IEC TR 61850-90-17

Edition 1.0 2017-05

TECHNICAL REPORT

colour inside

Communication networks and systems for power utility automation – Part 90-17: Using IEC 61850 to transmit power quality data

IEC TR 61850-90-17:2017-05(en)

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COMMUNICATION NETWORKS AND SYSTEMS FOR POWER UTILITY AUTOMATION –

Part 90-17: Using IEC 61850 to transmit power quality data

FOREWORD

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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 61850-90-17, which is a technical report, has been prepared by IEC technical committee 57: Power systems management and associated information exchange, in cooperation with IEC technical committee 85: Measuring equipment for electrical and electromagnetic quantities.

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

Enquiry draft	Report on voting
57/1676/DTR	57/1836/RVDTR

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

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

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific document. At this date, the document 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- withdrawn,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

Power quality (PQ) measurement methods are defined in IEC 61000-4-30.

Power quality measurement instruments are used to evaluate the quality of electricity (voltage characteristics) supplied by distribution and transmission systems and to evaluate the performance (emission) of equipment.

These instruments provide different types of data for different applications of PQ data:

- Power quality monitoring:
  - Continuity of supply monitoring,
  - Monitoring of different voltage characteristics: Voltage quality (VQ) covers a wide range of voltage disturbances and deviations in voltage magnitude or waveform from the optimum values.
- Power quality compliance reporting:
  - Continuous monitoring and compliance reporting of different voltage characteristics at point of connection.
  - Additional data are helpful for:
    a) Detailed problem analysis (e.g. waveform or transient records),
    b) Flexible data evaluation (e.g. grid codes for data post processing).

NOTE See also “Document on Guidelines of Good Practice on the Implementation and Use of Voltage Quality Monitoring Systems for Regulatory Purposes, which has been jointly developed by CEER and the ECRB” (C12-EQS-51-03) and CIGRÉ/CIRED Joint Working Group (JWG) C4.112: “Guidelines for Power quality monitoring – measurement locations, processing and presentation of data”.

IEC 61850 provides the services and data modeling for transmission of PQ related data from instruments to substation/SCADA systems.

There is a desire to have a communication mechanism that is compliant to the concept of IEC 61850. This document lays out how this shall be done.

File based transmission of PQ data is based on the following standards:

- IEC 60255-24/IEEE Std. C37.111, *Measuring relays and protection equipment – Part 24: Common format for transient data exchange (COMTRADE) for power systems for fault records,*
- IEEE Std. 1159.3, PQDIF for PQ records (events, measurements, records).

During modelling of PQ applications IEC 61850-7-4 and IEC 61850-7-3 will be reviewed.

COMMUNICATION NETWORKS AND SYSTEMS FOR POWER UTILITY AUTOMATION –

Part 90-17: Using IEC 61850 to transmit power quality data

1 Scope

This part of IEC 61850, which is a technical report, provides a way of exchanging power quality data between instruments whose functions include measuring, recording and possibly monitoring power quality phenomena in power supply systems, and clients using them in a way that is compliant to the concepts of IEC 61850.

The main goal is the interoperability of power quality instruments.

NOTE 1 The measurement of PQ phenomena maybe provided by communication e.g. IEC 61850-9-2 or instrument transformers. Their application is outside of the scope of this document.

NOTE 2 This document does not set any limits for power quality values, but only repeats limits from other sources (e.g. EN 50160, IEC TS 62749) as suitable examples.

NOTE 3 This document provides recommendations for naming conventions for PQ measurements provided by power quality instruments to manifest the usage of Power quality measurement methods and to ensure interoperability.

This document provides

- Guidelines for using of IEC 61850 for power quality domain,
- Name space extensions based on power quality function assessment,
- Profile for using IEC 61850 in the specific context of IEC 61000-4-30.

Specific power quality requirements that cannot be wholly covered with existing Logical Nodes (LN) or Common Data Classes (CDC) (e.g. LN for continuous power quality recorders, LN for RVC, etc.) will be addressed and added in the next editions of IEC 61850-7-3 and IEC 61850-7-4.

NOTE 4 This document references to/is compliance with the future 61850 amendment 2.1, and also bring the needed elements which are mandatory to understand the document; at least the new presence conditions rules, as well as the enumeration models.

The namespace introduced by this document in Clause 7 has the following properties:

- Namespace Version: 2016
- Namespace Revision:
- UML model file which reflects this namespace edition: wg10uml02v20draftPQ00-wg18uml02v11b-wg17uml02v17c-jwg25uml02v04c-tc17umlv0-tc38umlv0.eap, UML model version WG10UML02v20DraftUpdate
- Namespace release date: 2017-01-17
- Namespace name: “(Tr)IEC61850-90-17:2016”

This name space is considered as "transitional" since the models are expected to be included in future editions of IEC 61850-7-4xx. Potential extensions/modifications may happen if/when the models are moved to International Standard status. Only the new data objects and CDCs which are represented in bold-italic will be tagged with this namespace name. The others still refer to the namespace where they are primarily defined.

The Profile (set of additional rules) for using IEC 61850 in the specific context of IEC 61000-4-30, introduced in this document in Clause 6 is named "Profile_61000-4-30_(Tr)IEC61850-90-17:2016".

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 TR 61000-3-6, *Electromagnetic compatibility (EMC) – Part 3-6: Limits – Assessment of emission limits for the connection of distorting installations to MV, HV and EHV power systems*

IEC TR 61000-3-7, *Electromagnetic compatibility (EMC) – Part 3-7: Limits – Assessment of emission limits for the connection of fluctuating installations to MV, HV and EHV power systems*

IEC TR 61000-3-13, *Electromagnetic compatibility (EMC) – Part 3-13: Limits – Assessment of emission limits for the connection of unbalanced installations to MV, HV and EHV power systems*

IEC TR 61000-3-14, *Electromagnetic compatibility (EMC) – Part 3-14: Assessment of emission limits for harmonics, interharmonics, voltage fluctuations and unbalance for the connection of disturbing installations to LV power systems*

IEC 61000-4-7:2009, *Electromagnetic compatibility (EMC) – Part 4-7: Testing and measurement techniques – General guide on harmonics and interharmonics measurements and instrumentation, for power supply systems and equipment connected thereto*

IEC 61000-4-15:2010, *Electromagnetic compatibility (EMC) – Part 4-15: Testing and measurement techniques – Flickermeter – Functional and design specifications*

IEC 61000-4-30:2015, *Electromagnetic compatibility (EMC) – Part 4-30: Testing and measurement techniques – Power quality measurement methods*

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

IEC 61850-7-1:2011, *Communication networks and systems for power utility automation – Part 7-1: Basic communication structure – Principles and models*

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

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

IEC 61850-8-1:2011, *Communication networks and systems for power utility automation – Part 8-1: Specific communication service mapping (SCSM) – Mappings to MMS (ISO 9506-1 and ISO 9506-2) and to ISO/IEC 8802-3*

IEC TR 61850-90-2, *Communication networks and systems for power utility automation – Part 90-2: Using IEC 61850 for the communication between substations and control centres*

IEC 62586-1:2013, *Power quality measurement in power supply systems – Part 1: Power quality instruments (PQI)*

IEC TS 62749:2015, *Assessment of power quality – Characteristics of electricity supplied by public networks*

IEEE Std. 1159.3:2003, *Power Quality Data Interchange Format (PQDIF)*

EN 51060, *Voltage characteristics in public distribution systems*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1
power quality instrument
PQI
instrument according to IEC 62586-1 whose main function is to measure, record and possibly monitor power quality parameters in power supply systems, and whose measuring methods (class A or class S) are defined in IEC 61000-4-30

3.2
power quality instrument class A
PQI-A
PQI according to IEC 62586-1 whose measuring methods comply with class A of IEC 61000-4-30

3.3
channel
individual measurement path through an instrument

Note 1 to entry: "Channel" and "phase" are not the same. A voltage channel is by definition the difference in potential between 2 conductors. Phase refers to a single conductor. On polyphase systems, a channel may be between 2 phases, or between a phase and neutral, or between a phase and earth, or between neutral and earth.

3.4
power quality instrument class S
PQI-S
PQI according to IEC 62586-1 whose measuring methods comply with class S of IEC 61000-4-30

3.5
declared input voltage
Udin
value obtained from the declared supply voltage by a transducer ratio

3.6
declared supply voltage
Uc
nominal voltage Un of the system

Note 1 to entry: If by agreement between the supplier and the customer a voltage different from the nominal voltage is applied to the terminals, then this voltage is the declared supply voltage Uc.

3.7
flicker
impression of unsteadiness of visual sensation induced by a light stimulus whose luminance or spectral distribution fluctuates with time

[SOURCE: IEC 60050-161:1990, 161-08-13]

3.8
power quality
characteristics of the electricity at a given point on an electrical system, evaluated against a set of reference technical parameters

Note 1 to entry: These parameters might, in some cases, relate to the compatibility between electricity supplied on a network and the loads connected to that network.

3.9
r.m.s. (root-mean-square) value
square root of the arithmetic mean of the squares of the instantaneous values of a quantity taken over a specified time interval and a specified bandwidth

4 Abbreviated terms

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

ACSI	Abstract communication service interface
CDC	Common Data Class
COMFEDE	Common format for event data exchange
COMTRADE	Common format for transient data exchange
Ds	derived statistics
DB	Database
DMS	Distribution Management System
DO	Data Object
EHV	Extra high voltage
EMS	Energy management system
EMC	Electromagnetic Compatibility
F	Element is forbidden
GMS	Generation Management System
HV	High voltage (> 35 kV)
IED	Intelligent Electronic Device
IP	Internet Protocol
LAN	Local Area Network
LD	Logical Device
LN	Logical Node
LV	Low voltage (< 1 kV)
M	Element is mandatory
MMS	Manufacturing Messaging Specification. See IEC 61850-8-1
M-O-C	mandatory – optional – conditional
MS	Management System
MSV	Mains signalling voltage (ripple control)
MV	Medium voltage (1 kV to 35 kV)
n/a	Not applicable

nds	not derived statistics
O	Element is optional.
Pinst	Instantaneous flicker sensation. See IEC 61000-4-15
Plt	Long-term flicker evaluation. See IEC 61000-4-15
PQ	Power Quality
PQI	Power Quality Instrument. See IEC 62586-1
PQDIF	Quality Data Interchange Format
Pst	Short-term flicker evaluation based on an observation period of 10 minutes. See IEC 61000-4-15
PQI	Power Quality Instrument
RMS	root-mean-square value
r.m.s.	root-mean-square value
RVC	Rapid voltage change
SAIFI	System Average Interruption Frequency Index
SBM	Specified by manufacturer
SCADA	Supervisory Control and Data Acquisition
SCD	Substation Configuration Description
SCL	Substation Configuration Language
TCP	Transmission Control Protocol
THD	Total Harmonic Distortion
TR	Technical Report
TS	Technical Specification
Uc	Declared supply voltage
Udin	Declared input voltage
Un	Nominal voltage
XML	Extensible Markup Language

NOTE Abbreviations used for the identification of the common data classes/Logical Nodes (LN) and as names of the attributes are specified in the specific clauses of this document and are not repeated here.

5 Uses cases and requirements: Application of power quality data

5.1 General

Modelling of power quality instruments includes all methods to transfer power quality information from IED (e.g. PQI) to an application in the substation, control centre or maintenance centre.

5.2 Constraints / assumptions / design considerations

The IED is equipped with a communication interface to send the power quality information to the substation, control centre or maintenance centre. Additionally the IED may store power quality information in local records that can be retrieved from the substation, control centre or maintenance centre.

Power quality information is used either for operational purpose and / or for offline analysis and grid code evaluation:

1) SCADA-Control and PQ Monitoring:
   - Provide measurements of power quality values (10 s, 10/12 cycle, 150/180 cycle, etc.) in order to make operational decisions: obtain information to evaluate PQ trends (without PQ limit violations, e.g. increase of harmonics, THD, unbalance, etc.)
   - Continuity of supply monitoring: detect and transmit voltage events (alarming or critical limit violation) in real-time (1/2 cycle or 1 cycle) in order to make an operational decision by network operator.

NOTE: Precision Time Protocol (PTP) according to IEEE 1588/IEC 61588 is not required for power quality measurement or evaluation. The requirements for time clock uncertainty are specified in IEC 61000-4-30.

2) power quality monitoring systems (database driven analysis):
   - Periodic reporting of power quality indices, aggregated power quality values over a defined survey period,
   - supports compliance reports based on contracts between parties in the electrical system at connection point,
   - commenting of PQ events, reports on PQ-related disturbances, grid code compliance measurements etc.,
   - inform customers with equipment and processes that are sensitive to PQ disturbances,
   - obtain information to determine the need and dimensioning of reinforcement or reconstruction of supply networks,
   - Large installations: control of emissions levels, implement methods to improve power quality
   - Manufacturer of mass market products: reduce emission
     – emission requirements in standards are updated to take into account the development of markets and changes in technologies
   - Network operators: reduce emission
     – Set reasonable emission limits for network users
       a) Limits on emission from individual customers are necessary to maintain the voltage disturbance levels below the voltage quality requirements without excessive costs for other customers. The limits on emission should be reasonable for both the network operator and the customers causing the emission,
       b) based on planning levels and IEC TR 61000-3-6, IEC TR 61000-3-7, IEC TR 61000-3-13 and/or IEC TR 61000-3-14.

5.3 Actors

The power quality monitoring use case requires the actors shown in Table 1:

Table 1 – Actors and roles

Name	Role Description
IED	Has got all necessary information to manage specifically the power quality data.
User	Could be: • Control centre which is a place where a master station is located. The control centre (SCADA, EMS, DMS, GMS, grid operators) receives and processes data coming from IED. • Maintenance centre which is a place from where maintenance, management of asset, disturbance analysis and the metering are managed. • A local user which is a technician having to intervene on the substation automation system. • a microgrid controller can use power quality data to trigger intentional islanding (i.e. disconnect from the grid), and it will have to regulate power quality internally (take action based on local power quality data).

5.4 Use case diagram

Figure 1 shows a power quality use case diagram.

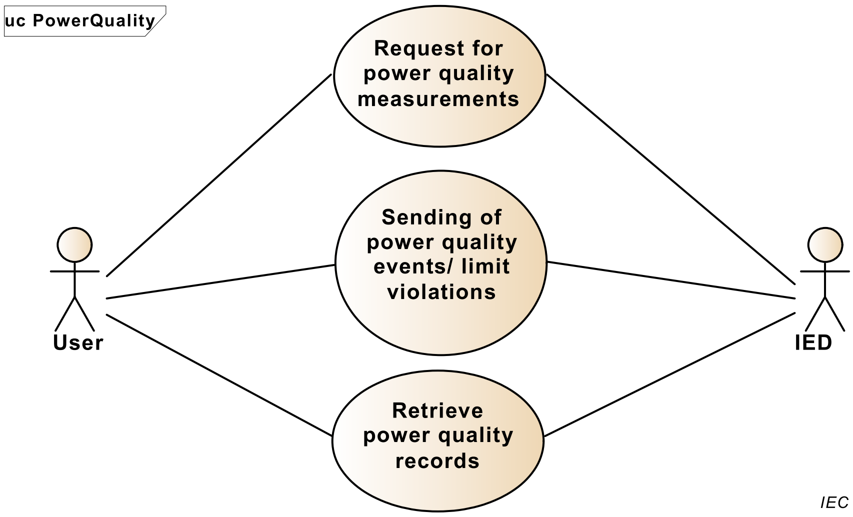

Figure 1 – Use cases related to Power Quality monitoring application

5.5 Use cases description

Table 2 gives descriptions of use cases and applications.

Table 2 – Use cases and applications

Name	Service or information provided
Request for power quality measurements	After received request from control centre and/or maintenance centre, IED sends the right information to user: PQ measurements and calculations
Sending of power quality events/limit violations	The user defines settings for PQ limits. Power quality events or limit violations measured/calculated in the IED will be transferred to the user spontaneously: PQ events
Retrieve power quality records	Historic Power quality information that has been stored in the IED can be retrieved on request of the substation or control centre via file transfer: PQ records, PQ events and/or PQ reports

5.6 Sequence diagram

5.6.1 Request for power quality measurements

Table 3 shows a use case "Request for power quality measurements".

Table 3 – Use case "Request for power quality measurements"

Use Case step	Description
Step 1	User sends a request to get measurements related to power quality management.
Step 2	IED transmits the information to the user.

Figure 2 shows a use case "Request for power quality measurements".

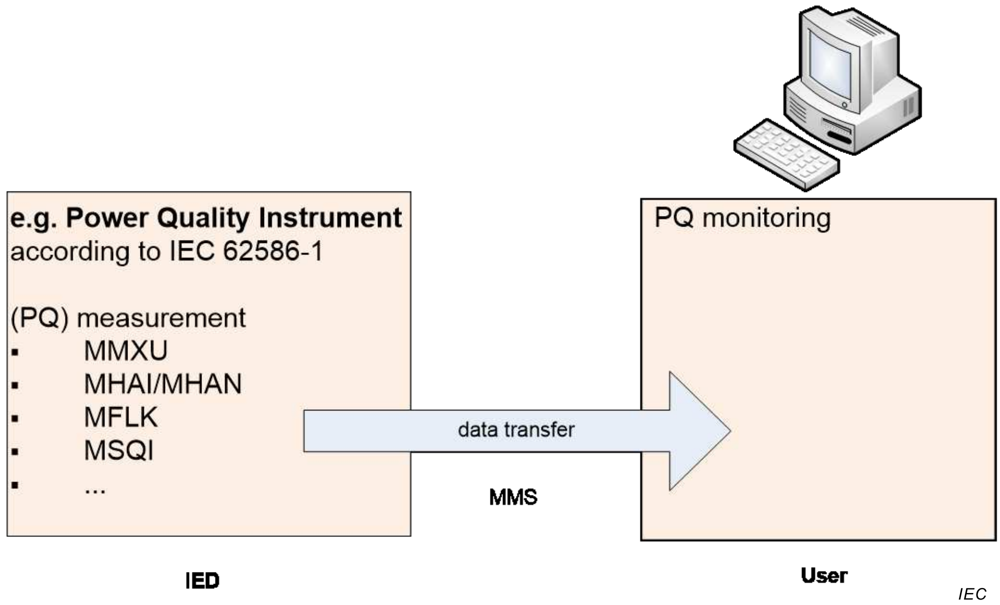

Figure 2 – Use case "Request for power quality measurements”

5.6.2 Sending of power quality events/limit violations

Table 4 shows a use case "Sending of power quality events/limits violations".

Table 4 – Use case "Sending of power quality events/limits violations"

Use Case step	Description
Step 1	The user defines settings for PQ limits.
Step 2	IED acquires power quality event or limit violation.
Step 3	The power quality event or limit violation is sent with time stamp, cause of transmission, etc. to the user.
Step 3a (optional)	A microgrid controller takes action based on local power quality data.

Figure 3 shows a use case "Sending of power quality events/limits violations".

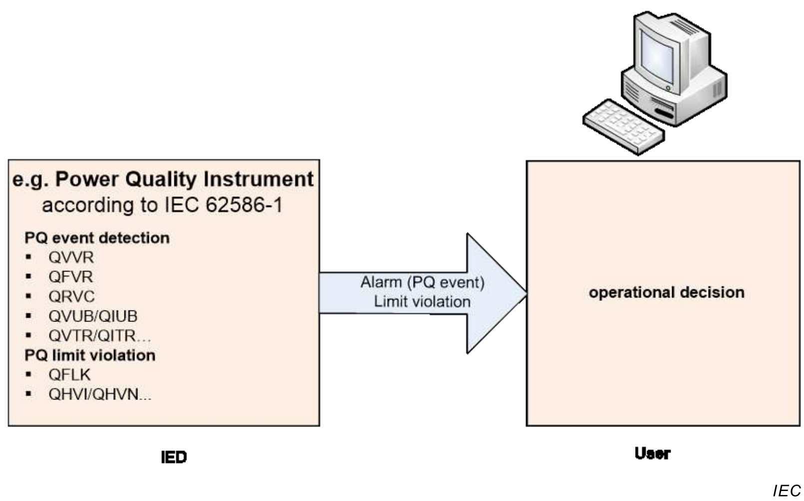

Figure 3 – Use case "Sending of power quality event/limit violation”

5.6.3 Retrieve power quality records

Table 5 shows a use case "Retrieve power quality records".

Table 5 – Use case "Retrieve power quality records"

Use Case step	Description
Step 1	User sends a request to get power quality records stored in the IED.
Step 2	IED transmits the information to the user.

Figure 4 shows a use case "Retrieve power quality records".

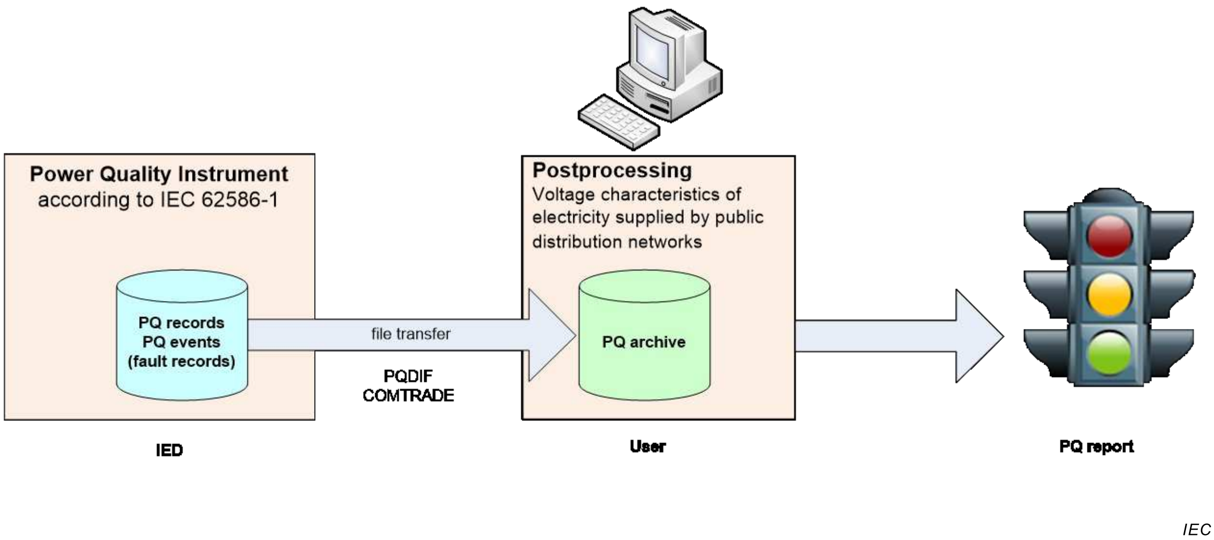

Figure 4 – Use case "Retrieve power quality records"

NOTE The generation of PQ reports in the IED and transmission of PQ reports instead of PQ long term records and PQ events is not in the scope of this document.

5.7 Classification and concepts for power quality measurements

5.7.1 General

Table 6 describes the characteristic PQ measurements respectively required in IEC 61000-4-30:2015, IEC TS 62749 and EN 50160 and maps according to the three use cases identified to IEC 61850-7-1. From PQ data application view three different kinds of functions are needed:

1) PQ data measurement (online montoring),
2) PQ event monitoring (discontinuous phenomena/events/limit violations),
3) PQ compliance reporting/analysis (Continuous phenomena/records, file transfer).

Table 6 – Mapping between PQ measurement methods, evaluation/reporting requirements and IEC 61850 modelling

IEC 61000-4-30:2015	IEEE Std. 1159:2009	EN 50160: 2010	IEC TS 62749:2015	IEC 61850-7-4 Ed. 2.1[1]
Electromagnetic compatibility (EMC) – Part 4-30: Testing and measurement techniques – Power quality measurement methods	IEEE Recommended Practice for Monitoring Electric Power Quality	Voltage characteristics of electricity supplied by public distribution networks	Assessment of power quality – Characteristics of electricity supplied by public networks	Communication networks and systems for power utility automation – Part 7-4: Basic communication structure – Compatible logical node classes and data classes
	Table 2	LV: ch 4; MV: ch. 5; HV: ch. 6		
5.1 Power frequency	7.0 Power frequency variations	ch. x.2.1 Power frequency	FREQUENCY DEVIATION	6.20.14 LN: Measurement: MMXU 6.22.4 LN: Frequency Variation: QFVR
5.2 Magnitude of the supply voltage	6.0 Voltage fluctuations	ch. x.2.2 Supply voltage variations	SUPPLY VOLTAGE variations	6.20.14 LN: Measurement: MMXU
5.3 Flicker	6.0 Voltage fluctuations	ch. x.2.3.2 Flicker severity	VOLTAGE FLUCTUATION and FLICKER	6.20.5 LN: Flicker Measurement unit: MFLK NOTE 2
5.4 Supply voltage dips and swells.	2.0 Short-duration root-mean-square (rms) variations 3.0 Long duration rms variations	ch.3.2 Supply voltage dips/swells	VOLTAGE DIPS and SWELLS	6.22.9 LN: Voltage Variation: QVVR
5.5 Voltage interruptions	2.2.1 Interruption 2.3.1 Interruption 3.1 Interruption, sustained	ch.3.1 Interruptions of the supply voltage	SUPPLY INTERRUPTION	6.22.9 LN: Voltage Variation: QVVR
5.6 Transient voltages	1.0 Transients	ch.3.3 Transient overvoltages	TRANSIENT OVERVOLTAGES (optional)	6.22.7 LN: Voltage Transient: QVTR NOTE 3
5.7 Supply voltage unbalance	4.1 Voltage imbalance	ch.x.2.4 Supply voltage unbalance	VOLTAGE UNBALANCE	6.20.15 LN: Sequence and imbalance MSQI 6.22.8 LN: Voltage Unbalance Variation: QVUB
5.8 Voltage harmonics	5.2 Harmonics	ch.x.2.5 Harmonic voltage	HARMONIC VOLTAGE	6.20.6 LN: Harmonics or interharmonics: MHAI/MHAN
5.9 Voltage interharmonics	5.3 Interharmonics	ch.x.2.6 Interharmonic voltages	INTERHARMONIC VOLTAGE	
5.10 Mains signalling voltage on the supply voltage	-	ch.x.2.7 Mains signalling voltages	MAINS SIGNALLING VOLTAGES	NOTE 4

[1] Under preparation. Stage at time of publication: IEC/FDIS 61850-7-4:2017.

IEC 61000-4-30:2015	IEEE Std. 1159:2009	EN 50160: 2010	IEC TS 62749:2015	IEC 61850-7-4 Ed. 2.1[1]
5.11 Rapid Voltage Changes (RVC)	6.0 Voltage fluctuations	ch.x.2.3 Individual rapid voltage changes	RAPID VOLTAGE CHANGES	NOTE 5
5.12 Underdeviation and overdeviation	NOTE 6			
5.13.1 Magnitude of current	3.4 Current overload	–	–	6.20.14 LN: Measurement: MMXU
5.13.2 Current recording	-	–	–	6.23.xx LN: Continuous PQ recorder function: RPQ
5.13.3 Harmonic currents	5.2 Harmonics	–	–	6.20.6 LN: Harmonics or interharmonics: MHAI/MHAN
5.13.4 Interharmonic currents	5.3 Interharmonics	–	–	6.20.6 LN: Harmonics or interharmonics: MHAI/MHAN
5.13.5 Current unbalance	4.2 Current imbalance	–	–	6.22.6 LN: Current Unbalance Variation: QIUB
				6.20.15 LN: Sequence and imbalance MSQI

NOTE 1 PQDIF file format will be added to IEC 61850-7-4 Ed.3[2]

NOTE 2 LN QFLK will be added to IEC 61850-7-4 Ed.3

NOTE 3 Optional function

NOTE 4 LN QVHA will be added to IEC 61850-7-4 Ed.3

NOTE 5 LN QRVC will be added to IEC 61850-7-4 Ed.3

NOTE 6 Optional function (moved to Annex D of IEC 61000-4-30:2015)

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2 Under consideration.

Table 7 identifies the requirements according to the 3 use cases and highlights the proposed extensions of IEC 61850-7-4.

Table 7 – Relation between LN and PQ use cases

	Request for power quality measurements	sending of power quality events/limits violations	retrieve power quality records
LN group M: Metering and measurement			
Logical node for voltage, current, frequency and power (optional) reporting: MMXU			
Logical node for harmonics/interharmonics/THD reporting: MHAI/MHAN			
Logical node for flicker reporting: MFLK			
Logical node for imbalance calculations: MSQI			
Logical node for emissions in the range from 2 kHz to 150 kHz: MHFE			
LN group R: Protection related functions			
Logical node for fault record alarming: RDRE (COMTRADE)			
MMX File transfer for fault records (COMTRADE)			
LN group Q: Power quality event detection or evaluation related			
Logical node for voltage variation reporting: QVVR			
Logical node for frequency variation reporting: QFVR			
Logical node for voltage unbalance variation reporting: QVUB			
Logical node for current unbalance variation reporting: QIUB			
Logical node for voltage transients reporting: QVTR			
Logical node for current transients reporting: QITR			
Logical node for supply voltage changes: QSVV			
Logical node for RVC (Rapid Voltage Changes): QRVC			
Logical node for harmonics/interharmonics/THD variation reporting: QVHA			
Logical node for flicker variation reporting: QFLK			
Logical node for continuous PQ records QCPR (PQDIF)			
MMX File transfer for PQ records (PQDIF)			

Bold-italic: new data objects required

Optional, additional information for network operators

requested by standards such as IEC 62586-1 (PQI-A) or EN 50160

5.8 PQ devices classification

Two different classes of devices are defined in IEC 61000-4-30:

- Class A:

  This class is used where precise measurements are necessary, for example, for contractual applications that may require resolving disputes, verifying compliance with standards, etc. Any measurements of a parameter carried out with two different instruments complying with the requirements of Class A, when measuring the same signals, will produce matching results within the specified uncertainty for that parameter.

- Class S:

  This class is used for statistical applications such as surveys or power quality assessment, possibly with a limited subset of parameters. Although it uses equivalent intervals of measurement as class A, the class S processing requirements are much lower.

This TR will focus on class A devices to cover the maximum of functions and state of the art data modelling.

5.9 PQ records

5.9.1 General

Table 8 shows PQ records for Class A and Class S devices.

Table 8 – PQ records for Class A and Class S devices

Function	PQ records	Class A	Class S	Flagging
Power Frequency	10 sec measurement	M	M	X
Magnitude of the Supply Voltage	10 min aggregation measurement 2 h aggregation measurement (optional)	M	M	X
Supply voltage unbalance		M	M	X
Voltage Harmonics		M	O	X
Voltage Interharmonics		M	O	X
Flicker	10 min Pst value 2 h Plt value	M	O	X
Mains Signalling Voltage	MSV(t) (10/12-cycle r.m.s. value interharmonic bin)	M	O	X
Magnitude of the currents	10 min aggregation measurement 2 h aggregation measurement (optional)	O	O	X
Current unbalance		O	O	X
Current Harmonics		O	O	X
Current Interharmonics		O	O	X
Current records	Triggered by voltage events, such as dips and swells and RVC (samples, ½ cycle r.m.s. values, etc.)	O	O	-
Conducted emissions in the frequency range 2 kHz to 150 kHz	10 min aggregation measurement	O	O	-
M: Requested by IEC 62586-1, O: not requested by IEC 62586-1				

PQ records are mandatory long term records in power quality instruments according to IEC 62586-1. IEC 61000-4-30 provides the power quality measurement methods, measurement ranges and accuracy requirements.

PQ records are used for power quality evaluation according to standards, which define limits for power quality values (e.g. EN 50160) or power quality indices (e.g. IEC TS 62749).

PQ records are stored in mass storage of instruments. It is necessary to transmit PQ long term records for evaluation (external post processing of PQ data) or to transmit PQ reports from IED to user (internal post processing).

NOTE IEC 61400-21 provides a uniform methodology that will ensure consistency and accuracy in the presentation, testing and assessment of power quality characteristics of grid connected wind turbines (WTs).

Figure 5 shows file transfer of PQ records from IEC to user.

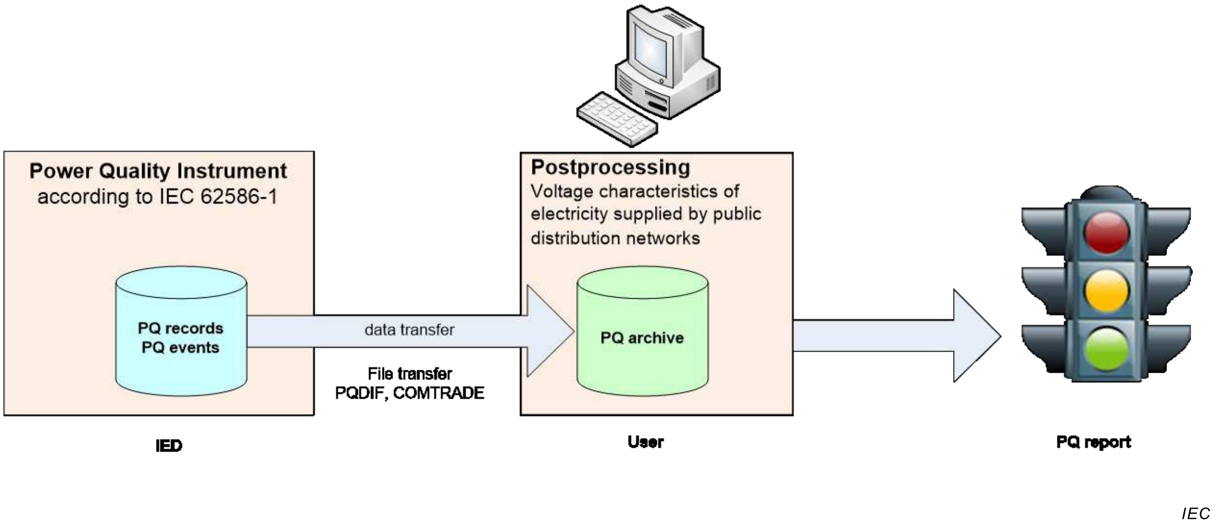


Figure 5 – File transfer of PQ records from IED to user

Figure 6 shows file transfer of PQ reports from IEC to user.

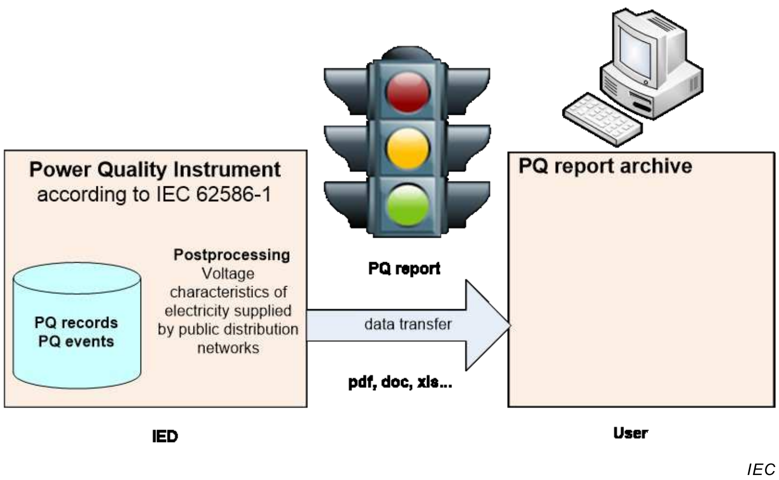


Figure 6 – File transfer of PQ reports from IED to user

Table 9 shows transfer of PQ records vs. transfer of PQ reports.

Table 9 – Transfer of PQ records vs. transfer of PQ reports

	Transfer of PQ records	Transfer of PQ reports
Evaluation settings	Flexible, adaptation to various grid codes possible	Fix settings are parameters in firmware
File format	Standardized: IEEE Std. 1159.3/ IEC 60255-24/IEEE Std. C37.111	Manufacturer specific

Figure 7 shows a voltage record example (6 h): 10 min r.m.s values of magnitude of supply voltage and additional record containing voltage variations (1/2 cycle r.m.s. values) in a single phase LV system (Udin = 230 V).

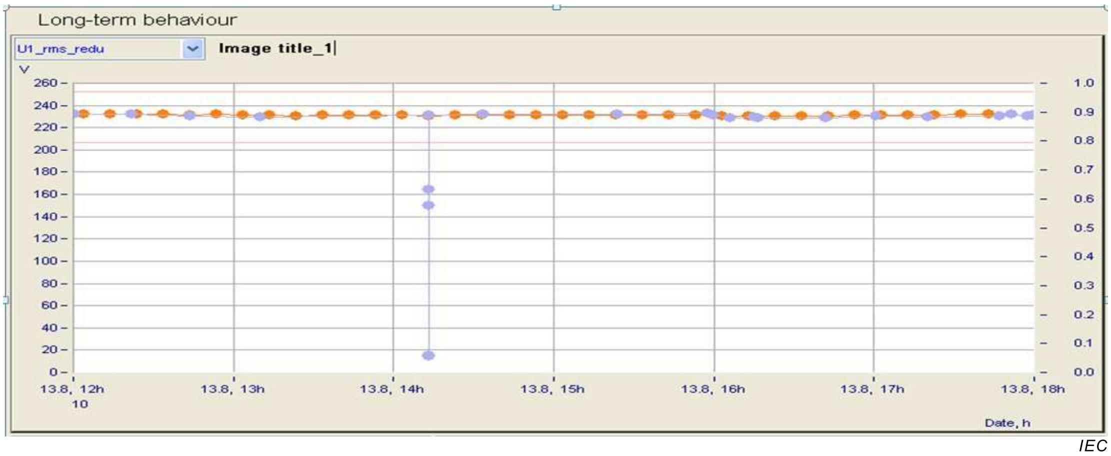


Figure 7 – Voltage record example (6 h): 10 min r.m.s values of magnitude of supply voltage and additional record containing voltage variations (1/2 cycle r.m.s. values) in a single phase LV system (Udin = 230 V)

PQ records contain mandatory measurements according to IEC 61000-4-30 and might contain additional information (e.g. fault records or ½ cycle r.m.s. value records).

5.9.2 Evaluation of PQ records

5.9.3 Power frequency

Requirements from IEC 61000-4-30:

- data storage interval: 10 s
  - 1 week = 60 480 values
  - 1 year = 3 153 600 values
- IEC 61000-4-30:2015: 10/12 cycles (wind turbines), 1 s (national standards)

Figure 8 shows a one-month power frequency record (10 s) and limits of frequency deviation 50 Hz ± 1 % according to EN 50160.

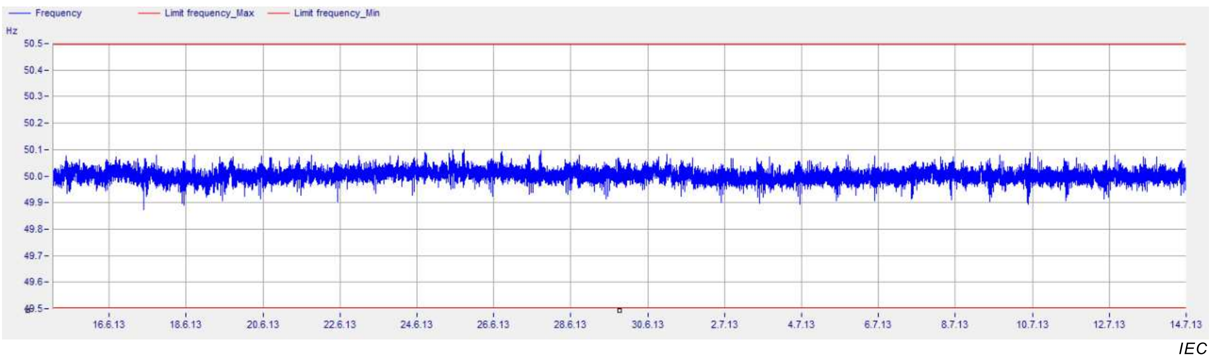


Figure 8 – One-month power frequency record (10 s) and limits of frequency deviation 50 Hz ± 1 % according to EN 50160

Evaluation according to EN 50160 (LV (< 1 kV), MV (1 kV to 36 kV), HV (36 kV to 150 kV)

Mean value of the fundamental frequency measured over 10 s shall be within a range of

- for systems with synchronous connection to an interconnected system:
  - 50 Hz ± 1 % (i.e. 49,5 Hz to 50,5 Hz) during 99,5 % of a year; (0,5 % of a year = 43,8 h)

   - 50 Hz + 4 % / – 6 % (i.e. 47 Hz to 52 Hz) during 100 % of the time;
- for systems with no synchronous connection to an interconnected system (e.g. supply systems on certain islands):
   - 50 Hz ± 2 % (i.e. 49 Hz to 51 Hz) during 95 % of a week;
   - 50 Hz ± 15 % (i.e. 42,5 Hz to 57,5 Hz) during 100 % of the time.

Evaluation according to IEC TS 62749:

- The frequency shall be maintained within a given deviation from the specified value, 50 Hz or 60 Hz.
   - e.g. Japan ± 0,2 Hz

Table 10 gives an evaluation of power frequency according to EN 50160.

Table 10 – Evaluation of power frequency data according to EN 50160

Unit	**Component**	**Cutoff value** (Deviation of 50 Hz)	**Value** min	**Value** max	**Values out of bounds**
% Hz	99,50	± 1 % 49,50 Hz to 50,50 Hz	-0,132 % 49,93 Hz	0,132 % 50,07 Hz	- -
% Hz	100	-6 % to +4 % 47,00 Hz to 52,00 Hz	-0,252 % 49,93 Hz	0,197 % 50,07 Hz	- -

5.9.4 Magnitude of power supply voltage

Requirements from IEC 61000-4-30:

- data storage Interval:
   - 10 min
      - 52 560 values/channel/year
      - 1 008 values/channel/week
      - 144 values/channel/day
      - 6 values/channel/hour
   - (2 h)
      - 4 380 values/channel/year
      - 84 values/channel/week
      - 12 values/channel/day

Figure 9 gives an example of a one day, 10 min voltage r.m.s record in a single phase LV system (Udin = 230 V) with dip (90 %) and swell (110 %) limits.

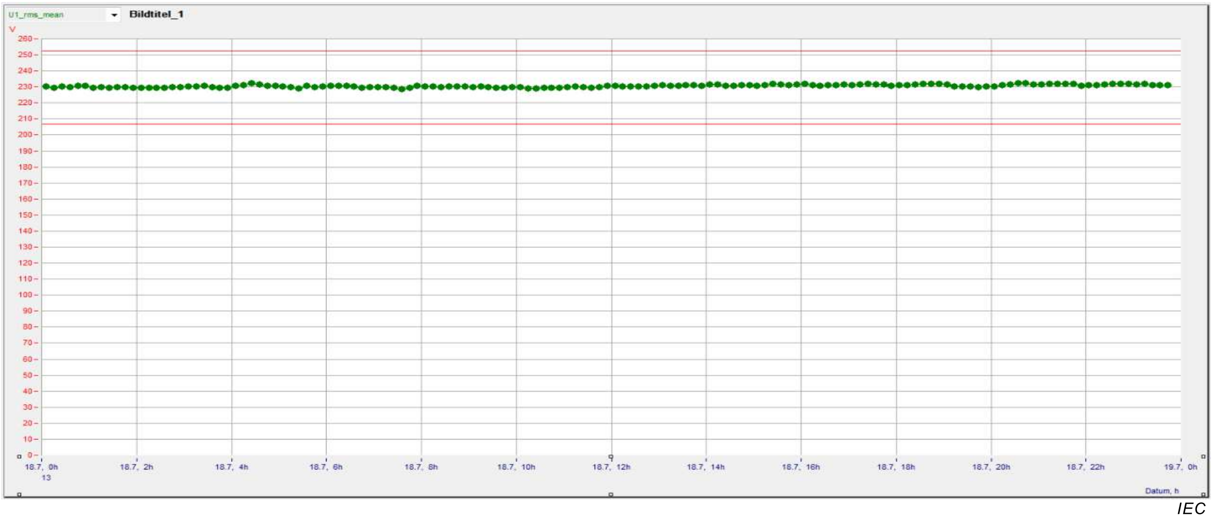


Figure 9 – Example of a one day 10 min voltage r.m.s record in a single phase LV system (Udin = 230 V) with dip (90 %) and swell (110 %) limits

Evaluation according to EN 50160:

1) LV (< 1 kV):
   - during each period of one week
     - 95 % of the 10 min mean r.m.s, values of the supply voltage shall be within the range of Un ± 10 % and
     - all 10 mín mean r.m.s. values of the supply voltage shall be within the range of Un +10 %/ -15 %.
2) MV (1 kV to 36 kV)
   - supply voltage variations
     - should not exceed ± 10 % of the declared voltage Uc measurement period of at least one week
     - at least 99 % of the 10 min mean r.m.s. values of the supply voltage shall be within the limits
     - none of the 10 min mean r.m.s. values of the supply voltage shall be outside the limits ± 15 % of Uc
3) HV (36 kV to 150 kV)
   - not defined

Evaluation according to IEC TS 62749

1) LV
   - during each period of one week, the 10 min r.m.s. values of the voltage at the supply terminals (U), excluding period with interruptions, should comply with the following conditions:
     - voltage percentile Uρ % does not exceed Un + 10 %
     - voltage percentile Uβ % is not lower than Un – 10 %

       ρ having a value in the range (99, 100) according to national conditions

       β having a value of 5 or in the range of (0, 1) according to national conditions
     - and voltage percentile U(100-ρ) % not being lower than Un – 15 %

2) MV (1 kV to 35 kV)

- during each period of one week, the 10 min r.m.s. values of the voltage at the supply terminals (U), excluding the periods of interruption, should comply with the following conditions:
  - voltage percentile U99 % does not exceed Uc + 10 %;
  - voltage percentile U1 % is not lower than Uc – 10 %,
  - voltage percentile U0 % not being lower than Un – 15;

3) HV (35 kV to 230 kV)

- during each period of one 1 week, the 10 min r.m.s. values of the voltage at the supply terminals (U), excluding the periods of interruption, should comply with the following conditions:
  - voltage percentile U99 % does not exceed Uc + 10 %;
  - voltage percentile U1 % is not lower than Uc – 10 %;

Table 11 shows the evaluation of a voltage magnitude record (single phase, LV: 230 V).

Table 11 – Evaluation of a voltage magnitude record (single phase, LV: 230 V)

Voltage changes

All tolerance criteria fulfilled.

Unit	Component	Cutoff value (% of 230.00 V)	Line	Value min	Value max	Values out of bounds
%	95	-	L1	-0.937 %	1.25 %	-
V		-		227.85 V	232.87 V	-
%		± 10.00 %	L2	-	-	-
V		207.00 .. 253.00 V		-	-	-
%		-	L3	-	-	-
V		-		-	-	-
%	100	-	L1	-0.937 %	1.83 %	-
V		-		227.85 V	234.21 V	-
%		-15.00 .. +10.00 %	L2	-	-	-
V		195.50 .. 253.00 V		-	-	-
%		-	L3	-	-	-
V		-		-	-	-

5.9.5 Supply voltage unbalance

Requirements from IEC 61000-4-30: measurement:

- Class A: u2, u0
  - data storage Interval: 10 min
    - 105120 values/year
    - 2016 values/week
    - 288 values/day
    - 12 values/hour
  - data storage Interval: 2 h
    - 8760 values/year
    - 168 values/week
    - 24 values/day

Voltage imbalance ratios are percent values to be calculated as follows:

$$u_2 = \left| \frac{\underline{U}_2}{\underline{U}_1} \right| \cdot 100$$

$$u_0 = \left| \frac{\underline{U}_0}{\underline{U}_1} \right| \cdot 100$$

Evaluation according to EN 50160 or IEC TS 62749

LV, MV (1 kV … 36 kV), (HV in IEC TS 62749)

- During each period of one week, 95 % of the 10 min mean r.m.s. values of the negative phase sequence component (fundamental) of the supply voltage shall be within the range 0 % to 2 % of the positive phase sequence component (fundamental)
- HV in EN 50160 (36 kV to 150 kV): not defined

5.9.6 Voltage Harmonics

Requirements from IEC 61000-4-30:

- Data storage interval:
  - 10 min (harmonic subgroup 1 to 50)
    - 2 628 000 values/channel/year
    - 50 400 values/channel/week
    - 7 200 values/channel/day
    - 300 values/channel/hour
  - 2 h (harmonic subgroup 1 to 50)
    - 219 000 values/channel/year
    - 4 200 values/channel/week
    - 600 values/channel/day
- 10/12-cycle gapless harmonic sub-group measurement, denoted Gsg,n

Figure 10 shows the harmonic subgroup calculation method according to IEC 61000-4-7/IEC 61000-4-30.

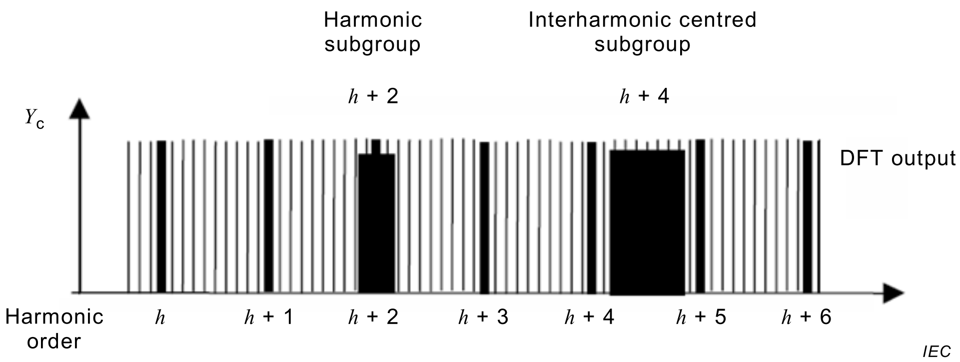
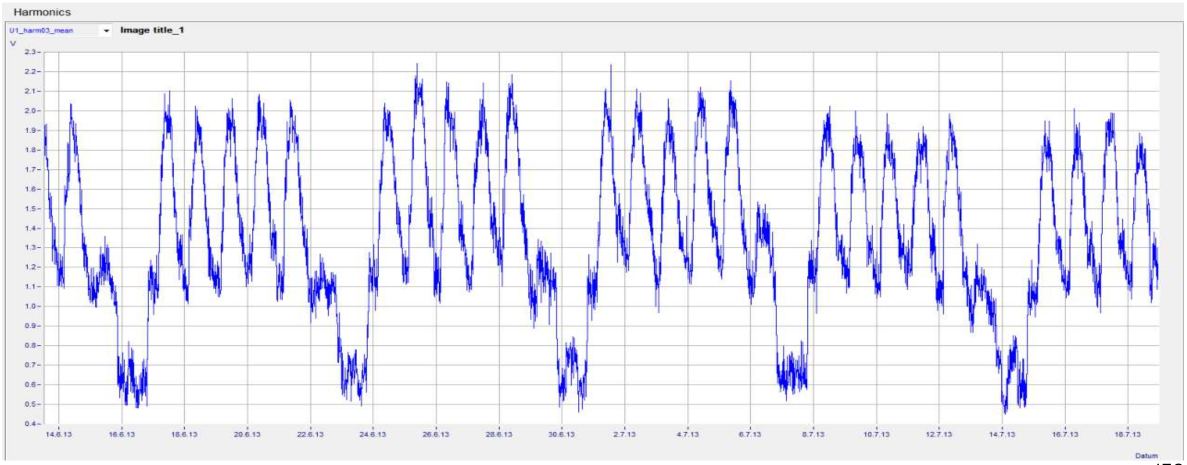


Figure 10 – Harmonic subgroup calculation method according to IEC 61000-4-7/IEC 61000-4-30

Figure 11 gives an example of a 10 min 3rd harmonic record (single phase, LV 230 V), 5 weeks.



IEC

NOTE Y-axis: 0,4 V to 2,3 V (0,174 % to 1 % of Udin).

Figure 11 – Example of 10 min 3rd harmonic record (single phase, LV 230 V), 5 weeks

Evaluation according to EN 50160:

1) (LV (< 1 kV), MV (1 kV to 36 kV)

- during each period of one week, 95 % of the 10 min mean r.m.s. values of each individual harmonic voltage shall be less than or equal to the given values,
- the total harmonic distortion (THD) of the supply voltage should be less than or equal to 8 %.

Table 12 shows the limits for harmonics in LV/MV networks.

Table 12 – Limits for harmonics in LV/MV networks

Odd harmonics				Even harmonics	
Not multiples of 3		Multiples of 3			
Order h	Relative voltage (U_n)	Order h	Relative voltage (U_n)	Order h	Relative voltage (U_n)
5	6,0 %	3	5,0 %	2	2,0 %
7	5,0 %	9	1,5 %	4	1,0 %
11	3,5 %	15	0,5 %	6 to 24	0,5 %
13	3,0 %	21	0,5 %		
17	2,0 %				
19	1,5 %				
23	1,5 %				
25	1,5 %				
NOTE No values are given for harmonics of order higher than 25, as they are usually small, but largely unpredictable due to resonance effects.					

2) HV (36 kV to 150 kV)

Table 13 shows the limits for harmonics in HV networks.

Table 13 – Limits for harmonics in HV networks

Odd harmonics				Even harmonics	
Not multiples of 3		Multiples of 3			
Order h	Relative voltage	Order h	Relative voltage	Order h	Relative voltage
5	4 %	3[a)]	3 %	2	1,9 %
7	3 %	9	1,3 %	4	1 %
11	2 %	15	0,5 %	6 to 24	0,5 %
13	1,8 %	21	0,5 %		
17	1,5 %				
19	1,3 %				
23	1 %				
25	0,9 %				
NOTE No values are given for harmonics of order higher than 25, as they are usually small, but largely unpredictable due to resonance effects.					
a) Depending on the network design the value for the third harmonic order can be substantially lower.					

Evaluation according to IEC TS 62749:

3) LV

- during each period of one week, the voltage percentile $U_{h95\ \%}$ of the 10 minute r.m.s. values of each individual harmonic voltage should be less than or equal to the given values.
- the total harmonic distortion (THD) of the supply voltage should be less than or equal to 8 %.

Table 14 shows the LV/MV network limits for harmonics/interharmonics according to IEC TS 62749.

Table 14 – LV/MV network limits for harmonics/interharmonics according to IEC TS 62749

Odd harmonics				Even harmonics	
Not multiples of 3		Multiples of 3[(Note)]			
Order h	$U_{h95\%}$	Order h	$U_{h95\%}$	Order h	$U_{h95\%}$
5	6,0 %	3	5,0 (6,0)%	2	2,0 %
7	5,0 %	9	1,5 (3,5) %	4	1,5 %
11	3,5 %	15	0,5 (2, 0) %	6 … 24	0,75 %
13	3,0 %	21	0,5 (1,6) %		
17	2,0 %				
19	1,8 %				
23	1,5 %				
25	1,5 %				
$29 \leqslant h \leqslant 49$	2,27 × (17/h) - 0,27 %	$27 \leqslant h \leqslant 45$	0.2 %	$26 \leqslant h \leqslant 50$	0,25 × (10/h) + 0,25 %

NOTE Depending on the type of neutral grounding systems and transformer connections in some countries, more triple harmonics will flow in neutral conductors and may cause higher harmonic voltages. In these cases, the highest value in brackets will better characterize the system harmonic voltages.

4) MV (1 kV to 35 kV)

- during each period of one week, the voltage percentile $U_{h95\ \%}$ of the 10 min r.m.s. values of each individual harmonic voltage should be less than or equal to the given values in Table 14. The total harmonic distortion (THD) of the supply voltage should be less than or equal to 6,5 %.

5) HV

- during each period of one week, the voltage percentile $U_{h95\ \%}$ of the 10 min r.m.s. values of each individual harmonic voltage should be less than or equal to the given values.
- The total harmonic distortion (THD) of the supply voltage shall be limited under a value within 3 % to 5 % (including harmonics for orders up to 50).

Table 15 shows HV network limits for harmonics/interharmonics according to IEC TS 62749.

Table 15 – HV network limits for harmonics/interharmonics according to IEC TS 62749

Odd harmonics				**Even harmonics**	
Not multiples of 3		**Multiples of 3**			
Order		**Order**		**Order**	
h	U_h	h	U_h	h	U_h
5	2,0 % to 5,0 %	3	2,0 % to 3,0 %	2	1,5 % to 1,9 %
7	2,0 % to 4,0 %	9	1,0 % to 2,0 %	4	0,8 % to 1,0 %
11	1,5 % to 3,0 %	15		6 to 12	0,5 %
13	1,5 % to 2,5 %				

NOTE Limits for individual harmonic voltage higher than 13 are under consideration due to limited accuracy of voltage transformers currently in use on HV systems.

5.9.7 Interharmonics

Requirements from IEC 61000-4-30:

- Data storage Interval:
  - 10 min (interharmonic centred subgroup 1 to 50)
    - 2 628 000 values/channel/year
    - 50 400 values/channel/week
    - 7 200 values/channel/day
    - 300 values/channel/hour
  - 2 h (interharmonic centred subgroup 1 to 50)
    - 219 000 values/channel/year
    - 4 200 values/channel/week
    - 600 values/channel/day
- 10/12-cycle gapless interharmonic centred subgroup measurements, denoted $C_{isg,n}$

Figure 12 shows the interharmonic centred subgroup calculation method according to IEC 61000-4-7 and IEC 61000-4-30.

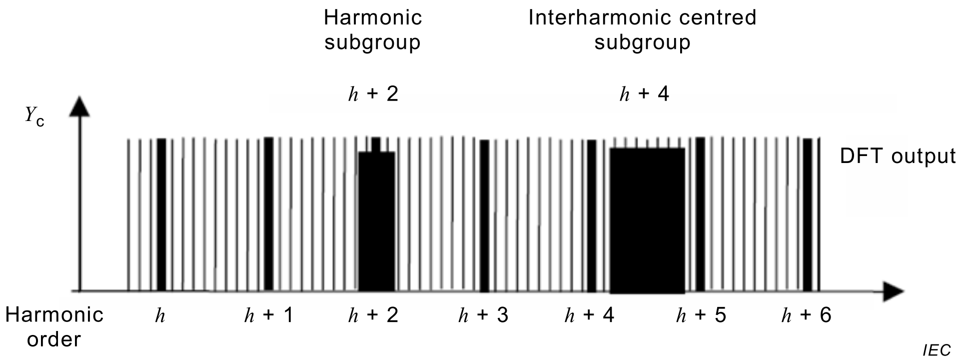


Figure 12 – Interharmonic centred subgroup calculation method according to IEC 61000-4-7 and IEC 61000-4-30

Evaluation according to EN 50160 (LV (< 1 kV), MV (1 kV to 36 kV), HV (36 kV to 150 kV):

- Levels are under consideration, pending more experience

  Evaluation according to IEC TS 62749 (LV (< 1 kV), MV (1 kV to 36 kV), HV (36 kV to 150 kV):
- Same levels as for harmonics

5.9.8 Mains signalling voltages

Requirements from IEC 61000-4-30 (for mains signalling frequencies below 3 kHz):

- Raw data*:* 10/12-cycle (harmonic/interharmonic/frequency bin)
- Optional MSV records up to 120 s (threshold trigger) 600 values/channel/record
- 150/180-cylce for EN 50160 evaluation:
  - 2 counters for daily MSV evaluation:
  - Counter C1: r.m.s. value is less than or equal voltage level given in Figure 13
  - Counter C2: r.m.s. value is higher than voltage level given in Figure 13

Requirements from EN 50160: For 99 % of a day the 3 s mean value of signal voltages shall be less than or equal to the values given in Figure 13. It is fulfilled, if the ratio C2/C1*100 % for one day is higher than 99 %.

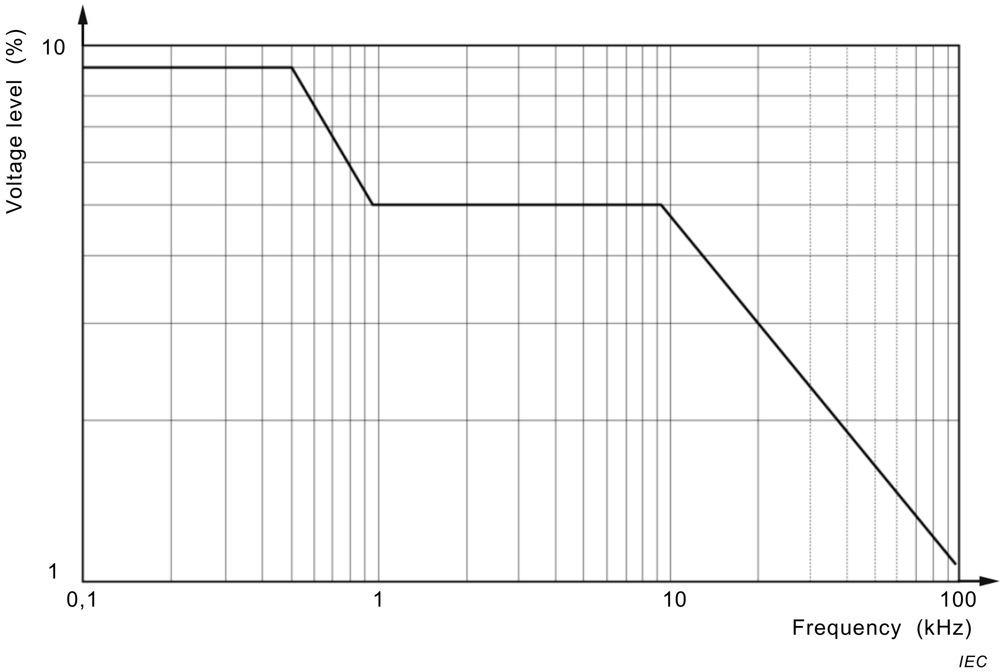


Figure 13 – Voltage levels of signal frequencies in percent of nominal voltage U_n used in public LV and MV networks from EN 50160 standard

5.9.9 Flicker

Requirements from IEC 61000-4-30:

- data storage Interval:
  - 10 min P_{st}
    - 52 560 values/channel/year
    - 1 008 values/channel/week
    - 144 values/channel/day
    - 6 values/channel/hour
  - 2 h P_{lt}
    - 4 380 values/channel/year
    - 84 values/channel/week
    - 12 values/channel/day

Figure 14 gives an example of a one month long term Flicker record (single phase, 230 V).

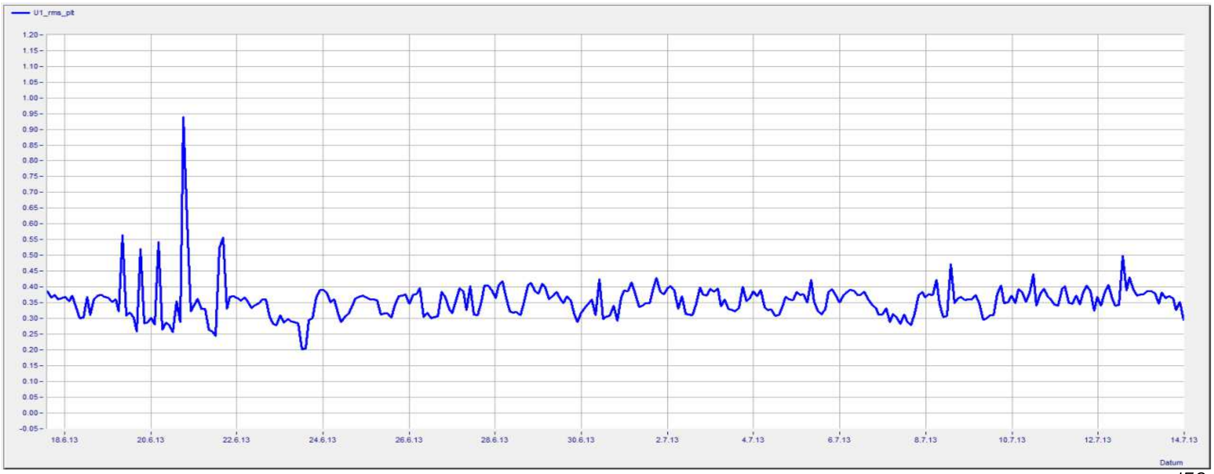


Figure 14 – Example of a one month long term Flicker record (single phase, 230 V)

Requirements from EN 50160 (LV (< 1 kV), MV (1 kV to 36 kV), HV (36 kV to 150 kV):

- During each period of one week the long term flicker severity P_{lt} caused by voltage fluctuation should be less than or equal to 1 for 95 % of the time

Requirements from IEC TS 62749 are shown in Tables 16 and 17:

Table 16 – Flicker severity Plt recommended values

Voltage levels	P_{lt}
LV/MV	1,0
HV	1,0

Table 17 – Evaluation of a Flicker record (single phase, nominal voltage 230 V)

Flicker

All tolerance criteria fulfilled.

Unit	Component	Cutoff value	Line	Value min	Value max	Values out of bounds
%	95	-	L1	-	-	-
plt		-		0.201	0.409	-
%		-	L2	-	-	-
plt		0 .. 1.00		-	-	-
%		-	L3	-	-	-
plt		-		-	-	-
%	100	-	L1	-	-	-
plt		-		0.201	0.940	-
%		-	L2	-	-	-
plt		0 .. 1.00		-	-	-
%		-	L3	-	-	-
plt		-		-	-	-

5.9.10 Conducted emission in the 2 kHz to 9 kHz range

Specification of experimental method described in informative annex B of IEC 61000-4-7.

Data storage Interval:

- 10 min (200 Hz harmonic bin 1 to 35)
  - 1 799 280 values/channel/year
  - 35 280 values/channel/week
  - 5 040 values/channel/day
  - 210 values/channel/hour

Figure 15 shows the grouping of 5 Hz frequencies to 200 Hz frequency bands Y.

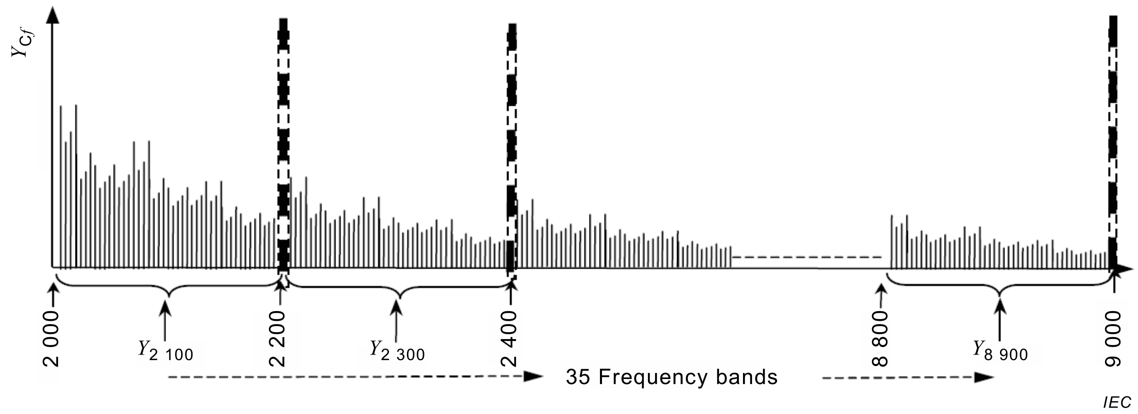


Figure 15 – Grouping of 5 Hz frequencies to 200 Hz frequency bands Y

Table 18 gives the requirements from IEC 61000-4-7:2009.

Table 18 – Requirements from IEC 61000-4-7:2009

Bin No.	center frequency f [kHz]	output Y (rms)			
1	2,1				
2	2,3				
3	2,5				
4	2,7				
5	2,9				
6	3,1				
7	3,3			200 Hz bins	
8	3,5				
9	3,7				
10	3,9			35	values per phase
11	4,1			175	values per second and phase
:	:	:			
35	8,9				

Information about emission magnitudes in the 2 kHz to 9 kHz band can be found in IEC 61000-2-4:2002, C.3, where, for example, on systems with U_{din} = 230 V, “few troubles were reported on networks having” emissions in the range 0,46 V to 3,45 V. For the same 2 kHz to 9 kHz band, IEC 61000-2-2:2002, B.2.3, suggests a reference level for any 200 Hz bandwidth of 0,69 V.

5.9.11 Conducted emissions in the 9 kHz to 150 kHz range

Specification of experimental method described in C.3 of IEC 61000-4-30:2015: For 9 kHz to 150 kHz, at each 10/12 cycle interval, 32 sets of these 71 bins are available. At each 10/12-cycle interval, the minimum, average, and maximum value of the 32 r.m.s. magnitudes of each of these 71 bins could be reported. In addition, at each 10/12-cycle interval, a single r.m.s. maximum value of all 71 bins across all channels could be reported.

Requirements from IEC 61000-4-30:2015:

- Data storage interval:
  - 10 min (2 kHz harmonic bin 1…71)
    - 215 880 values/channel/week
    - 30 840 values/channel/day
    - 1 285 values/channel/hour

Table 19 gives the requirements from IEC 61000-4-30:2015.

Table 19 – Requirements from IEC 61000-4-30:2015

Bin No.	**f1**[kHz]	**f2**[kHz]	**min**	**avg**	**max**		**max (over all 71 bins)**	
1	8	10						
2	10	12						
3	12	14					min, avg, max:	
4	14	16					calculated over x 512 pt. FFT for 10/12 cycle	
5	16	18						
6	18	20					x = 32 (31 or 37 or 41)	
7	20	22					2 kHz bins	
8	22	24						
9	24	26						
10	26	28					214	values per phase
11	28	30					1066	values per second and phase
12	30	32						
13	32	34						
:	:	:						
71	148	150						

5.9.12 Magnitude of current

Requirements from IEC 61000-4-30:2015:

- data storage interval:
  - 10 min
    - 52 560 values/channel/year
    - 1 008 values/channel/week
    - 144 values/channel/day
    - 6 values/channel/hour
  - (2 h)
    - 4 380 values/channel/year
    - 84 values/channel/week
    - 12 values/channel/day

5.9.13 Current unbalance

Requirements from IEC 61000-4-30:2015: measurement:

- Class A: u2, u0
  - data storage interval: 10 min
    - 105 120 values/year
    - 2 016 values/week
    - 288 values/day
    - 12 values/hour
  - (data storage Interval: 2 h)
    - 8 760 values/year
    - 168 values/week
    - 24 values/day

5.9.14 Current harmonics

Requirements from IEC 61000-4-30:2015:

- Data storage interval:
  - 10 min (harmonic subgroup 1 to 50)
    - 2 628 000 values/channel/year
    - 50 400 values/channel/week
    - 7 200 values/channel/day
    - 300 values/channel/hour
  - (2 h (harmonic subgroup 1 to 50))
    - 219 000 values/channel/year
    - 4 200 values/channel/week
    - 600 values/channel/day

5.9.15 Current interharmonics

Requirements from IEC 61000-4-30:2015:

- Data storage interval:
  - 10 min (harmonic subgroup 1 to 50)
    - 2 628 000 values/channel/year
    - 50 400 values/channel/week
    - 7 200 values/channel/day
    - 300 values/channel/hour
  - (2 h (harmonic subgroup 1 to 50))
    - 219 000 values/channel/year
    - 4 200 values/channel/week
    - 600 values/channel/day

5.9.16 Current recording

Requirements from IEC 61000-4-30:2015:

Whenever an rms voltage channel is recorded, the corresponding rms current channel shall also be recorded at an equivalent aggregation level. This applies both to triggered voltage events, such as dips and swells and RVC, and to continuing aggregation, such as 10-min and 2-hr.

5.10 PQ events

5.10.1 General

Table 20 gives a PQ event overview.

Table 20 – PQ event overview

Function	Triggered events	Flagging
Supply voltage dips and interrup-tions	Residual voltage U r.m.s. (1/2) or depth and time stamps (duration)	N.A. (source of flagging)
Supply voltage swells	maximum swell magnitude and time stamps (duration)	N.A. (source of flagging)
Voltage transients	[a]	–
Rapid voltage changes	New topic from IEC 61000-4-30:2015 and IEC TS 62749	–

[a] Measurement of transient voltages can be useful but is not mandatory.

5.10.2 Supply voltage dips and interruptions

NOTE 1 Power quality monitoring for voltage interruptions, dips and swells monitor voltage signals in a similar way to over-voltage or under-voltage protection functions, however they use different internal algorithms with different types of settings.

NOTE 2 Power quality monitoring for voltage interruptions, dips and swells monitor voltage signals in a similar way to over-voltage or under-voltage protection functions, however they use different internal algorithms with different types of settings. Base algorithm for PQ event detection is r.m.s. voltage refreshed each half-cycle (Urms(½) value of the r.m.s. voltage measured over 1 cycle, commencing at a fundamental zero crossing, and refreshed each half-cycle (for class A devices).

Figure 16 explains power quality voltage variations.

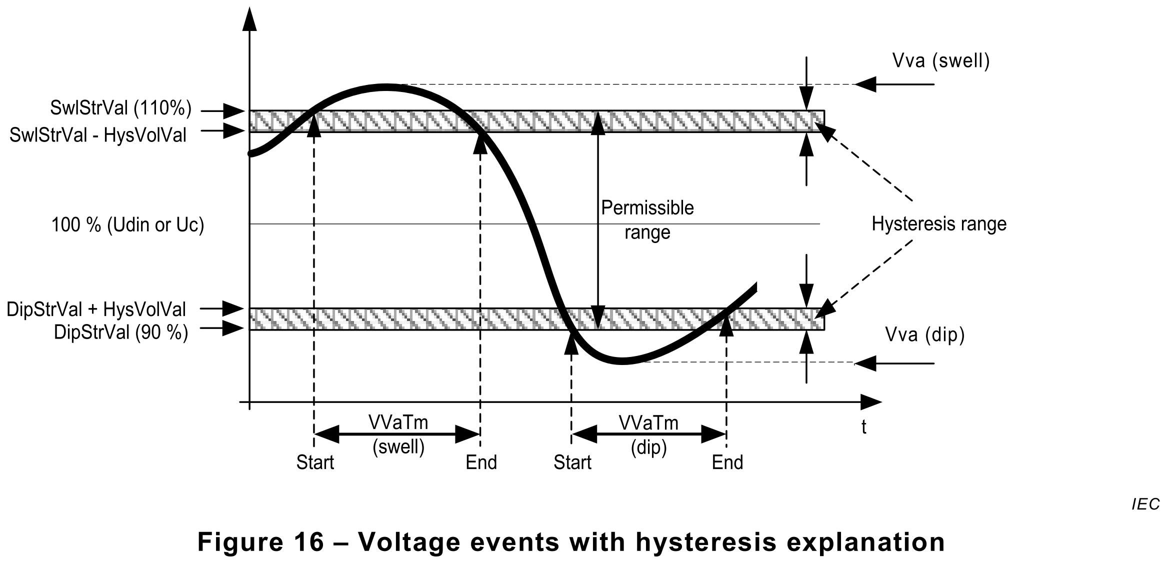


Figure 16 – Voltage events with hysteresis explanation

NOTE 3 Hysteresis is used for dips, swells and interruptions. Typically, the hysteresis is equal to 2 % of Udin.

Magnitude-duration table according to EN 50160:

- Voltage Dips (see Table 21: 5 thresholds with each 5 timers)
- Voltage Swells (see Table 21: 2 thresholds with each 3 timers)

Magnitude-duration table acc. IEC TS 62749:

- Dips, swells, interruptions (see Table 22: 8 thresholds with each 5 timers)

5.10.3 Evaluation of voltage events: Magnitude-duration table(s)

Table 21 shows the voltage dip/interruption and swell classification according to EN 50160.

Table 21 – Voltage dip/interruption and swell classification according to EN 50160

Residual Voltage U [%]	**Duration t** [ms]				
	20 ≤ t ≤ 200	200 < t ≤ 500	500 < t ≤ 1 000	1 000 < t ≤ 5 000	5 000 < t ≤ 60 000
90 > u > = 80	CELL A1	CELL A2	CELL A3	CELL A4	CELL A5
80 > u > = 70	CELL B1	CELL B2	CELL B3	CELL B4	CELL B5
70 > u > = 40	CELL C1	CELL C2	CELL C3	CELL C4	CELL C5
40 > u > = 5	CELL D1	CELL D2	CELL D3	CELL D4	CELL D5
5 > u	CELL X1	CELL X2	CELL X3	CELL X4	CELL X5

Swell voltage U [%]	Duration t [ms]		
	20 ≤ t ≤ 500	500 < t ≤ 5 000	5 000 < t ≤ 60 000
U > = 120	CELL S1	CELL S2	CELL S3
120 > u > = 110	CELL T1	CELL T2	CELL T3

Table 22 shows the voltage event classification according to IEC TS 62749.

Table 22 – Voltage event classification according to IEC TS 62749

Residual voltage U [%]	**Duration t** [ms]				
	20 ≤ t ≤ 200	200 < t ≤ 500	500 < t ≤ 1 000	1 000 < t ≤ 5 000	5 000 < t ≤ 60 000
u ≥ 120					
120 > u ≥ 110					
90 > u ≥ 80					
80 > u ≥ 70					
70 > u ≥ 40		1			
40 > u ≥ 10					
10 > u					
Voltage interruption					

Example: the event shown in Table 23 would be added to the blue marked field in Table 22.

Table 23 – Example of single event assessment according to IEC TS 62749

Event attribution	Details
Location	BlnW5 230 V
Time stamp	2013-07-18 17:23:15,39
Capturing Threshold	90 %
Residual Voltage	55,3 %
Time duration	247 ms
RMS Variation Shape	See Figure 17
Point on Wave	See Figure 18

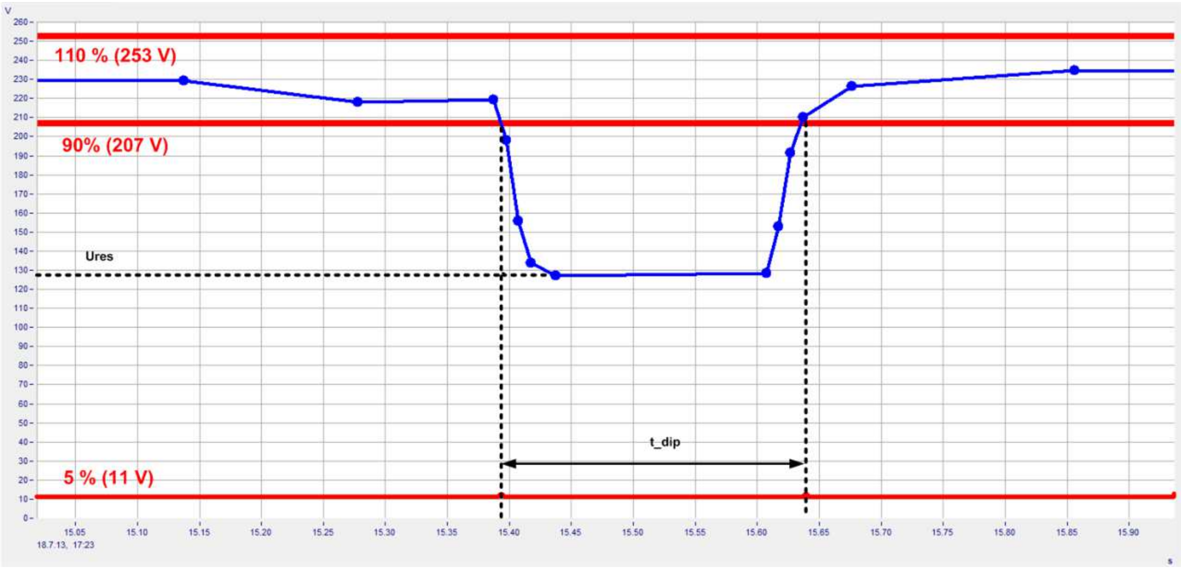


Figure 17 – Example of a voltage event: voltage dip with limits (dip, swell, interruption), hysteresis = 2 % of Udin and additional record of voltage variations (1/2 cycle r.m.s. values)

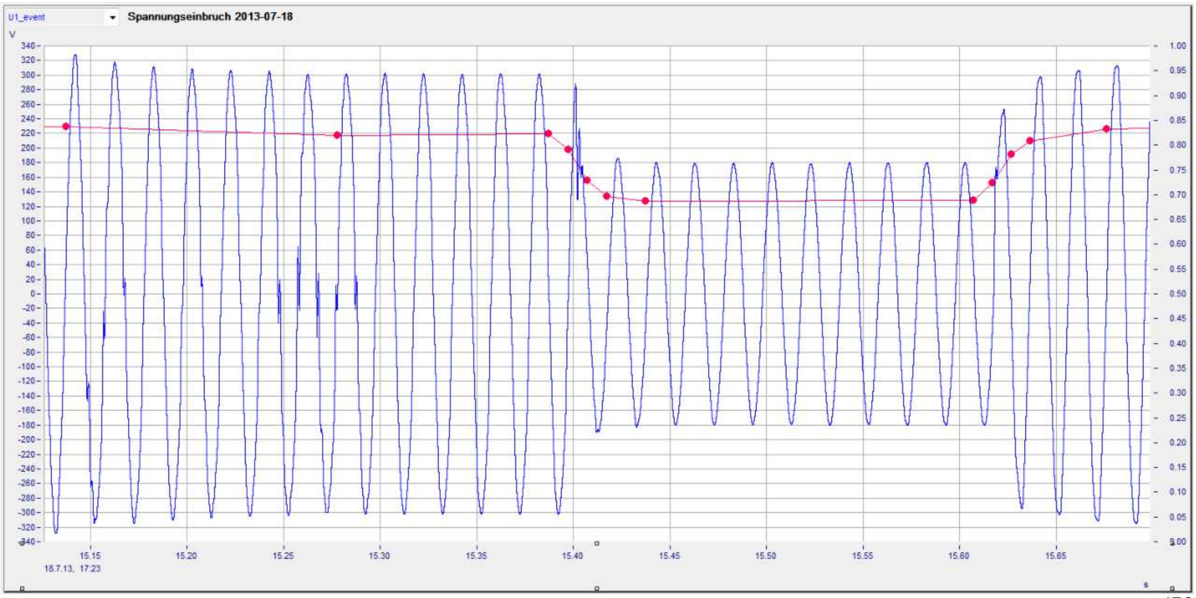


Figure 18 – Voltage dip event with additional fault record

5.10.4 Flagging

During a dip, swell, or interruption, the measurement algorithm for other parameters (for example, frequency measurement) might produce an unreliable value. The flagging concept therefore avoids counting a single event more than once in different parameters.

Flagging is only triggered by dips, swells, and interruptions. The detection of dips and swells is dependent on the threshold selected by the user, and this selection will influence which data are flagged.

The flagging concept is applicable for class A and class S during measurement of power frequency, voltage magnitude, flicker, supply voltage unbalance, voltage harmonics, voltage interharmonics and mains signaling.

Flagging of data and usage of flagged data in power quality reports are decided by users. The generation of additional flagging information in IED and IEC 61850 modelling is not necessary.

Table 24 shows flagging requirements versus use cases according to Figure 1.

Table 24 – Flagging requirements vs. use cases according to Figure 1

Request for power quality measurements	Flagging of operational measured values is not necessary
Retrieve power quality records	Flagging can be derived from combination of long term records and event list or can be added in PQDIF file
Sending of power quality events/limit violations	Events are source of flagging, but time resolution of event detection and measurement aggregation are different. It is not necessary to add quality information to operational measured values, even if they are not transmitted cyclically, only after value change.

Figure 19 shows flagged data.

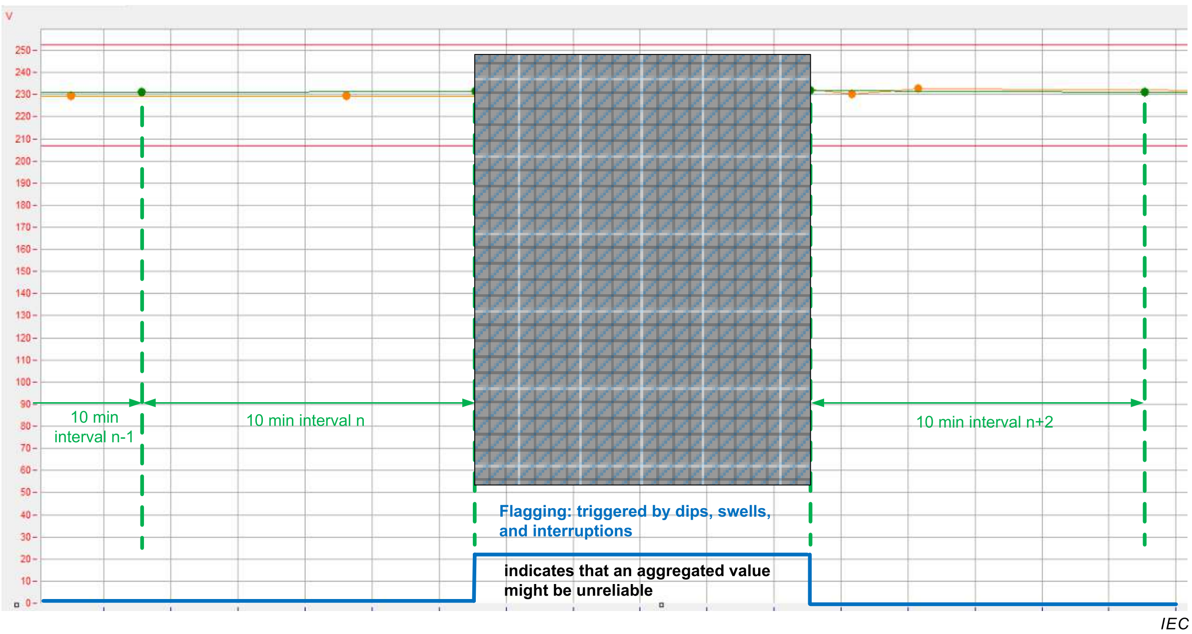


Figure 19 – Flagged data: supply voltage magnitude is flagged if a voltage dip occurred in aggregation interval

5.10.5 Rapid voltage changes (RVC)

A rapid voltage change is defined as the change in the r.m.s. value of a voltage signal that moves from a steady state value to a maximum change and then gradually varies and settles at a new level determined by $\Delta V_{steadystate}$. It is characterized by maximum depth ΔV_{max}, duration (T) and new steady state value (see Figure 20). In order for the event to be classified as an RVC, ΔV_{max} should be less than ±10% of V_n declared. Voltage changes with larger depth are generally classified as voltage dips.

The RVC hysteresis is set by the user according to the application, and shall be less than the RVC threshold.

NOTE Hysteresis in the range of 50 % of the RVC threshold might be considered.

It is useful to count the number of RVC events per hour, or per day, or both.

Figure 20 shows RVC characterization.

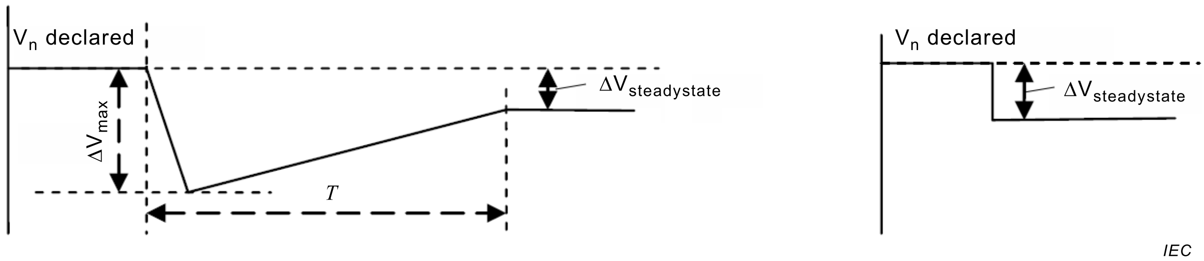


Figure 20 – RVC characterization

Requirements from IEC TS 62749: Rapid voltage change indicative values are in the range of 3 % to 5 % of *Udin* (U_C) for LV, MV and HV.

6 IEC 61850 information models for power quality profiles

6.1 Power quality modelling name conventions

The following name conventions are used for PQ LNs. LN prefix and numbering are related to the aggregation methods of IEC 61000-4-30:

- PQy0xxxx for 10/12 cycles r.m.s. values according to IEC 61000-4-30 (see Notes 1 and 2)
- PQy1xxxx for 150/180 cycles aggregated values according to IEC 61000-4-30
- PQy2xxxx for 10 min aggregated values according to IEC 61000-4-30
- PQy3xxxx for 2 h aggregated values according to IEC 61000-4-30
- PQy4xxxx for 10 s values according to IEC 61000-4-30 (frequency)

NOTE 1 PQy prefix for LN:

– PQA is used for class A IEDs;

– PQS is used for class S IEDs.

NOTE 2 PQy0xxxx

– the 10/12 cycles values are available in the full database, that will be downloaded;

– however, the user may need to get a 10/12 cycles values from time to time.

Additional information indicates the calculation methods, modes and intervals.

Table 25 gives calculation methods for power quality values according to IEC 61000-4-30.

Table 25 – Calculation methods for power quality values according to IEC 61000-4-30

	ClcMth	ClcMod	ClcIntvTyp	ClcIntvPer	ClcSrc	comment
PQy0xxxx	TRUE_RMS[3]	PERIOD	CYCLE	10 or 12	-	10/12 cycles
PQy1xxxx[4]	AVG	PERIOD	CYCLE	150 or 180	PQy0xxxx	150/180 cycles
PQy2xxxx	AVG[5]	PERIOD	MS	10*60*1000 (600 000)	PQy0xxxx or PQy1xxxx	10 min
PQy3xxxx	AVG	PERIOD	MS	2*3600*1000 (7 800 000)	PQy2xxxx	2 h
PQy4xxxx	***FREQUENCY***	PERIOD	MS	10 000	-	10 s

NOTE 3 ClcMth:

– TRUE_RMS for voltage magnitude

– *RMS* for harmonics/interharmonics and unbalance (u0, u2)

NOTE 4 $PQy1xxxx = \sum_{n=1}^{15}(\mathrm{PQy0xxxx(n)}/15)$

NOTE 5 Flicker level for Flicker Pst.

Many countries have national requirements that partially replace those in EN 50160. For example 1 min values for voltage in Norway or 10-min gliding P_{LT}-value in Netherlands.

For modified PQ values the manufacturer shall specify the cycle(s) (a), average values (b to e) and/or ClcSrc.

Table 26 shows calculation methods for modified power quality values.

Table 26 – Calculation methods for modified power quality values

	ClcMth	ClcMod	ClcIntvTyp	ClcIntvPer	ClcSrc	comment
PQyaxxxx	TRUE_RMS	PERIOD	CYCLE	a	-	a cycle(s)
PQybxxxx	AVG	PERIOD	CYCLE	b*ClcIntvPer(PQyaxxxx)	SBM	b cycle(s)
PQycxxxx	AVG	PERIOD	MS	c*60*1000	SBM	c min(s)
PQydxxxx	AVG	PERIOD	MS	d*3600*1000	SBM	d h(s)
PQyexxxx	AVG	PERIOD	MS	e	-	e s(s)
SBM = Specified by manufacturer						

6.2 Modelling of a Class A power quality instrument

6.2.1 Use case 1: Request for power quality measurements

Figure 21 shows state of the art modeling for use case “Request for power quality measurements”.

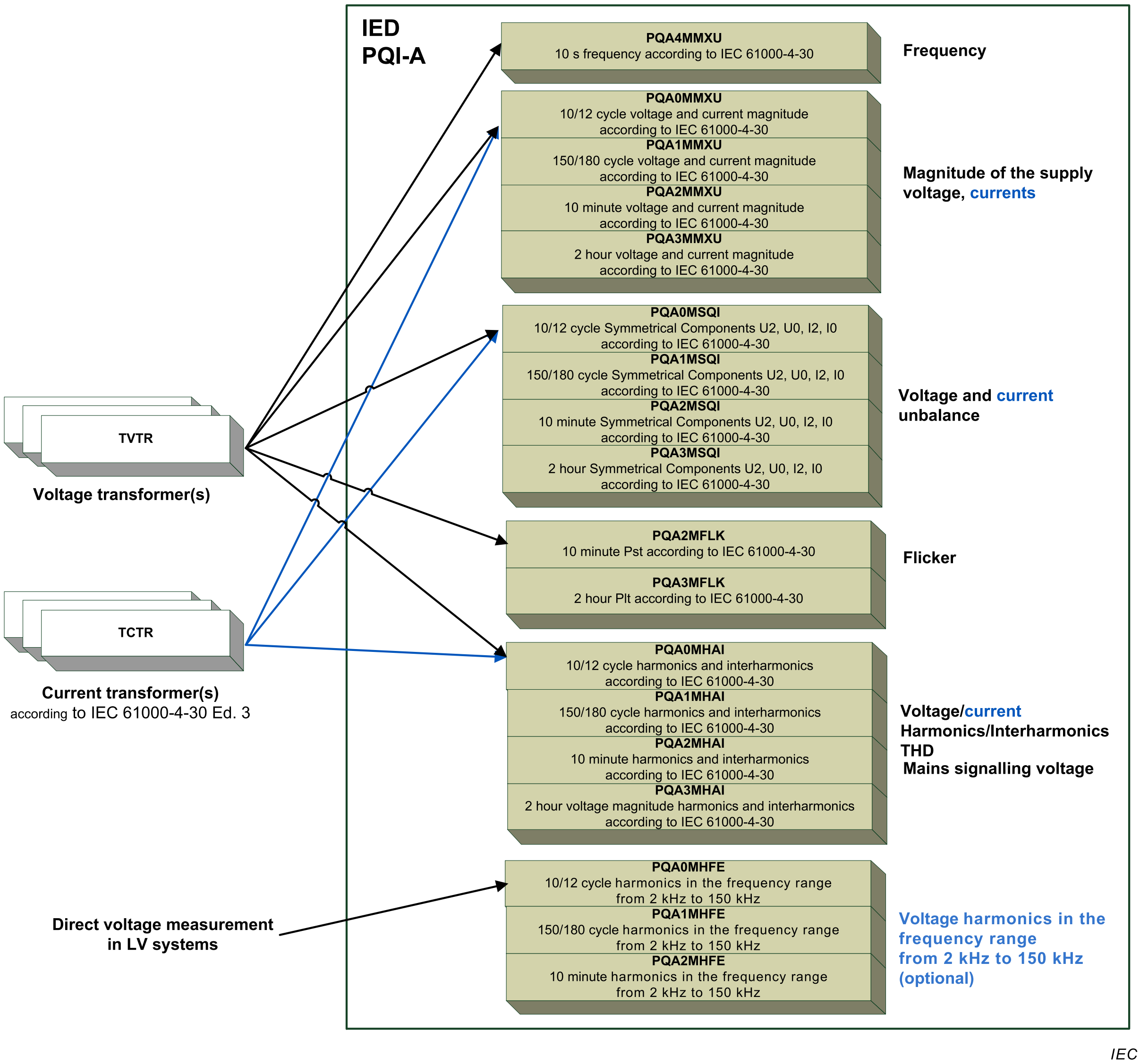


Figure 21 – State of the art data modeling for use case “Request for power quality measurements” (new in IEC 61000-4-30:2015)

6.2.2 Use case 2: Sending of power quality events/limit violations

Figure 22 shows state of the art modeling for use case "PQ alarming".

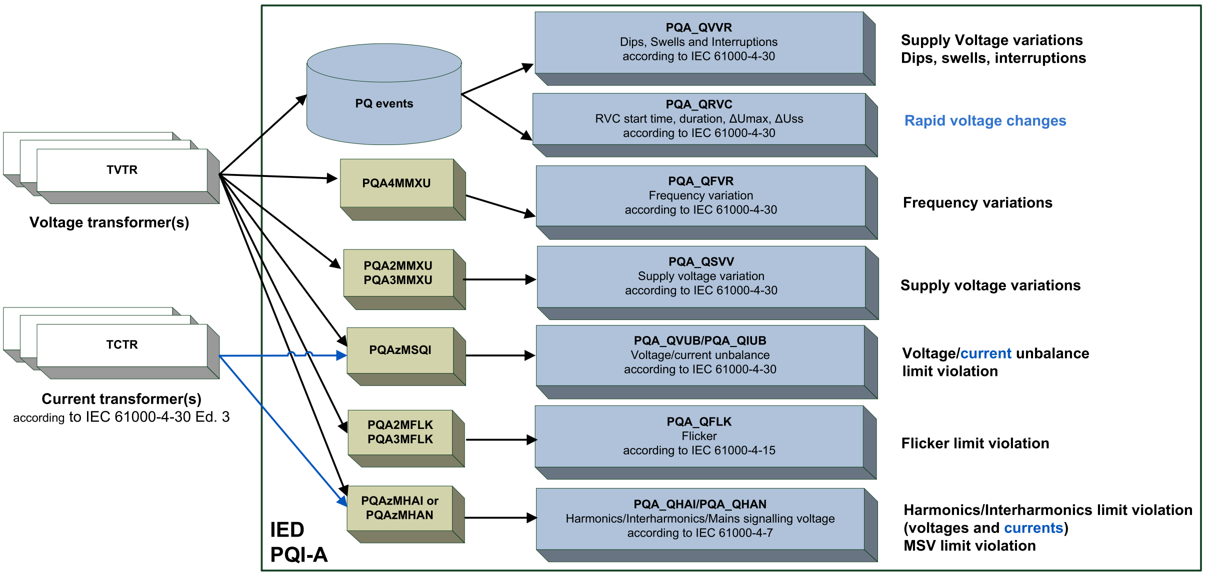


Figure 22 – State of the art data modeling for use case "Sending of power quality events/limit violations" (new in IEC 61000-4-30:2015)

6.2.3 Use case 3: Retrieve power quality records

Figure 23 shows state of the art modeling for use case “Retrieve power quality records".

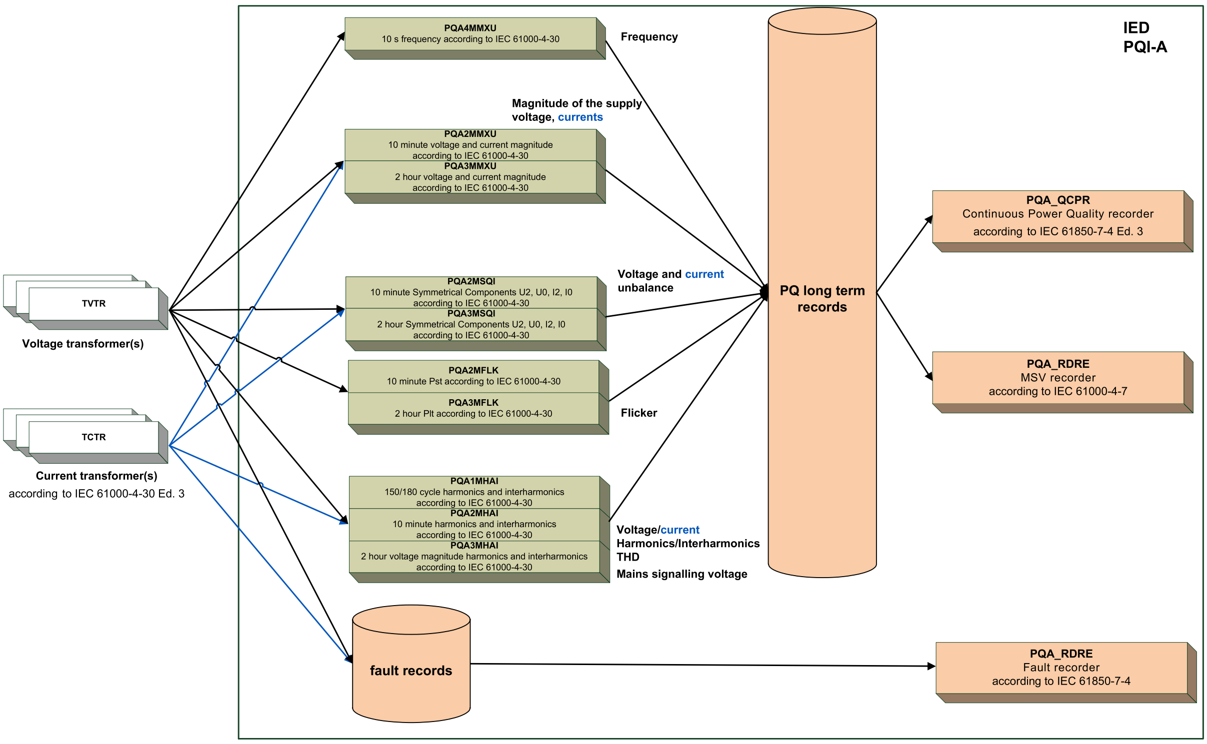


Figure 23 – State of the art data modelling for use case “Retrieve power quality records" (new in IEC 61000-4-30:2015)

6.3 IEC 61850 PQ mapping

Table 27 shows a mapping between power quality measurements and applications.

Table 27 – PQ mapping

	Measurement	Alarming	Evaluation	Reporting
Power Frequency	MMXU/MMXN	QFVR	QFVR	***QCPR***
Magnitude of the Supply Voltage	MMXU/MMXN	***QSVV***	QVVR	***QCPR***
Supply voltage unbalance	MSQI	QVUB	QVUB	***QCPR***
Voltage Harmonics	MHAI/MHAN	***QVHA***	***QVHA***	***QCPR***
Voltage Interharmonics	MHAI/MHAN	***QVHA***	***QVHA***	***QCPR***
Flicker	MFLK	***QFLK***	***QFLK***	***QCPR***
Mains Signalling Voltage	MHAI/MHAN	***QMSV***	***QMSV***	***QCPR***
Emissions 2 kHz to 150 kHz	***MHFE***	n/a	n/a	***QCPR***
Magnitude of the currents	MMXU/MMXN	n/a	n/a	***QCPR***
Current unbalance	MSQI	QIUB	QIUB	***QCPR***
Current Harmonics	MHAI/MHAN	n/a	n/a	***QCPR***
Current Interharmonics	MHAI/MHAN	n/a	n/a	***QCPR***
Voltage and current records	n/a	RDRE	n/a	RDRE
Supply voltage dips and interruptions	n/a	QVVR	QVVR	***QCPR***
Supply voltage swells	n/a	QVVR	QVVR	***QCPR***
Voltage transients	n/a	QVTR	n/a	***QCPR***
Current transients	n/a	QITR	n/a	***QCPR***
Rapid voltage changes	n/a	***QRVC***	n/a	***QCPR***
Bold italic: Qxxx: new data objects n/a: no limits given				

6.4 PQ monitoring

6.4.1 General

Relevant modeling elements (logical nodes) of IEC 61850 for PQ measurement:

- Logical node for voltage, current, power and frequency measurement: MMXU/MMXN,
- Logical node for harmonics measurement: MHAI/MHAN,
- Logical node for measurement of emission in 2 kHz to 9 kHz range: MHF1,
- Logical node for measurement of emission in 9 kHz to 150 kHz range: MHF2
- Logical node for flicker measurement: MFLK,
- Logical node for unbalance measurement: MSQI.

NOTE 1 Power quality instruments are designed to monitor a single phase of a power supply system or to monitor polyphase systems. IEC 61850-7-4 defines two sets of logical nodes to do this: MMXN, MHAN for single phase measurements and MMXU, MHAI for three phase measurements.

6.4.2 Use of LN MMXU/MMXN

Application:

- Frequency f (10 s),
- Magnitude of power supply voltage U (10/12 cycle, 150/180 cycle, 10 minutes,
- 2 h (optional)),
- Currents I (IEC 61000-4-30:2015) (10/12 cycle, 150/180 cycle, 10 min, 2 h (optional)),
- (optional): Power (active, reactive, apparent), 10 min.

NOTE 1 Measurements can be performed on single-phase or polyphase supply systems. Depending on the context, it may be necessary to measure voltages between phase conductors and neutral (line-to-neutral) or between phase conductors (line-to-line) or between phase conductors or neutral and earth (phase-to-earth, neutral-to-earth).

NOTE 2 Phase–to-phase instantaneous values can be measured directly or derived from instantaneous phase–to-neutral measured values.

NOTE 3 Current measurement is performed on each conductor of supply systems, including the neutral conductor and the protective earth conductor.

NOTE 4 MMXU is used for polyphase systems.

NOTE 5 MMXN is used for single-phase systems.

6.4.3 Use of LN MHAI/MHAN

Explanation of the power quality specific implementation

An array shall contain the harmonic and interharmonic values. The first array element shall contain the dc component.

By definition of IEC 61000-4-30 and IEC 61000-4-7, special groupings of harmonics and interharmonics are used for PQ applications: harmonic subgroups and interharmonic centred subgroups (see 5.9.6. and 5.9.7).

Table 28 shows the relation between nominal frequency, number of cycles and harmonics/interharmonics grouping for PQ application.

Table 28 – Relation between nominal frequency, number of cycles and harmonics/interharmonics grouping for PQ application

index	numCyc = 10	PQ grouping	PQ index
0	dc component		0
1	0,1 x fundamental frequency	1st interharmonic subgroup	1
2	0,2 x fundamental frequency		
3	0,3 x fundamental frequency		
4	0,4 x fundamental frequency		
5	0,5 x fundamental frequency		
6	0,6 x fundamental frequency		
7	0,7 x fundamental frequency		
8	0,8 x fundamental frequency		
9	0,9 x fundamental frequency	1st harmonic subgroup	2
10	1st harmonic = fundamental frequency		
11	1,1 x fundamental frequency		
12	1,2 x fundamental frequency	2nd interharmonic subgroup	3
13	1,3 x fundamental frequency		
14	1,4 x fundamental frequency		
15	1,5 x fundamental frequency		
16	1,6 x fundamental frequency		
17	1,7 x fundamental frequency		
18	1,8 x fundamental frequency		
19	1,9 x fundamental frequency	2nd harmonic subgroup	4
20	2nd harmonic		
21	2,1 x fundamental frequency		
22	2,2 x fundamental frequency	3rd interharmonic subgroup	5
23	2,3 x fundamental frequency		
24	2,4 x fundamental frequency		
:	:	:	:
499	49,9 x fundamental frequency	50th harmonic subgroup	100
500	50th harmonic		

(red)	Dc component
(green)	Harmonics
(yellow)	Interharmonics
(amber)	Subharmonics
(blue)	Harmonic subgroup
(orange)	Interharmonic subgroup

Table 29 shows the order of DC, harmonics and interharmonics in MHAI for PQ application.

Table 29 – Order of DC, harmonics and interharmonics in MHAI for PQ application

Index	PQ Application
0	dc component
1	1st interharmonic subgroup
2	1st harmonic subgroup
3	2nd interharmonic subgroup
4	2nd harmonic subgroup
5	3rd interharmonic subgroup
6	3rd harmonic subgroup
7	4th interharmonic subgroup
8	4th harmonic subgroup
9	5th interharmonic subgroup
10	5th harmonic subgroup
11	6th interharmonic subgroup
12	6th harmonic subgroup
13	7th interharmonic subgroup
14	7th harmonic subgroup
15	8th interharmonic subgroup
16	8th harmonic subgroup
17	9th interharmonic subgroup
18	9th harmonic subgroup
19	10th interharmonic subgroup
20	10th harmonic subgroup
...50 / ...80 /...100	...up to 25th order (EN 50160) 40th order (IEC 61000-4-30/IEC 62586 Class S) 50th order (IEC 61000-4-30/IEC 62586 Class A)

Application:

- Harmonics and interharmonics measurement (voltages and currents) in poly-phase systems
- total voltage/current harmonic or interharmonic distortion measurement

Application:

- Harmonics, interharmonics (voltages and currents) in single phase systems
- total voltage/current harmonic or interharmonic distortion alarming

6.4.4 Use of LN MHFE – new LN

- Application:
  - Measurement of harmonics in the frequency range from 2 kHz to 9 kHz according to IEC 61000-4-7:2009, Annex B
  - Measurement of harmonics in the frequency range from 9 kHz to 150 kHz according to of experimental method described in C.3 of IEC 61000-4-30:2015

6.4.5 Use of LN MFLK

Application:

- Flicker (P_{ST}, P_{LT}, P_{inst})

6.4.6 Use of LN MSQI

Application:

- Voltage/current unbalance

6.5 PQ event monitoring and PQ evaluation

6.5.1 General

Additionally the prescribed modeling elements (Logical nodes) of IEC 61850-7-4 Ed. 2.1[3] are used for PQ events and PQ evaluation/reporting:

- Logical node for voltage variation reporting: QVVR,
- Logical node for frequency variation reporting: QFVR,
- Logical node for voltage unbalance variation reporting: QVUB,
- Logical node for current unbalance variation reporting: QIUB,
- QITRExt
- QVTRExt
- Logical node for rapid voltage changes reporting: QRVC,
- Logical node for supply voltage variation reporting: QSVV,
- QFLK
- QVHA
- QMSV
- QCPR
- Logical node for total voltage/current harmonic or interharmonic distortion alarming: use ThdAVal and/or ThdVVal in MHAI/MHAN.

6.5.2 Use of LN QVVR voltage variations

Application: Voltage dip, swell, interruption monitoring

NOTE LN QVVR can be used to record events on a single phase context or in a three phase system context.

EvtCnt HST: Classifier bins of voltage event counters (i.e., the number of times that an event detected by the logical node occurred).

The values of the hstVal ARRAY 0...maxPts-1 of data type INT32 are the counts of periods with a variation event for the specified voltage u (%), and time t (ms).

In the example in Table 30, an implementation according to Table 22 is shown.

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3 Under preparation. Stage at the time of publication: IEC/AFDIS 61850-7-4:2017.

Table 30 – hstVal indices (e.g. according to IEC TS 62749)

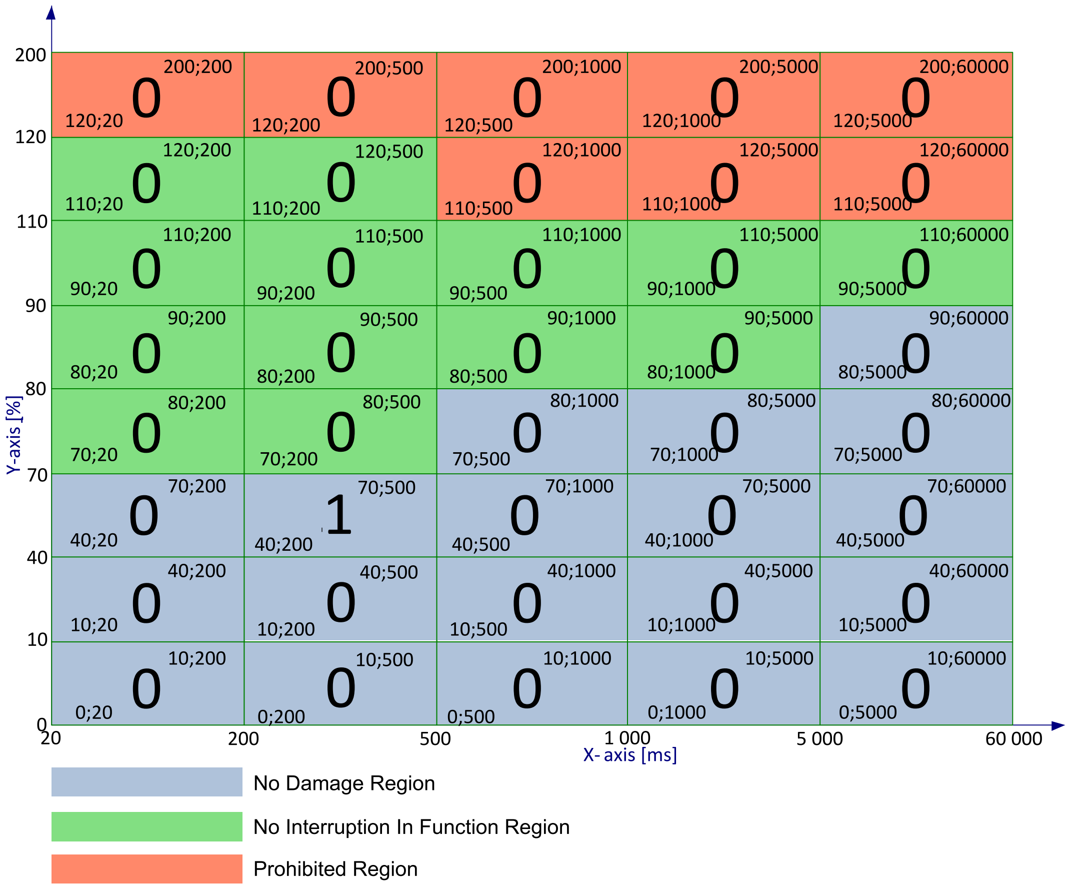
Residual voltage U [%]	**Duration t** [ms]				
	20 ≤ t ≤ 200	200 < t ≤ 500	500 < t ≤ 1 000	1 000 < t ≤ 5 000	5 000 < t ≤ 60 000
u ≥ 120	6	13	20	27	34
120 > u ≥ 110	5	12	19	26	33
90 > u ≥ 80	4	11	18	25	32
80 > u ≥ 70	3	10	17	24	31
70 > u ≥ 40	2	9	16	23	30
40 > u ≥ 10	1	8	15	22	29
10 > u (voltage interruption limit)	0	7	14	21	28

Table 31 shows the arrangement of tables and rows in array hstVal.

Table 31 – Array arrangement for voltage events

Index	**Voltage**	**Time** [ms]
hstVal [0]	u < 10 %	20 ≤ t ≤ 200
hstVal [1]	10 % ≤ u < 40 %	20 ≤ t ≤ 200
hstVal [2]	40 % ≤ u < 70 %	20 ≤ t ≤ 200
hstVal [3]	70 % ≤ u < 80 %	20 ≤ t ≤ 200
hstVal [4]	80 % ≤ u < 90 %	20 ≤ t ≤ 200
hstVal [5]	110 % ≤ u < 120 %	20 ≤ t ≤ 200
hstVal [6]	u ≥ 120 %	20 ≤ t ≤ 200
hstVal [7]	u < 10 %	200 ms < t < 500 ms
hstVal [8]	10 % ≤ u < 40 %	200 ms < t < 500 ms
hstVal [9]	40 % ≤ u < 70 %	200 ms < t < 500 ms
hstVal [10]	70 % ≤ u < 80 %	200 ms < t < 500 ms
hstVal [11]	80 % ≤ u < 90 %	200 ms < t < 500 ms
hstVal [12]	110 % ≤ u < 120 %	200 ms < t < 500 ms
hstVal [13]	u ≥ 120 %	200 ms < t < 500 ms
hstVal [14]	u < 10 %	500 ms < t < 1 000 ms
hstVal [15]	10 % ≤ u < 40 %	500 ms < t < 1 000 ms
hstVal [16]	40 % ≤ u < 70 %	500 ms < t < 1 000 ms
hstVal [17]	70 % ≤ u < 80 %	500 ms < t < 1 000 ms
hstVal [18]	80 % ≤ u < 90 %	500 ms < t < 1 000 ms
hstVal [19]	110 % ≤ u < 120 %	500 ms < t < 1 000 ms
hstVal [20]	u ≥ 120 %	500 ms < t < 1 000 ms
hstVal [21]	u < 10 %	1000 ms < t < 5 000 ms
hstVal [22]	10 % ≤ u < 40 %	1000 ms < t < 5 000 ms
hstVal [23]	40 % ≤ u < 70 %	1000 ms < t < 5 000 ms
hstVal [24]	70 % ≤ u < 80 %	1000 ms < t < 5 000 ms
hstVal [25]	80 % ≤ u < 90 %	1000 ms < t < 5 000 ms
hstVal [26]	110 % ≤ u < 120 %	1000 ms < t < 5 000 ms
hstVal [27]	u ≥ 120 %	1000 ms < t < 5 000 ms
hstVal [28]	u < 10 %	5000 ms < t < 60 000 ms
hstVal [29]	10 % ≤ u < 40 %	5000 ms < t < 60 000 ms
hstVal [30]	40 % ≤ u < 70 %	5000 ms < t < 60 000 ms
hstVal [31]	70 % ≤ u < 80 %	5000 ms < t < 60 000 ms
hstVal [32]	80 % ≤ u < 90 %	5000 ms < t < 60 000 ms
hstVal [33]	110 % ≤ u < 120 %	5000 ms < t < 60 000 ms
hstVal [34]	u ≥ 120 %	5000 ms < t < 60 000 ms

Figure 24 shows the modelling of a magnitude-duration table for voltage events with histogram HST.



IEC

Figure 24 – Modelling of magnitude-duration table for voltage events with histogram HST

Figure 25 shows a visualization of example event in Figure 17/Figure 18/Figure 24 in ITI curve.

IEC

Figure 25 – Visualization of example event in Figure 17/Figure 18/Figure 24 in ITI curve

6.5.3 Use of LN QSVV Supply Voltage Variations – new LN

NOTE LN QSVV will be added to IEC 61850-7-4 Ed.3[4].

Application: Supply voltage variation monitoring (y = {A, S})

- PQy2QSVV would count the number of 10 min intervals that the PQy2MMXU or PQy2MMXN outputs are outside voltage tolerance band (e.g. ±10 % acc. EN 50160)
- PQy3QSVV would count the number of 2 h intervals that the PQy3MMXU or PQy3MMXN outputs are outside voltage tolerance band
- The values of the hstVal ARRAY 0..maxPts-1 of data type INT32 have the following meaning (periods are 10 min or 2 h intervals)

Index	Meaning
EvtCnt.hstVal [0]	***Count number of periods with no voltage band violation***
hstVal [1]	Count of 10 min or 2 h periods with a voltage band violation
hstVal [2]	Count of 10 min or 2 h periods with a forbidden voltage average value

Example: EN 50160 states:

Under normal operating conditions:

- during each period of one week 95 % of the 10 min mean r.m.s, values of the supply voltage shall be within the range of Un ±10 %; and
- all 10 mín mean r.m.s. values of the supply voltage shall be within the range of
- Un +10 % and −15 %.

1 week = 1008 * 10 minute intervals

To fulfill EN 50160 the following counter values are required:

- hstVal [0] > 957
- hstVal [1] < 51
- hstVal [2] = 0

6.5.4 Use of LN QRVC rapid voltage changes – new LN

NOTE LN QRVC will be added to IEC 61850-7-4 Ed.3.

Application:

- RVC monitoring: RVC start time, duration, ΔUmax, ΔUss
- EvtCnt HST Classifier bins of power quality event counters for RVC counters
- The values of the hstVal ARRAY 0...maxPts-1 of data type INT32 have the following meaning

Index	Meaning
hstVal [0]	Counter for RVC events per hour
hstVal [1]	Counter for RVC events per day

4 Under consideration.

6.5.5 Use of LN QFVR frequency variations

Application:

- Frequency band violation reporting

The values of the hstVal ARRAY 0..maxPts-1 of data type INT32 have the following meaning:

(periods are 10 s intervals)

Index	Meaning
hstVal [0]	Count of periods with no events
hstVal [1]	Count of periods with an underfrequency variation event
hstVal [2]	Count of periods with an overfrequency variation event

6.5.6 Use of LN QVUB voltage unbalance

Application: Voltage unbalance limit violation for poly-phase systems

- Refers to measured values (y = {A, S}, z = 0 to 3)
  - PQyzMSQI.ImbNgV (Imbalance negative sequence voltage (U2 / U1))
  - PQyzMSQI.ImbZroV (Imbalance zero sequence voltage (U0 / U1))
- The values of the hstVal ARRAY 0..maxPts-1 of data type INT32 have the following meaning (periods are 10 min or 2 h intervals)

Index	Meaning
hstVal [0]	Count of 10 min periods with no events
hstVal [1]	Count of 10 min periods with an unbalance limit violation
hstVal [2]	Count of 2 h periods with no events
hstVal [3]	Count of 2 h periods with an unbalance limit violation

6.5.7 Use of LN QIUB current unbalance

Application: Current unbalance limit violation for poly-phase systems (IEC 61000-4-30:2015)

- Refers to measured values (z = 0 to3)
  - PQyzMSQI.ImbNgA (Imbalance negative sequence current (I2 / I1))
  - PQyzMSQI.ImbZroA (Imbalance zero sequence current (I0 / I1))
- The values of the hstVal ARRAY 0..maxPts-1 of data type INT32 have the following meaning (periods are 10 min or 2 h intervals)

Index	Meaning
hstVal [0]	Count of 10 min periods with no events
hstVal [1]	Count of 10 min periods with an unbalance limit violation
hstVal [2]	Count of 2 h periods with no events
hstVal [3]	Count of 2 h with an unbalance limit violation

6.5.8 Use of LN QFLK flicker limit violation

NOTE LN QFLK will be added to IEC 61850-7-4 Ed.3.

Application:

- Flicker limit violation for poly-phase systems (IEC 61000-4-15:2010)

- Refers to measured values:
  - PQy2MFLK.PPPst: Short-term flicker severities of last complete interval for phase to phase measured values.
  - PQy2MFLK.PhPst: Short-term flicker severities of last complete interval for phase to ground/phase to neutral measured values.
  - PQy3MFLK.PPPst: Long-term flicker severities of last complete interval for phase to phase measured values.
  - PQy3MFLK.PhPst: Long-term flicker severities of last complete interval for phase to ground/phase to neutral measured values.
- EvtCnt HST Classifier bins of power quality event counters for
  - short term/long term flicker severity and
  - phase to phase/phase to ground flicker measurement
- The values of the hstVal ARRAY 0..maxPts-1 of data type INT32 have the following meaning

Index	Meaning
hstVal [0]	Count of periods with short term **or** long term flicker severity below threshold
hstVal [1]	Count of periods with short term **or** long term flicker severity exceeding threshold

6.5.9 Use of LN QVHA harmonics/interharmonics limit violation – new LN -

NOTE 1 LN QVHA will be added to IEC 61850-7-4 Ed.3.

NOTE 2 This document does not define the number of harmonics that must be measurable with MHAI/MHAN and hence able to be checked for limit violations with QVHA. EN50160 defines limits up to the 25th harmonic and IEC TS 62749 defines limits up to 50 harmonics. IEC 61850-7-3 defines a rule to calculate the maximum number of harmonics 'NumHar' that can be theoretically measured as a function of the sample rate, evaluation time and frequency.

- The values of the hstVal ARRAY 0...maxPts-1 of data type INT32 have the following meaning (periods are 10 min or 2 h intervals)

Index	Meaning
hstVal [0]	Count of 10 min or 2 h periods with no limit violation
hstVal [1]	Count of 10 min or 2 h periods with a limit violation

6.5.10 Use of LN QMSV mains signalling voltage limit violation – new LN -

NOTE LN QMSV will be added to IEC 61850-7-4 Ed.3.

Application: observation of mains signalling voltage injection limits

- The values of the hstVal ARRAY 0...maxPts-1 of data type INT32 have the following meaning (periods are 150 or 180 cycle intervals)

Index	Meaning
hstVal [0]	Count of 150/180 cycle periods with no limit violation
hstVal [1]	Count of 150/180 cycle periods with a limit violation

6.5.11 Use of LN QCPR continuous power quality recorder – new LN -

NOTE LN QCPR will be added to IEC 61850-7-4 Ed. 3.

In IEC 61850-7-4 protection related fault recorder event LN (RDRE) is available. The file format to transfer fault records is COMTRADE. For power quality application PQ long term recorders are required. They are not started by network fault detection algorithm. PQ long term recorders are continuous recording all PQ relevant data; these data have different time bases (e.g. 10 s frequency records or 10 min voltage magnitude records).

The continuous power quality recorder has to fulfil following requirements:

- Start/stop control via time control (user setting, e.g. 12 h, 1 day), gapless recording,
- Recorder contains all relevant data for PQ reporting by user. Usually PQ data are stored in PQ archives (data base) after transmission on user side. To combine different records to a gapless PQ report with different evaluation period for single record length increasing record numbers (RecNum) are useful.
- The file format should conform to IEEE Std. 1159.3-2003, *Power Quality Data Interchange Format (PQDIF)*.

The continuous power quality recorder function shall usually be modelled as a logical device with following logical node types:

- Exactly one instance of QCPR for basic functions (this logical node type);
- a number of instances of RADR and/or RBDR for analogue/binary channels (to select the channels for recording);
- one instance of LLN0, as an inherent property of logical device; and,
- if required, other logical nodes may be added to the logical device.

All enabled channels shall be included in the recording. The output refers to IEEE Std. 1159.3, *Power Quality Data Interchange Format (PQDIF)* (see IEEE Std. 1159.3-2003).

6.5.12 Use of LN QVTR voltage transients

Measurement of transient voltages can be useful but is not mandatory. In IEC 61000-4-30:2015 some of the detection methods and examples of application are given. In IEC 61850-7-4:2010 LN QVTR and LN QITR were added for transient detection and reporting.

Application:

- Voltage transients
  - Up to 6 kV in low voltage networks

6.5.13 Use of LN QITR current transients

Measurement of transient currents can be useful but is not mandatory.

Application:

- Current transient (peak) reporting

7 Data model of namespace IEC 61850-90-17 for power quality

7.1 Namespace name and version

The namespace properties are given in section 1.

7.2 Abbreviated terms

Table 32 shows normative terms that are combined to create data object names.

Table 32 – Normative abbreviations for data object names

Term	Description
Flk	Flicker
Har	Harmonic
Hb	Harmonic bin
Msv	Mains signalling voltage
Ord	Order
Rvc	Rapid voltage change
Vss	Steady state voltage

7.3 Logical node classes

7.3.1 General

This clause specifies logical nodes defined in IEC 61850-90-17.

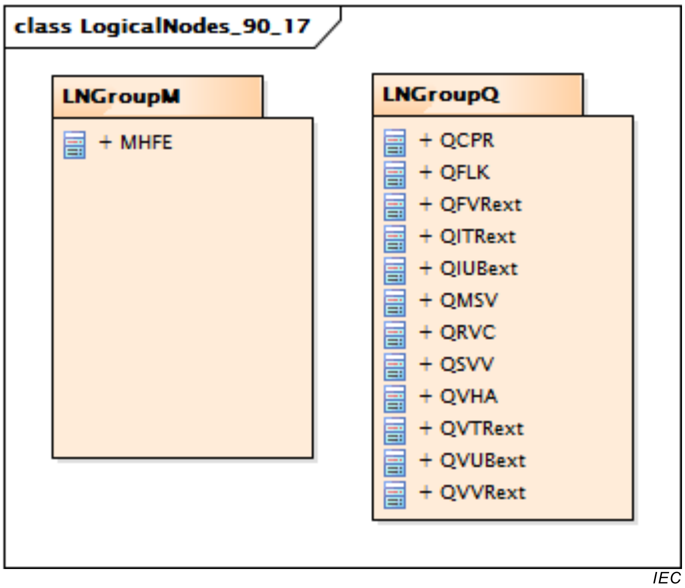


Figure 26 – Class diagram LogicalNodes_90_17::LogicalNodes_90_17

Figure 26: This diagram shows an overview of the logical node groups of this technical report, with their contents.

7.3.2 Package LNGroupM

7.3.2.1 General

This group represents extensions of measurement functions.

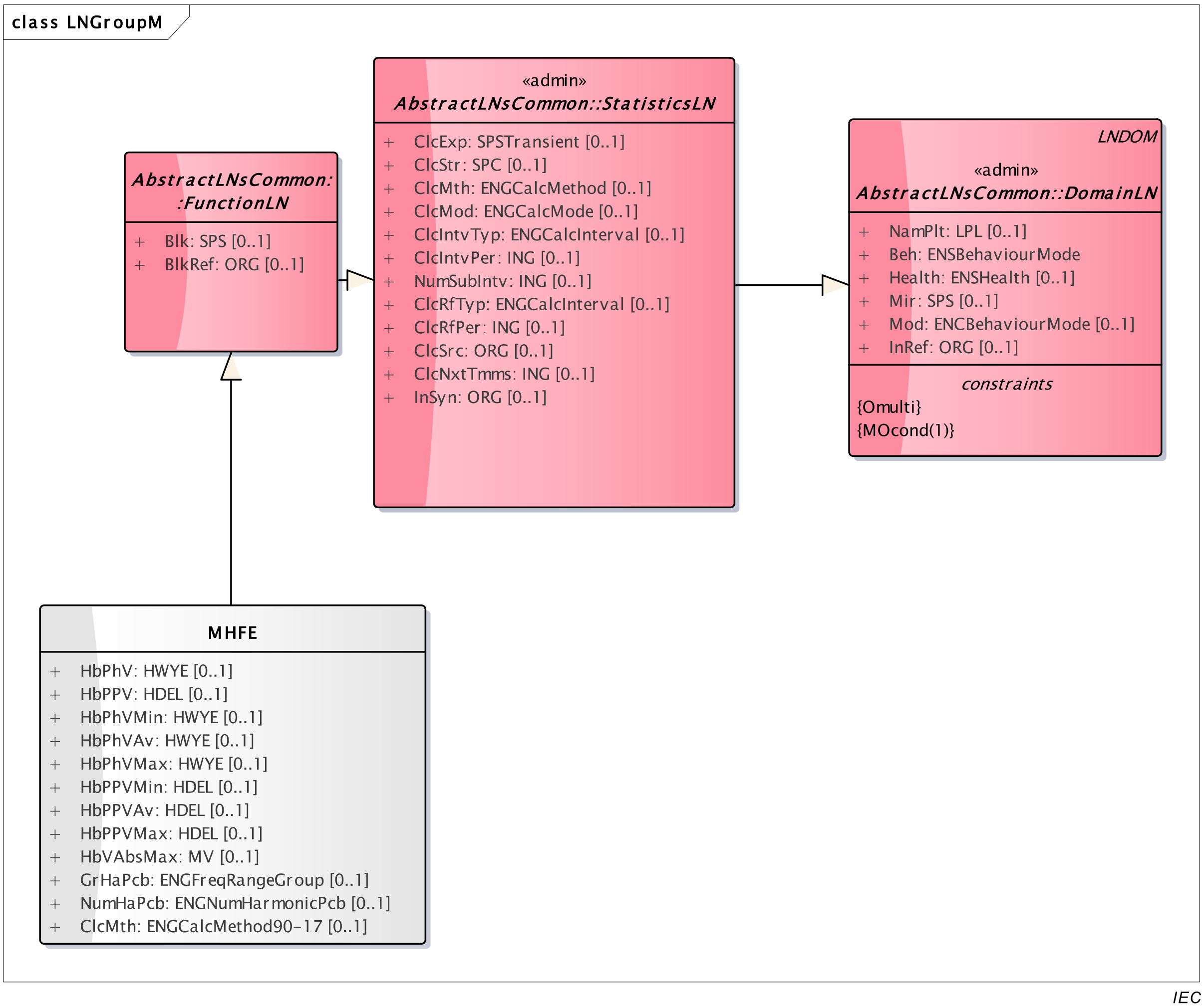


Figure 27 – Class diagram LNGroupM::LNGroupM

Figure 27: This diagram shows all logical nodes of this group.

7.3.2.2 LN: Harmonics in the range from 2 to 150 kHz Name: MHFE

Harmonics in the range from 2 to 150 kHz with 2 main applications:

- Measurement of harmonics in the frequency range from 2 kHz to 9 kHz according to IEC 61000-4-7:2009, Annex B
- Measurement of harmonics in the frequency range from 9 kHz to 150 kHz according to IEC 61000-4-30:2015, C.3

Table 33 shows all data objects of MHFE.

Table 33 – Data objects of MHFE

MHFE				
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 (Behaviour-ModeKind)		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				
HbPhV	HWYE		Sequence of harmonic bins of phase to ground/phase to neutral voltages	O / O
HbPPV	HDEL		Sequence of harmonic bins of phase to phase voltages.	O / O
HbPhVMin	HWYE		Sequence of minimum harmonic bins of phase to ground/phase to neutral voltages	O / O
HbPhVAv	HWYE		Sequence of average harmonic bins of phase to ground/phase to neutral voltages	O / O
HbPhVMax	HWYE		Sequence of maximum harmonic bins of phase to ground/phase to neutral voltages	O / O
HbPPVMin	HDEL		Sequence of minimum harmonic bins of phase to phase voltages.	O / O
HbPPVAv	HDEL		Sequence of average harmonic bins of phase to phase voltages.	O / O
HbPPVMax	HDEL		Sequence of maximum harmonic bins of phase to phase voltages.	O / O
HbVAbsMax	MV		Maximum rms voltage of all max bins	O / O
Controls				
ClcStr	SPC		inherited from: StatisticsLN	O / O
Mod	ENC (Behaviour-ModeKind)		inherited from: DomainLN	O / O
Settings				
GrHaPcb	ENG (FreqRange-GroupKind)		Frequency range enumeration 1 – 200 for (2 kHz to 9 kHz), 2- 2000 for (9 kHz to 150 kHz)	O / F
NumHaPcb	ENG (NumHarmon-icPcbKind)		Number of bins in harmonic sequences , enumera-tion 1 – 35 for the frequency range from 2 kHz to 9 kHz 2 – 71 for the frequency range from 9 kHz to 150 kHz	O / F
BlkRef	ORG		inherited from: FunctionLN	Omulti / F
ClcMth	ENG (CalcMethod90-17Kind)		Kind of statistical calculation, specifying how the data attributes that represent analogue values have been calculated. The calculation method shall be the same for all data objects of the logical node instance.	O / M
ClcMod	ENG (CalcModeKind)		inherited from: StatisticsLN	O / O
ClcIntvTyp	ENG (CalcInter-valKind)		inherited from: StatisticsLN	O / O
ClcIntvPer	ING		inherited from: StatisticsLN	O / O
NumSubIntv	ING		inherited from: StatisticsLN	O / O
ClcRfTyp	ENG (CalcInter-valKind)		inherited from: StatisticsLN	O / O

MHFE				
Data object name	**Common data class**	**T**	**Explanation**	**PresCond nds/ds**
ClcRfPer	ING		inherited from: StatisticsLN	O / O
ClcSrc	ORG		inherited from: StatisticsLN	F / M
ClcNxtT-mms	ING		inherited from: StatisticsLN	O / O
InSyn	ORG		inherited from: StatisticsLN	O / O
InRef	ORG		inherited from: DomainLN	Omulti / Omulti

7.3.3 Package LNGroupQ

7.3.3.1 General

This group represents extensions of power quality functions.

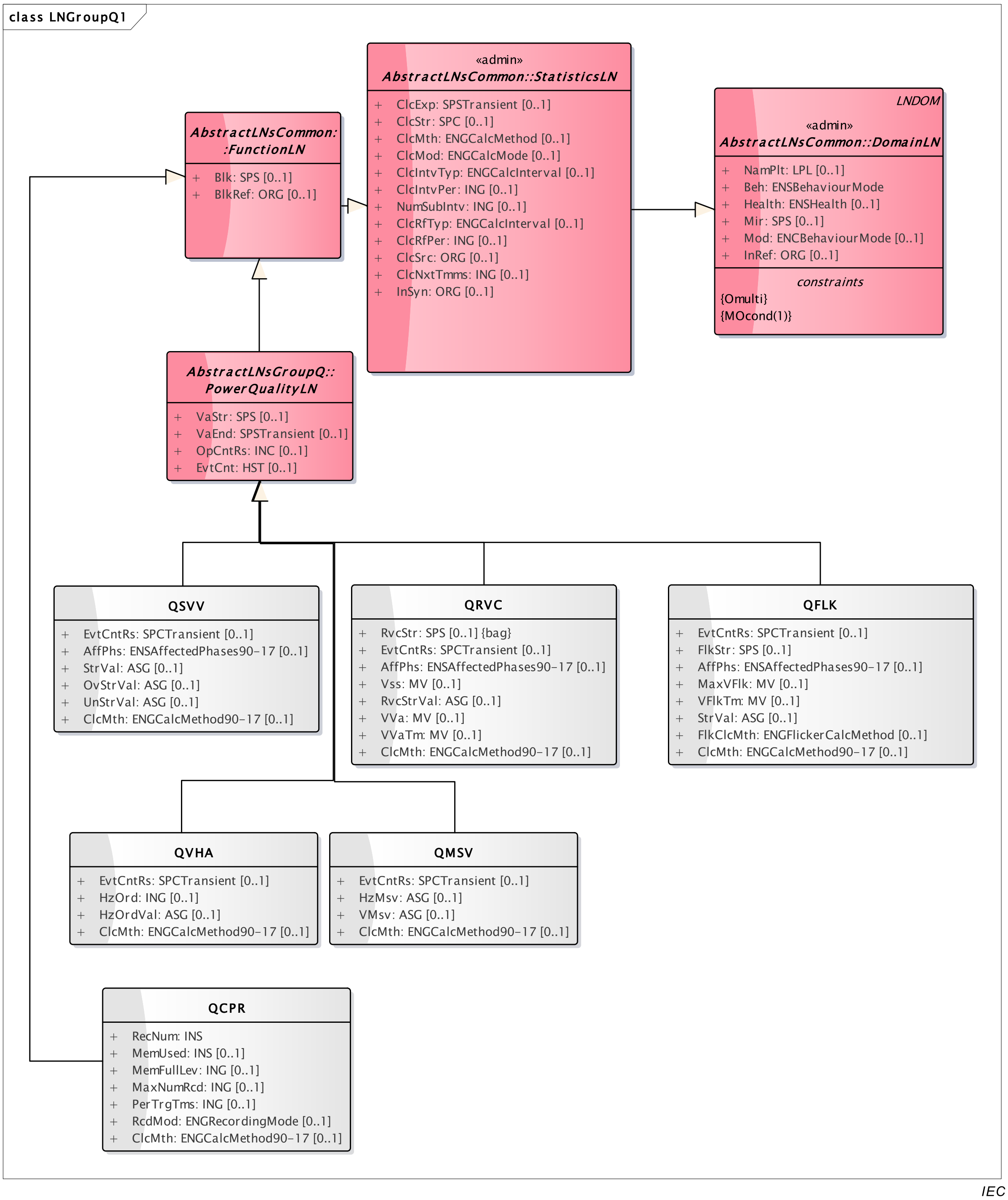


Figure 28 – Class diagram LNGroupQ::LNGroupQ1

Figure 28: This diagram shows the first part logical nodes of group Q.

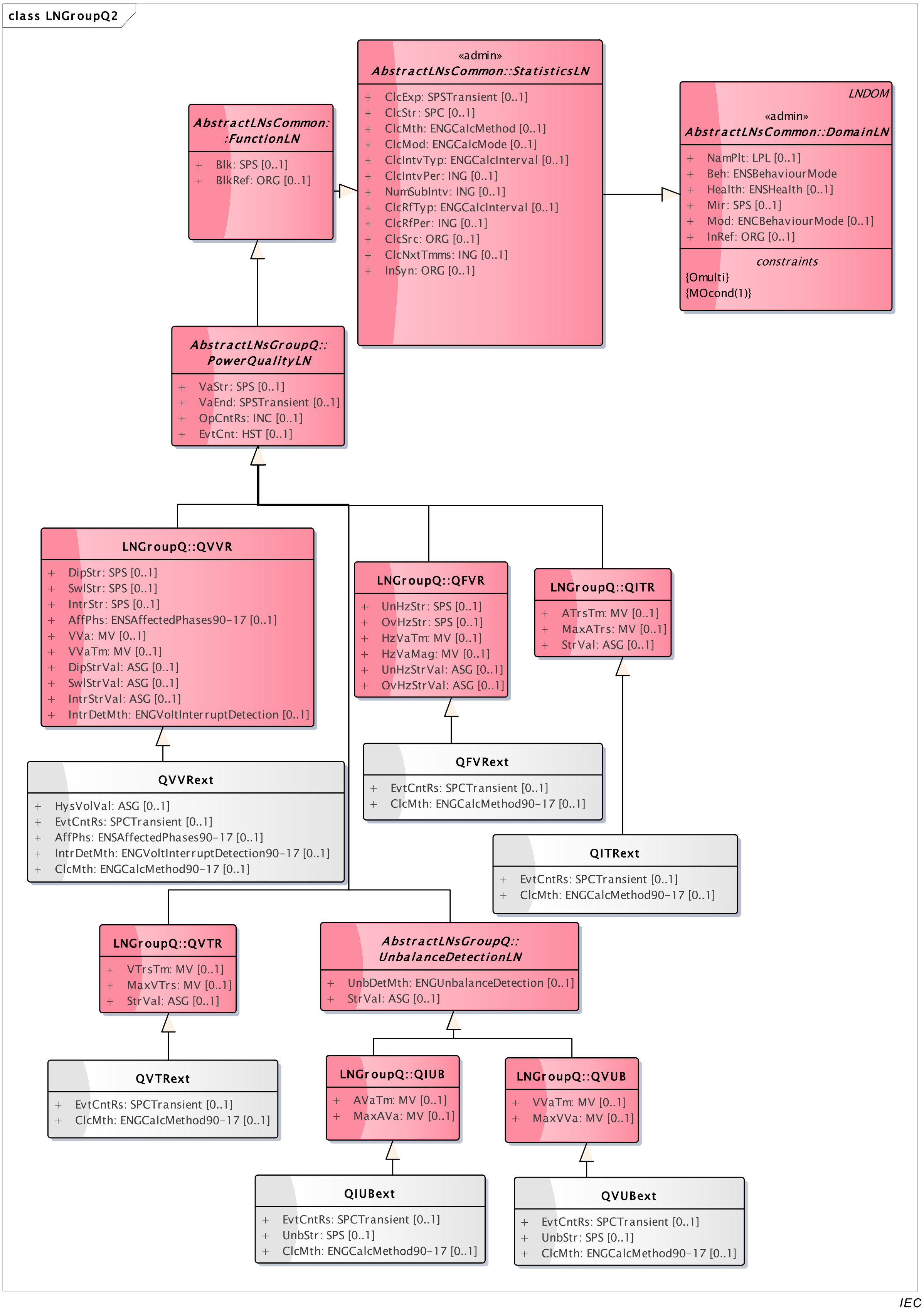


Figure 29 – Class diagram LNGroupQ::LNGroupQ2

Figure 29: This diagram shows the second part logical nodes of group Q.

7.3.3.2 LN: Flicker limit violation Name: QCPR

Flicker limit violation for poly-phase systems (typically as defined in IEC 61000-4-15:2010). Refers to measure elaborated by MFLK.

Table 34 shows all data objects of QCPR.

Table 34 – Data objects of QCPR

QCPR				
Data object name	**Common data class**	**T**	**Explanation**	**PresCond nds/ds**
Descriptions				
NamPlt	LPL		inherited from: DomainLN	O / O
Status information				
RecNum	INS		Record number; number allocation is a local issue	M / O
MemUsed	INS		Amount of the storage memory used [%].	O / O
Blk	SPS		inherited from: FunctionLN	O / F
ClcExp	SPS	T	inherited from: StatisticsLN	O / O
Beh	ENS (Behaviour-ModeKind)		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 (Behaviour-ModeKind)		inherited from: DomainLN	O / O
Settings				
MemFullLev	ING		Level at which to indicate that the storage memory is full [%].	O / F
MaxNum-Rcd	ING		Maximum number of records that can be recorded	O / F
PerTrgTms	ING		Periodic trigger time (in s)	O / F
RcdMod	ENG (Recording-ModeKind)		Recording mode.	O / F
BlkRef	ORG		inherited from: FunctionLN	Omulti / F
ClcMth	ENG (CalcMethod90-17Kind)		Kind of statistical calculation, specifying how the data attributes that represent analogue values have been calculated. The calculation method shall be the same for all data objects of the logical node instance.	O / M
ClcMod	ENG (CalcModeKind)		inherited from: StatisticsLN	O / O
ClcIntvTyp	ENG (CalcInter-valKind)		inherited from: StatisticsLN	O / O
ClcIntvPer	ING		inherited from: StatisticsLN	O / O
NumSubIntv	ING		inherited from: StatisticsLN	O / O
ClcRfTyp	ENG (CalcInter-valKind)		inherited from: StatisticsLN	O / O
ClcRfPer	ING		inherited from: StatisticsLN	O / O
ClcSrc	ORG		inherited from: StatisticsLN	F / M
ClcNxtT-mms	ING		inherited from: StatisticsLN	O / O
InSyn	ORG		inherited from: StatisticsLN	O / O
InRef	ORG		inherited from: DomainLN	Omulti / Omulti

7.3.3.3 LN: Flicker limit violation Name: QFLK

Flicker limit violation for poly-phase systems (typically as defined in IEC 61000-4-15:2010). Refers to measure elaborated by MFLK.

Table 35 shows all data objects of QFLK.

Table 35 – Data objects of QFLK

QFLK				
Data object name	**Common data class**	**T**	**Explanation**	**PresCond nds/ds**
Descriptions				
NamPlt	LPL		inherited from: DomainLN	O / O
Status information				
FlkStr	SPS		If true, the flicker limit violation event is in progress.	O / F
AffPhs	ENS (AffectedPhases90-17Kind)		Affected Phases	O / F
VaStr	SPS		inherited from: PowerQualityLN	O / F
VaEnd	SPS	T	inherited from: PowerQualityLN	O / F
EvtCnt	HST		inherited from: PowerQualityLN	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				
MaxVFlk	MV		Maximum flicker deviation of the last completed event	O / O
VFlkTm	MV		Flicker limit violation duration of the last completed event (in s)	O / O
Controls				
EvtCntRs	SPC	T	(controllable) Operating with value true initiates resetting of the event counter EvtCnt, if present; operating with value false is ignored. The change of its status value is a local issue.	O / F
OpCntRs	INC		inherited from: PowerQualityLN	O / O
ClcStr	SPC		inherited from: StatisticsLN	O / O
Mod	ENC (BehaviourModeKind)		inherited from: DomainLN	O / O
Settings				
StrVal	ASG		Flicker limit violation start value setting	O / F
FlkClcMth	ENG (FlickerCalcMethodKind)		Flicker calculation method selection	O / F
BlkRef	ORG		inherited from: FunctionLN	Omulti / F
ClcMth	ENG (CalcMethod90-17Kind)		Kind of statistical calculation, specifying how the data attributes that represent analogue values have been calculated. The calculation method shall be the same for all data objects of the logical node instance.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

QFLK				
Data object name	**Common data class**	**T**	**Explanation**	**PresCond nds/ds**
ClcRfTyp	ENG (CalcInter-valKind)		inherited from: StatisticsLN	O / O
ClcRfPer	ING		inherited from: StatisticsLN	O / O
ClcSrc	ORG		inherited from: StatisticsLN	F / M
ClcNxtT-mms	ING		inherited from: StatisticsLN	O / O
InSyn	ORG		inherited from: StatisticsLN	O / O
InRef	ORG		inherited from: DomainLN	Omulti / Omulti

7.3.3.4 LN: Frequency variation Name: QFVRext

Set of information objects to extend the QFVR LN for Frequency variations capturing.

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

Table 36 shows all data objects of QFVRext.

Table 36 – Data objects of QFVRext

QFVRext				
Data object name	**Common data class**	**T**	**Explanation**	**PresCond nds/ds**
Descriptions				
NamPlt	LPL		inherited from: DomainLN	O / O
Status information				
UnHzStr	SPS		inherited from: QFVR	O / F
OvHzStr	SPS		inherited from: QFVR	O / F
VaStr	SPS		inherited from: PowerQualityLN	O / F
VaEnd	SPS	T	inherited from: PowerQualityLN	O / F
EvtCnt	HST		inherited from: PowerQualityLN	O / F
Blk	SPS		inherited from: FunctionLN	O / F
ClcExp	SPS	T	inherited from: StatisticsLN	O / O
Beh	ENS (Behaviour-ModeKind)		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				
HzVaTm	MV		inherited from: QFVR	O / O
HzVaMag	MV		inherited from: QFVR	O / O
Controls				
EvtCntRs	SPC	T	(controllable) Operating with value true initiates resetting of the event counter EvtCnt, if present; operating with value false is ignored. The change of its status value is a local issue.	O / F
OpCntRs	INC		inherited from: PowerQualityLN	O / O
ClcStr	SPC		inherited from: StatisticsLN	O / O
Mod	ENC (Behaviour-ModeKind)		inherited from: DomainLN	O / O
Settings				
UnHzStrVal	ASG		inherited from: QFVR	O / F
OvHzStrVal	ASG		inherited from: QFVR	O / F
BlkRef	ORG		inherited from: FunctionLN	Omulti / F
ClcMth	ENG (CalcMethod90-17Kind)		Kind of statistical calculation, specifying how the data attributes that represent analogue values have been calculated. The calculation method shall be the same for all data objects of the logical node instance.	O / M
ClcMod	ENG (CalcModeKind)		inherited from: StatisticsLN	O / O
ClcIntvTyp	ENG (CalcInter-valKind)		inherited from: StatisticsLN	O / O
ClcIntvPer	ING		inherited from: StatisticsLN	O / O
NumSubIntv	ING		inherited from: StatisticsLN	O / O
ClcRfTyp	ENG (CalcInter-valKind)		inherited from: StatisticsLN	O / O
ClcRfPer	ING		inherited from: StatisticsLN	O / O
ClcSrc	ORG		inherited from: StatisticsLN	F / M
ClcNxtT-mms	ING		inherited from: StatisticsLN	O / O
InSyn	ORG		inherited from: StatisticsLN	O / O
InRef	ORG		inherited from: DomainLN	Omulti / Omulti

7.3.3.5 LN: Current transient Name: QITRext

Set of information objects to extend the QITR LN for Current transients capturing.

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

Table 37 shows all data objects of QITRext.

Table 37 – Data objects of QITRext

QITRext				
Data object name	**Common data class**	**T**	**Explanation**	**PresCond nds/ds**
Descriptions				
NamPlt	LPL		inherited from: DomainLN	O / O
Status information				
VaStr	SPS		inherited from: PowerQualityLN	O / F
VaEnd	SPS	T	inherited from: PowerQualityLN	O / F
EvtCnt	HST		inherited from: PowerQualityLN	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				
ATrsTm	MV		inherited from: QITR	O / O
MaxATrs	MV		inherited from: QITR	O / O
Controls				
EvtCntRs	SPC	T	(controllable) Operating with value true initiates resetting of the event counter EvtCnt, if present; operating with value false is ignored. The change of its status value is a local issue.	O / F
OpCntRs	INC		inherited from: PowerQualityLN	O / O
ClcStr	SPC		inherited from: StatisticsLN	O / O
Mod	ENC (BehaviourModeKind)		inherited from: DomainLN	O / O
Settings				
StrVal	ASG		inherited from: QITR	O / F
BlkRef	ORG		inherited from: FunctionLN	Omulti / F
ClcMth	ENG (CalcMethod90-17Kind)		Kind of statistical calculation, specifying how the data attributes that represent analogue values have been calculated. The calculation method shall be the same for all data objects of the logical node instance.	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

7.3.3.6 LN: Current unbalance variation Name: QIUBext

Set of information objects to extend the QIUB LN for Current unbalance variations capturing.

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

Table 38 shows all data objects of QIUBext.

Table 38 – Data objects of QIUBext

QIUBext				
Data object name	**Common data class**	**T**	**Explanation**	**PresCond nds/ds**
Descriptions				
NamPlt	LPL		inherited from: DomainLN	O / O
Status information				
UnbStr	SPS		If true, the current unbalance variation event is in progress.	O / F
VaStr	SPS		inherited from: PowerQualityLN	O / F
VaEnd	SPS	T	inherited from: PowerQualityLN	O / F
EvtCnt	HST		inherited from: PowerQualityLN	O / F
Blk	SPS		inherited from: FunctionLN	O / F
ClcExp	SPS	T	inherited from: StatisticsLN	O / O
Beh	ENS (Behaviour-ModeKind)		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				
AVaTm	MV		inherited from: QIUB	O / O
MaxAVa	MV		inherited from: QIUB	O / O
Controls				
EvtCntRs	SPC	T	(controllable) Operating with value true initiates resetting of the event counter EvtCnt, if present; operating with value false is ignored. The change of its status value is a local issue.	O / F
OpCntRs	INC		inherited from: PowerQualityLN	O / O
ClcStr	SPC		inherited from: StatisticsLN	O / O
Mod	ENC (Behaviour-ModeKind)		inherited from: DomainLN	O / O
Settings				
UnbDetMth	ENG (UnbalanceDe-tectionKind)		inherited from: UnbalanceDetectionLN	O / F
StrVal	ASG		inherited from: UnbalanceDetectionLN	O / F
BlkRef	ORG		inherited from: FunctionLN	Omulti / F
ClcMth	ENG (CalcMethod90-17Kind)		Kind of statistical calculation, specifying how the data attributes that represent analogue values have been calculated. The calculation method shall be the same for all data objects of the logical node instance.	O / M
ClcMod	ENG (CalcModeKind)		inherited from: StatisticsLN	O / O
ClcIntvTyp	ENG (CalcInter-valKind)		inherited from: StatisticsLN	O / O
ClcIntvPer	ING		inherited from: StatisticsLN	O / O
NumSubIntv	ING		inherited from: StatisticsLN	O / O
ClcRfTyp	ENG (CalcInter-valKind)		inherited from: StatisticsLN	O / O
ClcRfPer	ING		inherited from: StatisticsLN	O / O
ClcSrc	ORG		inherited from: StatisticsLN	F / M
ClcNxtT-mms	ING		inherited from: StatisticsLN	O / O
InSyn	ORG		inherited from: StatisticsLN	O / O
InRef	ORG		inherited from: DomainLN	Omulti / Omulti

7.3.3.7 LN: Mains signalling voltage limit violation Name: QMSV

Observation of mains signalling voltage injection limits

Table 39 shows all data objects of QMSV.

Table 39 – Data objects of QMSV

QMSV				
Data object name	**Common data class**	**T**	**Explanation**	**PresCond nds/ds**
Descriptions				
NamPlt	LPL		inherited from: DomainLN	O / O
Status information				
VaStr	SPS		inherited from: PowerQualityLN	O / F
VaEnd	SPS	T	inherited from: PowerQualityLN	O / F
EvtCnt	HST		inherited from: PowerQualityLN	O / F
Blk	SPS		inherited from: FunctionLN	O / F
ClcExp	SPS	T	inherited from: StatisticsLN	O / O
Beh	ENS (Behaviour-ModeKind)		inherited from: DomainLN	M / M
Health	ENS (HealthKind)		inherited from: DomainLN	O / O
Mir	SPS		inherited from: DomainLN	MOcond(1) / MOcond(1)
Controls				
EvtCntRs	SPC	T	(controllable) Operating with value true initiates resetting of the event counter EvtCnt, if present; operating with value false is ignored. The change of its status value is a local issue.	O / F
OpCntRs	INC		inherited from: PowerQualityLN	O / O
ClcStr	SPC		inherited from: StatisticsLN	O / O
Mod	ENC (Behaviour-ModeKind)		inherited from: DomainLN	O / O
Settings				
HzMsv	ASG		Frequency of the mains signalling voltage setting. In Hz	O / F
VMsv	ASG		RMS voltage limit for selected frequency (e.g. 9 %)	O / F
BlkRef	ORG		inherited from: FunctionLN	Omulti / F
ClcMth	ENG (CalcMethod90-17Kind)		Kind of statistical calculation, specifying how the data attributes that represent analogue values have been calculated. The calculation method shall be the same for all data objects of the logical node instance.	O / M
ClcMod	ENG (CalcModeKind)		inherited from: StatisticsLN	O / O
ClcIntvTyp	ENG (CalcInter-valKind)		inherited from: StatisticsLN	O / O
ClcIntvPer	ING		inherited from: StatisticsLN	O / O
NumSubIntv	ING		inherited from: StatisticsLN	O / O
ClcRfTyp	ENG (CalcInter-valKind)		inherited from: StatisticsLN	O / O
ClcRfPer	ING		inherited from: StatisticsLN	O / O
ClcSrc	ORG		inherited from: StatisticsLN	F / M
ClcNxtT-mms	ING		inherited from: StatisticsLN	O / O
InSyn	ORG		inherited from: StatisticsLN	O / O
InRef	ORG		inherited from: DomainLN	Omulti / Omulti

7.3.3.8 LN: Rapid Voltage Changes Name: QRVC

Rapid Voltage Changes (RVC) monitoring:

RVC start time, duration, ΔUmax, ΔUss

Table 40 shows all data objects of QRVC.

Table 40 – Data objects of QRVC

QRVC				
Data object name	**Common data class**	**T**	**Explanation**	**PresCond nds/ds**
Descriptions				
NamPlt	LPL		inherited from: DomainLN	O / O
Status information				
RvcStr	SPS		If true, the RVC event is in progress	O / F
AffPhs	ENS (AffectedPhases90-17Kind)		Phases affected by the event	O / F
VaStr	SPS		inherited from: PowerQualityLN	O / F
VaEnd	SPS	T	inherited from: PowerQualityLN	O / F
EvtCnt	HST		inherited from: PowerQualityLN	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				
Vss	MV		Steady state voltage value after last completed RVC event	O / O
VVa	MV		Maximum voltage variation of the last completed RVC event	O / O
VVaTm	MV		RVC duration of the last completed RVC event (in s)	O / O
Controls				
EvtCntRs	SPC	T	(controllable) Operating with value true initiates resetting of the event counter EvtCnt, if present; operating with value false is ignored. The change of its status value is a local issue.	O / F
OpCntRs	INC		inherited from: PowerQualityLN	O / O
ClcStr	SPC		inherited from: StatisticsLN	O / O
Mod	ENC (BehaviourModeKind)		inherited from: DomainLN	O / O
Settings				
RvcStrVal	ASG		Rapid Voltage Change (RVC) function start voltage value setting. When the voltage in at least one phase goes below this setting, it will start the RVC detection function and the timer that will measure the duration of the RVC. The RVC ends when monitored phase voltages reach a new steady state voltage level. If RVC event ends, the RVC start value RvcStrVal is set to measure steady state voltage Vss.	O / F
BlkRef	ORG		inherited from: FunctionLN	Omulti / F

QRVC				
Data object name	**Common data class**	**T**	**Explanation**	**PresCond nds/ds**
ClcMth	ENG (CalcMethod90-17Kind)		Kind of statistical calculation, specifying how the data attributes that represent analogue values have been calculated. The calculation method shall be the same for all data objects of the logical node instance.	O / M
ClcMod	ENG (CalcModeKind)		inherited from: StatisticsLN	O / O
ClcIntvTyp	ENG (CalcInter-valKind)		inherited from: StatisticsLN	O / O
ClcIntvPer	ING		inherited from: StatisticsLN	O / O
NumSubIntv	ING		inherited from: StatisticsLN	O / O
ClcRfTyp	ENG (CalcInter-valKind)		inherited from: StatisticsLN	O / O
ClcRfPer	ING		inherited from: StatisticsLN	O / O
ClcSrc	ORG		inherited from: StatisticsLN	F / M
ClcNxtT-mms	ING		inherited from: StatisticsLN	O / O
InSyn	ORG		inherited from: StatisticsLN	O / O
InRef	ORG		inherited from: DomainLN	Omulti / Omulti

7.3.3.9 LN: Supply Voltage Variations Name: QSVV

This LN allows counting the number of defined duration intervals that the measurement outputs (MMXN or MMXU) are outside voltage tolerance band (e.g. ±10 % acc. EN 50160)

Table 41 shows all data objects of QSVV.

Table 41 – Data objects of QSVV

QSVV				
Data object name	**Common data class**	**T**	**Explanation**	**PresCond nds/ds**
Descriptions				
NamPlt	LPL		inherited from: DomainLN	O / O
Status information				
AffPhs	ENS (Affect-edPhases90-17Kind)		Affected Phases	O / F
VaStr	SPS		inherited from: PowerQualityLN	O / F
VaEnd	SPS	T	inherited from: PowerQualityLN	O / F
EvtCnt	HST		inherited from: PowerQualityLN	O / F
Blk	SPS		inherited from: FunctionLN	O / F
ClcExp	SPS	T	inherited from: StatisticsLN	O / O
Beh	ENS (Behaviour-ModeKind)		inherited from: DomainLN	M / M
Health	ENS (HealthKind)		inherited from: DomainLN	O / O
Mir	SPS		inherited from: DomainLN	MOcond(1) / MOcond(1)
Controls				
EvtCntRs	SPC	T	(controllable) Operating with value true initiates resetting of the event counter EvtCnt, if present; operating with value false is ignored. The change of its status value is a local issue.	O / F
OpCntRs	INC		inherited from: PowerQualityLN	O / O
ClcStr	SPC		inherited from: StatisticsLN	O / O
Mod	ENC (Behaviour-ModeKind)		inherited from: DomainLN	O / O
Settings				
StrVal	ASG		Voltage band start value setting (e.g. ±10 %)	O / F
OvStrVal	ASG		Voltage band upper forbidden range setting (e.g. +10 %)	O / F
UnStrVal	ASG		Voltage band lower forbidden range setting (e.g. -15 %)	O / F
BlkRef	ORG		inherited from: FunctionLN	Omulti / F
ClcMth	ENG (CalcMethod90-17Kind)		Kind of statistical calculation, specifying how the data attributes that represent analogue values have been calculated. The calculation method shall be the same for all data objects of the logical node instance.	O / M
ClcMod	ENG (CalcModeKind)		inherited from: StatisticsLN	O / O
ClcIntvTyp	ENG (CalcInter-valKind)		inherited from: StatisticsLN	O / O
ClcIntvPer	ING		inherited from: StatisticsLN	O / O
NumSubIntv	ING		inherited from: StatisticsLN	O / O
ClcRfTyp	ENG (CalcInter-valKind)		inherited from: StatisticsLN	O / O
ClcRfPer	ING		inherited from: StatisticsLN	O / O
ClcSrc	ORG		inherited from: StatisticsLN	F / M
ClcNxtT-mms	ING		inherited from: StatisticsLN	O / O
InSyn	ORG		inherited from: StatisticsLN	O / O
InRef	ORG		inherited from: DomainLN	Omulti / Omulti

7.3.3.10 LN: Harmonics limit violation Name: QVHA

Capture Harmonics/interharmonics limit violations

Table 42 shows all data objects of QVHA.

Table 42 – Data objects of QVHA

QVHA				
Data object name	**Common data class**	**T**	**Explanation**	**PresCond nds/ds**
Descriptions				
NamPlt	LPL		inherited from: DomainLN	O / O
Status information				
VaStr	SPS		inherited from: PowerQualityLN	O / F
VaEnd	SPS	T	inherited from: PowerQualityLN	O / F
EvtCnt	HST		inherited from: PowerQualityLN	O / F
Blk	SPS		inherited from: FunctionLN	O / F
ClcExp	SPS	T	inherited from: StatisticsLN	O / O
Beh	ENS (Behaviour-ModeKind)		inherited from: DomainLN	M / M
Health	ENS (HealthKind)		inherited from: DomainLN	O / O
Mir	SPS		inherited from: DomainLN	MOcond(1) / MOcond(1)
Controls				
EvtCntRs	SPC	T	(controllable) Operating with value true initiates resetting of the event counter EvtCnt, if present; operating with value false is ignored. The change of its status value is a local issue.	O / F
OpCntRs	INC		inherited from: PowerQualityLN	O / O
ClcStr	SPC		inherited from: StatisticsLN	O / O
Mod	ENC (Behaviour-ModeKind)		inherited from: DomainLN	O / O
Settings				
HzOrd	ING		Order number of harmonics/interharmonics to be observed	O / F
HzOrdVal	ASG		RMS limit for selected frequency (e.g. 0,5 %)	O / F
BlkRef	ORG		inherited from: FunctionLN	Omulti / F
ClcMth	ENG (CalcMethod90-17Kind)		Kind of statistical calculation, specifying how the data attributes that represent analogue values have been calculated. The calculation method shall be the same for all data objects of the logical node instance.	O / M
ClcMod	ENG (CalcModeKind)		inherited from: StatisticsLN	O / O
ClcIntvTyp	ENG (CalcInter-valKind)		inherited from: StatisticsLN	O / O
ClcIntvPer	ING		inherited from: StatisticsLN	O / O
NumSubIntv	ING		inherited from: StatisticsLN	O / O
ClcRfTyp	ENG (CalcInter-valKind)		inherited from: StatisticsLN	O / O
ClcRfPer	ING		inherited from: StatisticsLN	O / O
ClcSrc	ORG		inherited from: StatisticsLN	F / M
ClcNxtT-mms	ING		inherited from: StatisticsLN	O / O
InSyn	ORG		inherited from: StatisticsLN	O / O
InRef	ORG		inherited from: DomainLN	Omulti / Omulti

7.3.3.11 LN: Voltage transient Name: QVTRext

Set of information objects to extend the QVTR LN forVoltage transients capturing.

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

Table 43 shows all data objects of QVTRext.

Table 43 – Data objects of QVTRext

QVTRext				
Data object name	**Common data class**	**T**	**Explanation**	**PresCond nds/ds**
Descriptions				
NamPlt	LPL		inherited from: DomainLN	O / O
Status information				
VaStr	SPS		inherited from: PowerQualityLN	O / F
VaEnd	SPS	T	inherited from: PowerQualityLN	O / F
EvtCnt	HST		inherited from: PowerQualityLN	O / F
Blk	SPS		inherited from: FunctionLN	O / F
ClcExp	SPS	T	inherited from: StatisticsLN	O / O
Beh	ENS (Behaviour-ModeKind)		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				
VTrsTm	MV		inherited from: QVTR	O / O
MaxVTrs	MV		inherited from: QVTR	O / O
Controls				
EvtCntRs	SPC	T	(controllable) Operating with value true initiates resetting of the event counter EvtCnt, if present; operating with value false is ignored. The change of its status value is a local issue.	O / F
OpCntRs	INC		inherited from: PowerQualityLN	O / O
ClcStr	SPC		inherited from: StatisticsLN	O / O
Mod	ENC (Behaviour-ModeKind)		inherited from: DomainLN	O / O
Settings				
StrVal	ASG		inherited from: QVTR	O / F
BlkRef	ORG		inherited from: FunctionLN	Omulti / F
ClcMth	ENG (CalcMethod90-17Kind)		Kind of statistical calculation, specifying how the data attributes that represent analogue values have been calculated. The calculation method shall be the same for all data objects of the logical node instance.	O / M
ClcMod	ENG (CalcModeKind)		inherited from: StatisticsLN	O / O
ClcIntvTyp	ENG (CalcInter-valKind)		inherited from: StatisticsLN	O / O
ClcIntvPer	ING		inherited from: StatisticsLN	O / O
NumSubIntv	ING		inherited from: StatisticsLN	O / O
ClcRfTyp	ENG (CalcInter-valKind)		inherited from: StatisticsLN	O / O
ClcRfPer	ING		inherited from: StatisticsLN	O / O
ClcSrc	ORG		inherited from: StatisticsLN	F / M
ClcNxtT-mms	ING		inherited from: StatisticsLN	O / O
InSyn	ORG		inherited from: StatisticsLN	O / O
InRef	ORG		inherited from: DomainLN	Omulti / Omulti

7.3.3.12 LN: Voltage unbalance variation Name: QVUBext

Set of information objects to extend the QVUB LN for Voltage unbalance variations capturing.

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

Table 44 shows all data objects of QVUBext.

Table 44 – Data objects of QVUBext

QVUBext				
Data object name	**Common data class**	**T**	**Explanation**	**PresCond nds/ds**
Descriptions				
NamPlt	LPL		inherited from: DomainLN	O / O
Status information				
UnbStr	SPS		If true, the voltage unbalance variation event is in progress.	O / F
VaStr	SPS		inherited from: PowerQualityLN	O / F
VaEnd	SPS	T	inherited from: PowerQualityLN	O / F
EvtCnt	HST		inherited from: PowerQualityLN	O / F
Blk	SPS		inherited from: FunctionLN	O / F
ClcExp	SPS	T	inherited from: StatisticsLN	O / O
Beh	ENS (Behaviour-ModeKind)		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				
VVaTm	MV		inherited from: QVUB	O / O
MaxVVa	MV		inherited from: QVUB	O / O
Controls				
EvtCntRs	SPC	T	(controllable) Operating with value true initiates resetting of the event counter EvtCnt, if present; operating with value false is ignored. The change of its status value is a local issue.	O / F
OpCntRs	INC		inherited from: PowerQualityLN	O / O
ClcStr	SPC		inherited from: StatisticsLN	O / O
Mod	ENC (Behaviour-ModeKind)		inherited from: DomainLN	O / O
Settings				
UnbDetMth	ENG (UnbalanceDe-tectionKind)		inherited from: UnbalanceDetectionLN	O / F
StrVal	ASG		inherited from: UnbalanceDetectionLN	O / F
BlkRef	ORG		inherited from: FunctionLN	Omulti / F
ClcMth	ENG (CalcMethod90-17Kind)		Kind of statistical calculation, specifying how the data attributes that represent analogue values have been calculated. The calculation method shall be the same for all data objects of the logical node instance.	O / M
ClcMod	ENG (CalcModeKind)		inherited from: StatisticsLN	O / O
ClcIntvTyp	ENG (CalcInter-valKind)		inherited from: StatisticsLN	O / O
ClcIntvPer	ING		inherited from: StatisticsLN	O / O
NumSubIntv	ING		inherited from: StatisticsLN	O / O
ClcRfTyp	ENG (CalcInter-valKind)		inherited from: StatisticsLN	O / O
ClcRfPer	ING		inherited from: StatisticsLN	O / O
ClcSrc	ORG		inherited from: StatisticsLN	F / M
ClcNxtT-mms	ING		inherited from: StatisticsLN	O / O
InSyn	ORG		inherited from: StatisticsLN	O / O
InRef	ORG		inherited from: DomainLN	Omulti / Omulti

7.3.3.13 LN: Voltage variation Name: QVVRext

Set of information objects to extend the QVVR LN for Voltage variations capturing.

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

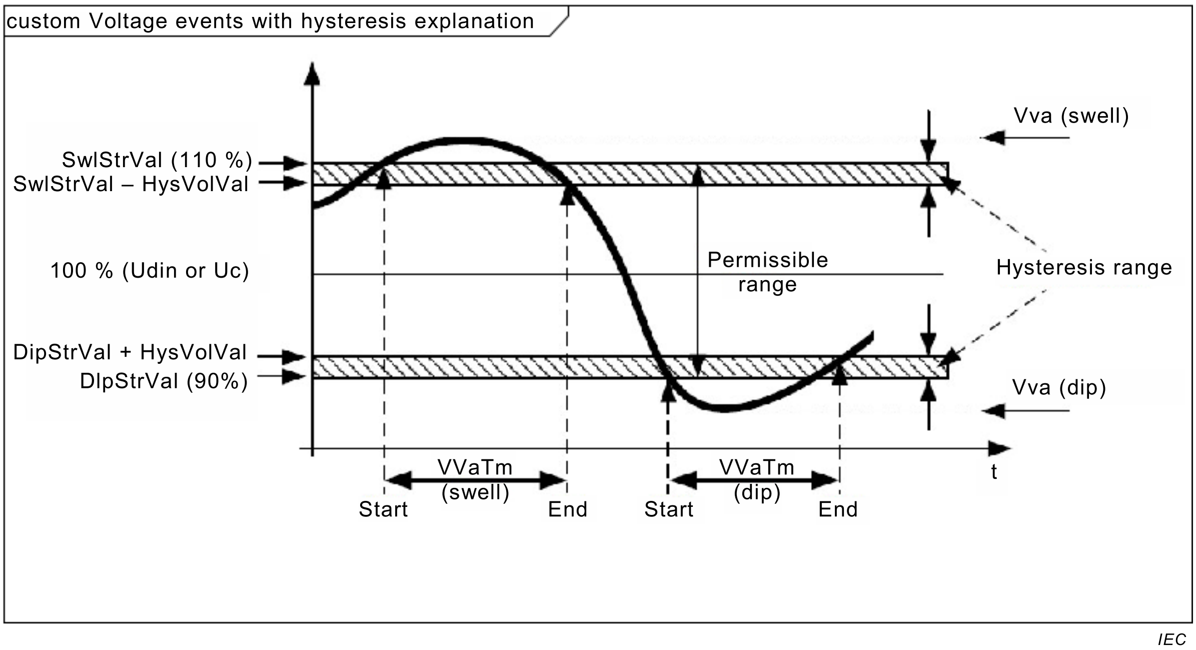


Figure 30 – Voltage events with hysteresis explanation

Figure 30 explains power quality voltage variations.

Table 45 shows all data objects of QVVRext.

Table 45 – Data objects of QVVRext

QVVRext				
Data object name	**Common data class**	**T**	**Explanation**	**PresCond nds/ds**
Descriptions				
NamPlt	LPL		inherited from: DomainLN	O / O
Status information				
DipStr	SPS		inherited from: QVVR	O / F
SwlStr	SPS		inherited from: QVVR	O / F
IntrStr	SPS		inherited from: QVVR	O / F
AffPhs	ENS (Affect-edPhases90-17Kind)		inherited from: QVVR	O / F
VaStr	SPS		inherited from: PowerQualityLN	O / F
VaEnd	SPS	T	inherited from: PowerQualityLN	O / F
EvtCnt	HST		inherited from: PowerQualityLN	O / F
Blk	SPS		inherited from: FunctionLN	O / F
ClcExp	SPS	T	inherited from: StatisticsLN	O / O
Beh	ENS (Behaviour-ModeKind)		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				
VVa	MV		inherited from: QVVR	O / O
VVaTm	MV		inherited from: QVVR	O / O
Controls				
EvtCntRs	SPC	T	(controllable) Operating with value true initiates resetting of the event counter EvtCnt, if present; operating with value false is ignored. The change of its status value is a local issue.	O / F
OpCntRs	INC		inherited from: PowerQualityLN	O / O
ClcStr	SPC		inherited from: StatisticsLN	O / O
Mod	ENC (Behaviour-ModeKind)		inherited from: DomainLN	O / O
Settings				
HysVolVal	ASG		Hysteresis voltage value setting (in V)	O / F
DipStrVal	ASG		inherited from: QVVR	O / F
SwlStrVal	ASG		inherited from: QVVR	O / F
IntrStrVal	ASG		inherited from: QVVR	O / F
IntrDetMth	ENG (VoltInterruptDe-tection90-17Kind)		inherited from: QVVR	O / F
BlkRef	ORG		inherited from: FunctionLN	Omulti / F
ClcMth	ENG (CalcMethod90-17Kind)		Kind of statistical calculation, specifying how the data attributes that represent analogue values have been calculated. The calculation method shall be the same for all data objects of the logical node instance.	O / M
ClcMod	ENG (CalcModeKind)		inherited from: StatisticsLN	O / O
ClcIntvTyp	ENG (CalcInter-valKind)		inherited from: StatisticsLN	O / O
ClcIntvPer	ING		inherited from: StatisticsLN	O / O
NumSubIntv	ING		inherited from: StatisticsLN	O / O
ClcRfTyp	ENG (CalcInter-valKind)		inherited from: StatisticsLN	O / O
ClcRfPer	ING		inherited from: StatisticsLN	O / O
ClcSrc	ORG		inherited from: StatisticsLN	F / M

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

7.4 Data semantics

Table 46 shows all attributes defined on classes of LogicalNodes_90_17 package.

Table 46 – Attributes defined on classes of LogicalNodes_90_17 package

Name	Type	(Used in) Description
AffPhs	ENS (Affect-edPhases90-17Kind)	(QFLK) Affected Phases (QRVC) Phases affected by the event (QSVV) Affected Phases
ClcMth	ENG (CalcMeth-od90-17Kind)	(MHFE) Kind of statistical calculation, specifying how the data attributes that represent analogue values have been calculated. The calculation method shall be the same for all data objects of the logical node instance. (QVVRext) Kind of statistical calculation, specifying how the data attributes that represent analogue values have been calculated. The calculation method shall be the same for all data objects of the logical node instance. (QFVRext) Kind of statistical calculation, specifying how the data attributes that represent analogue values have been calculated. The calculation method shall be the same for all data objects of the logical node instance. (QITRext) Kind of statistical calculation, specifying how the data attributes that represent analogue values have been calculated. The calculation method shall be the same for all data objects of the logical node instance. (QVTRext) Kind of statistical calculation, specifying how the data attributes that represent analogue values have been calculated. The calculation method shall be the same for all data objects of the logical node instance. (QIUBext) Kind of statistical calculation, specifying how the data attributes that represent analogue values have been calculated. The calculation method shall be the same for all data objects of the logical node instance. (QVUBext) Kind of statistical calculation, specifying how the data attributes that represent analogue values have been calculated. The calculation method shall be the same for all data objects of the logical node instance. (QSVV) Kind of statistical calculation, specifying how the data attributes that represent analogue values have been calculated. The calculation method shall be the same for all data objects of the logical node instance. (QRVC) Kind of statistical calculation, specifying how the data attributes that represent analogue values have been calculated. The calculation method shall be the same for all data objects of the logical node instance. (QFLK) Kind of statistical calculation, specifying how the data attributes that represent analogue values have been calculated. The calculation method shall be the same for all data objects of the logical node instance. (QVHA) Kind of statistical calculation, specifying how the data attributes that represent analogue values have been calculated. The calculation method shall be the same for all data objects of the logical node instance. (QMSV) Kind of statistical calculation, specifying how the data attributes that represent analogue values have been calculated. The calculation method shall be the same for all data objects of the logical node instance. (QCPR) Kind of statistical calculation, specifying how the data attributes that represent analogue values have been calculated. The calculation method shall be the same for all data objects of the logical node instance.

Name	Type	(Used in) Description
EvtCntRs	SPC (T)	(QIUBext) (controllable) Operating with value true initiates resetting of the event counter EvtCnt, if present; operating with value false is ignored. The change of its status value is a local issue. (QVUBext) (controllable) Operating with value true initiates resetting of the event counter EvtCnt, if present; operating with value false is ignored. The change of its status value is a local issue. (QFVRext) (controllable) Operating with value true initiates resetting of the event counter EvtCnt, if present; operating with value false is ignored. The change of its status value is a local issue. (QITRext) (controllable) Operating with value true initiates resetting of the event counter EvtCnt, if present; operating with value false is ignored. The change of its status value is a local issue. (QVTRext) (controllable) Operating with value true initiates resetting of the event counter EvtCnt, if present; operating with value false is ignored. The change of its status value is a local issue. (QVVRext) (controllable) Operating with value true initiates resetting of the event counter EvtCnt, if present; operating with value false is ignored. The change of its status value is a local issue. (QFLK) (controllable) Operating with value true initiates resetting of the event counter EvtCnt, if present; operating with value false is ignored. The change of its status value is a local issue. (QMSV) (controllable) Operating with value true initiates resetting of the event counter EvtCnt, if present; operating with value false is ignored. The change of its status value is a local issue. (QRVC) (controllable) Operating with value true initiates resetting of the event counter EvtCnt, if present; operating with value false is ignored. The change of its status value is a local issue. (QSVV) (controllable) Operating with value true initiates resetting of the event counter EvtCnt, if present; operating with value false is ignored. The change of its status value is a local issue. (QVHA) (controllable) Operating with value true initiates resetting of the event counter EvtCnt, if present; operating with value false is ignored. The change of its status value is a local issue.
FlkClcMth	ENG (Flicker-CalcMethodKind)	(QFLK) Flicker calculation method selection
FlkStr	SPS	(QFLK) If true, the flicker limit violation event is in progress.
GrHaPcb	ENG (FreqRange-GroupKind)	(MHFE) Frequency range enumeration 1- 200 for (2 kHz to 9 kHz), 2- 2000 for (9 kHz to 150 kHz)
HbPPV	HDEL	(MHFE) Sequence of harmonic bins of phase to phase voltages.
HbPPVAv	HDEL	(MHFE) Sequence of average harmonic bins of phase to phase voltages.
HbPPVMax	HDEL	(MHFE) Sequence of maximum harmonic bins of phase to phase voltages.
HbPPVMin	HDEL	(MHFE) Sequence of minimum harmonic bins of phase to phase voltages.
HbPhV	HWYE	(MHFE) Sequence of harmonic bins of phase to ground/phase to neutral voltages
HbPhVAv	HWYE	(MHFE) Sequence of average harmonic bins of phase to ground/phase to neutral voltages
HbPhVMax	HWYE	(MHFE) Sequence of maximum harmonic bins of phase to ground/phase to neutral voltages
HbPhVMin	HWYE	(MHFE) Sequence of minimum harmonic bins of phase to ground/phase to neutral voltages
HbVAbsMax	MV	(MHFE) Maximum rms voltage of all max bins
HysVolVal	ASG	(QVVRext) Hysteresis voltage value setting (in V)
HzMsv	ASG	(QMSV) Frequency of the mains signalling voltage setting. In Hz
HzOrd	ING	(QVHA) Order number of harmonics/interharmonics to be observed
HzOrdVal	ASG	(QVHA) RMS limit for selected frequency (e.g. 0,5 %)
IntrDetMth	ENG (VoltInter-ruptDetection90-17Kind)	(QVVRext) Voltage interruption detection method.

Name	Type	(Used in) Description
MaxNumRcd	ING	(QCPR) Maximum number of records that can be recorded
MaxVFlk	MV	(QFLK) Maximum flicker deviation of the last completed event
MemFullLev	ING	(QCPR) Level at which to indicate that the storage memory is full [%].
MemUsed	INS	(QCPR) Amount of the storage memory used [%].
NumHaPcb	ENG (NumHar-monicPcbKind)	(MHFE) Number of bins in harmonic sequences , enumeration 1 – 35 for the frequency range from 2 kHz to 9 kHz 2- 71 for the frequency range from 9 kHz to 150 kHz
OvStrVal	ASG	(QSVV) Voltage band upper forbidden range setting (e.g. +10 %)
PerTrgTms	ING	(QCPR) Periodic trigger time (in s)
RcdMod	ENG (Record-ingModeKind)	(QCPR) Recording mode.
RecNum	INS	(QCPR) Record number; number allocation is a local issue
RvcStr	SPS	(QRVC) If true, the RVC event is in progress
RvcStrVal	ASG	(QRVC) Rapid Voltage Change (RVC) function start voltage value setting. When the voltage in at least one phase goes below this setting, it will start the RVC detection function and the timer that will measure the duration of the RVC. The RVC ends when monitored phase voltages reach a new steady state voltage level. If RVC event ends, the RVC start value RvcStrVal is set to measure steady state voltage Vss.
StrVal	ASG	(QFLK) Flicker limit violation start value setting (QSVV) Voltage band start value setting (e.g. ±10 %)
UnStrVal	ASG	(QSVV) Voltage band lower forbidden range setting (e.g. -15 %)
UnbStr	SPS	(QIUBext) If true, the current unbalance variation event is in progress. (QVUBext) If true, the voltage unbalance variation event is in progress.
VFlkTm	MV	(QFLK) Flicker limit violation duration of the last completed event (in s)
VMsv	ASG	(QMSV) RMS voltage limit for selected frequency (e.g. 9 %)
VVa	MV	(QRVC) Maximum voltage variation of the last completed RVC event
VVaTm	MV	(QRVC) RVC duration of the last completed RVC event (in s)
Vss	MV	(QRVC) Steady state voltage value after last completed RVC event

7.5 Enumerated data attribute types

7.5.1 General

This subclause contains explicit definitions of enumerated types used in IEC TR 61850-90-17.

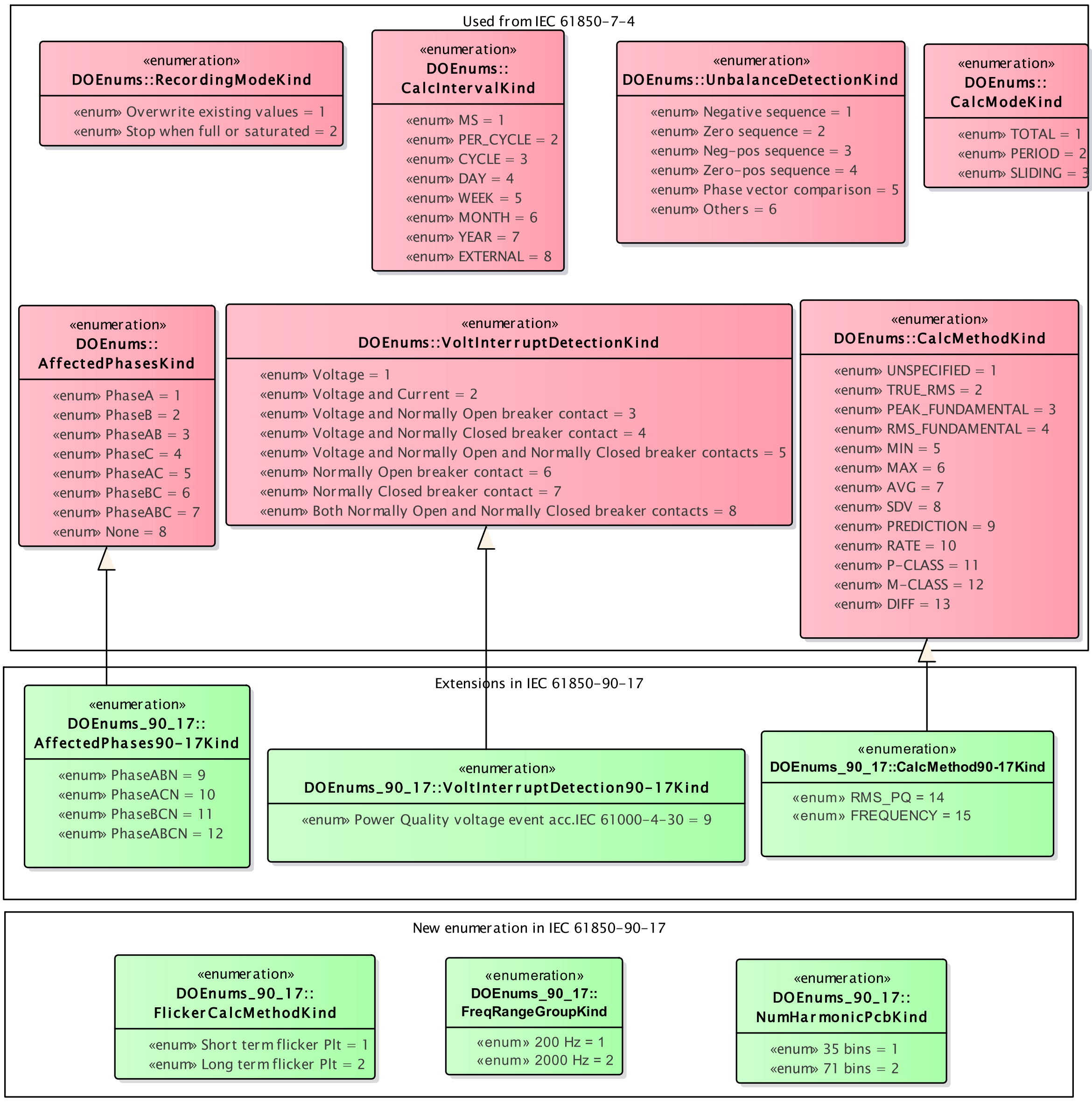


Figure 31 – Enumerated data attribute types

Figure 31 shows the specific enumerations defined within this namespace.

7.5.2 AffectedPhases90-17Kind enumeration

Table 47 shows all enumeration items of AffectedPhases90-17Kind.

Table 47 – Literals of AffectedPhases90-17Kind

AffectedPhases90-17Kind		
enumeration item	**value**	**description**
PhaseA	1	refer to IEC 61850-7-4(AffectedPhasesKind), A
PhaseB	2	refer to IEC 61850-7-4(AffectedPhasesKind), B
PhaseAB	3	refer to IEC 61850-7-4(AffectedPhasesKind), AB
PhaseC	4	refer to IEC 61850-7-4(AffectedPhasesKind), C
PhaseAC	5	refer to IEC 61850-7-4(AffectedPhasesKind), BC
PhaseBC	6	refer to IEC 61850-7-4(AffectedPhasesKind), BC
PhaseABC	7	refer to IEC 61850-7-4(AffectedPhasesKind), ABC
None	8	refer to IEC 61850-7-4(AffectedPhasesKind), None
PhaseABN	9	A-B-N Wye (Y)
PhaseACN	10	A-C-N Wye (Y)
PhaseBCN	11	B-C-N Wye (Y)
PhaseABCN	12	A-B-C-N Wye (Y)

7.5.3 CalcMethod90-17Kind enumeration

Table 48 shows all enumeration items of CalcMethod90-17Kind.

Table 48 – Literals of CalcMethod90-17Kind

CalcMethod90-17Kind		
enumeration item	**value**	**description**
UNSPECIFIED	1	refer to IEC 61850-7-4(CalcMethodKind), Calculation of the analogue values is unspecified.
TRUE_RMS	2	refer to IEC 61850-7-4(CalcMethodKind), All analogue values are true rms values.
PEAK_FUNDAMENTAL	3	refer to IEC 61850-7-4(CalcMethodKind), All analogue values are peak fundamental values.
RMS_FUNDAMENTAL	4	refer to IEC 61850-7-4(CalcMethodKind), All analogue values are rms fundamental values.
MIN	5	refer to IEC 61850-7-4(CalcMethodKind), All analogue values are minimum values.
MAX	6	refer to IEC 61850-7-4(CalcMethodKind), All analogue values are maximum values.
AVG	7	refer to IEC 61850-7-4(CalcMethodKind), All analogue values are average values.
SDV	8	refer to IEC 61850-7-4(CalcMethodKind), All analogue values are standard deviation values.
PREDICTION	9	(deprecated) refer to IEC 61850-7-4 (CalcMethodKind) All analogue values are long term changes over time.
RATE	10	(deprecated) refer to IEC 61850-7-4 (CalcMethodKind) (use 'DIFF' instead) All analogue values are actual changes over time calculated with the actual and previous value.
P-CLASS	11	refer to IEC 61850-7-4(CalcMethodKind) . All analogue values (i.e., all common attributes 'i' and 'f') meet the sampling and filtering characteristics specified in IEEE C37.118.1 for P-CLASS.
M-CLASS	12	refer to IEC 61850-7-4(CalcMethodKind). All analogue values (i.e., all common attributes 'i' and 'f') meet the sampling and filtering characteristics specified in IEEE C37.118.1 for M-CLASS.
DIFF	13	refer to IEC 61850-7-4(CalcMethodKind). All analogue values are [F(t+T)-F(t)] for a calculation interval T (in the same unit as the original entity). Note: The client can still calculate rate so: RATE = DIFF/T.
RMS_PQ	14	RMS of harmonics in PQ domain
FREQUENCY	15	10 sec average frequency in PQ domain

7.5.4 FlickerCalcMethodKind enumeration

Table 49 shows all enumeration items of FlickerCalcMethodKind.

Table 49 – Literals of FlickerCalcMethodKind

FlickerCalcMethodKind		
enumeration item	**value**	**description**
Short term flicker Plt	1	
Long term flicker Plt	2	

7.5.5 FreqRangeGroupKind enumeration

Table 50 shows all enumeration items of FreqRangeGroupKind.

Table 50 – Literals of FreqRangeGroupKind

FreqRangeGroupKind		
enumeration item	**value**	**description**
200 Hz	1	
2000 Hz	2	

7.5.6 NumHarmonicPcbKind enumeration

Table 51 shows all enumeration items of NumHarmonicPcbKind.

Table 51 – Literals of NumHarmonicPcbKind

NumHarmonicPcbKind		
enumeration item	**value**	**description**
35 bins	1	
71 bins	2	

7.5.7 VoltInterruptDetection90-17Kind enumeration

Table 52 shows all enumeration items of VoltInterruptDetection90-17Kind.

Table 52 – Literals of VoltInterruptDetection90-17Kind

VoltInterruptDetection90-17Kind		
enumeration item	**value**	**description**
Voltage	1	refer to IEC 61850-7-4 (VoltInterruptDetection-Kind)
Voltage and Current	2	refer to IEC 61850-7-4 (VoltInterruptDetection-Kind)
Voltage and Normally Open breaker contact	3	refer to IEC 61850-7-4 (VoltInterruptDetection-Kind)
Voltage and Normally Closed breaker contact	4	refer to IEC 61850-7-4 (VoltInterruptDetection-Kind)
Voltage and Normally Open and Normally Closed breaker contacts	5	refer to IEC 61850-7-4 (VoltInterruptDetection-Kind)
Normally Open breaker contact	6	refer to IEC 61850-7-4 (VoltInterruptDetection-Kind)
Normally Closed breaker contact	7	refer to IEC 61850-7-4 (VoltInterruptDetection-Kind)
Both Normally Open and Normally Closed breaker contacts	8	refer to IEC 61850-7-4 (VoltInterruptDetection-Kind)
Power Quality voltage event according to IEC 61000-4-30	9	

8 Communication services for data transfer

Data transfer (mandatory):

The services for PQ records are implemented in IEC 61850 by file transfer (IEC 61850-7-2 file transfer, FTP) of the following file types:

- COMTRADE for fault records (IEC 60255-24/IEEE Std. C37.111, *Measuring relays and protection equipment – Part 24: Common format for transient data exchange (COMTRADE) for power systems*),

- PQDIF: PQ data should conform to IEEE Std. 1159.3-2003, *Power Quality Data Interchange Format (PQDIF).*

PQDIF FILES

IEEE Std. 1159.3 (PQDIF) files shall be contained within a file directory whose name is “PQDIF”. The file specifications shall be consistent with the naming conventions and suffixes specified in IEEE Std. 1159.3.

The IEEE PQDIF specification IEEE Std. 1159.3 specifies the use of suffix pqd.

The PQDIF directories shall be located in the appropriate directory path (e.g. within the LD directory or at the root level).

Optional services:

- Logging: Additionally the IEC 61850 logging service is suggested as a means to replace file transfer for PQ records, since semantics can be modeled according to IEC 61850 using this service, whereas file transfer from a viewpoint of IEC 61850 transfers large binary objects without any semantic description as per IEC 61850.
  - Advantage: avoid file transfer for PQ records, Import PQ data from/to date/time
- COMFEDE: Logged event data in an IEC 61850 IED could additionally be retrieved by an XML file (Common Format for Event Data Exchange (COMFEDE) for Power Systems (IEEE Std. C37.239:2010)

Annex A
(normative)

SCL enumerations (IEC TR 61850-90-17)

A.1 SCL enumerations (from DOEnums_90_17)

The following enumeration extensions are modeled within the namespace of IEC 61850-90-17.

```
<EnumType id="AffectedPhases90-17Kind">
<EnumVal ord="1">PhaseA</EnumVal>
<EnumVal ord="2">PhaseB</EnumVal>
<EnumVal ord="3">PhaseAB</EnumVal>
<EnumVal ord="4">PhaseC</EnumVal>
<EnumVal ord="5">PhaseAC</EnumVal>
<EnumVal ord="6">PhaseBC</EnumVal>
<EnumVal ord="7">PhaseABC</EnumVal>
<EnumVal ord="8">None</EnumVal>
<EnumVal ord="9">PhaseABN</EnumVal>
<EnumVal ord="10">PhaseACN</EnumVal>
<EnumVal ord="11">PhaseBCN</EnumVal>
<EnumVal ord="12">PhaseABCN</EnumVal>
</EnumType>
<EnumType id="CalcMethod90-17Kind">
<EnumVal ord="1">UNSPECIFIED</EnumVal>
<EnumVal ord="2">TRUE_RMS</EnumVal>
<EnumVal ord="3">PEAK_FUNDAMENTAL</EnumVal>
<EnumVal ord="4">RMS_FUNDAMENTAL</EnumVal>
<EnumVal ord="5">MIN</EnumVal>
<EnumVal ord="6">MAX</EnumVal>
<EnumVal ord="7">AVG</EnumVal>
<EnumVal ord="8">SDV</EnumVal>
<EnumVal ord="9">PREDICTION</EnumVal>
<EnumVal ord="10">RATE</EnumVal>
<EnumVal ord="11">P-CLASS</EnumVal>
<EnumVal ord="12">M-CLASS</EnumVal>
<EnumVal ord="13">DIFF</EnumVal>
<EnumVal ord="14">RMS_PQ</EnumVal>
<EnumVal ord="15">FREQUENCY</EnumVal>
</EnumType>
<EnumType id="FlickerCalcMethodKind">
<EnumVal ord="1">Short term flicker Plt</EnumVal>
<EnumVal ord="2">Long term flicker Plt</EnumVal>
</EnumType>
<EnumType id="FreqRangeGroupKind">
<EnumVal ord="1">200 Hz</EnumVal>
```

```
<EnumVal ord="2">2000 Hz</EnumVal>
</EnumType>
<EnumType id="NumHarmonicPcbKind">
<EnumVal ord="1">35 bins</EnumVal>
<EnumVal ord="2">71 bins</EnumVal>
</EnumType>
<EnumType id="VoltInterruptDetection90-17Kind">
<EnumVal ord="1">Voltage</EnumVal>
<EnumVal ord="2">Voltage and Current</EnumVal>
<EnumVal ord="3">Voltage and Normally Open breaker contact</EnumVal>
<EnumVal ord="4">Voltage and Normally Closed breaker contact</EnumVal>
<EnumVal ord="5">Voltage and Normally Open and Normally Closed breaker contacts</EnumVal>
<EnumVal ord="6">Normally Open breaker contact</EnumVal>
<EnumVal ord="7">Normally Closed breaker contact</EnumVal>
<EnumVal ord="8">Both Normally Open and Normally Closed breaker contacts</EnumVal>
<EnumVal ord="9">Power Quality voltage event acc.IEC 61000-4-30</EnumVal>
</EnumType>
```

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