IEC TR 61850-90-3

Edition 1.0 2016-05

TECHNICAL REPORT

colour inside

Communication networks and systems for power utility automation – Part 90-3: Using IEC 61850 for condition monitoring diagnosis and analysis

IEC TR 61850-90-3:2016-05(en)

IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

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

IEC Catalogue - webstore.iec.ch/catalogue
The stand-alone application for consulting the entire bibliographical information on IEC International Standards, Technical Specifications, Technical Reports and other documents. Available for PC, Mac OS, Android Tablets and iPad.

IEC publications search - www.iec.ch/searchpub
The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee,…). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished
Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and also once a month by email.

Electropedia - www.electropedia.org
The world's leading online dictionary of electronic and electrical terms containing 20 000 terms and definitions in English and French, with equivalent terms in 15 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

IEC Glossary - std.iec.ch/glossary
65 000 electrotechnical terminology entries in English and French extracted from the Terms and Definitions clause of IEC publications issued since 2002. Some entries have been collected from earlier publications of IEC TC 37, 77, 86 and CISPR.

IEC Customer Service Centre - webstore.iec.ch/csc
If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: csc@iec.ch.

IEC TR 61850-90-3

Edition 1.0 2016-05

TECHNICAL REPORT

colour inside

Communication networks and systems for power utility automation – Part 90-3: Using IEC 61850 for condition monitoring diagnosis and analysis

INTERNATIONAL ELECTROTECHNICAL COMMISSION

ICS 33.200

ISBN 978-2-8322-3318-4

Warning! Make sure that you obtained this publication from an authorized distributor.

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

____

COMMUNICATION NETWORKS AND SYSTEMS FOR POWER UTILITY AUTOMATION –

Part 90-3: Using IEC 61850 for condition monitoring diagnosis and analysis

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.

The main task of IEC technical committees is to prepare International Standards. However, a technical committee may propose the publication of a technical report when it has collected data of a different kind from that which is normally published as an International Standard, for example "state of the art".

IEC TR 61850-90-3, which is a technical report, has been prepared by IEC technical committee 57: Power systems management and associated information exchange.

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

Enquiry draft	Report on voting
57/1522/DTR	57/1654/RVC

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

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

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

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC website 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

The CMD (Condition Monitoring Diagnosis) which diagnoses power grid health status has been one of the major issues to improve the reliability of the power system by preventing a potential failure in advance. Since too many different information modelling, information exchange, and configuration techniques for CMD in various forms from many vendors are currently used, they need to be standardized within the IEC.

IEC 61850 is intended to be used to communicate with the condition monitoring equipment. A seamless communication with the sensor network is also desirable.

COMMUNICATION NETWORKS AND SYSTEMS FOR POWER UTILITY AUTOMATION –

Part 90-3: Using IEC 61850 for condition monitoring diagnosis and analysis

1 Scope

Since the outcome of this work will affect several parts of IEC 61850, in a first step, this technical report has been prepared to address the topic from an application specific viewpoint across all affected parts of IEC 61850. This approach is similar to what is done as an example with IEC 61850-90-1 for the communication between substations. Once this technical report has been approved, the affected parts of the standard will be amended with the results from the report.

The major part of the work will consist in defining new logical nodes that contain the information for condition monitoring. It is important that the existing standards are analyzed with regard to information that is already available today. The information available in these logical nodes can as well be useful for asset management systems.

Another important aspect is a homogenous modelling approach that is to be used as well by other domains with a similar scope. Therefore, this technical report will include a chapter that describes the basic modelling approach that was used.

This technical report will address communication aspects related to specific sensor networks that are widely used as well as information exchange towards asset management systems where the IEEE PC37.239 is applicable, but it is not specific for the Condition Based Monitoring.

Several IEC technical committees cooperate to achieve harmonized (unified) models for CMD applications. Other areas of IEC work affected by the information contained in this technical report are: Overhead lines; Power transformers; Switchgear and controlgear; Electrical cables; Instrument transformers; and Wind turbines.

The parameters which are identifying this new namespace are:

- Namespace Version: 2015
- Namespace Revision: A
- UML model file which reflects this namespace edition: wg10uml02v18a-wg18uml02v11b-wg17uml02v17c-jwg25uml02v04c.eap, UML model version WG10UML02v18
- Namespace release date: 2015-10-05
- Namespace name: “(Tr)IEC61850-90-3:A”

The namespace “(Tr)IEC61850-90-3:A" is considered as "transitional" since the models are expected to be included in next editions of IEC 61850-7-4xx International Standards (IS). Potential extensions/modifications may happen if/when the models are moved to the International Standard status. Only the new data objects and CDCs which are not said to be inherited from existing LNs will be tagged with this namespace name. The others should still refer to the namespace where they are primarily defined."

Clauses 13 through 15 and their subclauses including XML enumerations are automatically generated from the UML model.

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

IEC 61850-5:2013, *Communication networks and systems for power utility automation – Part 5: Communication requirements for functions and devices models 3*

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

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

IEC 62271-203:2011, *High-voltage switchgear and controlgear – Part 203: Gas-insulated metal-enclosed switchgear for rated voltages above 52 kV*

3 Terms, definitions, abbreviations, acronyms and conventions

3.1 Terms and definitions

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

3.1.1
sensor
device that measures a physical quantity and converts it into a (digital) signal which can be read by an observer or by an instrument.

3.1.2
expert system
computer that contains the knowledge and analytical skills of one or more human experts, related to a specific subject

3.1.3
water tree
phenomenon that could lead to insulation degradation or breakdown by penetration of water or foreign materials into cable jacket

3.1.4
line sensor unit
sensor unit composed of current, temperature, and wind, etc. to supervise the overhead line

3.1.5
cable
a bundle of insulated wires through which an electric current can be passed. Cable types are gas, oil, solid state, etc.

3.1.6
overhead line
wire through which an electric current can be passed

3.1.7
wire
usually pliable metallic strand or rod made in many lengths and diameters, sometimes clad and often electrically insulated, used chiefly to conduct electricity.

3.1.8
ERP
Enterprise Resource Planning
amalgamation of a company's information systems designed to bind more closely a variety of company functions including human resources, inventories and financials while simultaneously linking the company to customers and vendors

3.1.9
asset management
process that involves various things in the company both in the form of asset or human resources who work there; a collective investment whose objective is to provide maximum results at minimum investment or low cost

3.2 Abbreviations, acronyms and conventions

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".

Table 1 shows normative terms that are combined to create data object names.

Table 1 – Normative abbreviations for data object names

Term	Description
A	Current; phase A (L1)
AC	AC, alternating current
AWatt	Wattmetric component of current
Abr	Abrasion
Abs	Absolute
Absb	Absorbing
Acc	Accuracy; acceleration
Accm	Accumulated
Ack	Acknowledgement, acknowledge
Acs	Access
Act	Action, activity, active, activate
Actr	Actuator
Acu	Acoustic
Adj	Adjustment
Adp	Adapter, adaptation
Aff	Affected
Age	Ageing
Ahr	Ampere hours
Air	Air
Alg	Algorithm
Alm	Alarm
Als	Alarm set
Alt	Altitude

Term	Description
Amnt	Amount
Amp	Ampere, current DC or non-phase-related AC
An	Analogue
Anc	Ancillary
Ane	Anemometer
Ang	Angle
Ap	Access point
Apc	Analogue point control
App	Apparent
Ar	Amperes reactive (reactive current)
Arc	Arc
Area	Area
Arr	Array
At	At
Asyn	Asynchronous
Auth	Authorisation
Auto	Automatic
Aux	Auxiliary
Av	Average
Avl	Availability
Ax	Axial
Azi	Azimuth
B	Bushing; phase B (L2)
BG	Before Gain
Bac	Binary-controlled analogue value
Bar	Barrier
Base	Base
Bat	Battery
Bck	Backup
Bec	Beacon
Beh	Behaviour
Ber	Bit error rate
Bias	Bias
Bl	Blade
Blb	Bulb
Blk	Block, blocked
Blow	Blowby
Bnd	Band, bandwidth
Boil	Boiler
Bot	Bottom
Brcb	Buffered report control block
Brg	Bearing
Brk	Brake
Bsc	Binary status control

Term	Description
Bst	Boost
Bt	Heartbeat
Bub	Bubbling
Bus	Bus
Byp	Bypass
C	Carbon; phase C (L3)
C2H2	Acetylene
C2H4	Ethylene
C2H6	Ethane
CB	Circuit breaker
CE	Cooling equipment (see also Cl)
CG	Core ground
CH4	Methane
CHP	Combined heat and power
CO	Carbon monoxide
CO2	Carbon dioxide
Cab	Cable
Cal	Calorie, caloric
Cam	Cam, e.g. rotating non-circular disk
Cap	Capability, capacity
Capac	Capacitance
Car	Carrier
Cbr	Calibration
Ccw	Counter clockwise
Ccy	Currency
Cds	Condensation
Ceil	Ceiling
Cel	Cell
Cf	Crest factor
Cff	Coefficient
Cfg	Configuration
Cg	Combusted Gas
Ch	Channel
Cha	Charger
Chg	Change
Chk	Check
Chr	Characteristic
Circ	Circulating, circuit
Cl	Cooling, coolant, cooling system (see also CE)
Clc	Calculate, calculated
Cloud	Cloud
Clr	Clear
Cls	Close, closed
Cm	Centimetres

Term	Description
Cmbu	Combustible, combustion
Cmd	Command
Cmpl	Completed, completion, complete
Cmut	Commute, commutator
Cndct	Conductivity
Cnt	Counter
Cntt	Contractual
Cnv	Converter
Col	Coil
Comm	Communication
Comp	Compensation
ConfRev	Configuration revision (confRev from IEC 61850-7-2)
Conn	Connected, connections
Cons	Constant (general)
Cor	Correction
Core	Core
Cost	Cost
Crank	Crank
Crd	Coordination
Crit	Critical
Crl	Correlation
Crp	Creeping, slow movement
Crv	Curve
Csmp	Consumption, consumed
Ctl	Control
Ctr	Center
Cum	Cumulative
Cur	Current
Cut	Cut, cut-out, cut-in
Cvr	Cover, cover level
Cw	Clockwise
Cwb	Crowbar
Cyc	Cycle
D	Derivate
DC	DC, direct current
DER	Distributed energy resource
DExt	De-excitation
DPCSO	Double point controllable status output
DQ0	Direct, quadrature, and zero axis quantities
DS	Device state
DT	Daylight saving time
Dam	Dam
Damp	Damping
Date	Date, date and time of action

Term	Description
Day	Day
Db	Deadband
Dcl	DC-link
Dct	Direct
De	De (prefix)
Dea	Dead
Dec	Decrease
Deg	Degree
Dehum	De-humidifier
Del	Delta
Den	Density
Dep	Dependent
Det	Detected
Detun	Detuning
Dev	Device
Dew	Dew
Dff	Diffuse
Dfl	Deflector (used in Pelton turbines)
Dia	Diaphragm
Diag	Diagnostics
Dif	Differential, difference
Dig	Digital
Dip	Dip
Dir	Direction
Dis	Distance
Dist	Distribution
Dith	Dither
Dl	Delay
Dlt	Delete
Dlv	Delivery
Dmd	Demand
Dn	Down, downstream
Dpc	Double point control
Dpt	Departure
Drag	Drag hand
Dropout	Dropout
Drp	Droop
Drt	Derate
Drtb	Draft tube
Drv	Drive
Dsc	Discrepancy
Dsch	Discharge
Dscon	Disconnected
Dsp	Displacement

Term	Description
Dtc	Detection
Dur	Duration
Dust	Dust
Dv	Deviation
Dyn	Dynamic
Dw	Delta Omega
ECP	Electrical connection point
EE	External equipment
EF	Earth fault
EFN	Earth-fault neutrilizer (Petersen coil)
EV	Electrical Vehicle
EVSE	EV Supply Equipment
Echo	Echo
Efc	Efficiency
El	Elevation
Ela	Elasticity
Em	Emission
Emg	Emergency
En	Energy
Ena	Enabled, enable, allow operation
Enc	Enumerated control
Encl	Enclosure
End	End
Eng	Engine
Env	Environment
Eq	Equalization, equal, equivalent
Err	Error
Est	Estimated
Ev	Evaluation
Evn	Even
Evt	Event
Ex	External
ExIm	Export/import
Exc	Exceeded
Excl	Exclusion
Exp	Expired
Exps	Expansion
Expt	Export
Ext	Excitation
F	Float
FA	Fault arc
FPM	Fuel processing module
Fa	"Fire all" sequence (to thyristors)
Fact	Factor

Term	Description
Fail	Failure
Fan	Fan
Fbc	Field breaker configuration
Fer	Frame error rate
Fil	Filter, filtration system
Fire	Fire
Fish	Fish
Fix	Fixed
Fld	Field
Fll	Fall
Flm	Flame
Flood	Flood
Flsh	Flash, flashing
Flt	Fault
Flush	Flush
Flw	Flow, flowing
Fol	Follower, following
Forc	Forced
Fu	Fuse
Fuel	Fuel
Full	Full
Fwd	Forward
Gain	Gain
Gas	Gas
Gbx	Gearbox
Gdv	Guide vane
Gen	General
Gn	Generator
Gnd	Ground
GoCBRef	GOOSE control block reference
Gocb	GOOSE control block
Gr	Group
Gra	Gradient
Grd	Guard
Gri	Grid
Gross	Gross
Gs	Grease
Gte	Gate
Gust	Gust
H	Harmonics (phase-related)
H2	Hydrogen
H2O	Water (chemical aspect: liquid, steam, etc.)
HP	Hot point
HPh	Harmonics phase

Term	Description
Ha	Harmonics (non-phase-related AC)
Hd	Head
Hdr	Hydrological, hydro, water
Health	Health
Heat	Heater, heating, heat (see also Ht)
Hi	High, highest
Hlf	Half
Hold	Hold
Hor	Horizontal
Horn	Horn
Ht	Heating, heating system (see also Heat)
Htex	Heat-exchanger
Hub	Hub
Hum	Humidity
Hy	Hydraulic, hydraulic system
Hyd	Hydrological, hydro, water
Hys	Hysteresis
Hz	Frequency
Hz1	Frequency at side 1
Hz2	Frequency at side 2
I	Integral, integration
ISCSO	Integer status controllable status output
Ia	Information available
Iafm	Information available force majeure
Iano	Information available non-operative
Ianofo	Information available non-operative forced outage
Ianopca	Information available non-operative planned corrective action
Ianos	Information available non-operative suspended
Ianosm	Information available non-operative scheduled maintenance
Iao	Information available operative
Iaog	Information available operative generating
Iaogfp	Information available operative generating with full performance
Iaogpp	Information available operative generating with partial performance
Iaong	Information available operative non-generating
Iaongel	Information available operative non-generating out of electrical specification
Iaongen	Information available operative non-generating out of environment specification
Iaongrs	Information available operative non-generating requested shutdown
Iaongts	Information available operative non-generating technical standby
Ice	Ice
Id	Identity, identifier
Imb	Imbalance
Imp	Impedance non-phase-related AC
Impact	Impact
Impt	Import

Term	Description
In	Input
Ina	Inactivity
Inc	Integer control
Incl	Inclination
Incr	Increment, increase
Ind	Indication
Indp	Independent
Iner	Inertia
Inh	Inhibit
Inl	Inline
Inlet	Inlet
Inn	Inner
Ins	Insulation
Insol	Insolation
Inst	Instantaneous
Int	Integer
Intn	Internal
Intr	Interrupt, interruption
Intv	Interval
Inv	Inverter, inverted, inverse
Isc	Integer status control
Isld	Islanded
Iso	Isolation
Iu	Information unavailable
Ix	Index
Jmp	Jump
Jnt	Joint
K	Constant (regulation)
K0Fact	Zero-sequence (residual) compensation factor
KFact	K factor (harmonics)
Kck	Kicker
Key	Key, physical control device
L	Lower (action)
LDC	Line drop compensation
LDCR	Line drop compensation resistance
LDCX	Line drop compensation reactance
LDCZ	Line drop compensation impedance
LED	Light-emitting diode
LTC	Load tap changer
Last	Last
Ld	Lead
Len	Length
Let	Let-thru
Lev	Level

Term	Description
Lft	Lifting, lift
Lg	Lag
Life	Lifetime
Lim	Limit
Lin	Line
Liv	Live
Lkd	Locked
Lkg	Leakage
Ll	Last long (interval)
Lo	Low (state or value)
Loc	Local
Locb	Log control block
Lod	Load, loading
Log	Log
Lok	(use Lkd instead) Locked
Loop	Loop
Los	Loss
Ls	Last short (interval)
Lst	List
Lu	Lubrication
Lub	Lubrication
Lum	Luminosity
M	Minutes
Made	Made
Mag	Magnetic, magnitude
Maint	Maintenance
Man	Manual
Mat	Material
Max	Maximum
Mbr	Membrane
Md	Motor drive
Mdul	Module
Mech	Mechanical
Media	Media
Mem	Memory
Min	Minimum
Mlt	Multiple
Mns	Mains
Mod	Mode
Mot	Motor
Mrk	Market
Mrg	Margin
Mst	Moisture
Msvcb	Multicast sampled values control block

Term	Description
Mth	Method
Mult	Multiplier
Mvm	Movement, moving
Mx	Maximum
N2	Nitrogen
NOx	Nitrogen oxide
NQS	Average partial discharge current
Nam	Name
Name	Name (reserved for use in data objects EEName and LNName only)
Ndl	Needle (used in Pelton turbines)
NdsCom	Needs commissioning
Neut	Neutral
Ng	Negative
Nhd	Net head
Night	Night
No	No, not
Nom	Nominal, normalising
Num	Number
Nxt	Next
O2	Oxygen
O3	Ozon, trioxygen
Obl	Obligation
Oc	Open circuit
Odd	Odd
Of	Offline
Off	Off, device disengaged, not running
Ofs	Offset
Oil	Oil
On	On, device applied, running
Oo	Out of
Op	Operate, operating, operation
Operate	Operate order to any device
Opn	Open, opened
Out	Output
Ov	Over, override, overflow
Ovl	Overload
Ox	Oxidant
P	Proportional
PF	Power factor
PH	Acidity, value of pH
PNV	Phase-to-neutral voltage
POW	Point on wave switching
PP	Phase to phase
PPV	Phase to phase voltage

Term	Description
PT1	Low-pass exponential time rate filter
Pa	Partial
Pair	Pair, paired
Pap	Paper
Par	Parallel
Pas	Passive
Pcb	Power quality qualifier bin
Pct	Percent, percentage
Pdm	Power quality demodulation
Pe	Electric Power
Per	Periodic, period
Ph	Phase to reference
Phs	Phase
Phy	Physical
Pi	Instantaneous real power
Pin	Pin
Pipe	Pipe
Pk	Peak
Pl	Plant
Plg	Plug
Pls	Pulse
Plt	Plate; long-term flicker severity
Pmp	Pump
Po	Polar
Pol	Polarizing
Polytr	Polytrophic
Pos	Position
Pot	Potentiometer
Prc	Price, pricing
Pre	Pre-
Prec	Precondition, initial status
Pres	Pressure
Prg	Progress, in progress
Prm	Permissive
Prs	Presence
Pro	Protection
Proc	Process
Proxy	Proxy
Prt	Parts, part
Ps	Positive
Psk	Penstock
Pss	PSS, power system stabiliser function
Pst	Post, short-term flicker severity
Pt	Point

Term	Description
Pth	Pitch
Pwr	Power
Qty	Quantity
Qu	Queue
Qud	Quad
R	Raise, increase
Rad	Radiation
Ral	Rail
Ramp	Ramp
Rat	Ratio
Rb	Runner blade
Rcd	Record, recording
Rch	Reach
Rcl	Reclaim
Rct	Reaction
Rdy	Ready
Re	Retry
React	Reactance, reactive
Rec	Reclose
Rec1	Reclose after single phase fault
Rec13	Reclose after evolving fault
Rec3	Reclose after three phase fault
Recha	Recharge, recharging
Rect	Rectifier
Red	Redundant; (deprecated meaning) reduction
Ref	Reference
Reg	Regulation
Rel	Release
Req	Requested
Res	Residual
Reso	Resonance
Rf	Refreshment
Ridth	Ride-through
Ris	Resistance
Rl	Relation, relative
Rm	Mutual resistance
Rmp	Ramping, ramp
Rms	Root mean square
Rn	Rain
Rnbk	Runback
Rng	Range
Rod	Rod
Root	Root
Rot	Rotation, rotor

Term	Description
Rpt	Repeat, repetition
Rs	Reset, resettable
Rsl	Result
Rst	Restraint, restriction
Rsv	Reserve
Rte	Rate
Rtg	Rating
Run	Run
Rv	Reverse
Rvrt	Revert
Rwy	Runaway, e.g. in runaway speed
Rx	Receive, received
S10	Coefficient S1.0
S12	Coefficient S1.2
SM	Servo, servo-motor
SNL	Speed-no-load, connected but not generating
SOx	Sulphur oxide
SPCSO	Single point controllable status output
SPl	Single pole/phase
ST	Standard time
Saf	Safety
Sag	Sag
Sar	Surge arrestor
Sat	Saturation
Sc	Short circuit
Scale	Scale
Schd	Schedule
Sco	Supply change over
Sec	Security
Sel	Select
Self	Self
Seq	Sequence
Ser	Series, serial
Set	Setting
Sq	Square
Sgcb	Setting group control block
Sh	Shunt
Shar	Shared
Shft	Shaft
Sig	Signal
Sign	Sign
Sim	Simulation, simulated
Sld	Solidity
Slnt	Salinity, saline content

Term	Description
Slp	Sleep; slip
Smok	Smoke
Smp	Sampling
Snd	Sound pressure
Snpt	Snapshot
Snr	Signal to noise ratio
Snw	Snow
Soc	State of charge
Sof	Switch on to fault
Spc	Single point control
Spcf	Specific
Spd	Speed
Spec	Spectra
Spir	Spiral
Spt	Setpoint
Src	Source
Srfc	Surface
St	Status, state
Sta	Station, function at plant level
Stab	Stabilizer
Stat	Statistics
Stc	Stack
Std	Standard
Stdby	Standby
Step	Step
Stk	Stroke
Stl	Still, not moving
Stnd	Stand, standing
Sto	Storage, e.g. activity of storing data
Stop	Stop
Storm	Storm
Stow	Stow
Str	Start
Strg	String
Stt	Stator
Stuck	Stuck, cannot move
Sub	Sub
Sum	Sum
Sup	Supply
Sv	Sampled value
SvCBRef	SV control block reference
Svc	Service
Sw	Switch, switched
Swg	Swing

Term	Description
Swl	Power quality event swell
Syn	Synchronisation, synchronous, synchronism, synchrocheck
Sys	System
TP	Three pole/phase
Ta	Armature time constant
Tag	Tag (maintenance work in progress)
Tan	Tangent
Tap	Tap
Task	Task
Td	Transformer derating
Td0p	Td0'
Td0s	Td0''
Tdd	Total demand distortion
Tdf	Transformer derating factor
Tdp	Td'
Tds	Td''
Tech	Technology
Term	Termination
Test	Test
Tgt	Target
Thd	Total harmonic distortion
Thm	Thermal
Ti	Telephone influence
Tilt	Tilt
Tm	Time
Tm1	Time constant 1
Tm2	Time constant 2
Tm3	Time constant 3
Tmh	Time in h
Tmm	Time in min
Tmms	Time in ms
Tmp	Temperature (°C)
Tms	Time in s
Tnk	Tank
Tns	Tension (stress)
Torq	Torque
Tot	Total
Tow	Tower
Tp	Test Point
Tpc	Teleprotection
Tq0p	Tq0'
Tq0s	Tq0''
Tqp	Tq'
Tqs	Tq''

Term	Description
Tr	Trip (electrical protection function)
Trb	Turbine
Trf	Transformer
Trg	Trigger
Trip	Trip (non-electrical function)
Trk	Track, tracking
Trs	Transient
Ts	Total signed
Tu	Total unsigned
Tun	Tuning
Tur	Turbine
Tx	Transmit, transmitted
Typ	Type
Ups	Uninterruptible power supply
Uhf	Ultra-high-frequency
Un	Un-; under
Unav	Unavailable
Unb	Unbalanced
Unld	Unload
Unt	Unit, production unit
Up	Up, upstream
Ups	Uninterruptible Power Supply
Urcb	Unbuffered report control block
Use	Use
Used	Used
Usvcb	Unicast sampled values control block
Util	Utility
V	Voltage
V1	Voltage at side 1
V2	Voltage at side 2
VA	Apparent power (volt amperes)
VAh	Apparent energy
VAr	Reactive power (volt amperes reactive)
VArh	Reactive energy
Va	Variation
Vac	Vacuum
Val	Value
Vbr	Vibration
Ver	Vertical
Viol	Violation
Vis	Visibility
Visc	Viscosity
Vlm	Volume
Vlv	Valve

Term	Description
Vol	Voltage DC or non-phase-related AC
VolAmpr	Non-phase-related AC reactive power
W	Active power
W200	Watts peak at 200 W/m2
Wac	Watchdog
Wash	Washout
Watt	Active power non-phase-related AC
Wav	Wave, waveform
Wd	Wind
Week	Week
Wei	Weak end infeed
Wet	Wet
Wgt	Weight
Wh	Watt hours
Wid	Width
Win	Window
Wnd	Winding
Wkup	Wake up
Wld	Welding
Wrm	Warm
Wrn	Warning
Wrs	Warning set
Wtr	Water (physical aspect: river, cooling, etc.)
Wup	Windup
X	Reactance (imaginary part of impedance)
X0	Zero sequence reactance
X1	Positive sequence reactance
X2	Negative sequence reactance X2
Xd	Synchronous reactance Xd
Xdir	X-direction
Xdp	Transient synchronous reactance Xd'
Xds	Subtransient reactance Xd''
Xm	Mutual reactance
Xq	Synchronous reactance Xq
Xqp	Transient synchronous reactance Xq'
Xqs	Subtransient reactance Xq''
Xsec	Cross-section
Ydir	Y-direction
Yw	Yaw
Z	Impedance
Zer	Zero
Zero	(use 'Zer' instead) Zero
Zm	Mutual impedance
Zn	Zone

Term	Description
Zro	Zero sequence
km	Kilometre
ppm	Parts per million

4 Use cases

The IEC 61850 based CMD modelling concept is shown in Figure 1, in which the modelling is done hierarchically from the bottom, the sensor device level to the upper level, the management decision level. Any use case in CMD shares the same designing concept which starts from condition monitoring through sensors to detect initial alarm (warning) points at the sensor level. In some cases, the CMD engine needs to process those sensed data statistically to decide another alarm (warning) point. The processing may involve another level of data crunching. In addition, the structured CMD information shall be provided for the asset management in RCC and/or NCC.

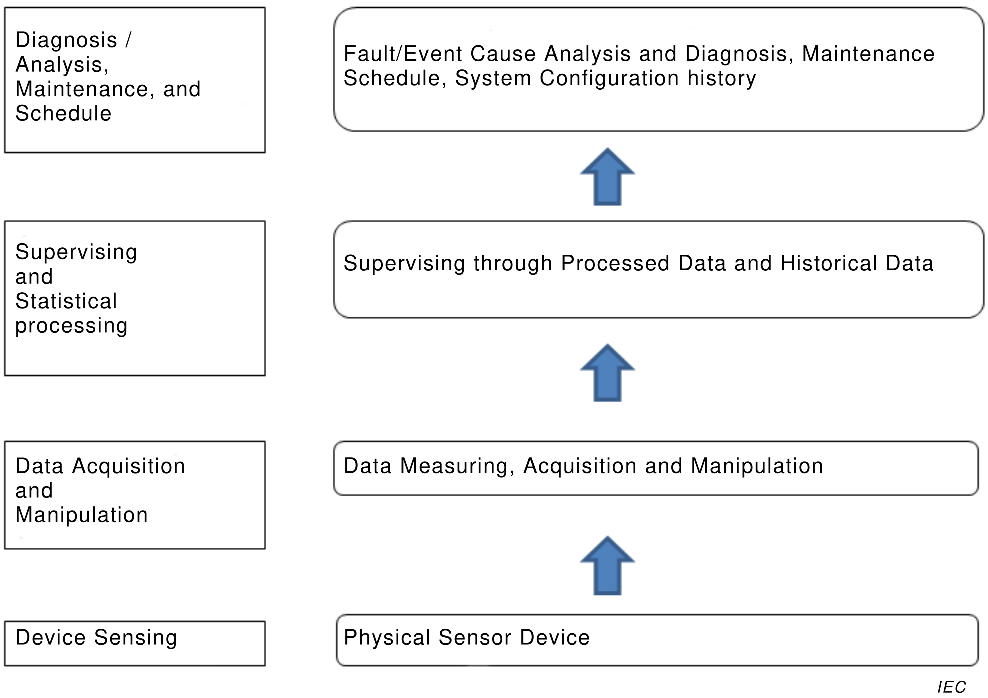


Figure 1 – CMD Modelling Concept

5 GIS (Gas Insulated Switchgear)

5.1 Summary

This clause describes different use cases for condition monitoring of gas insulated switchgear (GIS).

A condition monitoring system for GIS acquires condition data from sensors that are installed at the different GIS components. Typically the following GIS components are of interest:

- The circuit breaker including main contacts
- The operating mechanism of the circuit breaker
- All SF6 gas compartments

- Other HV switches of the GIS as disconnector or earth switches

The use cases described in this document are divided in

- Gas compartments
- Circuit Breakers and Switches
- Operating Mechanism

Due to different technologies of GIS components the type and amount of monitoring data can vary. Today especially for operating mechanisms several variants exist on the markets. Below are given some examples of possible technologies for specific components:

- Energy storing principle
  - Mechanical (spring)
  - Hydraulic (gas media)
  - Electrical (capacitors)
- Linkage between energy storage and piston
  - Mechanical
  - Hydraulic

In IEC 61850-7-4:2010 the Logical Nodes SSWI, SCBR, SOPM and SIMG are presented for GIS monitoring. These Logical Nodes cover all the possible data for different technologies. Nevertheless some new LNs are necessary to cover the sensor.

5.2 GIS overview

A GIS consists of several components as circuit breakers, disconnector switches, earthing switches and instrument transformers. All high voltage parts are encapsulated in separate compartments that contain the insulating medium. Typically this insulating medium is SF6 or gas mixture.

The insulation management is important and, usually two thresholds are used per compartment for control issues. In few cases in one phase encapsulated GIS a pipe can link the three compartments and only one sensor is used. In this case this use of this principle prevents the use of smart algorithms to detect leakage at the early stage or to detect an internal fault based on the pressure study as there is only one sensor.

The GIS interfaces to a control system that includes security functions as blocking and interlocking based on the insulation threshold. To control the GIS one or more operator HMIs (human machine interface) are accessible at different control levels (e.g. local, station level through network control).

In most cases a GIS Monitoring system is installed in parallel to the control system. However it is also possible that the monitoring system is included e.g. in a bay control device. In case of control real time has to be used for the threshold (around one second is sufficient).

The monitoring system gets signals from the GIS through sensors and/or indications and control signals. The results of the monitoring system can be sent to the operator HMI, a special monitoring (or maintenance) HMI.

The monitoring system can also help users to respect the last changes brought in the current revision of IEC 62271-203:2011, which defines that "Handling losses during installation, on-site tests and maintenance shall be recorded". Each refilling shall be recorded with indication of additional SF6 mass filled in the compartment". Figure 2 shows the overview of the GIS CMD.

Within this document it is assumed that the monitoring system is connected to an IEC 61850 station bus to present the results to maintenance HMI or other consuming systems.

In addition, the connection to the GIS can be accomplished using an IEC 61850 process bus.

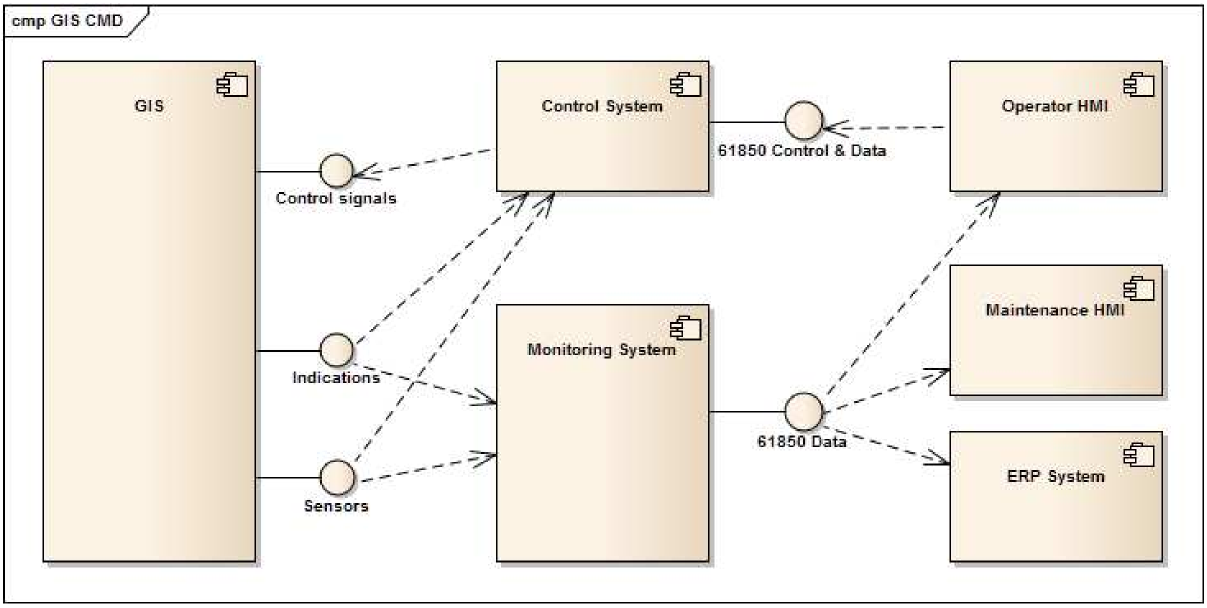


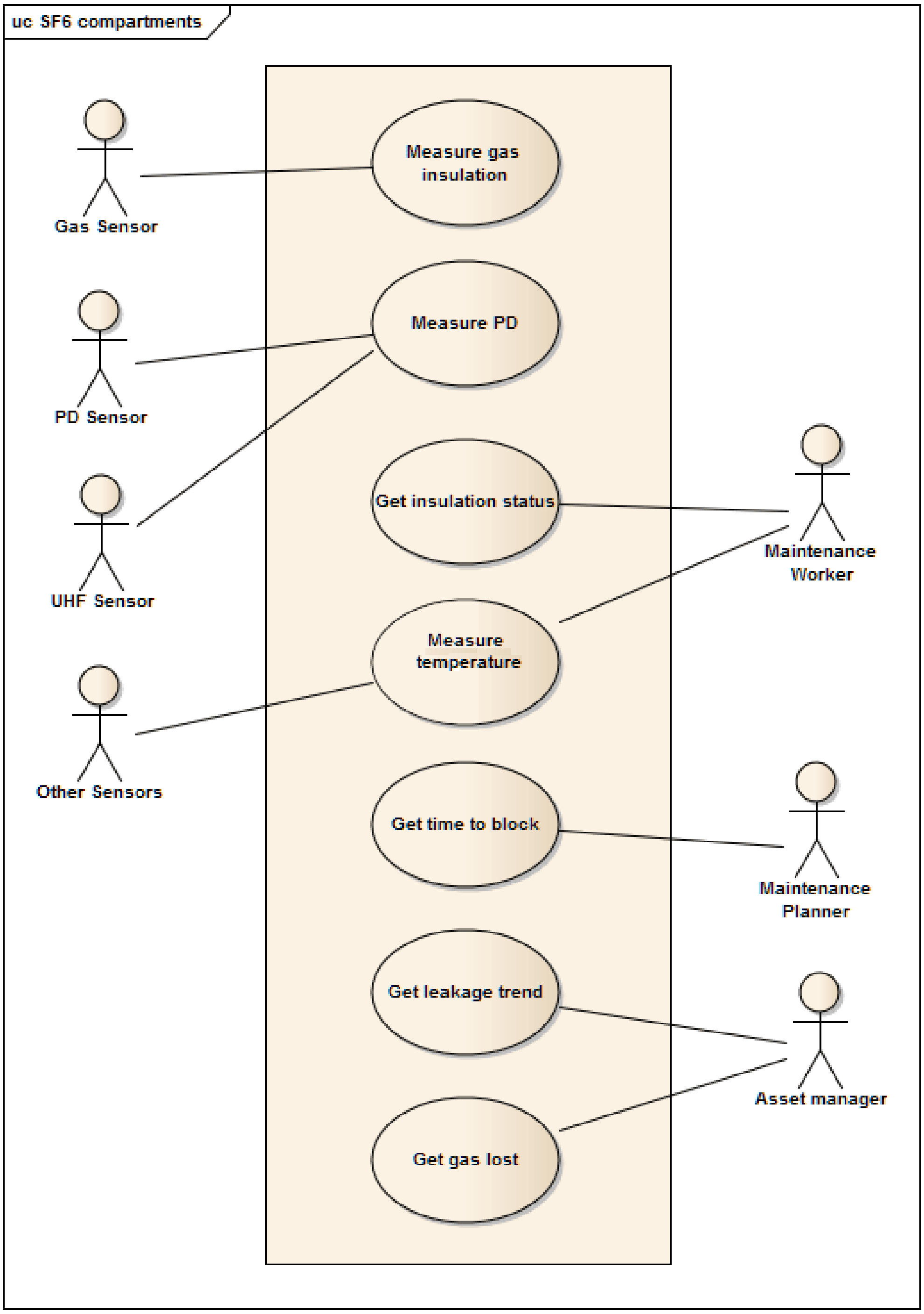
Figure 2 – GIS CMD Overview

5.3 GIS use case diagrams

5.3.1 Gas compartments

The following use cases are applied to all Gas compartments inside the substation. In principle besides SF6 other insulating media can be used.

The goal of the Monitoring is to detect leakages in an early stage. In case of a leakage it notifies maintenance planning. Furthermore it gives additional information to support repair works (see Figure 3).



IEC

Figure 3 – GIS use case diagram

Actor(s):

Name	Role description
Gas sensor	Measures the pressure and temperature inside a gas compartment of the GIS. Density calculation is performed by the sensor itself or by the IED's.
PD sensor	Measures the phi-q-N for partial discharge inside a gas compartment of the GIS
UHF sensor	Measure the PD activity using the UHF signal treatment. As the UHF sensor is fitted on a compartment, the UHF signal localization is not directly associated to this compartment.
Other sensors	Depending on the technology additional sensors can be used. Measures the moisture / SO_2, etc.
Maintenance worker	Inspects and repairs the GIS
Maintenance planner	Schedules maintenance work
Asset management	System used for asset management (Expert system, historian, maintenance planner, etc.)

Use case(s):

Name	Service or information provided
Measure gas insulation (SF6)	Diagnose the status of the gas with predefined setting value
Measure PD	Diagnose the status of the partial discharge with predefined setting value
Get insulation status	Diagnose the status of the insulation using actual density, density history, SF6 with predefined setting value
Get time to block (control)	Calculate the time until the blocking level is reached to the predefined setting value and provide results to the user
Get leakage trend	Calculate the leakage trend and compare with predefined settings value (0,5 % per year)
Get gas lost (asset management)	The mass of gas lost is calculated from the compartment volume and the leakage trend
Temperature supervision	Receive temperature from each compartment sensor; generate alarm when value is beyond programmed limit

Basic flow:

Measure gas insulation (SF6)

Use case step	Description
Step 1	Measure the density if a density sensor is used or measure the pressure and temperature of the insulating medium (SF6) and/or measure the moisture or other parameters
Step 2	Compare the measured value of density / pressure / temperature /moisture /… to limits and store results
Step 3	Provide the results to the user. Send a notification if a limit has been passed.

Measure PD method 1

Use case step	Description
Step 1	Measure the phi-q-N for partial discharge inside GIS compartment
Step 2	Compare the measured value to limits and store results
Step 3	Provide the results to the user Send a notification if a limit has been passed

Measure PD method2

Use case step	Description
Step 1	Measure the UHF signals from sensors (wide band or narrow band)
Step 2	Depending on the principle, calculate the average and the variance of the values
Step 3	Compare the measured value to limits and store results
Step 4	Provide the results to the user Send a notification if a limit has been passed

Get insulation status

Use case step	Description
Step 1	Get the results of density measurement/calculation – actual density value – history of density value
Step 2	Get the results of temperature measurement – actual temperature value – history of temperature value
Step 3	Get the results of pressure measurement – actual density value – history of density value
Step 4	Get the results of other measurements (moisture, quality, etc.) – actual value – history of value

Get time to block

Use case step	Description
Step 1	Get the results of density measurement and store them
Step 2	Calculate a leakage rate based on stored values
Step 3	Calculate the time until blocking level is reached based on leakage rate, actual density value and blocking limit
Step 4	Provide the result to the user Send a notification if time to block is below a certain limit

Get leakage trend (Asset management)

Use case step	Description
Step 1	Get the results of density measurement and store them
Step 2	Calculate a leakage trend based on stored values
Step 3	Provide the result to the user

Get gas lost (Asset management)

Use case step	Description
Step 1	Get the results of leakage trend per compartment and store them
Step 2	Calculate the gas mass lost with the knowledge of the compartment volume and the leakage trend
Step 3	Provide the result to the user

Measure temperature

Use case step	Description
Step 1	Receive temperature from sensors
Step 2	Generate alarm when measured or calculated value is beyond programmed limit

Pre-conditions:

In order to have a better result the density calculation has to be performed when the GIS is in stable condition (five o'clock in the morning for example).

5.3.2 Circuit breaker and switches

5.3.2.1 General

The following use cases are applied to all high voltage switching devices inside the substation. Typically abrasion monitoring is applied only to circuit breakers.

5.3.2.2 Abrasion monitoring

Goal of abrasion monitoring, as shown in Figure 4, is to calculate the effective wear on the main contacts, especially for circuit breakers.

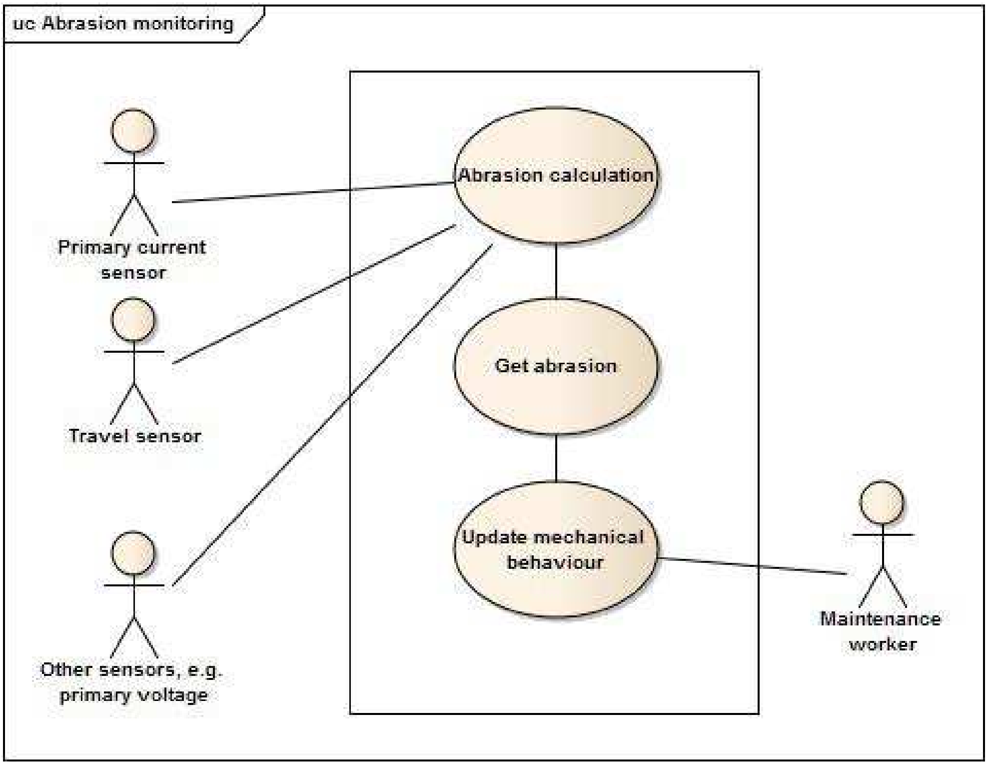


Figure 4 – Abrasion monitoring use case

Actor(s):

Name	Role description
Primary current sensor	Measures the primary current flow through main contacts of the circuit breaker
Travel sensor	Measures the movement of the main contact of the circuit breaker
Other sensors	Depending on the technology additional sensors can be used.
Maintenance worker	Inspects and repairs the switch gear

Use case(s):

Name	Service or information provided
Abrasion calculation	Measures the current and contact movement, calculates the abrasion, and sends notification to the user
Get abrasion	Get results from Abrasion calculation
Update mechanical behaviour	Measure the movement of the contact and provide results

Basic flow:

Abrasion calculation

Use case step	Description
Step 1	On each operation – Measure the current flow through each contact – Measure the contact movement (travel) – Optional: measure additional signals, e.g. voltage
Step 2	Calculate the abrasion of each contact for this operation
Step 3	Accumulate the abrasion
Step 4	Provide the results to the user Send a notification if a limit has been passed

Get abrasion

Use case step	Description
Step 1	Get results from Abrasion calculation

Update mechanical behaviour

Use case step	Description
Step 1	On each operation – Measure the movement of the contact – Optional: Measure the movement of the piston, energy level, motor current etc.
Step 2	Compare the measurements with normal behaviour
Step 3	Provide the results to the user Send a notification if a limit has been passed

5.3.2.3 Switch monitoring

Switch monitoring, as shown in Figure 5, allows the user to detect abnormal conditions on the switch before a regular maintenance is carried out. Furthermore it provides information to support maintenance planning.

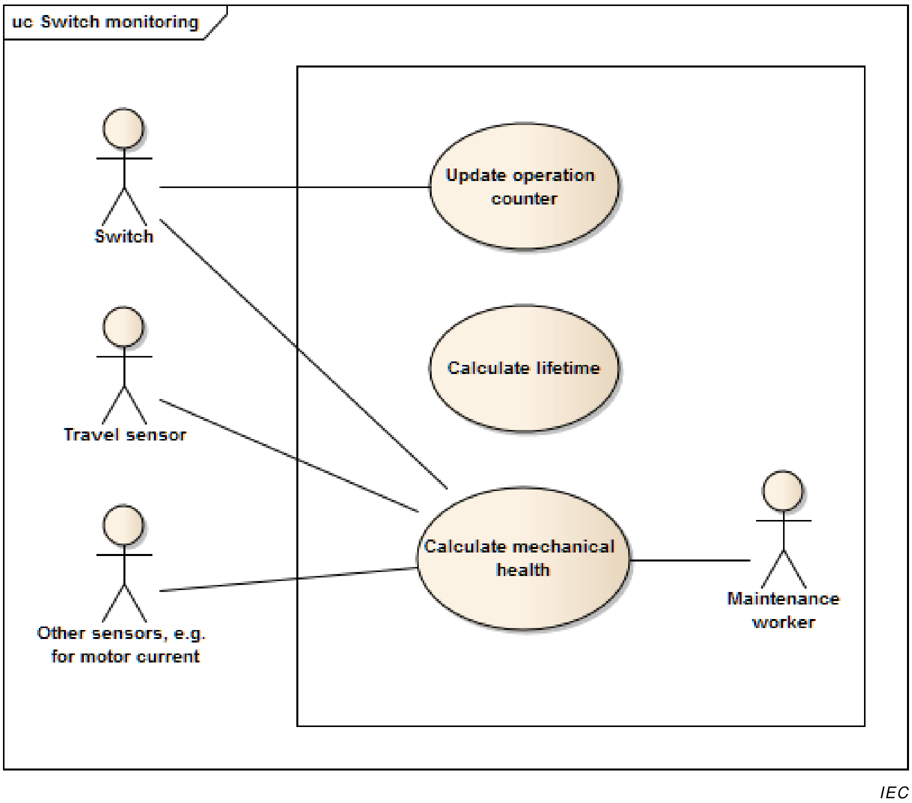


Figure 5 – Switch monitoring use case

Actor(s):

Name	Role description
Switch	Signalize the switch position to the monitoring system
Travel sensor	Measures the movement of the switch
Other sensors	Depending on the technology additional sensors can be used.
Maintenance worker	Inspects and repairs the switch gear

Use cases:

Name	Service or information provided
Update operation counter	Count the number of operations and notify the user if the number of operations exceeds the predefined limit.
Calculate mechanical health	From the collected information, i.e., travel sensor and other sensors, calculate the mechanical health.
Calculating lifetime	From the collected information, i.e., abrasion and operation counter, calculate the remaining life time based on existing wear and health.

Basic flow:

Update Operation counter

Use case step	Description
Step 1	Wait for a position change – or – Wait for operation command
Step 2	Increment the operation counter
Step 3	Compare the counter to given limits
Step 4	Provide the results to the user Send a notification if a limit has been passed

Calculate mechanical health

Use case step	Description
Step 1	Get information on the component Switch Travel sensor Other sensors, e.g., for motor current
Step 2	Calculating mechanical health
Step 3	Provide the results to the maintenance worker

Calculating Lifetime

Use case step	Description
Step 1	Get information on the component Lifetime Abrasion Operation count
Step 2	Calculating remaining lifetime based on previous operation duty
Step 3	Calculating remaining lifetime based on existing wear and health
Step 4	Estimate the time to overhaul or replacement
Step 5	Provide the results to the user Send a notification if a limit has been passed

5.3.3 Operating mechanism

5.3.3.1 Operating mechanism monitoring

Operating mechanism as shown in Figure 6 is mainly intended to help the operator to check the equipment's operating status.

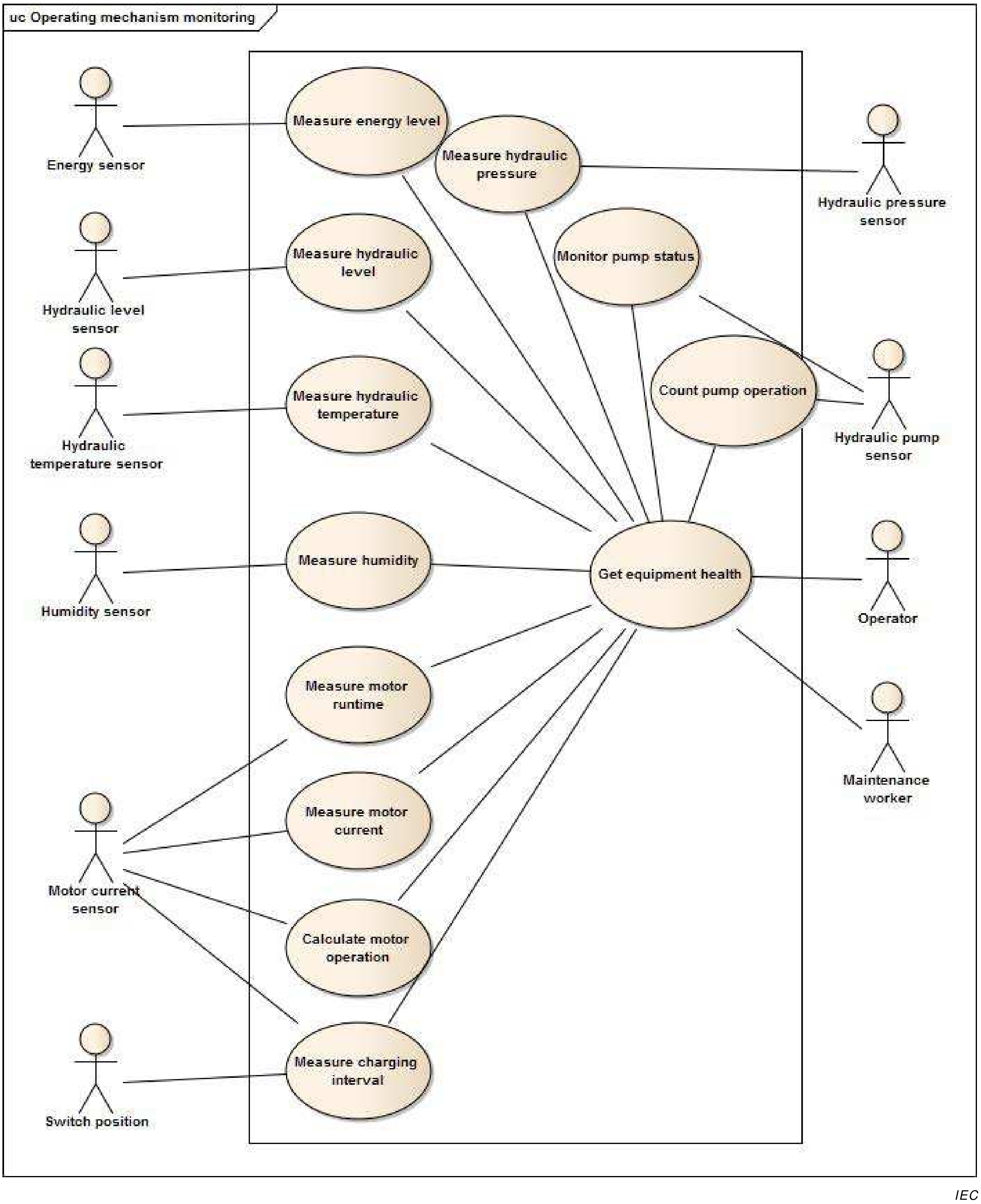


Figure 6 – Operating mechanism monitoring use case

Actor(s):

Name	Role description
Energy sensor	Measures the remaining energy in the operating mechanism. Typical operating mechanisms today use spring, hydraulics, or gas based energy storage.
Hydraulic level sensor	Measures the hydraulic level inside the operating mechanism. Hydraulics can be used either to transfer energy from energy storage to the main contact or to realize the energy storage itself.
Hydraulic temperature sensor	Measures the temperature of the hydraulic
Motor current sensor	Measures the current of a) the charging motor for the energy storage or b) the drive motor
Humidity sensor	Measures the humidity
Hydraulic pressure sensor	Measure the pressure of the hydraulic
Hydraulic pump sensor	Monitor the normal/abnormal status of the hydraulic pump
Switch position	Indicates the position of the connected switch
Operator	A special monitoring (or maintenance) HMI
Maintenance worker	Inspects and repairs the GIS

Use cases:

Name	Service or information provided
Measure energy level	Measure the energy level, calculate the blocking levels, and send a notification if a limit has been passed
Measure hydraulic level	Measure the hydraulic level and provide results to the user
Measure hydraulic temperature	Measure the hydraulic temperature and send a notification if a limit has been passed
Measure humidity	Measure the humidity in switchgear and send a notification if a limit has been passed
Measure motor runtime	Measure the motor runtime for spring or hydraulic charging and send a notification if a limit has been passed
Measure motor current	Measure the motor current and send a notification if a limit has been passed
Calculate motor operation	Increase the operation counter and send a notification if a limit has been passed
Measure hydraulic pressure	Measure the hydraulic pressure and send a notification if a limit has been passed
Monitor pump status	Monitor the pump status and send a notification if the status is abnormal
Count pump operations	Increase the operation counter and send a notification if a limit has been passed
Measure charging interval	Measure the time between each motor activation, determine the cause of motor activation, send a notification if a limit has been passed
Get equipment health	Get health information from the energy level, Hydraulic level, Hydraulic temperature, Motor runtime, Motor current, Operation count and Charging interval

Basic flow:

Measure energy level

Use case step	Description
Step 1	Measure the energy level
Step 2	Calculate blocking levels
Step 3	Provide the results to the user Send a notification if a limit has been passed

Measure the hydraulic level

Use case step	Description
Step 1	Measure the hydraulic level
Step 2	Calculate blocking levels
Step 3	Provide the results to the user Send a notification if a limit has been passed

Measure hydraulic temperature

Use case step	Description
Step 1	Measure the hydraulic temperature
Step 2	Compare to limits
Step 3	Provide the results to the user Send a notification if a limit has been passed

Measure humidity

Use case step	Description
Step 1	Measure the humidity in switchgear
Step 2	Compare to limits
Step 3	Provide the results to the user Send a notification if a limit has been passed

Measure motor runtime

Use case step	Description
Step 1	On each operation measure the motor runtime for spring or hydraulic charging
Step 2	Compare runtime to limits
Step 3	Provide the results to the user Send a notification if a limit has been passed

Measure motor current

Use case step	Description
Step 1	On each operation measure the motor current (either r. m. s., peak or other certain criteria)
Step 2	Compare current to limits
Step 3	Provide the results to the user Send a notification if a limit has been passed

Calculate motor operations

Use case step	Description
Step 1	Wait for a operation
Step 2	Increment the operation counter
Step 3	Compare the counter to given limits
Step 4	Provide the results to the user Send a notification if a limit has been passed

Measure charging interval

Use case step	Description
Step 1	Measure the time between each motor activation = charging interval
Step 2	Determine the cause of motor activation (operation or energy low). If cause is operation then abort
Step 3	Compare charging interval to limits
Step 4	Provide the results to the user Send a notification if a limit has been passed

Measure hydraulic pressure

Use case step	Description
Step 1	Measure the hydraulic pressure
Step 2	Compare to limits
Step 3	Provide the results to the user Send a notification if a limit has been passed

Monitor pump status

Use case step	Description
Step 1	Monitor the hydraulic pump status (normal or abnormal)
Step 2	Provide the results to the user Send a notification if the status is abnormal

Count pump operations

Use case step	Description
Step 1	Wait for a operation
Step 2	Increment the operation counter
Step 3	Compare the counter to given limits
Step 4	Provide the results to the user Send a notification if a limit has been passed

Get equipment health

Use case step	Description
Step 1	Get results from Energy level, Hydraulic level, Hydraulic temperature, Motor runtime, Motor current, Operation count and Charging interval
Step 2	Compare the results from step 1 with normal behaviour
Step 3	Provide the results to the user Send a notification if a limit has been passed

5.3.3.2 Maintenance planning

Maintenance planning as shown in Figure 7 is mainly intended to calculate time to maintenance.

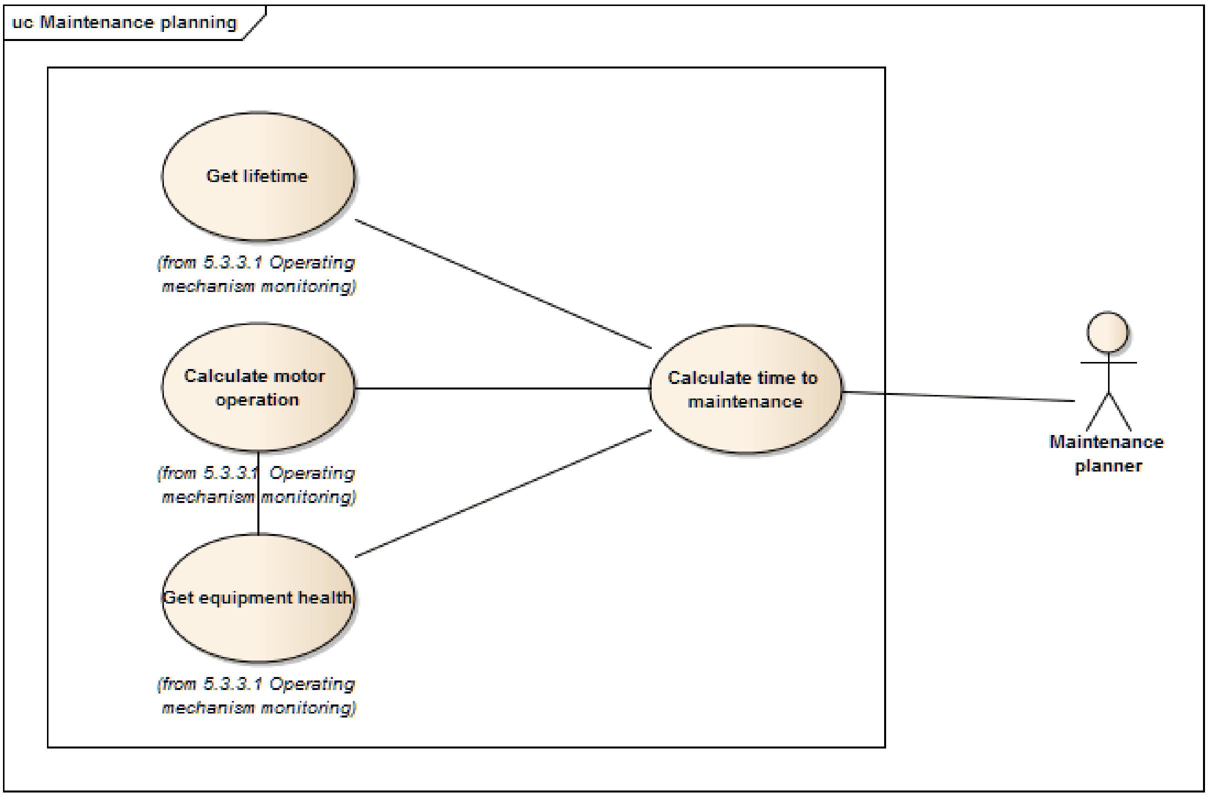


Figure 7 – Maintenance planning use case

Actor(s):

Name	Role description
Maintenance planner	Schedules maintenance work

Use case:

Name	Service or information provided
Get lifetime	Get current life time
Calculate motor operation	Calculate the motor operation counter to
Get equipment health	Check the equipment health
Calculate time to maintenance	Calculate the maintenance time to send a monitoring signal.

Basic flow

Get lifetime

Use case step	Description
Step 1	Store the installation or commissioning date.
Step 2	Calculate difference to actual data.
Step 3	Provide the results to the user. Send a notification if a limit has been passed.

Calculate motor operations

Use case step	Description
Step 1	Wait for a operation
Step 2	Increment the operation counter
Step 3	Compare the counter to given limits
Step 4	Provide the results to the user Send a notification if a limit has been passed

Get equipment health

Use case step	Description
Step 1	Get results from Energy level, Hydraulic level, Hydraulic temperature, Motor runtime, Motor current, Operation count and Charging interval
Step 2	Compare the results from step 1 with normal behaviour
Step 3	Provide the results to the user Send a notification if a limit has been passed

Calculate time to maintenance

Use case step	Description
Step 1	Store data of last maintenance (overhaul, inspection or commissioning)
Step 2	Get results of Calculate motor operation since last maintenance Lifetime since last maintenance Equipment health
Step 3	Calculate time to maintenance based on data from step 2 and actual date
Step 4	Provide the results to the user Send a notification if a limit has been passed

5.3.4 Monitoring issues for POW (Point-on-wave switching controller)

The point on wave is used and described in detail in Subclause 7.7 of IEC TR 61850-7-500[1].

In the point-on-wave switching the phases are independently operated at the most favorable time instant. This results in better power quality and reduces the electrical stresses on the equipment which in turn allows for longer maintenance intervals.

Specific monitoring information for process control is required to predict the operating time of the circuit breaker considering the parameters that have impact on CB closing/opening time.

---

1 Under consideration.

Specific monitoring information such as operation count comes from the CMD that are not the goal of this part of IEC 61850.

Circuit breaker operating monitoring as shown in Figure 8 is intended to help the operator or the maintenance worker to predict operating time.

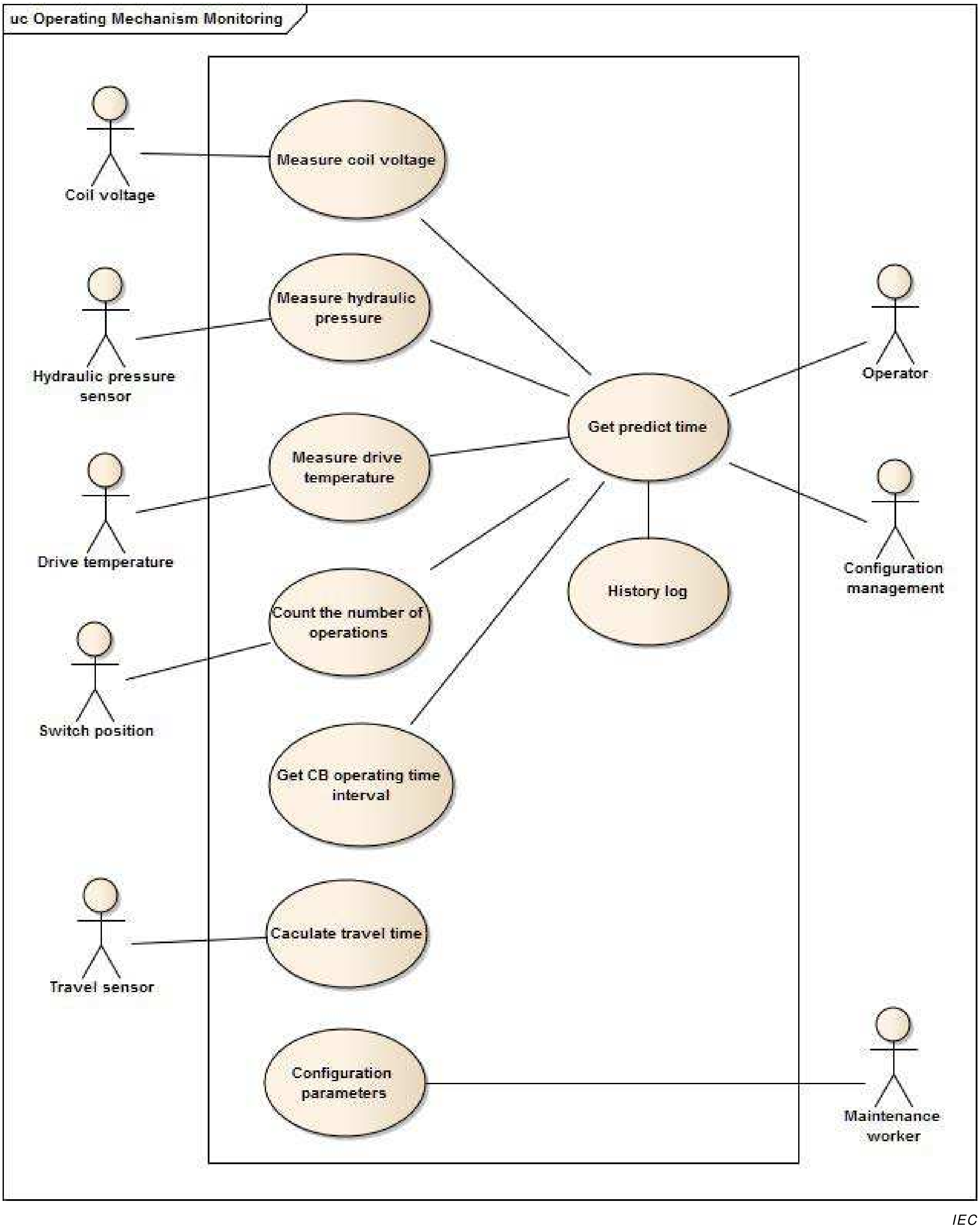


Figure 8 – CB operating time monitoring use case

Actor(s):

Name	Role description
Coil voltage	Measures the voltage of the CB coil
Hydraulic pressure sensor	Measures the hydraulic pressure inside the operating mechanism
Drive temperature	Measures the temperature of the drive
Switch position	Indicates the time of the last position of the connected switch
Operator	A special monitoring (or maintenance) HMI
Maintenance worker	Inspects and repairs the GIS
Configuration management	System used to configure parameters of IED and manage configurations
Travel sensor	Measures the movement of the switch

Use case:

Name	Service or information provided
Measure coil voltage	Measure the coil voltage, calculate the CB operating offset time due to voltage level
Measure hydraulic pressure	Measure the hydraulic pressure and calculate the CB operating offset time due to hydraulic pressure
Measure drive temperature	Measure the drive temperature and calculate the CB operating offset time due to the temperature
Count the number of operations	Count the number of operations, record the time stamp of each operation and store them
Get CB operating time interval	Calculate the CB interval time between the last operation (If hydraulics calculate the CB operating offset time due to idle time)
Get predict time	Calculate the predict time of the next operation
Calculate travel time	Calculate the travel time of circuit switch
Configuration parameters	Accept, validate and manage configuration parameters
History log	Log measured values, calculated values and events with timestamps

Basic flow

Measure coil voltage

Use case step	Description
Step 1	Measure the voltage
Step 2	Calculate the CB operating offset time due to voltage level
Step 3	Provide the CB offset time 1

Measure hydraulic pressure

Use case step	Description
Step 1	Measure the pressure
Step 2	Calculate the CB operating offset time due to hydraulic pressure
Step 3	Provide the CB offset time 2

Measure drive temperature

Use case step	Description
Step 1	Measure the temperature
Step 2	Calculate the CB operating offset time due to the temperature
Step 3	Provide the CB offset time 3

Switch position

Use case step	Description
Step 1	Store the time stamp of connected switches
Step 2	Count the number of operations, record the time stamp of each operation and store them

Get CB operating time interval

Use case step	Description
Step 1	When a CB operation is required Calculate the CB interval time between the last operation (If hydraulics calculate the CB operating offset time due to idle time)
Step 2	Provide the CB offset time 4

Get predict time

Use case step	Description
Step 1	When the CB operation is required calculate with all offset time the predict operation time based on CB offset time 1 to 4
Step 2	Get predict time

Calculate travel time

Use case step	Description
Step 1	Measure the travel time of circuit
Step 2	Calculate the traveling position of circuit breaker

Configuration parameters

Use case step	Description
Step 1	Accept, validate and manage configuration parameters

History logs

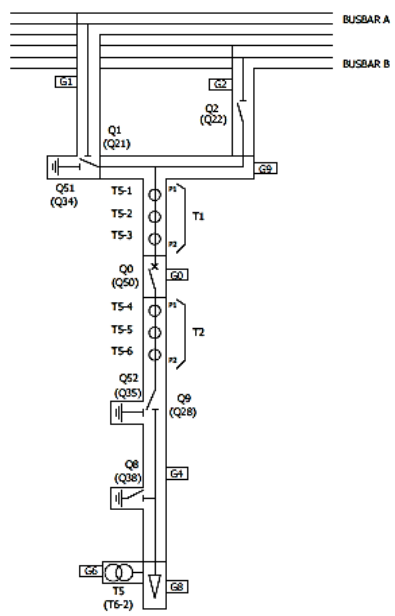
Use case step	Description
Step 1	Log measured values, calculated values and events with timestamps

5.4 Preliminary modelling approach

5.4.1 GIS data modelling example

Figure 9 shows a GIS internal structure as an example to improve understanding.

CUSTOMER NAMES	DESIGNATION
Q0	CIRCUIT BREAKER
Q1	ELECTRICAL BUSBAR SELECTION DISCONNECTOR SWITCH
Q2	ELECTRICAL BUSBAR SELECTION DISCONNECTOR SWITCH
Q9	ELECTRICAL DISCONNECTOR SWITCH
Q51	ELECTRICAL EARTHING SWITCH
Q52	ELECTRICAL EARTHING SWITCH
Q8	HIGH SPEED ELECTRICAL EARTHING SWITCH
T1	CURRENT TRANSFORMERS
T2	CURRENT TRANSFORMERS
T5	VOLTAGE TRANSFORMERS
G0	CIRCUIT BREAKER GAS COMPARTMENT
G1	BUSBAR A GAS COMPARTMENT
G2	BUSBAR B GAS COMPARTMENT
G4	FEEDER GAS COMPARTMENT
G6	VOLTAGE TRANSFORMERS GAS COMPARTMENT
G8	CABLE BOX GAS COMPARTMENT
G9	GAS COMPARTMENT



IEC

Figure 9 – GIS internal structure

5.4.2 GIS gas modelling

The gas monitoring system can be modelled as a logical device in which the logical nodes shown in Figure 10 are implemented ("S" nodes, supervision nodes, are represented in a yellow box):

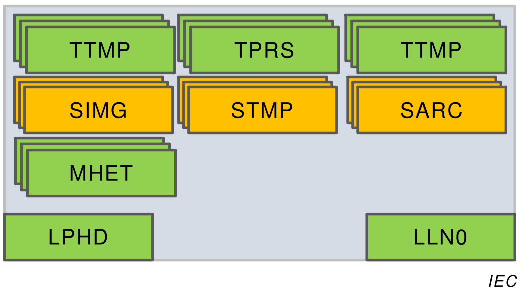


Figure 10 – Example of 3 phases compartment modelling

The LNs TTMP and TPRS allow measuring a single temperature measurement and the absolute pressure of a medium respectively.

The LN THUM is used to represent measurement of humidity in the media that is monitored.

The LN SIMG is used for insulation medium gas and allows monitoring the insulation gas density, the insulation gas pressure and the insulation gas temperature.

The LN STMP provides the temperature measurement. It provides alarm and trip/shutdown functions. This LN shall be instantiated for each sensor if more than one sensor is connected.

The LN SARC allows supervision of the gas volumes of GIS regarding arcs switching or fault arcs.

The logical node MHET for heat measurement can also be implemented in this gas logical device in order to measure the heat of the GIS material. The temperature can also be read using STMP if the sensor also gives the temperature.

The LN LPHD is used for physical device information while the logical node LLN0 is used to address common issues for the logical device.

5.4.3 Circuit breaker modelling

The CB system could be modelled as shown in Figure 11:

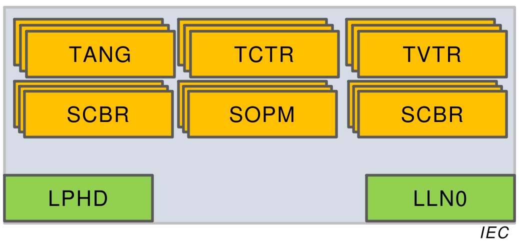


Figure 11 – Example of 3 phases CB modelling

The LN TANG allows measurement of the angle between the main sharp and the reference.

The LNs TCTR and TVTR allow the sending of the current and the voltage respectively to the IED which controls the circuit breaker.

The LN SCBR provides the data to monitor the circuit breaker such as status information, contact abrasion alarm, contact abrasion warning and current coil.

A data object for the voltage coil is not defined in this logical node so a data object for this parameter will be created in order to monitor the voltage of the coil. This voltage coil is mandatory in case of POW.

Data object for “control voltage of coil” is not available in SCBR. A new data object to measure the coil voltage is added: “CoilV” with MV CDC.

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

5.4.4 Switches modelling

A switch modelling is shown in Figure 12.

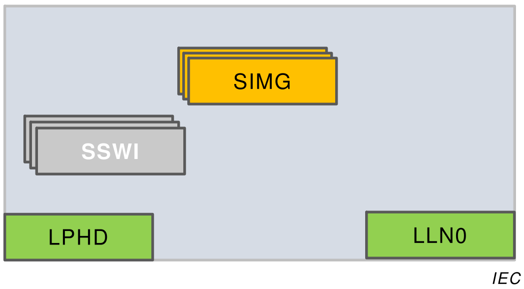


Figure 12 – Example of 3 phases switch modelling

If one apparatus is needed per phase, the LN TCTR and LN SSWI have to be instantiated.

The LN TCTR provides the motor switch current.

5.4.5 PD monitoring by UHF method

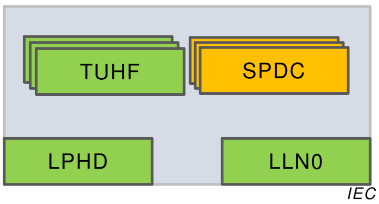


Figure 13 – Example of PD monitoring modelling

The UHF antenna location is the key of the PD monitoring; the UHF generated by the PD signal is completely independent of the GIS bay and can be measured by several UHF antennas. The conversion from UHF amplitude to a charge in pC (pico Coulomb) cannot be made. In case of alarm, the location in the GIS has to be considered. Figure 13 shows a modelling example for PD monitoring.

The LN TUHF is used to measure the UHF signal and return the analogue value.

With this LN the six UHF acquisition channels and the external UHF channel of the UHF module would be set.

The LN SPDC is used to measure the partial discharges in the GIS. IEC 60270 cannot be applied in real-time by the UHF method.

6 Power transformer

6.1 Summary

This clause describes several different use cases for CMD (Condition Monitoring and Diagnostics) in transformers. All use cases in CMD share the same design concept which starts from condition monitoring through sensors to detect initial alarm (warning) points at the sensor level. In various cases, the CMD engine calculates other important transformer data using the sensed data and transformer constants entered through configuration. The CMD engine also processes data statistically to generate other alarm (warning) points. The data processing may be executed at different levels.

CMD for transformer varies according to different users criteria. There is more than one way to monitor and diagnose the transformer components. Choice depends on user/country accepted practices, criticality of transformer, previous history of failure for certain transformer families/designs, etc.

The transformer has three major CMD components:

- Core and coil
- Bushings
- Cooling system

NOTE CMD for LTC is treated in a separate chapter of this document.

6.2 Transformer overview

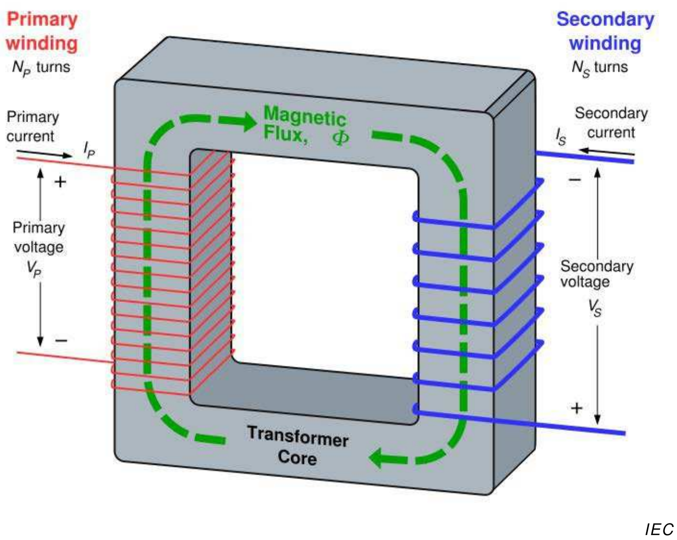


Figure 14 – Transformer principle

The basic principle of a transformer is very simple. An alternating current circulating on a winding around a ferromagnetic core produces a magnetic flux that will in turn produce a current on a secondary winding. The voltage level on the secondary is proportional to the ratio of turns of the primary winding relative to the secondary winding (see Figure 14).

The simple transformer as presented in the description above is not practical in real life. A power transformer is in fact a complex system (see Figure 15). Special conductors isolated with special paper are used for the windings; the core is laminated to reduce losses, a cooling system is necessary to maintain operation on high loads and high temperature, oil is normally used as insulation means as well as a cooling means. Fans and pumps are also used to cool and circulate the oil. Bushings are used to provide external connections to the various voltage levels. Several sensors are installed for protection and monitoring of the transformer.

A tap-changer is frequently used in generation and transmission transformers to vary the ratio of turns from primary to secondary with the aim of voltage regulation. There are different types of tap-changers, some internal to the transformer and some external. There is a specific session in this technical report that deals with LTCs.

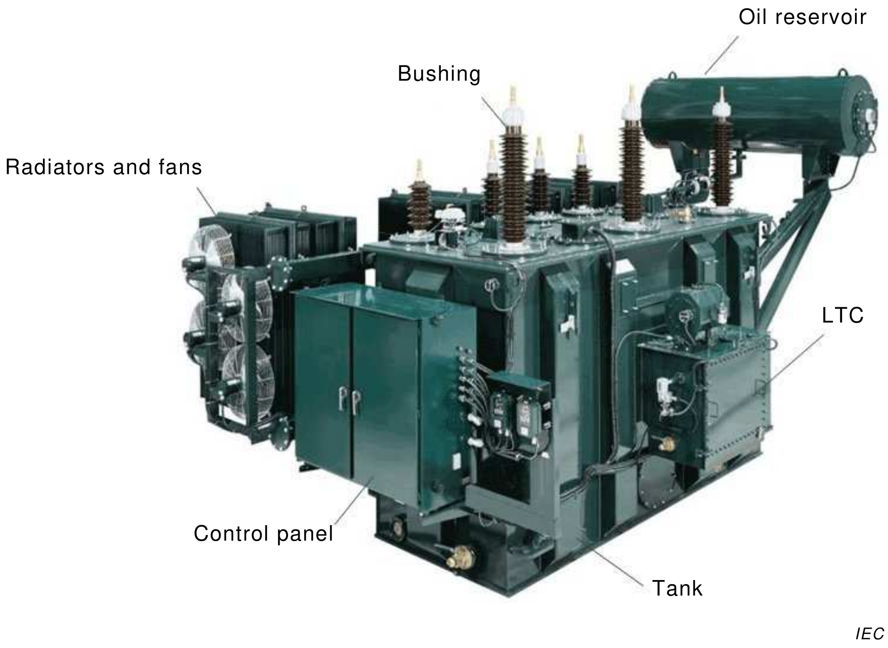


Figure 15 – Typical power transformer

6.3 Transformer CMD use case diagram

6.3.1 Dissolved gas and moisture in oil supervision

Dissolved Gas Analysis (DGA) is considered by most transformer experts as the single most important technique for CMD in transformers. It detects problems mainly in the core and coil components of the transformer. Online DGA is now very popular and adopted worldwide for transformers ranging from large transmission substations to smaller distribution. Several manufacturers offer products that measure from a single key gas to all combustible gases. A good percentage of online DGA analyzers available also measure relative humidity. Rate of change of gas concentrations is considered a very important indicator. Figure 16 shows a use case for dissolved gas and moisture in oil.

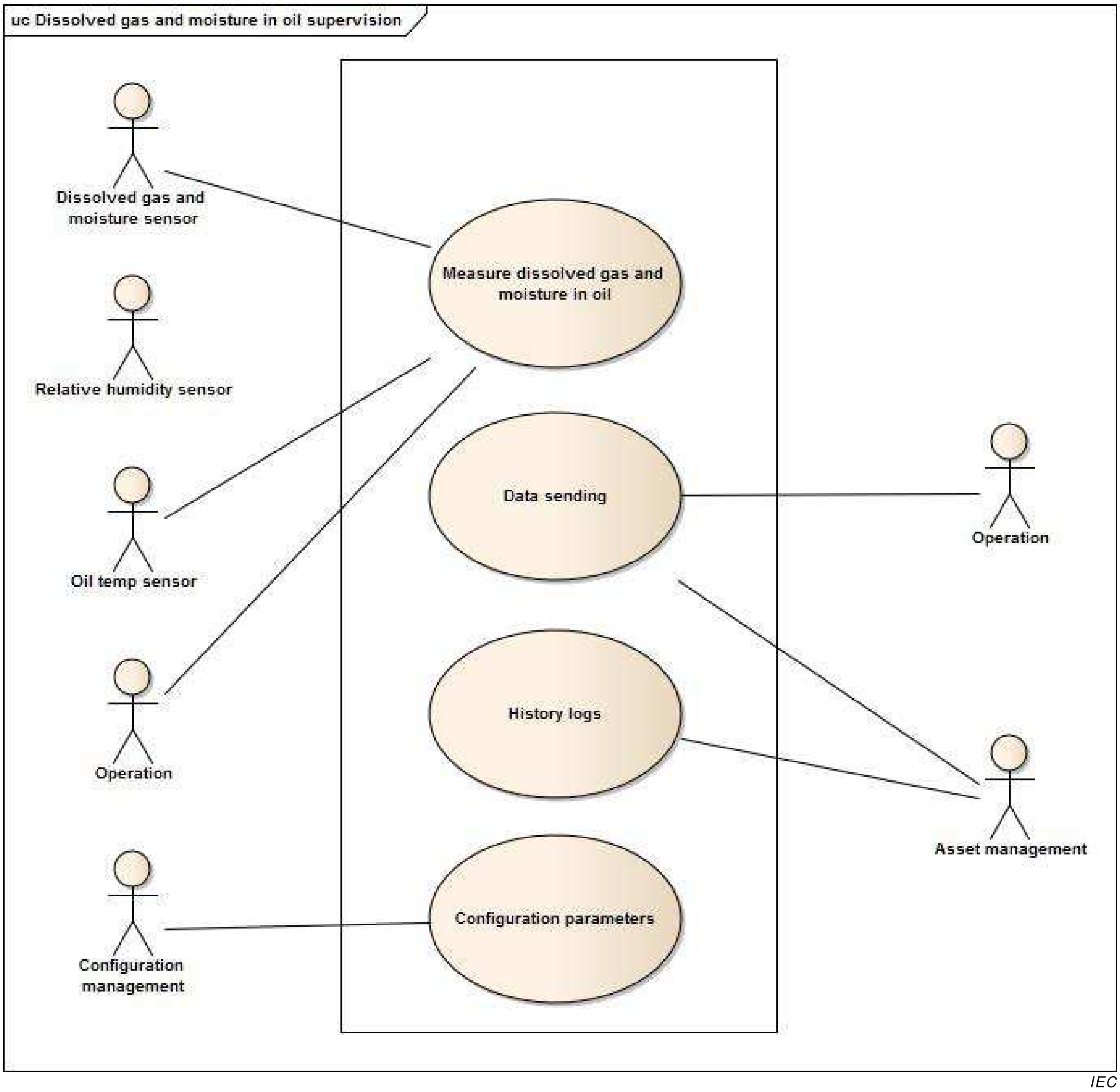


Figure 16 – Use case for oil supervision

Actor(s):

Name	Role description
Dissolved gas and moisture sensor	Measure dissolved gas concentration (ranges from one to multiple gases)
Relative humidity (RH) sensor	Measure relative humidity in oil
Oil temperature sensor	Measure temperature of the oil at the location of the humidity sensor
Asset management	System used for asset management (Expert system, historian, maintenance planner, etc.)
Operation	System used for asset operation (SCADA, DMS, SAS, etc.)
Configuration management	System used to configure parameters of IED and manage configurations

Use cases:

Name	Services or information provided
Measure dissolved gas and moisture in oil	Receive gas concentration data from online DGA sensor, generate alarm when value is beyond programmed limit Calculate rate of change and generate alarm when value is beyond programmed limit Receive moisture in % RH from moisture sensor, receive the temperature of oil at the point of moisture measurement, calculate moisture in ppm from previous values and generate alarm when value is beyond programmed limit Accept change of alarm limits by operation in addition to settings done by configuration management
Data sending	Send time series data and alarms
History logs	Log measured values, calculated values and events with timestamps
Configuration parameters	Accept and validate configuration parameters

Basic flow:

Measure dissolved gas in oil

Use case step	Description
Step 1	Receive dissolved gas, relative humidity and oil temperature at RH sensor data from sensors or IED
Step 2	Calculate rate of change for each gas concentration according to period constant configured and ratios
Step 3	Accept change of alarm limits by operation
Step 4	Generate alarm when value is beyond programmed limit

Data sending

Use case step	Description
Step 1	Send measured data, calculated data and alarms to appropriate client(s) including timestamp

History logs

Use case step	Description
Step 1	Log measured values, calculated values and events with timestamps

Configuration parameters

Use case step	Description
Step 1	Accept, validate and manage configuration parameters

6.3.2 Partial discharge (PD) supervision

Various users prefer to use partial discharge analysis instead of online DGA. Others combine both techniques when monitoring critical transformers. There are different techniques for detection of PD: acoustic detection and electric detection. PD detects problems in the core and coil and bushing components of the transformer. Several manufacturers offer products that measure and analyze PD in the transformer. Figure 17 shows a PD use case.

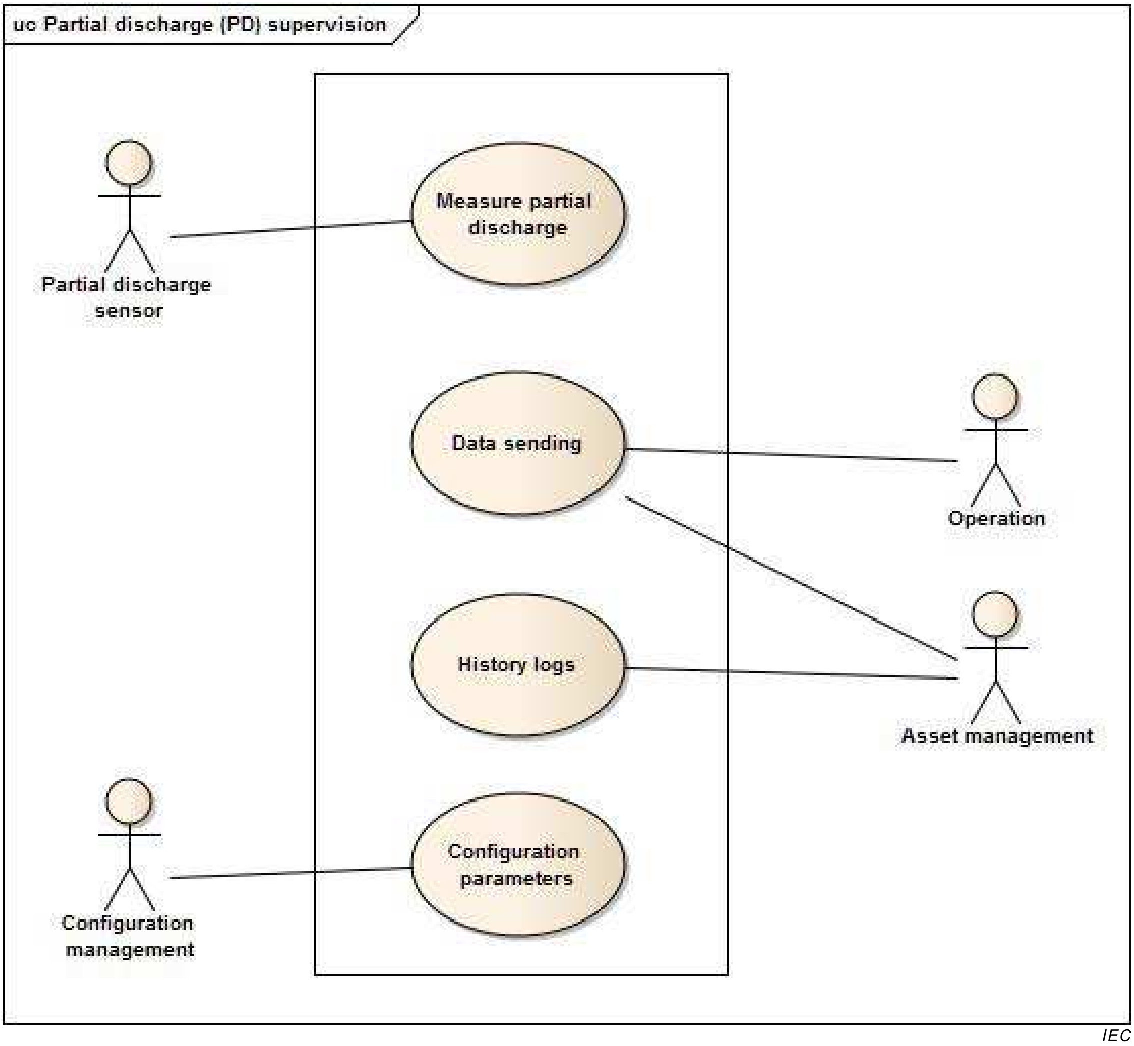


Figure 17 – Partial discharge (PD) use case

Actor(s):

Name	Role description
Partial discharge sensor	Measure partial discharge in the transformer
Asset management	System used for asset management (Expert system, historian, maintenance planner, etc.)
Operation	System used for asset operation (SCADA, DMS, SAS, etc.)
Configuration management	System used to configure parameters of IED and manage configurations

Use cases:

Name	Services or information provided
Measure partial discharge	Receive partial discharge data from PD sensor, generate alarm when value is beyond programmed limit
Data sending	Send time series data and alarms
History logs	Log measured values and events with timestamps
Configuration parameters	Accept and validate configuration parameters

Basic flow:

Measure partial discharge

Use case step	Description
Step 1	Receive PD data from sensor or IED
Step 2	Generate alarm when value is beyond programmed limit

Data sending

Use case step	Description
Step 1	Send measured data, calculated data and alarms to appropriate client(s) including timestamp

History logs

Use case step	Description
Step 1	Log measured values and events with timestamps

Configuration parameters

Use case step	Description
Step 1	Accept, validate and manage configuration parameters

6.3.3 Temperature supervision

Most transformer components and sub-components are greatly affected by temperature. Higher temperatures will cause an accelerated aging of the transformer and a much higher risk of failure. Figure 18 shows a temperature supervision use case.

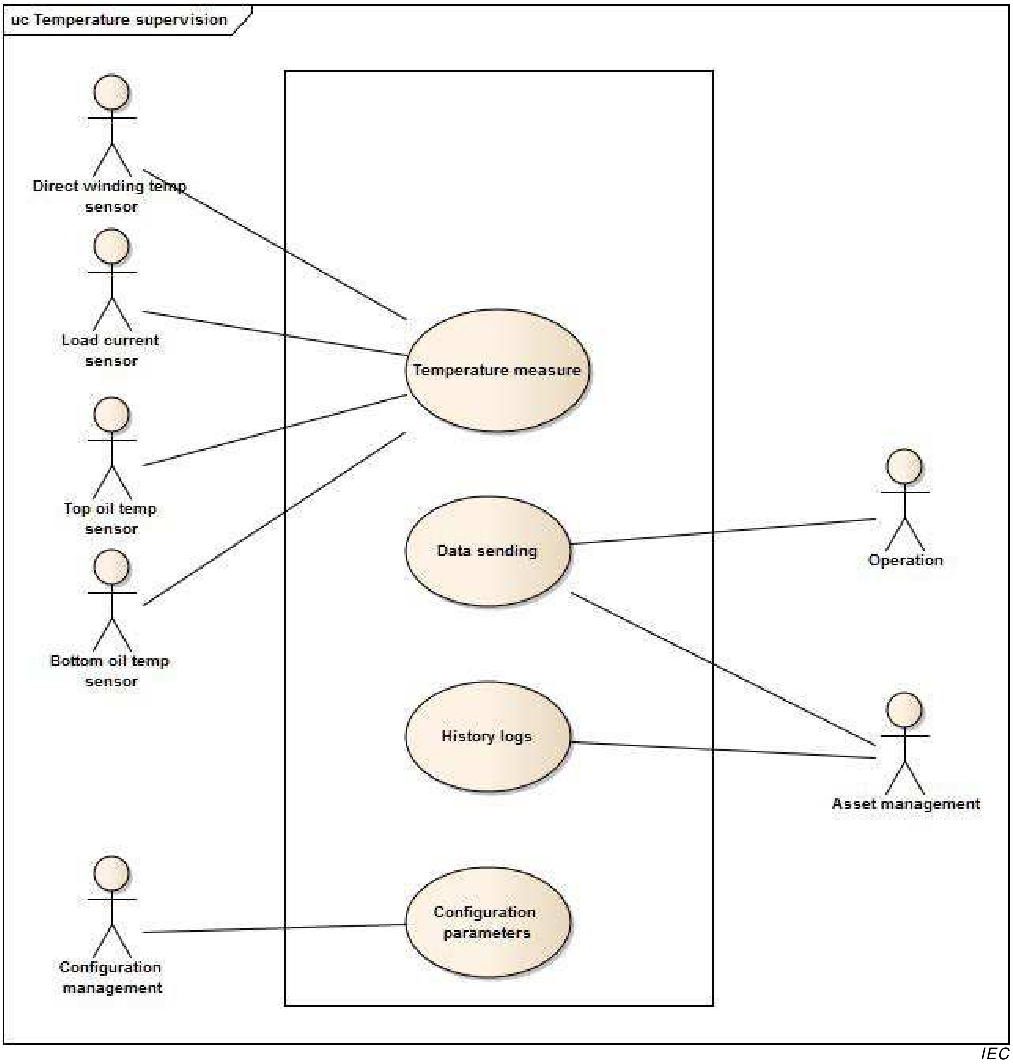


Figure 18 – Use case for temperature supervision

Actor(s):

Name	Role description
Direct winding temp sensor	Measure winding temperature directly
Load current sensor	Measure the transformer load current
Top oil temperature sensor	Measure the transformer oil temperature at the top of the tank
Bottom oil temperature sensor	Measure the transformer oil temperature at the bottom of the tank
Asset management	System used for asset management (Expert system, historian, maintenance planner, etc.)
Operation	System used for asset operation (SCADA, DMS, SAS, etc.)
Configuration management	System used to configure parameters of IED and manage configurations

Use cases:

Name	Services or information provided
Temperature measure	Receive winding hot spot temperature; generate alarm when value is beyond programmed limit Receive load current, top oil temperature, bottom oil temperature, calculate winding hot spot temperature and generate alarm when value is beyond programmed limit Accept change of alarm limits by operation in addition to configuration management
Data sending	Send time series data and alarms
History logs	Log measured values, calculated values and events with timestamps
Configuration parameters	Accept and validate configuration parameters

Basic flow:

Temperature measure

Use case step	Description
Step 1	Receive winding temperature from sensor or IED
Step 2	Receive load current from sensor or IED
Step 3	Receive top oil temperature from sensor or IED
Step 4	Receive bottom oil temperature from sensor or IED
Step 5	Calculate winding hot spot temperature
Step 6	Generate alarm when measured or calculated value is beyond programmed limit

Data sending

Use case step	Description
Step 1	Send measured data, calculated data and alarms to appropriate client(s) including timestamp

History logs

Use case step	Description
Step 1	Log measured values, calculated values and events with timestamps

Configuration parameters

Use case step	Description
Step 1	Accept, validate and manage configuration parameters

6.3.4 Solid insulation aging supervision

Contrary to oil aging, solid insulation aging is an irreversible process due to the degradation of cellulose, which is the basic material of paper and barriers. This aging depends on several factors such as oil and winding temperature, moisture and presence of oxygen. It is very easy to measure moisture in oil but it is very unpractical, if not impossible, to measure online the moisture content in the paper or in the barriers. Calculations are required to obtain those values. Figure 19 shows a use case for solid insulation supervision.

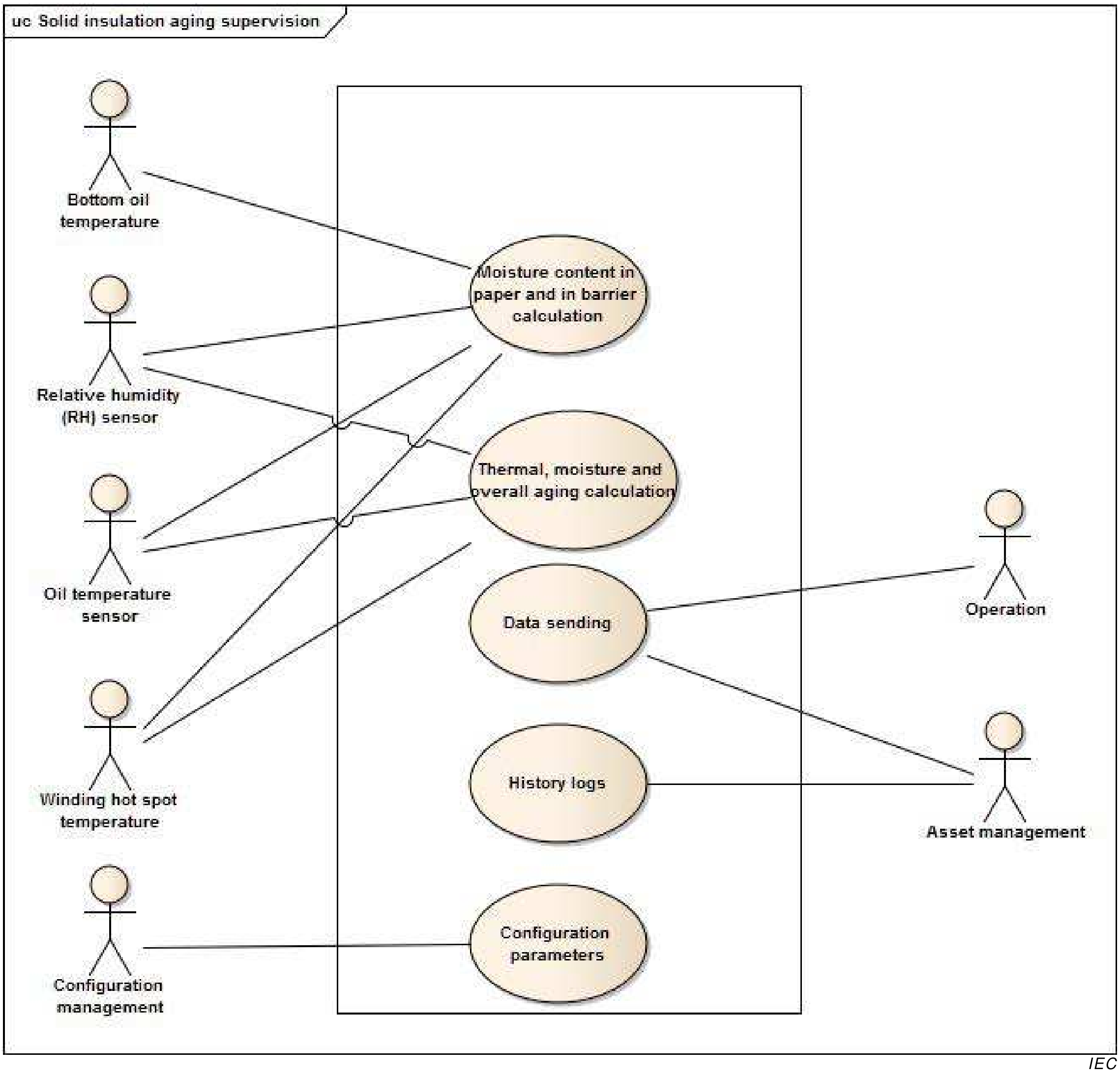


Figure 19 – Use case for solid insulation aging supervision

Actor(s):

Name	Role description
Bottom oil temperature	Measure the oil temperature at the bottom of the tank
Relative humidity (RH) sensor	Measure relative humidity in oil
Oil temperature sensor	Measure temperature of the oil at the location of the humidity sensor
Winding hot spot temperature	Measured or calculated, it is the temperature of the hottest point of the transformer winding (see Temperature supervision use case)
Asset management	System used for asset management (Expert system, historian, maintenance planner, etc.)
Operation	System used for asset operation (SCADA, DMS, SAS, etc.)
Configuration management	System used to configure parameters of IED and manage configurations

Use cases:

Name	Services or information provided
Moisture content in paper and in barrier calculation	Use bottom oil temperature, relative humidity, oil temperature at RH sensor and winding hot spot temperature to calculate moisture content in paper and in barriers
Thermal, moisture and overall aging calculation	Use relative humidity, oil temperature at RH sensor and winding hot spot temperature to calculate aging of the solid insulation due to thermal and moisture effects and the total aging
Data sending	Send time series data and alarms
History logs	Log measured values, calculated values and events with timestamps
Configuration parameters	Accept and validate configuration parameters

Basic flow:

Moisture content in paper and in barrier calculation

Use case step	Description
Step 1	Receive bottom oil temperature from sensor or IED
Step 2	Receive moisture in % RH from sensor or IED
Step 3	Receive oil temperature at RH sensor data from sensor or IED
Step 4	Receive winding hot spot temperature from sensor or IED (measured or calculated)
Step 5	Calculate moisture content in paper and in the barriers
Step 6	Generate alarm when measured or calculated value is beyond programmed limit

Thermal, moisture and overall aging calculation

Use case step	Description
Step 1	Receive moisture in % RH from sensor or IED
Step 2	Receive oil temperature at RH sensor data from sensor or IED
Step 3	Receive winding hot spot temperature from sensor or IED (measured or calculated)
Step 4	Calculate aging of the solid insulation due to thermal and moisture effects and the total aging

Data sending

Use case step	Description
Step 1	Send measured data, calculated data and alarms to appropriate client(s) including timestamp

History logs

Use case step	Description
Step 1	Log measured values, calculated values and events with timestamps

Configuration parameters

Use case step	Description
Step 1	Accept, validate and manage configuration parameters

6.3.5 Bubbling temperature supervision

Bubbling is very dangerous for the integrity of the transformer and should be avoided. Bubbling is affected by moisture in the transformer and by the transformer temperature. The bubbling threshold temperature can be calculated for given moisture conditions. Figure 20 shows a use case for bubbling temperature supervision.

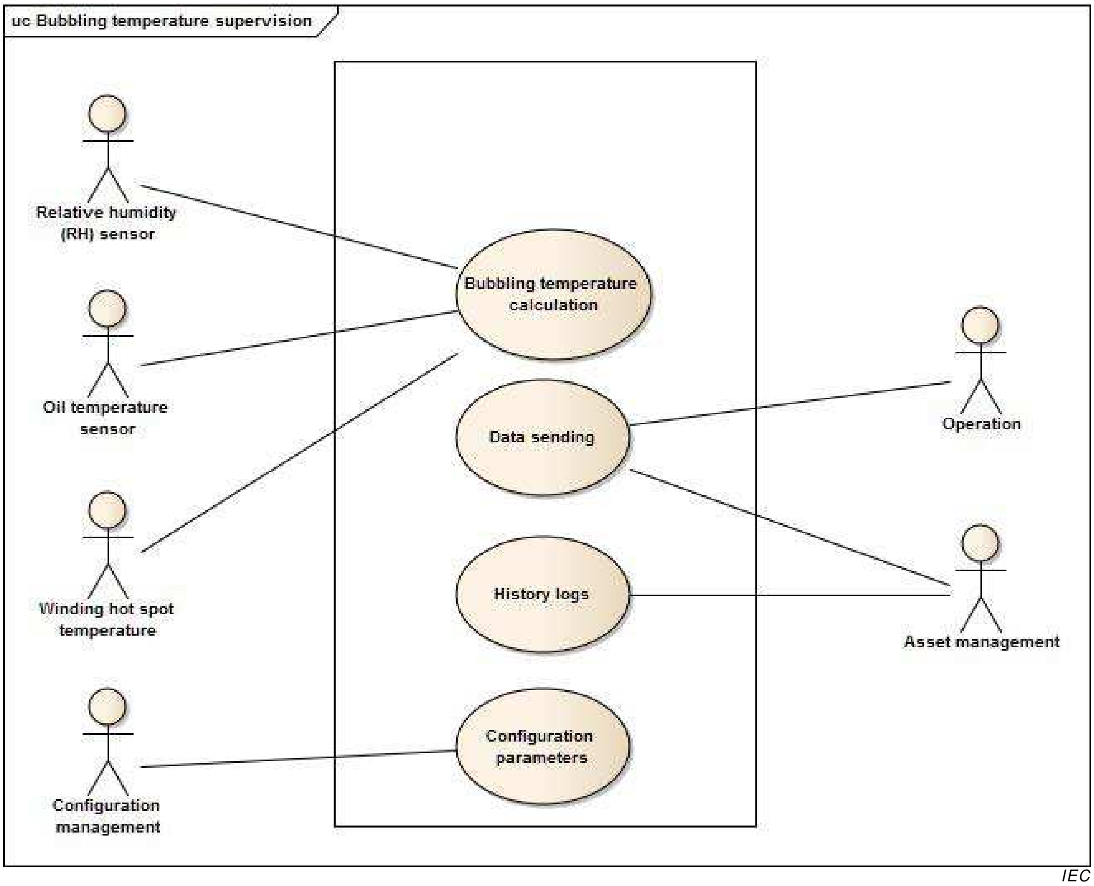


Figure 20 – Use case for bubbling temperature supervision

Actor(s):

Name	Role description
Relative humidity (RH) sensor	Measure relative humidity in oil
Oil temperature sensor	Measure temperature of the oil at the location of the humidity sensor
Winding hot spot temperature	Measured or calculated, it is the temperature of the hottest point of the transformer winding (see Temperature supervision use case)
Asset management	System used for asset management (Expert system, historian, maintenance planner, etc.)
Operation	System used for asset operation (SCADA, DMS, SAS, etc.)
Configuration management	System used to configure parameters of IED and manage configurations

Use cases:

Name	Services or information provided
Bubbling temperature calculation	Read relative humidity, oil temperature at RH sensor and winding hot spot temperature to calculate the bubbling temperature
Data sending	Send time series data and alarms
History logs	Log measured values, calculated values and events with timestamps
Configuration parameters	Accept and validate configuration parameters

Basic flow:

Bubbling temperature calculation

Use case step	Description
Step 1	Receive moisture in % RH from sensor or IED
Step 2	Receive oil temperature at RH sensor data from sensor or IED
Step 3	Receive winding hot spot temperature from sensor or IED (measured or calculated)
Step 4	Calculate bubbling temperature
Step 5	Generate alarm when measured or calculated value is beyond programmed limit

Data sending

Use case step	Description
Step 1	Send calculated data to appropriate client(s) including timestamp

History logs

Use case step	Description
Step 1	Log measured values, calculated values and events with timestamps

6.3.6 Bushing supervision

Bushing failures are responsible for a very large number of transformer failures. The use of bushing monitoring is increasing. There are different techniques; other than PD method already described, the most popular are the monitoring of tan δ, sum of currents, bushing capacitance. Figure 21 shows a use case for bushing supervision.

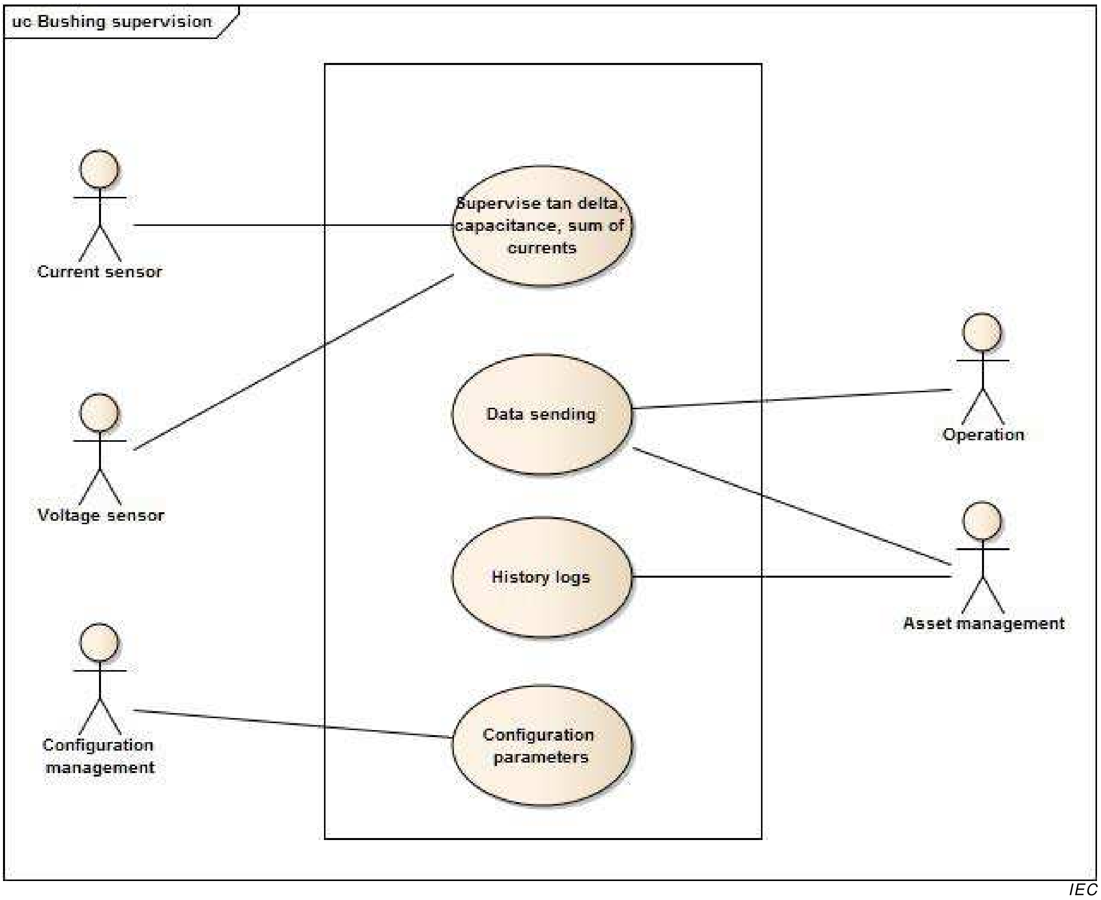


Figure 21 – Use case for bushing supervision

Actor(s):

Name	Role description
Current sensor	Measure bushing leakage current
Voltage sensor	Measure bushing voltage from capacitive coupler
Asset management	System used for asset management (Expert system, historian, maintenance planner, etc.)
Operation	System used for asset operation (SCADA, DMS, SAS, etc.)
Configuration management	System used to configure parameters of IED and manage configurations

Use cases:

Name	Services or information provided
Supervise tan δ, capacitance, sum of currents	Read bushing leakage current and bushing voltage and calculate tan δ, capacitance and sum of currents; generate alarm when value is beyond programmed limit
Data sending	Send time series and alarms
History logs	Log measured values, calculated values and events with timestamps
Configuration parameters	Accept and validate configuration parameters

Basic flow:

Supervise tan δ, capacitance and sum of currents

Use case step	Description
Step 1	Read bushing leakage current and bushing voltage
Step 2	Calculate tan δ, capacitance and sum of currents
Step 3	Generate alarm when calculated value is beyond programmed limit

Data sending

Use case step	Description
Step 1	Send measured data, calculated data and alarms to appropriate client(s) including timestamp

History logs

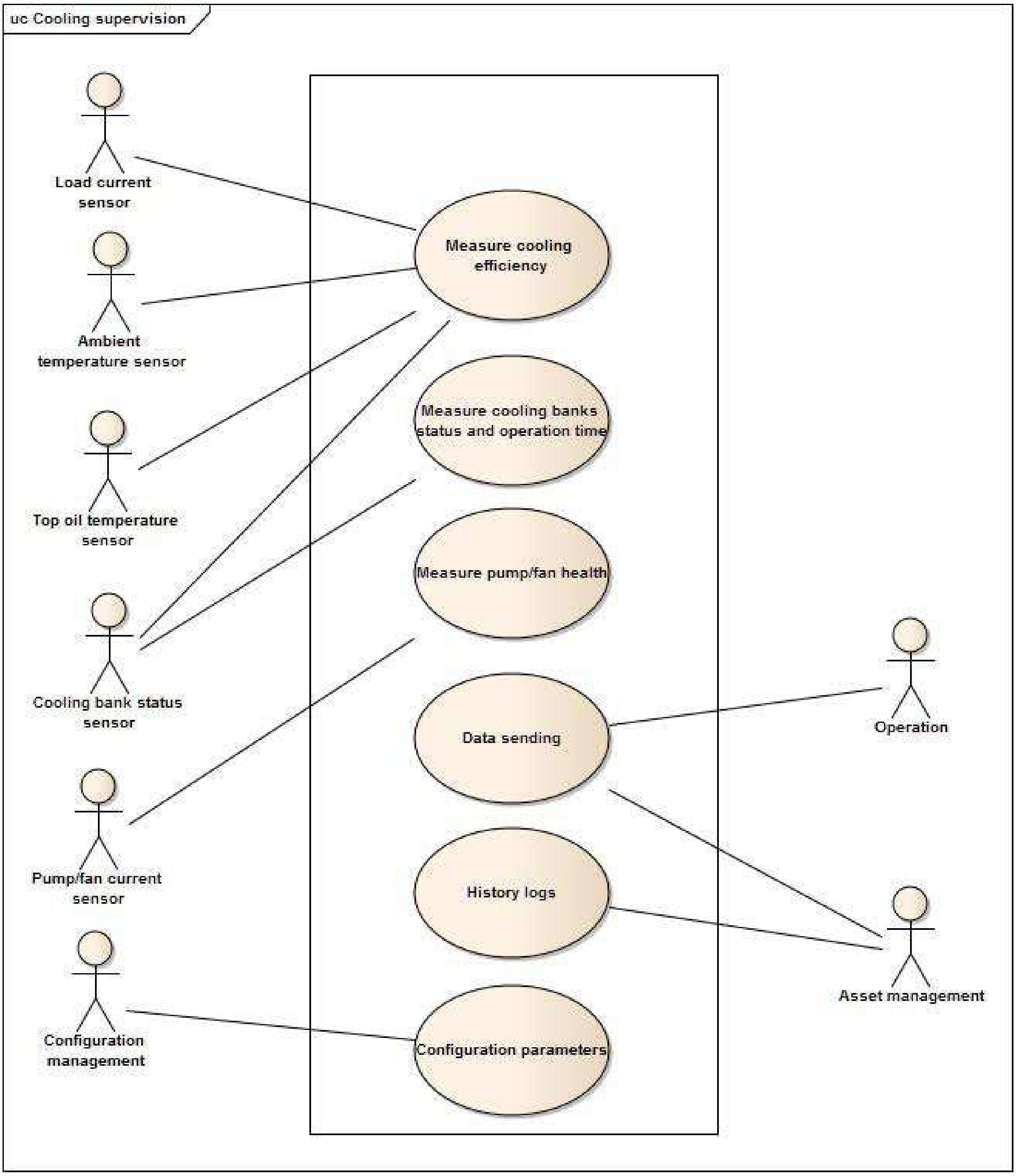
Use case step	Description
Step 1	Log measured values, calculated values and events with timestamps

Configuration parameters

Use case step	Description
Step 1	Accept, validate and manage configuration parameters

6.3.7 Cooling supervision

High temperatures will cause aging acceleration in the transformer. Loading capacity is also affected by high temperatures. Moreover the peak load period occurs during summer in various countries. Cooling is then a very important component of a transformer. Its efficiency can be calculated by using a thermal model and also banks, pumps and fans can be monitored for various conditions. Figure 22 shows a use case for cooling supervision.



IEC

Figure 22 – Use case for cooling supervision

Actor(s):

Name	Role description
Load current sensor	Measure the transformer load current
Ambient temperature sensor	Measure ambient temperature
Top oil temperature sensor	Measure the transformer oil temperature at the top of the tank
Cooling bank status sensor	Digital sensor that detects if a cooling bank is in operation
Pump/fan current sensor	Measure the pump/fan current
Asset management	System used for asset management (Expert system, historian, maintenance planner, etc.)
Operation	System used for asset operation (SCADA, DMS, SAS, etc.)
Configuration management	System used to configure parameters of IED and manage configurations

Use cases:

Name	Services or information provided
Measure cooling efficiency	Read load current, ambient temperature, top oil temperature and the status of the cooling banks or the currents of fans and pumps and calculate the cooling efficiency; generate alarm when value is beyond programmed limit
Measure cooling banks status and operation time	Read the status of the cooling banks or the currents of fans and pumps and accumulate the operation time per bank
Measure pump/fan health	Measure pump/fan current to compare with signature; generate alarm when value is beyond programmed limit
Data sending	Send time series data and alarms
History logs	Log measured values, calculated values and events with timestamps
Configuration parameters	Accept and validate configuration parameters

Basic flow:

Measure cooling efficiency

Use case step	Description
Step 1	Measure load current, ambient temperature, top oil temperature and read the status of cooling banks or the currents of fans and pumps
Step 2	Calculate cooling efficiency
Step 3	Generate alarm when value is beyond programmed limit

Measure cooling banks status and operation time

Use case step	Description
Step 1	Read the status of the cooling banks or the currents of fans and pumps
Step 2	Accumulate the operation time per bank
Step 3	Generate alarm when value is beyond programmed limit

Measure pump/fan health

Use case step	Description
Step 1	Measure pump/fan current
Step 2	Generate alarm when value is beyond programmed limit

Data sending

Use case step	Description
Step 1	Send measured data, calculated data and alarms to appropriate client(s) including timestamp

History logs

Use case step	Description
Step 1	Log measured values, calculated values and events with timestamps

Configuration parameters

Use case step	Description
Step 1	Accept, validate and manage configuration parameters

6.3.8 Ancillary sensors supervision

There are several other ancillary sensors in transformers. Their uses vary according to the design, size, age and other factors. Figure 23 shows a use case for ancillary sensor supervision.

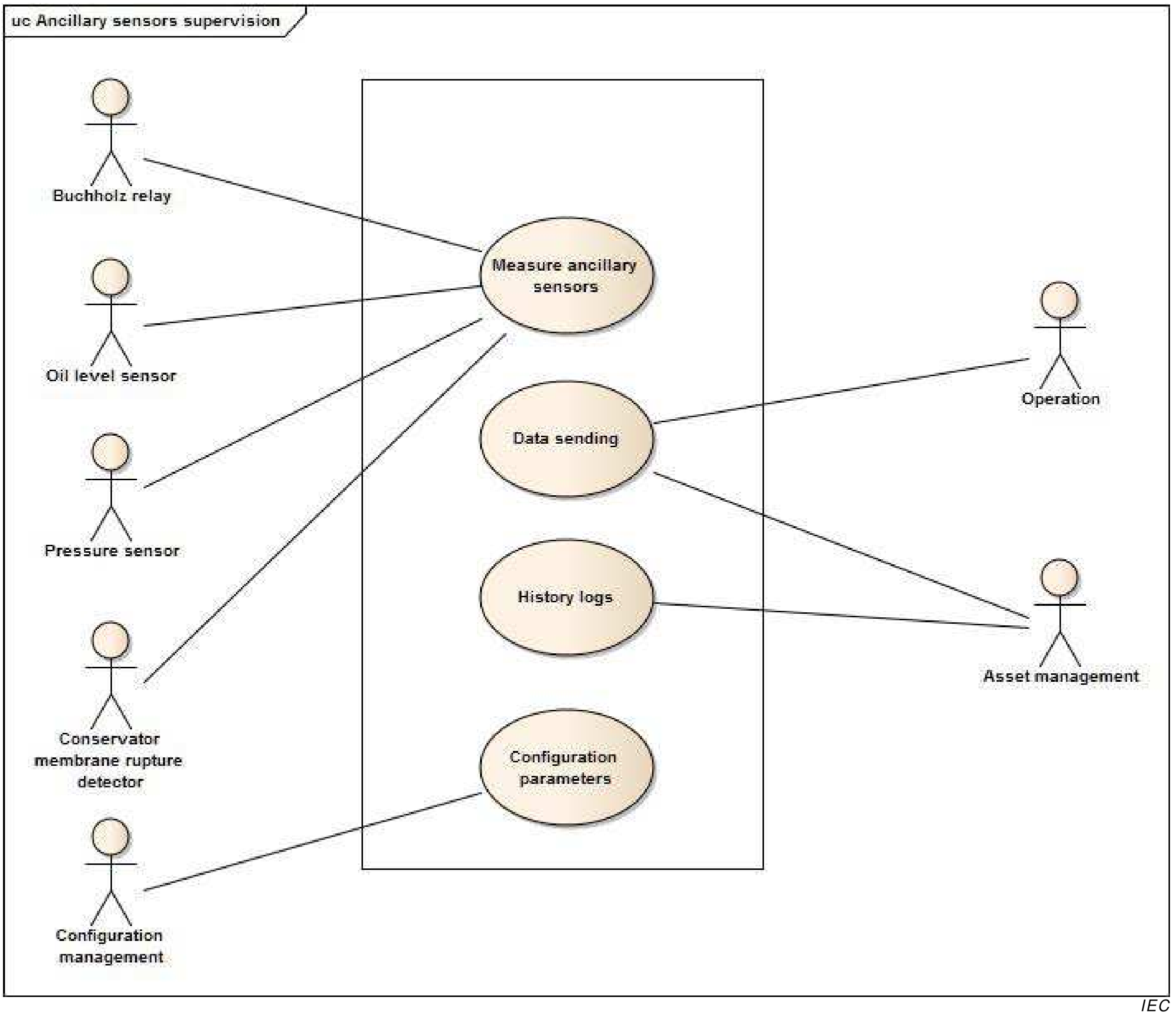


Figure 23 – Use case for ancillary sensors supervision

Actor(s):

Name	Role description
Buchholz relay	Relay that detects sudden pressure and gas accumulation. It is not a predictive sensor
Oil level sensor	Measure the level of the oil to monitor oil leaks
Pressure sensor	Measure pressure to detect leaks or expansion of gases
Conservator membrane rupture detector	Detect a rupture in the membrane of the conservator
Asset management	System used for asset management (Expert system, historian, maintenance planner, etc.)
Operation	System used for asset operation (SCADA, DMS, SAS, etc.)
Configuration management	System used to configure parameters of IED and manage configurations

Use cases:

Name	Services or information provided
Measure ancillary sensors	Detect status of Buchholz relay and conservator membrane rupture detector, measure oil level, measure oil pressure; generate alarms when value is beyond programmed limit or status is in alarm
Data sending	Send time series data and alarms
History logs	Log measured values, calculated values and events with timestamps
Configuration parameters	Accept and validate configuration parameters

Basic flow:

Measure ancillary sensors

Use case step	Description
Step 1	Detect status of Buchholz relay and conservator membrane rupture detector, measure oil level and pressure
Step 2	Generate alarm when value is beyond programmed limit or status is in alarm

Data sending

Use case step	Description
Step 1	Send measured data, calculated data and alarms to appropriate client(s) including timestamp

History logs

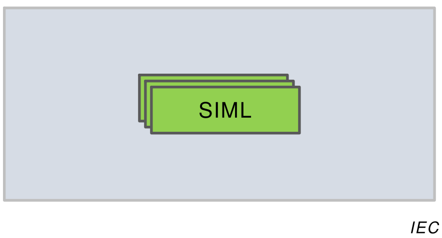
Use case step	Description
Step 1	Log measured values, calculated values and events with timestamps

Configuration parameters

Use case step	Description
Step 1	Accept, validate and manage configuration parameters

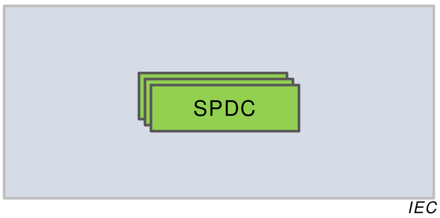
6.4 Preliminary modelling approach

6.4.1 Dissolved gas and moisture in oil supervision



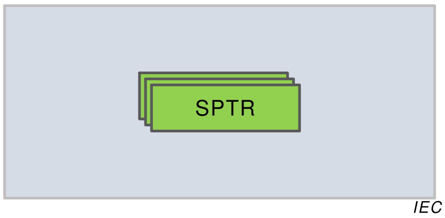
For a description of this LN, see IEC 61850-5. The insulation medium is a liquid such as oil used for example for some transformers and tap changers.

6.4.2 Partial discharge (PD) supervision



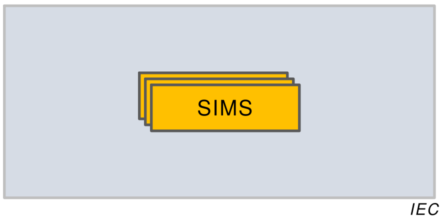
SPDC is a LN for monitoring and diagnostics for partial discharges.

6.4.3 Transformer supervision



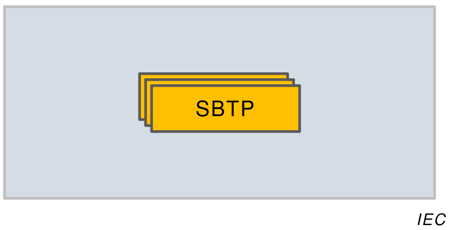
This LN is used for supervision of power transformer. It is used to assess the condition of the power transformer.

6.4.4 Solid insulation aging supervision



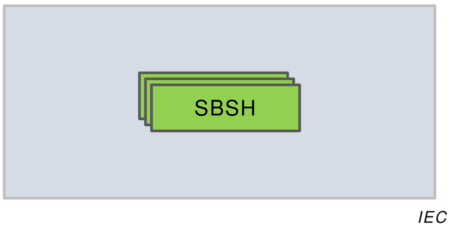
This LN is used for supervision of insulation medium in solid state.

6.4.5 Bubbling temperature supervision (use SIML)



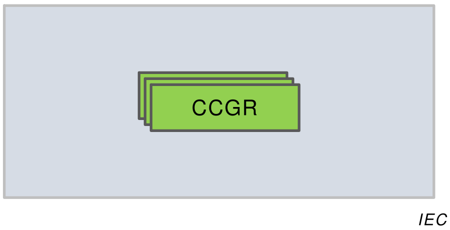
This LN is used for supervision of bubbling temperature, and it has been merged into a new LN SSTP in IEC TR 61850-90-3 to supervise saturation temperature including condensation as well as bubbling temperature.

6.4.6 Bushing supervision



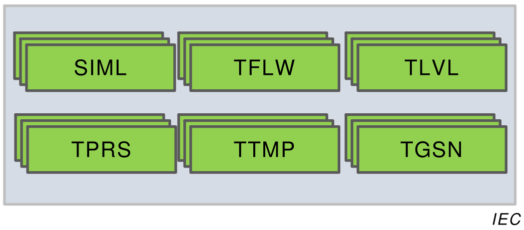
This LN is used to supervise bushing parts.

6.4.7 Cooling supervision



This LN is used to control cooling equipment in IEC 61850-7-4. In IEC TR 61850-90-3, a new LN SCGR is used to supervise cooling group.

6.4.8 Ancillary sensors supervision



The ancillary equipment is supervised through TFLW (liquid flow sensor), TLVL media level sensor), TPRS (pressure sensor), TTMP (temperature sensor), and TGSN (generic sensor if there is no specific sensor available) along with SIML (liquid medium supervision).

7 Load tap changer (LTC)

7.1 Summary

This chapter illustrates use cases and data flow for the following CMD functions related to LTC (on-Load Tap Changer).

a) Monitoring LTC operation properties
b) Monitoring LTC operation counts
c) Monitoring contact abrasion
d) Monitoring LTC oil temperature
e) Monitoring operation of oil filter unit

Please note that the following functions should be categorized into CMD for power transformers. We do not discuss them in this clause.

f) Monitoring oil temperature

g) Monitoring oil leak

h) Monitoring gas contained in oil

i) Monitoring bushing

7.2 Load tap changer overview

The on-load tap-changer is a device for changing the tap of a winding, suitable for operation while the transformer is energized or on load. The features are as follows:

- Changing the tap while the transformer is on load
- Requirement for long life time although it has some parts such as contact that is consumed by many operations.
- Cooperation with the transformer in the case of power system fault or overload.

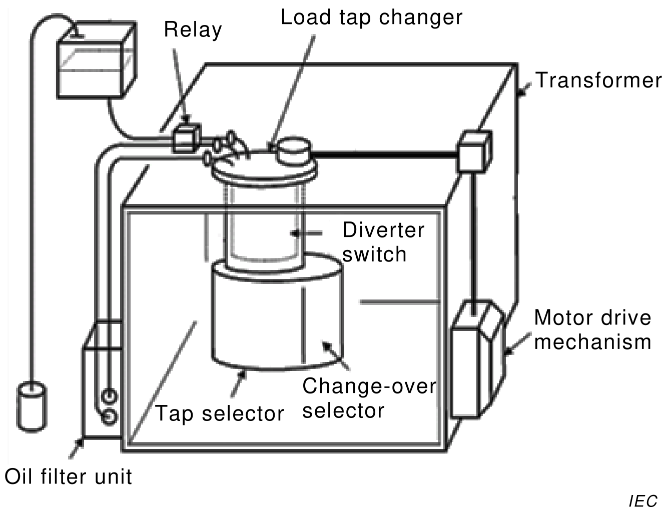


Figure 24 – Structure of load tap changer

Figure 24 shows a typical structure of load tap changer:

- Diverter switch: Switching device used in conjunction with a tap selector to carry, make or break currents in circuits which have already been selected.
- Tap selector: Device designed to carry (but not to make or break) current, used in conjunction with a diverter switch to select tap connections.
- Change-over selector: Device designed to carry (but not to make or break) current, used in conjunction with the tap selector or selector switch to enable its contacts and the connection taps to be used more than once when moving from one extreme position to the other.
- Motor drive mechanism: Driving mechanism which incorporates an electric motor and a control circuit
- Oil filter unit: Device purifying insulated oil

7.3 Constraints/assumptions/design considerations

We assume a system configuration for CMD as depicted in Figure 25. It is assumed that use cases are related to the IEDs surrounded by the dotted line in Figure 25.

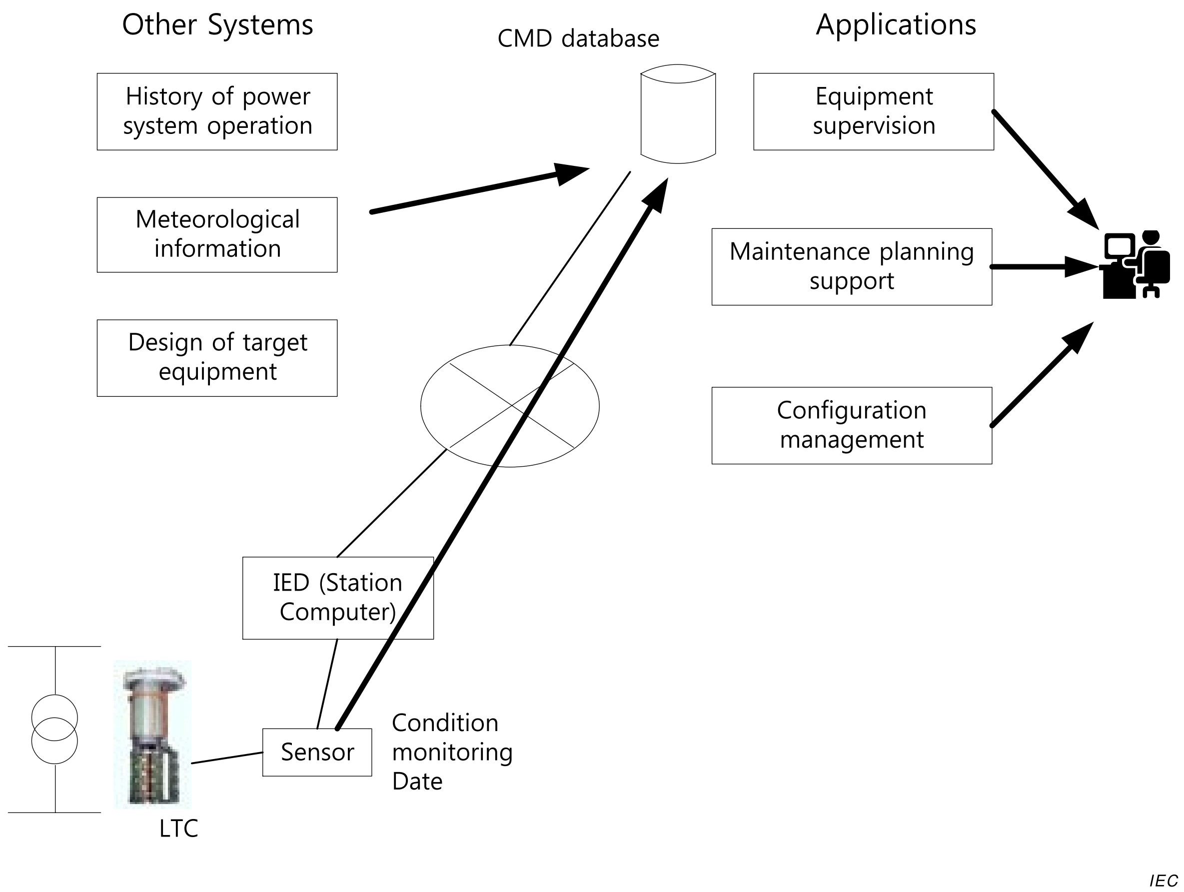


Figure 25 – Configuration of LTC CMD system

- Sensor: measures various information from a target equipment, and sends signals to an IED.
- IED (Intelligent Electronic Device): Stores data according to time sequence. Processes several data from sensors to new data such as percentage of contact abrasion. Judges whether a data is within the normal range or not.
- IED (Station Computer/Gateway) exchanges data with CMD database or other computers via WAN.
- CMD database: stores data from IEDs and provides them to applications.

The following applications are assumed to process CMD data.

a) Equipment supervision

   This application supervises status of target equipment.

b) Maintenance planning support

   This application supports the planning of maintenance work. This planning includes inspection/repair scheduling and lifetime prediction as well as identifying the fault cause.

c) Configuration management

   This application manages specifications, connectivity and histories of target equipment. Histories include records of inspection, maintenance, fault and repair.

These applications may acquire data from other systems in order to accomplish their functions. Examples of these data are:

- History of power system operations
- Meteorological information
- Design of target equipment

7.4 Data flow

Figures 26, 27 and 28 show data flows for LTC monitoring:

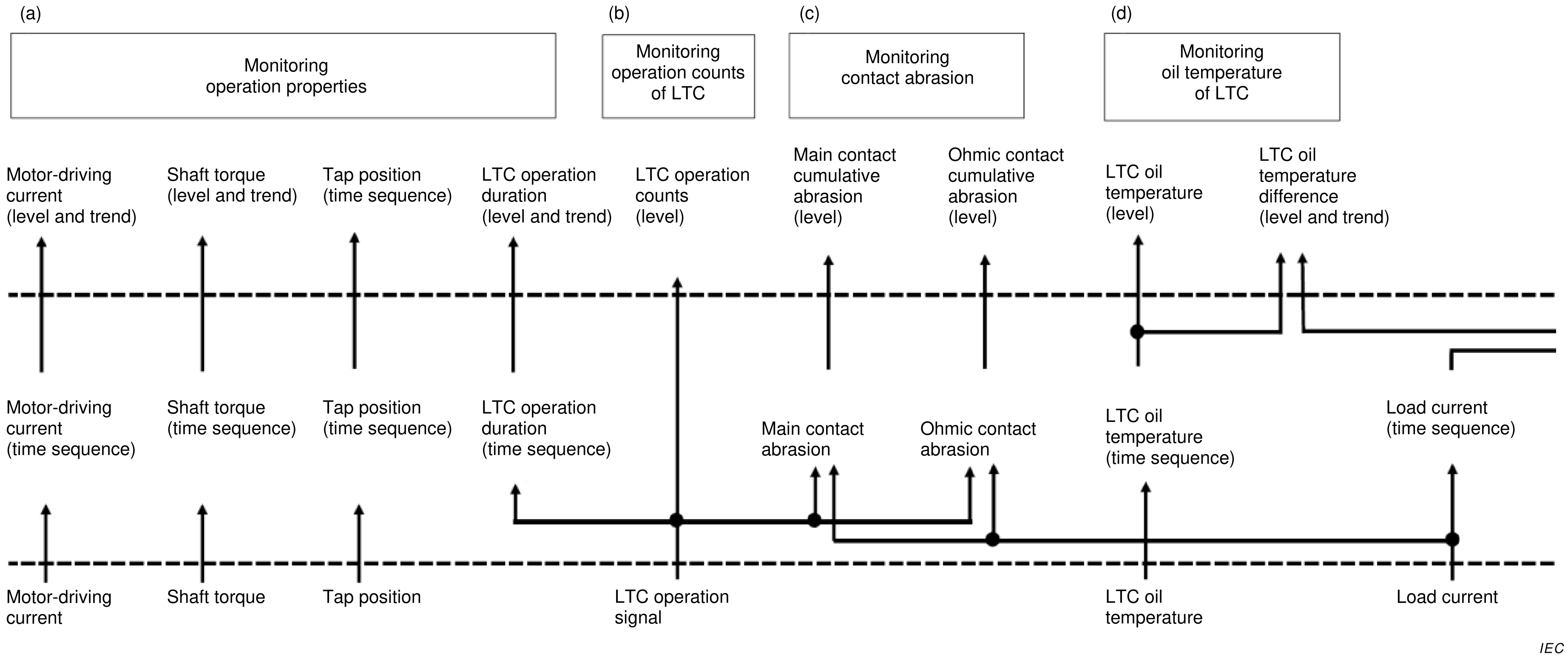


Figure 26 – Data flows for LTC CMD (part 1)

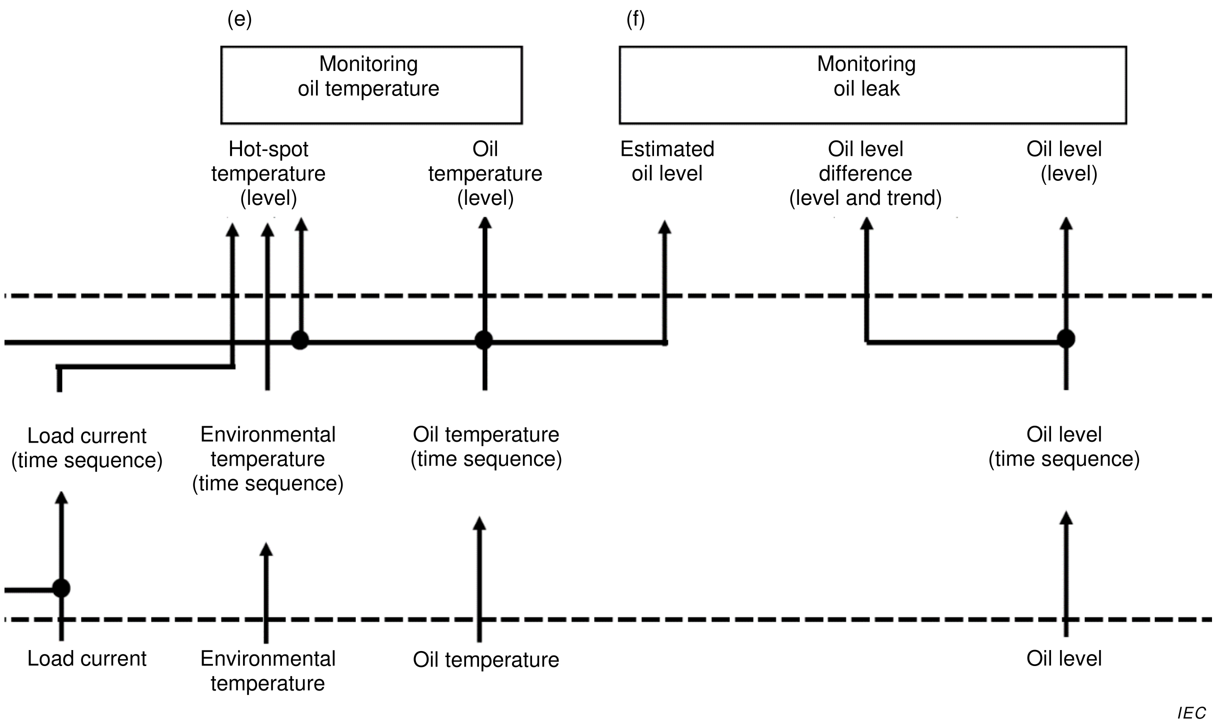


Figure 27 – Data flows for LTC CMD (part 2)

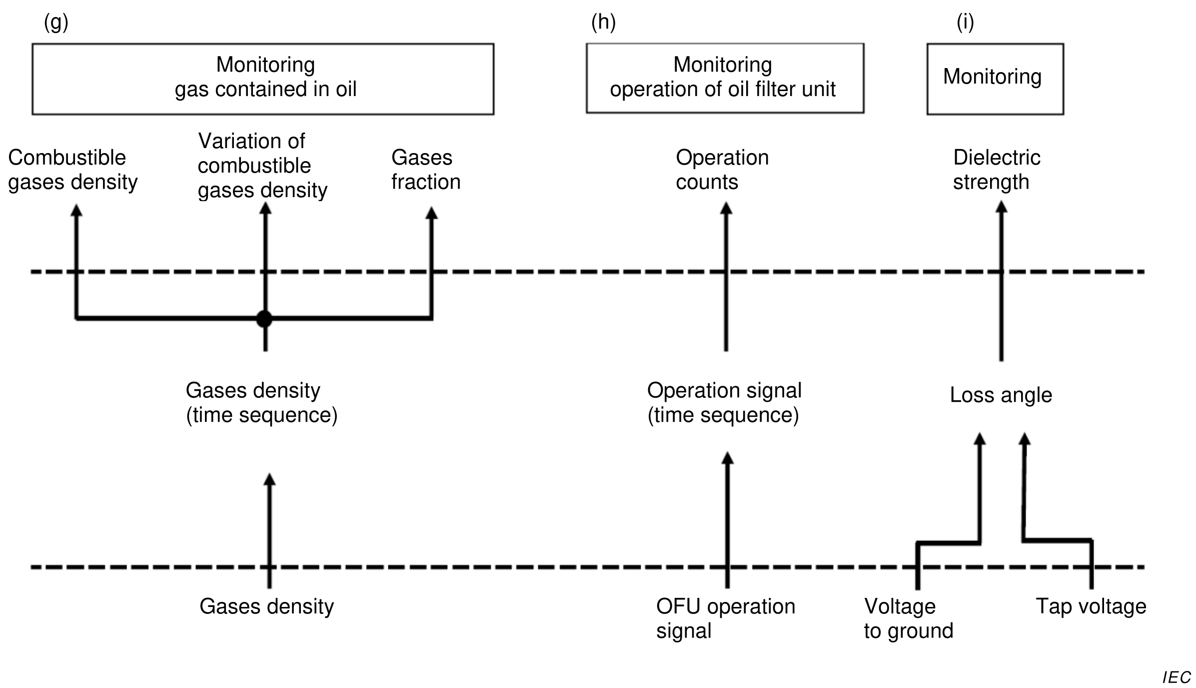


Figure 28 – Data flows for LTC CMD (part 3)

7.5 Use case diagram

This subclause shows use cases for the CMD functions that have been described in the summary section. A use case as shown in Figure 29 illustrates functions in the system to be designed and the actors of the system.

7.5.1 Monitoring LTC operation properties

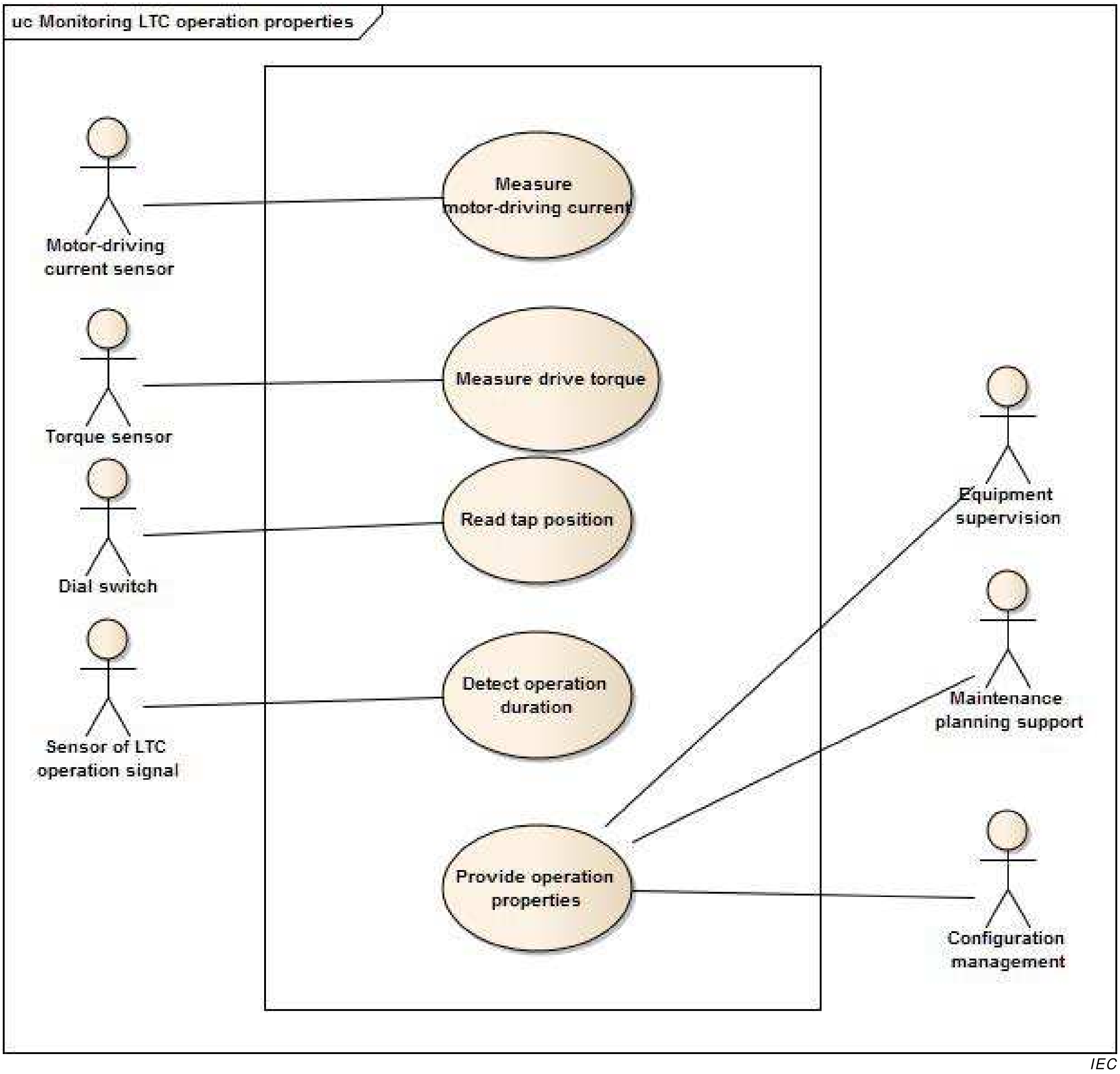


Figure 29 – Use case for monitoring LTC operation properties

Actor(s):

Name	Role description
Motor-driving current sensor	Measure the motor driving current.
Torque sensor	Measure the drive torque.
Tap position sensor	Indicate tap position of LTC.
LTC operation signal Sensor	Detect start/end time of LTC operation.
Equipment supervision	Supervise status of target equipment.
Maintenance planning support	Support planning maintenance work.
Asset management	Manage specifications and histories of target equipment.

Use cases:

Name	Service or information provided
Measure motor-driving Current	Read motor-driving current value from sensor Store the data according to time sequence
Measure drive torque	Read drive torque value from sensor Store these data according to time sequence
Read tap position	Read tap position from dial switch Store the data according to time sequence
Detect operation duration	Detect an LTC operation signal from sensor Save the operation with its time stamp Calculate duration using start-up and completion time stamps Store the durations according to time sequence
Provide operation properties	Provide the stored data Send a notification if some of the stored data is not within the normal range

Basic flow:

Measure motor-driving current

Use case step	Description
Step 1	Read motor-driving current value from sensor.
Step 2	Store the data according to time sequence.

Measure drive torque

Use case step	Description
Step 1	Read drive torque value from sensor.
Step 2	Store the data according to time sequence.

Read tap position

Use case step	Description
Step1	Read tap position from dial switch.
Step2	Store the data according to time sequence.

Detect operation duration

Use case step	Description
Step 1	Detect start-up signal from sensor and save the time.
Step 2	Detect completion signal from sensor and save the time.
Step 3	Calculate duration using start-up and completion time stamp.
Step 4	Store the durations according to time sequence.

Provide operation properties

Use case step	Description
Step 1	Make data set using operation time stamp. This data set contains motor-driving current, shaft torque, tap position and operation duration.
Step 2	Provide a set of data to a user. Send a notification if a certain number of the stored data is not within the normal range.

7.5.2 Monitoring LTC operation counts

Figure 30 shows a use case for monitoring LTC operation counts.

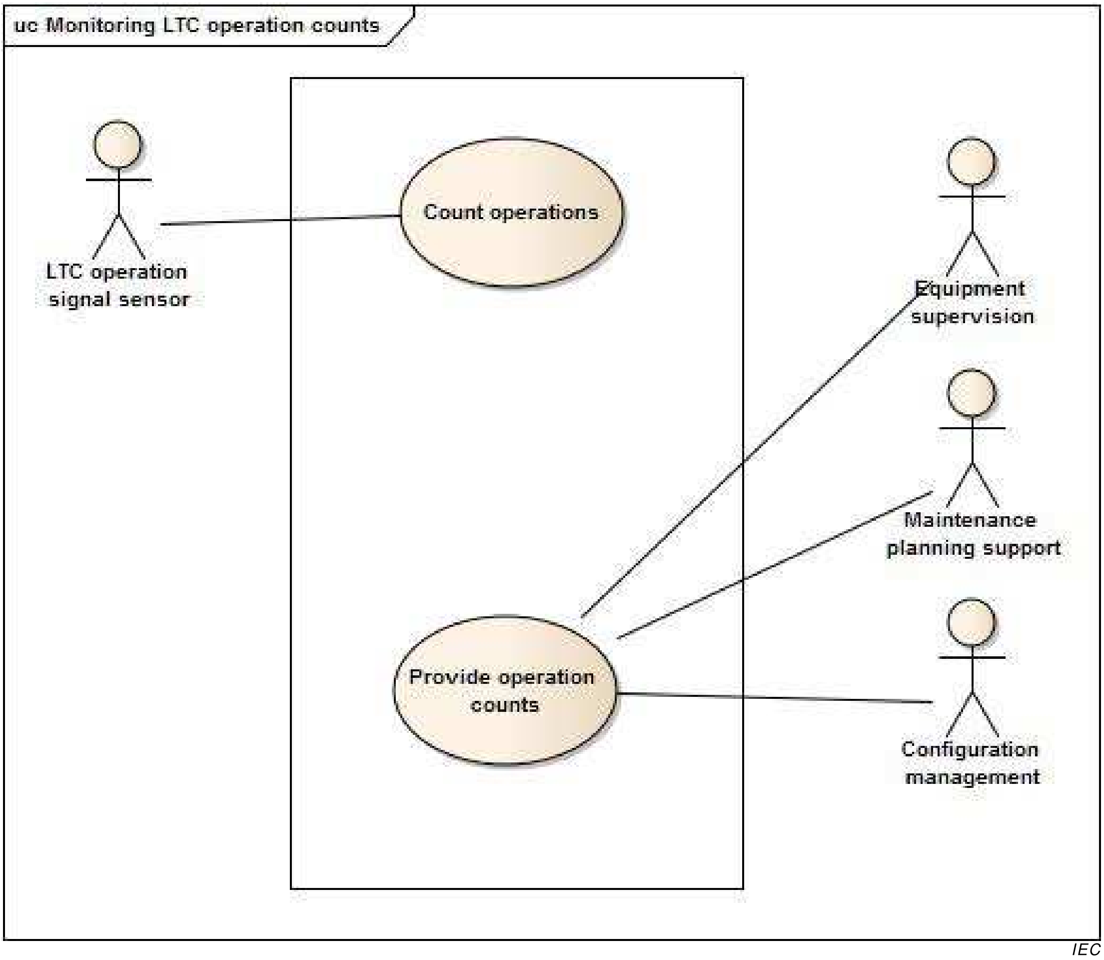


Figure 30 – Use case for monitoring LTC operation counts

Actor(s):

Name	Role description
LTC operation signal Sensor	Detect start/end time of LTC operation.
Equipment supervision	Supervise status of target equipment.
Maintenance planning support	Support planning maintenance work.
Asset management	Manage specifications and histories of target equipment.

Use case:

Name	Service or information provided
Count operations	Detect an LTC operation signal Calculate the operation count
Provide operation counts	Provide the operation count Send a notification if the operation counts exceeds the reset threshold

Basic flow:

Count operations

Use case step	Description
Step 1	Detect an LTC operation signal.
Step 2	Calculate the operation counts.

Provide operation counts

Use case step	Description
Step 1	Provide the operation counts. If the operation counts exceed the pre-set threshold, a notification is provided with the operation counts.

7.5.3 Monitoring contact abrasion

Figure 31 shows a use case for monitoring LTC contact abrasion.

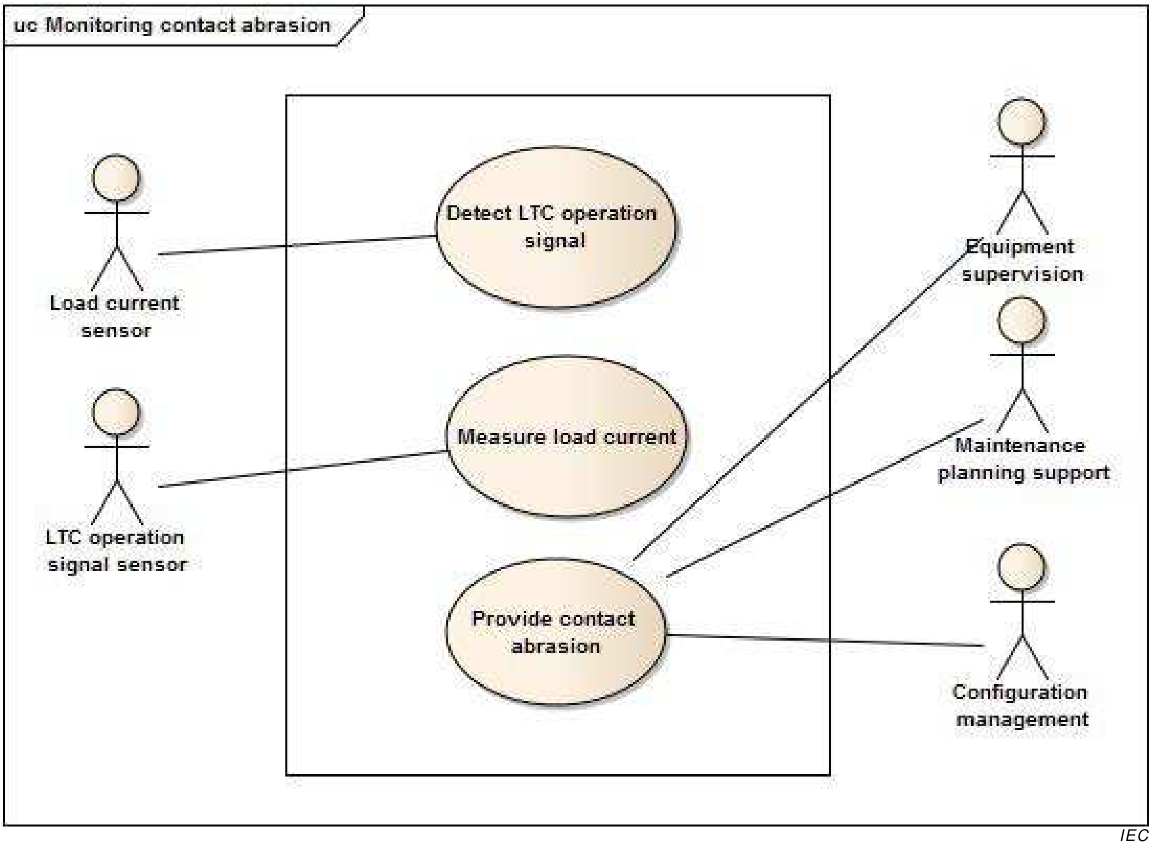


Figure 31 – Use case for monitoring contact abrasion

Actor(s):

Name	Role description
Load current sensor (CT embedded in bushing)	Measure load current.
LTC operation signal sensor	Detect start/end time of LTC operation.
Equipment supervision	Supervise status of target equipment.
Maintenance planning support	Support planning maintenance work.
Asset management	Manage specifications and histories of target equipment.

Use case:

Name	Service or information provided
Detect LTC operation Signal	Detect an LTC operation signal from sensor Save the operations with its time stamp
Measure load current	Read load current value from CT Store these data according to time sequence
Provide contact abrasion	Calculate contact abrasion Store these data according to time sequence Provide the stored data Send a notification if a certain number of the data is not within the normal range

Basic flow:

Detect LTC operation signal

Use case step	Description
Step 1	Detect an operation start-up signal from sensor.
Step 2	Save the operation start-up data with its time stamp.
Step 3	Detect operation completion signal from sensor.
Step 4	Save the operation completion data with its time stamp.

Measure load current

Use case step	Description
Step1	Read load current value from CT.
Step2	Store the data according to time sequence.

Provide contact abrasion

Use case step	Description
Step 1	Integrate load current from LTC start-up to completion.
Step 2	Calculate the percentage of contact abrasion based on the integrated load current.
Step 3	Store the percentage according to time sequence.
Step 4	Provide the percentage. If the data is not within the normal range a notification is attached to the data.

7.5.4 Monitoring LTC oil temperature and flow

Figure 32 shows a use case for monitoring LTC oil temperature and flow.

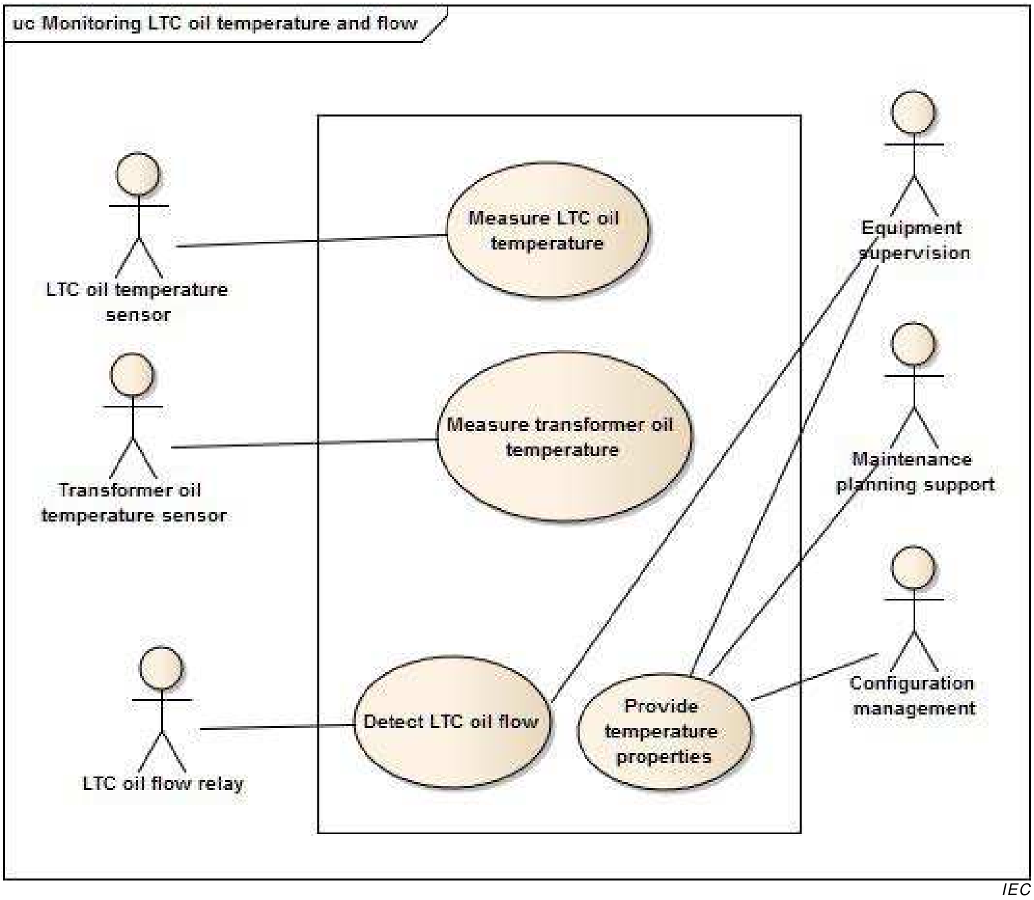


Figure 32 – Use case for monitoring LTC oil temperature and flow

Actor(s):

Name	Role description
LTC oil temperature sensor	Measure temperature of LTC oil.
Transformer oil temperature sensor	Measure temperature of transformer oil.
LTC oil flow relay	Detect LTC oil flow relay operation caused by gas produced by arc discharge.
Equipment supervision	Supervise status of target equipment.
Maintenance planning support	Support planning maintenance work.
Asset management	Manage specifications and histories of target equipment.

Use case:

Name	Service or information provided
Measure LTC oil temperature	Read LTC oil temperature value from sensor Store these data according to time sequence
Measure transformer oil temperature	Read transformer oil temperature value from sensor Store these data according to time sequence
Provide temperature properties	Calculate LTC oil temperature difference Store LTC oil temperature and LTC oil temperature difference data according to time sequence Provide the stored data Send a notification if these data exceed the preset threshold
Detect LTC oil flow	Detect LTC oil flow relay operation caused by gas Send a notification when LTC oil flow is detected

Basic flow:

Supervise LTC oil temperature

Use case step	Description
Step1	Read LTC oil temperature value from sensor
Step2	Store the data according to time sequence.

Supervise oil temperature

Use case step	Description
Step1	Read transformer oil temperature value from sensor
Step2	Store the data according to time sequence.

Provide temperature properties

Use case step	Description
Step 1	Calculate LTC oil temperature difference from LTC oil temperature and transformer oil temperature
Step 2	Store LTC oil temperature and LTC oil temperature difference data according to time sequence
Step 3	Provide the stored data. If these exceed the preset threshold, a notification is attached to the data.

Detect LTC oil flow

Use case step	Description
Step1	Detect LTC oil flow relay operation caused by gas
Step2	Send a notification when LTC oil flow is detected

7.5.5 Monitoring operation of oil filter unit

Figure 33 shows a use case for monitoring the operation of the LTC oil filter unit.

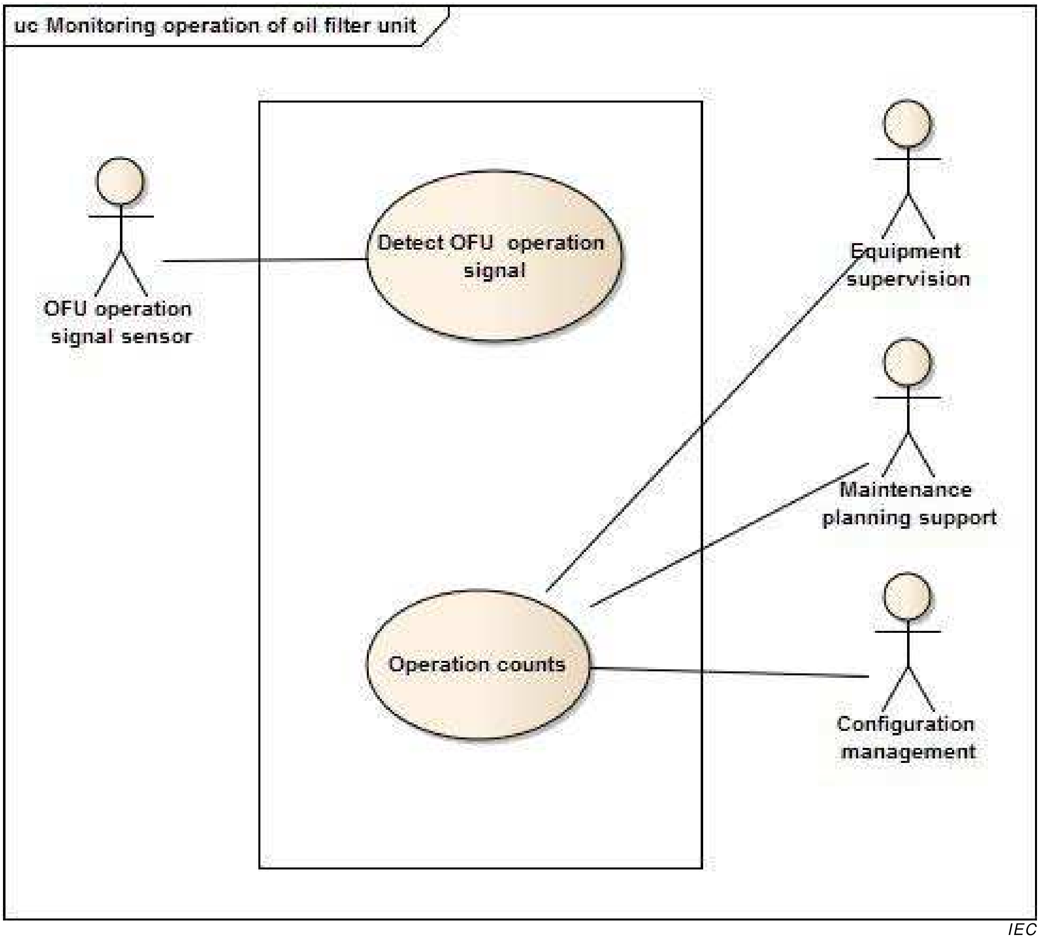


Figure 33 – Use case for monitoring operation of oil filter unit

Actor(s):

Name	Role description
OFU (Oil Filter Unit) operation signal sensor	Detect start/end time of OFU operation.
Equipment supervision	Supervise status of target equipment.
Maintenance planning support	Support planning maintenance work.
Asset management	Manage specifications and histories of target equipment.

Use case:

Name	Service or information provided
Detect OFU operation signal	Detect an OFU (Oil Filter Unit) operation signal Increment operation count
Operation counts	Provide the operation counts Send a notification if the operation counts exceed the pre-set threshold

Basic flow:

Detect OFU operation signal

Use case step	Description
Step 1	Detect an OFU (Oil Filter Unit) operation signal.
Step 2	Increment operation count.

Operation counts

Use case step	Description
Step1	Provide operation counts. If the counts exceed the preset threshold a notification is attached to the data.

7.6 Data description table

7.6.1 Monitoring operation property

Supervisory data table

Supervisor Item	Data	Data description	CDC	M/O/C
Supervisory device	MotDrvA	Motor driving current	MV	O
	Torq	Drive torque	MV	O
	TapPos	Tap position	INS	O
	OpDur	LTC operation duration	MV	O

Supervisory status data table

Status Item	Data	Data description	CDC	M/O/C
Supervisory device	MDAAlm	Motor driving current alarm information	SPS	O
	MDAWrn	Motor driving current warning information	SPS	O
	TorqAlm	Drive torque alarm information	SPS	O
	TorqWrn	Drive torque warning information	SPS	O
	EndPosR	End position reached while raising or highest allowed tap position reached	SPS	O
	EndPosL	End position reached while lowering or lowest allowed tap position reached	SPS	O
	OpDurAlm	LTC operation duration alarm information	SPS	O
	OpDurWrn	LTC operation duration warning information	SPS	O

Supervisory threshold data table

Threshold Item	Data	Data description	CDC	M/O/C
Supervisory device	MDAAlmSet	Motor driving current threshold for alarm	ASG	O
	MDAWrnSet	Motor driving current threshold for warning	ASG	O
	TorqAlmSet	Drive torque threshold for alarm	ASG	O
	TorqWrnSet	Drive torque threshold for warning	ASG	O
	OpDurAlmSet	LTC operation duration threshold for alarm	ASG	O
	OpDurWrnSet	LTC operation duration threshold for warning	ASG	O

Motor driving current sensor data table

Sensor Item	Data	Data description	CDC	M/O/C
Data acquisition device (Motor driving current sensor)	AmpSv	Motor drive current	SAV	O

Shaft torque sensor data table

Sensor Item	Data	Data description	CDC	M/O/C
Data acquisition device (Shaft torque sensor)	TrqSv	Torque	SAV	O

Tap Position data table

Sensor Item	Data	Data description	CDC	M/O/C
Data acquisition device (Tap position sensor)	TapPos	Change tap position to dedicated position	ISC	C
	TapChg	Change tap position (stop, higher, lower)	BSC	C

Condition C: depending on the tap-change method, at least one of the two controls TapChg and TapPos shall be used.

LTC operation signal sensor data table

Sensor Item	Data	Data description	CDC	M/O/C
Data acquisition device (LTC operation signal sensor)	TapPos	Change tap position to dedicated position	ISC	C
	TapChg	Change tap position (stop, higher, lower)	BSC	C

Condition C: depending on the tap-change method, at least one of the two controls TapChg and TapPos shall be used.

7.6.2 Monitoring operation counts

Supervisory data table

Supervisor Item	Data	Data description	CDC	M/O/C
Supervisory device	OpCntRs	Resettable operation counter	INC	O

Supervisory status data table

Status Item	Data	Data description	CDC	M/O/C
Supervisory device	OpCntAlm	Operation counts alarm	SPS	O
	OpCntWrn	Operation counts warning	SPS	O

Supervisory threshold data table

Threshold Item	Data	Data description	CDC	M/O/C
Supervisory device	OpCntAlmSet	Operation counts threshold for alarm	ING	O
	OpCntWrnSet	Operation counts in a minute threshold for warning	ING	O

LTC operation signal sensor data table

Sensor Item	Data	Data description	CDC	M/O/C
Data acquisition device (LTC operation signal sensor)	TapPos	Change tap position to dedicated position	ISC	C
	TapChg	Change tap position (stop, higher, lower)	BSC	C

Condition C: depending on the tap-change method, at least one of the two controls TapChg and TapPos shall be used.

7.6.3 Monitoring contact abrasion

Supervisory data table

Supervisor Item	Data	Data description	CDC	M/O/C
Supervisory device	AbrPrt	Abrasion (in %) of parts subject to wear	MV	O

Supervisory status data table

Status Item	Data	Data description	CDC	M/O/C
Supervisory device	AbrPrtAlm	Abrasion alarm	SPS	O
	AbrPrtWrn	Abrasion warning	SPS	O

Supervisory threshold data table

Threshold Item	Data	Data description	CDC	M/O/C
Supervisory device	AbrPrtAlmSet	Abrasion threshold for alarm	ING	O
	AbrPrtWrnSet	Abrasion threshold for warning	ING	O

LTC operation signal sensor data table

Sensor Item	Data	Data description	CDC	M/O/C
Data acquisition device	TapPos	Change tap position to dedicated position	ISC	C
(LTC operation signal sensor)	TapChg	Change tap position (stop, higher, lower)	BSC	C

Condition C: depending on the tap-change method, at least one of the two controls TapChg and TapPos shall be used.

Load current sensor data table

Sensor Item	Data	Data description	CDC	M/O/C
Data acquisition device (Load current sensor)	AmpSv	Load current	SAV	O

7.6.4 Monitoring LTC oil temperature and flow

Supervisory data table

Supervisor Item	Data	Data description	CDC	M/O/C
Supervisory device	Tmp	LTC oil temperature	MV	O
	OTDif	Temperature difference between LTC oil and transformer oil	MV	O

Supervisory status data table

Status Item	Data	Data description	CDC	M/O/C
Supervisory device	TmpAlm	Insulation liquid temperature alarm	SPS	O
	TmpWrn	Insulation liquid temperature warning	SPS	O
	OTDifAlm	Temperature difference alarm	SPS	O
	OTDifWrn	Temperature difference warning	SPS	O
	GasFlwTr	Insulation liquid flow trip because of gas	SPS	O

Supervisory threshold data table

Threshold Item	Data	Data description	CDC	M/O/C
Supervisory device	TmpAlmSet	Temperature alarm level setting	ASG	O
	TmpWrnSet	Temperature warning level setting	ASG	O
	OTDifAlmSet	Temperature difference threshold for alarm	ING	O
	OTDifWrnSet	Temperature difference threshold for warning	ING	O

LTC oil temperature sensor / Transformer oil temperature sensor data table

Sensor Item	Data	Data description	CDC	M/O/C
Data acquisition device (LTC oil temperature sensor)	TmpSv	LTC oil temperature	SAV	O

7.6.5 Monitoring operation of oil filter unit

Supervisory data table

Supervisor Item	Data	Data description	CDC	M/O/C
Supervisory device	OFCnt	Oil filter counts	INS	O

Supervisory status data table

Status Item	Data	Data description	CDC	M/O/C
Supervisory device	OFCntAlm	Oil filter counts alarm	SPS	O
	OFCntWrn	Oil filter counts warning	SPS	O

Supervisory threshold data table

Threshold Item	Data	Data description	CDC	M/O/C
Supervisory device	OFCntAlmSet	Oil filter counts threshold for alarm	ING	O
	OFCntAlmWrnSet	Oil filter counts threshold for warning	ING	O

Oil filter operation signal sensor data table

Sensor Item	Data	Data description	CDC	M/O/C
Data acquisition device (Oil filter operation signal sensor)	OpCtl	Operate filter	SPC	O

8 Underground cable (UGC)

8.1 Summary

A condition monitoring system for underground cables acquires condition data from sensors that are installed into, on or around the cables to be monitored. A typical system configuration is illustrated in Figure 34.

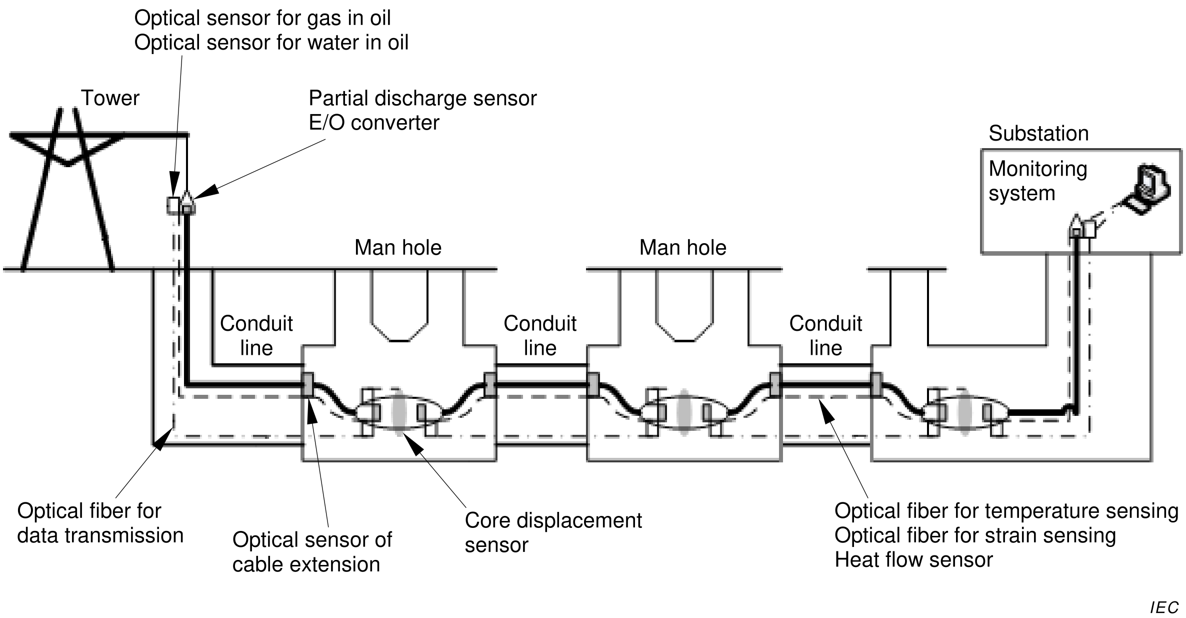


Figure 34 – An online system monitoring OF (Oil Filled) cable conditions

(This figure taken from Figure 4-3-38 in reference [1][2])

8.2 Underground cable overview

8.2.1 General

There are two major types of under-ground cables described as follows. Therefore this document is focused on CMD for these types.

8.2.2 XLPE (cross-linked polyethylene insulated) cable

This subclause mentions the characteristics of XLPE cable from the viewpoints of jacket, terminal and connection.

2 Numbers in square brackets refer to the bibliography.

A cable has two major parts, core and jacket. Core is usually made of metal to carry electricity. On the other hand, jacket is made of XLPE to insulate the core from surroundings electrically. It covers the core as illustrated in Figure 35.

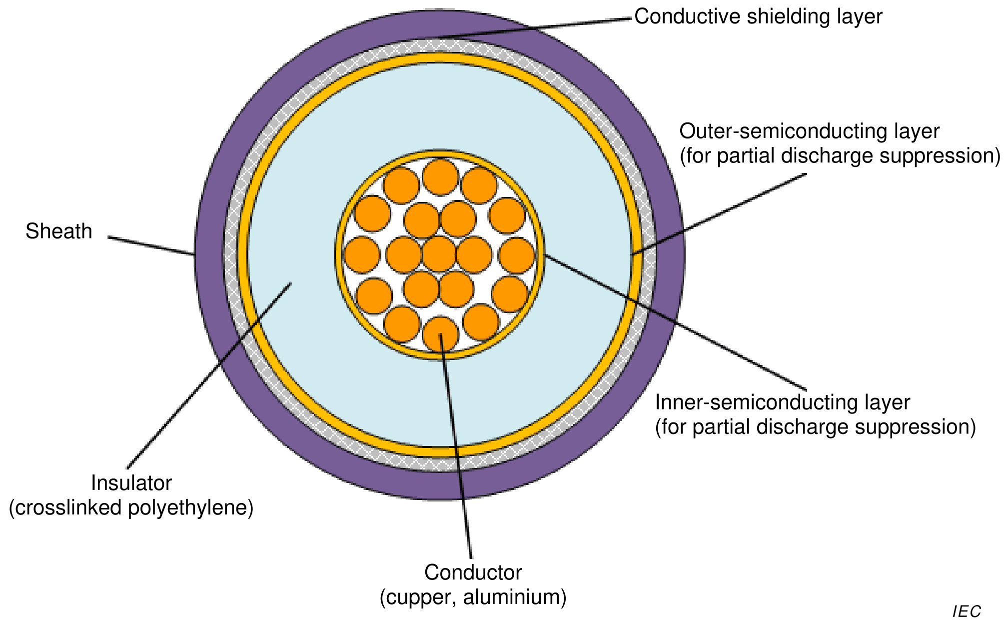


Figure 35 – Cable cross-section drawing

Several methodologies have been applied to construct a cable terminal. A prefabrication method is one of the most popular ways to construct a cable terminal. It provides easy construction as well as superior insulation. Oil immersion method is another one that used to be applied for high voltage cables. It is superior in terms of insulation. Other methods include taping method, plugging-in method and semi-prefabrication method.

Cables are connected using the same methods as for terminal. In addition, mold processing or a method using rubber block is applied to cable connection.

8.2.3 OF (Oil Filled) cable

Oil is filled between core wire and jacket in this type of cables. This means that supervision of OF cable is same as or similar to that for oil in power transformer.

8.3 Constraints/assumptions/design considerations

This clause describes use cases and related information for CMD of UGC itself. Please note that we make no reference to UGC-related facilities such as an oil pump or tunnel.

We discuss the data that are monitored by an online system. The meaning of “online system” in this document is that sensors are always or temporally installed to cables and data from sensors is transferred to a remote IED via a communication network. This document does not discuss the data that a crew acquires by a testing device.

8.4 Data flow

Figure 36 illustrates supervisions of underground cables and their data flows. They are common for XLPE cables and OF cables. The use cases mentioned in the following subclauses assume the data described in Figure 36.

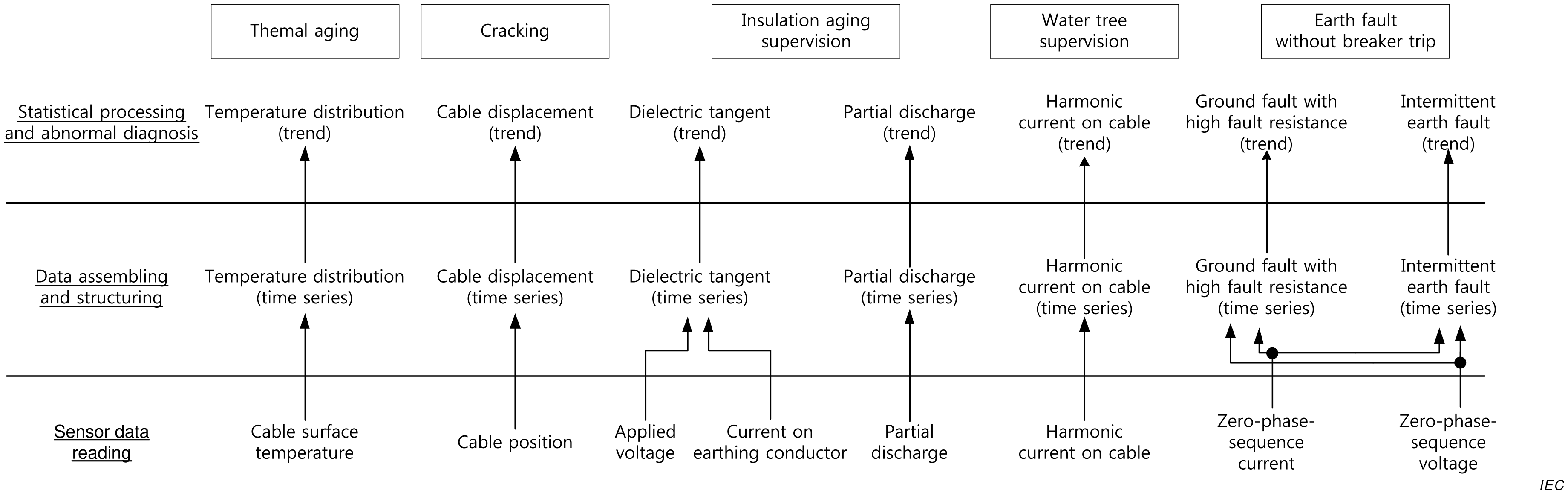


Figure 36 – Supervisions of UGC and their data flows

Figure 37 depicts supervisions of OF cables and their data flows. They are not applied to supervisions for XLPE cables. Some use cases mentioned in the following subclauses assume the data described in Figure 37.

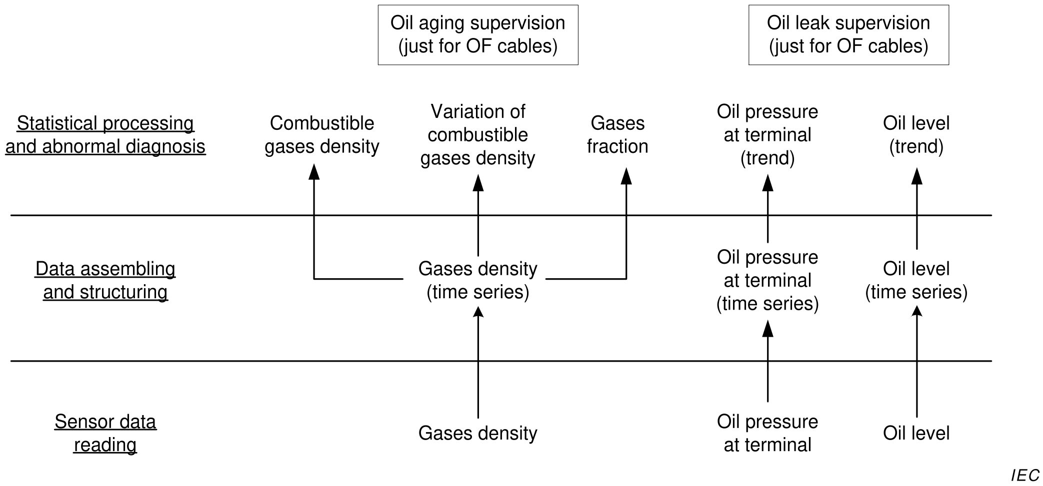


Figure 37 – Supervisions of OF cables and their data flows

8.5 Use case diagram

8.5.1 General

This subclause shows use cases for the CMD functions that have been described in the summary section. The use case in Figure 38 illustrates functions in the system to be designed and the actors of the system.

8.5.2 Thermal aging supervision

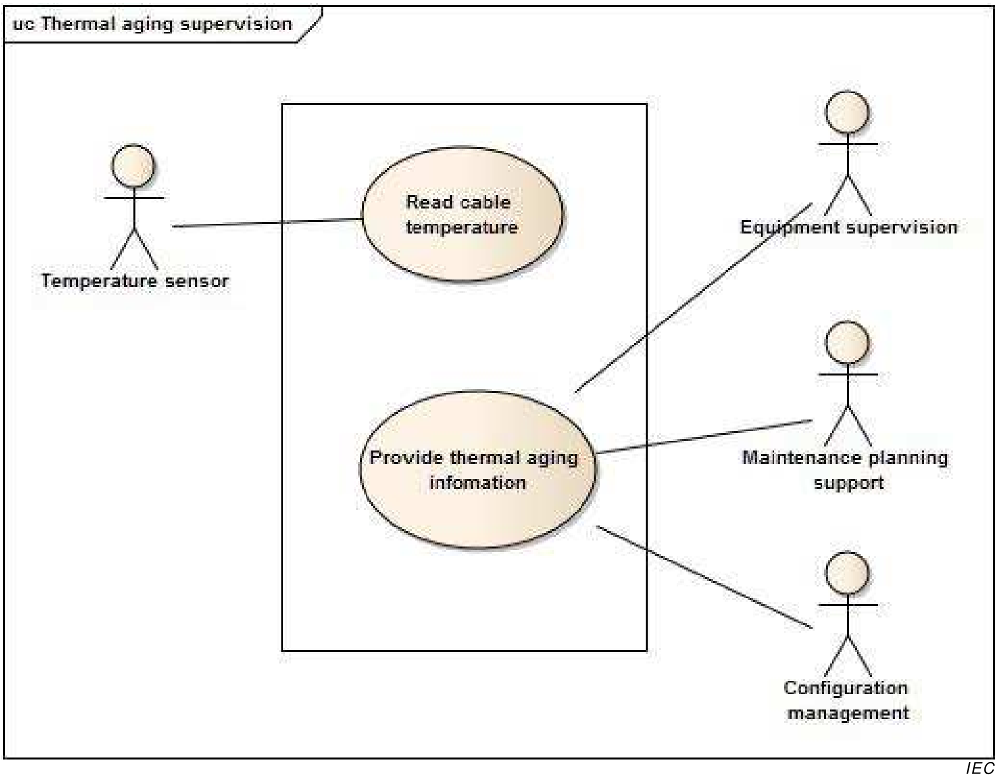


Figure 38 – Use case for thermal aging supervision

Actor(s):

Name	Role description
Temperature sensor	Measure temperature on cable surface. It could measure temperature at one point, or multiple points.
Equipment supervision	Supervise status of target equipment.
Maintenance planning support	Support planning maintenance work.
Asset management	Manage specifications and histories of target equipment.

Use case:

Name	Service or information provided
Read cable temperature	Read temperature value from sensors. Store these data according to time sequence.
Provide thermal aging information	Process information related to thermal aging of cable based on the stored data. Provide the stored or processed data Send a notification if some of the data is not within the normal range

Basic flow:

Read cable temperature

Use case step	Description
Step 1	Read temperature value from sensor
Step 2	Store these data according to time sequence

Provide thermal aging information

Use case step	Description
Step 1	Analyze temperature distributions on the supervised cable.
Step 2	Judge the temperature distributions are within the normal range or not.
Step 3	Provide the data set to a user. Send a notification if a certain number of the stored data is not within the normal range.

8.5.3 Supervision of cable parts cracking

The length of UGC varies according to its temperature, so that a force is applied to parts of a cable such as connection. If a force exceeds the proof strength of cable parts, they are cracked. Cable displacement is thought to have a relation to a force applied to a cable.

A sensor shown in Figure 39 has been proposed for measurement of cable displacement in three dimensions. A system for CMD of UGC could acquire data from such a sensor.

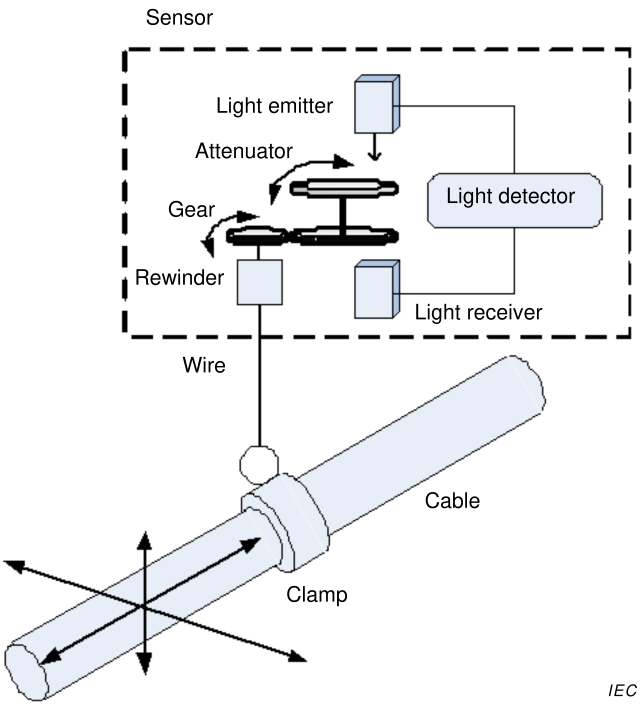


Figure 39 – A sensor detecting cable positions in 3 dimensions

Figure 40 shows a use case for supervision of cable parts cracking.

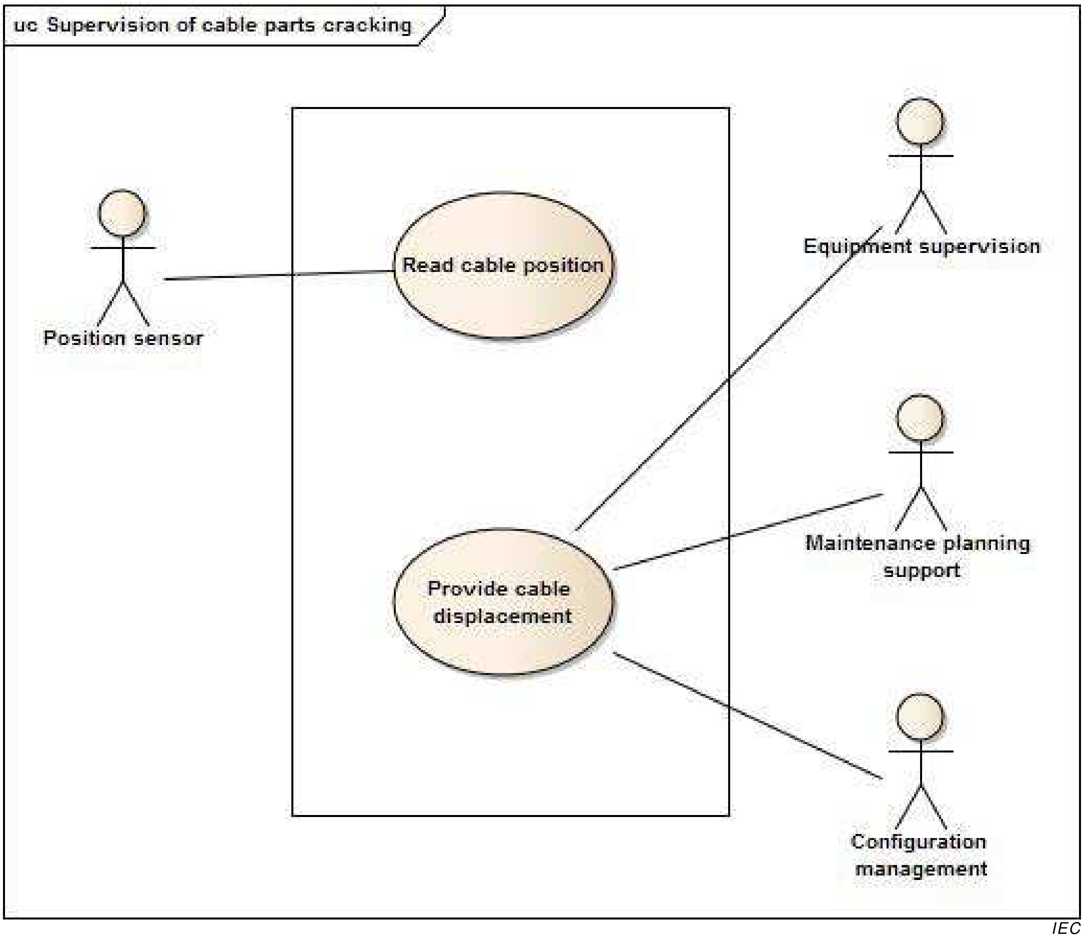


Figure 40 – Use case for supervision of cable parts cracking

Actor(s):

Name	Role description
Position sensor	Measure how long a cable is displaced from a reference point.
Equipment supervision	Supervise status of target equipment.
Maintenance planning support	Support planning maintenance work.
Asset management	Manage specifications and histories of target equipment.

Use case:

Name	Service or information provided
Read cable position	Read a cable position value (3-dimensional) from sensors. Store these data according to time sequence
Provide cable displacement	Process information related to cable displacement based on the stored data. Provide the stored or processed data Send a notification if some of the data is not within the normal range

Basic flow:

Read cable position

Use case step	Description
Step 1	Read a cable position value (3-dimensional) from sensor
Step 2	Store these data according to time sequence

Provide cable displacement

Use case step	Description
Step 1	Analyze displacement on the supervised cable based on the stored data.
Step 2	Judge the displacement data is within the normal range or not.
Step 3	Provide the data set to a user. Send a notification if a certain number of the stored data is not within the normal range.

8.5.4 Insulation aging supervision

Figure 41 shows a use case for insulation aging supervision.

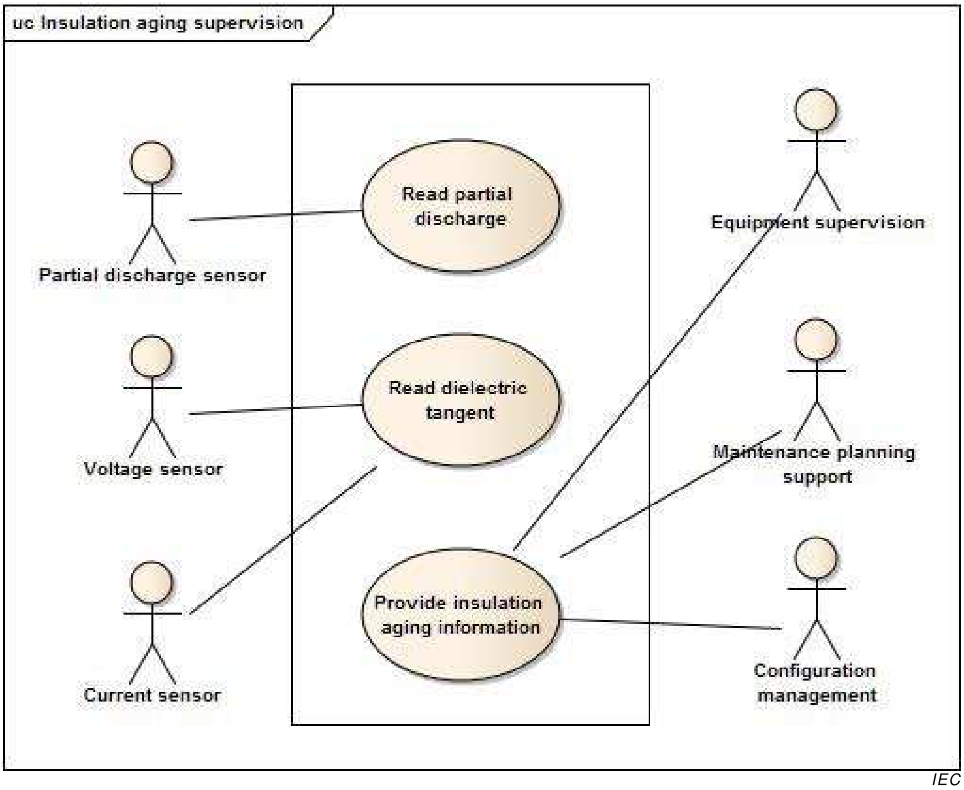


Figure 41 – Use case for insulation aging supervision

Actor(s):

Name	Role description
Partial discharge sensor	Measure partial discharge from a cable.
Voltage sensor	Measure voltage applied to a conductor.
Current sensor	Measure current applied to a conductor.
Equipment supervision	Supervise status of target equipment.
Maintenance planning support	Support planning maintenance work.
Asset management	Manage specifications and histories of target equipment.

Use case:

Name	Service or information provided
Read partial discharge	Read partial discharge value from sensor Store these data according to time sequence
Read dielectric tangent	Read values of applied voltage and current on earthing conductor from sensors Store these data according to time sequence.
Provide insulation aging information	Process information related to insulation aging based on the stored data. Provide the stored or processed data Send a notification if some of the data is not within the normal range

Basic flow:

Read partial discharge

Use case step	Description
Step 1	Read partial discharge value from sensor
Step 2	Store these data according to time sequence

Read dielectric tangent

Use case step	Description
Step 1	Read values of applied voltage and current on earthing conductor from sensors
Step 2	Calculate dielectric tangent from the values of voltage and current.
Step 3	Store these data according to time sequence

Provide insulation aging information

Use case step	Description
Step 1	Analyze partial discharge and dielectric tangent on the supervised cable based on the stored data.
Step 2	Judge the insulation aging of the cable is within the normal range or not.
Step 3	Provide the data set to a user. Send a notification if a certain number of the stored data is not within the normal range.

8.5.5 Water-tree supervision

Figure 42 shows a use case for water-tree supervision.

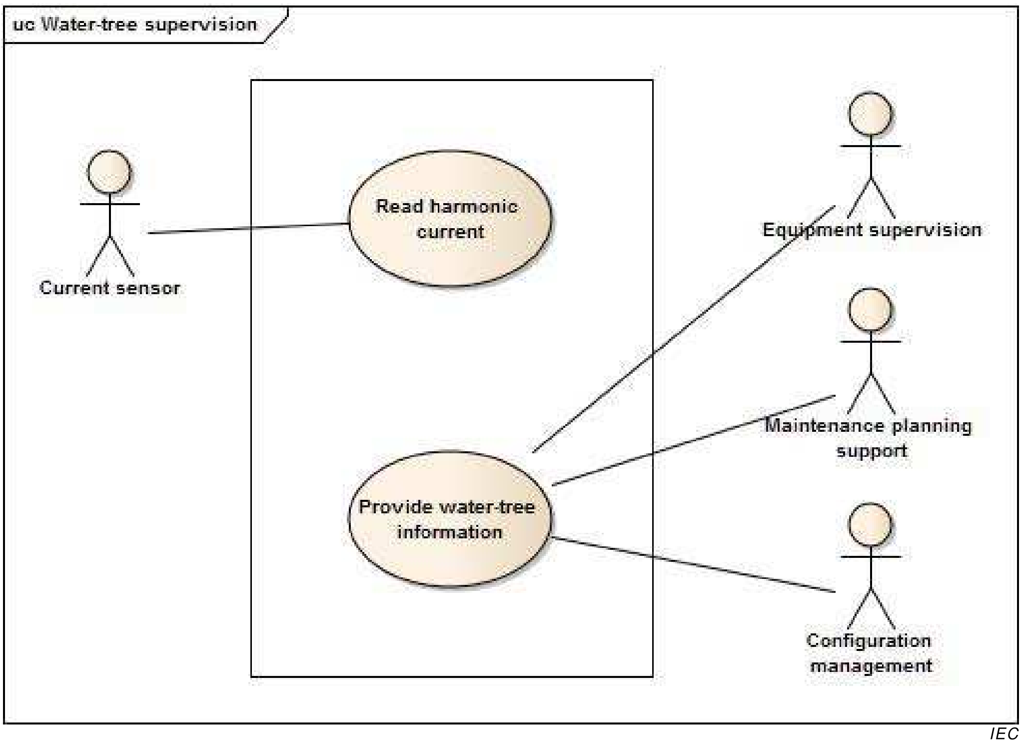


Figure 42 – Use case for water-tree supervision

Actor(s):

Name	Role description
Current sensor	Measure harmonic current on cable surface.
Equipment supervision	Supervise status of target equipment.
Maintenance planning support	Support planning maintenance work.
Asset management	Manage specifications and histories of target equipment.

Use case:

Name	Service or information provided
Read harmonic current	Read harmonic current value from sensor Store these data according to time sequence
Provide water-tree information	Process information related to water-tree based on the stored data. Provide the stored or processed data Send a notification if some of the data is not within the normal range

Basic flow:

Read harmonic current

Use case step	Description
Step 1	Read harmonic current value from sensor
Step 2	Store these data according to time sequence

Provide water-tree information

Use case step	Description
Step 1	Analyze water-tree initiation on the supervised cable based on the stored data.
Step 2	Judge the water-tree initiation data is within the normal range or not.
Step 3	Provide the data set to a user. Send a notification if a certain number of the stored data is not within the normal range.

8.5.6 Supervision of earth fault without circuit breaker trip

Figure 43 shows a use case for supervision of earth fault without circuit breaker trip.

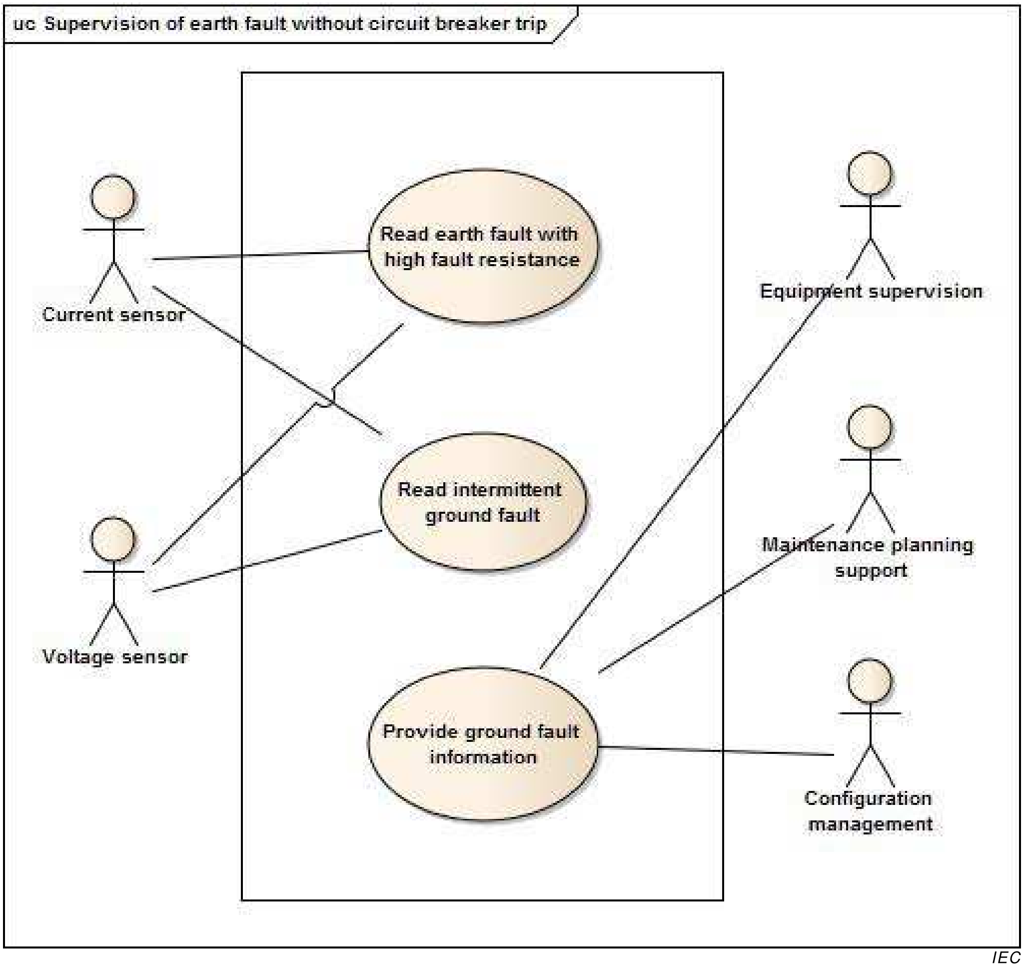


Figure 43 – Use case for supervision of earth fault without circuit breaker trip

Actor(s):

Name	Role description
Current sensor	Measure zero-phase-sequence current
Voltage sensor	Measure zero-phase-sequence voltage
Equipment supervision	Supervise status of target equipment.
Maintenance planning support	Support planning maintenance work.
Asset management	Manage specifications and histories of target equipment.

Use case:

Name	Service or information provided
Read earth fault with high fault resistance	Read current and voltage values from sensor Judge whether an earth fault occurs or not. Store these data according to time sequence
Read intermittent earth fault	Read current and voltage values from sensor Judge whether an earth fault occurs or not. Store these data according to time sequence
Provide earth fault information	Process information related to earth fault based on the stored data. Provide the stored or processed data Send a notification if some of the data is not within the normal range

Basic flow:

Read earth fault with high fault resistance

Use case step	Description
Step 1	Read current and voltage values from sensor
Step 2	Judge whether the earth fault occurs or not.
Step 3	Store these data according to time sequence

Read intermittent earth fault

Use case step	Description
Step 1	Read current and voltage values from sensor
Step 2	Judge whether the earth fault occurs or not.
Step 3	Store these data according to time sequence

Provide earth fault information

Use case step	Description
Step 1	Analyze earth faults on the supervised cable based on the stored data.
Step 2	Provide the data set to a user. Send a notification if a certain number of the stored data is not within the normal range.

8.5.7 Oil aging supervision

Figure 44 shows a use case for oil aging supervision.

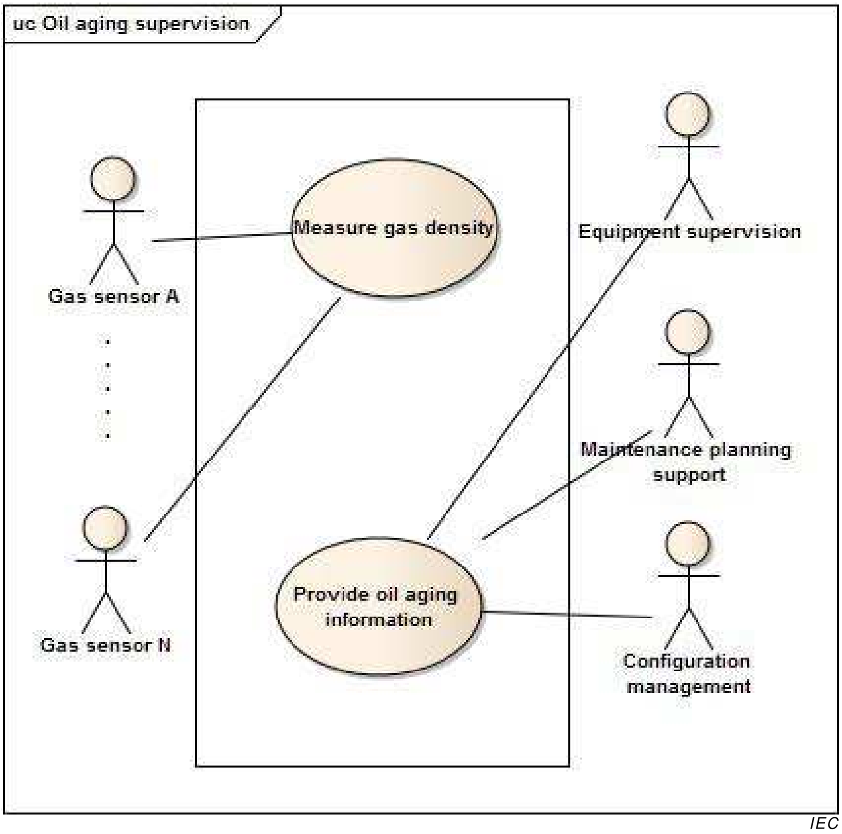


Figure 44 – Use case for oil aging supervision

Actor(s):

Name	Role description
Gas sensor	Measure density of a particular gas. Another type of sensor would be installed for another sort of gas.
Equipment supervision	Supervise status of target equipment.
Maintenance planning support	Support planning maintenance work.
Asset management	Manage specifications and histories of target equipment.

Use case:

Name	Service or information provided
Measure gas density	Read the value of gas density from sensor Store these data according to time sequence
Provide oil aging information	Process information related to oil aging based on the stored data. Provide the stored or processed data Send a notification if some of the data is not within the normal range

Basic flow:

Measure gas density

Use case step	Description
Step 1	Read the value of gas density from sensor
Step 2	Store these data according to time sequence

Provide oil aging information

Use case step	Description
Step 1	Analyze oil aging on the supervised cable based on the stored data.
Step 2	Judge the oil aging data is within the normal range or not.
Step 3	Provide the data set to a user. Send a notification if a certain number of the stored data is not within the normal range.

8.5.8 Oil leak supervision

Figure 45 shows a use case for oil leak supervision.

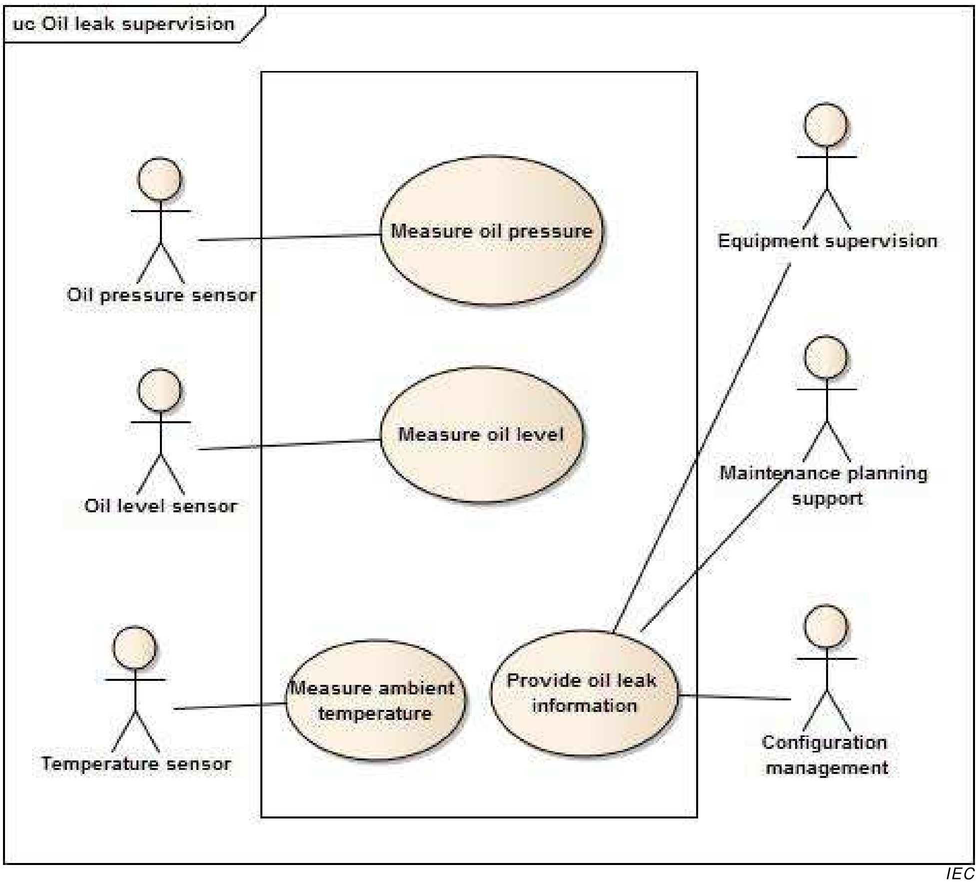


Figure 45 – Use case for oil leak supervision

Actor(s):

Name	Role description
Oil pressure sensor	Measure pressure of oil injected into a cable.
Oil level sensor	Measure oil level in a tank.
Temperature sensor	Measure ambient temperature around a tank
Equipment supervision	Supervise status of target equipment.
Maintenance planning support	Support planning maintenance work.
Asset management	Manage specifications and histories of target equipment.

Use case:

Name	Service or information provided
Measure oil pressure	Read the value of oil pressure from sensor Store these data according to time sequence
Measure oil level	Read the value of oil level from sensor Store these data according to time sequence
Measure ambient temperature	Read the value of temperature sensor Store these data according to time sequence
Provide oil leak information	Process information related to oil leak based on the stored data. Provide the stored or processed data Send a notification if some of the data is not within the normal range

Basic flow:

Measure oil pressure

Use case step	Description
Step 1	Read the value of oil pressure from sensor
Step 2	Store these data according to time sequence

Measure oil level

Use case step	Description
Step 1	Read the value of oil level from sensor
Step 2	Store these data according to time sequence

Measure ambient temperature

Use case step	Description
Step 1	Read the value of temperature sensor
Step 2	Store these data according to time sequence

Provide oil leak information

Use case step	Description
Step 1	Analyze oil leak on the supervised cable based on the stored data.
Step 2	Judge the oil leak data is within the normal range or not.
Step 3	Provide the data set to a user. Send a notification if a certain number of the stored data is not within the normal range.

References: [8], [9], [10]

8.6 Data description table

8.6.1 Sensor items held in existing LNs

Sensor Item	Data	Data description	CDC	M/O/C
Current sensor	AmpSv	Current (sampled value)	SAV	C
Temperature sensor	TmpSv	Temperature [°C]	SAV	C
Position sensor	AxDspSv	Total axial displacement	SAV	C
Voltage sensor	VolSv	Voltage (sampled value)	SAV	C
Pressure sensor	PresSv	Pressure of media [Pa]	SAV	C
Level sensor	LevPctSv	Level [%]	SAV	C

8.6.2 Sensor items requiring a new LN

Sensor Item	Data	Data description	CDC	M/O/C
Density sensor	DenSv	Density (mol/L) This type of sampled values holds gas density. A new LN could be named TDEN.	SAV	C

8.6.3 Supervising items held in existing LNs

Supervising Item	Data	Data description	CDC	M/O/C
Partial discharge	AcuPaDsch	Acoustic level of partial discharge	MV	C
	AppPaDsch	Apparent charge of partial discharge, peak level (PD)	MV	C
	NQS	Average discharge current	MV	C
	UhfPaDsch	UHF level of partial discharge	MV	C
Harmonic current	HA	Sequence of harmonics or inter harmonics current	HWYE	O
Earth fault with high resistance	Str	Start	ACD	M
Intermittent earth fault	Str	Start	ACD	M
Gases density	H2ppm, N2ppm, etc.	Measurement of Hydrogen (H2 in ppm). Measurement of N2 in ppm. Gas fraction could be represented using these DOs.	MV	O
Oil level	Lev	Insulation liquid level (usually in m)	MV	O

8.6.4 Supervising items requiring new DO's in an existing LN

Supervising Item	Data	Data description	CDC	M/O/C
Variation of combustible gases density	CGasppmVar	The variation (amount of change) of combustible gases	MV	O
Temperature distribution	TmpDis	Temperature distribution on cable	MV	O
Cable displacement	DspDis	Cable displacement from its proper position	MV	O

8.6.5 Supervising items requiring a new LN

Supervising Item	Data	Data description	CDC	M/O/C
Dielectric tangent	TanLosAng	Tangent of loss angle of the monitored cable	MV	O

9 Transmission line (TL)

9.1 Summary

This document describes TL (Transmission Line) use cases and data modelling for CMD (Condition Monitoring analysis and Diagnostics). Any use case in CMD shares the same designing concept which starts from condition monitoring through sensors to detect initial alarm (warning) points at the sensor level. In some cases, a CMD engine is needed to process those sensed data statistically to decide another alarm point. The processing may require another level of data processing hierarchically. In addition, the structured CMD information can be provided to the RCC (Regional Control Centre) and/or NCC (National Control Centre) for the asset management.

TL has 4 major CMD components:

a) Transmission line component – Line between towers,

b) Transmission tower component – Tower frame and ground base,

c) Insulator component – Insulator between tower and line,

d) Transmission tower surrounding area component – Tower surrounding area including trees and natural conditions,

9.2 Transmission line overview

9.2.1 Overhead transmission line (OHTL)

TL CMD can be clustered as shown in Figure 46. Transmission line data are managed based on the cluster. In each tower cluster, CMD servers process the collected data from each sensor to send alarm. The CMD manager supervises line, tower and insulator soundness and can be also used for maintenance at the asset management. The CMD server statistically processes the collected data, analyses and diagnoses the processed data. In case of a violation of the predefined setting value, the CMD server sends an alarm event and statistics to the CMD manager. Figure 46 depicts the general TL CMD functionalities in hierarchy.

The OHTL condition information can be grouped as line condition information, tower condition information, insulator condition information, meteorological information and other material information for line and tower.

The line condition information is composed of the line current and direction, temperature, slope and location.

The tower condition information comes from the tension, the amount of earth rod corrosion, the inclination, the vibration, the meteorological data and the tower construction material.

The insulator condition information gets data from the corona, the insulator leakage current and the acoustics.

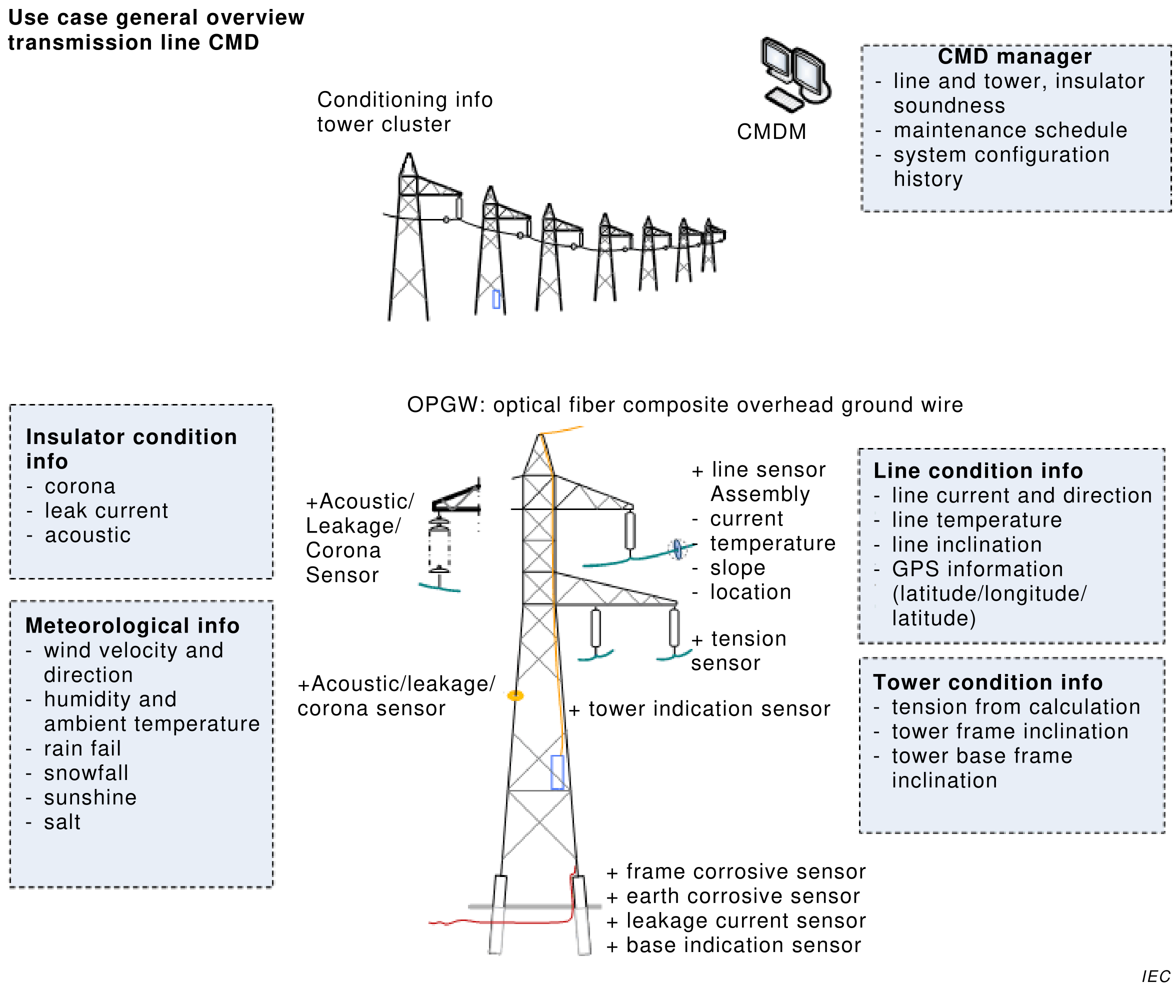


Figure 46 – Example configuration of OHTL tower cluster

9.2.2 Line sensor unit

The TL sensor unit collects the line current and direction, line temperature, inner ambient temperature, direction and velocity of the wind, line slope and GPS information. Figure 47 shows the component of the line sensor unit.

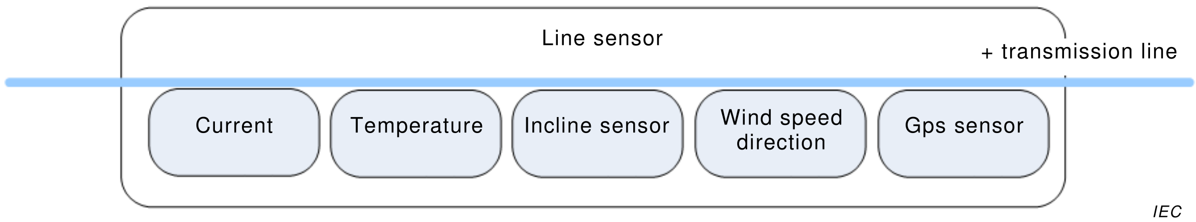


Figure 47 – Line sensor unit

The line sensor unit collects the sampled data, which are filtered and processed, to be sent to the line condition server through communication interfaces.

9.3 TL CMD use case diagram

9.3.1 Line condition supervisor

The line condition server collects line condition data from sensors. The line condition server (LCS) diagnoses the status of the transmission line by comparing collected and processed data with predefined setting values. If a violation of the predefined setting value is found, the line condition server sends an alarm event and statistical data to the NCC/RCC. Figure 48 shows a use case for line condition supervisor.

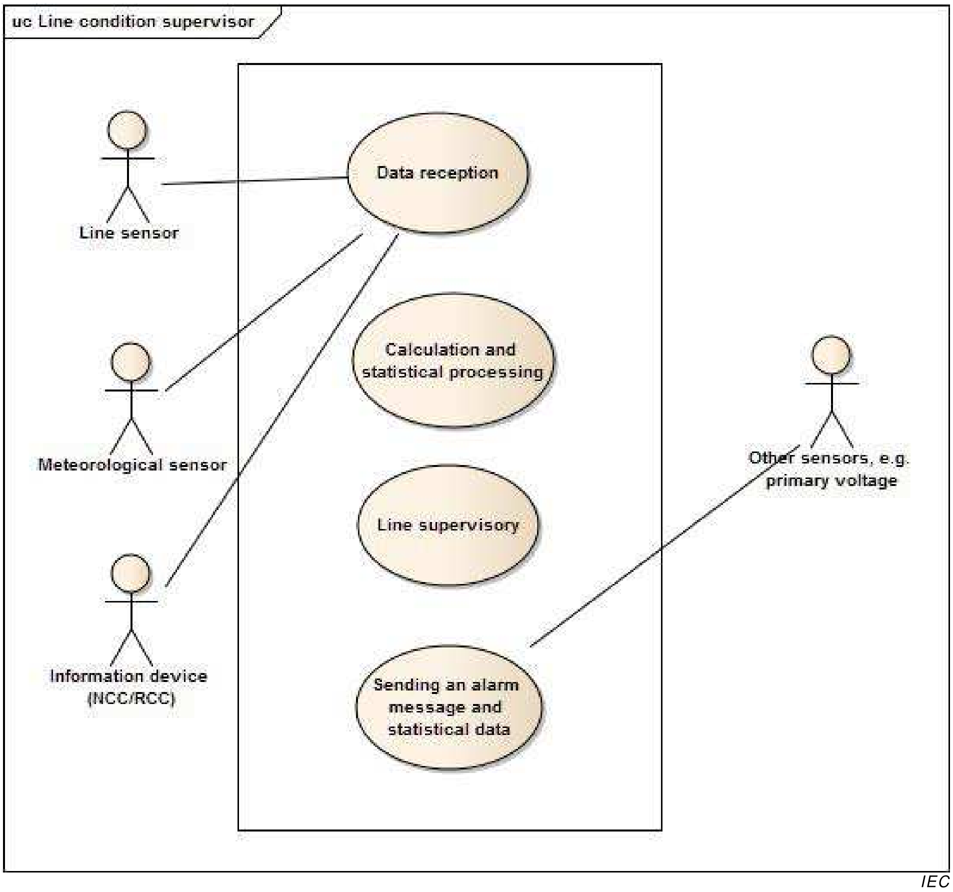


Figure 48 – Use case for line condition supervisor

Actor(s):

Name	Role description
Line sensor	Measure line current, current direction, temperature and slope and send them to the line condition server.
Meteorological sensor	Measure wind velocity/direction, humidity, ambient temperature, snowfall and insulation.
Configuration management	Provide the predefined setting values with line information. The predefined data values are line bundle, line diameter, line metal quality, line tension, line length, etc.
Asset management	Monitor the transmission line. In case of predefined setting value violation at the line condition server, the operation center receives an alarm message with statistical data from the line condition server.

Use cases

Name	Services or information provided
Data reception	Receive data from line sensor, meteorological sensor and information device through communication interface
Calculation and statistical processing	The transmission capability is calculated from the line current, line voltage, line temperature, ambient temperature, insulation and line specification information. The line sag/swing is calculated from the line length between towers, tower (or line) height, line tension, line slope, wind direction, wind speed, snowfall and line and tower specification information. The line status is monitored from line current, line slope, line tension to check the line's physical failure. (on, off(cut), droop, ..)
Line supervisory	Diagnose the status of transmission line (e.g., transmission capability, line sag/swing (horizontal, vertical), fault current, surge fault and outage) with predefined setting values.
Sending an alarm message and statistical data	In case of the predefined setting value being violated, the line condition server sends an alarm message and statistical data to the NCC/RCC

Basic flow:

Data reception

Use case step	Description
Step 1	Receive data using communication interface
Step 2	Store the data

Calculation and statistical processing

Use case step	Description
Step 1	Retrieve stored data for supervision
Step 2	Statistical processing for supervision and diagnosis

Line supervisory

Use case step	Description
Step 1	Retrieve stored data for supervision
Step 2	Supervise and diagnose the status of line by comparing the processed data with predefined setting value

Sending alarm message or statistical data

Use case step	Description
Step 1	In case of the predefined setting value being violated, the line condition server retrieves data or processed data result.
Step 2	Send an alarm message and statistical data to the NCC/RCC

9.3.2 Tower condition supervisor

The tower condition server collects tower condition data from sensors. The tower condition server (TCS) diagnoses the status of the transmission tower by comparing collected and processed data with the predefined setting value. In case of the predefined setting value being violated, the tower condition server sends an alarm message and statistical data to the operation center (NCC/RCC). Figure 49 shows a use case for tower condition supervisor.

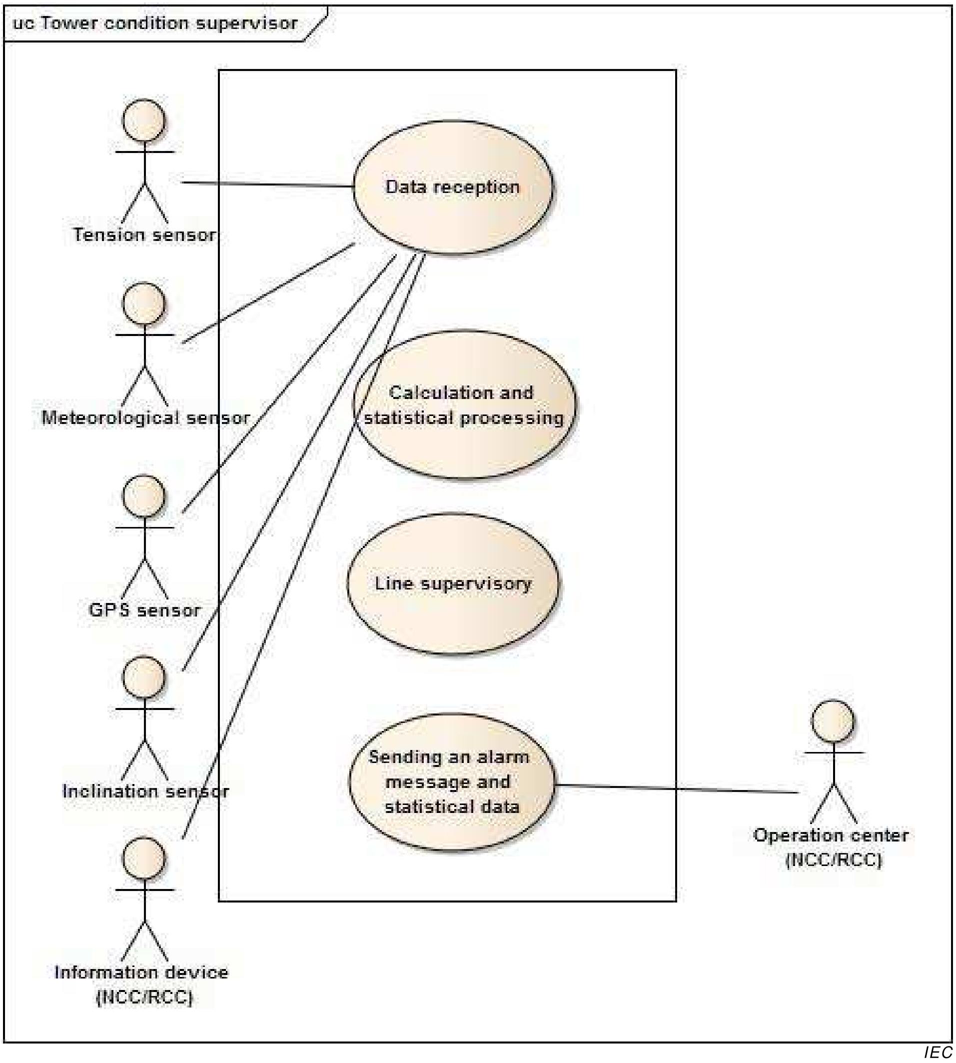


Figure 49 – Use case for tower condition supervisor

Actor(s):

Name	Role description
Meteorological sensor	Provide wind velocity/direction, rainfall and snowfall.
Tension sensor	Provide tension from load cell between transmission line and tower.
Inclination sensor	Provide slope data of Inclination sensor.
GPS sensor	Provide location information, i.e., altitude, latitude, longitude and UTC Time.
Configuration management	Provide the predefined setting value for tower. The predefined data are length between tower, tower type, tower metal quality, tower weight, etc.
Asset management	Monitor status of the transmission tower. In case of the predefined setting value being violated, the operation center (RCC/NCC) receives an alarm message with statistical data from the tower condition server.

Use cases:

Name	Services or information provided
Data reception	Receives data from meteorological sensor, tension sensor, inclination sensor, GPS sensor and other information devices through communication interfaces.
Calculation and statistical processing	The tower conditional statistical data is monitored from the wind/direction, rainfall, snowfall, tower gradient angle, ground base inclination angle, tension and other tower information. The tower status is monitored through the tension variation rate and slope variation rate to detect collapse.
Tower supervisory	Diagnoses the status of transmission tower (tower conditional data) with predefined setting values.
Sending an alarm message and statistical data	In case of the predefined setting value being violated, the tower condition server sends an alarm message and statistical data to the NCC/RCC

Basic flow:

Data reception

Use case step	Description
Step 1	Receive data using communication interface
Step 2	Store the data on corresponding data DB

Calculation and statistical processing

Use case step	Description
Step 1	Retrieve stored data for supervision
Step 2	Statistical processing for supervision (diagnosis)

Line supervisory

Use case step	Description
Step 1	Retrieve stored data for supervision
Step 2	Supervise and diagnose the status of tower by comparing the processed data with predefined setting value

Sending alarm message or statistical data

Use case step	Description
Step 1	In case of the predefined setting value being violated, the tower condition server retrieves data or processed data result.
Step 2	Send an alarm message and statistical data to the NCC/RCC

9.3.3 Insulator condition supervisor

The insulator condition server collects insulator related data from sensors. The insulator condition server (ICS) diagnoses the status of insulator by comparing collected and processed data with predefined setting values. In case of a violation of the predefined setting value, the insulator condition server sends an alarm event and statistical data to the operation center (NCC/RCC). Figure 50 shows a use case for insulator condition supervisor.

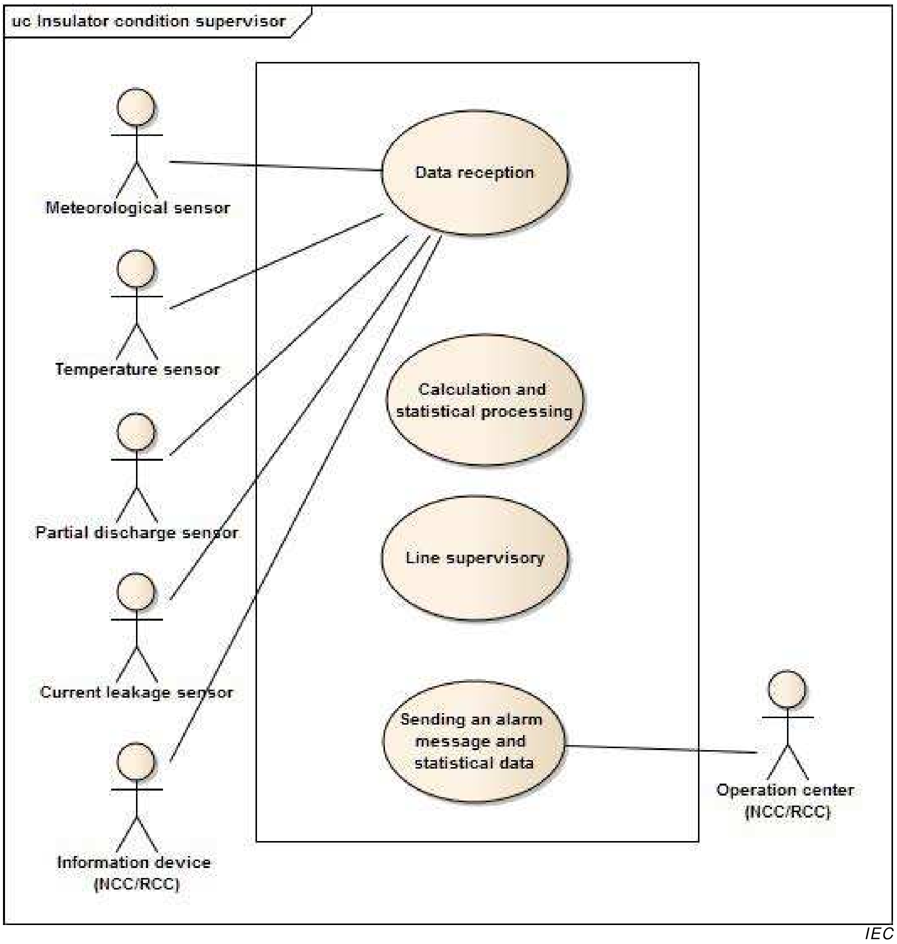


Figure 50 – Use case for insulator condition supervisor

Actor(s):

Name	Role description
Meteorological sensor	Provide wind velocity/direction, rainfall, snowfall and salt.
Partial discharge sensor	Provide PD data (acoustic, UHF)
Temperature sensor	Provide insulator temperature
Current leakage sensor	Provide current leakage data
Configuration management	Provide the predefined setting values
Asset management	Monitor status of the insulator. In case of the predefined setting value being violated, the operation center (RCC/NCC) receives an alarm message with statistical data from the insulator condition server.

Use cases

Name	Services or information provided
Data reception	Receives data from meteorological sensor, acoustic sensor, current sensor and information device through communication interfaces.
Calculation and statistical processing	The insulator condition is monitored by acoustic and current leakage data. A bad insulator is detected through the continual high humidity value even after rain stops. The insulator status change is monitored and triggered from the current, acoustic and humidity data.
Line supervisory	Supervise the status of the insulator with predefined setting values.
Sending an alarm message and statistical data	In case of the predefined setting value being violated, the insulator condition server sends an alarm message and statistical data to the NCC/RCC

Basic flow:

Data reception

Use case step	Description
Step 1	Receive data using communication interface
Step 2	Store the data

Calculation and statistical processing

Use case step	Description
Step 1	Retrieve stored data for supervision
Step 2	Statistical processing for supervision (diagnosis)

Line supervisory

Use case step	Description
Step 1	Retrieve stored data for supervision
Step 2	Supervise and diagnose the status of insulator by comparing the processed data with predefined setting value

Sending alarm message or statistical data

Use case step	Description
Step 1	In case of the predefined setting value being violated, the insulator condition server retrieves data or processed data result.
Step 2	Send an alarm event and statistical data to the NCC/RCC

9.3.4 Surrounding area supervisor

The surrounding area server sends a fire alarm message to the operation center (NCC/RCC) on detecting the fire through the fire sensor. Figure 51 shows a use case for surrounding area supervisor.

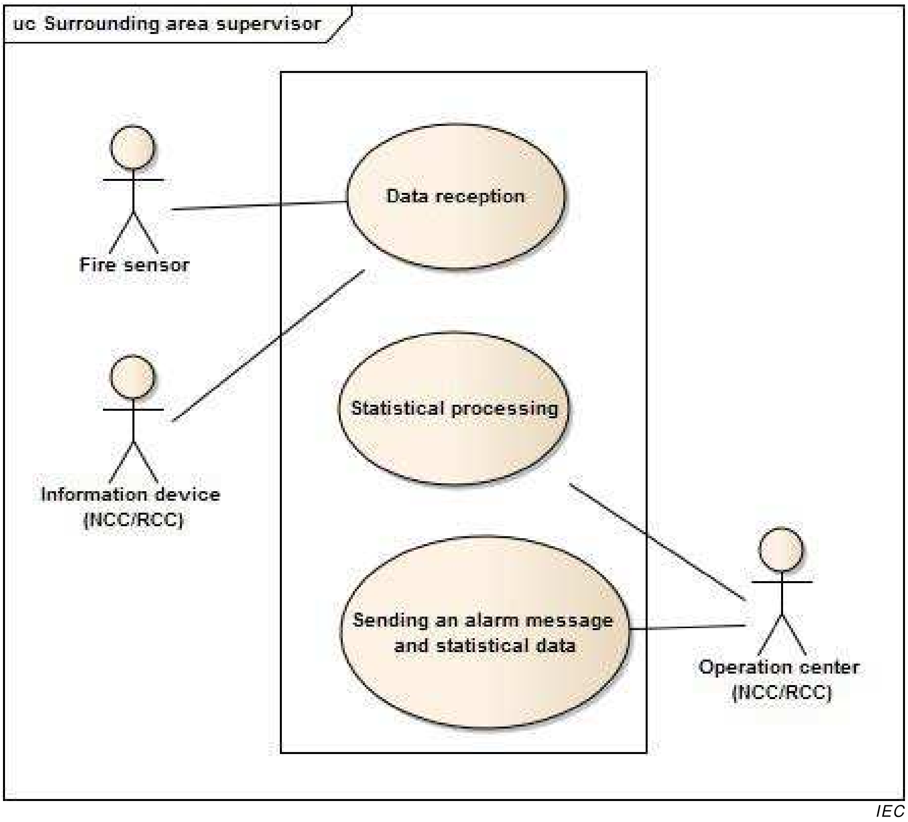


Figure 51 – Use case for surrounding area supervisor

Actor(s):

Name	Role description
Fire sensor	Detect fire around tower.
Image sensor	Capture surrounding area image
Configuration management	Provide the predefined setting values
Asset management	Read the image data for on-line supervisor. The operation center (RCC/NCC) receives an alarm message with image data from the surrounding area server.

Use cases

Name	Services or information provided
Data reception	Receive fire alarm
Statistical processing	Statistical processing of captured images
Sending an alarm message and statistical data	Send fire alarm to the NCC/RCC

Basic flow:

Data reception

Use case step	Description
Step 1	Receive fire alarm data using communication interface
Step 2	Store the data

Statistical processing

Use case step	Description
Step 1	N/A
Step 2	N/A

Sending alarm message or statistical data

Use case step	Description
Step 1	Surrounding area supervisor retrieves alarm data.
Step 2	Send a fire alarm message and statistical data to the NCC/RCC

9.4 Data description table

Logical Node	Data	Data description	CDC	M/O/C
Tower (KTOW, New)	TowTns	Tower tension	MV	O
	TowInclAng	Tower inclination angle: (-90 to 90 degree)	MV	O
	BaseInclAng	Ground base inclination angle (0 -90 degree)	MV	O
	TnsSv	Tension between line and tower (N)	SAV	O
Fire alarm sensor (SFIR, New)	Alm	Fire alarm	SPS	M
Overhead line (ZLIN, DO added)	DynCurRtg	Dynamic current rating of overhead line (%) Measuring dynamic rating (calculated output)	MV	M
	DynWRtg	Dynamic power rating of overhead line (%) Measuring dynamic rating (calculated output)	MV	O
	LinSag	Line sag of overhead line (m) Measuring sag (calculated output)	MV	O
	LinHorSwg	Max degree of line horizontal swing (degree) Measuring swing	MV	O
	LinVerSwg	Max degree of line vertical swing (degree) Measuring swing	MV	O
	LinCur	Overhead line current	MV	O
	LinTmp	Overhead line temperature	MV	O
	InnTmp	Inner temperature of line sensor	MV	O
	LinInclAng	Overhead line inclination angle (-90 to 90 degree)	MV	O
	MaxCurCpy	Designed max current capacity (A)	ASG	O
	MaxVCpy	Designed max voltage capacity (kV)	ASG	O
	LinWgt	Line weight per km (kg/km)	ASG	O
	LinEla	Modulus of elasticity (kg/mm^2)	ASG	O
	LinCffExps	Coefficient linear expansion (1/degree)	ASG	O
Meteorological data (MMET, DO added)	IceCvr	Ice cover in weight (kg)	MV	O

10 Auxiliary power system

10.1 Summary

This section intends to describe the needed requirement to support condition monitoring of the auxiliary power sub-systems of a Power Utility Automation System.

Auxiliary power is with no contest a key part of any Power Utility Automation system and any failure on such part may have critical impacts to its good working.

It describes the main use cases, the need for data exchange and concludes on data modelling.

In the considered scope, we have embraced all the means which could provide, control and monitor the auxiliary power and its associated electrical network, could be AC or DC. It includes also Uninterruptible Power Supply System (UPS).

10.2 Auxiliary power system overview

10.2.1 General

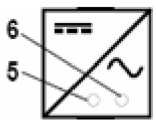
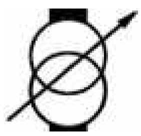
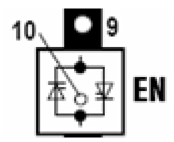
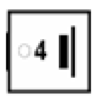
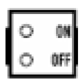
The typical auxiliary power system we have considered in this section:

- Secured DC system from AC input power
- Secured AC system from DC input with AC backup
- Secured AC system from AC input with AC backup

These three cases cover the most common cases of producing auxiliary power in Power Utility Automation.

The typical electrical diagrams of each of these cases are given in Figure 52:

10.2.2 Legend of diagrams

Symbol	Content
	AC to DC rectifier
	DC to AC inverter
	Variable ratio transformer
	Controllable fast AC switches
	Power storage
	Controllable switch

IEC

Figure 52 – Legend of diagrams

10.2.3 Secured DC system from AC input power

Figure 53 depicts a secured DC system from AC input power.

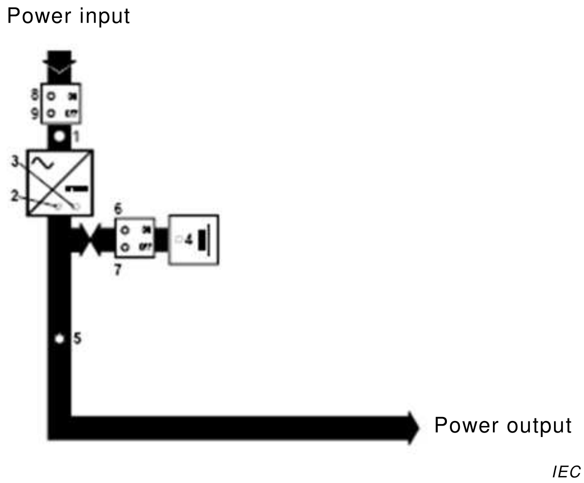


Figure 53 – Secured DC system from AC input power

10.2.4 Secured AC system from DC input with AC backup

Figure 54 depicts a secured AC system from DC input with AC backup.

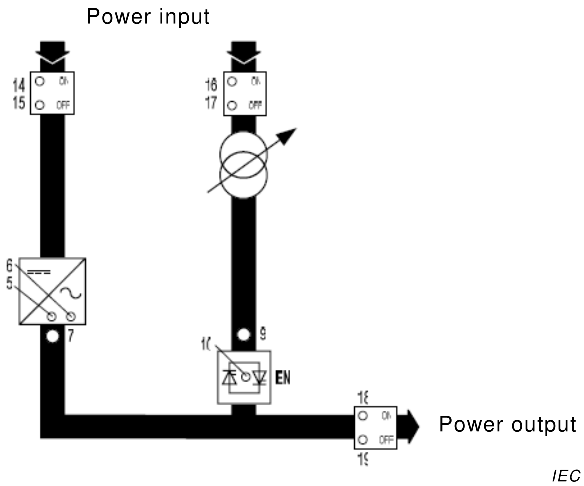


Figure 54 – Secured AC system from DC input with AC backup

10.2.5 Secured AC system from AC input with AC backup

Figure 55 depicts a secured AC system from AC input with AC backup.

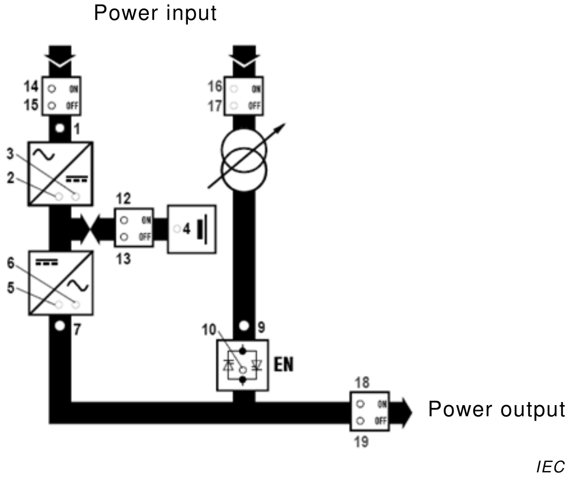


Figure 55 – Secured AC system from AC input with AC backup

10.3 Data flow

A first layer of data flows acquires information for power input and power input backup flows, as well as power storage status. It also monitors the status of the auxiliary power output and potential switches used for switching from one source to another.

Depending on conditions, some automation (auxiliary power system management) may decide to control the above mentioned switches (out of the scope of this study).

The auxiliary power system will then elaborate summarized information of the local auxiliary power system (including forecasting conditions depending on storage capabilities) and expose them either to remote systems, as well as local loads (power auxiliary loads – including IEDs) which may decide on specific behaviours, as shown in Figure 56.

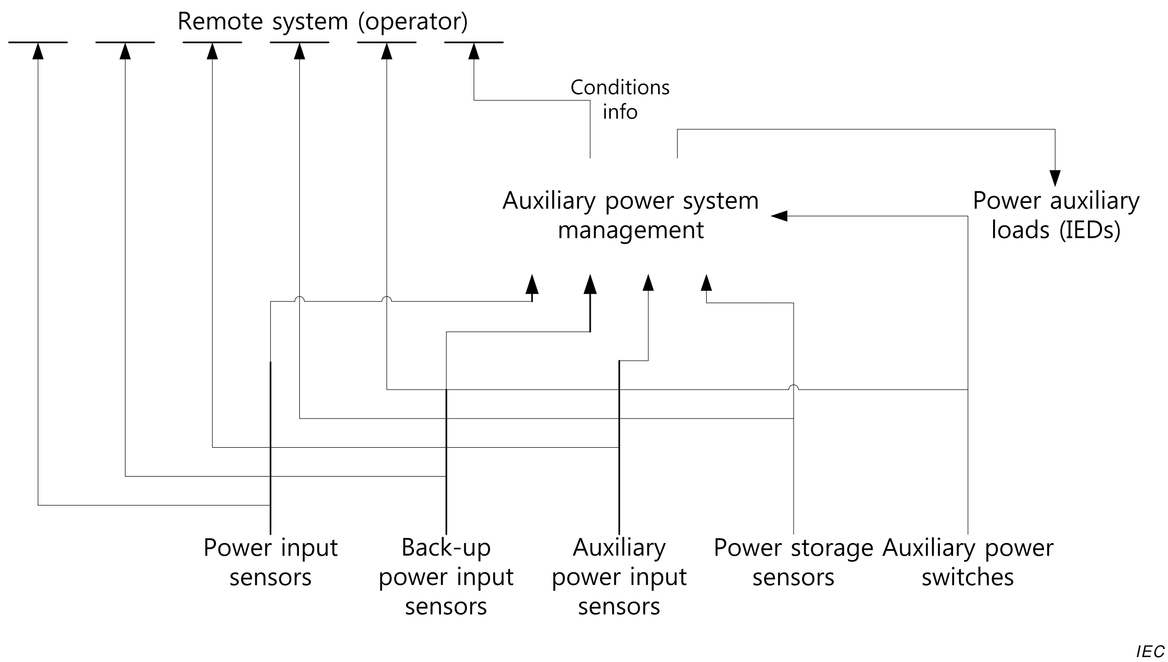
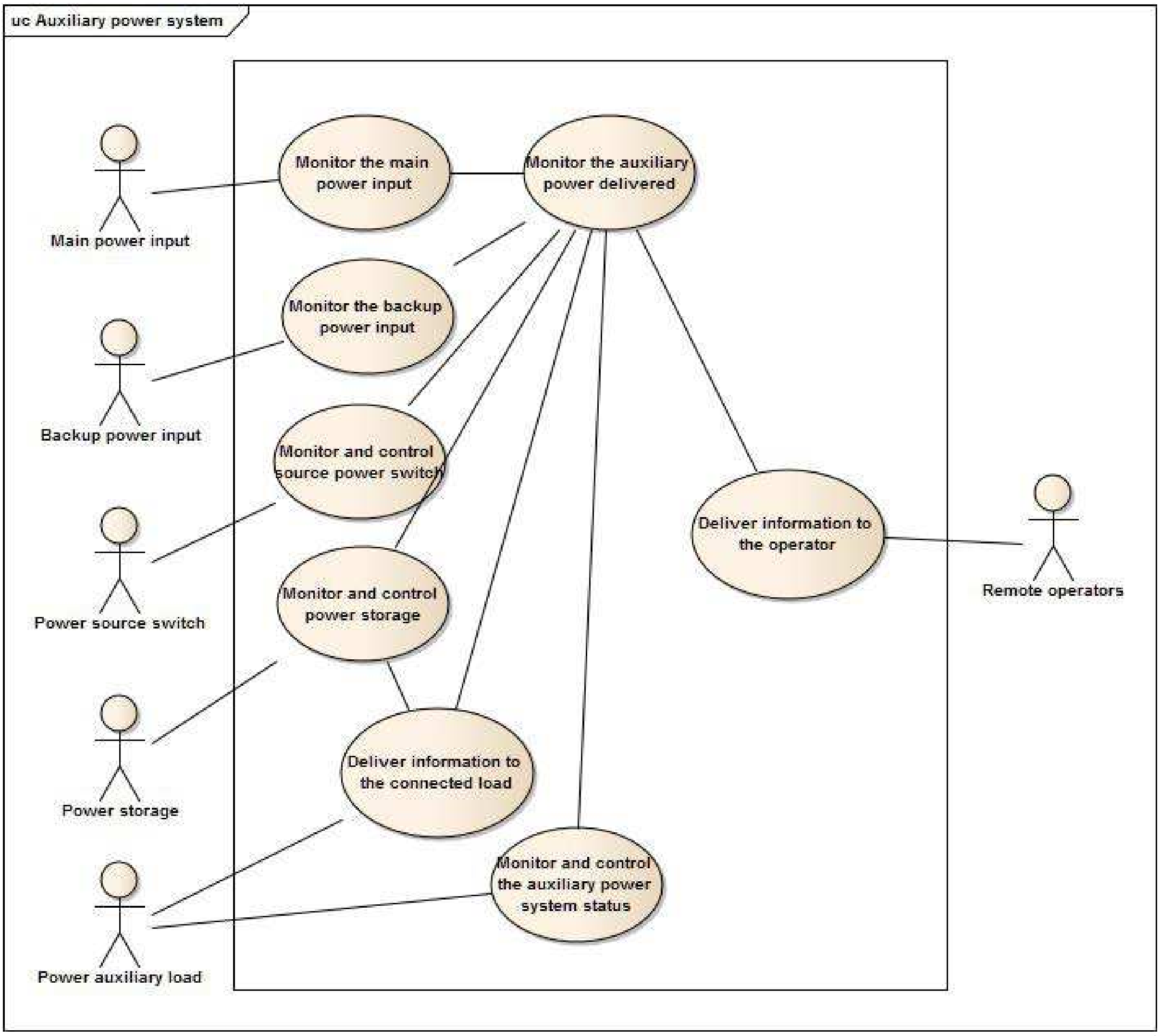


Figure 56 – Data flow of auxiliary power system

10.4 Use case diagram

Figure 57 shows a use case for auxiliary power system.



IEC

Figure 57 – Use case for auxiliary power system

Actor(s):

Name	Role description
Main power input	Act as the main power input to feed loads with auxiliary power
Backup power input	Act as the backup power input to feed loads with auxiliary power
Power source switches	Switches which will be operated by the "Monitor and control" system of the auxiliary power system to select the healthy source
Power storage	Act as the system where power will be stored (act as a load) and extracted (act as a generator) to feed loads with auxiliary power in case of absence of main and backup power.
Power auxiliary loads	Act as the system of loads and associated power distribution mean, fed by the Auxiliary power system. These loads may be "smart" and react automatically depending on the information delivered by the auxiliary power system
Remote operators	Act as the remote operators, who want to be informed on the auxiliary power system status and on events in case of external or internal failures

Use case:

Use cases	Use cases description
Monitor the main power input	Depending on settings, detect the loss of the main power. Elaborate the main power Input status and quality information, on a continuous basis and on the loss of power event occurrence.
Monitor the backup power input	Depending on settings, detect the loss of the backup power. Elaborate the backup power Input status and quality information, on a continuous basis and on the loss of power event occurrence.
Monitor the auxiliary power delivered	Elaborate the auxiliary power output status and quality information, on a continuous basis and on the loss of power event occurrence.
Monitor and control power storage	Monitor the power storage system status and health (battery), Control its charging from the available power. Evaluate the remaining load of the power storage and remaining duration of powering.
Monitor and control source power switches	Monitor the power switch status and health (could be a static switch) Control its (their) position(s).
Monitor and control the auxiliary power system status	Monitor the status of each elements of the auxiliary power system and depending on the measured conditions and settings, control the components in order to deliver auxiliary power to loads.
Deliver information to the operator	Expose monitoring and status data for remote operator.
Deliver information to the connected loads	Expose monitoring status data for the connected loads

NOTE This analysis opens the door of handling the full secondary network and equipment modelling into IEC 61850, but it is out of the current scope of this release of the document.

10.5 Data modelling

10.5.1 Functional breakdown

10.5.1.1 General

Before going into further detail, it is important to consider the functional breakdown of such a system and the requirements for covering all the considered functions into a conditioned monitoring application.

10.5.1.2 Secured DC system from AC input power

IEC 61850 proposed LN breakdown (requirement), as illustrated in Figure 58:

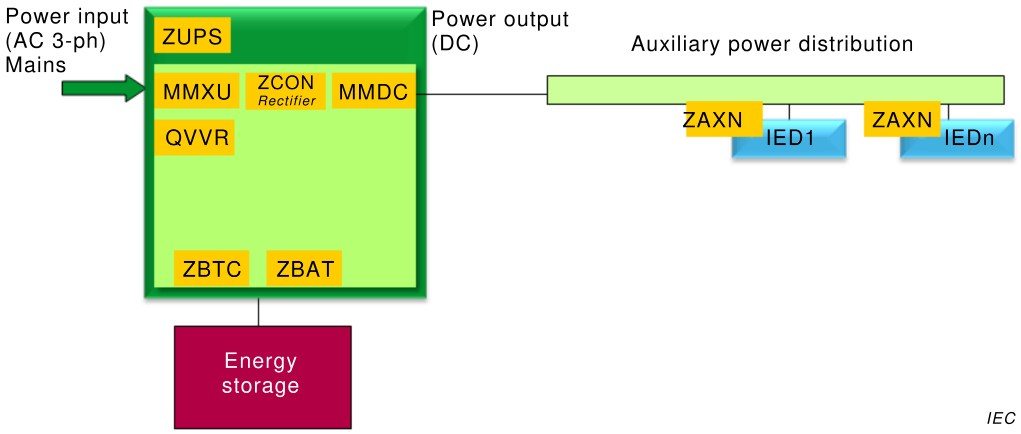


Figure 58 – Secured DC system from AC input power

Where:

- ZUPS represent the overall Auxiliary Power system status
- MMXU, QVVR, ZCON(Rectifier) cover the AC input monitoring and rectifier conversion
- ZBTC and ZBAT cover the energy storage system monitoring and control (optional)
- MMDC is used to monitor the DC output
- ZAXN is used to monitor the auxiliary power at consumer level

10.5.1.3 Secured AC system from DC input with AC backup

IEC 61850 proposed LN breakdown (requirement), as illustrated in Figure 59:

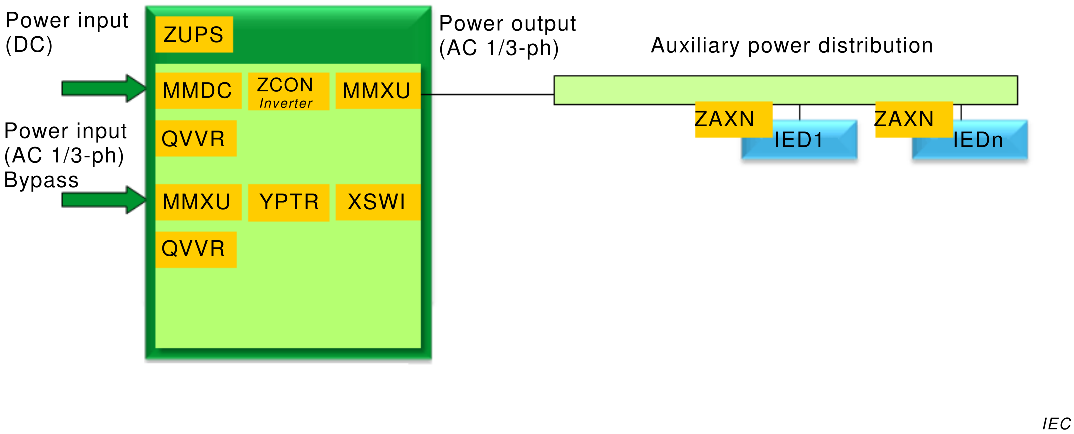


Figure 59 – Secured AC system from DC input with AC backup

Where:

- ZUPS represent the overall auxiliary power system status
- MMDC, QVVR, ZCON(Inverter) cover the DC input monitoring and inverter conversion
- MMXU, QVVR, YPTR cover AC input monitoring and conversion
- XSWI is used to automatically bypass the DC input by the backup AC one
- MMXU is used to monitor the AC output
- ZAXN is used to monitor the auxiliary power at consumer level

10.5.1.4 Secured AC system from AC input with AC backup

Figure 60 shows how LNs can be used for a secured AC system from AC input with AC backup.

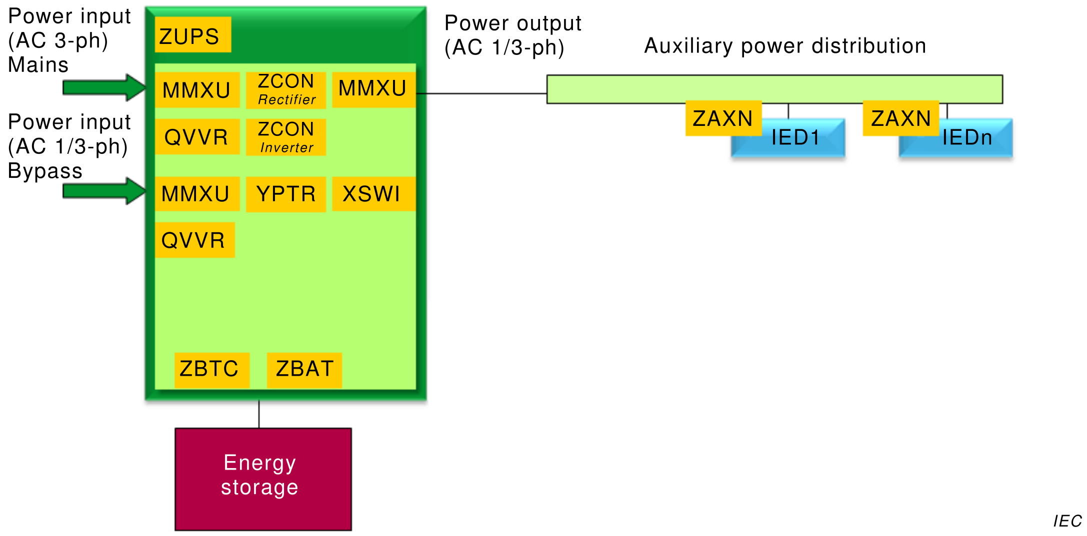


Figure 60 – Secured AC system from AC input with AC backup

Where:

- ZUPS represent the overall Auxiliary Power system status
- MMXU, QVVR, ZCON(Rectifier), ZCON(Inverter) cover the secured AC input monitoring and conversion
- MMXU, QVVR, YPTR cover the bypass AC input monitoring and conversion
- XSWI is used to automatically bypass the secured main path by the backup AC one
- MMXU is used to monitor the AC output
- ZAXN is used to monitor the auxiliary power at consumer level

11 Communication Requirements

CMD IEDs or sensors can vary from powerful IEDs that generate a large amount of data to a tiny distributed sensor with minimum information. Also they can vary from devices that are normally installed close to an available LAN/WAN or devices scattered through a larger geographic region and/or situation where it is not easy or practical to use Ethernet.

11.1 General issues

Communication architecture for CMD compartments is shown in Figure 61. Sensing data acquired by the numerous sensors are collected at the IEC 61850 terminal node using various communication protocols. Communication protocols and data model between the sensor nodes and the IEC 61850 terminal node can be any protocol, e.g., Zigbee or Bluetooth, or proprietary protocol. Data flow between the sensor node to the IEC 61850 terminal node is unidirectional, from sensor to IEC 61850 terminal node. The IEC 61850 terminal node, which converts the received sensing data to IEC 61850 data model defined in IEC 61850-7-4 or in this technical report, is the starting point of IEC 61850 based communication. The IEC 61850 terminal node shall have all T LNs and S LNs or T LNs and S LNs could be in the different device. The T LNs shall have EEHealth attribute to monitor the status of sensor networks' communication links. Thus the IEC 61850 terminal nodes shall be included in the engineering process defined in IEC 61850-6. Communication between the IEC 61850 terminal node and RCC follows the requirements defined in IEC 61850-5.

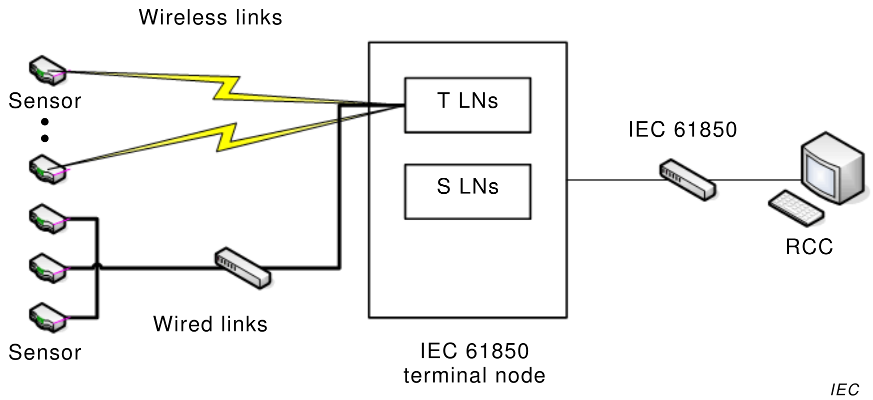


Figure 61 – Communication architecture for CMD

11.2 Response behaviour requirements (6.4 of IEC 61850-5:2013)

Since interoperability is claimed for a proper running of functions also, the reaction of the application in the receiving node has to be considered.

a) The reaction of the receiving node has to fit into the overall requirement of the distributed function to be performed.
b) The basic behaviour of the functions in any degraded case, i.e. in case of erroneous messages, lost data by communication interrupts, resource limitations, out of range data, etc. has to be specified. This is important if the overall task cannot be closed successfully, e.g. if the remote node does not respond or react in a proper way.
c) The external communication system has to fit into the overall requirements of the distributed function to be performed.

These requirements are function related local issues and, therefore, outside the scope of this communication standard. But the requirement left for this standard is the provision of proper quality attributes to be transferred with the data under consideration. Most of alarms defined in 90-3 are "status only" and not resettable. The BRCB subscription is recommended for such usage.

11.3 Requirements for data integrity (Clause 14 of IEC 61850-5:2013)

Integrity means that for a given background noise the resulting errors are below a certain acceptable limit. In IEC 61850-3, the three integrity classes according to IEC 60870-4 are referenced. Integrity was also introduced as PICOM attribute in 10.1.2 of IEC 61850-5:2003. All safety related messages like commands and trips with direct impact on the process shall have the highest integrity class, i.e., class 3. All other messages may be transmitted with a lower data integrity but not lower than class 2. Normally, the noise level is given and cannot be influenced. Nevertheless, to reach integrity three groups of known measures exist to limit its impact.

a) Proper design of devices and the communication system, e.g. protecting enclosures and the use of fiber optic links
b) Apply an appropriate coding, i.e. a Hamming distance

11.4 Communication requirements for the WAN

WAN may be used for the communication from the IEC 61850 terminal node to asset management or between the terminal nodes. The communication aspect of the WAN will follow the communication architecture defined in IEC 61850-90-12.

11.5 Performance issue

Performance requirements on the communication of CMD application depends on the application itself. Generally, if not specified, performance requirements follow the communication requirements specified in IEC 61850-5. To satisfy the timing requirements for specific application, the user needs to define the communication requirements.

11.6 Plug and Play

Sensors for CMD might often be attached onto or detached from the system because they should be attached onto the target equipment only when the monitoring is needed. Therefore, CMD systems require such functions that can deal with sensor's attachment or detachment. The specification to achieve them will be discussed in the system management of IEC 61850.

12 Asset Management

12.1 Definition

Asset management can be defined as the management of physical infrastructure assets that form the primary element of the electric utility network with the objective of ensuring and demonstrating that the assets deliver the required function and level of performance in terms of service or production, in a sustainable manner, at an optimum cost without compromising health, safety, environmental performance or the organization's reputation. It involves the processes of acquisition, operation, maintenance, improvements, and disposal of an asset. Modern asset management optimizes the assets considering use of capital, capability of generating revenue, use of resources, evaluation of risks, compliance to standards and regulations, lifecycle extension, and many more factors in order to find the right balance.

12.2 Comparison of asset management to other systems

Asset management systems are very different in nature from substation automation, EMS, DMS, and SCADA where online and on-time information is of the essence.

	SCADA, DMS, EMS	Substation Automation	Asset Management
Client	Grid operation	Local operation	Maintenance, planning, finance, operation
Main purpose	Optimize grid operation	Optimize local operation	Optimize asset
Number of points acquired from CMD IEDs	Small	Small to medium	Large
Type of system processing	Continuous	Continuous	Batch or continuous
Type of data acquisition	Online, real-time	Online, real-time	• Deferred time-series acquisition • Manual entry • Online • Real Time
Source of information	SA, IEDs, primary equipment	IEDs, primary equipment	IEDs, primary equipment, offline test reports, SCADA, DMS, EMS, SA, Historian, ERP systems
Data exchange	SCADA protocols	SCADA protocols	• file import/export • database connectivity • limited use of SCADA protocols Data historians
Abnormal condition detection	Alarm thresholds	Alarm thresholds	Advanced algorithms to detect anomalies, calculate aging; statistical treatment of assets of similar class, make and model; self-learning Online systems can send pre-programmed alarms and status
Discrimination of criticality	No	No	Ranking of assets for a combination of risk and criticality

12.3 IEC 61850 services for Asset Management

12.3.1 General

IEC 61850 already defines services that can be used by asset management systems. The services shown in Figure 62 are described.

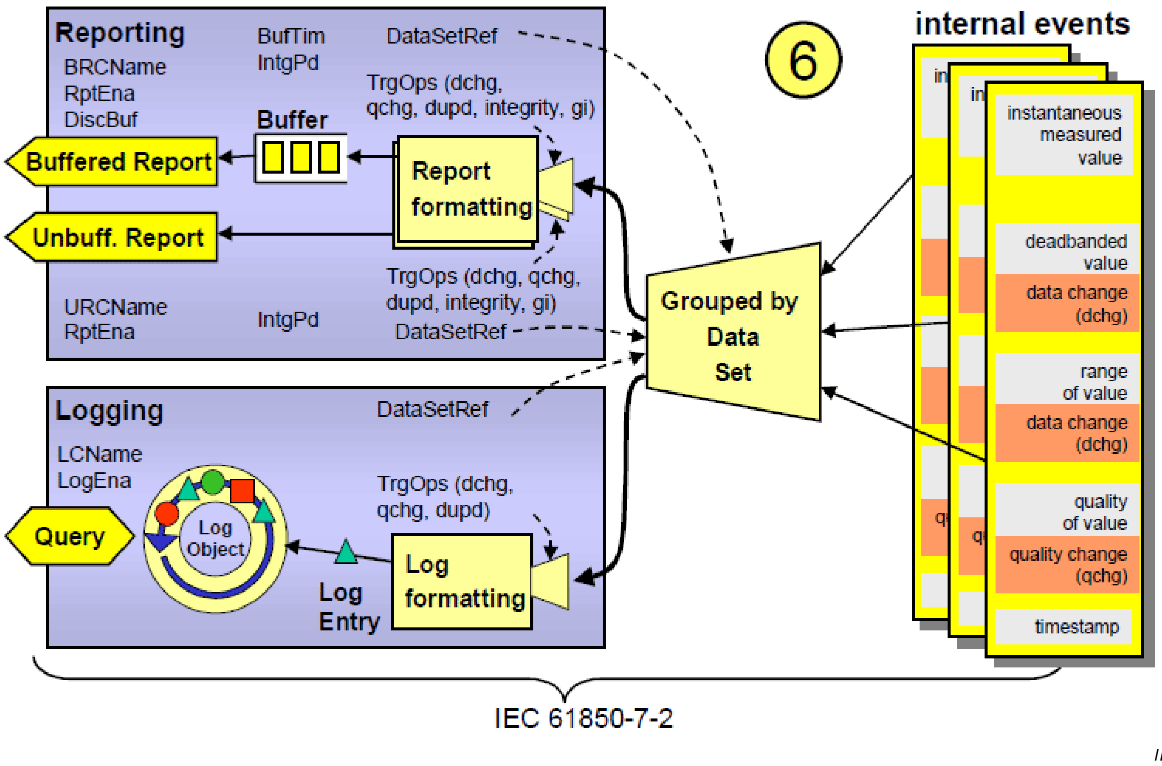


Figure 62 – Reporting and logging model (conceptual) from IEC 61850-7-1

12.3.2 Data set

Data set permits the grouping of data and data attributes. Used for direct access and for reporting and logging.

12.3.3 Log

The Log service logs entries according to definitions of log control block (LCB). The LCB controls which data values to log and when these data values are to be stored. The log entries are stored into the log as they arrive and the logs are stored in time sequence order. Logs can be queried to allow a deferred retrieval of sequence of events (SOE). The log is organized as a circular buffer and the number of entries that can be stored depend on the size of log entries and on the buffer size.

Logs are very suitable to feed deferred time-series or sequence of events data to asset management systems that may or may not carry permanent connections to CMD equipment. Logs can be set to require very low bandwidth. There is no possibility of losing changes of data and multiple clients can receive the information.

12.3.4 Report

Report comprises an agreed, or client defined, set of data compiled by an IED for transmission to a client at regular, or specified time intervals, or on demand. A report may also be generated as a result of one or more trigger conditions that may be either pre-set or pre-defined by the client. Reports may be triggered by changes of process data values (for example, state change or dead band) or by quality changes. Reports may be sent immediately in the case of Un-buffered Reports or deferred in the case of Buffered Reports. Buffered Reports provide change-of-state and sequence-of events information exchange. Un-buffered reports have the potential to lose changes of data which does not occur with Buffered reports.

12.3.5 Polling

Polling of data values is also available for IEC 61850 clients. Polling can lose changes of values of data and may be bandwidth consuming if used for a large number of points.

12.3.6 SCSM

The Specific Communication Service Mapping allows future mapping of IEC 61850 to protocols other than MMS. That guarantees the evolution of the standard (e.g. should CMD communications need to support scattered sensors communicating over tiny footprint protocols).

12.4 CMD

CMD devices and systems are very important sources of information for asset management systems. It varies greatly in terms of what the architects of an asset management will require in terms of information and with respect to particular details of certain installations or users. CMD can provide information on asset condition and rate of deterioration (ageing) to effectively project future of assets and ensure most adequate asset investment planning.

Normally asset management systems are interested in ageing, either time related (e.g. seals getting brittle over time) or usage related (e.g. tears and wear of circuit breaker contacts during operation). In usage related ageing, further distinctions can be made to normal usage related ageing (e.g. transformer ageing due to normal operation) and stress related ageing (e.g. transformer ageing due to operation beyond its design characteristics). Ageing is normally influenced by factors such as ambient temperature, loading, vibration, etc.

CMD information also helps to determine optimum time for maintenance and repairs that act in the opposite direction of ageing in certain assets. However there are some component ageing that cannot be reversed (e.g. paper insulation on transformer windings). Asset management systems compute that to calculate the remaining life of the various assets.

12.5 Conclusion

Asset management is a business approach designed to align the management of asset-related spending to corporate goals. It is a framework for making data-driven infrastructure investment decisions so that life-cycle costs are minimized while satisfying performance, risk tolerance, budget, and other organizational goals. Stated simply, asset management is a corporate strategy that seeks to balance performance, cost, and risk. It also requires the corporate culture, business processes, and information systems capable of making rigorous and consistent spending decisions based on asset-level data. A higher level of performance requires higher cost. By capitalizing on the information available in CMD the asset manager will be able to very specifically determine the health and performance of specific assets and the system conditions the asset experiences. One can envision a much higher calibre asset management process and also a much more automated one.

12.6 Maintenance

Maintenance occurs typically at a periodic time base or – at the best – the equipment itself calls for maintenance. Goal of the maintenance planning is to optimize the maintenance schedule based on the condition on several components inside the substation. Additionally the Monitoring System supports repair work by providing additional information. Figure 63 shows a use case for maintenance.

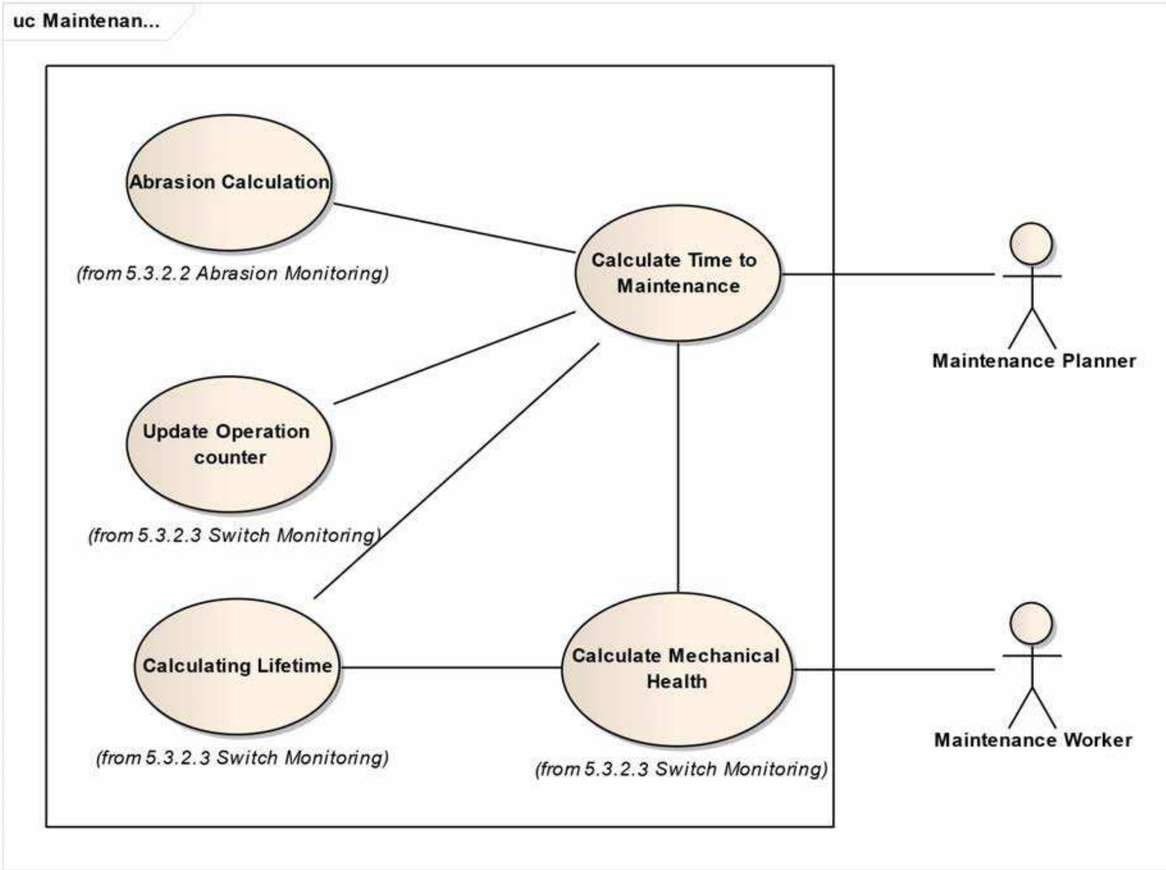


Figure 63 – Use case for maintenance

Actor(s):

Name	Role description
Maintenance Worker	Inspects and repairs the GIS
Maintenance Planner	Schedules maintenance work

Use cases

Name	Service or information provided
Abrasion calculation	Measures the current and contact movement, calculates the abrasion, and sends notification to the user
Update operation counter	Count the number of operation and notify to the user if the number of operation is exceed the predefined limit.
Calculating lifetime	From the collected information, calculate the remaining life time based on existing wear and heath.
Calculate mechanical health	From the collected information, calculate the mechanical health.
Calculate time to maintenance	Calculate the maintenance time to send a monitoring signal

Basic flow:

Abrasion Calculation

Use Case step	Description
Step 1	On each operation Measure the current flow through each contact Measure the contact movement (travel) Optional: measure additional signals, e.g. voltage
Step 2	Calculate the abrasion of each contact for this operation
Step 3	Accumulate the abrasion
Step 4	Provide the results to the user Send a notification if a limit has been passed

Update Operation Counter

Use Case step	Description
Step 1	Wait for a position change – or – Wait for operation command
Step 2	Increment the operation counter
Step 3	Compare the counter to given limits
Step 4	Provide the results to the user Send a notification if a limit has been passed

Calculating Lifetime

Use Case step	Description
Step 1	Get information on the component – Lifetime – Abrasion – Operation count
Step 2	Calculating remaining lifetime based on previous operation duty
Step 3	Calculating remaining lifetime based on existing wear and health
Step 4	Estimate the time to overhaul or replacement
Step 5	Provide the results to the user Send a notification if a limit has been passed

Calculate Mechanical Health

Use Case step	Description
Step 1	Get information on the component – Switch – Travel sensor – Other sensors, e.g., for motor current
Step 2	Calculating mechanical health
Step 3	Provide the results to the user

Calculate Time to Maintenance

Use Case step	Description
Step 1	Store data of last maintenance (overhaul, inspection or commissioning)
Step 2	Get results of Operation Count since last maintenance Lifetime since last maintenance Equipment Health
Step 3	Calculate time to maintenance based on data from step 2 and actual date
Step 4	Provide the results to the user Send a notification if a limit has been passed

Exceptions / **Alternate Flow**: N/A

Pre-conditions: N/A

Post-conditions: N/A

12.7 ERP Update

Goal of an ERP calculation is to estimate the remaining investment value of the substation. The calculation itself is carried out using specialized software. The monitoring system may provide information to update the ERP system based on the actual status. Figure 64 shows a use case for ERP update.

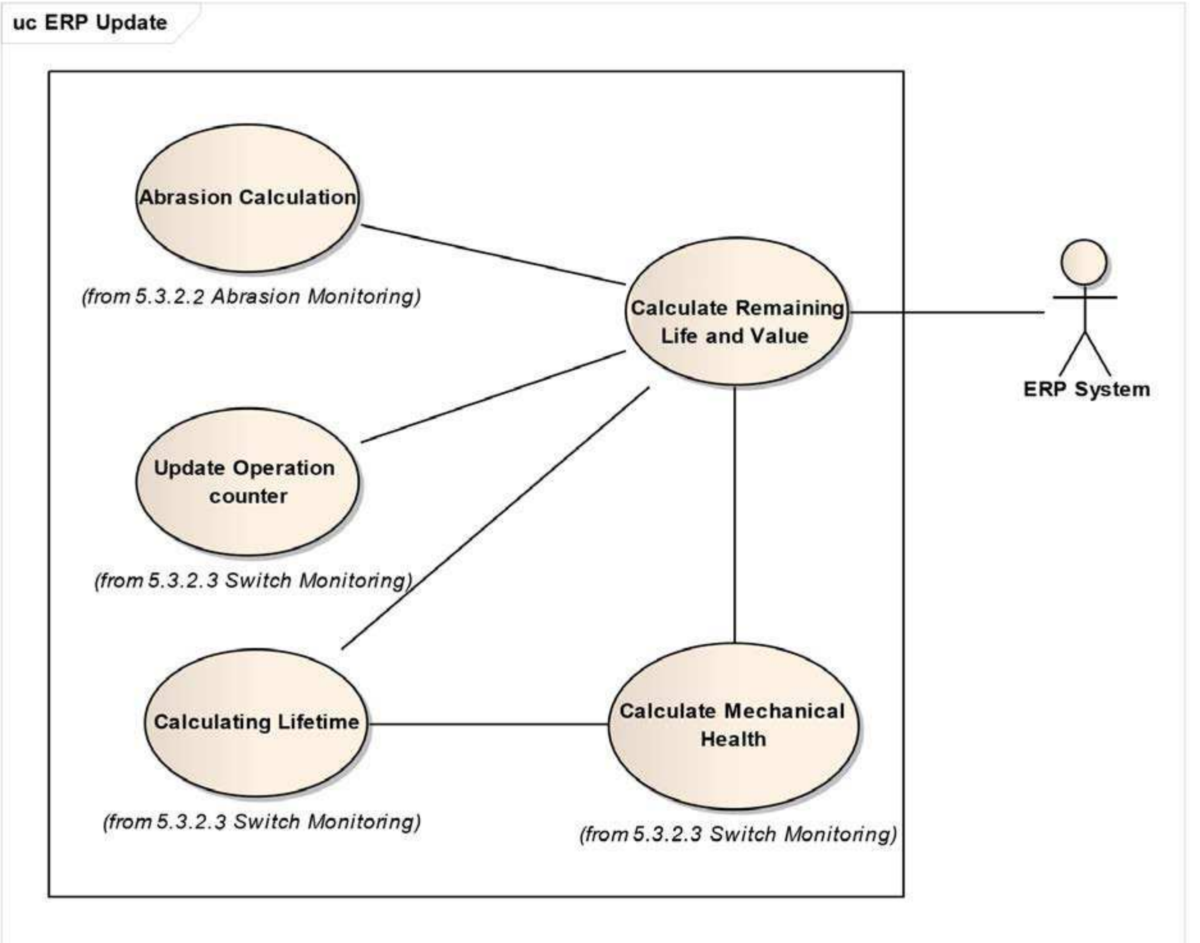


Figure 64 – Use case for ERP update

Actor(s):

Name	Role description
ERP system	Assess the investment of the substation

Use cases

Name	Service or information provided
Abrasion calculation	Measures the current and contact movement, calculates the abrasion, and sends notification to the user
Update operation counter	Count the number of operation and notify to the user if the number of operation is exceed the predefined limit.
Calculate life time	From the collected information, i.e., abrasion and operation counter, calculate the remaining life time based on existing wear and heath.
Calculate mechanical health	From the collected information, calculate the mechanical health.
Calculate remaining life and value	Calculate the remaining life and value of the system

Basic flow:

Abrasion Calculation

Use Case step	Description
Step 1	On each operation Measure the current flow through each contact Measure the contact movement (travel) Optional: measure additional signals, e.g. voltage
Step 2	Calculate the abrasion of each contact for this operation
Step 3	Accumulate the abrasion
Step 4	Provide the results to the user Send a notification if a limit has been passed

Update Operation Counter

Use Case step	Description
Step 1	Wait for a position change – or – Wait for operation command
Step 2	Increment the operation counter
Step 3	Compare the counter to given limits
Step 4	Provide the results to the user Send a notification if a limit has been passed

Calculating Lifetime

Use Case step	Description
Step 1	Get information on the component – Lifetime – Abrasion – Operation count
Step 2	Calculating remaining lifetime based on previous operation duty
Step 3	Calculating remaining lifetime based on existing wear and health
Step 4	Estimate the time to overhaul or replacement
Step 5	Provide the results to the user Send a notification if a limit has been passed

Calculate remaining Lifetime and value

Use Case step	Description
Step 1	Get information on the component – Lifetime – Abrasion – Operation count
Step 2	Calculate remaining lifetime based on previous operation duty
Step 3	Calculate remaining lifetime based on existing wear and health
Step 4	Estimate the time to overhaul or replacement
Step 5	Provide the results to the user Send a notification if a limit has been passed

Exceptions / Alternate Flow: N/A

Pre-conditions: N/A

Post-conditions: N/A

13 Logical node classes

13.1 General

This clause specifies logical nodes defined in IEC TR 61850-90-3, as shown in Figure 65.

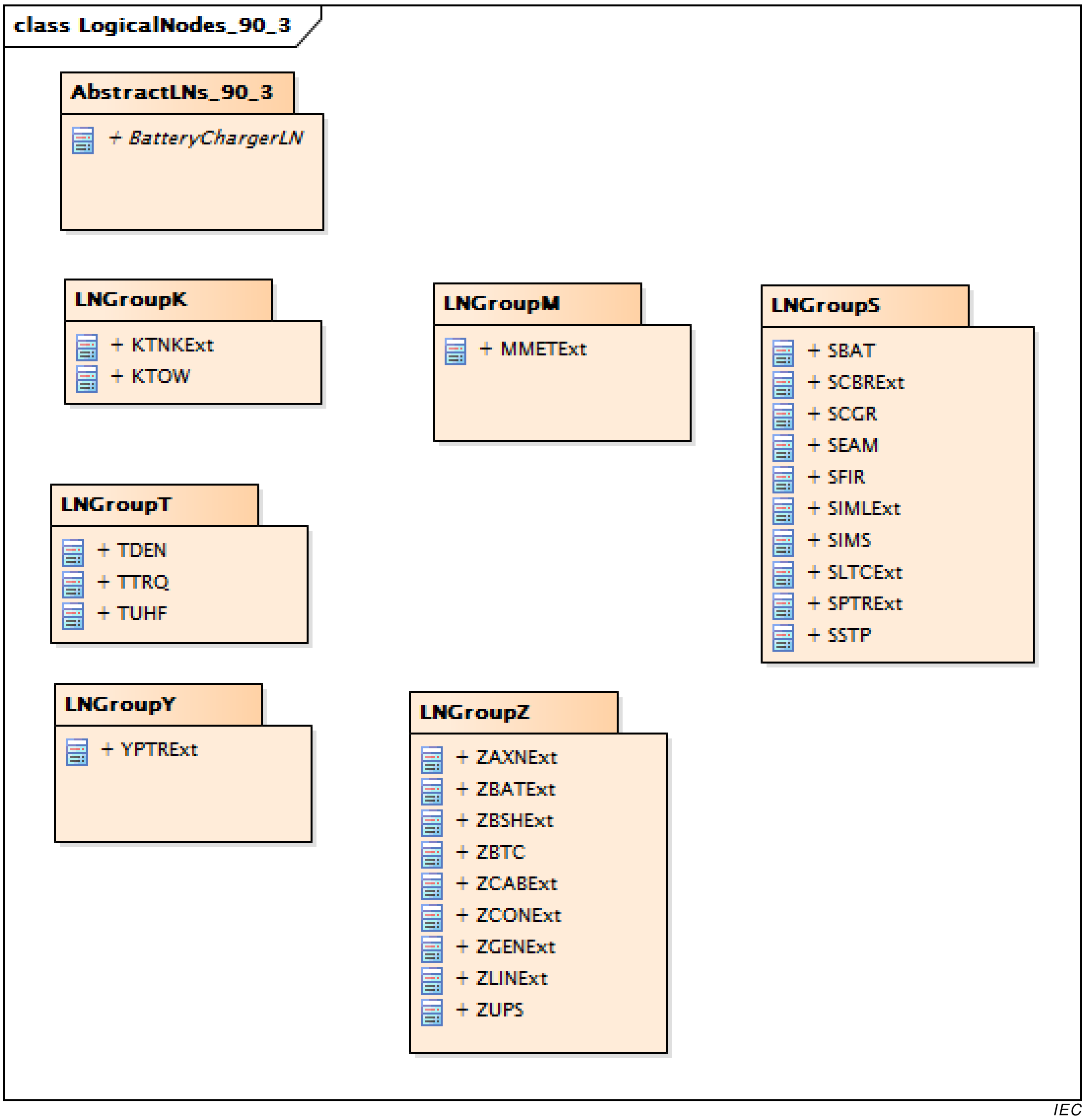


Figure 65 – Class diagram LogicalNodes_90_3::LogicalNodes_90_3

13.2 Abstract Logical Nodes (AbstractLNs_90_3)

13.2.1 General

Figure 66 depicts class diagrams for abstract LN in this part of IEC 61850.

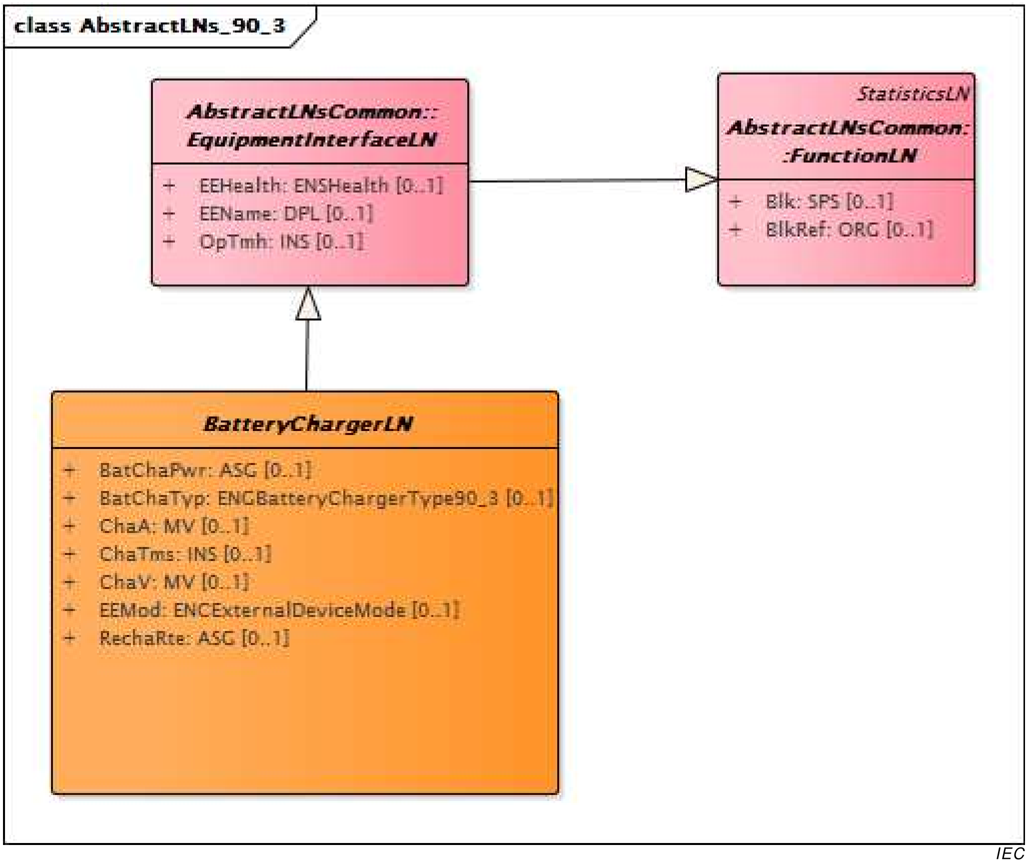


Figure 66 – Class diagram AbstractLNs_90_3::AbstractLNs_90_3

13.2.2 <<abstract>> LN: Battery Charger Name: BatteryChargerLN

Abstract type, holding common attributes of the battery charge logical nodes.

Table 2 shows all data objects of BatteryChargerLN.

Table 2 – Data objects of BatteryChargerLN

BatteryChargerLN				
Data object name	**Common data class**	**T**	**Explanation**	**PresCond nds/ds**
Descriptions				
EEName	DPL		inherited from: EquipmentInterfaceLN	O / F
NamPlt	LPL		inherited from: DomainLN	O / O
Status information				
ChaTms	INS		Charging time since last off/reset (in second)	O / O
EEMod	ENS (ExternalDeviceModeKind)		(controllable) Battery charger (external device) functioning mode	O / F
EEHealth	ENS (HealthKind)		inherited from: EquipmentInterfaceLN	O / F
OpTmh	INS		inherited from: EquipmentInterfaceLN	O / O
Blk	SPS		inherited from: FunctionLN	O / F
ClcExp	SPS	T	inherited from: StatisticsLN	O / O
Beh	ENS (BehaviourModeKind)		inherited from: DomainLN	M / M
Health	ENS (HealthKind)		inherited from: DomainLN	O / O
Mir	SPS		inherited from: DomainLN	MOcond(1) / MOcond(1)
Measured and metered values				
ChaA	MV		Charging current	O / O
ChaV	MV		Charging voltage	O / O
Controls				
ClcStr	SPC		inherited from: StatisticsLN	O / O
Mod	ENC (BehaviourModeKind)		inherited from: DomainLN	O / O
Settings				
BatChaPwr	ASG		Battery charging power required	O / F
BatChaTyp	ENG (BatteryChargerType90_3Kind)		Type of battery charger:	O / F
RechaRte	ASG		Recharge rate (in A/s)	O / F
BlkRef	ORG		inherited from: FunctionLN	Omulti / F
ClcMth	ENG (CalcMethodKind)		inherited from: StatisticsLN	O / M
ClcMod	ENG (CalcModeKind)		inherited from: StatisticsLN	O / O
ClcIntvTyp	ENG (CalcIntervalKind)		inherited from: StatisticsLN	O / O
ClcIntvPer	ING		inherited from: StatisticsLN	O / O
NumSubIntv	ING		inherited from: StatisticsLN	O / O
ClcRfTyp	ENG (CalcIntervalKind)		inherited from: StatisticsLN	O / O
ClcRfPer	ING		inherited from: StatisticsLN	O / O
ClcSrc	ORG		inherited from: StatisticsLN	F / M
ClcNxtTmms	ING		inherited from: StatisticsLN	O / O
InSyn	ORG		inherited from: StatisticsLN	O / O
InRef	ORG		inherited from: DomainLN	Omulti / Omulti

13.3 Logical nodes for tanks (LNGroupK)

13.3.1 General

This group of logical nodes represents various devices that can be supervised, controlled or operated but that are not primarily of electrical nature.

NOTE These logical nodes are likely to be included in a later edition of IEC 61850-7-4. When published, logical nodes specified in IEC 61850-7-4 are to take precedence over the definition here.

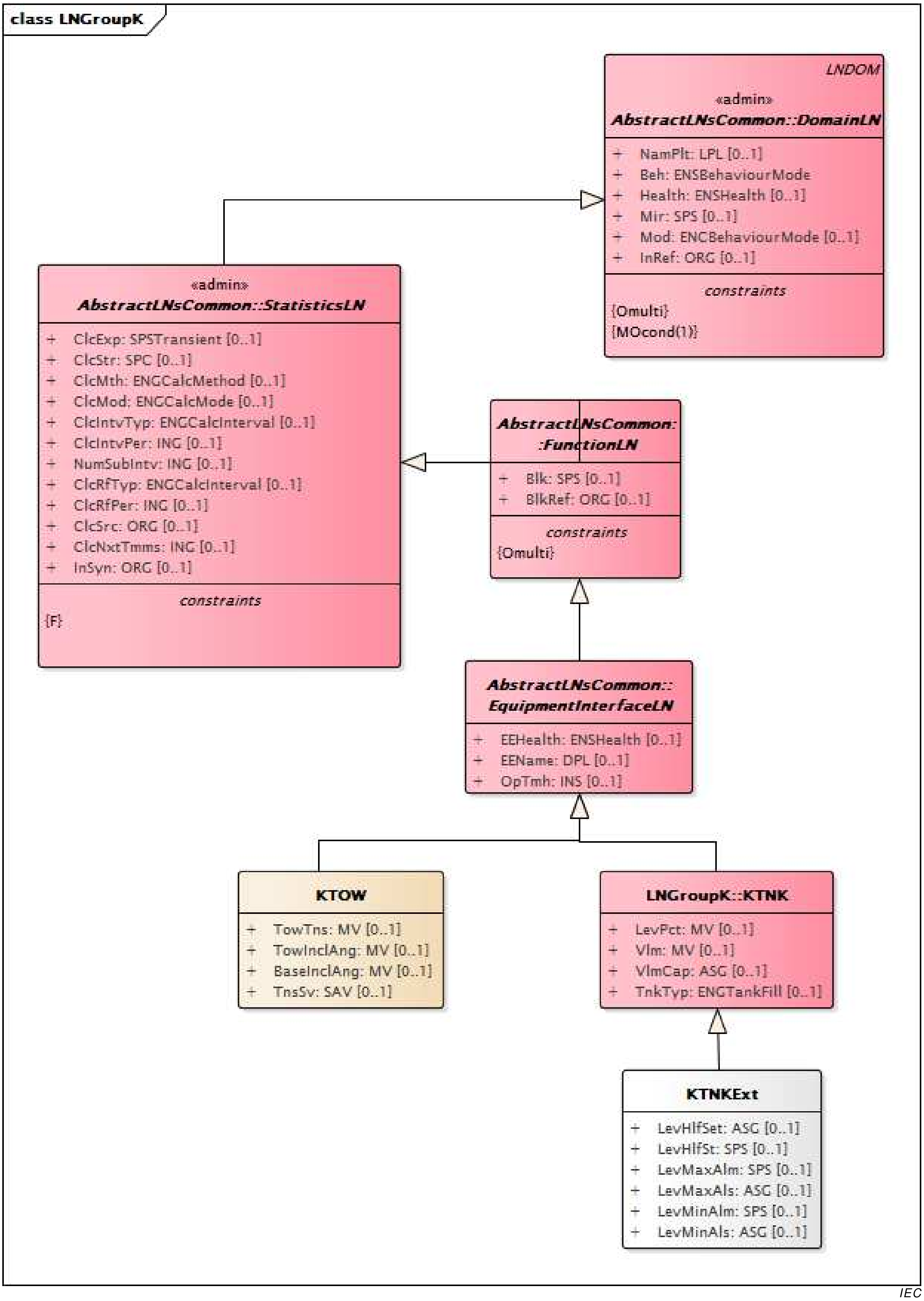


Figure 67 – Class diagram LNGroupK::LNGroupK

Figure 67 shows all concrete logical nodes of this group, with the supertypes that factor their common attributes.

13.3.2 LN: Tank Name: KTNKExt

Set of information objects to extend the KTNK LN to supervise physical devices such as tank.

The "Ext" suffix attached to the LN name is only there for editorial purpose and is not present in the real model

Table 3 shows all data objects of KTNKExt.

Table 3 – Data objects of KTNKExt

KTNKExt				
Data object name	**Common data class**	**T**	**Explanation**	**PresCond nds/ds**
Descriptions				
EEName	DPL		inherited from: EquipmentInterfaceLN	O / F
NamPlt	LPL		inherited from: DomainLN	O / O
Status information				
LevHlfSt	SPS		if true, the level of the tank is above a predefined Half level threshold, otherwise is false.	O / F
LevMaxAlm	SPS		If true, a predefined alarm level of the maximum level of the tank has been reached	O / F
LevMinAlm	SPS		If true, a predefined alarm level of the maximum level of the tank has been reached, and the level is below the threshold, otherwise false	O / F
EEHealth	ENS (HealthKind)		inherited from: EquipmentInterfaceLN	O / F
OpTmh	INS		inherited from: EquipmentInterfaceLN	O / O
Blk	SPS		inherited from: FunctionLN	O / F
ClcExp	SPS	T	inherited from: StatisticsLN	O / O
Beh	ENS (BehaviourModeKind)		inherited from: DomainLN	M / M
Health	ENS (HealthKind)		inherited from: DomainLN	O / O
Mir	SPS		inherited from: DomainLN	MOcond(1) / MOcond(1)
Measured and metered values				
LevPct	MV		inherited from: KTNK	O / O
Vlm	MV		inherited from: KTNK	O / O
Controls				
ClcStr	SPC		inherited from: StatisticsLN	O / O
Mod	ENC (BehaviourModeKind)		inherited from: DomainLN	O / O
Settings				
LevHlfSet	ASG		Half level threshold setting for alarm (in m3)	O / F
LevMaxAls	ASG		Maximum level threshold setting for alarm (in m3)	O / F
LevMinAls	ASG		Minimum level threshold setting for alarm (in m3)	O / F
VlmCap	ASG		inherited from: KTNK	O / F
TnkTyp	ENG (TankFillKind)		inherited from: KTNK	O / F
BlkRef	ORG		inherited from: FunctionLN	Omulti / F
ClcMth	ENG (CalcMethodKind)		inherited from: StatisticsLN	O / M
ClcMod	ENG (CalcModeKind)		inherited from: StatisticsLN	O / O

KTNKExt				
Data object name	**Common data class**	**T**	**Explanation**	**PresCond nds/ds**
ClcIntvTyp	ENG (CalcIntervalKind)		inherited from: StatisticsLN	O / O
ClcIntvPer	ING		inherited from: StatisticsLN	O / O
NumSubIntv	ING		inherited from: StatisticsLN	O / O
ClcRfTyp	ENG (CalcIntervalKind)		inherited from: StatisticsLN	O / O
ClcRfPer	ING		inherited from: StatisticsLN	O / O
ClcSrc	ORG		inherited from: StatisticsLN	F / M
ClcNxtTmms	ING		inherited from: StatisticsLN	O / O
InSyn	ORG		inherited from: StatisticsLN	O / O
InRef	ORG		inherited from: DomainLN	Omulti / Omulti

13.3.3 LN: Tower Name: KTOW

Table 4 shows all data objects of KTOW.

Table 4 – Data objects of KTOW

KTOW				
Data object name	**Common data class**	**T**	**Explanation**	**PresCond nds/ds**
Descriptions				
EEName	DPL		inherited from: EquipmentInterfaceLN	O / F
NamPlt	LPL		inherited from: DomainLN	O / O
Status information				
EEHealth	ENS (HealthKind)		inherited from: EquipmentInterfaceLN	O / F
OpTmh	INS		inherited from: EquipmentInterfaceLN	O / O
Blk	SPS		inherited from: FunctionLN	O / F
ClcExp	SPS	T	inherited from: StatisticsLN	O / O
Beh	ENS (BehaviourModeKind)		inherited from: DomainLN	M / M
Health	ENS (HealthKind)		inherited from: DomainLN	O / O
Mir	SPS		inherited from: DomainLN	MOcond(1) / MOcond(1)
Measured and metered values				
TowTns	MV		Tower tension	O / O
TowInclAng	MV		Tower inclination angle: (-90 to 90 degree)	O / O
BaseInclAng	MV		Ground base inclination angle: 0 -90 degree	O / O
TnsSv	SAV		Tension between line and tower: N	O / O
Controls				
ClcStr	SPC		inherited from: StatisticsLN	O / O
Mod	ENC (BehaviourModeKind)		inherited from: DomainLN	O / O
Settings				
BlkRef	ORG		inherited from: FunctionLN	Omulti / F

KTOW				
Data object name	**Common data class**	**T**	**Explanation**	**PresCond nds/ds**
ClcMth	ENG (CalcMethodKind)		inherited from: StatisticsLN	O / M
ClcMod	ENG (CalcModeKind)		inherited from: StatisticsLN	O / O
ClcIntvTyp	ENG (CalcIntervalKind)		inherited from: StatisticsLN	O / O
ClcIntvPer	ING		inherited from: StatisticsLN	O / O
NumSubIntv	ING		inherited from: StatisticsLN	O / O
ClcRfTyp	ENG (CalcIntervalKind)		inherited from: StatisticsLN	O / O
ClcRfPer	ING		inherited from: StatisticsLN	O / O
ClcSrc	ORG		inherited from: StatisticsLN	F / M
ClcNxtTmms	ING		inherited from: StatisticsLN	O / O
InSyn	ORG		inherited from: StatisticsLN	O / O
InRef	ORG		inherited from: DomainLN	Omulti / Omulti

13.4 Logical nodes for metering and measurement (LNGroupM)

13.4.1 General

NOTE These logical nodes are likely to be included in a later edition of IEC 61850-7-4. When published, logical nodes specified in IEC 61850-7-4 are to take precedence over the definition here.

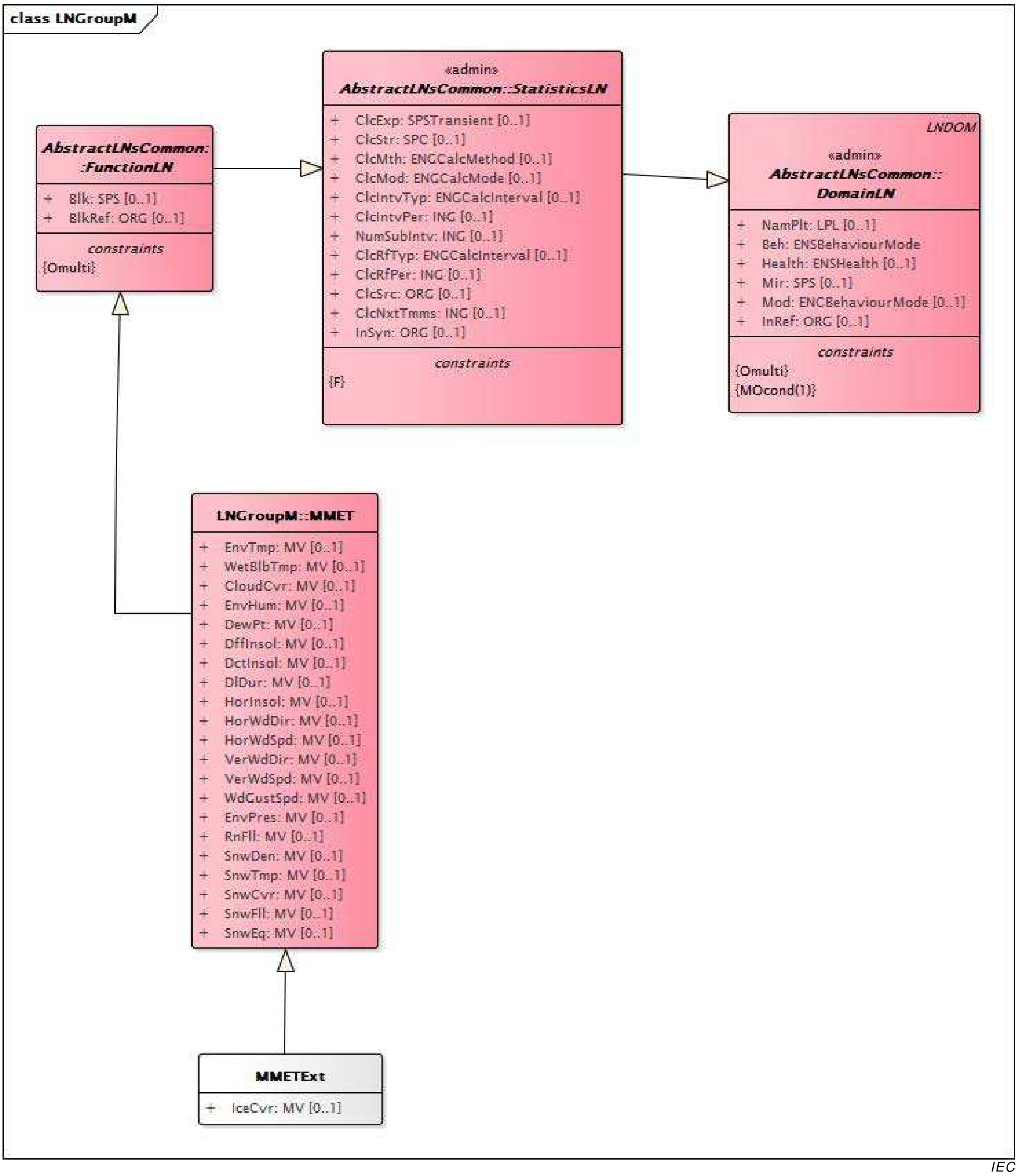


Figure 68 – Class diagram LNGroupM::LNGroupM

Figure 68 shows the second part of concrete logical nodes of this group, with the supertypes that factor their common attributes.

13.4.2 LN: Meteorological information Name: MMETExt

Set of information objects to extend the MMET LN.

This logical node represents meteorological information, which can come from a meteorological station information or be a collection of meteorological information from many sources, that is, from sensors located at different places.

The "Ext" suffix attached to the LN name is only there for editorial purpose and is not present in the real model

Table 5 shows all data objects of MMETExt.

Table 5 – Data objects of MMETExt

MMETExt				
Data object name	**Common data class**	**T**	**Explanation**	**PresCond nds/ds**
Descriptions				
NamPlt	LPL		inherited from: DomainLN	O / O
Status information				
Blk	SPS		inherited from: FunctionLN	O / F
ClcExp	SPS	T	inherited from: StatisticsLN	O / O
Beh	ENS (BehaviourModeKind)		inherited from: DomainLN	M / M
Health	ENS (HealthKind)		inherited from: DomainLN	O / O
Mir	SPS		inherited from: DomainLN	MOcond(1) / MOcond(1)
Measured and metered values				
IceCvr	MV		Ice cover in weight (kg)	O / O
EnvTmp	MV		inherited from: MMET	O / O
WetBlbTmp	MV		inherited from: MMET	O / O
CloudCvr	MV		inherited from: MMET	O / O
EnvHum	MV		inherited from: MMET	O / O
DewPt	MV		inherited from: MMET	O / O
DffInsol	MV		inherited from: MMET	O / O
DctInsol	MV		inherited from: MMET	O / O
DlDur	MV		inherited from: MMET	O / O
HorInsol	MV		inherited from: MMET	O / O
HorWdDir	MV		inherited from: MMET	O / O
HorWdSpd	MV		inherited from: MMET	O / O
VerWdDir	MV		inherited from: MMET	O / O
VerWdSpd	MV		inherited from: MMET	O / O
WdGustSpd	MV		inherited from: MMET	O / O
EnvPres	MV		inherited from: MMET	O / O
RnFll	MV		inherited from: MMET	O / O
SnwDen	MV		inherited from: MMET	O / O
SnwTmp	MV		inherited from: MMET	O / O
SnwCvr	MV		inherited from: MMET	O / O
SnwFll	MV		inherited from: MMET	O / O
SnwEq	MV		inherited from: MMET	O / O
Controls				
ClcStr	SPC		inherited from: StatisticsLN	O / O
Mod	ENC (BehaviourModeKind)		inherited from: DomainLN	O / O
Settings				

MMETExt				
Data object name	**Common data class**	**T**	**Explanation**	**PresCond nds/ds**
BlkRef	ORG		inherited from: FunctionLN	Omulti / F
ClcMth	ENG (CalcMethodKind)		inherited from: StatisticsLN	O / M
ClcMod	ENG (CalcModeKind)		inherited from: StatisticsLN	O / O
ClcIntvTyp	ENG (CalcIntervalKind)		inherited from: StatisticsLN	O / O
ClcIntvPer	ING		inherited from: StatisticsLN	O / O
NumSubIntv	ING		inherited from: StatisticsLN	O / O
ClcRfTyp	ENG (CalcIntervalKind)		inherited from: StatisticsLN	O / O
ClcRfPer	ING		inherited from: StatisticsLN	O / O
ClcSrc	ORG		inherited from: StatisticsLN	F / M
ClcNxtTmms	ING		inherited from: StatisticsLN	O / O
InSyn	ORG		inherited from: StatisticsLN	O / O
InRef	ORG		inherited from: DomainLN	Omulti / Omulti

13.5 Logical nodes for supervision and monitoring (LNGroupS)

13.5.1 General

This group of logical nodes represents: A) functions that are related to electrical protections although not protections themselves and B) protective functions that act on physical measurements other than electrical for their function. The logical nodes in this group will normally provide an alarm signal if the measured level passes a set value. They can optionally provide a trip signal.

NOTE These logical nodes are likely to be included in a later edition of IEC 61850-7-4. When published, logical nodes specified in IEC 61850-7-4 are to take precedence over the definition here.

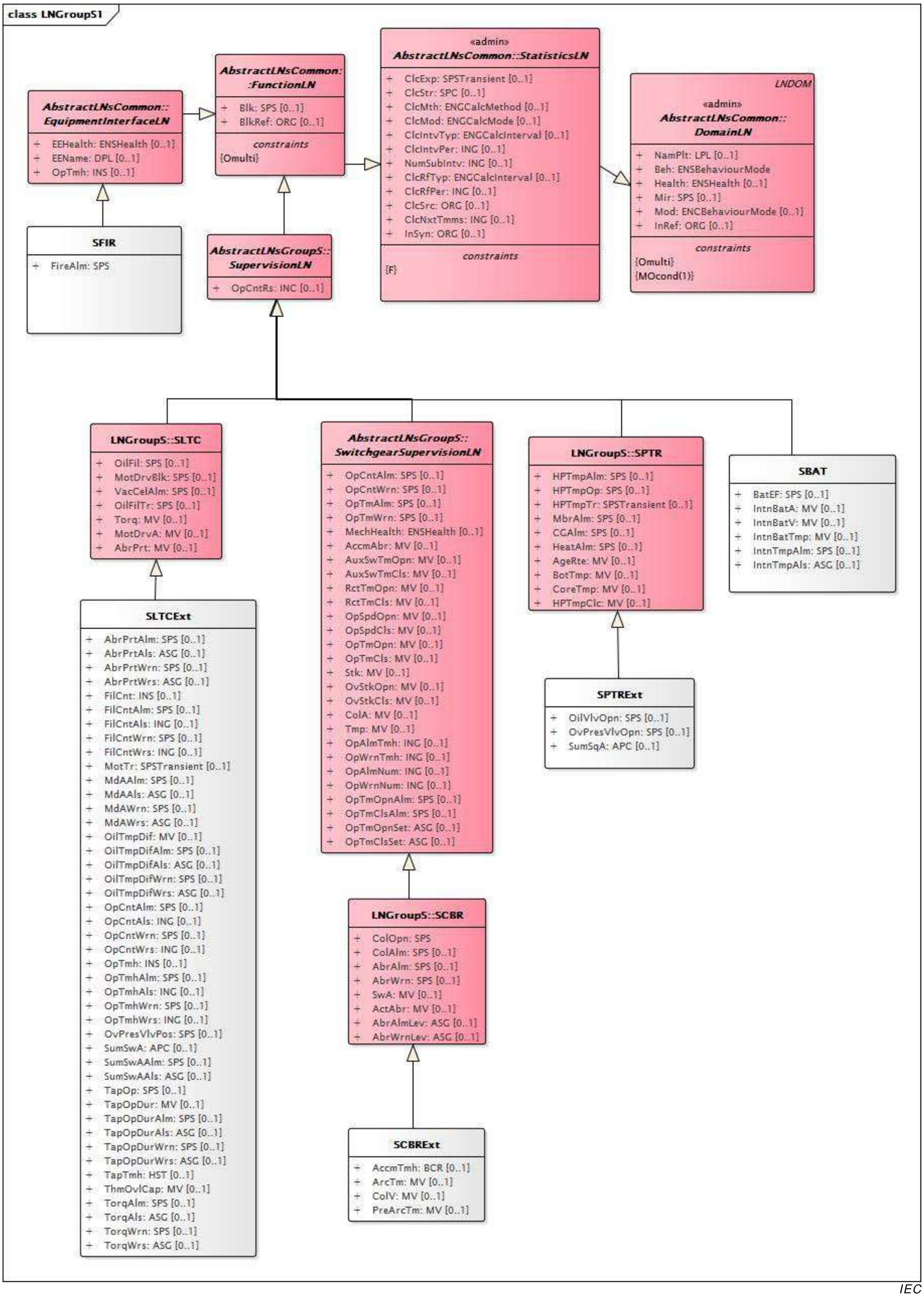


Figure 69 – Class diagram LNGroupS::LNGroupS1

Figure 69 shows all concrete logical nodes of this group, with the supertypes that factor their common attributes.

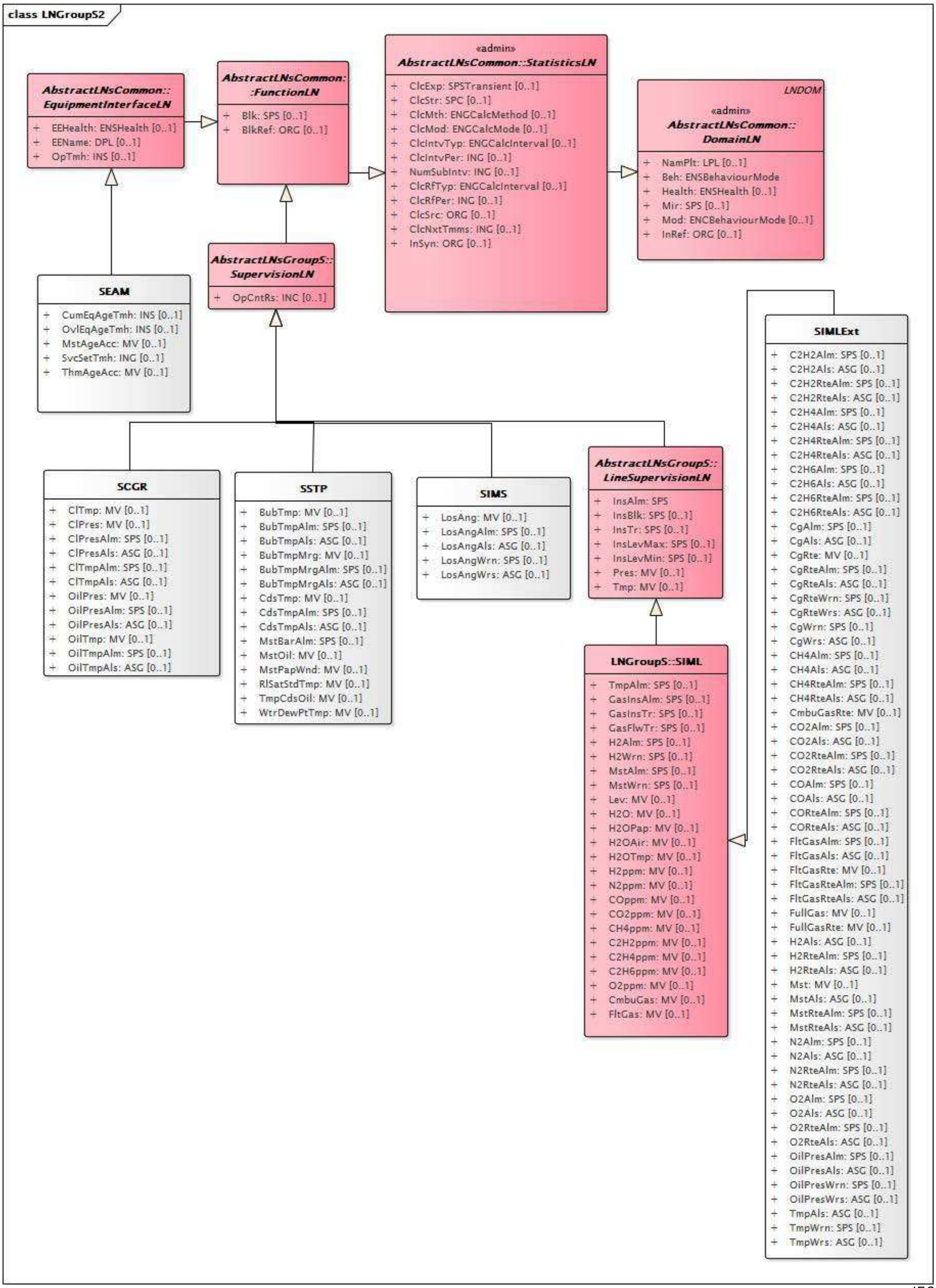


Figure 70 – Class diagram LNGroupS::LNGroupS2

The diagram in Figure 70 shows all concrete logical nodes of this group S, with the supertypes that factor their common attributes.

13.5.2 LN: Battery Name: SBAT

This logical node represents battery supervision.

Table 6 shows all data objects of SBAT.

Table 6 – Data objects of SBAT

SBAT				
Data object name	**Common data class**	**T**	**Explanation**	**PresCond nds/ds**
Descriptions				
NamPlt	LPL		inherited from: DomainLN	O / O
Status information				
BatEF	SPS		If true, Battery Earth Fault is present	O / F
IntnTmpAlm	SPS		If true, a predefined threshold for the battery internal temperature as defined in IntnTmpAls has been reached.	O / F
Blk	SPS		inherited from: FunctionLN	O / F
ClcExp	SPS	T	inherited from: StatisticsLN	O / O
Beh	ENS (BehaviourModeKind)		inherited from: DomainLN	M / M
Health	ENS (HealthKind)		inherited from: DomainLN	O / O
Mir	SPS		inherited from: DomainLN	MOcond(1) / MOcond(1)
Measured and metered values				
IntnBatA	MV		Internal Battery current	O / O
IntnBatV	MV		Internal battery voltage	O / O
IntnBatTmp	MV		Battery internal temperature (in °C)	O / O
Controls				
OpCntRs	INC		inherited from: SupervisionLN	O / O
ClcStr	SPC		inherited from: StatisticsLN	O / O
Mod	ENC (BehaviourModeKind)		inherited from: DomainLN	O / O
Settings				
IntnTmpAls	ASG		Internal battery temperature alarm threshold setting (in °C)	O / F
BlkRef	ORG		inherited from: FunctionLN	Omulti / F
ClcMth	ENG (CalcMethodKind)		inherited from: StatisticsLN	O / M
ClcMod	ENG (CalcModeKind)		inherited from: StatisticsLN	O / O
ClcIntvTyp	ENG (CalcIntervalKind)		inherited from: StatisticsLN	O / O
ClcIntvPer	ING		inherited from: StatisticsLN	O / O
NumSubIntv	ING		inherited from: StatisticsLN	O / O
ClcRfTyp	ENG (CalcIntervalKind)		inherited from: StatisticsLN	O / O
ClcRfPer	ING		inherited from: StatisticsLN	O / O
ClcSrc	ORG		inherited from: StatisticsLN	F / M
ClcNxtTmms	ING		inherited from: StatisticsLN	O / O
InSyn	ORG		inherited from: StatisticsLN	O / O
InRef	ORG		inherited from: DomainLN	Omulti / Omulti

13.5.3 LN: Circuit breaker supervision Name: SCBRExt

Set of information objects to extend the SCBR LN.

This logical node is used for monitoring and diagnostics for circuit breakers.

The "Ext" suffix attached to the LN name is only there for editorial purpose and is not present in the real model

Table 7 shows all data objects of SCBRExt.

Table 7 – Data objects of SCBRExt

SCBRExt				
Data object name	**Common data class**	**T**	**Explanation**	**PresCond nds/ds**
Descriptions				
NamPlt	LPL		inherited from: DomainLN	O / O
Status information				
AccmTmh	BCR		Cumulated time in Hours of current through trip or reclose coil	O / O
ColOpn	SPS		inherited from: SCBR	M / F
ColAlm	SPS		inherited from: SCBR	O / F
AbrAlm	SPS		inherited from: SCBR	O / F
AbrWrn	SPS		inherited from: SCBR	O / F
OpCntAlm	SPS		inherited from: SwitchgearSupervisionLN	O / F
OpCntWrn	SPS		inherited from: SwitchgearSupervisionLN	O / F
OpTmAlm	SPS		inherited from: SwitchgearSupervisionLN	O / F
OpTmWrn	SPS		inherited from: SwitchgearSupervisionLN	O / F
MechHealth	ENS (HealthKind)		inherited from: SwitchgearSupervisionLN	O / F
OpTmOpnAlm	SPS		inherited from: SwitchgearSupervisionLN	O / F
OpTmClsAlm	SPS		inherited from: SwitchgearSupervisionLN	O / F
Blk	SPS		inherited from: FunctionLN	O / F
ClcExp	SPS	T	inherited from: StatisticsLN	O / O
Beh	ENS (BehaviourModeKind)		inherited from: DomainLN	M / M
Health	ENS (HealthKind)		inherited from: DomainLN	O / O
Mir	SPS		inherited from: DomainLN	MOcond(1) / MOcond(1)
Measured and metered values				
ArcTm	MV		Arc duration time	O / O
ColV	MV		Control voltage of coil	O / O
PreArcTm	MV		Pre arc duration time	O / O
SwA	MV		inherited from: SCBR	O / O
ActAbr	MV		inherited from: SCBR	O / O
AccmAbr	MV		inherited from: SwitchgearSupervisionLN	O / O
AuxSwTmOpn	MV		inherited from: SwitchgearSupervisionLN	O / O
AuxSwTmCls	MV		inherited from: SwitchgearSupervisionLN	O / O
RctTmOpn	MV		inherited from: SwitchgearSupervisionLN	O / O

SCBRExt				
Data object name	**Common data class**	**T**	**Explanation**	**PresCond nds/ds**
RctTmCls	MV		inherited from: SwitchgearSupervisionLN	O / O
OpSpdOpn	MV		inherited from: SwitchgearSupervisionLN	O / O
OpSpdCls	MV		inherited from: SwitchgearSupervisionLN	O / O
OpTmOpn	MV		inherited from: SwitchgearSupervisionLN	O / O
OpTmCls	MV		inherited from: SwitchgearSupervisionLN	O / O
Stk	MV		inherited from: SwitchgearSupervisionLN	O / O
OvStkOpn	MV		inherited from: SwitchgearSupervisionLN	O / O
OvStkCls	MV		inherited from: SwitchgearSupervisionLN	O / O
ColA	MV		inherited from: SwitchgearSupervisionLN	O / O
Tmp	MV		inherited from: SwitchgearSupervisionLN	O / O
Controls				
OpCntRs	INC		inherited from: SupervisionLN	O / O
ClcStr	SPC		inherited from: StatisticsLN	O / O
Mod	ENC (BehaviourModeKind)		inherited from: DomainLN	O / O
Settings				
AbrAlmLev	ASG		inherited from: SCBR	O / F
AbrWrnLev	ASG		inherited from: SCBR	O / F
OpAlmTmh	ING		inherited from: SwitchgearSupervisionLN	O / F
OpWrnTmh	ING		inherited from: SwitchgearSupervisionLN	O / F
OpAlmNum	ING		inherited from: SwitchgearSupervisionLN	O / F
OpWrnNum	ING		inherited from: SwitchgearSupervisionLN	O / F
OpTmOpnSet	ASG		inherited from: SwitchgearSupervisionLN	O / F
OpTmClsSet	ASG		inherited from: SwitchgearSupervisionLN	O / F
BlkRef	ORG		inherited from: FunctionLN	Omulti / F
ClcMth	ENG (CalcMethodKind)		inherited from: StatisticsLN	O / M
ClcMod	ENG (CalcModeKind)		inherited from: StatisticsLN	O / O
ClcIntvTyp	ENG (CalcIntervalKind)		inherited from: StatisticsLN	O / O
ClcIntvPer	ING		inherited from: StatisticsLN	O / O
NumSubIntv	ING		inherited from: StatisticsLN	O / O
ClcRfTyp	ENG (CalcIntervalKind)		inherited from: StatisticsLN	O / O
ClcRfPer	ING		inherited from: StatisticsLN	O / O
ClcSrc	ORG		inherited from: StatisticsLN	F / M
ClcNxtTmms	ING		inherited from: StatisticsLN	O / O
InSyn	ORG		inherited from: StatisticsLN	O / O
InRef	ORG		inherited from: DomainLN	Omulti / Omulti

13.5.4 LN: Cooling Group Supervision Name: SCGR

Logical node dedicated to the monitoring of a cooling group (for generators or other)

Table 8 shows all data objects of SCGR.

Table 8 – Data objects of SCGR

SCGR				
Data object name	**Common data class**	**T**	**Explanation**	**PresCond nds/ds**
Descriptions				
NamPlt	LPL		inherited from: DomainLN	O / O
Status information				
ClPresAlm	SPS		If true, a predefined alarm level of the pressure of the generator coolant has been reached	O / F
ClTmpAlm	SPS		if true, a predefined alarm level of the temperature of the generator coolant has been reached	O / F
OilPresAlm	SPS		If true, a predefined level of the generator oil pressure has been reached	O / F
OilTmpAlm	SPS		If true, a predefined alarm level of the Generator oil temperature has been reached.	O / F
Blk	SPS		inherited from: FunctionLN	O / F
ClcExp	SPS	T	inherited from: StatisticsLN	O / O
Beh	ENS (BehaviourModeKind)		inherited from: DomainLN	M / M
Health	ENS (HealthKind)		inherited from: DomainLN	O / O
Mir	SPS		inherited from: DomainLN	MOcond(1) / MOcond(1)
Measured and metered values				
ClTmp	MV		Generator coolant temperature in °C	O / O
ClPres	MV		Generator coolant pressure	O / O
OilPres	MV		Generator oil pressure	O / O
OilTmp	MV		Oil Temperature in °C	O / O
Controls				
OpCntRs	INC		inherited from: SupervisionLN	O / O
ClcStr	SPC		inherited from: StatisticsLN	O / O
Mod	ENC (BehaviourModeKind)		inherited from: DomainLN	O / O
Settings				
ClPresAls	ASG		Alarm threshold setting for the Generator coolant pressure	O / F
ClTmpAls	ASG		Alarm threshold setting for the Generator coolant temperature (in °C)	O / F
OilPresAls	ASG		Generator Oil Pressure Alarm threshold setting	O / F
OilTmpAls	ASG		Generator Oil temperature threshold setting for alarm (in °C)	O / F
BlkRef	ORG		inherited from: FunctionLN	Omulti / F
ClcMth	ENG (CalcMethodKind)		inherited from: StatisticsLN	O / M
ClcMod	ENG (CalcModeKind)		inherited from: StatisticsLN	O / O
ClcIntvTyp	ENG (CalcIntervalKind)		inherited from: StatisticsLN	O / O
ClcIntvPer	ING		inherited from: StatisticsLN	O / O
NumSubIntv	ING		inherited from: StatisticsLN	O / O

SCGR				
Data object name	**Common data class**	**T**	**Explanation**	**PresCond nds/ds**
ClcRfTyp	ENG (CalcIntervalKind)		inherited from: StatisticsLN	O / O
ClcRfPer	ING		inherited from: StatisticsLN	O / O
ClcSrc	ORG		inherited from: StatisticsLN	F / M
ClcNxtTmms	ING		inherited from: StatisticsLN	O / O
InSyn	ORG		inherited from: StatisticsLN	O / O
InRef	ORG		inherited from: DomainLN	Omulti / Omulti

13.5.5 LN: Equipment Ageing Model Name: SEAM

Equipment Ageing Model LN. Contains settings and outcome aiming at determining the real age of an equipment, based on its operation context.

Table 9 shows all data objects of SEAM.

Table 9 – Data objects of SEAM

SEAM				
Data object name	**Common data class**	**T**	**Explanation**	**PresCond nds/ds**
Descriptions				
EEName	DPL		inherited from: EquipmentInterfaceLN	O / F
NamPlt	LPL		inherited from: DomainLN	O / O
Status information				
CumEqAgeTmh	INS		Cumulative equivalent aging (in hours)	O / O
OvlEqAgeTmh	INS		Equivalent aging for the overloading duration (in hours)	O / O
EEHealth	ENS (HealthKind)		inherited from: EquipmentInterfaceLN	O / F
OpTmh	INS		inherited from: EquipmentInterfaceLN	O / O
Blk	SPS		inherited from: FunctionLN	O / F
ClcExp	SPS	T	inherited from: StatisticsLN	O / O
Beh	ENS (BehaviourModeKind)		inherited from: DomainLN	M / M
Health	ENS (HealthKind)		inherited from: DomainLN	O / O
Mir	SPS		inherited from: DomainLN	MOcond(1) / MOcond(1)
Measured and metered values				
MstAgeAcc	MV		Moisture aging acceleration factor ("none" unit)	O / O
ThmAgeAcc	MV		Thermal aging acceleration factor ("none" unit)	O / O
Controls				
ClcStr	SPC		inherited from: StatisticsLN	O / O
Mod	ENC (BehaviourModeKind)		inherited from: DomainLN	O / O
Settings				
SvcSetTmh	ING		Service time setting (in hours)	O / F
BlkRef	ORG		inherited from: FunctionLN	Omulti / F

SEAM				
Data object name	**Common data class**	**T**	**Explanation**	**PresCond nds/ds**
ClcMth	ENG (CalcMethodKind)		inherited from: StatisticsLN	O / M
ClcMod	ENG (CalcModeKind)		inherited from: StatisticsLN	O / O
ClcIntvTyp	ENG (CalcIntervalKind)		inherited from: StatisticsLN	O / O
ClcIntvPer	ING		inherited from: StatisticsLN	O / O
NumSubIntv	ING		inherited from: StatisticsLN	O / O
ClcRfTyp	ENG (CalcIntervalKind)		inherited from: StatisticsLN	O / O
ClcRfPer	ING		inherited from: StatisticsLN	O / O
ClcSrc	ORG		inherited from: StatisticsLN	F / M
ClcNxtTmms	ING		inherited from: StatisticsLN	O / O
InSyn	ORG		inherited from: StatisticsLN	O / O
InRef	ORG		inherited from: DomainLN	Omulti / Omulti

13.5.6 LN: Fire Supervision Name: SFIR

Table 10 shows all data objects of SFIR.

Table 10 – Data objects of SFIR

SFIR				
Data object name	**Common data class**	**T**	**Explanation**	**PresCond nds/ds**
Descriptions				
EEName	DPL		inherited from: EquipmentInterfaceLN	O / F
NamPlt	LPL		inherited from: DomainLN	O / O
Status information				
FireAlm	SPS		If true, a Fire alarm is occurring, otherwise no fire	M / F
EEHealth	ENS (HealthKind)		inherited from: EquipmentInterfaceLN	O / F
OpTmh	INS		inherited from: EquipmentInterfaceLN	O / O
Blk	SPS		inherited from: FunctionLN	O / F
ClcExp	SPS	T	inherited from: StatisticsLN	O / O
Beh	ENS (BehaviourModeKind)		inherited from: DomainLN	M / M
Health	ENS (HealthKind)		inherited from: DomainLN	O / O
Mir	SPS		inherited from: DomainLN	MOcond(1) / MOcond(1)
Controls				
ClcStr	SPC		inherited from: StatisticsLN	O / O
Mod	ENC (BehaviourModeKind)		inherited from: DomainLN	O / O
Settings				
BlkRef	ORG		inherited from: FunctionLN	Omulti / F
ClcMth	ENG (CalcMethodKind)		inherited from: StatisticsLN	O / M
ClcMod	ENG (CalcModeKind)		inherited from: StatisticsLN	O / O
ClcIntvTyp	ENG (CalcIntervalKind)		inherited from: StatisticsLN	O / O
ClcIntvPer	ING		inherited from: StatisticsLN	O / O
NumSubIntv	ING		inherited from: StatisticsLN	O / O
ClcRfTyp	ENG (CalcIntervalKind)		inherited from: StatisticsLN	O / O
ClcRfPer	ING		inherited from: StatisticsLN	O / O
ClcSrc	ORG		inherited from: StatisticsLN	F / M
ClcNxtTmms	ING		inherited from: StatisticsLN	O / O
InSyn	ORG		inherited from: StatisticsLN	O / O
InRef	ORG		inherited from: DomainLN	Omulti / Omulti

13.5.7 LN: Insulation medium supervision (liquid) Name: SIMLExt

Set of information objects to extend the SIML LN.

This logical node is used for supervision of liquid insulation medium such as oil, like that used for example for some transformers and tap changers.

The "Ext" suffix attached to the LN name is only there for editorial purpose and is not present in the real model

Table 11 shows all data objects of SIMLExt.

Table 11 – Data objects of SIMLExt

SIMLExt				
Data object name	**Common data class**	**T**	**Explanation**	**PresCond nds/ds**
Descriptions				
NamPlt	LPL		inherited from: DomainLN	O / O
Status information				
C2H2Alm	SPS		If true, a predefined level limit of C2H2 for the insulation medium has been reached (for example, low insulation level). Setting of the predefined level limit is a local issue. The action to take may be to refill the insulation medium.	O / F
C2H2RteAlm	SPS		If true, a predefined level limit of C2H2 rate of change for the insulation medium has been reached (for example, low insulation level). Setting of the predefined level limit is a local issue. The action to take may be to refill the insulation medium.	O / F
C2H4Alm	SPS		If true, a predefined level limit of C2H4 for the insulation medium has been reached (for example, low insulation level). Setting of the predefined level limit is a local issue. The action to take may be to refill the insulation medium.	O / F
C2H4RteAlm	SPS		If true, a predefined level limit of C2H4 rate of change for the insulation medium has been reached (for example, low insulation level). Setting of the predefined level limit is a local issue. The action to take may be to refill the insulation medium.	O / F
C2H6Alm	SPS		If true, a predefined level limit of C2H6 for the insulation medium has been reached (for example, low insulation level). Setting of the predefined level limit is a local issue. The action to take may be to refill the insulation medium.	O / F
C2H6RteAlm	SPS		If true, a predefined level limit of C2H6 rate of change for the insulation medium has been reached (for example, low insulation level). Setting of the predefined level limit is a local issue. The action to take may be to refill the insulation medium.	O / F
CgAlm	SPS		If true, a predefined level limit of Total Dissolved Combustible Gases for the insulation medium has been reached (for example, low insulation level). Setting of the predefined level limit is a local issue. The action to take may be to refill the insulation medium.	O / F
CgRteAlm	SPS		If true, a predefined level limit of Total Dissolved Gases rate of change for the insulation medium has been reached (for example, low insulation level). The action to take may be to refill the insulation medium.	O / F
CgRteWrn	SPS		If true, a predefined warning level of Total Dissolved Gases rate of change for the insulation medium has been reached (for example, low insulation level). The action to take may be to refill the insulation medium.	O / F
CgWrn	SPS		If true, a predefined warning level limit of Total Dissolved Combustible Gases for the insulation medium has been reached	O / F

SIMLExt				
Data object name	**Common data class**	**T**	**Explanation**	**PresCond nds/ds**
CH4Alm	SPS		If true, a predefined level limit of CH4 for the insulation medium has been reached (for example, low insulation level). Setting of the predefined level limit is a local issue. The action to take may be to refill the insulation medium.	O / F
CH4RteAlm	SPS		If true, a predefined level limit of CH4 rate of change for the insulation medium has been reached (for example, low insulation level). Setting of the predefined level limit is a local issue. The action to take may be to refill the insulation medium.	O / F
CO2Alm	SPS		If true, a predefined level limit of CO2 for the insulation medium has been reached (for example, low insulation level). Setting of the predefined level limit is a local issue. The action to take may be to refill the insulation medium.	O / F
CO2RteAlm	SPS		If true, a predefined level limit of CO2 ROC or the insulation medium has been reached (for example, low insulation level). Setting of the predefined level limit is a local issue. The action to take may be to refill the insulation medium.	O / F
COAlm	SPS		If true, a predefined level limit of CO for the insulation medium has been reached (for example, low insulation level). Setting of the predefined level limit is a local issue. The action to take may be to refill the insulation medium.	O / F
CORteAlm	SPS		If true, a predefined level limit of CO rate of change for the insulation medium has been reached (for example, low insulation level). Setting of the predefined level limit is a local issue. The action to take may be to refill the insulation medium.	O / F
FltGasAlm	SPS		If true, a predefined level alarm limit FltGasAls of fault gas in Buchholz relay has been reached	O / F
FltGasRteAlm	SPS		If true, a predefined alarm level RteFGAlmSet of fault gas rate in Buchholz relay been reached	O / F
H2RteAlm	SPS		If true, a predefined level limit of H2 rate of change for the insulation medium has been reached (for example, low insulation level). Setting of the predefined level limit is a local issue. The action to take may be to refill the insulation medium.	O / F
MstRteAlm	SPS		If true, a predefined level limit of Moisture rate of change for the insulation medium has been reached (for example, low insulation level). The action to take may be to refill the insulation medium.	O / F
N2Alm	SPS		If true, a predefined level limit of N2 for the insulation medium has been reached (for example, low insulation level). Setting of the predefined level limit is a local issue. The action to take may be to refill the insulation medium.	O / F
N2RteAlm	SPS		If true, a predefined level limit of N2 rate of change for the insulation medium has been reached (for example, low insulation level). Setting of the predefined level limit is a local issue. The action to take may be to refill the insulation medium.	O / F
O2Alm	SPS		If true, a predefined level limit of O2 for the insulation medium has been reached (for example, low insulation level). Setting of the predefined level limit is a local issue. The action to take may be to refill the insulation medium.	O / F

SIMLExt				
Data object name	**Common data class**	**T**	**Explanation**	**PresCond nds/ds**
O2RteAlm	SPS		If true, a predefined level limit of O2 rate of change for the insulation medium has been reached (for example, low insulation level). Setting of the predefined level limit is a local issue. The action to take may be to refill the insulation medium.	O / F
OilPresAlm	SPS		If true, the predefined alarm level limit OilPAlmSet of Oil pressure for the insulation medium has been reached	O / F
OilPresWrn	SPS		If true, the predefined warning level limit OilPWrnSet of Oil pressure for the insulation medium has been reached	O / F
TmpWrn	SPS		If true, the predefined level warning limit TmpWrnSet for the temperature of LTC has been reached.	O / F
TmpAlm	SPS		inherited from: SIML	O / F
GasInsAlm	SPS		inherited from: SIML	O / F
GasInsTr	SPS		inherited from: SIML	O / F
GasFlwTr	SPS		inherited from: SIML	O / F
H2Alm	SPS		inherited from: SIML	O / F
H2Wrn	SPS		inherited from: SIML	O / F
MstAlm	SPS		inherited from: SIML	O / F
MstWrn	SPS		inherited from: SIML	O / F
InsAlm	SPS		inherited from: LineSupervisionLN	M / F
InsBlk	SPS		inherited from: LineSupervisionLN	O / F
InsTr	SPS		inherited from: LineSupervisionLN	O / F
InsLevMax	SPS		inherited from: LineSupervisionLN	O / F
InsLevMin	SPS		inherited from: LineSupervisionLN	O / F
Blk	SPS		inherited from: FunctionLN	O / F
ClcExp	SPS	T	inherited from: StatisticsLN	O / O
Beh	ENS (BehaviourModeKind)		inherited from: DomainLN	M / M
Health	ENS (HealthKind)		inherited from: DomainLN	O / O
Mir	SPS		inherited from: DomainLN	MOcond(1) / MOcond(1)
Measured and metered values				
CgRte	MV		Rate of change of total dissolved combustible gases (TDCG) (in ppm/s)	O / O
CmbuGasRte	MV		Rate of change of total dissolved combustible gas (in m3/s)	O / O
FltGasRte	MV		Rate of increase of fault gas volume in Buchholz relay (m3/s)	O / O
FullGas	MV		Overall dissolved gas (in m3)	O / O
FullGasRte	MV		Rate of increase of overall dissolved gas (m3/s)	O / O
Mst	MV		Measured amount of moisture in the insulating liquid in ppm	O / O
Lev	MV		inherited from: SIML	O / O
H2O	MV		inherited from: SIML	O / O
H2OPap	MV		inherited from: SIML	O / O

SIMLExt				
Data object name	**Common data class**	**T**	**Explanation**	**PresCond nds/ds**
H2OAir	MV		inherited from: SIML	O / O
H2OTmp	MV		inherited from: SIML	O / O
H2ppm	MV		inherited from: SIML	O / O
N2ppm	MV		inherited from: SIML	O / O
COppm	MV		inherited from: SIML	O / O
CO2ppm	MV		inherited from: SIML	O / O
CH4ppm	MV		inherited from: SIML	O / O
C2H2ppm	MV		inherited from: SIML	O / O
C2H4ppm	MV		inherited from: SIML	O / O
C2H6ppm	MV		inherited from: SIML	O / O
O2ppm	MV		inherited from: SIML	O / O
CmbuGas	MV		inherited from: SIML	O / O
FltGas	MV		inherited from: SIML	O / O
Pres	MV		inherited from: LineSupervisionLN	O / O
Tmp	MV		inherited from: LineSupervisionLN	O / O
Controls				
OpCntRs	INC		inherited from: SupervisionLN	O / O
ClcStr	SPC		inherited from: StatisticsLN	O / O
Mod	ENC (BehaviourModeKind)		inherited from: DomainLN	O / O
Settings				
C2H2Als	ASG		C2H2 alarm setting in ppm	O / F
C2H2RteAls	ASG		C2H2 rate of change alarm setting in ppm/s	O / F
C2H4Als	ASG		C2H4 alarm setting in ppm	O / F
C2H4RteAls	ASG		C2H4 rate of change alarm setting in ppm/s	O / F
C2H6Als	ASG		C2H6 alarm setting in ppm	O / F
C2H6RteAls	ASG		C2H6 rate of change alarm setting in ppm/s	O / F
CgAls	ASG		Total dissolved combustible gases (TDCG) alarm setting in ppm	O / F
CgRteAls	ASG		Alarm threshold for the rate of change of Total Dissolved Combustible Gas (in ppm/s)	O / F
CgRteWrs	ASG		Warning threshold for the rate of change of Total Dissolved Combustible Gas (in ppm/s)	O / F
CgWrs	ASG		Warning threshold setting for the Total Dissolved Combustible gas (TDCG) in ppm	O / F
CH4Als	ASG		CH4 alarm setting in ppm	O / F
CH4RteAls	ASG		CH4 rate of change alarm setting in ppm/s	O / F
CO2Als	ASG		CO2 alarm setting in ppm	O / F
CO2RteAls	ASG		CO2 Rate of change alarm setting in ppm/s	O / F
COAls	ASG		CO alarm setting in ppm	O / F
CORteAls	ASG		CO Rate of change alarm setting in ppm/s	O / F
FltGasAls	ASG		Alarm threshold setting for Fault Gas volume in BuchHolz relay (in m3)	O / F
FltGasRteAls	ASG		Alarm threshold setting for the rate of increase of Fault Gas volume in Bucholz relay	O / F

SIMLExt				
Data object name	**Common data class**	**T**	**Explanation**	**PresCond nds/ds**
H2Als	ASG		H2 alarm setting in ppm	O / F
H2RteAls	ASG		H2 Rate of change alarm setting in ppm/s	O / F
MstAls	ASG		Moisture alarm threshold setting in ppm	O / F
MstRteAls	ASG		Moisture rate of change alarm threshold setting in ppm/s	O / F
N2Als	ASG		N2 alarm setting in ppm	O / F
N2RteAls	ASG		N2 rate of change alarm setting in ppm/s	O / F
O2Als	ASG		O2 alarm setting in ppm	O / F
O2RteAls	ASG		O2 rate of change alarm setting in ppm:s	O / F
OilPresAls	ASG		Alarm threshold setting for the Oil Pressure	O / F
OilPresWrs	ASG		Warning threshold setting for the Oil Pressure	O / F
TmpAls	ASG		Temperature alarm threshold setting (in °C)	O / F
TmpWrs	ASG		Temperature warning threshold setting (in °C)	O / F
BlkRef	ORG		inherited from: FunctionLN	Omulti / F
ClcMth	ENG (CalcMethodKind)		inherited from: StatisticsLN	O / M
ClcMod	ENG (CalcModeKind)		inherited from: StatisticsLN	O / O
ClcIntvTyp	ENG (CalcIntervalKind)		inherited from: StatisticsLN	O / O
ClcIntvPer	ING		inherited from: StatisticsLN	O / O
NumSubIntv	ING		inherited from: StatisticsLN	O / O
ClcRfTyp	ENG (CalcIntervalKind)		inherited from: StatisticsLN	O / O
ClcRfPer	ING		inherited from: StatisticsLN	O / O
ClcSrc	ORG		inherited from: StatisticsLN	F / M
ClcNxtTmms	ING		inherited from: StatisticsLN	O / O
InSyn	ORG		inherited from: StatisticsLN	O / O
InRef	ORG		inherited from: DomainLN	Omulti / Omulti

13.5.8 LN: Insulation moisture supervision (solid) Name: SIMS

Logical node SIMS is used for supervision of solid insulation medium. It contains data objects to monitor dielectric tangent values for diagnosis.

Table 12 shows all data objects of SIMS.

Table 12 – Data objects of SIMS

SIMS				
Data object name	**Common data class**	**T**	**Explanation**	**PresCond nds/ds**
Descriptions				
NamPlt	LPL		inherited from: DomainLN	O / O
Status information				
LosAngAlm	SPS		If true, the predefined level alarm limit LosAngAls for the tangent of loss angle of the monitored cable has been reached	O / F
LosAngWrn	SPS		If true, the predefined level warning limit LosAngWrs for the tangent of loss angle of the monitored cable has been reached	O / F
Blk	SPS		inherited from: FunctionLN	O / F
ClcExp	SPS	T	inherited from: StatisticsLN	O / O
Beh	ENS (BehaviourModeKind)		inherited from: DomainLN	M / M
Health	ENS (HealthKind)		inherited from: DomainLN	O / O
Mir	SPS		inherited from: DomainLN	MOcond(1) / MOcond(1)
Measured and metered values				
LosAng	MV		Tangent of loss angle of the monitored cable (no unit)	O / O
Controls				
OpCntRs	INC		inherited from: SupervisionLN	O / O
ClcStr	SPC		inherited from: StatisticsLN	O / O
Mod	ENC (BehaviourModeKind)		inherited from: DomainLN	O / O
Settings				
LosAngAls	ASG		Threshold for alarm state of the tangent of loss angle (no unit)	O / F
LosAngWrs	ASG		Threshold for warning state of the tangent of loss angle (no unit)	O / F
BlkRef	ORG		inherited from: FunctionLN	Omulti / F
ClcMth	ENG (CalcMethodKind)		inherited from: StatisticsLN	O / M
ClcMod	ENG (CalcModeKind)		inherited from: StatisticsLN	O / O
ClcIntvTyp	ENG (CalcIntervalKind)		inherited from: StatisticsLN	O / O
ClcIntvPer	ING		inherited from: StatisticsLN	O / O
NumSubIntv	ING		inherited from: StatisticsLN	O / O
ClcRfTyp	ENG (CalcIntervalKind)		inherited from: StatisticsLN	O / O
ClcRfPer	ING		inherited from: StatisticsLN	O / O
ClcSrc	ORG		inherited from: StatisticsLN	F / M
ClcNxtTmms	ING		inherited from: StatisticsLN	O / O
InSyn	ORG		inherited from: StatisticsLN	O / O
InRef	ORG		inherited from: DomainLN	Omulti / Omulti

13.5.9 LN: Tap changer supervision Name: SLTCExt

Set of information objects to extend the SLTC LN for condition supervision of tap changer.

The "Ext" suffix attached to the LN name is only there for editorial purpose and is not present in the real model

Table 13 shows all data objects of SLTCExt.

Table 13 – Data objects of SLTCExt

SLTCExt				
Data object name	**Common data class**	**T**	**Explanation**	**PresCond nds/ds**
Descriptions				
NamPlt	LPL		inherited from: DomainLN	O / O
Status information				
AbrPrtAlm	SPS		If true, the predefined level alarm limit AbrPrtAls for the Abrasion of parts has been reached.	O / F
AbrPrtWrn	SPS		If true, the predefined level warning limit AbrPrtWrs for the Abrasion of parts has been reached.	O / F
FilCnt	INS		Oil Filtration counter	O / O
FilCntAlm	SPS		If true, the predefined level alarm limit FilCntAls for the oil filtration counter has been reached.	O / F
FilCntWrn	SPS		If true, the predefined level warning limit FilCntWrs for the oil filtration counter has been reached.	O / F
MotTr	SPS	T	Trip of Load tap changer Motor protection	O / F
MdAAlm	SPS		If true, the predefined level alarm limit MdAAls for the motor drive current has been reached.	O / F
MdAWrn	SPS		If true, the predefined level warning limit MdAWrs for the motor drive current has been reached.	O / F
OilTmpDifAlm	SPS		If true, the predefined level alarm limit OilTmpDifAls for the oil temperature difference has been reached.	O / F
OilTmpDifWrn	SPS		If true, the predefined level warning limit OilTmpDifWrs for the oil temperature difference has been reached.	O / F
OpCntAlm	SPS		If true, the predefined level alarm limit OpCntAls for the LTC operations has been reached.	O / F
OpCntWrn	SPS		If true, the predefined level warning limit OpCntWrs for the LTC operations has been reached.	O / F
OpTmh	INS		Operation time of the LTC since start of the operation (in hour)	O / O
OpTmhAlm	SPS		If true, the predefined level alarm limit OpTmhAls for the LTC operation duration has been reached.	O / F
OpTmhWrn	SPS		If true, the predefined level warning limit OpTmhWrs for the LTC operation duration has been reached.	O / F
OvPresVlvPos	SPS		If true, the valve position is in over pressure	O / F
SumSwAAlm	SPS		If true, the predefined level alarm limit SumSwAAls for the sum of commuted currents has been reached.	O / F
TapOp	SPS		If true, the tap changer is operating	O / F
TapOpDurAlm	SPS		If true, the tap change operation duration has exceeded the threshold defined in TapOpDurAls	O / F

SLTCExt				
Data object name	**Common data class**	**T**	**Explanation**	**PresCond nds/ds**
TapOpDurWrn	SPS		If true, the tap change operation duration has exceeded the warning threshold defined in TapOpDurWrs	O / F
TapTmh	HST		Cumulated operating time of each tap positions (in hours)	O / F
TorqAlm	SPS		If true, the predefined level alarm limit TorqAls for the drive torque has been reached.	O / F
TorqWrn	SPS		If true, the predefined level warning limit TorqWrs for the drive torque has been reached.	O / F
OilFil	SPS		inherited from: SLTC	O / F
MotDrvBlk	SPS		inherited from: SLTC	O / F
VacCelAlm	SPS		inherited from: SLTC	O / F
OilFilTr	SPS		inherited from: SLTC	O / F
Blk	SPS		inherited from: FunctionLN	O / F
ClcExp	SPS	T	inherited from: StatisticsLN	O / O
Beh	ENS (BehaviourModeKind)		inherited from: DomainLN	M / M
Health	ENS (HealthKind)		inherited from: DomainLN	O / O
Mir	SPS		inherited from: DomainLN	MOcond(1) / MOcond(1)
Measured and metered values				
OilTmpDif	MV		Oil Temperature Difference between LTC oil and Transformer oil (in °C)	O / O
TapOpDur	MV		Duration of the latest tap change operation (in s)	O / O
ThmOvlCap	MV		Calculated thermal overload capability (in Amp)	O / O
Torq	MV		inherited from: SLTC	O / O
MotDrvA	MV		inherited from: SLTC	O / O
AbrPrt	MV		inherited from: SLTC	O / O
Controls				
SumSwA	APC		(controllable) Sum of commuted currents of LTC in Amp. It can be reset or set to any value.	O / O
OpCntRs	INC		inherited from: SupervisionLN	O / O
ClcStr	SPC		inherited from: StatisticsLN	O / O
Mod	ENC (BehaviourModeKind)		inherited from: DomainLN	O / O
Settings				
AbrPrtAls	ASG		Abrasion of parts (in %) threshold setting for alarm	O / F
AbrPrtWrs	ASG		Abrasion of parts (in %) threshold setting for warning	O / F
FilCntAls	ING		Oil filtration counts threshold setting for alarm	O / F
FilCntWrs	ING		Oil filtration counts threshold setting for warning	O / F
MdAAls	ASG		Motor drive Currant alarm threshold setting	O / F
MdAWrs	ASG		Motor drive current threshold setting for warning	O / F
OilTmpDifAls	ASG		Oil Temperature difference threshold setting for alarm (in °C)	O / F

SLTCExt				
Data object name	**Common data class**	**T**	**Explanation**	**PresCond nds/ds**
OilTmpDifWrs	ASG		Oil Temperature difference threshold setting for warning (in °C)	O / F
OpCntAls	ING		LTC Operation Counts threshold setting for alarm	O / F
OpCntWrs	ING		LTC Operation Counts threshold setting for warning	O / F
OpTmhAls	ING		LTC operation duration threshold setting for alarm (in hours)	O / F
OpTmhWrs	ING		LTC operation duration threshold setting for warning (in hours)	O / F
SumSwAAls	ASG		Alarm threshold setting for the sum of commuted currents by LTC (in Amp)	O / F
TapOpDurAls	ASG		Threshold for the tap change operation duration alarm	O / F
TapOpDurWrs	ASG		Threshold for the tap change operation duration alarm	O / F
TorqAls	ASG		Drive torque threshold setting for alarm	O / F
TorqWrs	ASG		Drive torque threshold setting for warning	O / F
BlkRef	ORG		inherited from: FunctionLN	Omulti / F
ClcMth	ENG (CalcMethodKind)		inherited from: StatisticsLN	O / M
ClcMod	ENG (CalcModeKind)		inherited from: StatisticsLN	O / O
ClcIntvTyp	ENG (CalcIntervalKind)		inherited from: StatisticsLN	O / O
ClcIntvPer	ING		inherited from: StatisticsLN	O / O
NumSubIntv	ING		inherited from: StatisticsLN	O / O
ClcRfTyp	ENG (CalcIntervalKind)		inherited from: StatisticsLN	O / O
ClcRfPer	ING		inherited from: StatisticsLN	O / O
ClcSrc	ORG		inherited from: StatisticsLN	F / M
ClcNxtTmms	ING		inherited from: StatisticsLN	O / O
InSyn	ORG		inherited from: StatisticsLN	O / O
InRef	ORG		inherited from: DomainLN	Omulti / Omulti

13.5.10 LN: Power Transformer supervision Name: SPTRExt

Set of information objects to extend the SPTR LN for Power Transformer supervision.

The "Ext" suffix attached to the LN name is only there for editorial purpose and is not present in the real model.

Table 14 shows all data objects of SPTRExt.

Table 14 – Data objects of SPTRExt

SPTRExt				
Data object name	**Common data class**	**T**	**Explanation**	**PresCond nds/ds**
Descriptions				
NamPlt	LPL		inherited from: DomainLN	O / O
Status information				
OilVlvOpn	SPS		if true, the pressure Oil Valve is opened otherwise closed	O / F
OvPresVlvOpn	SPS		if true, the OverPressure Valve is opened otherwise closed	O / F
HPTmpAlm	SPS		inherited from: SPTR	O / F
HPTmpOp	SPS		inherited from: SPTR	O / F
HPTmpTr	SPS	T	inherited from: SPTR	O / F
MbrAlm	SPS		inherited from: SPTR	O / F
CGAlm	SPS		inherited from: SPTR	O / F
HeatAlm	SPS		inherited from: SPTR	O / F
Blk	SPS		inherited from: FunctionLN	O / F
ClcExp	SPS	T	inherited from: StatisticsLN	O / O
Beh	ENS (BehaviourModeKind)		inherited from: DomainLN	M / M
Health	ENS (HealthKind)		inherited from: DomainLN	O / O
Mir	SPS		inherited from: DomainLN	MOcond(1) / MOcond(1)
Measured and metered values				
AgeRte	MV		inherited from: SPTR	O / O
BotTmp	MV		inherited from: SPTR	O / O
CoreTmp	MV		inherited from: SPTR	O / O
HPTmpClc	MV		inherited from: SPTR	O / O
Controls				
SumSqA	APC		Sum of square of short circuit currents of the transformer, expressed in Amp square	O / O
OpCntRs	INC		inherited from: SupervisionLN	O / O
ClcStr	SPC		inherited from: StatisticsLN	O / O
Mod	ENC (BehaviourModeKind)		inherited from: DomainLN	O / O
Settings				
BlkRef	ORG		inherited from: FunctionLN	Omulti / F
ClcMth	ENG (CalcMethodKind)		inherited from: StatisticsLN	O / M
ClcMod	ENG (CalcModeKind)		inherited from: StatisticsLN	O / O
ClcIntvTyp	ENG (CalcIntervalKind)		inherited from: StatisticsLN	O / O
ClcIntvPer	ING		inherited from: StatisticsLN	O / O
NumSubIntv	ING		inherited from: StatisticsLN	O / O
ClcRfTyp	ENG (CalcIntervalKind)		inherited from: StatisticsLN	O / O
ClcRfPer	ING		inherited from: StatisticsLN	O / O
ClcSrc	ORG		inherited from: StatisticsLN	F / M

SPTRExt				
Data object name	**Common data class**	**T**	**Explanation**	**PresCond nds/ds**
ClcNxtTmms	ING		inherited from: StatisticsLN	O / O
InSyn	ORG		inherited from: StatisticsLN	O / O
InRef	ORG		inherited from: DomainLN	Omulti / Omulti

13.5.11 LN: Saturation temperature supervision Name: SSTP

Saturation temperature supervision LN

Table 15 shows all data objects of SSTP.

Table 15 – Data objects of SSTP

SSTP				
Data object name	**Common data class**	**T**	**Explanation**	**PresCond nds/ds**
Descriptions				
NamPlt	LPL		inherited from: DomainLN	O / O
Status information				
BubTmpAlm	SPS		If true, the predefined level alarm limit BubTmpAls for the bubbling temperature has been reached.	O / F
BubTmpMrgAlm	SPS		If true, the Bubbling temperature margin alarm threshold defined in BubTmpMrgAls has been reached.	O / F
CdsTmpAlm	SPS		If true, Water condensation temperature has reached the alarm threshold defined in CdsTmpAls	O / F
MstBarAlm	SPS		if true, Moisture content in barrier has reached an alarming level	O / F
Blk	SPS		inherited from: FunctionLN	O / F
ClcExp	SPS	T	inherited from: StatisticsLN	O / O
Beh	ENS (BehaviourModeKind)		inherited from: DomainLN	M / M
Health	ENS (HealthKind)		inherited from: DomainLN	O / O
Mir	SPS		inherited from: DomainLN	MOcond(1) / MOcond(1)
Measured and metered values				
BubTmp	MV		Bubbling temperature (in °C)	O / O
BubTmpMrg	MV		Bubbling temperature margin (in °C)	O / O
CdsTmp	MV		Condensation temperature (in °C)	O / O
MstOil	MV		Moisture content in oil (in ppm)	O / O
MstPapWnd	MV		Moisture content in winding paper (in ppm)	O / O
RlSatStdTmp	MV		Relative saturation at a standard temperature (%)	O / O
TmpCdsOil	MV		Temperature of water condensation in oil (in °C)	O / O
WtrDewPtTmp	MV		Dew point of water (in °C)	O / O
Controls				

SSTP				
Data object name	**Common data class**	**T**	**Explanation**	**PresCond nds/ds**
OpCntRs	INC		inherited from: SupervisionLN	O / O
ClcStr	SPC		inherited from: StatisticsLN	O / O
Mod	ENC (BehaviourModeKind)		inherited from: DomainLN	O / O
Settings				
BubTmpAls	ASG		Bubbling Temperature alarm threshold setting (in °C)	O / F
BubTmpMrgAls	ASG		Bubbling temperature margin Alarm threshold setting (in °C)	O / F
CdsTmpAls	ASG		Condensation temperature alarm threshold setting (in °C)	O / F
BlkRef	ORG		inherited from: FunctionLN	Omulti / F
ClcMth	ENG (CalcMethodKind)		inherited from: StatisticsLN	O / M
ClcMod	ENG (CalcModeKind)		inherited from: StatisticsLN	O / O
ClcIntvTyp	ENG (CalcIntervalKind)		inherited from: StatisticsLN	O / O
ClcIntvPer	ING		inherited from: StatisticsLN	O / O
NumSubIntv	ING		inherited from: StatisticsLN	O / O
ClcRfTyp	ENG (CalcIntervalKind)		inherited from: StatisticsLN	O / O
ClcRfPer	ING		inherited from: StatisticsLN	O / O
ClcSrc	ORG		inherited from: StatisticsLN	F / M
ClcNxtTmms	ING		inherited from: StatisticsLN	O / O
InSyn	ORG		inherited from: StatisticsLN	O / O
InRef	ORG		inherited from: DomainLN	Omulti / Omulti

13.6 Logical nodes for instrument transformers and sensors (LNGroupT)

13.6.1 General

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).

NOTE These logical nodes are likely to be included in a later edition of IEC 61850-7-4. When published, logical nodes specified in IEC 61850-7-4 are to take precedence over the definition here.

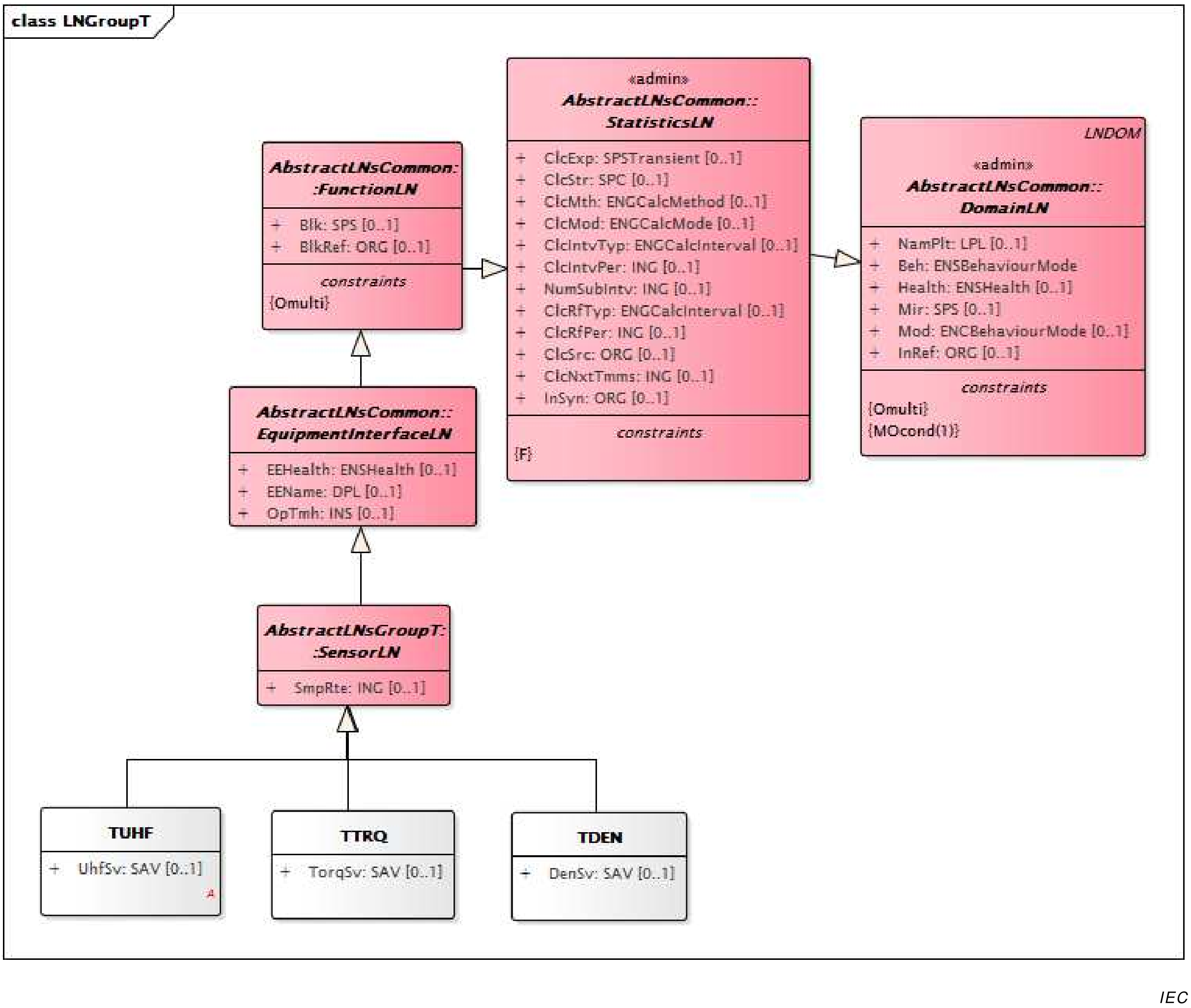


Figure 71 – Class diagram LNGroupT::LNGroupT

Figure 71 shows all concrete logical nodes of this group, with the supertypes that factor their common attributes.

13.6.2 LN: Density Sensor Name: TDEN

Logical node TDEN shall be used to expose density value from density sensor. Any kind of materials could be monitored using this LN.

Table 16 shows all data objects of TDEN.

Table 16 – Data objects of TDEN

TDEN				
Data object name	**Common data class**	**T**	**Explanation**	**PresCond nds/ds**
Descriptions				
EEName	DPL		inherited from: EquipmentInterfaceLN	O / F
NamPlt	LPL		inherited from: DomainLN	O / O
Status information				
EEHealth	ENS (HealthKind)		inherited from: EquipmentInterfaceLN	O / F
OpTmh	INS		inherited from: EquipmentInterfaceLN	O / O
Blk	SPS		inherited from: FunctionLN	O / F
ClcExp	SPS	T	inherited from: StatisticsLN	O / O
Beh	ENS (BehaviourModeKind)		inherited from: DomainLN	M / M
Health	ENS (HealthKind)		inherited from: DomainLN	O / O
Mir	SPS		inherited from: DomainLN	MOcond(1) / MOcond(1)
Measured and metered values				
DenSv	SAV		Density (mol/L) Sample Value This type of sampled value holds gas density.	O / O
Controls				
ClcStr	SPC		inherited from: StatisticsLN	O / O
Mod	ENC (BehaviourModeKind)		inherited from: DomainLN	O / O
Settings				
SmpRte	ING		inherited from: SensorLN	O / F
BlkRef	ORG		inherited from: FunctionLN	Omulti / F
ClcMth	ENG (CalcMethodKind)		inherited from: StatisticsLN	O / M
ClcMod	ENG (CalcModeKind)		inherited from: StatisticsLN	O / O
ClcIntvTyp	ENG (CalcIntervalKind)		inherited from: StatisticsLN	O / O
ClcIntvPer	ING		inherited from: StatisticsLN	O / O
NumSubIntv	ING		inherited from: StatisticsLN	O / O
ClcRfTyp	ENG (CalcIntervalKind)		inherited from: StatisticsLN	O / O
ClcRfPer	ING		inherited from: StatisticsLN	O / O
ClcSrc	ORG		inherited from: StatisticsLN	F / M
ClcNxtTmms	ING		inherited from: StatisticsLN	O / O
InSyn	ORG		inherited from: StatisticsLN	O / O
InRef	ORG		inherited from: DomainLN	Omulti / Omulti

13.6.3 LN: Torque Name: TTRQ

Torque sensor LN.

Table 17 shows all data objects of TTRQ.

Table 17 – Data objects of TTRQ

TTRQ				
Data object name	**Common data class**	**T**	**Explanation**	**PresCond nds/ds**
Descriptions				
EEName	DPL		inherited from: EquipmentInterfaceLN	O / F
NamPlt	LPL		inherited from: DomainLN	O / O
Status information				
EEHealth	ENS (HealthKind)		inherited from: EquipmentInterfaceLN	O / F
OpTmh	INS		inherited from: EquipmentInterfaceLN	O / O
Blk	SPS		inherited from: FunctionLN	O / F
ClcExp	SPS	T	inherited from: StatisticsLN	O / O
Beh	ENS (BehaviourModeKind)		inherited from: DomainLN	M / M
Health	ENS (HealthKind)		inherited from: DomainLN	O / O
Mir	SPS		inherited from: DomainLN	MOcond(1) / MOcond(1)
Measured and metered values				
TorqSv	SAV		Torque (sampled value)	O / O
Controls				
ClcStr	SPC		inherited from: StatisticsLN	O / O
Mod	ENC (BehaviourModeKind)		inherited from: DomainLN	O / O
Settings				
SmpRte	ING		inherited from: SensorLN	O / F
BlkRef	ORG		inherited from: FunctionLN	Omulti / F
ClcMth	ENG (CalcMethodKind)		inherited from: StatisticsLN	O / M
ClcMod	ENG (CalcModeKind)		inherited from: StatisticsLN	O / O
ClcIntvTyp	ENG (CalcIntervalKind)		inherited from: StatisticsLN	O / O
ClcIntvPer	ING		inherited from: StatisticsLN	O / O
NumSubIntv	ING		inherited from: StatisticsLN	O / O
ClcRfTyp	ENG (CalcIntervalKind)		inherited from: StatisticsLN	O / O
ClcRfPer	ING		inherited from: StatisticsLN	O / O
ClcSrc	ORG		inherited from: StatisticsLN	F / M
ClcNxtTmms	ING		inherited from: StatisticsLN	O / O
InSyn	ORG		inherited from: StatisticsLN	O / O
InRef	ORG		inherited from: DomainLN	Omulti / Omulti

13.6.4 LN: UHF Sensor Name: TUHF

Table 18 shows all data objects of TUHF.

Table 18 – Data objects of TUHF

TUHF				
Data object name	**Common data class**	**T**	**Explanation**	**PresCond nds/ds**
Descriptions				
EEName	DPL		inherited from: EquipmentInterfaceLN	O / F
NamPlt	LPL		inherited from: DomainLN	O / O
Status information				
EEHealth	ENS (HealthKind)		inherited from: EquipmentInterfaceLN	O / F
OpTmh	INS		inherited from: EquipmentInterfaceLN	O / O
Blk	SPS		inherited from: FunctionLN	O / F
ClcExp	SPS	T	inherited from: StatisticsLN	O / O
Beh	ENS (BehaviourModeKind)		inherited from: DomainLN	M / M
Health	ENS (HealthKind)		inherited from: DomainLN	O / O
Mir	SPS		inherited from: DomainLN	MOcond(1) / MOcond(1)
Measured and metered values				
UhfSv	SAV		UHF signal	O / O
Controls				
ClcStr	SPC		inherited from: StatisticsLN	O / O
Mod	ENC (BehaviourModeKind)		inherited from: DomainLN	O / O
Settings				
SmpRte	ING		inherited from: SensorLN	O / F
BlkRef	ORG		inherited from: FunctionLN	Omulti / F
ClcMth	ENG (CalcMethodKind)		inherited from: StatisticsLN	O / M
ClcMod	ENG (CalcModeKind)		inherited from: StatisticsLN	O / O
ClcIntvTyp	ENG (CalcIntervalKind)		inherited from: StatisticsLN	O / O
ClcIntvPer	ING		inherited from: StatisticsLN	O / O
NumSubIntv	ING		inherited from: StatisticsLN	O / O
ClcRfTyp	ENG (CalcIntervalKind)		inherited from: StatisticsLN	O / O
ClcRfPer	ING		inherited from: StatisticsLN	O / O
ClcSrc	ORG		inherited from: StatisticsLN	F / M
ClcNxtTmms	ING		inherited from: StatisticsLN	O / O
InSyn	ORG		inherited from: StatisticsLN	O / O
InRef	ORG		inherited from: DomainLN	Omulti / Omulti

13.7 Logical nodes for power transformers (LNGroupY)

13.7.1 General

This group of logical nodes provides data needed to represent the power transformer and related switchgear equipment in the automation system. Note: These logical nodes are likely to be included in a later edition of IEC 61850-7-4. When published, logical nodes specified in IEC 61850-7-4 shall take precedence over definition here.

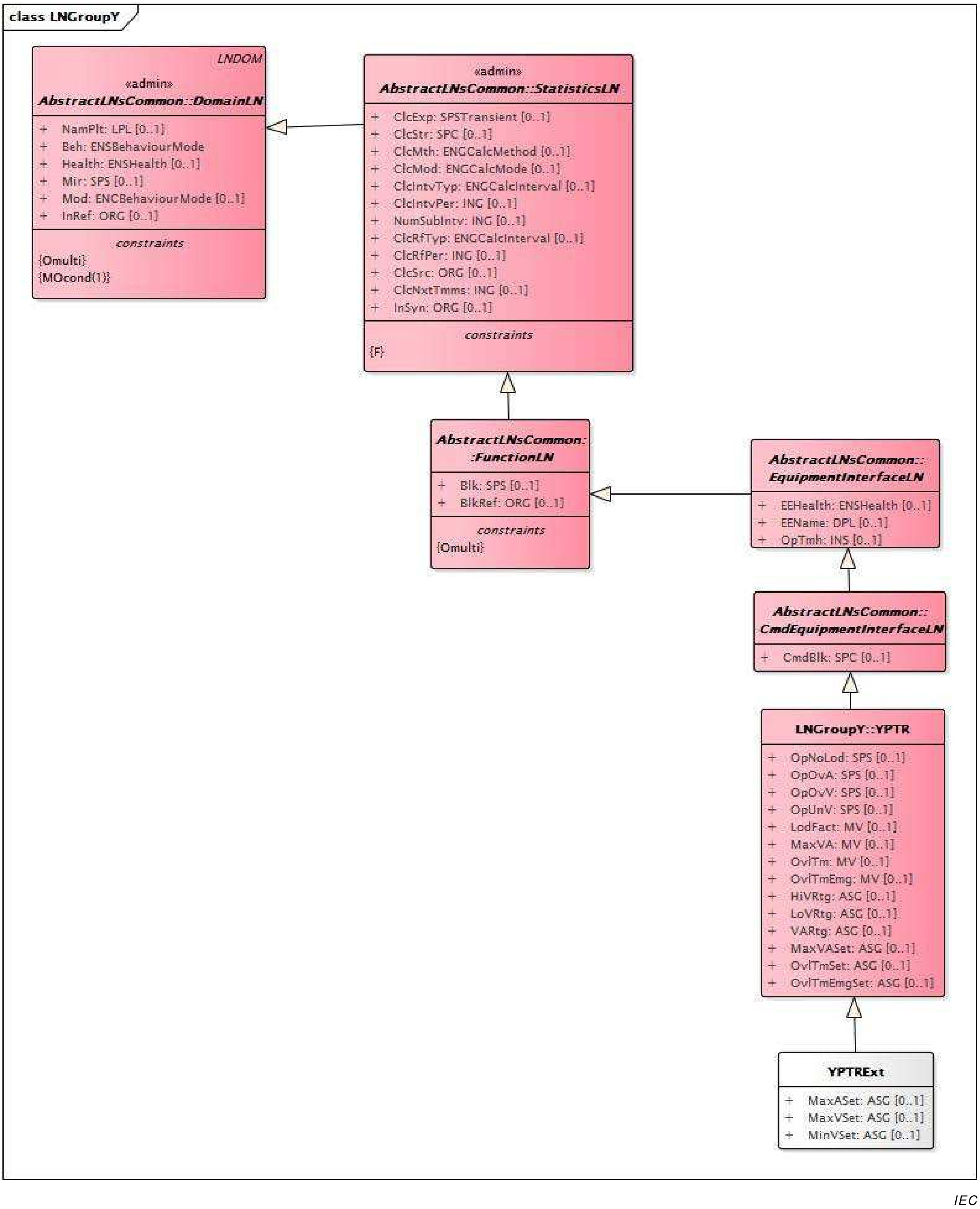


Figure 72 – Class diagram LNGroupY::LNGroupY

Figure 72 shows all concrete logical nodes of this group, with the supertypes that factor their common attributes.

13.7.2 LN: Power Transformer Supervision Name: YPTRExt

Set of information objects to extend the YPTR LN for modelling Power Transformer.

The "Ext" suffix attached to the LN name is only there for editorial purpose and is not present in the real model.

Table 19 shows all data objects of YPTRExt.

Table 19 – Data objects of YPTRExt

YPTRExt				
Data object name	**Common data class**	**T**	**Explanation**	**PresCond nds/ds**
Descriptions				
EEName	DPL		inherited from: EquipmentInterfaceLN	O / F
NamPlt	LPL		inherited from: DomainLN	O / O
Status information				
OpNoLod	SPS		inherited from: YPTR	O / F
OpOvA	SPS		inherited from: YPTR	O / F
OpOvV	SPS		inherited from: YPTR	O / F
OpUnV	SPS		inherited from: YPTR	O / F
EEHealth	ENS (HealthKind)		inherited from: EquipmentInterfaceLN	O / F
OpTmh	INS		inherited from: EquipmentInterfaceLN	O / O
Blk	SPS		inherited from: FunctionLN	O / F
ClcExp	SPS	T	inherited from: StatisticsLN	O / O
Beh	ENS (BehaviourModeKind)		inherited from: DomainLN	M / M
Health	ENS (HealthKind)		inherited from: DomainLN	O / O
Mir	SPS		inherited from: DomainLN	MOcond(1) / MOcond(1)
Measured and metered values				
LodFact	MV		inherited from: YPTR	O / O
MaxVA	MV		inherited from: YPTR	O / O
OvlTm	MV		inherited from: YPTR	O / O
OvlTmEmg	MV		inherited from: YPTR	O / O
Controls				
CmdBlk	SPC		inherited from: CmdEquipmentInterfaceLN	O / F
ClcStr	SPC		inherited from: StatisticsLN	O / O
Mod	ENC (BehaviourModeKind)		inherited from: DomainLN	O / O
Settings				
MaxASet	ASG		Maximum permissible current setting	O / F
MaxVSet	ASG		Maximum permissible voltage setting	O / F
MinVSet	ASG		Minimum permissible voltage setting	O / F
HiVRtg	ASG		inherited from: YPTR	O / F
LoVRtg	ASG		inherited from: YPTR	O / F
VARtg	ASG		inherited from: YPTR	O / F
MaxVASet	ASG		inherited from: YPTR	O / F
OvlTmSet	ASG		inherited from: YPTR	O / F
OvlTmEmgSet	ASG		inherited from: YPTR	O / F
BlkRef	ORG		inherited from: FunctionLN	Omulti / F
ClcMth	ENG (CalcMethodKind)		inherited from: StatisticsLN	O / M

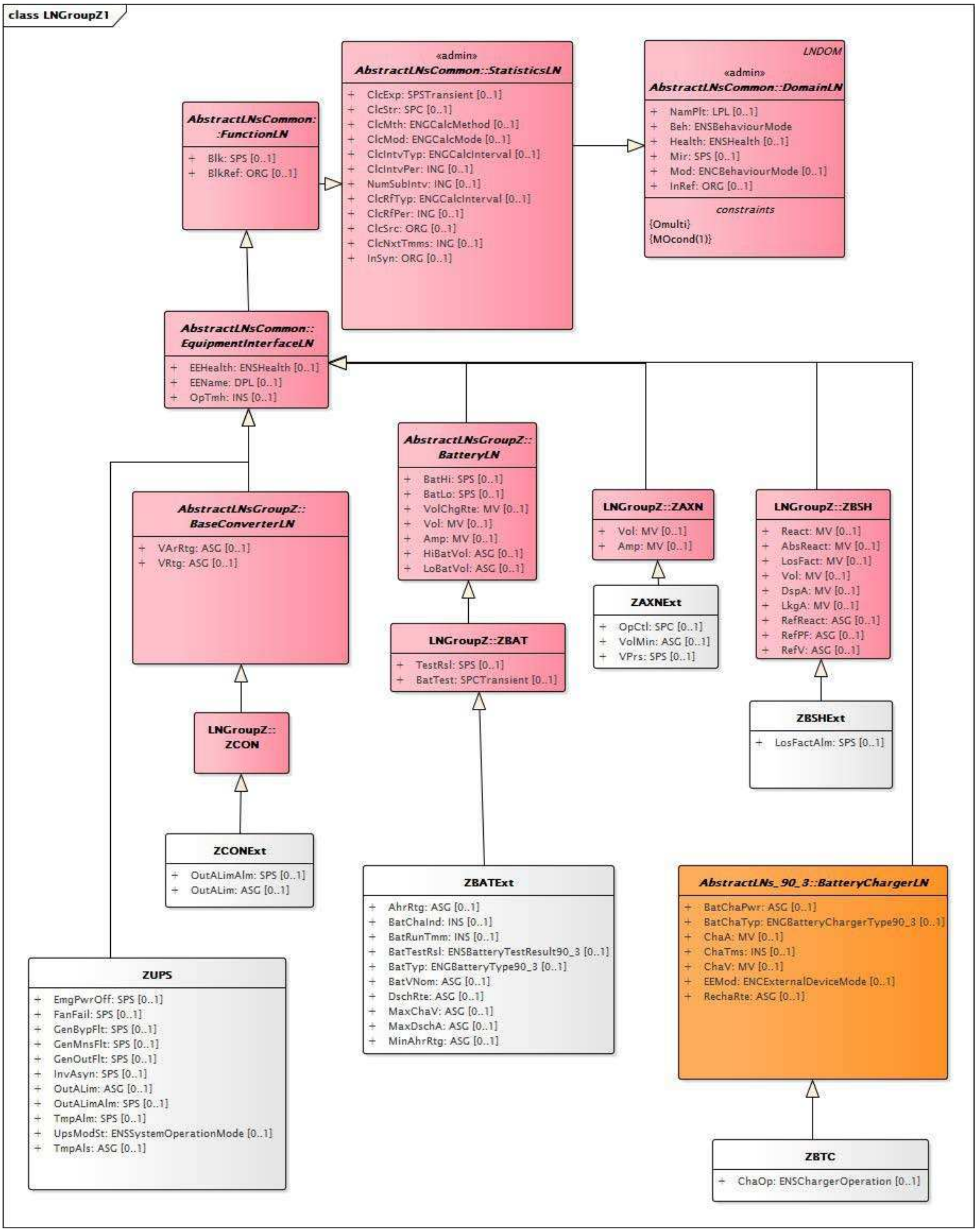
YPTRExt				
Data object name	**Common data class**	**T**	**Explanation**	**PresCond nds/ds**
ClcMod	ENG (CalcModeKind)		inherited from: StatisticsLN	O / O
ClcIntvTyp	ENG (CalcIntervalKind)		inherited from: StatisticsLN	O / O
ClcIntvPer	ING		inherited from: StatisticsLN	O / O
NumSubIntv	ING		inherited from: StatisticsLN	O / O
ClcRfTyp	ENG (CalcIntervalKind)		inherited from: StatisticsLN	O / O
ClcRfPer	ING		inherited from: StatisticsLN	O / O
ClcSrc	ORG		inherited from: StatisticsLN	F / M
ClcNxtTmms	ING		inherited from: StatisticsLN	O / O
InSyn	ORG		inherited from: StatisticsLN	O / O
InRef	ORG		inherited from: DomainLN	Omulti / Omulti

13.8 Logical nodes for further power system equipment (LNGroupZ)

13.8.1 General

This group of logical nodes refers all to power system objects which are reusable in other power systems domains but not modelled in other logical node groups of this standard.

NOTE These logical nodes are likely to be included in a later edition of IEC 61850-7-4. When published, logical nodes specified in IEC 61850-7-4 are to take precedence over the definition here.



IEC

Figure 73 – Class diagram LNGroupZ::LNGroupZ1

The diagram in Figure 73 shows class diagrams of LN group Z.

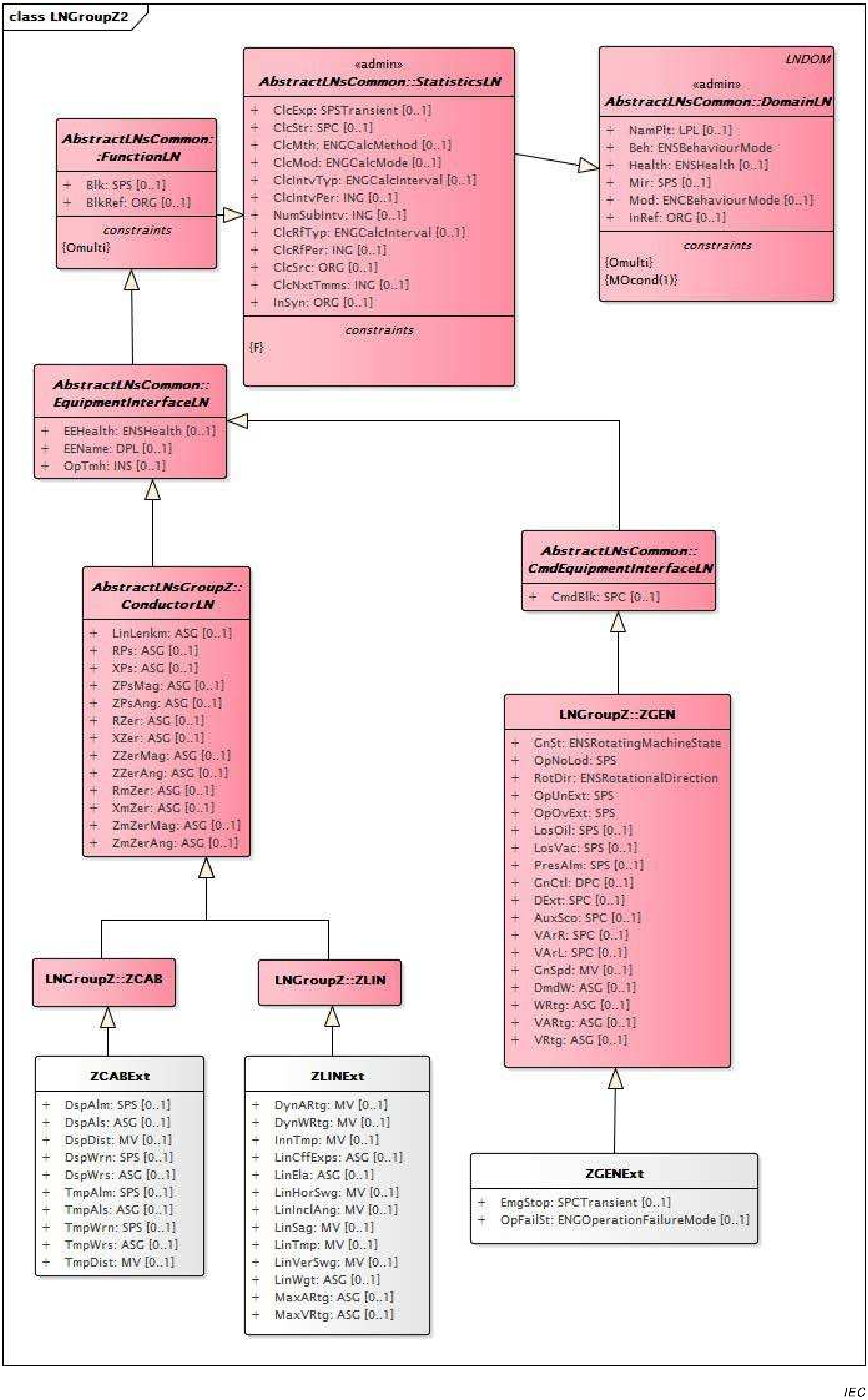


Figure 74 – Class diagram LNGroupZ::LNGroupZ2

Figure 74 shows the first part of the concrete logical nodes of this group, with the supertypes that factor their common attributes.

13.8.2 LN: Auxiliary network Name: ZAXNExt

Set of information objects to extend the ZAXN LN.

This logical node is used to model auxiliary networks, which belong to the power supply system of substations and other power systems installations.

The "Ext" suffix attached to the LN name is only there for editorial purpose and is not present in the real model

Table 20 shows all data objects of ZAXNExt.

Table 20 – Data objects of ZAXNExt

ZAXNExt				
Data object name	**Common data class**	**T**	**Explanation**	**PresCond nds/ds**
Descriptions				
EEName	DPL		inherited from: EquipmentInterfaceLN	O / F
NamPlt	LPL		inherited from: DomainLN	O / O
Status information				
VPrs	SPS		if true, indicate that Voltage has reached a level over the minimum threshold possibly defined in VolMin	O / F
EEHealth	ENS (HealthKind)		inherited from: EquipmentInterfaceLN	O / F
OpTmh	INS		inherited from: EquipmentInterfaceLN	O / O
Blk	SPS		inherited from: FunctionLN	O / F
ClcExp	SPS	T	inherited from: StatisticsLN	O / O
Beh	ENS (BehaviourModeKind)		inherited from: DomainLN	M / M
Health	ENS (HealthKind)		inherited from: DomainLN	O / O
Mir	SPS		inherited from: DomainLN	MOcond(1) / MOcond(1)
Measured and metered values				
Vol	MV		inherited from: ZAXN	O / O
Amp	MV		inherited from: ZAXN	O / O
Controls				
OpCtl	SPC		(controllable) If true, the interface to the considered auxiliary network is running, until stopped with value false. Its usage makes sense mostly in case of multiple auxiliary networks.	O / F
ClcStr	SPC		inherited from: StatisticsLN	O / O
Mod	ENC (BehaviourModeKind)		inherited from: DomainLN	O / O
Settings				
VolMin	ASG		Voltage threshold above which auxiliary network voltage is declared present.	O / F
BlkRef	ORG		inherited from: FunctionLN	Omulti / F
ClcMth	ENG (CalcMethodKind)		inherited from: StatisticsLN	O / M

ZAXNExt				
Data object name	**Common data class**	**T**	**Explanation**	**PresCond nds/ds**
ClcMod	ENG (CalcModeKind)		inherited from: StatisticsLN	O / O
ClcIntvTyp	ENG (CalcIntervalKind)		inherited from: StatisticsLN	O / O
ClcIntvPer	ING		inherited from: StatisticsLN	O / O
NumSubIntv	ING		inherited from: StatisticsLN	O / O
ClcRfTyp	ENG (CalcIntervalKind)		inherited from: StatisticsLN	O / O
ClcRfPer	ING		inherited from: StatisticsLN	O / O
ClcSrc	ORG		inherited from: StatisticsLN	F / M
ClcNxtTmms	ING		inherited from: StatisticsLN	O / O
InSyn	ORG		inherited from: StatisticsLN	O / O
InRef	ORG		inherited from: DomainLN	Omulti / Omulti

13.8.3 LN: Battery Name: ZBATExt

Set of information objects to extend the ZBAT LN.

This logical node is used to model batteries.

The "Ext" suffix attached to the LN name is only there for editorial purpose and is not present in the real model

Table 21 shows all data objects of ZBATExt.

Table 21 – Data objects of ZBATExt

ZBATExt				
Data object name	**Common data class**	**T**	**Explanation**	**PresCond nds/ds**
Descriptions				
EEName	DPL		inherited from: EquipmentInterfaceLN	O / F
NamPlt	LPL		inherited from: DomainLN	O / O
Status information				
BatChaInd	INS		Battery Charge level indicator (in % of A.h rating – AhrRtg)	O / O
BatRunTmm	INS		Expected battery remaining runtime. The expected battery remaining runtime is expected to be calculated by a vendor specific algorithm. Typically the calculation is based on the battery charger indication level and the battery drain current.	O / O
BatTestRsl	ENS (BatteryTestResult90-3Kind)		Battery test results	O / F
TestRsl	SPS		inherited from: ZBAT	O / F
BatHi	SPS		inherited from: BatteryLN	O / F
BatLo	SPS		inherited from: BatteryLN	O / F
EEHealth	ENS (HealthKind)		inherited from: EquipmentInterfaceLN	O / F
OpTmh	INS		inherited from: EquipmentInterfaceLN	O / O

ZBATExt				
Data object name	**Common data class**	**T**	**Explanation**	**PresCond nds/ds**
Blk	SPS		inherited from: FunctionLN	O / F
ClcExp	SPS	T	inherited from: StatisticsLN	O / O
Beh	ENS (BehaviourModeKind)		inherited from: DomainLN	M / M
Health	ENS (HealthKind)		inherited from: DomainLN	O / O
Mir	SPS		inherited from: DomainLN	MOcond(1) / MOcond(1)
Measured and metered values				
VolChgRte	MV		inherited from: BatteryLN	O / O
Vol	MV		inherited from: BatteryLN	O / O
Amp	MV		inherited from: BatteryLN	O / O
Controls				
BatTest	SPC	T	inherited from: ZBAT	O / F
ClcStr	SPC		inherited from: StatisticsLN	O / O
Mod	ENC (BehaviourModeKind)		inherited from: DomainLN	O / O
Settings				
AhrRtg	ASG		Amp-hour capacity rating setting (in Ah)	O / F
BatTyp	ENG (BatteryType90_3Kind)		Type of battery	O / F
BatVNom	ASG		Nominal voltage of battery	O / F
DschRte	ASG		Self discharge rate	O / F
MaxChaV	ASG		Maximum battery charge voltage rating.	O / F
MaxDschA	ASG		Maximum battery discharge current rating.	O / F
MinAhrRtg	ASG		Setting representing the minimum resting amp.hour capacity rating allowed (in A.h)	O / F
HiBatVol	ASG		inherited from: BatteryLN	O / F
LoBatVol	ASG		inherited from: BatteryLN	O / F
BlkRef	ORG		inherited from: FunctionLN	Omulti / F
ClcMth	ENG (CalcMethodKind)		inherited from: StatisticsLN	O / M
ClcMod	ENG (CalcModeKind)		inherited from: StatisticsLN	O / O
ClcIntvTyp	ENG (CalcIntervalKind)		inherited from: StatisticsLN	O / O
ClcIntvPer	ING		inherited from: StatisticsLN	O / O
NumSubIntv	ING		inherited from: StatisticsLN	O / O
ClcRfTyp	ENG (CalcIntervalKind)		inherited from: StatisticsLN	O / O
ClcRfPer	ING		inherited from: StatisticsLN	O / O
ClcSrc	ORG		inherited from: StatisticsLN	F / M
ClcNxtTmms	ING		inherited from: StatisticsLN	O / O
InSyn	ORG		inherited from: StatisticsLN	O / O
InRef	ORG		inherited from: DomainLN	Omulti / Omulti

13.8.4 LN: Bushing Name: ZBSHExt

Set of information objects to extend the ZBSH LN.

This logical node is used to model bushing.

The "Ext" suffix attached to the LN name is only there for editorial purpose and is not present in the real model.

Table 22 shows all data objects of ZBSHExt.

Table 22 – Data objects of ZBSHExt

ZBSHExt				
Data object name	**Common data class**	**T**	**Explanation**	**PresCond nds/ds**
Descriptions				
EEName	DPL		inherited from: EquipmentInterfaceLN	O / F
NamPlt	LPL		inherited from: DomainLN	O / O
Status information				
LosFactAlm	SPS		if true, the loss factor (tan delta) has reached a predefined threshold	O / F
EEHealth	ENS (HealthKind)		inherited from: EquipmentInterfaceLN	O / F
OpTmh	INS		inherited from: EquipmentInterfaceLN	O / O
Blk	SPS		inherited from: FunctionLN	O / F
ClcExp	SPS	T	inherited from: StatisticsLN	O / O
Beh	ENS (BehaviourModeKind)		inherited from: DomainLN	M / M
Health	ENS (HealthKind)		inherited from: DomainLN	O / O
Mir	SPS		inherited from: DomainLN	MOcond(1) / MOcond(1)
Measured and metered values				
React	MV		inherited from: ZBSH	O / O
AbsReact	MV		inherited from: ZBSH	O / O
LosFact	MV		inherited from: ZBSH	O / O
Vol	MV		inherited from: ZBSH	O / O
DspA	MV		inherited from: ZBSH	O / O
LkgA	MV		inherited from: ZBSH	O / O
Controls				
ClcStr	SPC		inherited from: StatisticsLN	O / O
Mod	ENC (BehaviourModeKind)		inherited from: DomainLN	O / O
Settings				
RefReact	ASG		inherited from: ZBSH	O / F
RefPF	ASG		inherited from: ZBSH	O / F
RefV	ASG		inherited from: ZBSH	O / F
BlkRef	ORG		inherited from: FunctionLN	Omulti / F
ClcMth	ENG (CalcMethodKind)		inherited from: StatisticsLN	O / M
ClcMod	ENG (CalcModeKind)		inherited from: StatisticsLN	O / O

ZBSHExt				
Data object name	**Common data class**	**T**	**Explanation**	**PresCond nds/ds**
ClcIntvTyp	ENG (CalcIntervalKind)		inherited from: StatisticsLN	O / O
ClcIntvPer	ING		inherited from: StatisticsLN	O / O
NumSubIntv	ING		inherited from: StatisticsLN	O / O
ClcRfTyp	ENG (CalcIntervalKind)		inherited from: StatisticsLN	O / O
ClcRfPer	ING		inherited from: StatisticsLN	O / O
ClcSrc	ORG		inherited from: StatisticsLN	F / M
ClcNxtTmms	ING		inherited from: StatisticsLN	O / O
InSyn	ORG		inherited from: StatisticsLN	O / O
InRef	ORG		inherited from: DomainLN	Omulti / Omulti

13.8.5 LN: Battery Charger Name: ZBTC

General purpose Battery Charger (mostly to be used in conjunction with ZBAT) as the charger associated to a battery modelled with ZBAT

Table 23 shows all data objects of ZBTC.

Table 23 – Data objects of ZBTC

ZBTC				
Data object name	**Common data class**	**T**	**Explanation**	**PresCond nds/ds**
Descriptions				
EEName	DPL		inherited from: EquipmentInterfaceLN	O / F
NamPlt	LPL		inherited from: DomainLN	O / O
Status information				
ChaOp	ENS (ChargerOperationKind)		Current Battery Charging method	O / F
ChaTms	INS		inherited from: BatteryChargerLN	O / O
EEMod	ENS (ExternalDeviceModeKind)		inherited from: BatteryChargerLN	O / F
EEHealth	ENS (HealthKind)		inherited from: EquipmentInterfaceLN	O / F
OpTmh	INS		inherited from: EquipmentInterfaceLN	O / O
Blk	SPS		inherited from: FunctionLN	O / F
ClcExp	SPS	T	inherited from: StatisticsLN	O / O
Beh	ENS (BehaviourModeKind)		inherited from: DomainLN	M / M
Health	ENS (HealthKind)		inherited from: DomainLN	O / O
Mir	SPS		inherited from: DomainLN	MOcond(1) / MOcond(1)
Measured and metered values				
ChaA	MV		inherited from: BatteryChargerLN	O / O
ChaV	MV		inherited from: BatteryChargerLN	O / O

ZBTC				
Data object name	**Common data class**	**T**	**Explanation**	**PresCond nds/ds**
Controls				
ClcStr	SPC		inherited from: StatisticsLN	O / O
Mod	ENC (BehaviourModeKind)		inherited from: DomainLN	O / O
Settings				
BatChaPwr	ASG		inherited from: BatteryChargerLN	O / F
BatChaTyp	ENG (BatteryChargerType 90_3Kind)		inherited from: BatteryChargerLN	O / F
RechaRte	ASG		inherited from: BatteryChargerLN	O / F
BlkRef	ORG		inherited from: FunctionLN	Omulti / F
ClcMth	ENG (CalcMethodKind)		inherited from: StatisticsLN	O / M
ClcMod	ENG (CalcModeKind)		inherited from: StatisticsLN	O / O
ClcIntvTyp	ENG (CalcIntervalKind)		inherited from: StatisticsLN	O / O
ClcIntvPer	ING		inherited from: StatisticsLN	O / O
NumSubIntv	ING		inherited from: StatisticsLN	O / O
ClcRfTyp	ENG (CalcIntervalKind)		inherited from: StatisticsLN	O / O
ClcRfPer	ING		inherited from: StatisticsLN	O / O
ClcSrc	ORG		inherited from: StatisticsLN	F / M
ClcNxtTmms	ING		inherited from: StatisticsLN	O / O
InSyn	ORG		inherited from: StatisticsLN	O / O
InRef	ORG		inherited from: DomainLN	Omulti / Omulti

13.8.6 LN: Power cable Name: ZCABExt

Set of information objects to extend the ZCAB LN.

This logical node is used to model power cable.

The "Ext" suffix attached to the LN name is only there for editorial purpose and is not present in the real model

Table 24 shows all data objects of ZCABExt.

Table 24 – Data objects of ZCABExt

ZCABExt				
Data object name	**Common data class**	**T**	**Explanation**	**PresCond nds/ds**
Descriptions				
EEName	DPL		inherited from: EquipmentInterfaceLN	O / F
NamPlt	LPL		inherited from: DomainLN	O / O
Status information				
DspAlm	SPS		If true, the cable displacement has reached the alarm threshold defined by DspAlmSet	O / F
DspWrn	SPS		If true, the cable displacement has reached the warning threshold defined by DspWrnSet	O / F
TmpAlm	SPS		If true, the cable surface temperature has reached the alarm threshold defined by TmpAlmSet.	O / F
TmpWrn	SPS		If true, the cable surface temperature has reached the warning threshold defined by TmpWrnSet.	O / F
EEHealth	ENS (HealthKind)		inherited from: EquipmentInterfaceLN	O / F
OpTmh	INS		inherited from: EquipmentInterfaceLN	O / O
Blk	SPS		inherited from: FunctionLN	O / F
ClcExp	SPS	T	inherited from: StatisticsLN	O / O
Beh	ENS (BehaviourModeKind)		inherited from: DomainLN	M / M
Health	ENS (HealthKind)		inherited from: DomainLN	O / O
Mir	SPS		inherited from: DomainLN	MOcond(1) / MOcond(1)
Measured and metered values				
DspDist	MV		Cable displacement distribution (in m)	O / O
TmpDist	MV		Surface temperature distribution of the cable in (°C)	O / O
Controls				
ClcStr	SPC		inherited from: StatisticsLN	O / O
Mod	ENC (BehaviourModeKind)		inherited from: DomainLN	O / O
Settings				
DspAls	ASG		Threshold for alarm state of cable displacement (in m)	O / F
DspWrs	ASG		Threshold for warning state of displacement (in m).	O / F
TmpAls	ASG		Threshold for alarm state of cable surface temperature (in °C)	O / F
TmpWrs	ASG		Threshold for warning state of cable surface temperature (in °C)	O / F
LinLenkm	ASG		inherited from: ConductorLN	O / F
RPs	ASG		inherited from: ConductorLN	O / F
XPs	ASG		inherited from: ConductorLN	O / F
ZPsMag	ASG		inherited from: ConductorLN	O / F
ZPsAng	ASG		inherited from: ConductorLN	O / F
RZer	ASG		inherited from: ConductorLN	O / F
XZer	ASG		inherited from: ConductorLN	O / F
ZZerMag	ASG		inherited from: ConductorLN	O / F
ZZerAng	ASG		inherited from: ConductorLN	O / F

ZCABExt				
Data object name	**Common data class**	**T**	**Explanation**	**PresCond nds/ds**
RmZer	ASG		inherited from: ConductorLN	O / F
XmZer	ASG		inherited from: ConductorLN	O / F
ZmZerMag	ASG		inherited from: ConductorLN	O / F
ZmZerAng	ASG		inherited from: ConductorLN	O / F
BlkRef	ORG		inherited from: FunctionLN	Omulti / F
ClcMth	ENG (CalcMethodKind)		inherited from: StatisticsLN	O / M
ClcMod	ENG (CalcModeKind)		inherited from: StatisticsLN	O / O
ClcIntvTyp	ENG (CalcIntervalKind)		inherited from: StatisticsLN	O / O
ClcIntvPer	ING		inherited from: StatisticsLN	O / O
NumSubIntv	ING		inherited from: StatisticsLN	O / O
ClcRfTyp	ENG (CalcIntervalKind)		inherited from: StatisticsLN	O / O
ClcRfPer	ING		inherited from: StatisticsLN	O / O
ClcSrc	ORG		inherited from: StatisticsLN	F / M
ClcNxtTmms	ING		inherited from: StatisticsLN	O / O
InSyn	ORG		inherited from: StatisticsLN	O / O
InRef	ORG		inherited from: DomainLN	Omulti / Omulti

13.8.7 LN: Converter Name: ZCONExt

Set of information objects to extend the ZCON LN.

This logical node is used to model power converters.

The "Ext" suffix attached to the LN name is only there for editorial purpose and is not present in the real model.

Table 25 shows all data objects of ZCONExt.

Table 25 – Data objects of ZCONExt

ZCONExt				
Data object name	**Common data class**	**T**	**Explanation**	**PresCond nds/ds**
Descriptions				
EEName	DPL		inherited from: EquipmentInterfaceLN	O / F
NamPlt	LPL		inherited from: DomainLN	O / O
Status information				
OutALimAlm	SPS		If true, a predefined alarm limit for output current has been reached.	O / F
EEHealth	ENS (HealthKind)		inherited from: EquipmentInterfaceLN	O / F
OpTmh	INS		inherited from: EquipmentInterfaceLN	O / O
Blk	SPS		inherited from: FunctionLN	O / F
ClcExp	SPS	T	inherited from: StatisticsLN	O / O
Beh	ENS (BehaviourModeKind)		inherited from: DomainLN	M / M
Health	ENS (HealthKind)		inherited from: DomainLN	O / O
Mir	SPS		inherited from: DomainLN	MOcond(1) / MOcond(1)
Controls				
ClcStr	SPC		inherited from: StatisticsLN	O / O
Mod	ENC (BehaviourModeKind)		inherited from: DomainLN	O / O
Settings				
OutALim	ASG		Output current limit alarm set	O / F
VArRtg	ASG		inherited from: BaseConverterLN	O / F
VRtg	ASG		inherited from: BaseConverterLN	O / F
BlkRef	ORG		inherited from: FunctionLN	Omulti / F
ClcMth	ENG (CalcMethodKind)		inherited from: StatisticsLN	O / M
ClcMod	ENG (CalcModeKind)		inherited from: StatisticsLN	O / O
ClcIntvTyp	ENG (CalcIntervalKind)		inherited from: StatisticsLN	O / O
ClcIntvPer	ING		inherited from: StatisticsLN	O / O
NumSubIntv	ING		inherited from: StatisticsLN	O / O
ClcRfTyp	ENG (CalcIntervalKind)		inherited from: StatisticsLN	O / O
ClcRfPer	ING		inherited from: StatisticsLN	O / O
ClcSrc	ORG		inherited from: StatisticsLN	F / M
ClcNxtTmms	ING		inherited from: StatisticsLN	O / O
InSyn	ORG		inherited from: StatisticsLN	O / O
InRef	ORG		inherited from: DomainLN	Omulti / Omulti

13.8.8 LN: Generator Name: ZGENExt

Set of information objects to extend the ZGEN LN.

This logical node is used to model generators.

The "Ext" suffix attached to the LN name is only there for editorial purpose and is not present in the real model

Table 26 shows all data objects of ZGENExt.

Table 26 – Data objects of ZGENExt

ZGENExt				
Data object name	**Common data class**	**T**	**Explanation**	**PresCond nds/ds**
Descriptions				
EEName	DPL		inherited from: EquipmentInterfaceLN	O / F
NamPlt	LPL		inherited from: DomainLN	O / O
Status information				
GnSt	ENS (RotatingMachineStateKind)		inherited from: ZGEN	M / F
OpNoLod	SPS		inherited from: ZGEN	M / F
RotDir	ENS (RotationalDirectionKind)		inherited from: ZGEN	M / F
OpUnExt	SPS		inherited from: ZGEN	M / F
OpOvExt	SPS		inherited from: ZGEN	M / F
LosOil	SPS		inherited from: ZGEN	O / F
LosVac	SPS		inherited from: ZGEN	O / F
PresAlm	SPS		inherited from: ZGEN	O / F
EEHealth	ENS (HealthKind)		inherited from: EquipmentInterfaceLN	O / F
OpTmh	INS		inherited from: EquipmentInterfaceLN	O / O
Blk	SPS		inherited from: FunctionLN	O / F
ClcExp	SPS	T	inherited from: StatisticsLN	O / O
Beh	ENS (BehaviourModeKind)		inherited from: DomainLN	M / M
Health	ENS (HealthKind)		inherited from: DomainLN	O / O
Mir	SPS		inherited from: DomainLN	MOcond(1) / MOcond(1)
Measured and metered values				
GnSpd	MV		inherited from: ZGEN	O / O
Controls				
EmgStop	SPC	T	(controllable) Operating with value true initiates stopping the generator due to emergency issue; operating with value false is ignored. The change of its status value is a local issue.	O / F
GnCtl	DPC		inherited from: ZGEN	O / F
DExt	SPC		inherited from: ZGEN	O / F
AuxSco	SPC		inherited from: ZGEN	O / F
VArR	SPC		inherited from: ZGEN	O / F
VArL	SPC		inherited from: ZGEN	O / F
CmdBlk	SPC		inherited from: CmdEquipmentInterfaceLN	O / F
ClcStr	SPC		inherited from: StatisticsLN	O / O
Mod	ENC (BehaviourModeKind)		inherited from: DomainLN	O / O

ZGENExt				
Data object name	**Common data class**	**T**	**Explanation**	**PresCond nds/ds**
Settings				
OpFailSt	ENG (OperationFailureModeKind)		Operation failure mode state	O / F
DmdW	ASG		inherited from: ZGEN	O / F
WRtg	ASG		inherited from: ZGEN	O / F
VARtg	ASG		inherited from: ZGEN	O / F
VRtg	ASG		inherited from: ZGEN	O / F
BlkRef	ORG		inherited from: FunctionLN	Omulti / F
ClcMth	ENG (CalcMethodKind)		inherited from: StatisticsLN	O / M
ClcMod	ENG (CalcModeKind)		inherited from: StatisticsLN	O / O
ClcIntvTyp	ENG (CalcIntervalKind)		inherited from: StatisticsLN	O / O
ClcIntvPer	ING		inherited from: StatisticsLN	O / O
NumSubIntv	ING		inherited from: StatisticsLN	O / O
ClcRfTyp	ENG (CalcIntervalKind)		inherited from: StatisticsLN	O / O
ClcRfPer	ING		inherited from: StatisticsLN	O / O
ClcSrc	ORG		inherited from: StatisticsLN	F / M
ClcNxtTmms	ING		inherited from: StatisticsLN	O / O
InSyn	ORG		inherited from: StatisticsLN	O / O
InRef	ORG		inherited from: DomainLN	Omulti / Omulti

13.8.9 LN: Power overhead line Name: ZLINExt

Set of information objects to extend the ZLIN LN.

This logical node is used to model overhead line with all physical characteristics.

The "Ext" suffix attached to the LN name is only there for editorial purpose and is not present in the real model.

Table 27 shows all data objects of ZLINExt.

Table 27 – Data objects of ZLINExt

ZLINExt				
Data object name	**Common data class**	**T**	**Explanation**	**PresCond nds/ds**
Descriptions				
EEName	DPL		inherited from: EquipmentInterfaceLN	O / F
NamPlt	LPL		inherited from: DomainLN	O / O
Status information				
EEHealth	ENS (HealthKind)		inherited from: EquipmentInterfaceLN	O / F
OpTmh	INS		inherited from: EquipmentInterfaceLN	O / O
Blk	SPS		inherited from: FunctionLN	O / F
ClcExp	SPS	T	inherited from: StatisticsLN	O / O
Beh	ENS (BehaviourModeKind)		inherited from: DomainLN	M / M
Health	ENS (HealthKind)		inherited from: DomainLN	O / O
Mir	SPS		inherited from: DomainLN	MOcond(1) / MOcond(1)
Measured and metered values				
DynARtg	MV		Dynamic current rating of overhead line expressed as a percentage of the maximum current rating of the line MaxARtg (%) – Measured dynamic rating (calculated output)	O / O
DynWRtg	MV		Dynamic power rating of overhead line expressed as a percentage of the maximum power rating of the line (%). Measured dynamic rating (calculated output)	O / O
InnTmp	MV		Inner temperature of line (°C)	O / O
LinHorSwg	MV		Max degree of line horizontal swing (Degree) – measured swing	O / O
LinInclAng	MV		Overhead line inclination angle: (-90 to 90 degree)	O / O
LinSag	MV		Line sag of overhead line (m). Measured sag (calculated output)	O / O
LinTmp	MV		Overhead line temperature	O / O
LinVerSwg	MV		Max degree of line vertical swing (degree) – measured swing	O / O
Controls				
ClcStr	SPC		inherited from: StatisticsLN	O / O
Mod	ENC (BehaviourModeKind)		inherited from: DomainLN	O / O
Settings				
LinCffExps	ASG		Coefficient linear expansion (in 1/°C)	O / F
LinEla	ASG		Modulus of elasticity (in Pascal – Pa)	O / F
LinWgt	ASG		Line weight per m in kg/m	O / F
MaxARtg	ASG		Designed static maximum current rating (A)	O / F
MaxVRtg	ASG		Designed maximum voltage rating.	O / F
LinLenkm	ASG		inherited from: ConductorLN	O / F
RPs	ASG		inherited from: ConductorLN	O / F
XPs	ASG		inherited from: ConductorLN	O / F
ZPsMag	ASG		inherited from: ConductorLN	O / F
ZPsAng	ASG		inherited from: ConductorLN	O / F

ZLINExt				
Data object name	**Common data class**	**T**	**Explanation**	**PresCond nds/ds**
RZer	ASG		inherited from: ConductorLN	O / F
XZer	ASG		inherited from: ConductorLN	O / F
ZZerMag	ASG		inherited from: ConductorLN	O / F
ZZerAng	ASG		inherited from: ConductorLN	O / F
RmZer	ASG		inherited from: ConductorLN	O / F
XmZer	ASG		inherited from: ConductorLN	O / F
ZmZerMag	ASG		inherited from: ConductorLN	O / F
ZmZerAng	ASG		inherited from: ConductorLN	O / F
BlkRef	ORG		inherited from: FunctionLN	Omulti / F
ClcMth	ENG (CalcMethodKind)		inherited from: StatisticsLN	O / M
ClcMod	ENG (CalcModeKind)		inherited from: StatisticsLN	O / O
ClcIntvTyp	ENG (CalcIntervalKind)		inherited from: StatisticsLN	O / O
ClcIntvPer	ING		inherited from: StatisticsLN	O / O
NumSubIntv	ING		inherited from: StatisticsLN	O / O
ClcRfTyp	ENG (CalcIntervalKind)		inherited from: StatisticsLN	O / O
ClcRfPer	ING		inherited from: StatisticsLN	O / O
ClcSrc	ORG		inherited from: StatisticsLN	F / M
ClcNxtTmms	ING		inherited from: StatisticsLN	O / O
InSyn	ORG		inherited from: StatisticsLN	O / O
InRef	ORG		inherited from: DomainLN	Omulti / Omulti

13.8.10 LN: UPS (Uninterruptable Power Supply) Name: ZUPS

Table 28 shows all data objects of ZUPS.

Table 28 – Data objects of ZUPS

ZUPS				
Data object name	**Common data class**	**T**	**Explanation**	**PresCond nds/ds**
Descriptions				
EEName	DPL		inherited from: EquipmentInterfaceLN	O / F
NamPlt	LPL		inherited from: DomainLN	O / O
Status information				
EmgPwrOff	SPS		If true, the function current status is Emergency Power Off (EPO) state, i.e has been requested to power off.	O / F
FanFail	SPS		If true, a failure related to UPS fans is occurring, otherwise false	O / F
GenBypFlt	SPS		If true, a General Bypass fault is occurring, otherwise is false	O / F
GenMnsFlt	SPS		If true, a General Mains fault is occurring, otherwise is false	O / F
GenOutFlt	SPS		If true, a General Output fault is occurring, otherwise is false	O / F
InvAsyn	SPS		if true UPS Inverter is running asynchronously, otherwise is false	O / F
OutALimAlm	SPS		If true, a predefined alarm limit of the output current has been reached	O / F
TmpAlm	SPS		If true, a predefined alarm level for the UPS temperature defined in OvTmpAls has been reached	O / F
UpsModSt	ENS (SystemOperationModeKind)		System operation mode status	O / F
EEHealth	ENS (HealthKind)		inherited from: EquipmentInterfaceLN	O / F
OpTmh	INS		inherited from: EquipmentInterfaceLN	O / O
Blk	SPS		inherited from: FunctionLN	O / F
ClcExp	SPS	T	inherited from: StatisticsLN	O / O
Beh	ENS (BehaviourModeKind)		inherited from: DomainLN	M / M
Health	ENS (HealthKind)		inherited from: DomainLN	O / O
Mir	SPS		inherited from: DomainLN	MOcond(1) / MOcond(1)
Controls				
ClcStr	SPC		inherited from: StatisticsLN	O / O
Mod	ENC (BehaviourModeKind)		inherited from: DomainLN	O / O
Settings				
OutALim	ASG		Maximum output current threshold limit for alarm	O / F
TmpAls	ASG		Maximum temperature alarm threshold for alarm (in °C)	O / F
BlkRef	ORG		inherited from: FunctionLN	Omulti / F
ClcMth	ENG (CalcMethodKind)		inherited from: StatisticsLN	O / M
ClcMod	ENG (CalcModeKind)		inherited from: StatisticsLN	O / O
ClcIntvTyp	ENG (CalcIntervalKind)		inherited from: StatisticsLN	O / O

ZUPS				
Data object name	Common data class	T	Explanation	PresCond nds/ds
ClcIntvPer	ING		inherited from: StatisticsLN	O / O
NumSubIntv	ING		inherited from: StatisticsLN	O / O
ClcRfTyp	ENG (CalcIntervalKind)		inherited from: StatisticsLN	O / O
ClcRfPer	ING		inherited from: StatisticsLN	O / O
ClcSrc	ORG		inherited from: StatisticsLN	F / M
ClcNxtTmms	ING		inherited from: StatisticsLN	O / O
InSyn	ORG		inherited from: StatisticsLN	O / O
InRef	ORG		inherited from: DomainLN	Omulti / Omulti

14 Data object name semantics and enumerations

14.1 Data semantics

Table 29 shows all attributes defined on classes of LogicalNodes_90_3 package.

Table 29 – Attributes defined on classes of LogicalNodes_90_3 package

Name	Type	(Used in) Description
AbrPrtAlm	SPS	(SLTCExt) If true, the predefined level alarm limit AbrPrtAls for the Abrasion of parts has been reached.
AbrPrtAls	ASG	(SLTCExt) Abrasion of parts (in %) threshold setting for alarm
AbrPrtWrn	SPS	(SLTCExt) If true, the predefined level warning limit AbrPrtWrs for the Abrasion of parts has been reached.
AbrPrtWrs	ASG	(SLTCExt) Abrasion of parts (in %) threshold setting for warning
AccmTmh	BCR	(SCBRExt) Cumulated time in Hours of current through trip or reclose coil
AhrRtg	ASG	(ZBATExt) Amp-hour capacity rating setting (in Ah)
ArcTm	MV	(SCBRExt) Arc duration time
BaseInclAng	MV	(KTOW) Ground base inclination angle: 0 -90 degree
BatChaInd	INS	(ZBATExt) Battery Charge level indicator (in % of A.h rating – AhrRtg)
BatChaPwr	ASG	(BatteryChargerLN) Battery charging power required
BatChaTyp	ENG (BatteryChargerType90_3Kind)	(BatteryChargerLN) Type of battery charger:
BatEF	SPS	(SBAT) If true, Battery Earth Fault is present
BatRunTmm	INS	(ZBATExt) Expected battery remaining runtime. The expected battery remaining runtime is expected to be calculated by a vendor specific algorithm. Typically the calculation is based on the battery charger indication level and the battery drain current.
BatTestRsl	ENS (BatteryTestResult90-3Kind)	(ZBATExt) Battery test results
BatTyp	ENG (BatteryType90_3Kind)	(ZBATExt) Type of battery
BatVNom	ASG	(ZBATExt) Nominal voltage of battery
BubTmp	MV	(SSTP) Bubbling temperature (in °C)

Name	Type	(Used in) Description
BubTmpAlm	SPS	(SSTP) If true, the predefined level alarm limit BubTmpAls for the bubbling temperature has been reached.
BubTmpAls	ASG	(SSTP) Bubbling Temperature alarm threshold setting (in °C)
BubTmpMrg	MV	(SSTP) Bubbling temperature margin (in °C)
BubTmpMrgAlm	SPS	(SSTP) If true, the Bubbling temperature margin alarm threshold defined in BubTmpMrgAls has been reached.
BubTmpMrgAls	ASG	(SSTP) Bubbling temperature margin Alarm threshold setting (in °C)
C2H2Alm	SPS	(SIMLExt) If true, a predefined level limit of C2H2 for the insulation medium has been reached (for example, low insulation level). Setting of the predefined level limit is a local issue. The action to take may be to refill the insulation medium.
C2H2Als	ASG	(SIMLExt) C2H2 alarm setting in ppm
C2H2RteAlm	SPS	(SIMLExt) If true, a predefined level limit of C2H2 rate of change for the insulation medium has been reached (for example, low insulation level). Setting of the predefined level limit is a local issue. The action to take may be to refill the insulation medium.
C2H2RteAls	ASG	(SIMLExt) C2H2 rate of change alarm setting in ppm/s
C2H4Alm	SPS	(SIMLExt) If true, a predefined level limit of C2H4 for the insulation medium has been reached (for example, low insulation level). Setting of the predefined level limit is a local issue. The action to take may be to refill the insulation medium.
C2H4Als	ASG	(SIMLExt) C2H4 alarm setting in ppm
C2H4RteAlm	SPS	(SIMLExt) If true, a predefined level limit of C2H4 rate of change for the insulation medium has been reached (for example, low insulation level). Setting of the predefined level limit is a local issue. The action to take may be to refill the insulation medium.
C2H4RteAls	ASG	(SIMLExt) C2H4 rate of change alarm setting in ppm/s
C2H6Alm	SPS	(SIMLExt) If true, a predefined level limit of C2H6 for the insulation medium has been reached (for example, low insulation level). Setting of the predefined level limit is a local issue. The action to take may be to refill the insulation medium.
C2H6Als	ASG	(SIMLExt) C2H6 alarm setting in ppm
C2H6RteAlm	SPS	(SIMLExt) If true, a predefined level limit of C2H6 rate of change for the insulation medium has been reached (for example, low insulation level). Setting of the predefined level limit is a local issue. The action to take may be to refill the insulation medium.
C2H6RteAls	ASG	(SIMLExt) C2H6 rate of change alarm setting in ppm/s
CH4Alm	SPS	(SIMLExt) If true, a predefined level limit of CH4 for the insulation medium has been reached (for example, low insulation level). Setting of the predefined level limit is a local issue. The action to take may be to refill the insulation medium.
CH4Als	ASG	(SIMLExt) CH4 alarm setting in ppm
CH4RteAlm	SPS	(SIMLExt) If true, a predefined level limit of CH4 rate of change for the insulation medium has been reached (for example, low insulation level). Setting of the predefined level limit is a local issue. The action to take may be to refill the insulation medium.
CH4RteAls	ASG	(SIMLExt) CH4 rate of change alarm setting in ppm/s
CO2Alm	SPS	(SIMLExt) If true, a predefined level limit of CO2 for the insulation medium has been reached (for example, low insulation level). Setting of the predefined level limit is a local issue. The action to take may be to refill the insulation medium.
CO2Als	ASG	(SIMLExt) CO2 alarm setting in ppm
CO2RteAlm	SPS	(SIMLExt) If true, a predefined level limit of CO2 ROC or the insulation medium has been reached (for example, low insulation level). Setting of the predefined level limit is a local issue. The action to take may be to refill the insulation medium.
CO2RteAls	ASG	(SIMLExt) CO2 Rate of change alarm setting in ppm/s

Name	Type	(Used in) Description
COAlm	SPS	(SIMLExt) If true, a predefined level limit of CO for the insulation medium has been reached (for example, low insulation level). Setting of the predefined level limit is a local issue. The action to take may be to refill the insulation medium.
COAls	ASG	(SIMLExt) CO alarm setting in ppm
CORteAlm	SPS	(SIMLExt) If true, a predefined level limit of CO rate of change for the insulation medium has been reached (for example, low insulation level). Setting of the predefined level limit is a local issue. The action to take may be to refill the insulation medium.
CORteAls	ASG	(SIMLExt) CO Rate of change alarm setting in ppm/s
CdsTmp	MV	(SSTP) Condensation temperature (in °C)
CdsTmpAlm	SPS	(SSTP) If true, Water condensation temperature has reached the alarm threshold defined in CdsTmpAls
CdsTmpAls	ASG	(SSTP) Condensation temperature alarm threshold setting (in °C)
CgAlm	SPS	(SIMLExt) If true, a predefined level limit of Total Dissolved Combustible Gases for the insulation medium has been reached (for example, low insulation level). Setting of the predefined level limit is a local issue. The action to take may be to refill the insulation medium.
CgAls	ASG	(SIMLExt) Total dissolved combustible gases (TDCG) alarm setting in ppm
CgRte	MV	(SIMLExt) Rate of change of total dissolved combustible gases (TDCG) (in ppm/s)
CgRteAlm	SPS	(SIMLExt) If true, a predefined level limit of Total Dissolved Gases rate of change for the insulation medium has been reached (for example, low insulation level). The action to take may be to refill the insulation medium.
CgRteAls	ASG	(SIMLExt) Alarm threshold for the rate of change of Total Dissolved Combustible Gas (in ppm/s)
CgRteWrn	SPS	(SIMLExt) If true, a predefined warning level of Total Dissolved Gases rate of change for the insulation medium has been reached (for example, low insulation level). The action to take may be to refill the insulation medium.
CgRteWrs	ASG	(SIMLExt) Warning threshold for the rate of change of Total Dissolved Combustible Gas (in ppm/s)
CgWrn	SPS	(SIMLExt) If true, a predefined warning level limit of Total Dissolved Combustible Gases for the insulation medium has been reached
CgWrs	ASG	(SIMLExt) Warning threshold setting for the Total Dissolved Combustible gas (TDCG) in ppm
ChaA	MV	(BatteryChargerLN) Charging current
ChaOp	ENS (ChargerOperationKind)	(ZBTC) Current Battery Charging method
ChaTms	INS	(BatteryChargerLN) Charging time since last off/reset (in second)
ChaV	MV	(BatteryChargerLN) Charging voltage
ClPres	MV	(SCGR) Generator coolant pressure
ClPresAlm	SPS	(SCGR) If true, a predefined alarm level of the pressure of the generator coolant has been reached
ClPresAls	ASG	(SCGR) Alarm threshold setting for the Generator coolant pressure
ClTmp	MV	(SCGR) Generator coolant temperature in °C
ClTmpAlm	SPS	(SCGR) if true, a predefined alarm level of the temperature of the generator coolant has been reached
ClTmpAls	ASG	(SCGR) Alarm threshold setting for the Generator coolant temperature (in °C)
CmbuGasRte	MV	(SIMLExt) Rate of change of total dissolved combustible gas (in m3/s)
ColV	MV	(SCBRExt) Control voltage of coil

Name	Type	(Used in) Description
CumEqAgeTmh	INS	(SEAM) Cumulative equivalent aging (in hours)
DenSv	SAV	(TDEN) Density (mol/L) Sample Value This type of sampled value holds gas density.
DschRte	ASG	(ZBATExt) Self discharge rate
DspAlm	SPS	(ZCABExt) If true, the cable displacement has reached the alarm threshold defined by DspAlmSet
DspAls	ASG	(ZCABExt) Threshold for alarm state of cable displacement (in m)
DspDist	MV	(ZCABExt) Cable displacement distribution (in m)
DspWrn	SPS	(ZCABExt) If true, the cable displacement has reached the warning threshold defined by DspWrnSet
DspWrs	ASG	(ZCABExt) Threshold for warning state of displacement (in m).
DynARtg	MV	(ZLINExt) Dynamic current rating of overhead line expressed as a percentage of the maximum current rating of the line MaxARtg (%) – Measured dynamic rating (calculated output)
DynWRtg	MV	(ZLINExt) Dynamic power rating of overhead line expressed as a percentage of the maximum power rating of the line (%). Measured dynamic rating (calculated output)
EEMod	ENS (ExternalDevice ModeKind)	(BatteryChargerLN) (controllable) Battery charger (external device) functioning mode
EmgPwrOff	SPS	(ZUPS) If true, the function current status is Emergency Power Off (EPO) state, i.e has been requested to power off.
EmgStop	SPC (T)	(ZGENExt) (controllable) Operating with value true initiates stopping the generator due to emergency issue; operating with value false is ignored. The change of its status value is a local issue.
FanFail	SPS	(ZUPS) If true, a failure related to UPS fans is occurring, otherwise false
FilCnt	INS	(SLTCExt) Oil Filtration counter
FilCntAlm	SPS	(SLTCExt) If true, the predefined level alarm limit FilCntAls for the oil filtration counter has been reached.
FilCntAls	ING	(SLTCExt) Oil filtration counts threshold setting for alarm
FilCntWrn	SPS	(SLTCExt) If true, the predefined level warning limit FilCntWrs for the oil filtration counter has been reached.
FilCntWrs	ING	(SLTCExt) Oil filtration counts threshold setting for warning
FireAlm	SPS	(SFIR) If true, a Fire alarm is occurring, otherwise no fire
FltGasAlm	SPS	(SIMLExt) If true, a predefined level alarm limit FltGasAls of fault gas in Buchholz relay has been reached
FltGasAls	ASG	(SIMLExt) Alarm threshold setting for Fault Gas volume in BuchHolz relay (in m3)
FltGasRte	MV	(SIMLExt) Rate of increase of fault gas volume in Buchholz relay (m3/s)
FltGasRteAlm	SPS	(SIMLExt) If true, a predefined alarm level RteFGAlmSet of fault gas rate in Buchholz relay been reached
FltGasRteAls	ASG	(SIMLExt) Alarm threshold setting for the rate of increase of Fault Gas volume in Bucholz relay
FullGas	MV	(SIMLExt) Overall dissolved gas (in m3)
FullGasRte	MV	(SIMLExt) Rate of increase of overall dissolved gas (m3/s)
GenBypFlt	SPS	(ZUPS) If true, a General Bypass fault is occurring, otherwise is false
GenMnsFlt	SPS	(ZUPS) If true, a General Mains fault is occurring, otherwise is false
GenOutFlt	SPS	(ZUPS) If true, a General Output fault is occurring, otherwise is false
H2Als	ASG	(SIMLExt) H2 alarm setting in ppm

Name	Type	(Used in) Description
H2RteAlm	SPS	(SIMLExt) If true, a predefined level limit of H2 rate of change for the insulation medium has been reached (for example, low insulation level). Setting of the predefined level limit is a local issue. The action to take may be to refill the insulation medium.
H2RteAls	ASG	(SIMLExt) H2 Rate of change alarm setting in ppm/s
IceCvr	MV	(MMETExt) Ice cover in weight (kg)
InnTmp	MV	(ZLINExt) Inner temperature of line (°C)
IntnBatA	MV	(SBAT) Internal Battery current
IntnBatTmp	MV	(SBAT) Battery internal temperature (in °C)
IntnBatV	MV	(SBAT) Internal battery voltage
IntnTmpAlm	SPS	(SBAT) If true, a predefined threshold for the battery internal temperature as defined in IntnTmpAls has been reached.
IntnTmpAls	ASG	(SBAT) Internal battery temperature alarm threshold setting (in °C)
InvAsyn	SPS	(ZUPS) if true UPS Inverter is running asynchronously, otherwise is false
LevHlfSet	ASG	(KTNKExt) Half level threshold setting for alarm (in m3)
LevHlfSt	SPS	(KTNKExt) if true, the level of the tank is above a predefined Half level threshold, otherwise is false.
LevMaxAlm	SPS	(KTNKExt) If true, a predefined alarm level of the maximum level of the tank has been reached
LevMaxAls	ASG	(KTNKExt) Maximum level threshold setting for alarm (in m3)
LevMinAlm	SPS	(KTNKExt) If true, a predefined alarm level of the maximum level of the tank has been reached, and the level is below the threshold, otherwise false
LevMinAls	ASG	(KTNKExt) Minimum level threshold setting for alarm (in m3)
LinCffExps	ASG	(ZLINExt) Coefficient linear expansion (in 1/°C)
LinEla	ASG	(ZLINExt) Modulus of elasticity (in Pascal – Pa)
LinHorSwg	MV	(ZLINExt) Max degree of line horizontal swing (Degree) – measured swing
LinInclAng	MV	(ZLINExt) Overhead line inclination angle: (-90 to 90 degree)
LinSag	MV	(ZLINExt) Line sag of overhead line (m). Measured sag (calculated output)
LinTmp	MV	(ZLINExt) Overhead line temperature
LinVerSwg	MV	(ZLINExt) Max degree of line vertical swing (degree) – measured swing
LinWgt	ASG	(ZLINExt) Line weight per m in kg/m
LosAng	MV	(SIMS) Tangent of loss angle of the monitored cable (no unit)
LosAngAlm	SPS	(SIMS) If true, the predefined level alarm limit LosAngAls for the tangent of loss angle of the monitored cable has been reached
LosAngAls	ASG	(SIMS) Threshold for alarm state of the tangent of loss angle (no unit)
LosAngWrn	SPS	(SIMS) If true, the predefined level warning limit LosAngWrs for the tangent of loss angle of the monitored cable has been reached
LosAngWrs	ASG	(SIMS) Threshold for warning state of the tangent of loss angle (no unit)
LosFactAlm	SPS	(ZBSHExt) if true, the loss factor (tan delta) has reached a predefined threshold
MaxARtg	ASG	(ZLINExt) Designed static maximum current rating (A)
MaxASet	ASG	(YPTRExt) Maximum permissible current setting
MaxChaV	ASG	(ZBATExt) Maximum battery charge voltage rating.
MaxDschA	ASG	(ZBATExt) Maximum battery discharge current rating.
MaxVRtg	ASG	(ZLINExt) Designed maximum voltage rating.
MaxVSet	ASG	(YPTRExt) Maximum permissible voltage setting

Name	Type	(Used in) Description
MdAAlm	SPS	(SLTCExt) If true, the predefined level alarm limit MdAAls for the motor drive current has been reached.
MdAAls	ASG	(SLTCExt) Motor drive Currant alarm threshold setting
MdAWrn	SPS	(SLTCExt) If true, the predefined level warning limit MdAWrs for the motor drive current has been reached.
MdAWrs	ASG	(SLTCExt) Motor drive current threshold setting for warning
MinAhrRtg	ASG	(ZBATExt) Setting representing the minimum resting amp.hour capacity rating allowed (in A.h)
MinVSet	ASG	(YPTRExt) Minimum permissible voltage setting
MotTr	SPS (T)	(SLTCExt) Trip of Load tap changer Motor protection
Mst	MV	(SIMLExt) Measured amount of moisture in the insulating liquid in ppm
MstAgeAcc	MV	(SEAM) Moisture aging acceleration factor ("none" unit)
MstAls	ASG	(SIMLExt) Moisture alarm threshold setting in ppm
MstBarAlm	SPS	(SSTP) if true, Moisture content in barrier has reached an alarming level
MstOil	MV	(SSTP) Moisture content in oil (in ppm)
MstPapWnd	MV	(SSTP) Moisture content in winding paper (in ppm)
MstRteAlm	SPS	(SIMLExt) If true, a predefined level limit of Moisture rate of change for the insulation medium has been reached (for example, low insulation level). The action to take may be to refill the insulation medium.
MstRteAls	ASG	(SIMLExt) Moisture rate of change alarm threshold setting in ppm/s
N2Alm	SPS	(SIMLExt) If true, a predefined level limit of N2 for the insulation medium has been reached (for example, low insulation level). Setting of the predefined level limit is a local issue. The action to take may be to refill the insulation medium.
N2Als	ASG	(SIMLExt) N2 alarm setting in ppm
N2RteAlm	SPS	(SIMLExt) If true, a predefined level limit of N2 rate of change for the insulation medium has been reached (for example, low insulation level). Setting of the predefined level limit is a local issue. The action to take may be to refill the insulation medium.
N2RteAls	ASG	(SIMLExt) N2 rate of change alarm setting in ppm/s
O2Alm	SPS	(SIMLExt) If true, a predefined level limit of O2 for the insulation medium has been reached (for example, low insulation level). Setting of the predefined level limit is a local issue. The action to take may be to refill the insulation medium.
O2Als	ASG	(SIMLExt) O2 alarm setting in ppm
O2RteAlm	SPS	(SIMLExt) If true, a predefined level limit of O2 rate of change for the insulation medium has been reached (for example, low insulation level). Setting of the predefined level limit is a local issue. The action to take may be to refill the insulation medium.
O2RteAls	ASG	(SIMLExt) O2 rate of change alarm setting in ppm:s
OilPres	MV	(SCGR) Generator oil pressure
OilPresAlm	SPS	(SIMLExt) If true, the predefined alarm level limit OilPAlmSet of Oil pressure for the insulation medium has been reached (SCGR) If true, a predefined level of the generator oil pressure has been reached
OilPresAls	ASG	(SIMLExt) Alarm threshold setting for the Oil Pressure (SCGR) Generator Oil Pressure Alarm threshold setting
OilPresWrn	SPS	(SIMLExt) If true, the predefined warning level limit OilPWrnSet of Oil pressure for the insulation medium has been reached
OilPresWrs	ASG	(SIMLExt) Warning threshold setting for the Oil Pressure
OilTmp	MV	(SCGR) Oil Temperature in °C
OilTmpAlm	SPS	(SCGR) If true, a predefined alarm level of the Generator oil temperature has been reached.

Name	Type	(Used in) Description
OilTmpAls	ASG	(SCGR) Generator Oil temperature threshold setting for alarm (in °C)
OilTmpDif	MV	(SLTCExt) Oil Temperature Difference between LTC oil and Transformer oil (in °C)
OilTmpDifAlm	SPS	(SLTCExt) If true, the predefined level alarm limit OilTmpDifAls for the oil temperature difference has been reached.
OilTmpDifAls	ASG	(SLTCExt) Oil Temperature difference threshold setting for alarm (in °C)
OilTmpDifWrn	SPS	(SLTCExt) If true, the predefined level warning limit OilTmpDifWrs for the oil temperature difference has been reached.
OilTmpDifWrs	ASG	(SLTCExt) Oil Temperature difference threshold setting for warning (in °C)
OilVlvOpn	SPS	(SPTRExt) if true, the pressure Oil Valve is opened otherwise closed
OpCntAlm	SPS	(SLTCExt) If true, the predefined level alarm limit OpCntAls for the LTC operations has been reached.
OpCntAls	ING	(SLTCExt) LTC Operation Counts threshold setting for alarm
OpCntWrn	SPS	(SLTCExt) If true, the predefined level warning limit OpCntWrs for the LTC operations has been reached.
OpCntWrs	ING	(SLTCExt) LTC Operation Counts threshold setting for warning
OpCtl	SPC	(ZAXNExt) (controllable) If true, the interface to the considered auxiliary network is running, until stopped with value false. Its usage makes sense mostly in case of multiple auxiliary networks.
OpFailSt	ENG (OperationFailureModeKind)	(ZGENExt) Operation failure mode state
OpTmh	INS	(SLTCExt) Operation time of the LTC since start of the operation (in hour)
OpTmhAlm	SPS	(SLTCExt) If true, the predefined level alarm limit OpTmhAls for the LTC operation duration has been reached.
OpTmhAls	ING	(SLTCExt) LTC operation duration threshold setting for alarm (in hours)
OpTmhWrn	SPS	(SLTCExt) If true, the predefined level warning limit OpTmhWrs for the LTC operation duration has been reached.
OpTmhWrs	ING	(SLTCExt) LTC operation duration threshold setting for warning (in hours)
OutALim	ASG	(ZCONExt) Output current limit alarm set (ZUPS) Maximum output current threshold limit for alarm
OutALimAlm	SPS	(ZCONExt) If true, a predefined alarm limit for output current has been reached. (ZUPS) If true, a predefined alarm limit of the output current has been reached
OvPresVlvOpn	SPS	(SPTRExt) if true, the OverPressure Valve is opened otherwise closed
OvPresVlvPos	SPS	(SLTCExt) If true, the valve position is in over pressure
OvlEqAgeTmh	INS	(SEAM) Equivalent aging for the overloading duration (in hours)
PreArcTm	MV	(SCBRExt) Pre arc duration time
RechaRte	ASG	(BatteryChargerLN) Recharge rate (in A/s)
RlSatStdTmp	MV	(SSTP) Relative saturation at a standard temperature (%)
SumSqA	APC	(SPTRExt) Sum of square of short circuit currents of the transformer, expressed in Amp square
SumSwA	APC	(SLTCExt) (controllable) Sum of commuted currents of LTC in Amp. It can be reset or set to any value.
SumSwAAlm	SPS	(SLTCExt) If true, the predefined level alarm limit SumSwAAls for the sum of commuted currents has been reached.
SumSwAAls	ASG	(SLTCExt) Alarm threshold setting for the sum of commuted currents by LTC (in Amp)

Name	Type	(Used in) Description
SvcSetTmh	ING	(SEAM) Service time setting (in hours)
TapOp	SPS	(SLTCExt) If true, the tap changer is operating
TapOpDur	MV	(SLTCExt) Duration of the latest tap change operation (in s)
TapOpDurAlm	SPS	(SLTCExt) If true, the tap change operation duration has exceeded the threshold defined in TapOpDurAls
TapOpDurAls	ASG	(SLTCExt) Threshold for the tap change operation duration alarm
TapOpDurWrn	SPS	(SLTCExt) If true, the tap change operation duration has exceeded the warning threshold defined in TapOpDurWrs
TapOpDurWrs	ASG	(SLTCExt) Threshold for the tap change operation duration alarm
TapTmh	HST	(SLTCExt) Cumulated operating time of each tap positions (in hours)
ThmAgeAcc	MV	(SEAM) Thermal aging acceleration factor ("none" unit)
ThmOvlCap	MV	(SLTCExt) Calculated thermal overload capability (in Amp)
TmpAlm	SPS	(ZCABExt) If true, the cable surface temperature has reached the alarm threshold defined by TmpAlmSet. (ZUPS) If true, a predefined alarm level for the UPS temperature defined in OvTmpAls has been reached
TmpAls	ASG	(ZCABExt) Threshold for alarm state of cable surface temperature (in °C) (ZUPS) Maximum temperature alarm threshold for alarm (in °C) (SIMLExt) Temperature alarm threshold setting (in °C)
TmpCdsOil	MV	(SSTP) Temperature of water condensation in oil (in °C)
TmpDist	MV	(ZCABExt) Surface temperature distribution of the cable in (°C)
TmpWrn	SPS	(ZCABExt) If true, the cable surface temperature has reached the warning threshold defined by TmpWrnSet. (SIMLExt) If true, the predefined level warning limit TmpWrnSet for the temperature of LTC has been reached.
TmpWrs	ASG	(ZCABExt) Threshold for warning state of cable surface temperature (in °C) (SIMLExt) Temperature warning threshold setting (in °C)
TnsSv	SAV	(KTOW) Tension between line and tower: N
TorqAlm	SPS	(SLTCExt) If true, the predefined level alarm limit TorqAls for the drive torque has been reached.
TorqAls	ASG	(SLTCExt) Drive torque threshold setting for alarm
TorqSv	SAV	(TTRQ) Torque (sampled value)
TorqWrn	SPS	(SLTCExt) If true, the predefined level warning limit TorqWrs for the drive torque has been reached.
TorqWrs	ASG	(SLTCExt) Drive torque threshold setting for warning
TowInclAng	MV	(KTOW) Tower inclination angle: (-90 to 90 degree)
TowTns	MV	(KTOW) Tower tension
UhfSv	SAV	(TUHF) UHF signal
UpsModSt	ENS (SystemOperationModeKind)	(ZUPS) System operation mode status
VPrs	SPS	(ZAXNExt) if true, indicate that Voltage has reached a level over the minimum threshold possibly defined in VolMin
VolMin	ASG	(ZAXNExt) Voltage threshold above which Auxiliary network voltage is declared present.
WtrDewPtTmp	MV	(SSTP) Dew point of water (in °C)

14.2 Enumerated data attribute types

14.2.1 General

This subclause contains explicit definition of enumerated types used in IEC TR 61850-90-3.

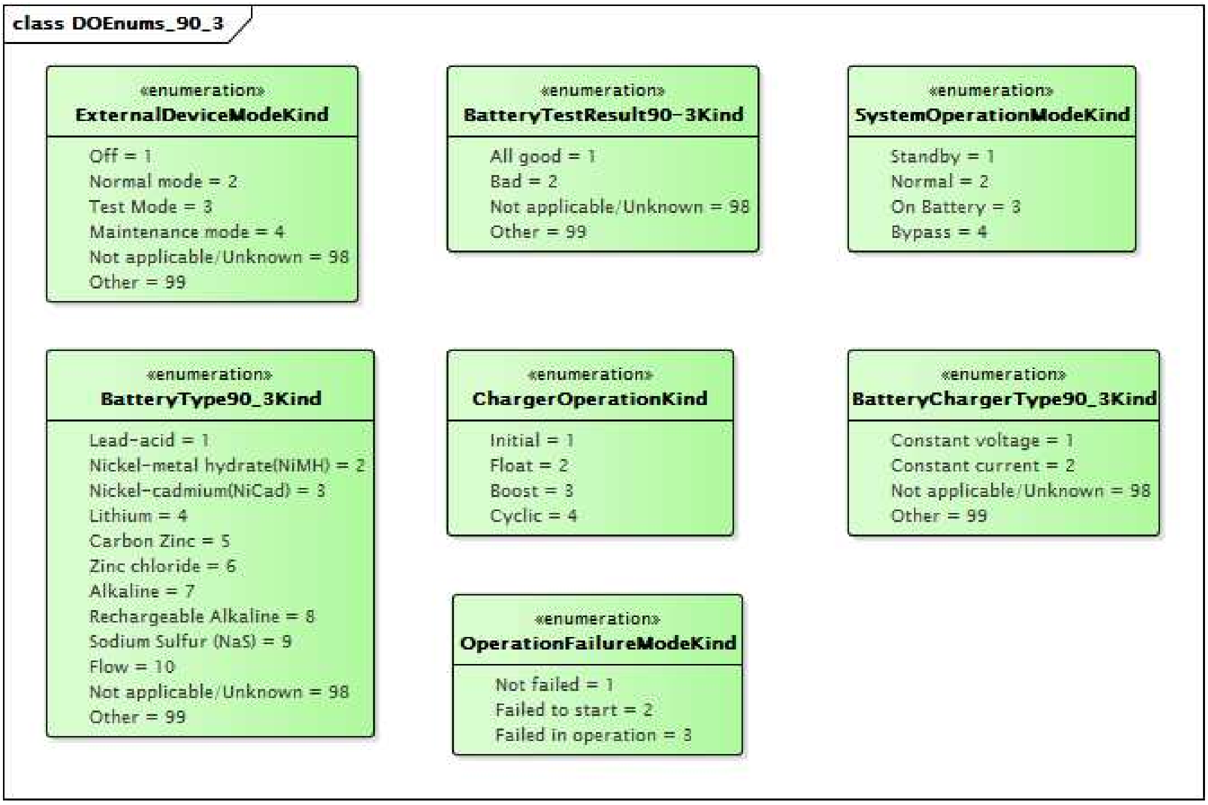


Figure 75 – Class diagram DOEnums_90_3::DOEnums_90_3

The diagram in Figure 75 shows class diagrams of DO enumerated type.

14.2.2 BatteryChargerType90_3Kind enumeration

This enumeration is intended to be identical to the enumeration BatteryChargerType present in the second edition of IEC 61850-7-420[3], but must have a unique naming because of the namespace naming rules.

Table 30 shows all enumeration items of BatteryChargerType90_3Kind.

Table 30 – Literals of BatteryChargerType90_3Kind

BatteryChargerType90_3Kind		
enumeration item	**value**	**description**
Constant voltage	1	Constant voltage
Constant current	2	Constant current
Not applicable/Unknown	98	Not applicable/Unknown
Other	99	Other

3 To be published.

14.2.3 BatteryTestResult90-3Kind enumeration

This enumeration is intended to be identical to the enumeration BatteryTestResultKind present in the second edition of IEC 61850-7-420, but must have a unique naming because of the namespace naming rules.

Table 31 shows all enumeration items of BatteryTestResult90-3Kind.

Table 31 – Literals of BatteryTestResult90-3Kind

BatteryTestResult90-3Kind		
enumeration item	**value**	**description**
All good	1	All good
Bad	2	Bad
Not applicable/Unknown	98	Not applicable/Unknown
Other	99	Other

14.2.4 BatteryType90_3Kind enumeration

This enumeration is intended to be identical to the enumeration BatteryTypeKind present in the second edition of IEC 61850-7-420, but must have a unique naming because of the namespace naming rules.

Table 32 shows all enumeration items of BatteryType90_3Kind.

Table 32 – Literals of BatteryType90_3Kind

BatteryType90_3Kind		
enumeration item	**value**	**description**
Lead-acid	1	Lead-acid
Nickel-metal hydrate(NiMH)	2	Nickel-metal hydrate(NiMH)
Nickel-cadmium(NiCad)	3	Nickel-cadmium(NiCad)
Lithium	4	Lithium
Carbon Zinc	5	Carbon Zinc
Zinc chloride	6	Zinc chloride
Alkaline	7	Alkaline
Rechargeable Alkaline	8	Rechargeable Alkaline
Sodium Sulfur (NaS)	9	Sodium Sulfur (NaS)
Flow	10	Flow
Not applicable/Unknown	98	Not applicable/Unknown
Other	99	Other

14.2.5 ChargerOperationKind enumeration

Type of gate

Table 33 shows all enumeration items of ChargerOperationKind.

Table 33 – Literals of ChargerOperationKind

ChargerOperationKind		
enumeration item	**value**	**description**
Initial	1	Initial
Float	2	Float
Boost	3	Boost
Cyclic	4	Cyclic

14.2.6 ExternalDeviceModeKind enumeration

Type of gate

Table 34 shows all enumeration items of ExternalDeviceModeKind.

Table 34 – Literals of ExternalDeviceModeKind

ExternalDeviceModeKind		
enumeration item	**value**	**description**
Off	1	The equipement is Off
Normal mode	2	Normal mode
Test Mode	3	The equipment is performing some internal tests, then some of the functions or performances may be affected.
Maintenance mode	4	The equipment is under maintenance and is not operational.
Not applicable/Unknown	98	Not applicable/Unknown
Other	99	Other

14.2.7 OperationFailureModeKind enumeration

Enumerate the possible failure mode of some specific equipments

Table 35 shows all enumeration items of OperationFailureModeKind.

Table 35 – Literals of OperationFailureModeKind

OperationFailureModeKind		
enumeration item	**value**	**description**
Not failed	1	Not Failed
Failed to start	2	Failed to start
Failed in operation	3	failed in operation

14.2.8 SystemOperationModeKind enumeration

Type of gate

Table 36 shows all enumeration items of SystemOperationModeKind.

Table 36 – Literals of SystemOperationModeKind

SystemOperationModeKind		
enumeration item	**value**	**description**
Standby	1	Standby
Normal	2	Normal
On Battery	3	On Battery
Bypass	4	Bypass

15 SCL enumerations (from DOEnums_90_3)

```
<EnumType id="BatteryChargerType90_3Kind">
    <EnumVal ord="1">Constant voltage</EnumVal>
    <EnumVal ord="2">Constant current</EnumVal>
    <EnumVal ord="98">Not applicable/Unknown</EnumVal>
    <EnumVal ord="99">Other</EnumVal>
</EnumType>
<EnumType id="BatteryTestResult90-3Kind">
    <EnumVal ord="1">All good</EnumVal>
    <EnumVal ord="2">Bad</EnumVal>
    <EnumVal ord="98">Not applicable/Unknown</EnumVal>
    <EnumVal ord="99">Other</EnumVal>
</EnumType>
<EnumType id="BatteryType90_3Kind">
    <EnumVal ord="1">Lead-acid</EnumVal>
    <EnumVal ord="2">Nickel-metal hydrate(NiMH)</EnumVal>
    <EnumVal ord="3">Nickel-cadmium(NiCad)</EnumVal>
    <EnumVal ord="4">Lithium</EnumVal>
    <EnumVal ord="5">Carbon Zinc</EnumVal>
    <EnumVal ord="6">Zinc chloride</EnumVal>
    <EnumVal ord="7">Alkaline</EnumVal>
    <EnumVal ord="8">Rechargeable Alkaline</EnumVal>
    <EnumVal ord="9">Sodium Sulfur (NaS)</EnumVal>
    <EnumVal ord="10">Flow</EnumVal>
    <EnumVal ord="98">Not applicable/Unknown</EnumVal>
    <EnumVal ord="99">Other</EnumVal>
</EnumType>
<EnumType id="ChargerOperationKind">
    <EnumVal ord="1">Initial</EnumVal>
    <EnumVal ord="2">Float</EnumVal>
    <EnumVal ord="3">Boost</EnumVal>
    <EnumVal ord="4">Cyclic</EnumVal>
</EnumType>
<EnumType id="ExternalDeviceModeKind">
    <EnumVal ord="1">Off</EnumVal>
    <EnumVal ord="2">Normal mode</EnumVal>
    <EnumVal ord="3">Test Mode</EnumVal>
```

```
    <EnumVal ord="4">Maintenance mode</EnumVal>
    <EnumVal ord="98">Not applicable/Unknown</EnumVal>
    <EnumVal ord="99">Other</EnumVal>
</EnumType>
<EnumType id="OperationFailureModeKind">
    <EnumVal ord="1">Not failed</EnumVal>
    <EnumVal ord="2">Failed to start</EnumVal>
    <EnumVal ord="3">Failed in operation</EnumVal>
</EnumType>
<EnumType id="SystemOperationModeKind">
    <EnumVal ord="1">Standby</EnumVal>
    <EnumVal ord="2">Normal</EnumVal>
    <EnumVal ord="3">On Battery</EnumVal>
    <EnumVal ord="4">Bypass</EnumVal>
</EnumType>
```

Annex A
(informative)

Usage of "T" logical node and "S" logical node in CMD application

For logical node assignments for CMD application, we basically obey the following philosophy:

"T" group logical nodes: These represent sensors and measured values for such as current, voltage, temperature, pressure, etc., which are inputs to calculate CMD properties such as contact abrasion, etc. "T" logical nodes itself have no variable about CMD properties.

"S" group logical nodes: These represent CMD properties which are calculated from "T" logical node variables.

This philosophy is almost the same as for protection and control domain described in IEC 61850-5. In Figure A.1, logical nodes for protection and measurement and these for CT/VT are clearly separated.

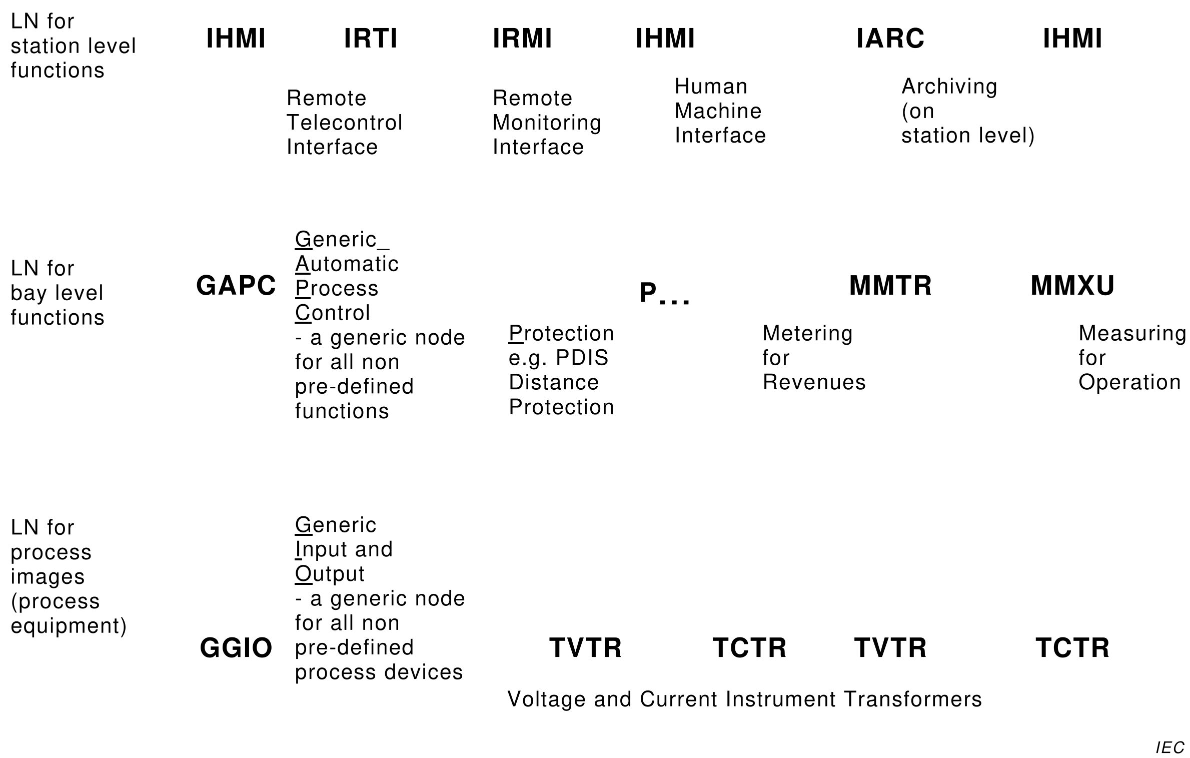


Figure A.1 – Decomposition of functions into interacting LN on different levels: Examples for generic function with tele control interface, protection function and measuring/metering function (from IEC 61850-5:2003)

Reference: [4]

Bibliography

[1] IEC 61400-25-6, *Wind turbines – Part 25-6: Communications for monitoring and control of wind power plants – Logical node classes and data classes for condition monitoring*

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

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

[4] IEC 61850-5, *Communication networks and systems for power utility automation – Part 5: Communication requirements for functions and device models*

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

[6] 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*

[7] IEC 61850-90-12, *Communication networks and systems for power utility automation – Part 90-12: Wide area network engineering guidelines*

[8] Electric Technology Research Association in Japan: "Underground power transmission technologies in 21st century," Denki kyodo kenkyu, Vol. 58, No. 1, May, 2002 (written in Japanese).

[9] Yukihiro Yagi: "Technologies for online diagnosis of cables," IEE Journal, Vol.127, No.1, pp.10–12, Jan. 2007 (written in Japanese).

[10] Shodai Takahashi and Tatsuki Okamoto: "Study on on-line monitoring system of very small deterioration signal caused by water tree in XLPE cables – Verification of compensation method for load current using model signals", CRIEPI report H04016, May 2006.

____

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