LN: Circuit switch Name: XSWI

This LN is used for modelling switches without short circuit breaking capability, for example disconnectors, air break switches, earthing switches, etc. Additional LNs, SIMS, etc. may be required to complete the logical model for the switch being represented. The closing and opening commands shall be subscribed from CSWI. If no “time activated control” service is available between CSWI or CPOW and XSWI, the opening and closing commands shall be performed with a GSE-message (see IEC 61850-7-2).

XSWI class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/ C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Descriptions				
EEName	DPL	External equipment name plate		O
Status information				
EEHealth	ENS	External equipment health		O
LocKey	SPS	Local-remote key		O
Loc	SPS	Local control behaviour		M
OpCnt	INS	Operation counter		M
SwTyp	ENS	Switch type		M
SwOpCap	ENS	Switch operating capability		O
MaxOpCap	INS	Switch operating capability when fully charged. Obsolete. Kept for backwards compatibility with Ed.1		O
Dsc	SPS	Discrepancy		O
Controls				
LocSta	SPC	Switching authority at station level		O
Pos	DPC	Switch position		M
BlkOpn	SPC	Block opening		M
BlkCls	SPC	Block closing		M
ChaMotEna	SPC	Charger motor enabled		O

5.17 Logical nodes for power transformers LN Group: Y

5.17.1 Modelling remarks

The logical nodes of this group provide data which are needed to represent the related switchgear equipment in the automation system. This data may be complemented by supervision logical nodes of group S if needed.

5.17.2 LN: Earth fault neutralizer (Petersen coil) Name: YEFN

For a description of this LN, see IEC 61850-5. This LN shall be used for suppression coils as tap coils and plunge core coils.

YEFN class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Descriptions				
EEName	DPL	External equipment name plate		O
Status Information				
EEHealth	ENS	External equipment health		O
LocKey	SPS	Local-remote key		O
Loc	SPS	Local control behaviour		M
OpTmh	INS	Operation time		O
EndPosR	SPS	End position raise reached		O
EndPosL	SPS	End position lower reached		O
PotAlm	SPS	Potentiometer alarm		O
MotAlm	SPS	Motor drive alarm		O
Measured and metered values				
ColPosA	MV	Coil position derived from the air gap		C1
ColAEFN	CMV	Real measured coil current		O
NeutVol	CMV	Neutral to ground voltage		O
Controls				
LocSta	SPC	Switching authority at station level		O
ColTapPos	ISC	Coil tap position		C2
ColPos	APC	Plunge core position		C2
ColChg	BAC	Change coil position (higher, lower, stop)		C2
Condition C1: Is only used if not fixed coil should be modelled. Condition C2: At least one of the data objects should be mandatory.				

5.17.3 LN: Tap changer Name: YLTC

For a description of this LN, see IEC 61850-5.

YLTC class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Descriptions				
EEName	DPL	External equipment name plate		O
Status information				
EEHealth	ENS	External equipment health		O

YLTC class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
OpCnt	INS	Operation counter		O
EndPosR	SPS	End position raise reached		M
EndPosL	SPS	End position lower reached		M
OoStep	SPS	Out of step alarm: supervision of selector switch synchronism		O
LTCCycAlm	SPS	LTC switching cycle incomplete: tap change operation without diverter switch operation		O
BlkLoVisc	SPS	Blocked by low oil viscosity		O
Controls				
TapPos	ISC	Change tap position to dedicated position		C
TapChg	BSC	Change tap position (stop, higher, lower)		C
Condition C: depending on the tap-change method, at least one of the two controls TapChg and TapPos shall be used.				

5.17.4 LN: Power shunt Name: YPSH

For a description of this LN, see IEC 61850-5. The LN class power shunt also includes the switch for closing and opening the shunt.

YPSH class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Descriptions				
EEName	DPL	External equipment name plate		O
Status information				
EEHealth	ENS	External equipment health		O
OpTmh	INS	Operation time		O
ShOpCap	ENS	Operating capability		M
MaxOpCap	INS	Power shunt operating capability when fully charged		O
Controls				
Pos	DPC	Switch position		M
BlkOpn	SPC	Block opening		M
BlkCls	SPC	Block closing		M
ChaMotEna	SPC	Charger motor enabled		O

5.17.5 LN: Power transformer Name: YPTR

For a description of this LN, see IEC 61850-5.

YPTR class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Descriptions				
EEName	DPL	External equipment name plate		O
Status information				
EEHealth	ENS	External equipment health		O
OpTmh	INS	Operation time		O
OpNoLod	SPS	Operation at no load		O

YPTR class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
OpOvA	SPS	Operation at overcurrent		O
OpOvV	SPS	Operation at overvoltage		O
OpUnV	SPS	Operation at undervoltage		O
Measured and metered values				
LodFact	MV	Load factor (apparent power / rated power)		O
MaxPwr	MV	Calculated maximum permissible permanent power (overload) [W]		O
OvlTm	MV	Calculated maximum permissible overload time with cooling unit [min]		O
OvlTEmg	MV	Calculated maximum permissible overload time without cooling unit (emergency case) [min]		O
Settings				
HiVRtg	ASG	Rated voltage (high voltage level)		O
LoVRtg	ASG	Rated voltage (low voltage level)		O
PwrRtg	ASG	Rated power		O
MaxPwrSpt	ASG	Maximum permissible permanent power (overload) [W]		O
OvlTmSpt	ASG	Maximum permissible overload time with cooling unit [min]		O
OvlTEmgSpt	ASG	Maximum permissible overload time without cooling unit (emergency case) [min]		O

5.18 Logical nodes for further power system equipment LN Group: Z

5.18.1 Modelling remarks

The logical nodes of group Z refer all to power system objects which are reusable in other power systems domains but not modelled in other LN groups of this standard.

5.18.2 LN: Auxiliary network Name: ZAXN

For a description of this LN, see IEC 61850-5. Auxiliary networks belong to the power supply system of substations and other power systems installations.

ZAXN class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Descriptions				
EEName	DPL	External equipment name plate		O
Status information				
EEHealth	ENS	External equipment health		O
OpTmh	INS	Operation time		O
Measured and metered values				
Vol	MV	Voltage of the auxiliary network		O
Amp	MV	Current of the auxiliary network		O

5.18.3 LN: Battery Name: ZBAT

For a description of this LN, see IEC 61850-5.

ZBAT class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		

ZBAT class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
Data objects				
Descriptions				
EEName	DPL	External equipment name plate		O
Status information				
EEHealth	ENS	External equipment health		O
OpTmh	INS	Operation time		O
TestRsl	SPS	Battery test results		O
BatHi	SPS	Battery high (voltage or charge – overcharge)		O
BatLo	SPS	Battery low (voltage or charge)		O
Measured and metered values				
Vol	MV	Battery voltage		M
VolChgRte	MV	Rate of battery voltage change		O
Amp	MV	Battery drain current		O
Controls				
BatTest	SPC	Start battery test		O
Settings				
LoBatVal	ASG	Low battery alarm value		O
HiBatVal	ASG	High battery alarm value		O

5.18.4 LN: Bushing Name: ZBSH

For a description of this LN, see IEC 61850-5.

ZBSH class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Descriptions				
EEName	DPL	External equipment name plate		O
Status information				
EEHealth	ENS	External equipment health		O
OpTmh	INS	Operation time		O
Measured and metered values				
React	MV	Relative capacitance of bushing related to the data object RefReact		M
AbsReact	MV	Online capacitance, absolute value		O
LosFact	MV	Loss factor (tan delta)		O
Vol	MV	Voltage of bushing measuring tap		O
DisplA	MV	Displacement current: apparent current at measuring tap		O
LeakA	MV	Leakage current: active current at measuring tap		O
Settings				
RefReact	ASG	Reference capacitance for bushing at commissioning		O
RefPF	ASG	Reference power factor for bushing at commissioning		O
RefV	ASG	Reference voltage for bushing at commissioning		O

5.18.5 LN: Power cable Name: ZCAB

For a description of this LN, see IEC 61850-5.

ZCAB class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		

ZCAB class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
Data objects				
Descriptions				
EEName	DPL	External equipment name plate		O
Status information				
EEHealth	ENS	External equipment health		O
OpTmh	INS	Operation time		O

5.18.6 LN: Capacitor bank Name: ZCAP

For a description of this LN, see IEC 61850-5.

ZCAP class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Descriptions				
EEName	DPL	External equipment name plate		O
Status information				
EEHealth	ENS	External equipment health		O
OpTmh	INS	Operation time		O
DschBlk	SPS	Blocked due to discharge		M
Controls				
CapDS	SPC	Capacitor bank device status		M

5.18.7 LN: Converter Name: ZCON

For a description of this LN, see IEC 61850-5.

ZCON class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Descriptions				
EEName	DPL	External equipment name plate		O
Status information				
EEHealth	ENS	External equipment health		O
OpTmh	INS	Operation time		O
Settings				
VArRtg	ASG	Rated bidirectional VArs		O
VRtg	ASG	Rated voltage		O

5.18.8 LN: Generator Name: ZGEN

For a description of this LN, see IEC 61850-5. ZGEN has to be used for all generators not modelled elsewhere in IEC 61850.

ZGEN class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		

ZGEN class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
Data objects				
Descriptions				
EEName	DPL	External equipment name plate		O
Status information				
EEHealth	ENS	External equipment health		O
OpTmh	INS	Operation time		O
GnSt	ENS	Generator state		M
OpNoLod	SPS	Operation at no load		M
RotDir	ENS	Phase rotation (Clockwise | Counter-Clockwise | Unknown)		M
OpUnExt	SPS	Operation at under-excitation		M
OpOvExt	SPS	Operation at over-excitation		M
LosOil	SPS	Loss of oil		O
LosVac	SPS	Loss of vacuum		O
PresAlm	SPS	Low pressure alarm		O
Controls				
GnCtl	DPC	Generator control		M
DExt	SPC	De-excitation		M
AuxSco	SPC	Auxiliary supply change over		O
ReactPwrR	SPC	Reactive power raise		O
ReactPwrL	SPC	Reactive power lower		O
Measured and metered values				
GnSpd	MV	Generator speed		O
Settings				
DmdPwr	ASG	Demanded power		O
PwrRtg	ASG	Rated power		O
VRtg	ASG	Rated voltage		O

5.18.9 LN: Gas insulated line Name: ZGIL

For a description of this LN, see IEC 61850-5.

ZGIL class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Descriptions				
EEName	DPL	External equipment name plate		O
Status information				
EEHealth	ENS	External equipment health		O
OpTmh	INS	Operation time		O

5.18.10 LN: Power overhead line Name: ZLIN

For a description of this LN, see IEC 61850-5. ZLIN represents an overhead line with all physical characteristics.

ZLIN class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		

ZLIN class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
Data objects				
Descriptions				
EEName	DPL	External equipment name plate		O
Status information				
EEHealth	ENS	External equipment health		O
OpTmh	INS	Operation time		O
Settings				
LinLenkm	ASG	Line length in km		O
RPs	ASG	Positive-sequence line resistance		O
XPs	ASG	Positive-sequence line reactance		O
RZer	ASG	Zero-sequence line resistance		O
XZer	ASG	Zero-sequence line reactance		O
ZPsMag	ASG	Positive-sequence line impedance value		O
ZPsAng	ASG	Positive-sequence line impedance angle		O
ZZerMag	ASG	Zero-sequence line impedance value		O
ZZerAng	ASG	Zero-sequence line impedance angle		O
RmZer	ASG	Mutual resistance		O
XmZer	ASG	Mutual reactance		O
ZmZerMag	ASG	Mutual impedance value		O
ZmZerAng	ASG	Mutual impedance angle		O

5.18.11 LN: Motor Name: ZMOT

For a description of this LN, see IEC 61850-5.

ZMOT class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Descriptions				
EEName	DPL	External equipment name plate		O
Status information				
EEHealth	ENS	External equipment health		O
OpTmh	INS	Operation time		O
LosOil	SPS	Loss of oil		O
LosVac	SPS	Loss of vacuum		O
PresAlm	SPS	Low pressure alarm		O
Controls				
DExt	SPC	De-excitation		M

5.18.12 LN: Reactor Name: ZREA

For a description of this LN, see IEC 61850-5.

ZREA class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		

ZREA class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
Data objects				
Descriptions				
EEName	DPL	External equipment name plate		O
Status information				
EEHealth	ENS	External equipment health		O
OpTmh	INS	Operation time		O
Settings				
VRtg	ASG	Rated voltage		O
ARtg	ASG	Rated current		O
VARtg	ASG	Rated apparent power		O
VArRtg	ASG	Rated reactive power		O

5.18.13 LN: Resistor Name: ZRES

Logical Node ZRES shall be used to represent a ohmic resistor. A typical application is the resistor of the starpoint (a neutral resistor). The resistor is normally not controlled.

ZRES class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Descriptions				
EEName	DPL	External equipment name plate		O
Status information				
EEHealth	ENS	External equipment health		O
OpTmh	INS	Operation time		O

5.18.14 LN: Rotating reactive component Name: ZRRC

For a description of this LN, see IEC 61850-5.

ZRRC class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Descriptions				
EEName	DPL	External equipment name plate		O
Status information				
EEHealth	ENS	External equipment health		O
OpTmh	INS	Operation time		O
LocKey	SPS	Local or remote key		O
LocSta	SPS	Control authority at station level		O
Loc	SPS	Local control behaviour		O
GnSt	ENS	Component state		M
Controls				
GnCtl	DPC	Component control (start, stop)		M
Measured and metered value				
GnSpd	MV	CS speed		O

5.18.15 LN: Surge arrestor Name: ZSAR

For a description of this LN, see IEC 61850-5.

ZSAR class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/ C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Descriptions				
EEName	DPL	External equipment name plate		O
Status information				
EEHealth	ENS	External equipment health		O
OpCnt	INS	Operation counter		O
OpSar	SPS	Operation of surge arrestor	T	M

5.18.16 LN: Semi-conductor controlled rectifier Name: ZSCR

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

ZSCR class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/ C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Descriptions				
EEName	DPL	External equipment name plate		O
Status information				
EEHealth	ENS	External equipment health		O
OpTmh	INS	Operation time		O
Alm	SPS	Control function alarm		M
Controls				
OpModRect	ENG	Control mode setting (A, V, W)		C
AmpSpt	APC	Current target set-point		C
VolSpt	APC	Voltage target set-point		C
Settings				
SetA	ASG	Current setting (if operating to a fixed current)		C
SetV	ASG	Voltage setting (if operating to a fixed voltage)		C
Condition C: The rectifier can be used to provide a fixed voltage and controllable current, to provide a fixed current and controllable voltage or have both current and voltage controllable. If either voltage or current is fixed, the set-point shall be given as a setting.				

5.18.17 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.

ZSMC class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Descriptions				
EEName	DPL	External equipment name plate		O
Status information				
EEHealth	ENS	External equipment health		O
OpTmh	INS	Operation time		O
RotDir	ENS	Rotational direction (Clockwise | Counter-clockwise | Unknown)		O
Settings				
PwrRtg	ASG	Rated apparent power [VA]		M
VRtg	ASG	Rated voltage [V]		M
ARtg	ASG	Rated stator current [A]		M
SpdRtg	ASG	Synchronous machine rated speed [s^{-1}]		M
SpdCrit	ASG	Synchronous machine critical speed of the generator [s^{-1}]		O
FldRisTmp	ASG	Reference temperature for field resistance [usually in °C]		O
StatRisTmp	ASG	Reference temperature for stator resistance [usually in °C]		O
StatRis	ASG	Stator resistance [ohm]		O
PFRtg	ASG	Rated power factor		O
Iner	ASG	Synchronous machine moment of inertia J [kgm^2]		O
FldAmpRtg	ASG	Rated field current [A]		O
FldAmpRtgO	ASG	No-load field current for rated stator voltage [A]		O
FldRis	ASG	Field resistance [ohm]		O
BaseImp	ASG	Base per unit impedance [ohm /phase]		O
StatLeakX	ASG	Stator leakage reactance [per unit]		O
Xd	ASG	D-axis synchronous reactance Xd [per unit] (unsaturated)		O
Xdp	ASG	D-axis transient synchronous reactance Xd' [per unit] (unsaturated)		O
Xds	ASG	D-axis reactance Xd'' [per unit] (unsaturated)		O
Xq	ASG	Q-axis synchronous reactance Xq [per unit] (unsaturated)		O
Xqp	ASG	Q-axis transient reactance Xq' [per unit] (unsaturated)		O
Xqs	ASG	Q-axis sub-transient reactance Xq'' [per unit] (unsaturated)		O
X0	ASG	Zero sequence reactance X0 [per unit] (unsaturated)		O
X2	ASG	Negative sequence reactance X2 [per unit] (unsaturated)		O
TmTdp	ASG	D-axis short circuit transient time constant Td' [s] (unsaturated)		O
TmTds	ASG	D-axis short-circuit sub-transient time constant Td'' [s] (unsaturated)		O
TmTd0p	ASG	D-axis open circuit transient time constant Td0' [s] (unsaturated)		O
TmTd0s	ASG	D-axis open circuit sub-transient time constant Td0'' [s] (unsaturated)		O
TmTqp	ASG	Q-axis short circuit transient time constant Tq' [s] (unsaturated)		O
TmTqs	ASG	Q-axis short circuit sub-transient time constant Tq'' [s] (unsaturated)		O
TmTq0p	ASG	Q-axis open circuit transient time constant Tq0' [s] (unsaturated)		O
TmTq0s	ASG	Q-axis open circuit sub-transient time constant Tq0'' [s] (unsaturated)		O
TmTa	ASG	Armature time constant Ta[s] (unsaturated)		O
SatCffS10	ASG	Saturation coefficient S1.0		O
SatCffS12	ASG	Saturation coefficient S1.2		O

5.18.18 LN: Thyristor controlled frequency converter Name: ZTCF

For a description of this LN, see IEC 61850-5.

ZTCF class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Descriptions				
EEName	DPL	External equipment name plate		O
Status information				
EEHealth	ENS	External equipment health		O
OpTmh	INS	Operation time		O
Settings				
PwrHz	ASG	Target frequency		O

5.18.19 LN: Thyristor controlled reactive component Name: ZTCR

For a description of this LN, see IEC 61850-5.

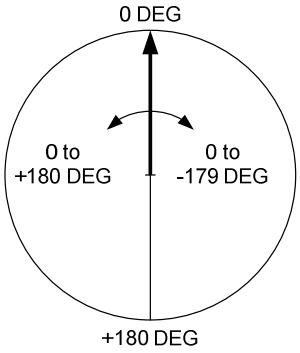
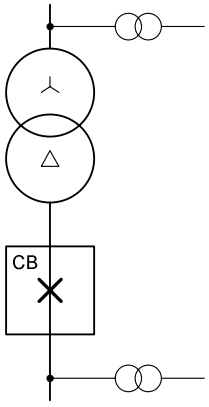
ZTCR class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Descriptions				
EEName	DPL	External equipment name plate		O
Status information				
EEHealth	ENS	External equipment health		O
OpTmh	INS	Operation time		O

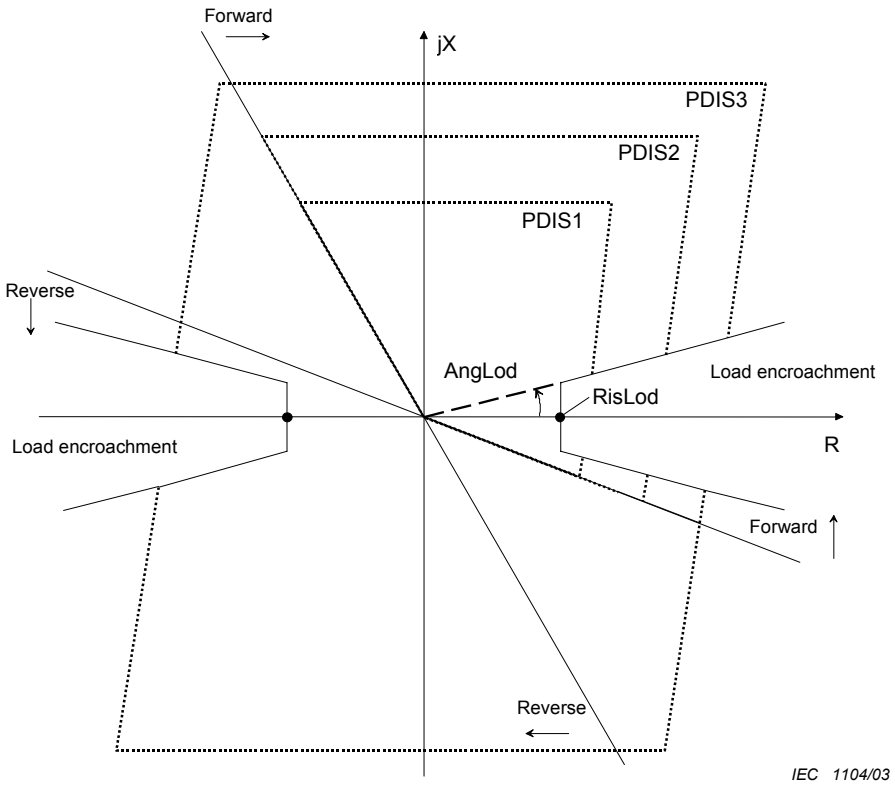
6 Data object name semantics

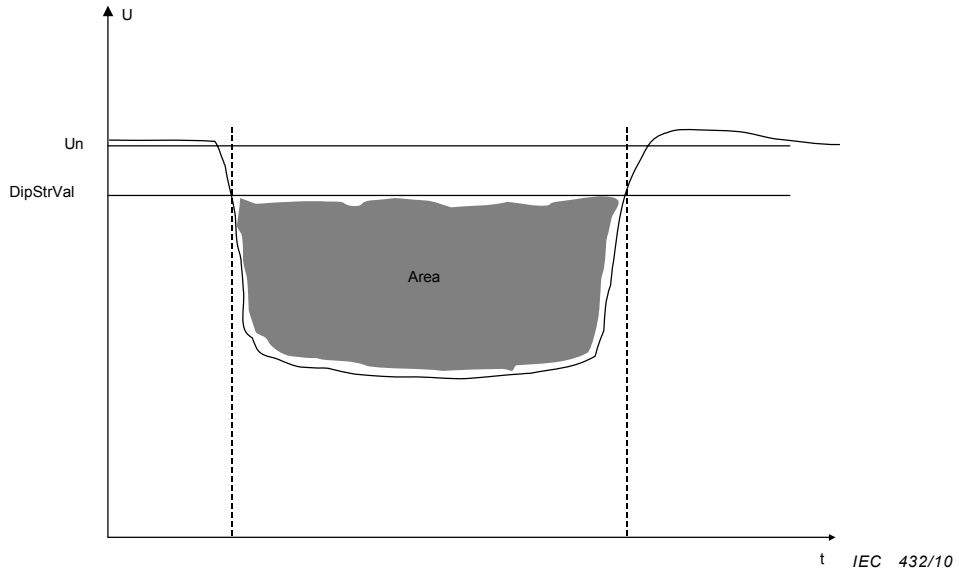
In Table 10, the data objects used in Clause 5 are described. The meaning of Boolean values are FALSE = 0, TRUE = 1.

Table 10 – Description of data objects

Data object name	Semantics
A	Phase currents (IL1, IL2, IL3)
AbrAlm	Contact abrasion alarm
AbrAlmLev	Abrasion sum threshold for alarm state
AbrPrt	Calculated or measured wear (e.g. of main contact), expressed in % where 0 % corresponds to new condition.
AbrWrn	Contact abrasion warning
AbrWrnLev	Abrasion sum threshold for warning state
AbsReact	Online capacitance, absolute value
ACAlm	AC supply failure
AccAbr	Cumulated abrasion of parts subject to wear
AccClc	Acceleration (change of rate of frequency difference)
AccClcDev	Deviation value, or change of acceleration: 'Δf' = $\Delta f1$-$\Delta f2$

Data object name	Semantics
AcsCtlFail	Number of access control failures detected: a data object that the client wanted to access exists in the server, but based on the access view of the association with that client, an access to the data object was refused.
ActAbr	Abrasion of last open operation
AcuPaDsch	Acoustic level of partial discharge in db
ADetun	Detuning of the compensated network. Either in A or in %. $I_{detune} = I_{EFN} - I_{CE}$ in A $I_{detune} = \frac{I_{EFN} - I_{CE}}{I_{CE}} 100$ in %
ADetunSpt	Setpoint for the detuning of the suppression coil
AdjSt	Adjustment message 1 – Completed 2 – Cancelled 3 – New adjustments 4 – Under way
AdpAngDeg	Adaptation angle, used to modify the measured phase-angle difference by a fixed analogue value in the range from –179...0...+180 DEG.  This setting allows e.g. to compensate the setting group of a step-up transformer between CB and VT (see example), or to compensate small phase shifts caused by harmonics on one of the two voltages. Example: 
AgeRte	Ageing rate, for example of transformer
Alm	General single alarm
AlmLevSpt	Alarm level setpoint
AlmLstOv	TRUE = indication that the alarm list has overflowed
AlmReset	Alarm signal reset
AlmThm	Thermal alarm
AlmVal	Alarm value is the pre-set value for a measurand that when reached will result in an alarm.

Data object name	Semantics
ALoc	Current (phasor) of the local current measurement
Amp	Current of a non-three-phase circuit
AmpLocPhsA	Current (sampled value) of the local current measurement (phase L1)
AmpLocPhsB	Current (sampled value) of the local current measurement (phase L2)
AmpLocPhsC	Current (sampled value) of the local current measurement (phase L3)
AmpLocRes	Current (sampled value) of the local current measurement (residual current)
AmpSpt	Current target set-point
AmpSv	Current (sampled value)
Ang	Angle between phase voltage and current
AngCor	Phase angle correction of a phasor (used for example for instrument transformers/transducers)
AngInd	This data object indicates whether the phase-angle difference (between the two voltages to be synchronised) is within the set limits or not. FALSE = value within the limits; TRUE = value outside the limits.
AngLod	Angle for load area. The following is an example of the definition of load encroachment used for the data objects AngLod and RisLod with polygonal characteristic, applicable also with MHO. PDIS1, PDIS2, and PDIS3 are different instances of the LN PDIS, one for each zone. See also RisGndRch in this table. 
AnIn	Analogue input used for generic I/O. It can be multiple in one LN-instance.
AnOut	Controllable analogue output It can be multiple in one LN-instance.
AngSv	Angle sampled value
ApNam	Access point name to which this channel belongs; only needed if more than one access point and more than one physical channel exists.
ApcIntTrk	Control service tracking for controllable analogue set point with integer command
ApcFTrk	Control service tracking for controllable analogue set point with float command
AppPaDsch	Apparent charge of partial discharge, peak level (PD)
ArcCntRs	Arc counter, resettable

Data object name	Semantics
AResoPt	Resonance-point of the compensated network. At this coil position of the Petersen-coil the current through the coil compensates the whole capacitive current to ground of the network.
ARtg	Rated current, intrinsic property of the device, which cannot be set/changed from remote
AStr	Current level: if this level is exceeded, the related functions start a dedicated action
ATrsTm	Transient duration
Area	The total calculated area of a power quality event (example voltage sag in figure) 
AuthFail	Number of authorisation failures: an association to the client could not be established due to an authorisation failure.
Auto	This data object 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. This data object is controllable, but with ctlModel="status_only" it can also be used.
AutoRecSt	This data object represents whether or not the auto reclosing is ready, in progress, or successful **Auto Reclosing Status** / **Value**: Ready 1; In Progress 2; Successful 3; Waiting for trip 4; Trip issued by protection 5; Fault disappeared 6; Wait to complete 7; Circuit breaker closed 8; Cycle unsuccessful 9; Unsuccessful 10; Aborted 11 The state "In Progress" is only used for backwards compatibility with edition 1. It is deprecated for edition2.
AutoUpLod	TRUE = automatic uploading of the disturbance recorder files
AuxSco	TRUE = commands change over to operation from the auxiliary power supply
AuxSwTmCls	Timing of the close operation measured by auxiliary switches (usually displayed in ms). Significant changes in timing can point to a malfunction of the mechanical link, e.g. missing lubricant.
AuxSwTmOpn	Timing of the open operation measured by auxiliary switches (usually displayed in ms). Description see AuxswTmCls
AvAmps	Average current in a defined evaluation interval (period)
AvAPhs	Arithmetic average of the magnitude of current of the 3 phases. Average(Ia,Ib,Ic)

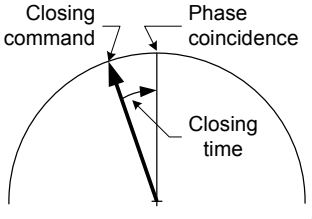
Data object name	Semantics
AVaTm	Current unbalance variation duration
AVChr33	Multiline curve characteristic definition. It is not multiple instantiable within one LN instance.
AVCrv	Characteristic curve for protection operation of the form: *y* = f(*x*), where *x* is the voltage (V) and (voltage) and *y* is the current (A). The integers representing the different curves are given in the definition of CDC CURVE in IEC 61850-7-3.
AvPFPhs	Arithmetic average of the magnitude of power factor of the 3 phases. Average(PFa, PFb, PFc)
AvPhVPhs	Arithmetic average of the magnitude of phase to reference voltage of the 3 phases. Average(PhVa, PhVb, PhVc)
AvPPVPhs	Arithmetic average of the magnitude of phase to phase voltage of the 3 phases. Average(PPVa, PPVb, PPVc)
AVSt	Delivers the active curve characteristic
AvVA	Average apparent power in a defined evaluation interval (period).
AvVAPhs	Arithmetic average of the magnitude of apparent power of the 3 phases. Average(VAa, VAb, VAc)
AvVAr	Average reactive power in a defined evaluation interval (period)
AvVArPhs	Arithmetic average of the magnitude of reactive power of the 3 phases. Average(VAra, VArb, VArc)
AvVolts	Average voltage in a defined evaluation interval (period)
AvW	Average active power in a defined evaluation interval (period)
AvWPhs	Arithmetic average of the magnitude of active power of the 3 phases. Average(Wa, Wb, Wc)
AWatt	Wattmetric part of the residual current at the fault location in case of an earthfault
AvZPhs	Arithmetic average of the magnitude of impedance of the 3 phases. Average(Za, Zb, Zc)
AxDsp	Total axial displacement [usually in mm]
AxDspSv	Total axial displacement
AxDAlmSpt	Axial displacement alarm level setpoint
AxDTrpSpt	Axial displacement trip level setpoint
BacTrk	Control service tracking for binary controlled analogue process value
BaseImp	Base per unit impedance [ohm /phase]
BatHi	TRUE = indicates that battery is in overcharge condition
BatLo	TRUE = indicates that battery voltage has dropped below a pre-set level
BatTest	TRUE = command to start the battery test

<table>
<tr><th>Data object name</th><th>Semantics</th></tr>
<tr><td>Beh</td><td>Since the logical device controls all logical nodes that are part of the logical device, the mode of the logical device (“LDMode” = LLN0.Mod) and the mode of a specific logical node (“LNMode” = XXXX.Mod) are related. The behaviour of a logical node is therefore a combination of LLN0.Mod and XXXX.Mod and is described in the ”LNBeh” = XXXX.Beh. This data object is read-only and has the same possible values as Mod (Mode). The value is determined according the following table:
<table>
<tr><th>LNMode
XXXX.Mod</th><th>LDMode
LLN0.Mod</th><th>LNBeh (read only)
XXXX.Beh</th><th>LNBeh Value</th></tr>
<tr><td>on</td><td>on</td><td>on</td><td>1</td></tr>
<tr><td>on</td><td>on-blocked</td><td>on-blocked</td><td>2</td></tr>
<tr><td>on</td><td>test</td><td>test</td><td>3</td></tr>
<tr><td>on</td><td>test/blocked</td><td>test/blocked</td><td>4</td></tr>
<tr><td>on</td><td>off</td><td>off</td><td>5</td></tr>
<tr><td>on-blocked</td><td>on</td><td>on-blocked</td><td>2</td></tr>
<tr><td>on-blocked</td><td>on-blocked</td><td>on-blocked</td><td>2</td></tr>
<tr><td>on-blocked</td><td>test</td><td>test/blocked</td><td>4</td></tr>
<tr><td>on-blocked</td><td>test/blocked</td><td>test/blocked</td><td>4</td></tr>
<tr><td>on-blocked</td><td>off</td><td>off</td><td>5</td></tr>
<tr><td>test</td><td>on</td><td>test</td><td>3</td></tr>
<tr><td>test</td><td>on-blocked</td><td>test/blocked</td><td>4</td></tr>
<tr><td>test</td><td>test</td><td>test</td><td>3</td></tr>
<tr><td>test</td><td>test/blocked</td><td>test/blocked</td><td>4</td></tr>
<tr><td>test</td><td>off</td><td>off</td><td>5</td></tr>
<tr><td>test/blocked</td><td>on</td><td>test/blocked</td><td>4</td></tr>
<tr><td>test/blocked</td><td>on-blocked</td><td>test/blocked</td><td>4</td></tr>
<tr><td>test/blocked</td><td>test</td><td>test/blocked</td><td>4</td></tr>
<tr><td>test/blocked</td><td>test/blocked</td><td>test/blocked</td><td>4</td></tr>
<tr><td>test/blocked</td><td>off</td><td>off</td><td>5</td></tr>
<tr><td>off</td><td>on</td><td>off</td><td>5</td></tr>
<tr><td>off</td><td>on-blocked</td><td>off</td><td>5</td></tr>
<tr><td>off</td><td>test</td><td>off</td><td>5</td></tr>
<tr><td>off</td><td>test/blocked</td><td>off</td><td>5</td></tr>
<tr><td>off</td><td>off</td><td>off</td><td>5</td></tr>
</table>
</td></tr>
<tr><td>Ber</td><td>Bit error rate of the communication channel. Used in case of a digital communication channel</td></tr>
<tr><td>Bias</td><td>Bias added to process variable</td></tr>
<tr><td>Blk</td><td>Dynamically blocking of function described by the LN</td></tr>
<tr><td>BlkA</td><td>TRUE = operation is blocked by current reasons</td></tr>
<tr><td>BlkAOv</td><td>TRUE = switch operation is blocked by current limit overflow</td></tr>
<tr><td>BlkCls</td><td>This data object is used to block ‘close operation’ (for example, for XCBR, XSWI, YPSH) from another logical node such as a protection node or from a local/remote switch. An example may be the low insulation gas density. Block closing is not reflected in operating capability. TRUE = block operation ‘close circuit breaker’.</td></tr>
<tr><td>BlkEF</td><td>TRUE = switch activity blocked due to earth fault</td></tr>
<tr><td>BlkLoVisc</td><td>The tap changer is blocked due the low viscosity because of the low temperature.</td></tr>
<tr><td>BlkLV</td><td>Control voltage below which auto lower commands blocked</td></tr>
<tr><td>BlkOpn</td><td>This data object is used to block ‘open operation’ (for example to XCBR, XSWI, YPSH) from another logical node such as a protection node or from a local/remote switch. An example may be the blocking of the buscoupler also for trips during busbar transfer. Block opening is not reflected in operating capability. TRUE = block operation ‘open circuit breaker’.</td></tr>
<tr><td>BlkRef</td><td>Blocking reference shows the receiving of dynamically blocking signal; this data object is multi-instantiable.</td></tr>
<tr><td>BlkRV</td><td>Control voltage above which auto raise commands blocked</td></tr>
<tr><td>BlkThm</td><td>Block closing command for circuit breaker because of thermal condition. If the temperature of protected equipment is still higher than a setting.</td></tr>
<tr><td>BlkV</td><td>TRUE = operation is blocked for voltage reasons</td></tr>
<tr><td>BlkVal</td><td>When the measurements exceed (or drop below, in the case of a dropout function) this value, the function operation is blocked.</td></tr>
<tr><td>BlkValA</td><td>Block value (minimum operating current)</td></tr>
<tr><td>BlkValV</td><td>Block value (minimum operating voltage)</td></tr>
</table>

<table>
<tr><th>Data object name</th><th>Semantics</th></tr>
<tr><td>BlkVLo</td><td>Control voltage below which auto raise commands are blocked. If the control voltage is under the limit of BlkVLo (e.g. because that part of the network is switched off), the ATCC issues no raise commands until the control voltage exceeds the limit of BlkVLo.</td></tr>
<tr><td>BlkVHi</td><td>Control voltage above which auto lower commands are blocked. If the control voltage is over the limit of BlkVHi, the ATCC issues no lower commands until the control voltage exceeds the limit of BlkVHi.</td></tr>
<tr><td>BlkVOv</td><td>TRUE = Switch operation is blocked by voltage limit overflow</td></tr>
<tr><td>BlkZn</td><td>This data object is used by the power swing protection to block operation of protection for a specific protection zone i.e. the related instance of PDIS.

TRUE = blocked, FALSE = not blocked</td></tr>
<tr><td>BndCtr</td><td>Centre of control bandwidth, forward power flow presumed</td></tr>
<tr><td>BndCtrChg</td><td>Band centre change (raise, lower), no status</td></tr>
<tr><td>BndWid</td><td>Band width, i.e. the defined range of control voltage given either as voltage value or percentage of the nominal voltage. Forward power flow is presumed if applicable.</td></tr>
<tr><td>BotTmp</td><td>Bottom oil temperature</td></tr>
<tr><td>BrcbTrk</td><td>Access service tracking for buffered report control block</td></tr>
<tr><td>BscTrk</td><td>Control service tracking for binary controlled step position information</td></tr>
<tr><td>CapacImb</td><td>Capacitive imbalance of the network</td></tr>
<tr><td>CapDS</td><td>TRUE = Capacitor bank is on line, or close. FALSE = capacitor bank off line or open</td></tr>
<tr><td>C2H2ppm</td><td>Measurement of C_2H_2 (Acetylene) in ppm</td></tr>
<tr><td>C2H4ppm</td><td>Measurement of C_2H_4 (Ethylene) in ppm</td></tr>
<tr><td>C2H6ppm</td><td>Measurement of C_2H_6 (Ethane) in ppm</td></tr>
<tr><td>CarLev</td><td>Power of received signal in case of an analogue communication channel</td></tr>
<tr><td>CBOpCap</td><td>This is an enumeration representing the physical capabilities of the breaker to operate. It reflects the switching energy as well as additional blocking due to some local problems.

CBOpCap is always less or equal to MaxOpCap.
<table>
<tr><th>Breaker operating capability</th><th>Value</th></tr>
<tr><td>None</td><td>1</td></tr>
<tr><td>Open</td><td>2</td></tr>
<tr><td>Close – Open</td><td>3</td></tr>
<tr><td>Open – Close – Open</td><td>4</td></tr>
<tr><td>Close – Open – Close – Open</td><td>5</td></tr>
<tr><td>Open – Close – Open – Close – Open</td><td>6</td></tr>
<tr><td>more</td><td>7</td></tr>
</table>
More values (6...n) describe higher operating capabilities. A new value, that is a new line in the table, must start alternating with “close” and “open” and must end always with “open”.</td></tr>
<tr><td>CBTmms</td><td>Closing time of breaker in ms. The time is used to compensate for the breaker closing time, i.e., the closing command will be given a defined time before phase coincidence. Closing time of breaker including other delays until the operation of the breaker. This is a property of the breaker that is subject to ageing.

IEC 433/10</td></tr>
<tr><td>CBTmms</td><td>Closing time of breaker including other delays until the operation of the breaker. This is a property of the breaker that is subject to ageing.</td></tr>
<tr><td>CCdt</td><td>Carbon production credit value</td></tr>
<tr><td>CEBlk</td><td>Control of automatic / manual operation (blocking). TRUE = automatic control of cooling equipment blocked (inhibited)</td></tr>
</table>

Data object name	Semantics
CECtl	Control of complete cooling group (pumps and fans). TRUE = on, FALSE = off
CETmpIn	Temperature of the behaviour cooling medium in a cooling equipment (input). Typically used for the water temperature for water cooled power transformers (OFWF or ODWF).
CETmpOut	Temperature of the behaviour cooling medium in a cooling equipment (output). Typically used for the water temperature for water cooled power transformers (OFWF or ODWF).
CEPres	Pressure of the behaviour cooling medium in a cooling equipment. Typically used for the water pressure for water cooled power transformers (OFWF or ODWF).
CEFlw	Flow of the behaviour cooling medium in a cooling equipment. Typically used for the water flow for water cooled power transformers (OFWF or ODWF).
CGAlm	TRUE = core ground alarm indicates that the insulation has broken down
CH4ppm	Measurement of CH_4 (methane) in ppm
ChaIntvTms	Time interval between last two charging operations
ChaMotEna	This data object is used to enable the charger motor; used to prevent overload of the power supply after a busbar trip. TRUE = enable charger motor, FALSE = disable charger motor
ChLiv	Physical channel status; true, if channel receives telegrams within a specified time interval
ChLivTms	Timeout time for channel live supervision; default 5 s
ChNum	Channel number being monitored (for example for COMTRADE)
ChrAng	The angle by which the current is displaced from the polarising quantity in order to obtain maximum sensitivity.
ChTrg	Channel triggered. TRUE = channel started recording, FALSE = behaviour not started recording
CircA	Measured circulating current, which circulates between transformers operated in parallel (one component of transformer secondary current in a paralleling installation).
ClcExp	Indicates that the calculation period of a statistical logical node has expired. This DATA OBJECTS shall be mandatory for all logical nodes that are intended to represent statistical data object, indicated by the common data classes, for example, CDC MV, CMV, WYE, etc.
ClcIntvTyp	Calculation interval type with possible values MS | PER_CYCLE | CYCLE | DAY | WEEK | MONTH | YEAR | EXTERNAL

<table>
<tr><th>Data object name</th><th>Semantics</th></tr>
<tr><td>ClcMth</td><td>The calculation method specifies how the data attributes that represent analogue values have been calculated. The calculation method shall be the same for all data objects of a given logical node instance.

The possible values shall be:

<table>
<tr><td>Value</td><td>Description</td></tr>
<tr><td>UNSPECIFIED</td><td>Indicates that the calculation of the analogue values is unspecified (i.e. all common attributes I and f). UNSPECIFIED is the default value.</td></tr>
<tr><td>TRUE_RMS</td><td>Indicates that all analogue values (i.e. all common attributes I and f) are true r.m.s. values.</td></tr>
<tr><td>PEAK_FUNDAMENTAL</td><td>Indicates that all analogue values (i.e. all common attributes I and f) are peak fundamental values.</td></tr>
<tr><td>RMS_FUNDAMENTAL</td><td>Indicates that all analogue values (i.e. all common attributes I and f) are r.m.s. fundamental values.</td></tr>
<tr><td>MIN</td><td>Indicates that all analogue values (i.e. all common attributes i and f) are minimum values.</td></tr>
<tr><td>MAX</td><td>Indicates that all analogue values (i.e. all common attributes i and f) are maximum values.</td></tr>
<tr><td>AVG</td><td>Indicates that all analogue values (i.e. all common attributes i and f) are average values.</td></tr>
<tr><td>SDV</td><td>Indicates that all analogue values (i.e. all common attributes i and f) are standard deviation values.</td></tr>
<tr><td>PREDICTION</td><td>Indicates that all analogue values (i.e. all common attributes i and f) are long term changes over time.</td></tr>
<tr><td>RATE</td><td>Indicates that all analogue values (i.e. all common attributes i and f) are actual changes over time calculated with the actual value and value before.</td></tr>
</table>
This DATA OBJECT shall be mandatory for all logical nodes that are intended to represent statistical data, indicated by the common data classes, for example, CDC MV, CMV, WYE, etc.

NOTE 1 If different calculation periods are required for the data objects of a logical node, then different logical nodes could be instantiated – with different calculation periods.

NOTE 2 The calculation algorithm and number of samples used for the calculation is an implementation issue.</td></tr>
<tr><td>ClcMod</td><td>Calculation mode

Possible values are:

<table>
<tr><td>Value</td><td>description</td></tr>
<tr><td>TOTAL</td><td>the total time from the first start of the device/application until the current time</td></tr>
<tr><td>PERIOD</td><td>the periodical time cycle</td></tr>
<tr><td>SLIDING</td><td>sliding window from now predefined window backwards</td></tr>
</table></td></tr>
<tr><td>ClcIntvPer</td><td>In case ClcIntvTyp equals to MS, PER-CYCLE, CYCLE, DAY, WEEK, MONTH, YEAR, number of units to consider to calculate the calculation interval duration.</td></tr>
<tr><td>ClcNxTmms</td><td>Remaining time up to the end of the current calculation interval – expressed in milliseconds</td></tr>
<tr><td>ClcRfPer</td><td>In case ClcIntvTyp equals to MS, PER-CYCLE, CYCLE, DAY, WEEK, MONTH, YEAR, number of units to consider to calculate the refreshment interval duration.</td></tr>
<tr><td>ClcRfTyp</td><td>Refreshment interval typ. Allowed values: MS, PER-CYCLE, CYCLE, DAY, WEEK, MONTH, YEAR, EXTERNAL</td></tr>
<tr><td>ClcSeqWrn</td><td>Number of calculation sequence exceeded in automatic/manual mode</td></tr>
<tr><td>ClcSrc</td><td>The reference to the logical node whose analogue data attributes are used to calculate the value contained in this logical node instance.

This DATA OBJECT shall be mandatory for all logical nodes that are intended to represent statistical data, indicated by the common data classes, for example, CDC MV, CMV, WYE, etc.</td></tr>
</table>

Data object name	Semantics
ClcStr	Enables the start calculation of statistical data. Either at once, or if available and set at operTm of the control model. This DATA OBJECT shall be mandatory for all logical nodes that are intended to represent statistical data, indicated by the common data classes, for example, CDC MV, CMV, WYE, etc.
ClcTotVA	Calculation method used for total apparent power (TotVA) (Vector | Arithmetic)
CycTrMod	This data object represents a type of trip function from RREC; 3phase means only 3phase tripping possible, 1 or 3phase means PTRC with 1 and 3phase tripping possibility and first trip depending on fault type. Specific means for example PTRC with 1phase and 2phase and 3phase tripping possibility and first trip depending on fault type. **Trip mode** / **Value** 3 phase tripping / 1 1 or 3 phase tripping / 2 specific / 3
ClsLim	Limitation on closing of a device (% of full opening)
ClsPos	Open end position reached (valve cannot move further)
CloudCvr	Cloud cover level
Cmd	Breaker closing command: TRUE issue–a comma–d - FALSE - issue no command
CntRs	Counter (resettable)
CO2Ems	CO_2 Emissions
CO2ppm	Measurement of CO_2 in ppm
COEms	CO Emissions
COppm	Measurement of CO in ppm
ColA	Current in opening or closing coil during last operation (usually displayed in A)
ColAlm	TRUE = supervision has detected an abnormal state of the coils
ColChgOp	Change coil position in operation
ColOpL	Change Petersen-coil position in direction to lower endswitch
ColOpR	Change Petersen-coil position in direction to upper endswitch
ColPos	Represents the continuous adjustment of a suppression coil (plunge core position) such as a Petersen coil
ColPosA	Measured value of the Petersen-coil position. The value is derived from the length of the air-gap and converted as current in A for the case of a solid earthfault.
ColTapPos	Represents the discrete adjustment of a suppression coil such as a Petersen coil
ConfRevNum	Expected configuration revision number of the GOOSE message
Cndct	Electrical conductivity of water in S/cm^2
Cmd	Command
CmdBlk	Blocking of control sequences of controllable data objects
ConsTms1	Time constant, for example for a thermal model
Cor	Magnitude correction of a phasor (used for example for instrument transformers/transducers)
CoreTmp	Core temperature
CrdTmms	Delay time in ms to wait on additional input if other actions are called for
Crv	Curve shape
CtlDlTmms	Control delay time before operating after reaching control point forward power flow presumed
CtlV	Voltage on secondary of transformer as used for voltage control
CTrd	Involved in carbon trading
DAct	Derivative action
Damp	Damping of the zero-sequence-system
DctInSol	Direct normal insolation [usually in W/m^2]

Data object name	Semantics
DeaBnd	Deadband
DeaBusVal	Dead bus value: maximum value at which the bus voltage is still recognised as zero (dead)
DeaLinVal	Dead line value: maximum value at which the line voltage is still recognised as zero (dead)
Den	Density of insulating medium
DenAlm	Density alarm because of an abnormal condition (FALSE = Normal, TRUE = alert)
DetSyn	Detection of synchronism (Δf): maximum value at which the frequency difference is ignored and the two voltages are treated as synchronous sources
DetValA	Used to detect that the breaker has opened when the current is below that setting
DewPt	Dew point
DExt	TRUE = Command to de-excite the machine
DFilTmms	Derivative time filter (ms)
DffInsol	Diffuse insolation [usually in W/m^2]
Diag	TRUE = diagnostic is running, FALSE = diagnostic is not running
DipStrVal	When the voltage in at least one phase goes below the voltage dip set point, it will start the voltage variation function and the timer that will measure the duration of the voltage variation power quality event. The event ends when all monitored phase voltages return above the threshold.
DifAClc	Differential current
DifAng	Setting for the phase angle difference between two measured values
DifAngClc	Calculated value for the phase-angle difference between two measured values. The accuracy and calculation method is a local issue.
DifAngNg	Maximum phase-angle difference negative: absolute value in degrees
DifAngPs	Maximum phase-angle difference positive: absolute value in degrees; this data object may be used for both, the positive and negative limit in case the synchronizer supports only a common parameter for positive and negative.
DifHz	Setting for the frequency difference between two measured values
DifHzClc	Calculated value for the frequency difference between two measured values. The accuracy and calculation method is a local issue.
DifHzNg	Difference frequency negative: absolute value
DifHzPs	Difference frequency positive; absolute value; this data object may be used for both, the positive and negative limit in case the synchronizer supports only a common parameter for positive and negative.
DifPresHi	Differential pressure high alarm level setting
DifV	Setting for the voltage difference between two measured values
DifVClc	Calculated value for the voltage difference (average value) between two measured values. The accuracy and calculation method is a local issue.
DifVNg	Maximum voltage difference (average value) negative
DifVPs	Maximum voltage difference (average value) positive; this data object may be used for both, the positive and negative limit in case the synchronizer supports only a common parameter for positive and negative.
Dir	The direction of a fault or power flow
DirMod	This data object is used to enable operation when the following directional conditions are met: ***Direction mode*** / **Value** Non directional / 1 Forward / 2 Reverse / 3
DlDur	Daylight duration (time elapsed between sunrise and sunset)
DltRcd	TRUE = delete the selected record

Data object name	Semantics
DlTmms	Supervision time for paralleling in ms; in case of synchronous conditions (no phase coincidence), the closing command may be given if all conditions have been fulfilled continuously during the supervision time.
DmdPwr	Demanded power
DmdVArh	Reactive energy demand (default demand direction: energy flow from busbar away)
DmdWh	Real energy demand (default demand direction: energy flow from busbar away)
Dn	Last count direction downward
DPCSO	Generic double point control. It can be multiple in one LN-instance.
DpcTrk	Control service tracking for controllable double point
DQ0Seq	Direct, quadrature, and zero axis quantity
Droop	Droop controls allow the use of distributed controllers without inter-controller communication. The droop is specified as percent change in effective setpoint at maximum action.
DropoutVal	Dropout value for blocking closing command
Dsc	Discrepancy
DschBlk	TRUE = indicates that switch close action for capacitor bank is blocked due to the discharge state of the bank
DTmms	Derivative time (ms)
DlSynTmms	Time delay between receiving the start synchronising signal and starting the synchronising process. This time is used to set up the actual values, before any interaction takes place.
DurTmms	Minimum duration of carrier signal sent by a communication based scheme in ms
Dust	Dust particles suspended in air
EchoWei	TxPrm is being sent as echo signal or in case of weak end infeed
EchoWeiOp	Additional indication that Op is the operate from the weak end infeed or echo function (typically with undervoltage control).
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 the health.
EEName	This information reflects the name plate of external equipment, for example the circuit breaker XCBR controlled by the logical node CSWI
En	Energy available in the drive mechanism expressed in %, where 100 % corresponds to rated value and 0 % to lowest block value
EnAlm	TRUE = supervision has detected an abnormal condition in the energy storing system, for example loss of N2 or equivalent.
EnaCls	The interlocking function itself determines the status of this data object and thus permits the closing of the device when TRUE. The control service checks this value before he controls “Close/On” a switch.
EnaOpn	The interlocking function itself determines the status of this data object and thus permits the opening of the device when TRUE. The control service checks this value before he controls “Open/Off” a switch.
EnBlk	TRUE = energy is too low for operation.
EncTrk	Control service tracking for enumerated controllable. One EncTrk instance is dedicated to track one specific enumerated command. Therefore EncTrk can be multiple instances in one LN instance.
EndPosL	TRUE = load tap changer is in the maximum lower position
EndPosR	TRUE = load tap changer is in the maximum raise position
EnvHum	Humidity of environment (usually in %)
EnvPres	Barometric pressure of environment
EnvTmp	Temperature of environment
EqTmm	Temperature equalisation time (min). For the duration of EqTmm, the thermal memory will be kept, that is the thermal memory is frozen. This time is active after the motor is switched off.
ErrPar	Error of parallel operation of transformer

<table>
<tr><th>Data object name</th><th>Semantics</th></tr>
<tr><td>ErrTerm</td><td>Control loop termination error value; the function cannot be fulfilled because of external reasons; the value gives difference between set point and actual value.</td></tr>
<tr><td>EvtCnt</td><td>Event counter – counts the number of times that a power quality event detected by the logical node occurred</td></tr>
<tr><td>EvTmms</td><td>Evaluation time in ms (time window) determines the lowest frequency</td></tr>
<tr><td>ExclTmms</td><td>Exclusion time in ms that consecutive triggers from the same source are ignored</td></tr>
<tr><td>FACntRs</td><td>Fault arc counter, resettable</td></tr>
<tr><td>FADet</td><td>TRUE = alarm that fault arc has been detected</td></tr>
<tr><td>FailMod</td><td>Circuit breaker failure detection mode.<table><tr><th>Detection mode</th><th>Value</th></tr><tr><td>Current</td><td>1</td></tr><tr><td>Breaker status</td><td>2</td></tr><tr><td>Both current and breaker status</td><td>3</td></tr><tr><td>Other</td><td>4</td></tr></table></td></tr>
<tr><td>FailTmms</td><td>The time delay in ms until the breaker failure function will issue the trip to an alternate device</td></tr>
<tr><td>FanA</td><td>Motor drive current of a fan in A</td></tr>
<tr><td>FanCtlGen
FanCtl</td><td>FanCtlGen – Control of all fans
FanCtl – Control of a single fan<table><tr><th>Fan control</th><th>Value</th></tr><tr><td>Inactive</td><td>1</td></tr><tr><td>Stage 1</td><td>2</td></tr><tr><td>Stage 2</td><td>3</td></tr><tr><td>Stage 3</td><td>4</td></tr></table>More stages may be added with numbers greater than 4</td></tr>
<tr><td>FanFlw</td><td>Air flow in fan</td></tr>
<tr><td>FanOvCur</td><td>Fan overcurrent trip</td></tr>
<tr><td>FctBlk</td><td>Dynamically blocking of function described by the LN</td></tr>
<tr><td>FctBlkRef</td><td>Blocking reference shows if a signal that blocks the function has been received.</td></tr>
<tr><td>Fer</td><td>Frame error rate on this channel; count of erroneous (or missed, in case of redundancy) messages for each 1 000 messages forwarded to the application</td></tr>
<tr><td>FilAlm</td><td>Filter alarm, can be indicated by too high or too low differential pressure</td></tr>
<tr><td>FilTyp</td><td>Filter type: Low pass | High pass | Bandpass | Bandstop (notch) | Deadband</td></tr>
<tr><td>FishCnt</td><td>Fish counter reading</td></tr>
<tr><td>FixCol</td><td>Size of the external Fixcoil. The ANCR can take into account this value for the calculation of the necessary compensation. The size is given in Amperes and represents the current through the coil in case of a solid earth fault.</td></tr>
<tr><td>FldAmpRtg</td><td>Rated field current [A]</td></tr>
<tr><td>FldAmpRtgO</td><td>No-load field current for rated stator voltage [A]</td></tr>
<tr><td>FldRis</td><td>Field resistance [ohm]</td></tr>
<tr><td>FldRisTmp</td><td>Reference temperature for field resistance [usually in °C]</td></tr>
<tr><td>FloodAlm</td><td>Flood alarm</td></tr>
<tr><td>FloodLev</td><td>Flood alarm level</td></tr>
<tr><td>FltDiskm</td><td>The distance to a fault in km</td></tr>
<tr><td>FltIndRs</td><td>Earthfault indication, resettable</td></tr>
</table>

<table>
<tr><th>Data object name</th><th>Semantics</th></tr>
<tr><td>FltLoop</td><td>
<table>
<tr><th>Fault loop</th><th>Value</th></tr>
<tr><td>Phase A to ground</td><td>1</td></tr>
<tr><td>Phase B to ground</td><td>2</td></tr>
<tr><td>Phase C to ground</td><td>3</td></tr>
<tr><td>Phase A to phase B</td><td>4</td></tr>
<tr><td>Phase B to phase C</td><td>5</td></tr>
<tr><td>Phase C to phase A</td><td>6</td></tr>
<tr><td>Others</td><td>7</td></tr>
</table>
</td></tr>
<tr><td>FltNum</td><td>Fault number (number allocation is local issue)</td></tr>
<tr><td>FltZ</td><td>Fault impedance</td></tr>
<tr><td>Flush</td><td>Filter flushing in progress</td></tr>
<tr><td>FlushCnt</td><td>Filter flushing counter (resettable)</td></tr>
<tr><td>Flw</td><td>Flow rate of water or other liquid [usually in m^3/s]</td></tr>
<tr><td>FuFail</td><td>TRUE = indicates that the TVTR fuse has opened/failed</td></tr>
<tr><td>GasFlwTr</td><td>Insulation liquid (for example oil) flow trip because of gas (maybe used for Buchholz trip)</td></tr>
<tr><td>GasInsAlm</td><td>Gas in insulation liquid (for example oil) alarm because of an abnormal condition (FALSE = normal, TRUE = alert, may be used for Buchholz trip)</td></tr>
<tr><td>GasInsTr</td><td>Gas in insulation liquid trip because of a dangerous condition (maybe used for Buchholz trip)</td></tr>
<tr><td>GenTrk</td><td>Common service tracking for all services for which no specific tracking data exists. The supported trackable services by GenTrk are a local issue.</td></tr>
<tr><td>GnCtl</td><td>Generator control</td></tr>
<tr><td>GndDlMod</td><td>Operate time delay for single-phase ground mode. TRUE = on, FALSE = off</td></tr>
<tr><td>GndDlTmms</td><td>Operate time delay for single-phase ground faults in ms</td></tr>
<tr><td>GndOp</td><td>Ground operate value ($3\ I_0$)</td></tr>
<tr><td>GndStr</td><td>When the ground measurements exceed this value (or drop below, in the case of a dropout function), the operation of the related function is initiated.</td></tr>
<tr><td>GnSpd</td><td>Generator speed</td></tr>
<tr><td>GnSt</td><td>Generator state
<table>
<tr><th>Generator state</th><th>Value</th></tr>
<tr><td>Stopped</td><td>1</td></tr>
<tr><td>Stopping</td><td>2</td></tr>
<tr><td>Started</td><td>3</td></tr>
<tr><td>Starting</td><td>4</td></tr>
<tr><td>Disabled</td><td>5</td></tr>
</table>
</td></tr>
<tr><td>GoCBRef</td><td>Reference to the subscribed GOOSE control block</td></tr>
<tr><td>GocbTrk</td><td>Access service tracking for GOOSE control block</td></tr>
<tr><td>GrAlm</td><td>This data object summarises different alarms, assigned via configuration. TRUE = indicates a group alarm</td></tr>
<tr><td>GrInd</td><td>This data object summarises different indications, assigned via configuration. TRUE indicates a group indication</td></tr>
<tr><td>GrnTag</td><td>Green tag information</td></tr>
<tr><td>GrRef</td><td>Reference to a higher-level logical device (LD). The Mod of this higher-level (referenced) LD influences the Beh of the LD and the Beh of all LNs in the LD where the GrRef is contained (see Beh of Table 10). See also the concept of “Logical device management hierarchy” described in IEC 61850-7-1.</td></tr>
<tr><td>GrdRxCmdRx</td><td>Alarm situation: Guard received together with the command, may indicate interference on the channel. Used in case of an analogue communication channel.</td></tr>
<tr><td>GriFltNum</td><td>Grid fault number is used for identification of disturbance records of a common fault (number allocation is local issue).</td></tr>
</table>

Data object name	Semantics
GrWrn	This data summarises different warnings, assigned via configuration. TRUE = indicates a group warning
H2ppm	Measurement of hydrogen (H_2 in ppm). Combustible gas measurement in oil indicating the amount of deterioration of the insulation system.
H2Alm	H_2 alarm for gas composition (FALSE = Normal, TRUE = alert)
H2Wrn	H_2 warning for gas composition
H2O	Relative saturation of moisture in oil (in %). Note that this a measurement used in conjunction with H_2OTmp.
H2OTmp	Temperature of oil at point of measurement of relative saturation of moisture in oil (usually in °C). Note that this is a measurement used in conjunction with H_2O
HA	Phase-related sequence of harmonics or interharmonics current for A, B C, N, Net, Res
HaAmp	Non-phase-related sequence of harmonics or interharmonics current
HaAmpTm	Non-phase-related current time product
HaCfAmp	Non-phase-related current crest factors (peak waveform value/sqrt(2)/fundamental)
HaCfVol	Non-phase-related voltage crest factors (peak waveform value/sqrt(2)/fundamental)
HaKFact	Non-phase-related K Factor
HaRmsAmp	Non-phase-related current RMS harmonic or interharmonic (un-normalized Thd)
HaRmsVol	Non-phase-related voltage RMS harmonic or interharmonic (un-normalized Thd)
HaRst	Number of the harmonic that is being monitored for restraint
HaTdFact	Non-phase-related transformer derating factor
HaTiFact	Non-phase-related voltage telephone influence factor, method 1, 2, 3, …
HATm	Phase-related current time product
HaTsWatt	Non-phase-related total harmonic or interharmonic active power (no fundamental) signed sum
HaTuWatt	Non-phase-related total harmonic or interharmonic active power (no fundamental) unsigned sum
HaVol	Non-phase-related sequence of harmonics or interharmonics voltage
HaVolAmp	Non-phase-related sequence of harmonics or interharmonics apparent power
HaVolAmpr	Non-phase-related sequence of harmonics or interharmonics reactive power
HaWatt	Non-phase-related sequence of harmonics or interharmonics active power
HCfA	Phase-related current crest factors (peak waveform value/sqrt(2)/fundamental)
HCfPhV	Phase to ground voltage crest factors (peak waveform value/sqrt(2)/fundamental)
HCfPPV	Phase to phase voltage crest factors (peak waveform value/sqrt(2)/fundamental)
Health	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 objects. For LLN0, this data object reflects the worst value of “health” of the logical nodes that are part of the logical device associated with LLN0. **Health state** / **Value** Ok (“green”) – no problems, normal operation / 1 Warning (“yellow”) – minor problems, but in safe operation mode / 2 Alarm (“red”) – severe problem, no operation possible / 3 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.
HeatAlm	TRUE = supervision has detected an abnormal state of the heater
HiBatVal	High battery alarm value
HiColPos	High position of a suppression coil
HiCtlV	Highest control voltage since last reset
HiDmdA	Highest current demand since last reset

Data object name	Semantics
HiLim	High limit reached (input signal equal to or above limit)
HiLimSpt	High limit setpoint
HiSet	High operate value, percentage of the nominal current
HiTapPos	Highest tap position since last reset
HiTrgLev	High (positive) trigger level
HiVRtg	Rated voltage (high voltage level)
HKf	Phase-related K factor for A, B, C
HorInsol	Total horizontal insolation [usually in W/m^2]
HorWdDir	Horizontal wind direction
HorWdSpd	Average horizontal wind speed [usually in m/s]
HPhV	Sequence of harmonics or interharmonics for phase to ground voltages AN, BN, CN, NG
HPPV	Sequence of harmonics or interharmonics for phase to phase voltage AB, BC, CA
HPTmpAlm	Hot point temperature alarm (FALSE = normal, TRUE = high)
HPTmpClc	Calculated winding hotspot temperature
HPTmpOp	Winding hotspot temperature operates (could be used to trip a XCBR via a LN PTRC)
HPTmpTr	TRUE = indicates that a trip has occurred due to winding hotspot temperature
HRmsA	Phase-related current RMS harmonic or interharmonics (un-normalized total harmonic distortion, Thd) for A, B, C, N
HRmsPhV	Phase to ground voltage RMS harmonic or interharmonic (un-normalized Thd) for AN, BN, CN, NG
HRmsPPV	Phase to phase voltage RMS harmonic or interharmonic (un-normalized Thd) for AB, BC, CA
HTdf	Phase-related transformer derating factor for A, B, C
HTif	Phase-related voltage telephone influence factor, method 1, 2, 3, …
HTsW	Phase-related total phase harmonic or interharmonic active power (no fundamental) signed sum for A, B, C
HTuW	Phase-related total phase harmonic or interharmonic active power (no fundamental) unsigned sum for A, B, C
HVA	Phase-related sequence of harmonics or interharmonics apparent power for A, B, C
HVAr	Phase-related sequence of harmonics or interharmonics reactive power for A, B, C
HVStr	When the third harmonic phase voltage measurement exceeds this value, the PHIZ protection control operation is initiated.
HW	Phase-related sequence of harmonics or interharmonics active power for A, B, C
HydPH	Acidity of water (0-14)
HyPres	Actual pressure of the energy transferring medium in %, where 100 % corresponds to rated value and 0 % to block value
HyTmp	Actual temperature of the energy transferring medium (usually in °C)
Hz	The frequency of a power system in Hz
Hz1Clc	Frequency f1 at side 1 of the breaker. The side is not standardized; Common use: f1 = reference voltage or running voltage.
Hz2Clc	Frequency f2 at side 2 of the breaker. D50
HzAdj	This data object allows to switch on/off the frequency matching function of an automatic synchronizer. TRUE = ON; FALSE = OFF
HzChr	Frequency adjustment characteristic: definition of the rate of change of the governor (speed controller). The value is 1/s.
HzInd	This data object indicates whether the frequency difference (between the to voltages to be synchronised) is within the set limits or not. FALSE = value within the limits; TRUE = value outside the limits.
HzChr	Frequency adjustment characteristic

Data object name	Semantics
HzIntvTms	Frequency adjustment pulse interval
HzRtg	Rated frequency, intrinsic property of the device, which cannot be set/changed from remote
HzSet	Setting of a frequency
HzTgtVal	Since frequency difference Δf and phase angle difference α are depending on each other (da/dt ~ Δf), the phase angle difference becomes constant in case of $\Delta f = 0$. Therefore, the target value of the frequency matcher is usually not 0. This data object allows to adjust manually the target value of the frequency matcher.
HzVaMag	Frequency variation magnitude of the last completed event
HzVaTm	Frequency variation duration of the last completed event
IAct	Integral action
ILim	Anti-windup integral limit. This parameter limits the absolute value of the integral term in case the loop is temporarily broken.
ImbA	Deviation from the average phase current. *ImbA.phsX* = $\lvert I_x - I_{ave} \rvert$ with $I_{ave} = (1/3) \times (I_A + I_B + I_C)$
ImbNgA	Current imbalance negative sequence method. *ImbNgA* = I_2 / I_1
ImbNgV	Voltage imbalance negative sequence method. *ImbNgV* = V_2 / V_1
ImbPPV	Deviation from the average phase-to-phase voltage. *ImbPPV.phsXY* = $\lvert V_{XY} - PPV_{ave} \rvert$ with $PPV_{ave} = (1/3) \times (V_{ab} + V_{bc} + V_{ca})$
ImbV	Deviation from the average phase-to-neutral voltage. *ImbV.phsX* = $\lvert V_X - V_{ave} \rvert$ with $V_{ave} = (1/3) \times (V_{an} + V_{bn} + V_{cn})$
ImbZroA	Current imbalance zero sequence method. *ImbZroA* = I_0 / I_1
ImbZroV	Voltage imbalance zero sequence method. *ImbZroV* = V_0 / V_1
Imp	Impedance
Ina	Number of associations terminated due to inactivity
IncTrk	Control service tracking for controllable integer
Ind	General indication. It can be multiple in one LN-instance
Incr	Increment of position change for open / close commands
Iner	Synchronous machine moment of inertia J [kgm^2]
IntrDetMth	Voltage interruption detection method is the method used to detect the interruption condition based on measured or calculated voltages, currents or the status of the breaker auxiliary contacts. **Voltage interruption detection method** / **Value** Voltage: 1 Voltage and current: 2 Voltage and normally open breaker contact: 3 Voltage and normally closed breaker contact: 4 Voltage and both normally open and normally closed breaker contacts: 5 Normally open breaker contact: 6 Normally closed breaker contacts: 7 Both normally open and normally closed breaker contacts: 8
InhTmm	Time setting for restart inhibition (min). Once the StrInh is activated, the motor should not be allowed to start until this time has elapsed.
InLog	Reference to data object for archiving
InOv	Input communications buffer overflow
InRef	Reference to the data object what is binded to this input
InTrg	Reference to trigger for archiving
InsAlm	TRUE = provides an alarm after a pre-set limit is reached, for example low insulation level. Setting of the limits is a local issue and depends on the supervised media property. An appropriate action may be to refill the insulation medium.

Data object name	Semantics
InsBlk	TRUE = block the operation of the isolated device when the level is reached where operation is not safe anymore. Setting of the limits is a local issue and depends on the supervised media property.
InsLevMax	TRUE = Insulation medium level has reached predetermined maximum level, mainly used for the filling process
InsLevMin	TRUE = Insulation medium level has dropped to a predetermined minimum level, mainly used for the filling process
InsTr	TRUE = The insulation of the device is not guaranteed anymore. The device has to switch off from the power system, i.e. it has to be isolated by tripping the surrounding breakers. Setting of the limits is a local issue and depends on the supervised media property.
InSyn	Object reference to the source of the external synchronization signal for the calculation interval
IntrStrVal	The voltage interruption set point. When the measured voltage goes below this value.
IntIn	Integer status input used for generic I/O
ISCSO	Generic integer control output. It can be multiple in one LN-instance
IscTrk	Control service tracking for integer controls step position information
ITmms	Integral time (ms)
K0Fact	K_0 is zero sequence compensation factor = $(Z_0 – Z_1)/3Z_1$ where Z_0 is zero sequence impedance, and Z_1 is positive sequence impedance
K0FactAng	Residual compensation factor angle for K_0
KckPls	The kicker pulse is a kind of frequency adjusting pulse, that may be issued if frequency difference is very small in order to achieve phase coincidence between the two voltages. With this data object, the kicker pulse function may be switched on or off. TRUE = ON; FALSE = OFF.
KD	Derivative gain
KI	Integral gain
KLd	Filter constant K lead
KLg	Filter constant K lag
KP	Proportional gain
LCoI	Lower arc suppression coil position (Petersen coil)
LastStNum	Last state number of received GOOSE telegram
LDC	Line drop compensation. LDC is R&X or Z model TRUE = R&X, FALSE = Z
LDCR	Line drop voltage due to line resistance component (FPF presumed) at rated current
LDCX	Line drop voltage due to line reactance component (FPF presumed) at rated current
LDCZ	Line drop voltage due to line total impedance (FPF presumed) at rated current
LEDRs	Resets all light emitting diodes, true causes reset to occur
Lev	Level of insulating medium or water level [m]
LevPct	Level in the tank (as percentage of full tank level)
LevMod	Internal trigger mode for disturbance recording. **Internal trigger mode** / **Value** Positive or rising / 1 Negative or falling / 2 Both / 3 Other / 4 The disturbance recorder trigger mode is defined by TrgMod. LevMod exists both for the disturbance recorder as a whole (RDRE) and for each of its individual channels (RADR, RBDR). The interaction of both is determined by the individual disturbance recorder.
LHz	TRUE = lower frequency, FALSE = no action
LimAOv	Current limit for overflow blocking
LimLodA	The data object LodA current (percent) above which automatic commands suspended

<table>
<tr><th>Data object name</th><th>Semantics</th></tr>
<tr><td>LimVOv</td><td>Voltage limit for overflow blocking</td></tr>
<tr><td>LinAng</td><td>Line angle is the feeder/line impedance angle</td></tr>
<tr><td>LinCapac</td><td>Capacitance of the line</td></tr>
<tr><td>LinLenKm</td><td>The length of the line in km</td></tr>
<tr><td>LivBusVal</td><td>Live bus value: minimum value at which the bus voltage is still recognised as live</td></tr>
<tr><td>LivBusVal</td><td>Voltage setting used to detect live bus, for example for auto reclosing</td></tr>
<tr><td>LivDeaMod</td><td>Live dead mode of operation under which switching may be carried out
<table>
<tr><th>Live dead mode</th><th>Value</th></tr>
<tr><td>Dead line, dead bus</td><td>1</td></tr>
<tr><td>Live line, dead bus</td><td>2</td></tr>
<tr><td>Dead line, live bus</td><td>3</td></tr>
<tr><td>Dead line, dead bus OR
Live line, dead bus</td><td>4</td></tr>
<tr><td>Dead line, dead bus OR
Dead line, live bus</td><td>5</td></tr>
<tr><td>Live line, dead bus OR
Dead line, live bus</td><td>6</td></tr>
<tr><td>Dead line, dead bus OR
Live line, dead bus OR
Dead line, live bus</td><td>7</td></tr>
</table></td></tr>
<tr><td>LivLinVal</td><td>Live line value: minimum value at which the line voltage is still recognised as live</td></tr>
<tr><td>LoBatVal</td><td>Low battery alarm value</td></tr>
<tr><td>LocKey</td><td>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 object indicates the switchover between local and remote operation; local = TRUE, remote = FALSE.</td></tr>
<tr><td>Loc</td><td>This data object describes the control behaviour of the related LN. (FALSE = not allowed at this level, TRUE = allowed at this level). (See also Annex B).</td></tr>
<tr><td>LocbTrk</td><td>Access service tracking for Log control block</td></tr>
<tr><td>LoColPos</td><td>Low position of a suppression coil</td></tr>
<tr><td>LoCtlV</td><td>Lowest control voltage since last reset</td></tr>
<tr><td>LocSta</td><td>Control authority at station level (see Loc). Switch between station and higher level. TRUE = command allowed at station level, but not from remote, FALSE = command is allowed from remote.</td></tr>
<tr><td>LodA</td><td>Load side current of transformer</td></tr>
<tr><td>LodFact</td><td>Load factor (apparent power / rated power) of a transformer</td></tr>
<tr><td>LodRsvAlm</td><td>Load reserve to alarm</td></tr>
<tr><td>LodRsvTr</td><td>Load reserve to trip</td></tr>
<tr><td>LogRef</td><td>Reference to Log</td></tr>
<tr><td>LogTrg</td><td>TriggerLogging by operator</td></tr>
<tr><td>LokRotTms</td><td>Locked rotor time (s). This time is the permissible locked rotor time during start-up.</td></tr>
<tr><td>LoLim</td><td>Low limit reached (input signal equal to or below limit)</td></tr>
<tr><td>LoLimSpt</td><td>Minimum limit setpoint</td></tr>
<tr><td>LoSet</td><td>Low operate value, percentage of the nominal current</td></tr>
<tr><td>LosFact</td><td>Loss factor (tan delta)</td></tr>
<tr><td>LosOil</td><td>TRUE = indicates that a loss of oil has been detected.</td></tr>
<tr><td>LosVac</td><td>TRUE = indicates when vacuum drops below a predetermined level</td></tr>
<tr><td>LoTapPos</td><td>Lowest tap position since last reset</td></tr>
<tr><td>LoTrgLev</td><td>Low (negative) trigger level</td></tr>
<tr><td>LoVRtg</td><td>Rated voltage (low voltage level)</td></tr>
<tr><td>LTCBlk</td><td>TRUE = block (inhibit) automatic control of LTC blocked (inhibited)</td></tr>
</table>

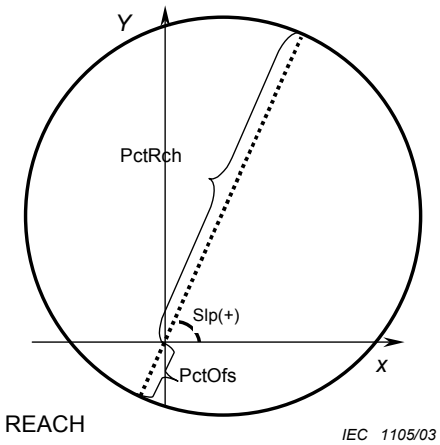
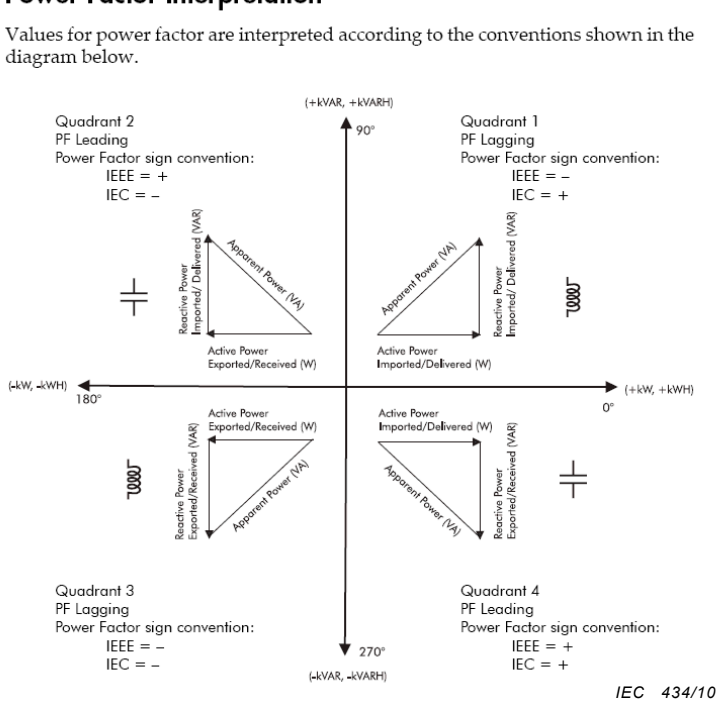
Data object name	Semantics
LTCDragRs	TRUE = reset LTC drag hands (high and low positions to present position)
LV	TRUE = lower voltage, FALSE = no action
MaxAmps	Maximum current in a defined evaluation interval (period)
MaxAPhs	Maximum magnitude of current of the 3 phases. Max(Ia,Ib,Ic)
MaxATrs	Maximum current transient value
MaxAVa	Maximum unbalance deviation value
MaxCyc	Maximum number of allowed cycles for any cyclic process, e.g. used for the autorecloser
MaxDlTmms	Operation instant difference (between intended and performed operation)
MaxEna	Monitoring of current exceeding a set value is enabled (TRUE) in order to detect a fault condition during power swing in the system
MaxFwdAng	Maximum phase angle in forward direction
MaxHzTmms	Maximum frequency adjustment pulse time. The value is used to define a maximum pulse length, limiting the calculated variable pulse time.
MaxImbA	Maximum deviation from the average current. Max(Idev_a,Idev_b,Idev_c)
MaxImbPPV	Maximum deviation from the average phase-to-phase voltage. MaxImbPPV = Max(PPVdev_a,PPVdev_b,PPVdev_c)
MaxImbV	Maximum deviation from the average phase-to-neutral voltage. MaxImbV = Max(Vdev_a,Vdev_b,Vdev_c)
MaxNumRcd	Maximum number of records that can be recorded
MaxNumStr	Setting for the maximum number of starts. This data object is also used for the permissible number of cold starts. For example, the motor manufacturer may state that three starts at the maximum are allowed within 1 h. These parameters are intended for this. So MaxNumStr is set to 3 and MaxStrTmm is set to 60 (min).
MaxOpCap	This data object shall provide the information of the operation capability available when the switch mechanism is fully charged. The maximum operating capability gives the information about the max number of close-open cycles to be performed. For example when one Close-Open-cycle can be performed then MaxOpCap equals 1.
MaxOpTmm	Maximum operation time in minutes
MaxOpTmms	The data object maximum operating time in ms for the LN is used for co-ordinating action of the related function
MaxPFPhs	Maximum magnitude of power factor of the 3 phases. Max(PFa, PFb, PFc)
MaxPhVPhs	Maximum magnitude of phase to reference voltage of the 3 phases. Max(PhVa, PhVb, PhVc)
MaxPPVPhs	Maximum magnitude of phase to phase voltage of the 3 phases. Max(PPVa, PPVb, PPVc)
MaxPwr	Maximum permissible permanent power (overload) [W]
MaxRvAng	Maximum phase angle in reverse direction
MaxStrTmm	The time period in which the maximum number of starts is allowed
MaxTmms	Maximum time after fault detection during which autoreclosing is permitted
MaxVA	Maximum apparent power in a defined evaluation interval (period)
MaxVAPhs	Maximum magnitude of apparent power of the 3 phases. Max(VAa, VAb, VAc)
MaxVAr	Maximum reactive power in a defined evaluation interval (period)
MaxVArPhs	Maximum magnitude of reactive power of the 3 phases. Max(VAra, VArb, VArc)
MaxVolts	Maximum voltage in a defined evaluation interval (period)
MaxVSyn	Maximum voltage for live synchronisation
MaxVTmms	Maximum voltage adjustment pulse time: the value is used to define a maximum pulse length, limiting the calculated variable pulse time

Data object name	Semantics
MaxVTrs	Maximum voltage transient value
MaxVVa	Maximum unbalance deviation value
MaxW	Maximum active power in a defined evaluation interval (period)
MaxWPhs	Maximum magnitude of active power of the 3 phases. Max(Wa, Wb, Wc)
MaxWrmStr	Permissible number of warm starts, in most cases cold starts – 1
MaxZPhs	Maximum magnitude of impedance of the 3 phases. Max(Za, Zb, Zc)
MbrAlm	Leakage supervision alarm of tank conservator membrane
MechHealth	Supervision has detected an abnormal condition of the mechanical chain, derived for example from travel curve or operating times. The values are the same as for the health.
MemClr	TRUE = clear memory
MemFull	This data object is the percentage at which to indicate memory is full.
MemOv	TRUE = memory overflow has occurred
MemRs	TRUE = resetting the memory in the recorder
MemUsed	Percentage of storage memory in use
MinAmps	Minimum current in a defined evaluation interval (period)
MinAPhs	Minimum magnitude of current of the 3 phases. Min(Ia,Ib,Ic)
MinFwdAng	Minimum phase angle in forward direction
MinHzTmms	Minimum frequency adjustment pulse time: the value is used to define a minimum pulse length, limiting the calculated variable pulse time. In case of constant pulse length, this value may be used to define the pulse length.
MinOpTmm	Minimum operation time in minutes
MinOpTmms	The data object minimum operating time in ms for the LN is used for co-ordinating with older electromechanical relays
MinPFPhs	Minimum magnitude of power factor of the 3 phases. Min(PFa, PFb, PFc)
MinPhVPhs	Minimum magnitude of phase to reference voltage of the 3 phases. Min(PhVa, PhVb, PhVc)
MinPPV	Minimum phase to phase voltage
MinPPVPhs	Minimum magnitude of phase to phase voltage of the 3 phases. Min(PPVa, PPVb, PPVc)
MinRvAng	Minimum phase angle in reverse direction
MinVA	Minimum apparent power in a defined evaluation interval (period).
MinVAPhs	Minimum magnitude of apparent power of the 3 phases. Min(VAra, VArb, VArc)
MinVAr	Minimum reactive power in a defined evaluation interval (period)
MinVArPhs	Minimum magnitude of reactive power of the 3 phases. Min(VAra, VArb, VArc)
MinVolts	Minimum voltage in a defined evaluation interval (period)
MinVSyn	Minimum voltage for live synchronisation
MinVTmms	Minimum voltage adjustment pulse time: the value is used to define a minimum pulse length, limiting the calculated variable pulse time. In case of constant pulse length, this value may be used to define the pulse length.
MinW	Minimum real power in a defined evaluation interval (period)
MinWPhs	Minimum magnitude of active power of the 3 phases. Min(Wa, Wb, Wc)
MinZPhs	Minimum magnitude of impedance of the 3 phases. Min(Za, Zb, Zc)

Data object name	Semantics
MltCmd	Multiple command generation (TRUE = multiple command). Used to distinguish between single command and multiple command modes of an automatic synchroniser. With this data object it can be selected whether the synchroniser should only give one command within a synchronising attempt, or it should always give a command if all conditions are fulfilled. TRUE = multiple commands allowed; FALSE = single command only.
Mod	Controllable data to change the behaviour of the LN by the operator (see Annex A)
MltLev	Select mode of authority for local control (True – control from multiple levels is allowed, False (default) – no other control level allowed)
MotA	Motor current (usually displayed in A)
MotAlm	TRUE = motor operating time exceeded
MotStrNum	Alarm level for motor run time in s
MotAlmTms	Alarm level for number of motor starts
MotDrvA	Motor drive current
MotDrvBlk	Motor drive overcurrent blocking t
MotOp	TRUE = motor is running
MotStr	I-Motor startup threshold. This value identifies a motor starting condition.
MotStrAlm	TRUE = motor starts limit exceeded
MotStrTms	Time interval for acquisition of motor starts
MotTm	Motor operating time of the last charging operation (usually displayed in s)
MstAlm	Moisture alarm (FALSE = normal, TRUE = high moisture)
MstWrn	Moisture warning (moisture has reached the warning level)
MsvcbTrk	Access service tracking for multicast sampled values control block
Mvm	Valve is moving
N2ppm	Measurement of N2 in ppm
NamPlt	This is the name plate of the logical node
NeutAlm	TRUE = neutral alarm is present
NgEna	Monitoring of negative sequence current is enabled (TRUE) in order to detect an unbalanced fault condition during power swing in the system.
NOxEms	NO_x emissions
NomA	Normalising demand current used in IEEE 519 TDD calculation
NQS	Average partial discharge current
NumCntRs	Number of times a counter is reset
NumCyc	Number of cycles of the basic frequency
NumPwrUp	The number of power up operations of the physical device since the last reset
NumRcd	Actual number of records
NumSubIntv	The number of sub-intervals a calculation period interval duration contains
O2CmbuGas	Oxygen in combustion gases
O2ppm	Measurement of O_2 in ppm
O3Air	Ozone in air
Ofs	Offset, for analogue values, the offset from zero of the analogue value
OilFil	TRUE = oil filtration is operational/running
OilMotA	Oil circulation motor drive current
OilTmpIn	Oil temperature cooler in
OilTmpOut	Oil temperature cooler out
OilTmpSet	Set point for oil temperature
OoStep	Out of step alarm: supervision of selector switch synchronism

Data object name	Semantics
Op	Operate (common data classes ACT) indicates the trip decision of a protection function (LN). The trip itself is issued by PTRC.
OpAlmTmh	Alarm limit for operation time in hours
OpAlmNum	Alarm limit for number of operations
OpCls	Operation close switch. OpCls shall be used if no control service is available between CSWI and XCBR and the GOOSE is used instead.
OpCnt	This data object represents a count of operations that is not resettable. In general, this type of counter is included in the following LNs: XCBR, XSWI, and YLTC. The counter shall not be reset from remote but maybe from local.
OpCntAlm	TRUE = number of operations has exceeded the alarm limit
OpCntRs	This data object represents a resettable LN operations counter. The use of the CDC INC permits setting the counter to something other than “0”.
OpCntWrn	TRUE = number of operations has exceeded the warning limit
OpDlTmms	Time delay in milliseconds before operating once operate conditions have been met
OpCtl	Command to operate a device (motor, pump, fan or similar) that will continue running until the command is negated
OpEx	Trip of a breaker failure function to a circuit breaker other than the faulty one to switch off the “rid fault (“external trip”)
OpIn	Retrip of a breaker failure function after a trip of a protection function was not successful (“internal trip”)
OpModRect	This data is used to define what mode a controllable rectifier shall operate in. **Operating mode of rectifier** / **Value** Current control mode / 1 Voltage control mode / 2 Active power control mode / 3
OpModSyn	This data object may be used to select the operating mode: **Operating mode for synchronizer** / **Value** Automatic synchronising mode / 1 Automatic paralleling mode / 2 Manual mode / 3 Test mode / 4 Description of the different values: 1 Synchroniser matches voltage and frequency and closes the circuit breaker automatically 2 Synchroniser closes the circuit breaker automatically 3 Synchroniser releases an external paralleling command (continuous mode) 4 Synchroniser does not send a closing command to the circuit breaker
OpnLim	Open position limitation, temporary limitation of maximum opening of valve, actuator or other device
OpNoLod	TRUE = provides indication that power system devices is operating with no load
OpnPos	Open end position reached (valve cannot move further)
OpOpn	Operation open switch. OpOpn shall be used if no control service is available between CSWI and XCBR and the GOOSE is used instead
OpOvA	TRUE = device is operating under an overcurrent condition
OpOvExt	TRUE = device operating in an over excited condition
OpOvV	TRUE = device is operating under an overvoltage condition
OpSar	TRUE = surge arrestor operation detected
OpSpdCls	Operation speed of main contact during close operation (usually displayed in m/s)
OpSpdOpn	Operation speed of main contact during open operation (usually displayed in m/s)
OpTmAlm	TRUE = Switch operating time exceeded
OpTmCls	Operation timing of main contact during close operation (usually displayed in ms).

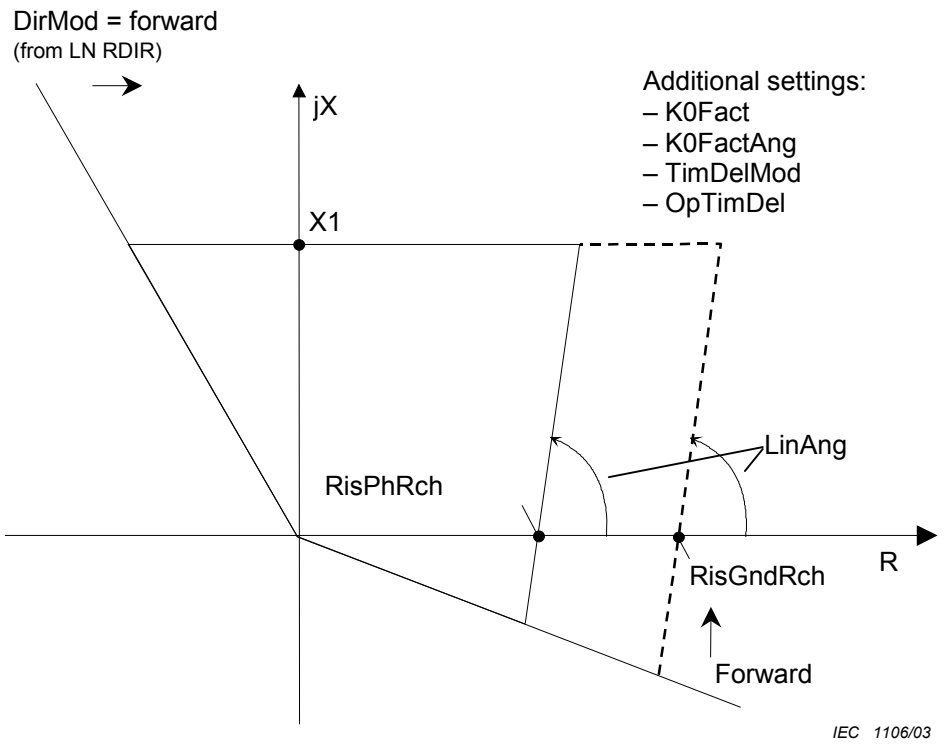
<table>
<tr><th>Data object name</th><th>Semantics</th></tr>
<tr><td>OpTmh</td><td>This data object indicates the operation time in hours of a physical device since start of the operation. Details are LN specific.</td></tr>
<tr><td>OpTmOpn</td><td>Operation timing of main contact during open operation (usually displayed in ms)</td></tr>
<tr><td>OpTmWrn</td><td>TRUE = operation time of a physical device exceeds the warning limit</td></tr>
<tr><td>OpUnExt</td><td>TRUE = device operated in an under-excited condition</td></tr>
<tr><td>OpUnV</td><td>TRUE = device operating in an under voltage condition</td></tr>
<tr><td>OpWrnTmh</td><td>Warning limit for operation time in hours</td></tr>
<tr><td>OpWrnNum</td><td>Warning limit for number of operations</td></tr>
<tr><td>Out</td><td>Analogue output of the function</td></tr>
<tr><td>OutOv</td><td>This data object indicates that a buffer overflow occurred for the output buffer and important annunciation’s may be lost (TRUE) for the communication. A general interrogation is recommended or an integrity scan is started automatically.</td></tr>
<tr><td>OvHzStr</td><td>Start (overfrequency variation event in progress)</td></tr>
<tr><td>OvHzStrVal</td><td>Overfrequency set point</td></tr>
<tr><td>OvlTm</td><td>Calculated maximum permissible overload time with cooling unit [min]</td></tr>
<tr><td>OvlTEmg</td><td>Calculated maximum permissible overload time without cooling unit (emergency case) [min]</td></tr>
<tr><td>OvlTmSpt</td><td>Maximum permissible overload time with cooling unit [min]</td></tr>
<tr><td>OvlTEmgSpt</td><td>Maximum permissible overload time without cooling unit (emergency case) [min]</td></tr>
<tr><td>OvStkCls</td><td>The movement of the main contact during a close operation, which is over the end position (usually displayed in mm)</td></tr>
<tr><td>OvStkOpn</td><td>The movement of the main contact during an open operation, which is over the end position (usually displayed in mm)</td></tr>
<tr><td>PAct</td><td>Proportional action</td></tr>
<tr><td>PaDschAlm</td><td>TRUE = Partial discharge has reached pre-set alarm level</td></tr>
<tr><td>ParOp</td><td>Transformers or suppression coils are operating in parallel.</td></tr>
<tr><td>ParColMod</td><td>Mode of parallel operation of petersen coil (controllable)
<table>
<tr><th>Mode of parallel operation</th><th>Value</th></tr>
<tr><td>Master/slave</td><td>1</td></tr>
<tr><td>Master/slave with fixed slave position</td><td>2</td></tr>
<tr><td>Master/slave with variable slave position</td><td>3</td></tr>
<tr><td>Parallel operation without communication</td><td>4</td></tr>
</table></td></tr>
<tr><td>ParMod</td><td>Set current regulator mode during control (master, slave, independent)</td></tr>
<tr><td>ParTraMod</td><td>Parallel transformer mode. Defined values are:
<table>
<tr><th>Mode of parallel operation</th><th>Value</th></tr>
<tr><td>No mode predefined</td><td>1</td></tr>
<tr><td>Master</td><td>2</td></tr>
<tr><td>Follower</td><td>3</td></tr>
<tr><td>Power factor</td><td>4</td></tr>
<tr><td>Negative reactance</td><td>5</td></tr>
<tr><td>Circulating current</td><td>6</td></tr>
<tr><td>Circulating reactive current (var balancing)</td><td>7</td></tr>
<tr><td>Circulating reactive current by equalizing calculated transformer power factor</td><td>8</td></tr>
</table></td></tr>
<tr><td>PartSens</td><td>Sensitivity to particulates</td></tr>
</table>

<table>
<tr><th>Data object name</th><th>Semantics</th></tr>
<tr><td>PctOfs</td><td>Distance characteristic offset in percent of the line length.
 
</td></tr>
<tr><td>PctRch</td><td>Distance characteristic reach in percent of the line length; see curve in PctOfs</td></tr>
<tr><td>PerTrgTms</td><td>Periodic trigger time in s</td></tr>
<tr><td>PF</td><td>Phase to ground power factor for phases 1, 2, and 3, including angle</td></tr>
<tr><td>PFRtg</td><td>Rated power factor</td></tr>
<tr><td>PFSign</td><td>Specification of the power factor sign according a certain standard. Two possible values:
<table>
<tr><th>PFSign</th><th>Value</th></tr>
<tr><td>Active power (usually named IEC)</td><td>1</td></tr>
<tr><td>Lead/Lag (usually named IEEE)</td><td>2</td></tr>
</table>
For explanations, see the following picture.

</td></tr>
<tr><td>PhAng</td><td>Phase angle of LodA relative to CtlV at 1,0 power factor, assuming forward power flow</td></tr>
<tr><td>PhDlMod</td><td>Operate time delay multiphase mode. TRUE = on, FALSE = off</td></tr>
<tr><td>PhDlTmms</td><td>Operate time delay for multiphase faults in ms</td></tr>
<tr><td>PhPcbLl</td><td>Classifier bins of last complete long interval for phase to ground (A, B, C)</td></tr>
<tr><td>PhPcbLs</td><td>Classifier bins of last complete short interval for phase to ground (A, B, C)</td></tr>
</table>

<table>
<tr><th>Data object name</th><th>Semantics</th></tr>
<tr><td>PhPdmSpec</td><td>Real time demodulated waveform spectra for phase to ground (A, B, C)</td></tr>
<tr><td>PhPdmWav</td><td>Real time demodulated waveform for phase to ground (A, B, C)</td></tr>
<tr><td>PhPiLoFil</td><td>Output 4 – 1 min average of output 5 for phase to ground measurements</td></tr>
<tr><td>PhPiMax</td><td>Output 5 – Instantaneous peak P value for phase to ground measurements</td></tr>
<tr><td>PhPiRoot</td><td>Output 3 – Square root of output 5 for phase to ground measurements</td></tr>
<tr><td>PhPlt</td><td>Long-term flicker severity of last complete interval for phase to ground measurements</td></tr>
<tr><td>PhPst</td><td>Short-term flicker severity of last complete interval for phase to ground measurements</td></tr>
<tr><td>PhStop</td><td>Phase stop value</td></tr>
<tr><td>PhStr</td><td>When the phase measurements exceed (or drop below, in the case of a dropout function) this value, the operation of the related function is initiated.</td></tr>
<tr><td>PhV</td><td>Phase to ground voltages for phases 1, 2, and 3, including angle</td></tr>
<tr><td>PhyHealth</td><td>See health in common logical node information</td></tr>
<tr><td>PhyNam</td><td>This is the name plate of the physical device</td></tr>
<tr><td>PIDAlg</td><td>PID algorithm. Possible vales are: P | I | D | PI | PD | ID | PID</td></tr>
<tr><td>PmpAlm</td><td>Loss of pump is indicated</td></tr>
<tr><td>PmpCtlGen
PmpCtl</td><td>PmpCtlGen – Control of all pumps.
PmpCtl – Control of a single pump.
<table><tr><th>Pump control</th><th>Value</th></tr><tr><td>Inactive</td><td>1</td></tr><tr><td>Stage 1</td><td>2</td></tr><tr><td>Stage 2</td><td>3</td></tr><tr><td>Stage 3</td><td>4</td></tr></table>
More stages may be added with numbers greater than 4</td></tr>
<tr><td>PmpOvCur</td><td>Pump overcurrent trip</td></tr>
<tr><td>PNV</td><td>Phase to neutral voltage in a 4-wire system as used in medium voltage networks. Sometimes named as phase to zero voltage.</td></tr>
<tr><td>PolQty</td><td>This data object indicates the reference quantity used to determine fault direction.
<table><tr><th>Polarizing quantity</th><th>Value</th></tr><tr><td>None</td><td>1</td></tr><tr><td>Zero sequence current</td><td>2</td></tr><tr><td>Zero sequence voltage</td><td>3</td></tr><tr><td>Negative sequence voltage</td><td>4</td></tr><tr><td>Phase to phase voltages (cross polarizing)</td><td>5</td></tr><tr><td>Phase to ground voltages</td><td>6</td></tr><tr><td>Positive sequence voltage</td><td>7</td></tr></table></td></tr>
<tr><td>PoRch</td><td>Polar reach is the diameter of the Mho diagram, see PctRch</td></tr>
<tr><td>Pos</td><td>This data object is accessed to verify the switch status or position.
Possible states for position are:
intermediate state | off | on | bad state.</td></tr>
<tr><td>PosA</td><td>This data object shall be used for switching, where single phase A may be operated separately.</td></tr>
<tr><td>PosB</td><td>This data object shall be used for switching, where single phase B may be operated separately.</td></tr>
<tr><td>PosC</td><td>This data object shall be used for switching, where single phase C may be operated separately.</td></tr>
<tr><td>PosChg</td><td>Change valve position (stop, raise, lower)</td></tr>
<tr><td>PosChgIncr</td><td>Incremental change of position</td></tr>
<tr><td>PosSpt</td><td>Valve position set-point</td></tr>
<tr><td>PosVlv</td><td>Valve position</td></tr>
</table>

<table>
<tr><th>Data object name</th><th>Semantics</th></tr>
<tr><td>POWCap</td><td>Point on wave switching capability.
<table><tr><th>POW switching capability</th><th>Value</th></tr><tr><td>None</td><td>1</td></tr><tr><td>Close</td><td>2</td></tr><tr><td>Open</td><td>3</td></tr><tr><td>Close and open</td><td>4</td></tr></table></td></tr>
<tr><td>PPPcbLl</td><td>Classifier bins of last complete long interval for phase to phase (AB, BC, CA)</td></tr>
<tr><td>PPPcbLs</td><td>Classifier bins of last complete short interval for phase to phase(AB, BC, CA)</td></tr>
<tr><td>PPPdmSpec</td><td>Real time demodulated waveform spectra for phase to phase (AB, BC, CA)</td></tr>
<tr><td>PPPdmWav</td><td>Real time demodulated waveform for phase to phase (AB, BC, CA)</td></tr>
<tr><td>PPPiLoFil</td><td>Output 4 – 1 min average of output 5 for phase to phase measurements</td></tr>
<tr><td>PPPiMax</td><td>Output 5 – Instantaneous peak P value for phase to phase measurements</td></tr>
<tr><td>PPPiRoot</td><td>Output 3 – Square root of output 5 for phase to phase measurements</td></tr>
<tr><td>PPPlt</td><td>Long-term flicker severity of last complete interval for phase to phase measurements</td></tr>
<tr><td>PPPst</td><td>Short-term flicker severity of last complete interval for phase to phase measurements</td></tr>
<tr><td>PPV</td><td>Phase to phase voltages</td></tr>
<tr><td>Pres</td><td>Pressure in a specific volume</td></tr>
<tr><td>PresAlm</td><td>Pressure alarm because of an abnormal condition (FALSE = normal, TRUE = alert)</td></tr>
<tr><td>PreTmms</td><td>This is the time prior to trigger for which data object is recorded when a trigger occurs</td></tr>
<tr><td>ProRx</td><td>TRUE = indicates that the protection function has received the information about a fault in forward direction from the other end of the line.</td></tr>
<tr><td>ProTx</td><td>TRUE = indicates that the protection function has detected a fault in forward direction and has transmitted this information to the other end of the line.</td></tr>
<tr><td>Proxy</td><td>TRUE = indicates that the LN (LPHD) is a proxy. This means that the LD embedding this LN is representing another physical device.</td></tr>
<tr><td>PstTmms</td><td>This is the time following the trigger that the data object capture is recorded</td></tr>
<tr><td>PwrDn</td><td>A device power down has been detected if PwrDn is TRUE</td></tr>
<tr><td>PwrFact</td><td>Power factor not allocated to a phase</td></tr>
<tr><td>PwrRtg</td><td>Rated power</td></tr>
<tr><td>PwrSupAlm</td><td>Alarm from power supply allocated to the physical device if PwrSupAlm is TRUE. May be an external contact. It refers always to the local power supply of the IED modeled by LPHD and not to the health (EEHealth) of the complete external supply system.</td></tr>
<tr><td>PwrUp</td><td>A device power up has been detected if PwrUp is TRUE</td></tr>
<tr><td>Rat</td><td>Winding ratio of an instrument transformer/transducer</td></tr>
<tr><td>RcdMade</td><td>TRUE = disturbance recording complete</td></tr>
<tr><td>RcdMod</td><td>This data object defines whether the recording will stop when the memory is full or saturated, or overwrite existing values.
<table><tr><th>Recording mode</th><th>Value</th></tr><tr><td>Overwrite existing values</td><td>1</td></tr><tr><td>Stop when full or saturated</td><td>2</td></tr></table></td></tr>
<tr><td>RcdStr</td><td>TRUE = disturbance recording processes started</td></tr>
<tr><td>RcdTrg</td><td>External command to trigger recorder (TRUE)</td></tr>
<tr><td>RclTmms</td><td>Recloser reclaim time (after successful reclose) in ms</td></tr>
<tr><td>RCol</td><td>Raise arc suppression coil position (Petersen coil)</td></tr>
<tr><td>RctTmCls</td><td>Time difference between activation to first position change for a close operation (usually displayed in ms)</td></tr>
<tr><td>RctTmOpn</td><td>Time difference between activation to first position change for an open operation (usually displayed in ms)</td></tr>
</table>

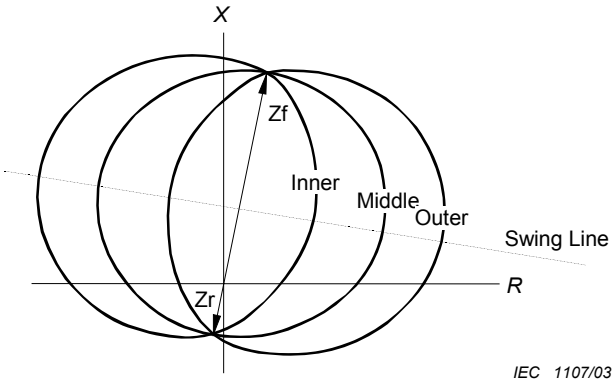
Data object name	Semantics
React	Relative capacitance of bushing related to reference capacitance for bushing at commissioning
ReactPwrL	TRUE = lower reactive power, FALSE = no action
ReactPwrR	TRUE = raise reactive power, FALSE = no action
Rec1Tmms	Reclose time for 1-phase faults i.e. time to reclose command after trip in the cycle indicated by the DO index. Multiple instances allow to set the reclose time per cycle or step.
Rec13Tmms	Reclose time for evolving faults. Multiple instances allow to set the reclose time per cycle or step.
Rec3Tmms	Reclose time for 3-phase faults. Multiple instances allow to set the reclose time per cycle or step.
RecCyc	Number of the actual recluse cycle (1 to *n*, typically *n* = 3). Default value 0 if no autoreclosing is going on.
RedChLiv	Physical channel status of redundant channel
RedFer	Frame error rate on redundant channel; count of missed messages on this channel for each 1 000 messages forwarded to the application
RedRxCnt	Number of received messages on redundant channel
RefPF	Reference power factor for bushing at commissioning
RefReact	Reference capacitance for bushing at commissioning
RefV	Reference voltage for bushing at commissioning
Rel	This data object indicates that all criteria are fulfilled and the switching/operation action is released to proceed if value is TRUE, and blocked if FALSE.
RelDeaBus	Releasing dead bus / dead line function
ReTrgMod	If the mode is true, the recorder will start a new recording if it is retriggered while still collecting samples on previous recording (during post fault time). If false, the recorder ignores the retrigger.
ReTrMod	Retrip mode **Retrip mode** / **Value** Off / 1 Without check / 2 With current check / 3 With breaker status check / 4 With current and breaker status check / 5 Other checks / 6
RHz	TRUE = raise frequency, FALSE = no action
Ris	Resistance in DC circuit

<table>
<tr><th>Data object name</th><th>Semantics</th></tr>
<tr><td>RisGndRch</td><td>Resistive reach of the quadrilateral ground distance element shown as the difference between the left and right resistive blinders in the diagram below. See also AngLod in this table.
 
</td></tr>
<tr><td>RisLod</td><td>Resistive reach for load area. See AngLod for an example of the definition of load encroachment used for the data objects AngLod and RisLod with polygonal characteristic, applicable also with MHO.</td></tr>
<tr><td>RisNgGnd</td><td>Resistance between negative pole and earth</td></tr>
<tr><td>RisPsGnd</td><td>Resistance between positive pole and earth</td></tr>
<tr><td>RisPhRch</td><td>Resistive reach of quadrilateral phase distance element; see RisGndRch</td></tr>
<tr><td>RmZer</td><td>Mutual resistance coupling from parallel line</td></tr>
<tr><td>RmpDn</td><td>Ramping rate on a downward trend</td></tr>
<tr><td>RmpUp</td><td>Ramping rate on an upward trend</td></tr>
<tr><td>RnbkRV</td><td>Runback raise voltage is the control voltage above which auto lower command issued.</td></tr>
<tr><td>RnFll</td><td>Rainfall (usually in mm)</td></tr>
<tr><td>RotDir</td><td>Rotational direction. Possible values are:
<table>
<tr><th>RotDir</th><th>Value</th></tr>
<tr><td>Clockwise (forward)</td><td>1</td></tr>
<tr><td>Counter-clockwise (reverse)</td><td>2</td></tr>
<tr><td>Unknown</td><td>3</td></tr>
</table></td></tr>
<tr><td>RPs</td><td>Positive-sequence line resistance</td></tr>
<tr><td>RsDlTmms</td><td>Time delay in ms before reset once reset conditions have been met</td></tr>
<tr><td>RsStat</td><td>This data object resets device statistics of this LN</td></tr>
<tr><td>RstA</td><td>Restraint current</td></tr>
</table>

<table>
<tr><th>Data object name</th><th>Semantics</th></tr>
<tr><td>RstMod</td><td>Identifies the restraint mode for the differential LN.
<table>
<tr><th>Restraint mode</th><th>Value</th></tr>
<tr><td>None</td><td>1</td></tr>
<tr><td>2nd harmonic</td><td>2</td></tr>
<tr><td>5th harmonic</td><td>3</td></tr>
<tr><td>2nd and 5th harmonic</td><td>4</td></tr>
<tr><td>Waveform analysis</td><td>5</td></tr>
<tr><td>2nd harmonic and waveform analysis</td><td>6</td></tr>
<tr><td>Other</td><td>7</td></tr>
<tr><td>5th harmonic and waveform analysis</td><td>8</td></tr>
<tr><td>2nd and 5th harmonic and waveform analysis</td><td>9</td></tr>
</table></td></tr>
<tr><td>RV</td><td>TRUE = raise voltage, FALSE = no action</td></tr>
<tr><td>RxBlk</td><td>Activation information RxBlk1 received from the other side(s), for logging purposes (teleprotection blocking signal received)</td></tr>
<tr><td>RxCnt</td><td>Number of received messages</td></tr>
<tr><td>RxPrm</td><td>Activation information RxPrm1 received from the other side(s), for logging purposes (Teleprotection permissive signal received)</td></tr>
<tr><td>RxSrc</td><td>Source for activation information RxPrm or RxBlk, must refer to data of type ACT</td></tr>
<tr><td>RxSrcTr</td><td>Source for activation information RxTr, must refer to data of type ACT</td></tr>
<tr><td>RxTr</td><td>Activation information RxTr1 received from the other side(s), for logging purposes (direct trip signal received)</td></tr>
<tr><td>RZer</td><td>Zero-sequence line resistance</td></tr>
<tr><td>SatCffS10</td><td>Saturation coefficient S1.0</td></tr>
<tr><td>SatCffS12</td><td>Saturation coefficient S1.2</td></tr>
<tr><td>SbsNdsCom</td><td>Subscription needs commissioning</td></tr>
<tr><td>SbsSim</td><td>Subscription with simulation</td></tr>
<tr><td>SbsSt</td><td>Status of the subscription (True = active, False = not active)</td></tr>
<tr><td>SrcRef</td><td>Reference to the IEC 61850 source data object. If this source data object has several (analogue) attributes, all shall be registered in the COMTRADE file, and an appropriate number of ChNum1 instances shall define the channel mapping to them with the number in the order of the attributes as defined in IEC 61850-7-3.</td></tr>
<tr><td>SecTmms</td><td>Pickup security timer on loss of carrier guard signal in ms</td></tr>
<tr><td>SelCls</td><td>Selection “close switch”</td></tr>
<tr><td>SelOpn</td><td>Selection “open switch”</td></tr>
<tr><td>SeqA</td><td>The absolute measured values of positive, negative and zero sequence current</td></tr>
<tr><td>SeqV</td><td>The absolute measured values of positive, negative and zero sequence voltage</td></tr>
<tr><td>SetA</td><td>Current setting for a limit in motor start-up (for example counting operate condition or thermal stress). This setting is used in motor start-up protection.</td></tr>
<tr><td>SetTms</td><td>Time setting for a limit in motor start-up (for example counting operate condition or thermal stress). This setting is used in motor start-up protection.</td></tr>
<tr><td>SgcbTrk</td><td>Access service tracking for setting group control block</td></tr>
<tr><td>ShOpCap</td><td>This is an enumeration representing the operating capabilities of the power shunt.
<table>
<tr><th>Shunt operating capability</th><th>Value</th></tr>
<tr><td>None</td><td>1</td></tr>
<tr><td>Open</td><td>2</td></tr>
<tr><td>Close</td><td>3</td></tr>
<tr><td>Open and close</td><td>4</td></tr>
</table></td></tr>
<tr><td>Sim</td><td>Simulated GOOSE values or simulated sampled measurand values will be used instead of original values since they are first received.</td></tr>
</table>

<table>
<tr><th>Data object name</th><th>Semantics</th></tr>
<tr><td>SimSt</td><td>Status showing that really Sim messages are received and accepted</td></tr>
<tr><td>Slnt</td><td>Salinity. Saline content of water [g/l]</td></tr>
<tr><td>SmokAlm</td><td>Smoke alarm</td></tr>
<tr><td>SmpRte</td><td>Sampling rate setting</td></tr>
<tr><td>SnwDen</td><td>Density of snowfall (usually in g/cm^3)</td></tr>
<tr><td>Snd</td><td>Sound pressure level</td></tr>
<tr><td>Snr</td><td>Signal to noise ratio (in dB), used in case of analogue communication</td></tr>
<tr><td>SnwTmp</td><td>Temperature of snowfall (usually in °C)</td></tr>
<tr><td>SnwCvr</td><td>Snow cover (usually in mm)</td></tr>
<tr><td>SnwFll</td><td>Snowfall (usually in mm)</td></tr>
<tr><td>SnwEq</td><td>Water equivalent of snowfall (usually in mm)</td></tr>
<tr><td>SOxEms</td><td>SO_x emissions</td></tr>
<tr><td>SPCSO</td><td>Generic single point controllable status output. It can be multiple in one LN-instance.</td></tr>
<tr><td>SpcTrk</td><td>Control service tracking for controllable single point</td></tr>
<tr><td>Spd</td><td>Rotational speed usually in 1/s</td></tr>
<tr><td>SpdCrit</td><td>Synchronous machine critical speed of the generator [s^{-1}]</td></tr>
<tr><td>SpdRtg</td><td>Synchronous machine rated speed [s^{-1}]</td></tr>
<tr><td>SpdSrfc</td><td>Surface speed of water flow (in m/s)</td></tr>
<tr><td>SpdSpt</td><td>Rotational speed setpoint</td></tr>
<tr><td>SPlTrTmms</td><td>Single pole delay time in ms before the breaker failure tries to retrip the failed breaker</td></tr>
<tr><td>SptChg</td><td>Setpoint change (raise, lower)</td></tr>
<tr><td>SptDvAlm</td><td>Deviation alarm</td></tr>
<tr><td>SptDir</td><td>Setpoint direction</td></tr>
<tr><td>SptDn</td><td>Setpoint going up (lowering)</td></tr>
<tr><td>SptEndSt</td><td>Setpoint end status
<table>
<tr><th>Setpoint end status</th><th>Value</th></tr>
<tr><td>Ended normally</td><td>1</td></tr>
<tr><td>Ended with overshoot</td><td>2</td></tr>
<tr><td>Cancelled: measurement was deviating</td><td>3</td></tr>
<tr><td>Cancelled: loss of communication with dispatch centre</td><td>4</td></tr>
<tr><td>Cancelled: loss of communication with local area network</td><td>5</td></tr>
<tr><td>Cancelled: loss of communication with the local interface</td><td>6</td></tr>
<tr><td>Cancelled: timeout</td><td>7</td></tr>
<tr><td>Cancelled: voluntarily</td><td>8</td></tr>
<tr><td>Cancelled: noisy environments</td><td>9</td></tr>
<tr><td>Cancelled: material failure</td><td>10</td></tr>
<tr><td>Cancelled: new set-point request</td><td>11</td></tr>
<tr><td>Cancelled: improper environment (blockage)</td><td>12</td></tr>
<tr><td>Cancelled: stability time was reached</td><td>13</td></tr>
<tr><td>Cancelled: immobilisation time was reached</td><td>14</td></tr>
<tr><td>Cancelled: equipment was in the wrong mode</td><td>15</td></tr>
<tr><td>Unknown causes</td><td>16</td></tr>
</table></td></tr>
<tr><td>SptMem</td><td>Setpoint in memory</td></tr>
<tr><td>SptUp</td><td>Setpoint going up (raising)</td></tr>
</table>

<table>
<tr><th>Data object name</th><th>Semantics</th></tr>
<tr><td>SptVal</td><td>Setpoint value</td></tr>
<tr><td>SptVol</td><td>Voltage setpoint</td></tr>
<tr><td>SrcRef</td><td>Reference to the IEC 61850 source data object</td></tr>
<tr><td>StatLeakX</td><td>Stator leakage reactance [per unit]</td></tr>
<tr><td>StatRisTmp</td><td>Reference temperature for stator resistance [usually °C]</td></tr>
<tr><td>StatRis</td><td>Stator resistance [ohm]</td></tr>
<tr><td>StClcTun</td><td>Result of tuning:<table><tr><th>StClcTun</th><th>Value</th></tr><tr><td>Not tuned</td><td>1</td></tr><tr><td>Tuned</td><td>2</td></tr><tr><td>Tuned but not compensated</td><td>3</td></tr><tr><td>Umax</td><td>4</td></tr><tr><td>Umax_nC (Umax- but not compensated)</td><td>5</td></tr><tr><td>Umax_not compensated due to U continous limitation</td><td>6</td></tr></table></td></tr>
<tr><td>StepNg</td><td>Step size when turning from positive to negative direction</td></tr>
<tr><td>StepPs</td><td>Step size when turning from negative to positive direction</td></tr>
<tr><td>Stk</td><td>Stroke of the last operation defined as distance between start and end position of the main contact or at the place of travel measurement (usually displayed in mm)</td></tr>
<tr><td>StoRte</td><td>Storage rate (often called sampling rate) of the disturbance recorder in samples per millisecond (ms)</td></tr>
<tr><td>Str</td><td>Start (common data classes ACD) indicates the detection of a fault or an unacceptable condition. Str may contain phase and directional information.</td></tr>
<tr><td>StrClc</td><td>Start calculation sequence to estimate the parameters of a network. In compensated networks, this can be done either by variating the suppression coil (Petersen coil) or with an current injection in the neutral point of the system.</td></tr>
<tr><td>StrCrv</td><td>Start level curve</td></tr>
<tr><td>StrDlTmms</td><td>Start delay time</td></tr>
<tr><td>StrInh</td><td>Status information restart inhibited. After a limit is reached (for example maximum number of starts or permissible temperature), restart inhibit is activated.</td></tr>
<tr><td>StrInhTmm</td><td>Time setting for restart inhibition. Once the StrInh is activated, the motor should not be allowed to start until this time has elapsed.</td></tr>
<tr><td>StrPOW</td><td>TRUE = start CPOW (for example by select) – Request by CSWI or RREC</td></tr>
<tr><td>StrVal</td><td>Level of the supervised value, which starts a dedicated action of the related function</td></tr>
<tr><td>StrWeekDay</td><td>Day of the start of the local week for statistical calculation.<table><tr><th>StrWeekDay</th><th>Value</th></tr><tr><td>Monday (default)</td><td>1</td></tr><tr><td>Tuesday</td><td>2</td></tr><tr><td>Wednesday</td><td>3</td></tr><tr><td>Thursday</td><td>4</td></tr><tr><td>Friday</td><td>5</td></tr><tr><td>Saturday</td><td>6</td></tr><tr><td>Sunday</td><td>7</td></tr></table></td></tr>
<tr><td>Stuck</td><td>Valve is blocked (cannot move from present position). Device is blocked through external influence (can not operate or move).</td></tr>
<tr><td>SumSwARs</td><td>Sum of switched amperes, resettable. This data object indicates the sum or integration of all switched currents since the last reset of the counter, for example after maintenance of the contacts, the nozzle and other aging parts.</td></tr>
<tr><td>SupVArh</td><td>Reactive energy supply (default supply direction: energy flow towards busbar)</td></tr>
<tr><td>SupWh</td><td>Real energy supply (default supply direction: energy flow towards busbar)</td></tr>
</table>

<table>
<tr><th>Data object name</th><th>Semantics</th></tr>
<tr><td>SvcViol</td><td>Service violation: the data object that the client wanted to access exists in the access view for the association with that client, but the requested service is not allowed.</td></tr>
<tr><td>SwArcDet</td><td>TRUE = alarm that switch arc has been detected</td></tr>
<tr><td>SwgReact</td><td>Value of the power swing reactance band, see figure under SwgVal</td></tr>
<tr><td>SwgRis</td><td>Value of the power swing resistance band, see figure under SwgVal</td></tr>
<tr><td>SwgTmms</td><td>Power swing detection time in ms</td></tr>
<tr><td>SwgVal</td><td>Value of the power swing band.
 
</td></tr>
<tr><td>SwOpCap</td><td>This is an enumeration representing the physical capabilities of the switch to operate. It includes additional blocking due to some local problems.

<table>
<tr><th>Switch operating capability</th><th>Value</th></tr>
<tr><td>None</td><td>1</td></tr>
<tr><td>Open</td><td>2</td></tr>
<tr><td>Close</td><td>3</td></tr>
<tr><td>Open and close</td><td>4</td></tr>
</table></td></tr>
<tr><td>SwTyp</td><td>
<table>
<tr><th>Switch type</th><th>Value</th></tr>
<tr><td>Load break switch</td><td>1</td></tr>
<tr><td>Disconnector</td><td>2</td></tr>
<tr><td>Earthing switch</td><td>3</td></tr>
<tr><td>High speed earthing switch</td><td>4</td></tr>
</table></td></tr>
<tr><td>SynPrg</td><td>Synchrocheck / Synchronizing in progress. Start/ Stop Synchrocheck/Synchronizing</td></tr>
<tr><td>TnkTyp</td><td>Type of tank (pressure only, level only, both pressure and level)</td></tr>
<tr><td>TapBlkL</td><td>Tap position of load tap changer where automatic lower commands blocked</td></tr>
<tr><td>TapBlkR</td><td>Tap position of load tap changer where automatic raise commands blocked</td></tr>
<tr><td>TapChg</td><td>This data object represents the control of a process to raise or lower a single step or tap</td></tr>
<tr><td>TapOpR</td><td>Change tap position raise (shall be used if no control service is available and the GOOSE is used instead)</td></tr>
<tr><td>TapOpL</td><td>Change tap position lower (shall be used if no control service is available and the GOOSE is used instead)</td></tr>
<tr><td>TapOpStop</td><td>Change tap position stop (shall be used if no control service is available and the GOOSE is used instead)</td></tr>
<tr><td>TapPos</td><td>Represents the discrete adjustment of a transformer such as used in a load tap changer to a specified tap position</td></tr>
<tr><td>TddA</td><td>Current total demand distortion (according to IEEE 519, phase-related)</td></tr>
<tr><td>TddAmp</td><td>Current total demand distortion (according to IEEE 519, non-phase-related)</td></tr>
<tr><td>TddEvnA</td><td>Current total demand distortion (according to IEEE 519, even components, phase-related)</td></tr>
<tr><td>TddEvnAmp</td><td>Current total demand distortion (according to IEEE 519, even components, non-phase-related)</td></tr>
</table>

Data object name	Semantics
TddOddA	Current total demand distortion (according to IEEE 519, odd components, phase-related)
TddOddAmp	Current total demand distortion (according to IEEE 519, odd components, non-phase-related)
TestRsl	Test results value is TRUE if passed and FALSE if failed
ThdA	Current total harmonic or interharmonic distortion (different methods, phase-related)
ThdAmp	Current total harmonic or interharmonic distortion (different methods, non-phase-related)
ThdATmms	Total harmonic or interharmonic distortion current alarm delay time in ms after the ThdAVal has been exceeded
ThdAVal	Total harmonic or interharmonic distortion amperes alarm setting – value entered in %. Thd values above this threshold cause an alarm.
ThdEvnA	Current total harmonic or interharmonic distortion (even components, phase-related)
ThdEvnAmp	Current total harmonic or interharmonic distortion (different methods, even components, non-phase-related)
ThdEvnPhV	Phase to ground voltage total harmonic or interharmonic distortion (different methods, even components, phase-related)
ThdEvnPPV	Phase to phase voltage total harmonic or interharmonic distortion (different methods, even components, phase-related)
ThdEvnVol	Phase voltage total harmonic or interharmonic distortion (different methods, even components, non-phase-related)
ThdOddA	Current total harmonic or interharmonic distortion (different methods, odd components, phase-related)
ThdOddAmp	Current total harmonic or interharmonic distortion (different methods, odd components, non-phase-related)
ThdOddPhV	Phase to ground voltage total harmonic or interharmonic distortion (different methods, odd components, phase-related)
ThdOddPPV	Phase to phase voltage total harmonic or interharmonic distortion (different methods, odd components, phase-related)
ThdOddVol	Phase to ground voltage total harmonic or interharmonic distortion (different methods, odd components, non-phase-related)
ThdPhV	Phase to ground voltage total harmonic or interharmonic distortion (different methods, phase-related)
ThdPPV	Phase to phase voltage total harmonic or interharmonic distortion (different methods, phase-related)
ThdVol	Voltage total harmonic or interharmonic distortion (different methods, non-phase-related)
ThdVTmms	Total harmonic or interharmonic distortion voltage alarm time delay in ms after the ThdVVal has been exceeded
ThdVVal	Total harmonic or interharmonic distortion alarm setting – value entered in %. Thd values above this threshold cause an alarm.
Tm1ms	Time constant 1 [ms]
Tm1ldms	Time constant 1 (lead) [ms]
Tm2ms	Time constant 2 [ms]
Tm2ldms	Time constant 2 (lead) [ms]
Tm3ms	Time constant 3 [ms]
TmAcc	Number of significant bits in the Fraction Of Second in the time accuracy part of the time stamp. See IEC 61850-7-2.
TmAChr33	Multiline curve characteristic definition. It is not multiple instantiable within one LN instance
TmACrv	Characteristic curve for protection operation of the form: $y = f(x)$, where x is the current (A) and y is the time (Tm). The integers representing the different curves are given in the definition of CDC CURVE in IEC 61850-7-3.
TmASt	Delivers the active curve characteristic
TmChgDayTm	Local time of next change to daylight saving time
TmChgStdTm	Local time of next change to standard time

<table>
<tr><th>Data object name</th><th>Semantics</th></tr>
<tr><td>TmChSt1</td><td>Time channel status (up/down)</td></tr>
<tr><td>TmDlChr</td><td>Time delay linear or inverse characteristic.
<table><tr><th>Timer delay</th><th>Value</th></tr><tr><td>Linear</td><td>TRUE</td></tr><tr><td>Inverse characteristic</td><td>FALSE</td></tr></table></td></tr>
<tr><td>TmDlMod</td><td>Operate time delay mode. TRUE = on, FALSE = off</td></tr>
<tr><td>TmDT</td><td>Indicating if for this location daylight saving time is in effect now.</td></tr>
<tr><td>TmExc</td><td>TRUE = Maximum allowed time exceeded (LN CPOW)</td></tr>
<tr><td>TmMult</td><td>This data object is the time dial multiplier or time dial setting mainly used for protection.</td></tr>
<tr><td>TmOfsTmm</td><td>Offset of local time from UTC in minutes</td></tr>
<tr><td>TmTmpChr33</td><td>Multiline curve characteristic definition. It is not multiple instantiable within one LN instance.</td></tr>
<tr><td>Tmp</td><td>The temperature of a specified component or in a specified volume (usually in °C)</td></tr>
<tr><td>TmpAlm</td><td>Temperature alarm because of an abnormal condition (FALSE = normal, TRUE = alert)</td></tr>
<tr><td>TmpMax</td><td>Maximum temperature</td></tr>
<tr><td>TmpRl</td><td>Relation between temperature and maximum temperature</td></tr>
<tr><td>TmSrc</td><td>Current time source</td></tr>
<tr><td>TmSrcSet1</td><td>Time source setting (“1588” in case the time source is a IEEE 1588 source or dotted IP-address)</td></tr>
<tr><td>TmSyn</td><td>Time synchronized according to IEC 61850-9-2
<table><tr><th>TmSyn</th><th>Value</th></tr><tr><td>Synchronized by a global area clock signal</td><td>2</td></tr><tr><td>Synchronized by a local area clock signal</td><td>1</td></tr><tr><td>Synchronized by an external area clock signal</td><td>0</td></tr></table></td></tr>
<tr><td>TmTa</td><td>Armature time constant Ta[s] (unsaturated)</td></tr>
<tr><td>TmTdp</td><td>D-axis short circuit transient time constant Td’ [s] (unsaturated)</td></tr>
<tr><td>TmTds</td><td>D-axis short-circuit sub-transient time constant Td’’[s] (unsaturated)</td></tr>
<tr><td>TmTmpCrv</td><td>Characteristic curve for protection operation of the form: y = f(x), where x is the temperature (Tmp) and y is the time (Tm). The integers representing the different curves are given in the definition of CDC CURVE in IEC 61850-7-3.</td></tr>
<tr><td>TmTmpSt</td><td>Delivers the active curve characteristic</td></tr>
<tr><td>TmTq0p</td><td>Q-axis open circuit transient time constant Tq0’ [s] (unsaturated)</td></tr>
<tr><td>TmTq0s</td><td>Q-axis open circuit sub-transient time constant Tq0’’[s] (unsaturated)</td></tr>
<tr><td>TmTqp</td><td>Q-axis short circuit transient time constant Tq’ [s] (unsaturated)</td></tr>
<tr><td>TmTqs</td><td>Q-axis short circuit sub-transient time constant Tq ’’ [s] (unsaturated)</td></tr>
<tr><td>TotTmms</td><td>Total time of synchronising process</td></tr>
<tr><td>TmUseDT</td><td>Flag indicating if this location is using daylight saving time</td></tr>
<tr><td>TmVChr33</td><td>Multiline curve characteristic definition. It is not multiple instantiable within one LN instance.</td></tr>
<tr><td>TmVCrv</td><td>Characteristic curve for protection operation of the form: y = f(x), where x is the voltage (V) and y is the time (Tm). The integers representing the different curves are given in the definition of CDC CURVE in IEC 61850-7-3.</td></tr>
<tr><td>TmVSt</td><td>Delivers the active curve characteristic</td></tr>
<tr><td>Torq</td><td>Drive torque</td></tr>
<tr><td>TotPF</td><td>Average power factor for a three-phase circuit (per unit)</td></tr>
<tr><td>TotVA</td><td>Total apparent power in a three-phase circuit</td></tr>
<tr><td>TotVAh</td><td>Net apparent energy since last rest</td></tr>
</table>

<table>
<tr><th>Data object name</th><th>Semantics</th></tr>
<tr><td>TotVAr</td><td>Total reactive power in a three-phase circuit</td></tr>
<tr><td>TotVArh</td><td>Net reactive energy since last reset</td></tr>
<tr><td>TotW</td><td>Total real power in a three-phase circuit</td></tr>
<tr><td>TotWh</td><td>Net real energy since last reset</td></tr>
<tr><td>TpcBlk</td><td>Teleprotection in blocked state</td></tr>
<tr><td>TpcRxMod</td><td>Teleprotection application mode in receive direction for each command (unused, blocking, permissive, direct, unblocking, status)</td></tr>
<tr><td>TpcTxMod</td><td>Teleprotection application mode in transmit direction for each command (unused, blocking, permissive, direct, unblocking, status)</td></tr>
<tr><td>TPTrTmms</td><td>Three-pole delay time in milliseconds before the breaker failure tries to retrip the failed breaker</td></tr>
<tr><td>Tr</td><td>Trip is the command to open the breaker when issued in case of fault by PTRC</td></tr>
<tr><td>TrBeh</td><td>Indicates for the next Trip if single pole tripping is allowed or three-pole tripping requested.
<table>
<tr><th>Trip behavior</th><th>Value</th></tr>
<tr><td>Single pole tripping</td><td>1</td></tr>
<tr><td>Undefined (default)</td><td>2</td></tr>
<tr><td>Three pole tripping</td><td>3</td></tr>
</table></td></tr>
<tr><td>TrgMod</td><td>Disturbance recorder trigger mode. The source of the external trigger is a local issue.
<table>
<tr><th>Trigger Mode</th><th>Value</th></tr>
<tr><td>Internal</td><td>1</td></tr>
<tr><td>External</td><td>2</td></tr>
<tr><td>Both</td><td>3</td></tr>
</table></td></tr>
<tr><td>TrgRef</td><td>Trigger reference shows the receiving trigger signal. It can be multiple in one LN-Instance.</td></tr>
<tr><td>TrMod</td><td>This data object represents a type of trip function; 3ph means only 3phase tripping possible, 1ph or 3ph means PTRC with 1 and 3 phase tripping possibility and first trip depending on fault type.</td></tr>
<tr><td>TrPlsTmms</td><td>Trip pulse time is the minimum pulse time for breaker operation.</td></tr>
<tr><td>TxBlk</td><td>Blocking information to be transmitted to the other side (teleprotection blocking signal)</td></tr>
<tr><td>TxCnt</td><td>Number of sent messages</td></tr>
<tr><td>TxPrm</td><td>Permissive information to be transmitted to the other side (teleprotection permissive signal)</td></tr>
<tr><td>TxTr</td><td>Direct trip information to be transmitted to the other side</td></tr>
<tr><td>TypRsCrv</td><td>This is the type of the reset curve that is used to co-ordinate the reset with electromechanical relays that do not reset instantaneously.
<table>
<tr><th>Reset curve</th><th>Value</th></tr>
<tr><td>None</td><td>1</td></tr>
<tr><td>Definite time delayed reset</td><td>2</td></tr>
<tr><td>Inverse reset</td><td>3</td></tr>
</table></td></tr>
<tr><td>UHFPaDsch</td><td>UHF level of partial discharge</td></tr>
<tr><td>UnbDetMth</td><td>Unbalance detection method is the method used to detect the unbalanced condition based on measured or calculated phase or sequence components of the monitored by the logical node system parameters.
<table>
<tr><th>Unbalance detection method</th><th>Value</th></tr>
<tr><td>Negative sequence</td><td>1</td></tr>
<tr><td>Zero sequence</td><td>2</td></tr>
<tr><td>Negative sequence / positive sequence</td><td>3</td></tr>
<tr><td>Zero sequence / positive sequence</td><td>4</td></tr>
<tr><td>Phase vectors comparison</td><td>5</td></tr>
<tr><td>Others</td><td>6</td></tr>
</table></td></tr>
</table>

<table>
<tr><th>Data object name</th><th>Semantics</th></tr>
<tr><td>UnBlkMod</td><td>This data object is the unblock function mode.
<table>
<tr><th>Unblock function mode</th><th>Value</th></tr>
<tr><td>Off</td><td>1</td></tr>
<tr><td>Permanent</td><td>2</td></tr>
<tr><td>Time window</td><td>3</td></tr>
</table></td></tr>
<tr><td>UnBlkTmms</td><td>Unblocking time</td></tr>
<tr><td>UnHzStr</td><td>Start (underfrequency variation event in progress)</td></tr>
<tr><td>UnHzStrVal</td><td>Underfrequency start point</td></tr>
<tr><td>Up</td><td>Last count direction upward</td></tr>
<tr><td>UrcbTrk</td><td>Access service tracking for unbuffered report control block</td></tr>
<tr><td>UsvcbTrk</td><td>Access service tracking for unicast sampled values control block</td></tr>
<tr><td>UseCyc</td><td>Actual set maximum number of cycles for any cyclic process, for example used for the autorecloser</td></tr>
<tr><td>V1Clc</td><td>Average value U_1 at side 1 of the breaker. The side is not standardized; Common use: U_1 = reference voltage or running voltage.</td></tr>
<tr><td>V2Clc</td><td>Average value U_2 at side 2 of the breaker. The side is not standardized; Common use: U_2 = variable voltage or incoming voltage.</td></tr>
<tr><td>VA</td><td>Phase apparent power</td></tr>
<tr><td>VAr</td><td>Phase reactive power (Q)</td></tr>
<tr><td>VAdj</td><td>This data object allows to switch off the voltage matching function of an automatic synchroniser; TRUE = ON; FALSE = OFF</td></tr>
<tr><td>VAdpFact</td><td>Adaptation factor U_1/ U_2: Equalising factor for the average values of the two voltages U_1 and U_2. The data object is used to correct measuring errors or deviation in the ratio of the VT.</td></tr>
<tr><td>VarStr</td><td>Start of the frequency variation event</td></tr>
<tr><td>VarEnd</td><td>Event finished but not reset</td></tr>
<tr><td>Vbr</td><td>Vibration level [mm/s^2]</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: definition of the rate of change of the voltage regulator. The value is 1/s.</td></tr>
<tr><td>VerWdDir</td><td>Vertical wind direction</td></tr>
<tr><td>VerWdSpd</td><td>Average vertical wind speed [usually in m/s]</td></tr>
<tr><td>VHzChr33</td><td>Multiline curve characteristic definition. It is not multiple instantiable within one LN instance.</td></tr>
<tr><td>VHzCrv</td><td>Characteristic curve for protection operation of the form: $y = f(x)$, where x is the frequency (Hz) and y is the voltage (V). The integers representing the different curves are given in the definition of CDC CURVE in IEC 61850-7-3.</td></tr>
<tr><td>VHzSt</td><td>Delivers the active curve characteristic</td></tr>
<tr><td>VInd</td><td>This data object indicates whether the voltage difference (average value) between the two voltages to be synchronised is within the set limits or not. FALSE = value within the limits; TRUE = value outside the limits.</td></tr>
<tr><td>VInvTms</td><td>Voltage adjustment pulse interval: defines the time between two adjusting pulses</td></tr>
<tr><td>VNom</td><td>This data object is used to set the nominal secondary voltage (input voltage to the synchroniser), in case the measuring voltages are connected hardwired to the synchroniser.</td></tr>
<tr><td>Vlm</td><td>Volumetric content of a container, reservoir, dam or tank [usually in m^3]</td></tr>
<tr><td>VlmCap</td><td>Maximum volume onto which container can be filled</td></tr>
<tr><td>Vol</td><td>AC voltage non-phase-related or DC voltage</td></tr>
<tr><td>VolAmp</td><td>Apparent power measurement of a non-three-phase circuit</td></tr>
<tr><td>VolAmpr</td><td>Volt-amperes reactive of a non-three-phase circuit</td></tr>
</table>

<table>
<tr><th>Data object name</th><th>Semantics</th></tr>
<tr><td>VolChgRte</td><td>Rate of voltage change (change over time)</td></tr>
<tr><td>VolNgGnd</td><td>Voltage between positive pole and earth</td></tr>
<tr><td>VolPsGnd</td><td>Voltage between negative pole and earth</td></tr>
<tr><td>VolResoPt</td><td>Voltage at the resonance point in compensated networks</td></tr>
<tr><td>VOvSt</td><td>TRUE = indicates voltage override control status</td></tr>
<tr><td>VRed</td><td>TRUE = voltage reduction is active to reduce load side voltage below the normal setting</td></tr>
<tr><td>VRedVal</td><td>Reduction of band centre (percent) when voltage step x is active</td></tr>
<tr><td>VRtg</td><td>Rated voltage, intrinsic property of the device, which cannot be set/changed from remote</td></tr>
<tr><td>VStr</td><td>Value of the voltage that must be reached for a dedicated action to be started of the related function</td></tr>
<tr><td>VTrsTm</td><td>Voltage transient duration</td></tr>
<tr><td>VVa</td><td>Voltage variation magnitude of the last completed event</td></tr>
<tr><td>VVaTm</td><td>Voltage variation duration of the last completed event</td></tr>
<tr><td>W</td><td>Phase active power (P)</td></tr>
<tr><td>WacTrg</td><td>The number of times the watchdog circuit has reset the device since the counter reset.</td></tr>
<tr><td>Wrn</td><td>General warning. It can be multiple in one LN-instance.</td></tr>
<tr><td>Watt</td><td>Real power in a non-three-phase circuit</td></tr>
<tr><td>WeiMod</td><td>This data object is the weak end infeed function mode.
NOTE Normal are values 1, 3 and 4.
<table>
<tr><th>Weak end infeed mode</th><th>Value</th></tr>
<tr><td>Off</td><td>1</td></tr>
<tr><td>Operate</td><td>2</td></tr>
<tr><td>Echo</td><td>3</td></tr>
<tr><td>Echo and operate</td><td>4</td></tr>
</table></td></tr>
<tr><td>WeiOp</td><td>Operate signal from week end infeed function</td></tr>
<tr><td>WeiTmms</td><td>Co-ordination time for weak end feed function in ms</td></tr>
<tr><td>WetBlbTmp</td><td>Wet bulb temperature [usually in °C]</td></tr>
<tr><td>WdGustSpd</td><td>Maximum wind gust speed [usually in m/s]</td></tr>
<tr><td>WrmStr</td><td>The number of warm starts made by the physical/logical device since the last reset</td></tr>
<tr><td>XZer</td><td>Zero sequence line reactance</td></tr>
<tr><td>XPs</td><td>Positive sequence line (reach) reactance</td></tr>
<tr><td>X2</td><td>Negative sequence reactance X2 [per unit] (unsaturated)</td></tr>
<tr><td>Xd</td><td>D-axis synchronous reactance Xd [per unit] (unsaturated)</td></tr>
<tr><td>Xdp</td><td>D-axis transient synchronous reactance Xd’ [per unit] (unsaturated)</td></tr>
<tr><td>Xds</td><td>D-axis reactance Xd’’ [per unit] (unsaturated)</td></tr>
<tr><td>XmZer</td><td>Mutual reactance coupling from parallel line</td></tr>
<tr><td>Xq</td><td>Q-axis synchronous reactance Xq [per unit] (unsaturated)</td></tr>
<tr><td>Xqp</td><td>Q-axis transient reactance Xq’ [per unit] (unsaturated)</td></tr>
<tr><td>Xqs</td><td>Q-axis sub-transient reactance Xq’’ [per unit] (unsaturated)</td></tr>
<tr><td>Z</td><td>Line impedance of all phases in a three-phase system (ZL1, ZL2, LZ3)</td></tr>
<tr><td>ZZerAng</td><td>Zero sequence source angle, near end (A)</td></tr>
<tr><td>ZZerMag</td><td>Zero sequence source magnitude, remote end (B)</td></tr>
<tr><td>ZPsAng</td><td>Positive sequence line angle</td></tr>
<tr><td>ZPsMag</td><td>Positive sequence line magnitude</td></tr>
<tr><td>ZeroEna</td><td>Zero sequence current supervision enabled (TRUE)</td></tr>
</table>

Data object name	Semantics
ZmZerAng	Mutual impedance coupling from parallel line angle
ZmZerMag	Mutual impedance coupling from parallel line magnitude

Annex A
(normative)

Interpretation of mode and behaviour

Switching between the modes (Mod.stVal) should only happen as a result of an operator command to the data object Mod. Mod and Beh are always accessible by the services. The communication services for the data object Mod do not care about the status of the Beh of the LN. Possible values of Mod and Beh are given in Table A.1.

Table A.1 – Values of mode and behaviour

Value	Mode	
1	on	The application represented by the LN works. All communication services work and get updated values
2	on-blocked	The application represented by the LN works. No output data (digital by relays or analogue setting) will be issued to the process. All communication services work and get updated values. Data objects will be transmitted with quality “operatorBlocked”. Control commands will be rejected. See note below Table A.1.
3	test	The application represented by the LN works. All communication services work and get updated values. Data objects will be transmitted with quality “test”. Control commands with quality test will be accepted only by LNs in “test” or “test-blocked” mode. “Processed as valid” means that the application should react in the manner what is foreseen for “test”.
4	test/blocked	The application represented by the LN works. No output data (digital by relays or analogue setting) will be issued to the process. All communication services work and get updated values. Data objects will be transmitted with quality “test”. Control commands with quality test will be accepted only by LNs in TEST or TEST-Blocked mode.
5	off	The application represented by the LN doesn’t work. No process output is possible. No control command should be acknowledged (negative response). Only the data object Mod and Beh should be accessible by the services.
NOTE The Mod =”blocked” from edition 1 is changed in edition 2 to “on-blocked”.		

Table A.2 gives an overview over the definition of mode and behaviour.

In the lower lines is given the functional processing of the LNs in different behaviour states. Logical nodes should process receiving data according to their quality information:

– “Processed as valid” means that the application should react according to the quality and the behaviour of the LN.

– “Processes as invalid” means the application should react as if the quality of the data had been invalid.

– “Processed as blocked” means that the application should decide how to react, besides no process-related action based on the value is performed.

– Statements “Processed” and “Not Processed” don’t belong to communication services and therefore no quality bit can be evaluated.

Table A.2 – Definition of mode and behaviour

MODE/BEHAVIOUR	on	on-blocked	test	test/blocked	off
Function behind LN	ON	ON	ON	ON	OFF
Output to the Process (Switchgear) via a non-IEC 61850 link for example wire (typical for X...,Y... and GGIO LNs)	YES	NO	YES	NO	NO
Output of FC ST, MX (issued independently from Beh)	value is relevant q is relevant	value is relevant q = operatorBlocked	value is relevant q = test	value is relevant q = test +operator-Blocked	value is irrelevant q = invalid
Response to (Normal) Command from Client (a+ / a- acknowledgement)	a+ pos. ack.	a- neg. ack.	a- neg. ack.	a- neg. ack.	a- neg. ack.
Response to TEST Command from Client (a+ / a- acknowledgement)	a- neg. ack.	a- neg. ack.	a+ pos. ack.	a+ pos. ack.	a- neg. ack.
Incoming data with q=normal	Processed as valid	Processed as valid	Processed as valid	Processed as valid	Not Processed
Incoming data with q=operatorBlocked	Processed as blocked	Processed as blocked	Processed as blocked	Processed as blocked	Not Processed
Incoming data with q=test	Processed as valid	Processed as invalid	Processed as valid	Processed as valid	Not Processed
Incoming data with q=test+operatorBlocked	Processed as invalid	Processed as invalid	Processed as blocked	Processed as blocked	Not Processed
Incoming data with q=invalid	Processed as invalid	Processed as invalid	Processed as invalid	Processed as invalid	Not Processed
Non-IEC 61850 binary (relay, contact) inputs and analogue (instrument transformer) inputs	Processed	Processed	Processed	Processed	Not Processed

NOTE A precondition of the use of different modes (Mod/Beh) is the processing of the quality status (q) of the receiving information.

Annex B
(normative)

Local / Remote concept

The data object LocKey represents the status of a physical key switch and allows to taking over the control authority.

The data object Loc shows the control behaviour of the logical node.

The data object LocSta shows the switching authority at station level. If LocSta=false control, commands are allowed from remote, e.g. network control center (NCC).

The data object MltLev shall be modelled in LLN0 only. It shows if more than one source of control commands is accepted at a certain level at the same time.

Example:

1) If MltLev=false, CSWI.Loc=false and CSWI.LocSta=true, only a control command with a station level originator is allowed, what means only one level has the switching authority.
2) If MltLev=true, CSWI.Loc=false and CSWI.LocSta=true, additionally to the allowed command from the station level, also commands from the bay level are allowed, which means that the station level and the bay level have the switching authority. So the final reaction on control commands regarding the different sources of the commands (specified by the originator of the control command) is defined by data objects Loc, LocSta and MltLev.

The concept is illustrated in Table B.1 and shall be applied.

Table B.1 – Relationship between Loc/Rem data objects and control authority

Switch	Bay control			Manual Control at switch (process)	Command from		
					Bay	Station	NCC
	Mode of switching authority for local control	Local control behaviour	Control authority at station level		orCat		
XCBR.Loc XSWI.Loc	LLN0. MltLev	CSWI. Loc	CSWI. LocSta		Local Ctl (Bay)	Station	Remote
T	F	n.a.	n.a.	AA	NA	NA	NA
F	F	T	n.a.	AA	AA	NA	NA
F	F	F	T	AA	NA	AA	NA
F	F	F	F	AA	NA	NA	AA
T	T	n.a.	n.a.	AA	NA	NA	NA
F	T	T	n.a.	AA	AA	NA	NA
F	T	F	T	AA	AA	AA	NA
F	T	F	F	AA	AA	AA	AA

Loc status (behaviour of the LN reg. switching authority)
T = TRUE command only allowed at this level
F = FALSE command not allowed at this level
n.a. = not applicable the position of this Loc is of no importance

Command
AA = ALWAYS ALLOWED command always allowed
NA = NOT ALLOWED command not allowed

MltLev (mode of switching authority for local control)
F = only one level (Originator) at a time has the switching authority (default, if this data object is not present)
T = more than one level (Originator) at any time has the switching authority (e.g. station and bay level)

Conclusions:
The local control switch LocKey, if available, is always allowed to be switched on/off.

Annex C
(informative)

Deprecated logical node classes

C.1 General

In this annex, those logical nodes are listed that are obsolete (no longer needed because of technical progress since the publication of the first edition (2003). They will be kept in the standard for backward compatibility with namespace indication of edition 1 (IEC 61850-7-4:2003).

C.2 LN: Metering statistics Name: MSTA

The metered values are not always used directly, but as average values, minima and maxima over a given evaluation period. The reporting may be started after the end of this period.

MSTA class				
Data object name	**Common data class**	**Explanation**	**T**	**M/O/C**
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2, Clause 22.		
Data objects				
Metered values				
AvAmps	MV	Average current		O
MaxAmps	MV	Maximum current		O
MinAmps	MV	Minimum current		O
AvVolts	MV	Average voltage		O
MaxVolts	MV	Maximum voltage		O
MinVolts	MV	Minimum voltage		O
AvVA	MV	Average apparent power		O
MaxVA	MV	Maximum apparent power		O
MinVA	MV	Minimum apparent power		O
AvW	MV	Average active power		O
MaxW	MV	Maximum active power		O
MinW	MV	Minimum active power		O
AvVAr	MV	Average reactive power		O
MaxVAr	MV	Maximum reactive power		O
MinVAr	MV	Minimum reactive power		O
Controls				
EvStr	SPC	Start of evaluation interval		O
Settings				
EvTmms	ING	Evaluation time (time window) for averages, etc.		O

Annex D
(informative)

Relationship between this standard and IEC 61850-5

The logical nodes listed in IEC 61850-5 define requirements; the logical nodes listed in this standard define the modelling. Some requirements of the LNs from IEC 61850-5 are modelled by LNs which are not explicitly referred to in this standard. Its functionality is provided by the services or by the communication stack. Some system support functions are too dependent on implementation to be standardized in this standard. Examples are listed in Table C.1.

Table D.1 – Relationship between IEC 61850-5 and this standard for some miscellaneous LNs

Functionality	Defined in IEC 61850-5 by LN	Modelled in IEC 61850-7-4 by LN	Comments
Time master	STIM	Not applicable	Dedicated function in a not-modelled interface IED, such as a GPS-receiver providing time from some external source to the IEC 61850 system.
System supervision	SSYS	Not applicable	Dependent on functions in the system and therefore, implemented distributed in the IEDs of the system (Example: health information from the LNs and services information, such as reception of GOOSE messages within $T_{max)}$. Some dedicated system supervision is provided by the system logical nodes (group L).
Test generator	GTES	Not applicable	Complex not-modelled function depending on test services provided which cannot be allocated to one single LN. For testing, see IEC 61850-10.

Annex E
(informative)

Algorithms used in logical nodes for automatic control

E.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

E.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 LN FCSD.

In Figure E.1, we can see an example of a two-dimensional curve used for shaping a flow value based on the gate position. The values entered in the table are based on statistical data obtained following a series of index tests.

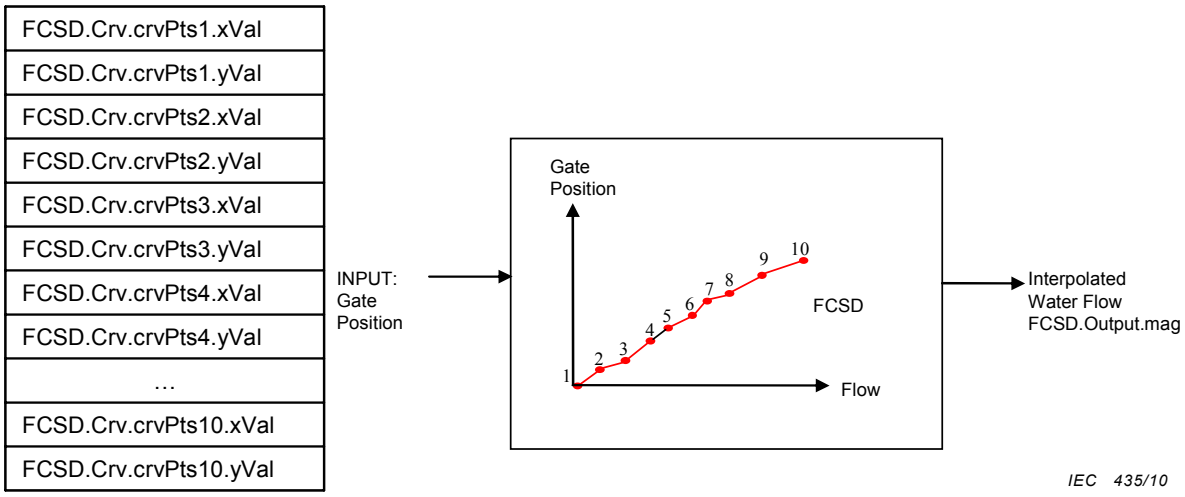


Figure E.1 – Example of curve based on an indexed gate position providing water flow

E.3 Logical node FCSV (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 are modifiable online.

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

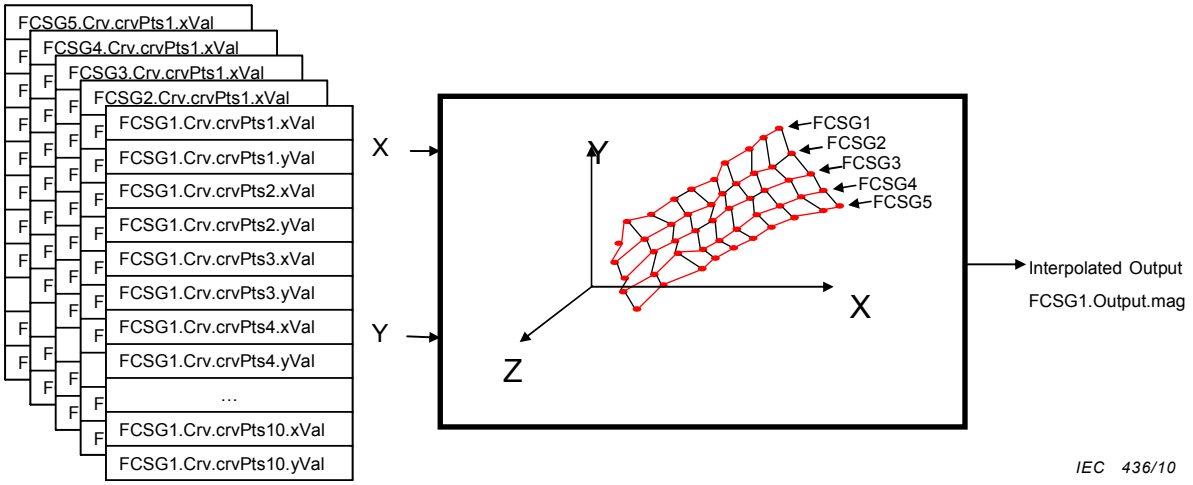


Figure E.2 – Example of curve based on an indexed guide vane position (x axis) vs. net head (y axis) giving an interpolated runner blade position (Z axis)

E.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.

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

– The integral function

This logical node is used to integrate an incoming value.

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

– The differential function

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

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

NOTE The symbols used come from IEC 61850-7-410.

In Figure E.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.

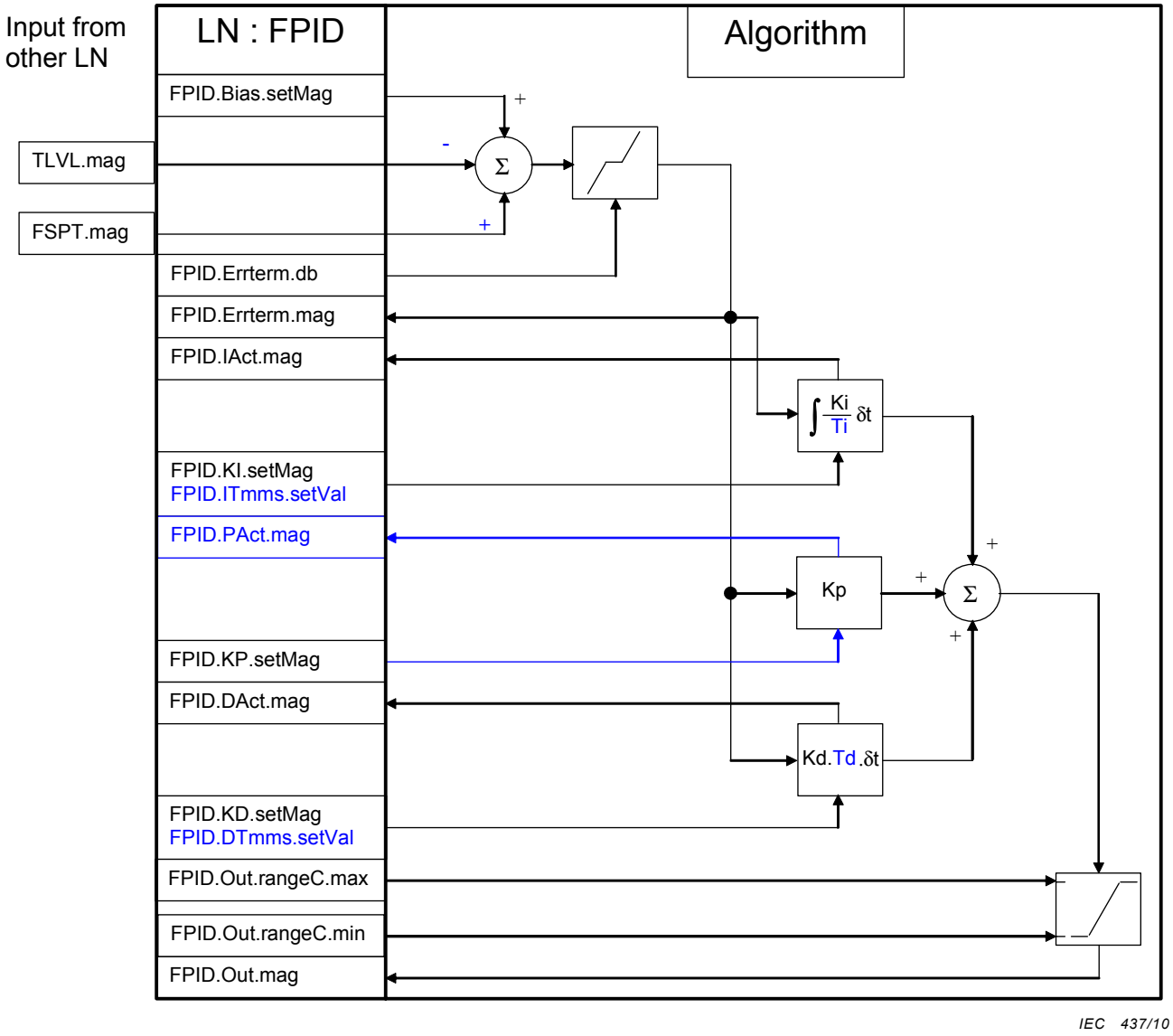


Figure E.3 – Example of a proportional-integral-derivate controller

E.5 Logical node FFIL (filter function)

The logical node is used to filter an incoming value.

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

More complex logical devices such as power stabilisation systems make a multiple use of filters. See Figure E.4.

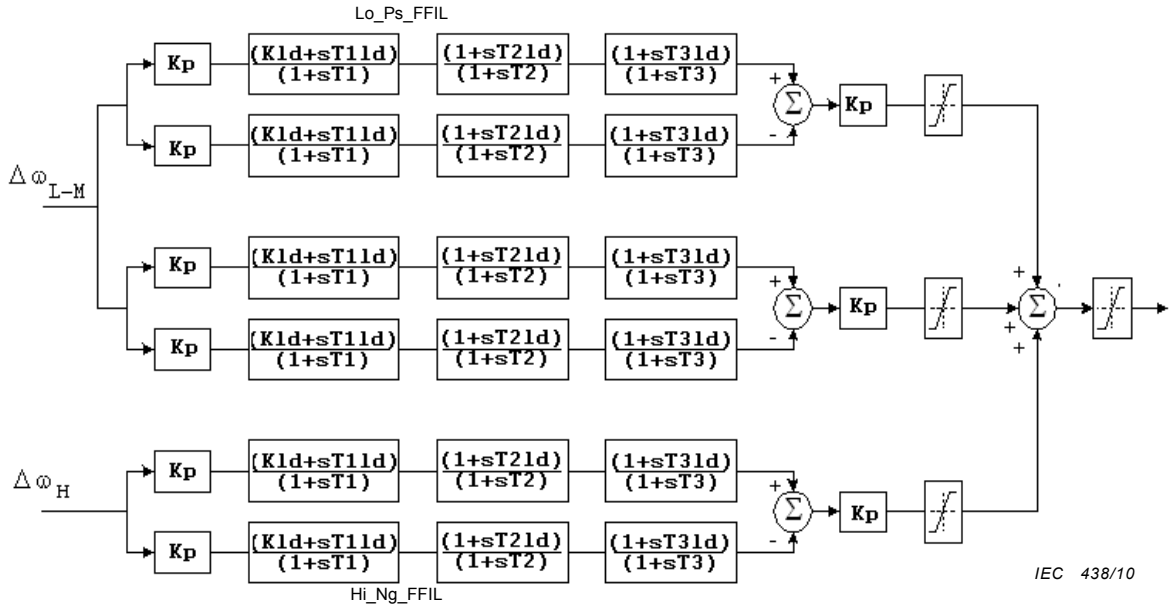


Figure E.4 – Example of a power stabilisation system

E.6 Logical node FRMP (set-point ramping function)

In the following example given in Figure E.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).

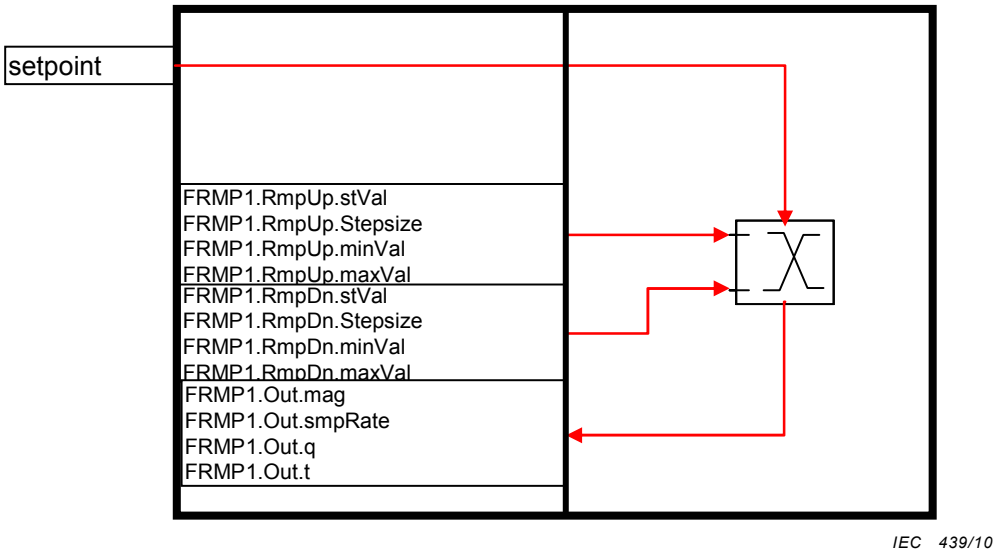


Figure E.5 – Example of a ramp generator

E.7 Logical node FSPT (setpoint control function)

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

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

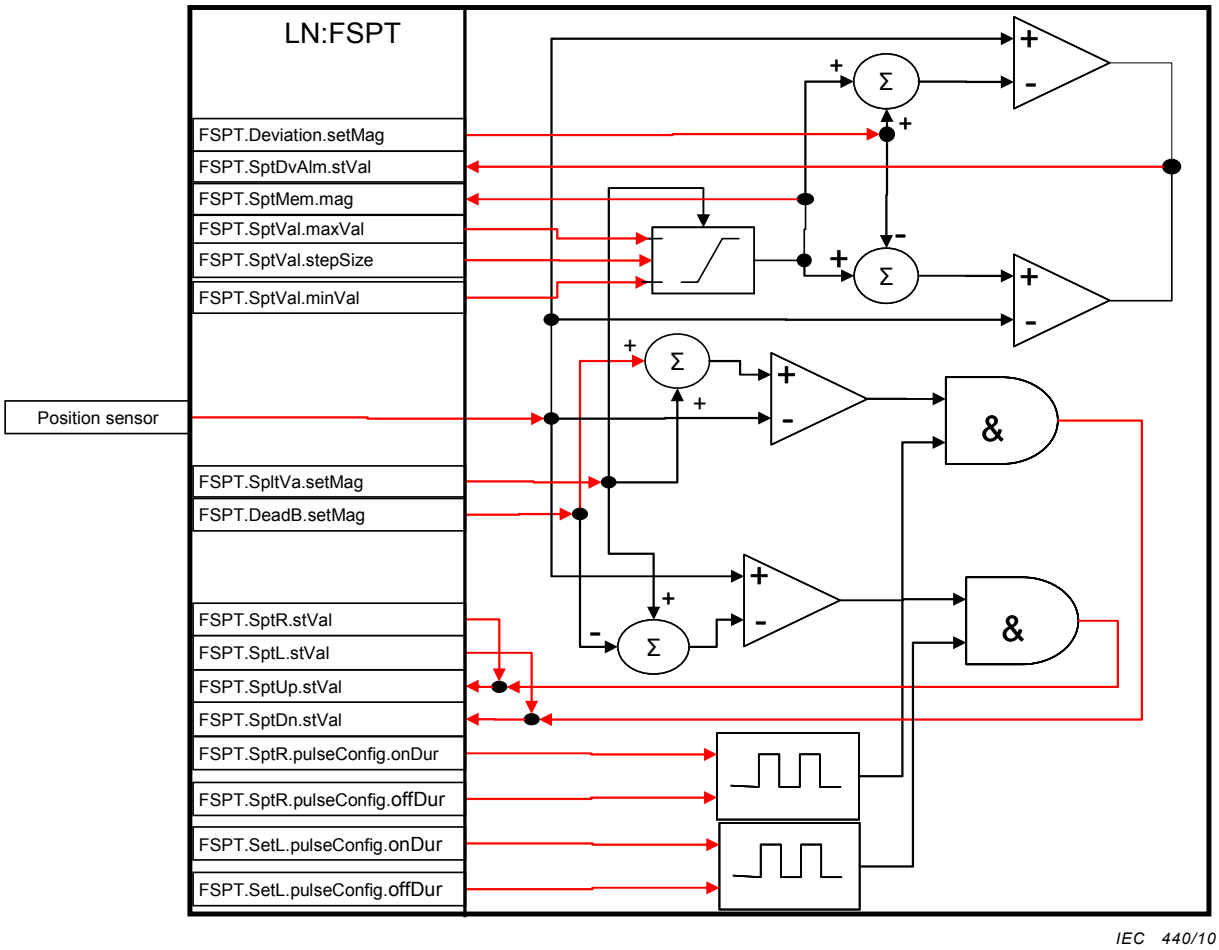


Figure E.6 – Example of an interface with a set-point algorithm

Annex F
(normative)

Statistical calculation

F.1 Statistical calculation basis

Here are some rules that have to be understood when implementing a calculation method.

- A statistical calculation transforms an “original” flow of data (indicated by ClcSrc)into “statistical” data with considered settings. These settings define the mathematical function to apply, the condition for starting, the calculation interval duration and possible sliding, the rate of data refreshment.
- When a statistical calculation method is applied to a logical node, it is supposed to be applied independently to any Instmag value specified in the considered statistical LN (refer to Figure F.1).
- This also applies to complex CDC such as vectors CMV/DEL/WYE. If the statistical method also applies to angle per phase, then the sum of the 3 angles may be larger than 360°.
- The common data class of a statistical data, resulting from a statistical calculation, is exactly identical to the CDC of the original data it applies to (referenced by ClcSrc), then a calculation method does not change a vector into a scalar.
- The content of a statistical LN can’t include object/attribute which were not present in the original one.
- Vector time consistency supported by WYE, DEL common data class is not to be broken down but is extended to the full refreshment interval duration. Time consistency is then valid considering the refreshment interval duration (refer to Figure F.1).
- Statistical calculation may be chained. For example, a first LN can produce RMS value, then a second statistical LN can calculate an average of the considered RMS value on a certain period, then an other statistical LN can calculate the maximum of the calculated average since the last reset of this maximum value.

Example for a MAX calculation method:

Considering a CMV common data class, applying a MAX calculation method will lead to calculate independently the Maximum for mag and the Maximum for angle.

Considering DEL/WYE, applying a MAX calculation method will lead to calculate independently the Maximum for the 3 phases values.

By applying a calculation method to a vector, on a defined (refreshment) interval, we obtain at the end of the period a vector, tagged with the time reference of the end of the period, and no refresh in between. Time references to each individual results (if any) are lost.

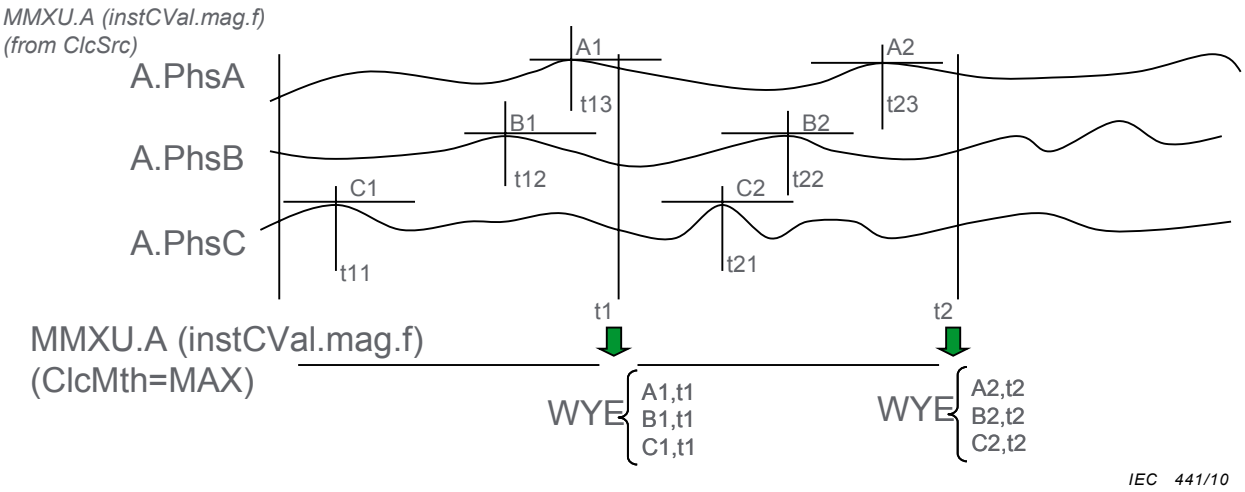


Figure F.1 – Statistical calculation of a vector

F.2 Time interval definitions (relating to statistical calculation)

Four different time-related parameters are needed to define properly the considered statistical calculation:

- The mode of calculation to define whether the calculation has to be performed periodically (sliding (SLIDING) or not sliding (PERIOD)) or not periodically (TOTAL).

  Refer ClcMod common LN data.

- The calculation interval duration, i.e. the duration window between the starting time of one interval up to the next starting time of the next interval. This duration can be based on cycle, time (UTC or local), or can be defined by an external trigger.

  The calculation interval duration shall be defined by using two data objects, ClcIntvTyp and ClcIntvPer.

  ClcIntvTyp indicates the time unit to consider in defining the calculation interval duration (if its value differs from EXTERNAL) or indicates that this duration is based on an EXTERNAL trigger if its value equals to EXTERNAL): refer ClcIntvTyp common LN data.

  When the time unit refers to DAY, WEEK, MONTH, YEAR, the time reference to consider is the local time (refer to LTIM LN).

  ClcIntvPer indicates the number of units to consider: refer ClcIntvPer common LN data.

  If the mode of calculation (ClcMod) is of type TOTAL (i.e. not periodic), ClcIntvTyp shall be of type EXTERNAL or ignored, and ClcIntvPer (if defined) shall be ignored.

- The calculation sub-interval duration. This parameter is specific to sliding window of calculation, and enables the user to define the duration step between to contiguous sliding windows.

  Because sub-interval duration shall always be an exact divider of the calculation period, only one data object is needed to define the calculation sub-interval duration, i.e. NumSubIntv, the number of sub-intervals a calculation period interval duration contains.

  If the mode of calculation (ClcMod) is not of type SLIDING (i.e. not periodic), NumSubIntv shall be ignored.

- The calculation refreshment interval duration, i.e. the duration between two updates of the calculation result.

  The calculation refreshment period duration shall be defined by using two data objects, ClcRfTyp and ClcRfPer.

  ClcRfTyp indicates the time unit to consider in defining the calculation refreshment period duration (if its value differs from EXTERNAL) or indicates that this duration is based on an EXTERNAL trigger (if its value equals to EXTERNAL): refer ClcRfTyp common LN data.

When the time unit refers to DAY, WEEK, MONTH, YEAR, the time reference to consider is the local time (refer to LTIM LN).

ClcRfPer indicates the number of units to consider: refer ClcRfPer common LN data.

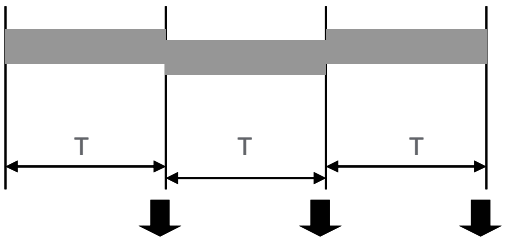
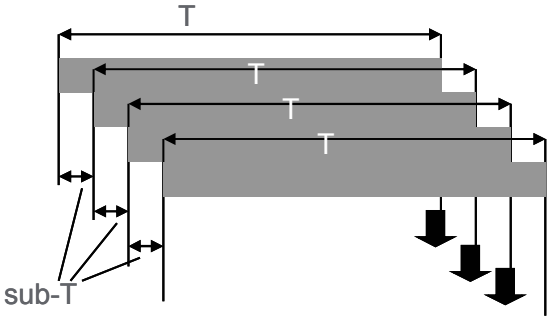
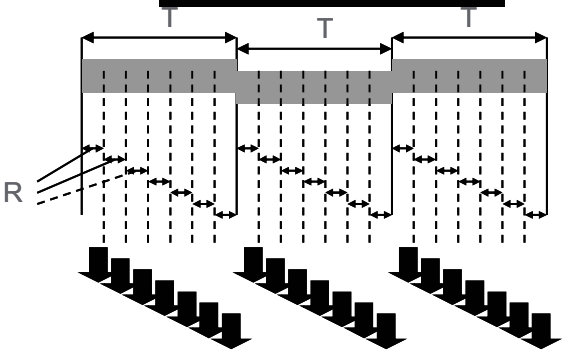
The calculation refreshment interval duration shall be shorter or equal than the calculation interval duration (if not EXTERNAL).

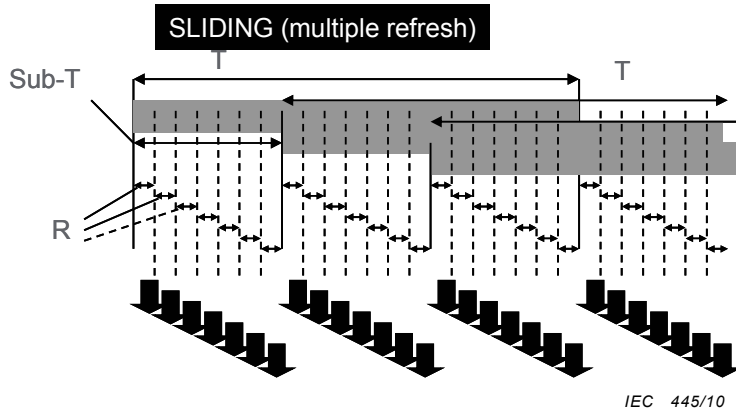
In case of SLIDING calculation mode, the calculation refreshment period duration shall be shorter than or equal to the calculation sub-interval duration.

If the refreshment period is not defined, it is supposed to be equal to the calculation period.

F.2.1 Examples

In the graphics (Figure G.1) below, the horizontal axis represents the current time, grey zones represent calculation interval. The symbol ⬇ indicates that the LN is producing a new instantaneous value.

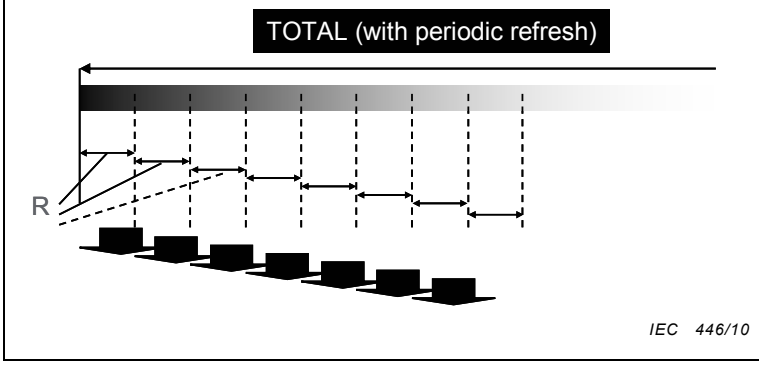
PERIOD (single refresh)  IEC 442/10	Periodic calculation (period = T). Refreshment period is equal to calculation period. This can be met for example, for demand calculation or min/max calculation. Sub-interval is not used.
SLIDING (single refresh)  IEC 443/10	Periodic sliding calculation (period = T). Refreshment period length is equal to sub-interval duration. This can be met for example, for demand calculation. Sub-interval is used to define the sliding duration “sub-T”
PERIOD (multiple refresh)  IEC 444/10	Periodic calculation (period = T). with higher refresh rate. Refreshment period is equal to R. This can be met for example, for prediction demand calculation. Sub-interval is not used.



Periodic sliding calculation (period = T). Refreshment period length (R) is shorter than the sub-interval duration (sub-T).

This can be met, for example, for prediction demand calculation.

Sub-interval is used to define the sliding duration “sub-T”.



Continuous calculation from the last reset with a refreshment period duration (R) of the calculation result.

This can be met, for example, for maximum demand calculation from the last reset.

Figure F.2 – Examples of statistical calculations

F.3 Calculation start

F.3.1 Start of statistical calculation means that

- all analogue values of the LN will be set internally to their initial state;
- until a new refresh is available, Instmag data will keep their previous values with their associated time-stamp (referring to the previous interval);
- for the very first calculation interval, they will be stated as “bad quality” until the first refresh is available.

F.3.2 The three possible start conditions available in the model

F.3.2.1 Periodic re-start

The LN will re-start calculation at the beginning of each calculation interval.

Depending on the calculation interval definition, starting time such as “Start of the day”, “Start of the week”, Start of the month”, Start of the year” will have to be implemented internally based on LTIM settings.

F.3.2.2 Aperiodic start

Aperiodic start will happen in two phases:

- Start enabler

  An start enabler may be send on-demand to the LN using ClcStr control which is part of the common LN data of the considered statistical LN: the calculation will be enabled depending on the CLCStr attributes: at time operTm (defined in UTC time reference) from the control model (if set) or immediately.

• Calculation start

If ClcMod is set to TOTAL, calculation will start as soon as it has been enabled.

If ClcMod is set to PERIOD or SLIDING, calculation will start at the next occurrence of calculation interval (depending on the value of ClcIntvTyp and ClcIntvPer). If ClcIntvTyp is set to MS, calculation will start at the next multiple of calculation intervals from the start of the day (example: if the calculation interval is set to 15 min (= 900 000 ms), calculation will start at the next occurrence of a full quarter of an hour (00:00, 00:15, 00:30, ….).

Power on of the device may be considered as a start enabler.

F.3.2.3 External synchronisation

An external trigger can be defined using the InSyn ORG reference defined in the common LN data part of the considered statistical LN. The referenced object shall be of BOOLEAN type.

If the calculation interval is explicitly set as EXTERNAL (ClcIntvTyp), each raising edge from FALSE to TRUE of the value of the objet referenced by InSyn will produce an immediate re-start of the statistical calculation of the LN as described above.

If ClcIntvTyp is not set to EXTERNAL, then the InSynch trigger shall be ignored.

Remaining time up to the end of the calculation interval:

If ClcMod is set to SLIDING or PERIOD, and if ClcNxTmms is defined as part of the data of the considered LN, ClcNxTmms will indicate the calculation remaining time up to the end of the current calculation interval in milliseconds.

Annex G
(normative)

Functional relationship of data objects of autorecloser RREC

G.1 Principal diagram of autorecloser

Figure G.1 gives the functional diagram of the autorecloser with its different data objects (status, settings etc.). In the bubbles are given the states of the autorecloser function as they are also specified in Clause 6, Table 10.

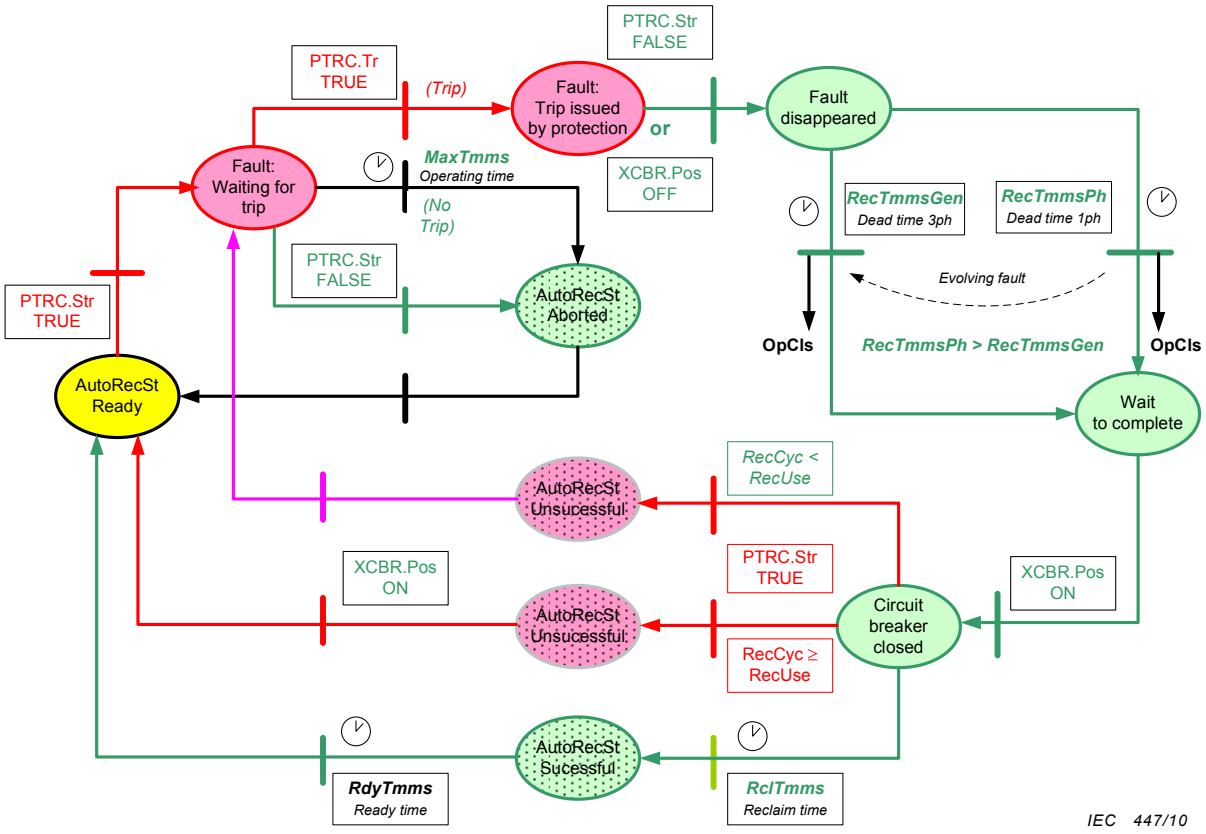


Figure G.1 – Diagram of autorecloser function

Annex H
(normative)

SCL enumerations

```
<EnumType id="AdjSt">
        <EnumVal ord="1">Completed</EnumVal>
        <EnumVal ord="2">Cancelled </EnumVal>
        <EnumVal ord="3">New adjustments </EnumVal>
        <EnumVal ord="4">Under way </EnumVal>
</EnumType>
<EnumType id="AutoRecSt">
        <EnumVal ord="1">Ready</EnumVal>
        <EnumVal ord="2">In progress</EnumVal>
        <EnumVal ord="3">Successful</EnumVal>
        <EnumVal ord="4">Waiting for trip</EnumVal>
        <EnumVal ord="5">Trip issued by protection</EnumVal>
        <EnumVal ord="6">Fault disappeared</EnumVal>
        <EnumVal ord="7">Wait to complete</EnumVal>
        <EnumVal ord="8">Circuit breaker closed</EnumVal>
        <EnumVal ord="9">Cycle unsuccessful</EnumVal>
        <EnumVal ord="10">Unsuccessful</EnumVal>
        <EnumVal ord="11">Aborted</EnumVal>
</EnumType>
<EnumType id="Beh">
        <EnumVal ord="1">on</EnumVal>
        <EnumVal ord="2">on-blocked</EnumVal>
        <EnumVal ord="3">test</EnumVal>
        <EnumVal ord="4">test/blocked</EnumVal>
        <EnumVal ord="5">off</EnumVal>
</EnumType>
<EnumType id="ClcIntvTyp">
        <EnumVal ord="1">MS</EnumVal>
        <EnumVal ord="2">PER_CYCLE</EnumVal>
        <EnumVal ord="3">CYCLE</EnumVal>
        <EnumVal ord="4">DAY</EnumVal>
        <EnumVal ord="5">WEEK</EnumVal>
        <EnumVal ord="6">MONTH</EnumVal>
        <EnumVal ord="7">YEAR</EnumVal>
        <EnumVal ord="8">EXTERNAL</EnumVal>
</EnumType>
<EnumType id="ClcMth">
        <EnumVal ord="1">UNSPECIFIED</EnumVal>
        <EnumVal ord="2">TRUE_RMS</EnumVal>
        <EnumVal ord="3">PEAK_FUNDAMENTAL</EnumVal>
        <EnumVal ord="4">RMS_FUNDAMENTAL</EnumVal>
        <EnumVal ord="5">MIN</EnumVal>
        <EnumVal ord="6">MAX</EnumVal>
        <EnumVal ord="7">AVG</EnumVal>
        <EnumVal ord="8">SDV</EnumVal>
        <EnumVal ord="9">PREDICTION</EnumVal>
        <EnumVal ord="10">RATE</EnumVal>
</EnumType>
<EnumType id="ClcMod">
        <EnumVal ord="1">TOTAL</EnumVal>
        <EnumVal ord="2">PERIOD</EnumVal>
        <EnumVal ord="3">SLIDING</EnumVal>
</EnumType>
<EnumType id="ClcRfTyp">
        <EnumVal ord="1">MS</EnumVal>
        <EnumVal ord="2">PER_CYCLE</EnumVal>
        <EnumVal ord="3">CYCLE</EnumVal>
        <EnumVal ord="4">DAY</EnumVal>
        <EnumVal ord="5">WEEK</EnumVal>
        <EnumVal ord="6">MONTH</EnumVal>
        <EnumVal ord="7">YEAR</EnumVal>
        <EnumVal ord="8">EXTERNAL</EnumVal>
</EnumType>
<EnumType id="ClcTotVA">
        <EnumVal ord="1">Vector</EnumVal>
        <EnumVal ord="2">Arithmetic</EnumVal>
</EnumType>
<EnumType id="CBOpCap">
        <EnumVal ord="1">None</EnumVal>
```

```
        <EnumVal ord="2">Open</EnumVal>
        <EnumVal ord="3">Close-Open</EnumVal>
        <EnumVal ord="4">Open-Close-Open</EnumVal>
        <EnumVal ord="5">Close-Open-Close-Open</EnumVal>
        <EnumVal ord="6">Open-Close-Open-Close-Open </EnumVal>
        <EnumVal ord="7">more</EnumVal>
</EnumType>
<EnumType id="CycTrMod">
        <EnumVal ord="1">three phase tripping</EnumVal>
        <EnumVal ord="2">one ot three phase tripping</EnumVal>
        <EnumVal ord="3">specific</EnumVal>
</EnumType>
<EnumType id="DirMod">
        <EnumVal ord="1">NonDirectional</EnumVal>
        <EnumVal ord="2">Forward</EnumVal>
        <EnumVal ord="3">Reverse</EnumVal>
</EnumType>
<EnumType id="EEHealth">
        <EnumVal ord="1">Ok</EnumVal>
        <EnumVal ord="2">Warning</EnumVal>
        <EnumVal ord="3">Alarm</EnumVal>
</EnumType>
<EnumType id="FailMod">
        <EnumVal ord="1">Current</EnumVal>
        <EnumVal ord="2">Breaker Status</EnumVal>
        <EnumVal ord="3">Both current and breaker status</EnumVal>
        <EnumVal ord="4">Other</EnumVal>
</EnumType>
<EnumType id="FanCtl">
        <EnumVal ord="1">Inactive</EnumVal>
        <EnumVal ord="2">Stage 1</EnumVal>
        <EnumVal ord="3">Stage 2</EnumVal>
        <EnumVal ord="4">Stage 3</EnumVal>
</EnumType>
<EnumType id="FanCtlGen">
        <EnumVal ord="1">Inactive</EnumVal>
        <EnumVal ord="2">Stage 1</EnumVal>
        <EnumVal ord="3">Stage 2</EnumVal>
        <EnumVal ord="4">Stage 3</EnumVal>
</EnumType>
<EnumType id="FilTyp">
        <EnumVal ord="1">Low pass</EnumVal>
        <EnumVal ord="2">High pass</EnumVal>
        <EnumVal ord="3">Bandpass</EnumVal>
        <EnumVal ord="4">Bandstop</EnumVal>
        <EnumVal ord="5">Deadband</EnumVal>
</EnumType>
<EnumType id="FltLoop">
        <EnumVal ord="1">Phase A to Ground</EnumVal>
        <EnumVal ord="2">Phase B to Ground</EnumVal>
        <EnumVal ord="3">Phase C to Ground</EnumVal>
        <EnumVal ord="4">Phase A to B</EnumVal>
        <EnumVal ord="5">Phase B to C</EnumVal>
        <EnumVal ord="6">Phase C to A</EnumVal>
        <EnumVal ord="7">Other</EnumVal>
</EnumType>
<EnumType id="GnSt">
        <EnumVal ord="1">Stopped</EnumVal>
        <EnumVal ord="2">Stopping</EnumVal>
        <EnumVal ord="3">Started</EnumVal>
        <EnumVal ord="4">Starting</EnumVal>
        <EnumVal ord="5">Disabled</EnumVal>
</EnumType>
<EnumType id="Health">
        <EnumVal ord="1">Ok</EnumVal>
        <EnumVal ord="2">Warning</EnumVal>
        <EnumVal ord="3">Alarm</EnumVal>
</EnumType>
<EnumType id="IntrDetMth">
        <EnumVal ord="1">Voltage</EnumVal>
        <EnumVal ord="2">Voltage and Current </EnumVal>
        <EnumVal ord="3">Voltage and Normally Open Breaker Contact </EnumVal>
        <EnumVal ord="4">Voltage and Normally Closed Breaker Contact </EnumVal>
        <EnumVal ord="5">Voltage and both Normally Open and Normally Closed Breaker Contacts
        </EnumVal>
        <EnumVal ord="6"> Normally Open Breaker Contact </EnumVal>
        <EnumVal ord="7"> Normally Closed Breaker Contacts </EnumVal>
        <EnumVal ord="8"> Both Normally Open and Normally Closed Breaker Contacts </EnumVal>
```

```
</EnumType>
<EnumType id="LevMod">
        <EnumVal ord="1">Positive or Rising</EnumVal>
        <EnumVal ord="2">Negative or Falling</EnumVal>
        <EnumVal ord="3">Both</EnumVal>
        <EnumVal ord="4">Other</EnumVal>
</EnumType>
<EnumType id="LivDeaMod">
        <EnumVal ord="1">Dead Line, Dead Bus</EnumVal>
        <EnumVal ord="2">Live Line, Dead Bus</EnumVal>
        <EnumVal ord="3">Dead Line, Live Bus</EnumVal>
        <EnumVal ord="4">Dead Line, Dead Bus OR Live Line, DeadBus</EnumVal>
        <EnumVal ord="5">Dead Line, Dead Bus OR Dead Line, Live Bus</EnumVal>
        <EnumVal ord="6">Live Line, Dead Bus OR Dead Line, Live Bus</EnumVal>
        <EnumVal ord="7">Dead Line, Dead Bus OR Live Line, Dead Bus OR Dead Line, Live
        Bus</EnumVal>
</EnumType>
<EnumType id="MechHealth">
        <EnumVal ord="1">Ok</EnumVal>
        <EnumVal ord="2">Warning</EnumVal>
        <EnumVal ord="3">Alarm</EnumVal>
</EnumType>
<EnumType id="Mod">
        <EnumVal ord="1">on</EnumVal>
        <EnumVal ord="2">on-blocked</EnumVal>
        <EnumVal ord="3">test</EnumVal>
        <EnumVal ord="4">test/blocked</EnumVal>
        <EnumVal ord="5">off</EnumVal>
</EnumType>
<EnumType id="OpModRect">
        <EnumVal ord="1">Current control mode</EnumVal>
        <EnumVal ord="2">Voltage control mode</EnumVal>
        <EnumVal ord="3">Active power control mode</EnumVal>
</EnumType>
<EnumType id="ParColMod">
        <EnumVal ord="1"> Master/ Slave</EnumVal>
        <EnumVal ord="2">Master/ Slave with fixed slave position</EnumVal>
        <EnumVal ord="3">Master/ Slave with variable slave posiiton</EnumVal>
        <EnumVal ord="4">Parallel operation without communication</EnumVal>
</EnumType>
<EnumType id="ParMod">
        <EnumVal ord="1">Master</EnumVal>
        <EnumVal ord="2">Slave</EnumVal>
        <EnumVal ord="3">Independent</EnumVal>
</EnumType>
<EnumType id="ParTraMod">
        <EnumVal ord="1"> No Mode Predefined</EnumVal>
        <EnumVal ord="2"> Master</EnumVal>
        <EnumVal ord="3"> Follower</EnumVal>
        <EnumVal ord="4"> Power Factor</EnumVal>
        <EnumVal ord="5"> Negative Reactance</EnumVal>
        <EnumVal ord="6"> Circulating Current</EnumVal>
        <EnumVal ord="7"> Circulating Reactive Current</EnumVal>
        <EnumVal ord="8">
        Circulating Reactive Current By Equalizing Calculated Transformer Power Factor</EnumVal>
</EnumType>
<EnumType id="PIDAlg">
        <EnumVal ord="1">P</EnumVal>
        <EnumVal ord="2">I</EnumVal>
        <EnumVal ord="3">>D</EnumVal>
        <EnumVal ord="4">PI</EnumVal>
        <EnumVal ord="5">PD</EnumVal>
        <EnumVal ord="6">ID</EnumVal>
        <EnumVal ord="7">PID</EnumVal>
</EnumType>
<EnumType id="PFSign">
        <EnumVal ord="1">Active Power</EnumVal>
        <EnumVal ord="2">Lead/Lag</EnumVal>
</EnumType>
<EnumType id="PhyHealth">
        <EnumVal ord="1">Ok</EnumVal>
        <EnumVal ord="2">Warning</EnumVal>
        <EnumVal ord="3">Alarm</EnumVal>
</EnumType>
<EnumType id="PmpCtl">
        <EnumVal ord="1">Inactive</EnumVal>
        <EnumVal ord="2">Stage1</EnumVal>
        <EnumVal ord="3">Stage2</EnumVal>
```

```
        <EnumVal ord="4">Stage3</EnumVal>
</EnumType>
<EnumType id="PmpCtlGen">
        <EnumVal ord="1">Inactive</EnumVal>
        <EnumVal ord="2">Stage1</EnumVal>
        <EnumVal ord="3">Stage2</EnumVal>
        <EnumVal ord="4">Stage3</EnumVal>
</EnumType>
<EnumType id="PolQty">
        <EnumVal ord="1">None</EnumVal>
        <EnumVal ord="2">Zero Sequence Current</EnumVal>
        <EnumVal ord="3">Zero Sequence Voltage</EnumVal>
        <EnumVal ord="4">Negative Sequence Voltage</EnumVal>
        <EnumVal ord="5">Phase to Phase Voltages</EnumVal>
        <EnumVal ord="6">Phase to Ground Voltages</EnumVal>
        <EnumVal ord="7"> Positive sequence voltage </EnumVal>
</EnumType>
<EnumType id="POWCap">
        <EnumVal ord="1">None</EnumVal>
        <EnumVal ord="2">Close</EnumVal>
        <EnumVal ord="3">Open</EnumVal>
        <EnumVal ord="4">Close and Open</EnumVal>
</EnumType>
<EnumType id="OpModSyn">
        <EnumVal ord="1"> Automatic synchronising mode </EnumVal>
        <EnumVal ord="2"> Automatic paralleling mode </EnumVal>
        <EnumVal ord="3"> Manual mode</EnumVal>
        <EnumVal ord="4"> Test mode</EnumVal>
</EnumType>
<EnumType id="RcdMod">
        <EnumVal ord="1">Overwrite existing values</EnumVal>
        <EnumVal ord="2">Stop when full or saturated</EnumVal>
</EnumType>
<EnumType id="ReTrMod">
        <EnumVal ord="1">Off</EnumVal>
        <EnumVal ord="2">Without Check</EnumVal>
        <EnumVal ord="3">With Current Check</EnumVal>
        <EnumVal ord="4">With Breaker Status Check</EnumVal>
        <EnumVal ord="5">With Current and Breaker Status Check</EnumVal>
        <EnumVal ord="6">Other Checks</EnumVal>
</EnumType>
<EnumType id="RotDir">
        <EnumVal ord="1">Clockwise</EnumVal>
        <EnumVal ord="2">Counter-Clockwise</EnumVal>
        <EnumVal ord="3">Unknown</EnumVal>
</EnumType>
<EnumType id="RstMod">
        <EnumVal ord="1">None</EnumVal>
        <EnumVal ord="2">Harmonic2</EnumVal>
        <EnumVal ord="3">Harmonic5</EnumVal>
        <EnumVal ord="4">Harmonic2and5</EnumVal>
        <EnumVal ord="5">WaveformAnalysis</EnumVal>
        <EnumVal ord="6">WaveformAnalysisAndHarmonic2</EnumVal>
        <EnumVal ord="7"> Other</EnumVal>
        <EnumVal ord="8"> WaveformAnalysisAndHarmonic5</EnumVal>
        <EnumVal ord="9"> WaveformAnalysisAndHarmonic2AndHarmonic5</EnumVal>
</EnumType>
<EnumType id="ShOpCap">
        <EnumVal ord="1">None</EnumVal>
        <EnumVal ord="2">Open</EnumVal>
        <EnumVal ord="3">Close</EnumVal>
        <EnumVal ord="4">Open and Close</EnumVal>
</EnumType>
<EnumType id="SptEndSt">
        <EnumVal ord="1">Ended normally</EnumVal>
        <EnumVal ord="2">Ended with overshoot</EnumVal>
        <EnumVal ord="3">Cancelled: measurement was deviating</EnumVal>
        <EnumVal ord="4">Cancelled: loss of communication with dispatch centre</EnumVal>
        <EnumVal ord="5">Cancelled: loss of communication with local area network</EnumVal>
        <EnumVal ord="6">Cancelled: loss of communication with the local interface</EnumVal>
        <EnumVal ord="7">Cancelled: timeout</EnumVal>
        <EnumVal ord="8">Cancelled: voluntarily</EnumVal>
        <EnumVal ord="9">Cancelled: noisy environments</EnumVal>
        <EnumVal ord="10">Cancelled: material failure</EnumVal>
        <EnumVal ord="11">Cancelled: new set-point request</EnumVal>
        <EnumVal ord="12">Cancelled: improper environment (blockage)</EnumVal>
        <EnumVal ord="13">Cancelled: stability time was reached</EnumVal>
        <EnumVal ord="14">Cancelled: immobilisation time was reached</EnumVal>
```

```
            <EnumVal ord="15">Cancelled: equipment was in the wrong mode</EnumVal>
            <EnumVal ord="16">Unknown causes</EnumVal>
        </EnumType>
        <EnumType id="StrWeekDay">
            <EnumVal ord="1">Monday</EnumVal>
            <EnumVal ord="2">Tuesday</EnumVal>
            <EnumVal ord="3">Wednesday</EnumVal>
            <EnumVal ord="4">Thursday</EnumVal>
            <EnumVal ord="5">Friday</EnumVal>
            <EnumVal ord="6">Saturday</EnumVal>
            <EnumVal ord="7">Sunday</EnumVal>
        </EnumType>
        <EnumType id="StClcTun">
            <EnumVal ord="1">Not tuned</EnumVal>
            <EnumVal ord="2">Tuned</EnumVal>
            <EnumVal ord="3">Tuned but not compensated</EnumVal>
            <EnumVal ord="4">Umax</EnumVal>
            <EnumVal ord="5">Umax but not compensated</EnumVal>
            <EnumVal ord="6">Umax but not compensated due to U continous limitation</EnumVal>
        </EnumType>
        <EnumType id="SwOpCap">
            <EnumVal ord="1">None</EnumVal>
            <EnumVal ord="2">Open</EnumVal>
            <EnumVal ord="3">Close</EnumVal>
            <EnumVal ord="4">Open and Close</EnumVal>
        </EnumType>
        <EnumType id="SwTyp">
            <EnumVal ord="1">Load Break Switch</EnumVal>
            <EnumVal ord="2">Disconnector</EnumVal>
            <EnumVal ord="3">Earthing Switch</EnumVal>
            <EnumVal ord="4">High Speed Earthing Switch</EnumVal>
        </EnumType>
        <EnumType id="TnkTyp">
            <EnumVal ord="1">pressure only</EnumVal>
            <EnumVal ord="2">level only</EnumVal>
            <EnumVal ord="3">both pressure and level</EnumVal>
        </EnumType>     <EnumType id="TmSyn">
            <EnumVal ord="2">Synchronized by a global area clock signal</EnumVal>
            <EnumVal ord="1">Synchronized by a local area clock signal</EnumVal>
            <EnumVal ord ="0">Not synchronized by a global area clock signal</EnumVal>
        </EnumType>
        <EnumType id="TpcRxMod">
            <EnumVal ord="1">Unused</EnumVal>
            <EnumVal ord="2">Blocking</EnumVal>
            <EnumVal ord="3">Permissive</EnumVal>
            <EnumVal ord="4">Direct</EnumVal>
            <EnumVal ord="5">Unblocking</EnumVal>
            <EnumVal ord="6">Status</EnumVal>
        </EnumType>
        <EnumType id="TpcTxMod">
            <EnumVal ord="1">Unused</EnumVal>
            <EnumVal ord="2">Blocking</EnumVal>
            <EnumVal ord="3">Permissive</EnumVal>
            <EnumVal ord="4">Direct</EnumVal>
            <EnumVal ord="5">Unblocking</EnumVal>
            <EnumVal ord="6">Status</EnumVal>
        </EnumType>
        <EnumType id="TrBeh">
            <EnumVal ord="1">Single Pole Tripping</EnumVal>
            <EnumVal ord="2">Undefined</EnumVal>
            <EnumVal ord="3">Three Pole Tripping</EnumVal>
        </EnumType>
        <EnumType id="TrgMod">
            <EnumVal ord="1">Internal</EnumVal>
            <EnumVal ord="2">External</EnumVal>
            <EnumVal ord="3">Both</EnumVal>
        </EnumType>
        <EnumType id="TrMod">
            <EnumVal ord="1">3 Phase Tripping</EnumVal>
            <EnumVal ord="2">1 or 3 Phase Tripping</EnumVal>
            <EnumVal ord="3">Specific</EnumVal>
            <EnumVal ord="4">1 Phase Tripping</EnumVal>
        </EnumType>
        <EnumType id="TypRsCrv">
            <EnumVal ord="1">None</EnumVal>
            <EnumVal ord="2">Definite Time Delayed Reset</EnumVal>
            <EnumVal ord="3">Inverse Reset</EnumVal>
        </EnumType>
```

```
<EnumType id="UnbDetMth">
        <EnumVal ord="1">Negative Sequence</EnumVal>
        <EnumVal ord="2">Zero Sequence</EnumVal>
        <EnumVal ord="3">Negative Sequence / Positive Sequence</EnumVal>
        <EnumVal ord="4">Zero Sequence / Positive Sequence Direct</EnumVal>
        <EnumVal ord="5"> Phase vectors comparison</EnumVal>
        <EnumVal ord="6"> Others</EnumVal>
</EnumType>
<EnumType id="UnBlkMod">
        <EnumVal ord="1">Off</EnumVal>
        <EnumVal ord="2">Permanent</EnumVal>
        <EnumVal ord="3">Time window</EnumVal>
</EnumType>
<EnumType id="WeiMod">
        <EnumVal ord="1">Off</EnumVal>
        <EnumVal ord="2">Operate</EnumVal>
        <EnumVal ord="3">Echo</EnumVal>
        <EnumVal ord="4">Echo and Operate</EnumVal>
</EnumType>
```

Bibliography

IEC 60870-5-101, *Telecontrol equipment and systems – Part 5-101: Transmission protocols – Companion standard for basic telecontrol tasks*

IEC 60870-5-103, *Telecontrol equipment and systems – Part 5-103: Transmission protocols – Companion standard for the informative interface of protection equipment*

IEC 61000-4-30, *Electromagnetic compatibility (EMC) – Part 4-30: Testing and measurement techniques – Power quality measurement methods*

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

IEC 61850-7-410:2007, *Communication networks and systems for power utility automation – Part 7-410: Hydroelectric power plants – Communication for monitoring and control*

IEC 61850-7-420, *Communication networks and systems for power utility automation – Part 7-420: Basic communication structure – Distributed energy resources logical nodes*

IEC 61850-8 (all parts), *Communication networks and systems in substations – Part 8-x: Specific communication service mapping (SCSM)*

IEC 61850-9 (all parts), *Communication networks and systems in substations – Part 9-x: Specific communication service mapping (SCSM)*

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

IEEE-SA TR 1550-1999, *Utility Communications Architecture (UCA) Version 2.0, Part 4: UCA Generic object models for substation and feeder equipment (GOMSFE)*

CIGRE Report 34-03, *Communication requirements in terms of data flow within substations, December 1996*

———————

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

3, rue de Varembé
PO Box 131
CH-1211 Geneva 20
Switzerland

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