57/747/CD

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Functions concerned:

☐ Safety ☐ EMC ☐ Environment ☐ Quality assurance

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Title:
Amendment 1 to IEC 61850-7-4 Ed. 1 (2003): Communication networks and systems in substations - Part 7-4: Basic communication structure for substation and feeder equipment - Compatible logical node classes and data classes (Addition of power quality monitoring)

(Titre) :

Introductory note

NOTE This project was originally initiated under the project number 61850-7-401 (see 57/624/NP and 57/644/RVN). Further to discussions within TC 57 WG 10 the WG 10 convenor now proposes this project to be developed as Amendment 1 to IEC 61850-7-4. A CD for amendment 2 (covering “TISSUES”) is also planned to be circulated. The next step would be to combine the two amendments with the first edition at the CDV stage and circulate a second edition of 61850-7-4 as a CDV.

CD IEC 61850-7-4, Amendment 1

Communication networks and systems in substations

Power Quality Amendments to IEC 61850-5 and IEC 61850-7-4

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

COMMUNICATION NETWORKS AND SYSTEMS IN SUBSTATIONS

Power Quality Amendments to IEC 61850-5 and IEC 61850-7-4

FOREWORD

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This CD of the Amendment to International Standard IEC 61850-7-4 has been prepared by the Power Quality Task Force of working group 10 of IEC technical committee 57.

This document contains amendments to Parts 5 and 7-4 of the standard series IEC 61850, a set of specifications for communication networks and systems in substations. For the ease of the readability, it was decided for the edition of the CD, to include the amendments of part 5 in the CD for the amendments of part 7-4. For the final publication, there will be individual amendments for part 5 and for part 7-4.

At time of publication of this part, the following parts were intended to be part of IEC 61850:

IEC 61850-1:	*Communication networks and systems in substations – Part 1: Introduction and overview*
IEC 61850-2:	*Communication networks and systems in substations – Part 2: Glossary*
IEC 61850-3:	*Communication networks and systems in substations – Part 3: General requirements*
IEC 61850-4:	*Communication networks and systems in substations – Part 4: System and project management*
IEC 61850-5:	*Communication networks and systems in substations – Part 5: Communication requirements for functions and device models*

IEC 61850-6: Communication networks and systems in substations – Part 6: Substation automation system configuration language

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

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

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

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

IEC 61850-8-1: Communication networks and systems in substations – Part 8-1: Specific communication service mapping (SCSM) – Mapping to MMS(ISO/IEC 9506 Part 1 and Part 2)

IEC 61850-9-1: Communication networks and systems in substations – Part 9-1: Specific communication service mapping (SCSM) – Serial unidirectional multidrop point to point link

IEC 61850-9-2: Communication networks and systems in substations – Part 9-2: Specific communication service mapping (SCSM) – Mapping on a IEEE 802.3 based process bus

IEC 61850-10: Communication networks and systems in substations – Part 10: Conformance Testing

INTRODUCTION

This document is addendum to a set of specifications, which details layered substation communication architecture.

This addendum to the standard IEC 61850 defines the models of power quality related functions.

COMMUNICATION NETWORKS AND SYSTEMS IN SUBSTATIONS

Power Quality Amendments to IEC 61850-5 and IEC 61850-7-4

1 Scope

This addendum standardizes logical nodes, data objects and definitions for exchanging information about power quality

2 Normative references

The following normative documents contain provisions, which, through reference in this text, constitute provisions of this international standard. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this international standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below

IEC 60384	*TBD*
IEC 60848	*Diagrams, charts, tables - rules for function charts*
IEC 60870-5-3	*Telecontrol equipment and systems. Part 5: Transmission protocols Section 3: General structure of application data*
IEC 61082	*Preparation of documents used in the electrotechnology*
IEC 61175	*Designation for signals and connections*
IEC 61346	*Industrial systems, installations and equipment and industrial products – Structuring principles and reference designations*
IEC 61850-1	*Communication networks and systems in substations – Part 1: Concept and Principles.*
IEC 61850-2	*Communication networks and systems in substations – Part 2: Glossary*
IEC 61850-3	*Communication networks and systems in substations – Part 3: General requirements.*
IEC 61850-4	*Communication networks and systems in substations – Part 4: System and project management*
IEC 61850-5	*Communication networks and systems in substations – Part 5: Communication requirements for functions and device models*
IEC 61850-6	*Communication networks and systems in substations – Part 6: Substation Automation System configuration language*
IEC 61850-7-1	*Communication networks and systems in substations – Part 7-1: Basic communication structure for substation and feeder equipment – Principles and models*
IEC 61850-7-2	*Communication networks and systems in substations – Part 7-2: Basic communication structure for substation and feeder equipment – Abstract communication service interface (ACSI)*
IEC 61850-7-3	*Communication networks and systems in substations – Part 7-3: Basic communication structure for substation and feeder equipment – Common data classes and attributes*
IEC 61850-7-4	*Communication networks and systems in substations – Part 7-4: Basic communication structure for substation and feeder equipment – Compatible logical node and data object addressing*

IEC 61850-8-1	*Communication networks and systems in substations – Part 8: Communication between station and bay levels*
IEC 61850-9-1	*Communication networks and systems in substations – Part 9-1: Sampled analogue values over serial unidirectional multidrop point to point link*
IEC 61850-9-2	*Communication networks and systems in substations – Part 9-2: Sampled analogue values over ISO 8802-3*
IEC 61850-10	*Communication networks and systems in substations – Part 10: Conformance testing*
IEC 61000-4-7	*Harmonics and interharmonics measurement*
IEC 61000-4-15	*Flicker measurement*
IEC 61000-4-30	*Power quality measurement*
IEEE 1159	*Power quality measurement - general*
IEEE 1159.1	*Power quality measurement specification*
IEEE 1159.3	*Power quality data interchange - PQDIF*
IEEE 1459	*Power measurement in distorted conditions*

IEEE COMTRADE

NRS 048 – South African PQ Standard

EN50160 and Application Guide - CENELEC

UNIPEDE DISDIP – sag reporting

EPRI DPQ Guides – general PQ guidelines

EN ISO 9001	*Quality systems – Model for quality assurance in design/development, production, installation and servicing*
EN ISO 9002	*Quality systems – Model for quality assurance in production, installation and servicing*
EN ISO 9003	*Quality systems – Model for quality assurance in final inspection and test*
EN ISO 9004	*Quality management and quality system elements*
ISO 9000-1	*Quality management and quality assurance standards – Part 1: Guidelines for selection and use*
ISO 9002	*TBD*
ISO 9003	*TBD*

ISO 9004	*TBD*
ISO 9646	*TBD*

3 Definitions

For the purpose of this International Standard, the terms and definitions provided in part IEC 61850-2 and the following definitions (from 61000-4-30/FDIS) apply together with the definitions of IEC 60050(161).

3.1.
Channel
individual measurement path through an instrument
NOTE “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.

3.2.
declared input voltage, *U*din
value obtained from the declared supply voltage by a transducer ratio

3.3.
declared supply voltage, *U*c
declared supply voltage *U*c is normally the nominal voltage *U*n of the system. If by agreement between the supplier and the customer a voltage different from the nominal voltage is applied to the terminal, then this voltage is the declared supply voltage *U*c

3.4.
dip threshold
voltage magnitude specified for the purpose of detecting the start and the end of a voltage dip

3.5.
flagged data
for any measurement time interval in which interruptions, dips or swells occur, the measurement results of all other parameters made during this time interval are flagged

3.6.
flicker
impression of unsteadiness of visual sensation induced by a light stimulus whose luminance or spectral distribution fluctuates with time
[IEV 161-08-13]

3.7.
fundamental component
component whose frequency is the fundamental frequency
[IEV 101-14-49, modified]
A set of values having defined correspondence with the quantities or values of another set.

3.8.
fundamental frequency
frequency in the spectrum obtained from a Fourier transform of a time function, to which all the frequencies of the spectrum are referred
[IEV 101-14-50, modified]
NOTE In case of any remaining risk of ambiguity, the fundamental frequency should be derived from the polarity and speed of rotation of the synchronous generator(s) feeding the system.

3.9.
harmonic component
any of the components having a harmonic frequency
[IEC 61000-2-2, definition 3.2.4]

NOTE Its value is normally expressed as an r.m.s. value. For brevity, such component may be referred to simply as a harmonic.

3.10.
harmonic frequency
frequency which is an integer multiple of the fundamental frequency
NOTE The ratio of the harmonic frequency to the fundamental frequency is the *harmonic order* (IEC 61000-2-2, definition 3.2.3).

3.11.
hysteresis
difference in magnitude between the start and end thresholds
NOTE 1 This definition of hysteresis is relevant to PQ measurement parameters and is different from the IEV definition which is relevant to iron core saturation.
NOTE 2 The purpose of hysteresis in the context of PQ measurements is to avoid counting multiple events when the magnitude of the parameter oscillates about the threshold level.

3.12.
influence quantity
any quantity which may affect the working performance of a measuring equipment
[IEV 311-06-01, modified]
NOTE This quantity is generally external to the measurement equipment.

3.13.
interharmonic component
component having an interharmonic frequency
[IEC 61000-2-2, definition 3.2.6]
NOTE Its value is normally expressed as an r.m.s. value. For brevity, such a component may be referred to simply as an *interharmonic*.

3.14.
interharmonic frequency
any frequency which is not an integer multiple of the fundamental frequency
[IEC 61000-2-2, definition 3.2.5]
NOTE 1 By extension from *harmonic order*, the *interharmonic order* is the ratio of an interharmonic frequency to the fundamental frequency. This ratio is not an integer (recommended notation m).
NOTE 2 In the case where $m < 1$ the term *subharmonic frequency* may be used.

3.15.
interruption
reduction of the voltage at a point in the electrical system below the interruption threshold

3.16.
interruption threshold
voltage magnitude specified for the purpose of detecting the start and the end of a voltage interruption

3.17.
measurement uncertainty
maximum expected deviation of a measured value from its actual value

3.18.
nominal voltage, *U*n
voltage by which a system is designated or identified

3.19.
overdeviation
difference between the measured value and the nominal value of a parameter, only when the measured value of the parameter is greater than the nominal value

3.20.
power quality
characteristics of the electricity at a given point on an electrical system, evaluated against a set of reference technical parameters
NOTE These parameters might, in some cases, relate to the compatibility between electricity supplied on a network and the loads connected to that network.

3.21.
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
[IEV 101-14-16 modified]

3.22.
r.m.s. voltage refreshed each half-cycle, *U*rms(1/2)
value of the r.m.s. voltage measured over 1 cycle, commencing at a fundamental zero crossing, and refreshed each half-cycle
NOTE 1 This technique is independent for each channel and will produce r.m.s. values at successive times on different channels for polyphase systems.
NOTE 2 This value is used only for voltage dip, voltage swell, and interruption detection.
surge
transient voltage wave propagating along a line or a circuit and characterized by a rapid increase followed by a slower decrease of the voltage
[IEV 161-08-11]

3.23.
range of influence quantities
range of values of a single influence quantity

3.24.
reference channel
one of the voltage measurement channels designated as the reference channel for polyphase measurements

3.25.
residual voltage, *U*res
minimum value of *U*rms(1/2) recorded during a voltage dip or interruption
NOTE The residual voltage is expressed as a value in volts, or as a percentage or per unit value of the declared input voltage.

3.26.
sliding reference voltage, *U*sr
voltage magnitude averaged over a specified time interval, representing the voltage preceding a voltage dip or swell
NOTE The sliding reference voltage is used to determine the voltage change during a dip or a swell.

3.27.
surge
transient voltage wave propagating along a line or a circuit and characterized by a rapid increase followed by a slower decrease of the voltage
[IEV 161-08-11]

3.28.
swell threshold
voltage magnitude specified for the purpose of detecting the start and the end of a swell

3.29.
time aggregation
combination of several sequential values of a given parameter (each determined over identical time intervals) to provide a value for a longer time interval
NOTE Aggregation in this document always refers to time aggregation.

3.30.
transient
pertaining to or designating a phenomenon or a quantity which varies between 2 consecutive steady states during a time interval short when compared with the time-scale of interest
[IEV 161-02-01]

3.31.
underdeviation
absolute value of the difference between the measured value and the nominal value of a parameter, only when the value of the parameter is lower than the nominal value

3.32.
voltage dip
temporary reduction of the voltage at a point in the electrical system below a threshold
NOTE 1 Interruptions are a special case of a voltage dip. Post-processing may be used to distinguish between voltage dips and interruptions.
NOTE 2 In some areas of the world a voltage dip is referred to as sag. The two terms are considered interchangeable; however, this standard will only use the term voltage dip.

3.33.
voltage swell
temporary increase of the voltage at a point in the electrical system above a threshold

3.34.
voltage unbalance
condition in a polyphase system in which the r.m.s. values of the line voltages (fundamental component), or the phase angles between consecutive line voltages, are not all equal
[IEV 161-08-09, modified]
NOTE 1 The degree of the inequality is usually expressed as the ratios of the negative- and zero-sequence components to the positive-sequence component.
NOTE 2 In this standard, voltage unbalance is considered in relation to 3-phase systems.

4 Abbreviated terms

ACSI	Abstract Communication Service Interface
ASDU	Application Service Data Unit
CDC	Common Data Class
HMI	Human Machine Interface
IED	Intelligent Electronic Device
IP	Inter-Networking Protocol
LD	Logical Device
LN	Logical Node
MMS	Manufacturing Message Specification (ISO/IEC 9506)
PE	Process Environment
SCADA	Supervisory Control And Data Acquisition
SCSM	Special Communication Service Mapping
TCP	Transport Control Protocol
TE	Telecommunication Environment

5 Addendum to Part 5: Communication requirements for functions and device models

5.1 General

This clause introduces the requirements for power quality monitoring functions.

5.2 Categories of functions

The following is an addendum to Part 5 - 8 Categories of functions and is a list of power quality monitoring functions identified.

5.2.1 Power quality monitoring functions

a) Power Quality related measurements

b) Power Quality events detection

c) Power Quality events reporting

d) Power Quality events recording

e) Power Quality events statistical analysis

5.3 Logical Nodes for power quality monitoring functions

5.3.1 General

This is an addendum to Part 5 Clause 11 List of logical nodes. It includes modified descriptions of existing logical nodes for Metering and measurement, as well as new logical nodes for Metering and measurement and Power quality events.

5.3.2 Logical nodes for Metering and measurement

Logical Node	**61850**	**Description or Comments**
Measuring - for operative purpose	**MMXU**	to acquire values from CTs and VTs and calculate measurements like rms values for current and voltage or power flows out of the acquired voltage and current samples. These values are normally used operational purposes like power flow supervision and management, screen displays, state estimation, etc. The requested accuracy for these functions has to be provided. Note: The measuring procedures in the multi-functional devices are part of the dedicated power quality event monitoring algorithms represented by the logical nodes Qxyz. Power Quality detection algorithms like any function are outside the scope of the communication standard. Therefore, the LN Mxyz shall not be used as input for Qxyz. Power Quality events related data like voltage sag value, etc. are always provided by the LNs of type Qxyz and not by LNs of type Mxyz.

Metering - for commercial purpose	**MMTR**	to acquire values from CTs and VTs and calculate the energy (integrated values) out of the acquired voltage and current samples. Metering is normally used also for billing and has to provide the requested accuracy. CTs and VTs used should be of metering accuracy. A dedicated instance of this LN may take the energy values from external meters e.g. by pulses instead directly from CTs and VTs.
Sequences and imbalances - e.g. for stability purpose	**MSQI**	to acquire values from CTs and VTs and to calculate the sequences and imbalances in a three/multi-phase power system.
Harmonics and interharmonics - e.g. for power quality purpose	**MHAI**	to acquire values from CTs and VTs and to calculate harmonics, interharmonics and related values in the power system mainly used for determining power quality.
Advanced	**MADV**	to acquire values from CTs and VTs and to calculate advanced measurement values (like power in non-sinusoidal conditions) in the power system mainly used for determining power quality.
Flicker	**MFLK**	to acquire values from VTs and to calculate flicker and related values in the power system mainly used for determining power quality.

5.3.3 Logical nodes for Power quality events monitoring

Logical Node	**61850**	**Description or Comments**
RMS voltage variations	**QVVR**	The voltage variation LN is a functional element which operates when its input voltage is outside of a predetermined value range, as is the case with voltage dips, voltage swells or voltage interruptions. It can detect temporary overvoltage or undervoltage conditions, as well as complete loss of voltage. Separate thresholds for under and overvoltage, as well as for voltage interruption should be available as configuration data objects in this LN. This LN should detect the duration and level of voltage variation. The detection of voltage variation events is typically based on the rms voltage measurements on a sub-cycle or full cycle algorithm. In case of bus VTs, voltage interruption should be detectable using other methods, such as breaker auxiliary contacts status. Since it is possible(for example during single-phase-to-ground faults) to have simultaneous under and overvoltage condition in different phases, the LN should monitor voltage variations on a per-phase basis.
Frequency variations	**QFVR**	The frequency variation LN is a functional element which operates when the measured system frequency is outside of a predetermined value range, as is the case during wide area system disturbances. It can detect temporary overfrequency or underfrequency conditions. Separate thresholds for over- or underfrequency, should be available as configuration data objects in this LN. This LN should detect the duration and level of frequency variation.
Voltage Unbalance variations	**QVUB**	This LN function is to detect voltage imbalances in a three/multi-phase power system. The unbalance variation LN operates when the unbalance of its input voltage is outside of a predetermined value range. The method for detection of the unbalance (usually the ratio of the negative sequence to positive sequence voltage) should be available to the user. This LN should detect the duration and level of voltage unbalance variation.

Current Unbalance variations	**QIUB**	This LN function is to detect current imbalances in a three/multi-phase power system. The unbalance variation LN operates when the unbalance of its input current is outside of a predetermined value range. The method for detection of the unbalance (usually the ratio of the negative sequence to positive sequence current) should be available to the user. This LN should detect the duration and level of current unbalance variation.
Voltage Transients	**QVTR**	This LN is a functional element that detects a very short (sub-cycle) variation based on the sampled values of the monitored voltage waveforms. It operates when the sampled values are outside of the user defined range. Separate thresholds for under and overdeviation should be available. This LN should detect the duration and level of the transient.
Current Transients	**QITR**	This LN is a functional element that detects a very short (sub-cycle) variation based on the sampled values of the monitored current waveforms. It operates when the sampled values are outside of the user defined range. This LN should detect the duration and level of the transient.

6 Addendum to Part 7-4: Basic communications structure for substation and feeder equipment – Compatible logical node classes and data classes

6.1 General

A new group of logical nodes for power quality event detection related functions needs to be added to Table 1 in Part 7-4 Section 5.1

6.2 Logical Node groups

Logical nodes are grouped according to the Logical Node Groups listed in Table 1. The names of power quality events detection related Logical Nodes shall begin with the character representing the group to which the Logical Node belongs.

Table 1 – List of Logical Node Groups

Group Indicator	Logical node groups
Q	Power Quality Events Detection Related

6.3 Logical Nodes for metering and measurement LN Group: M

6.3.1 Modelling Remarks

If the values for metering or measurement are provided by an external sensor connected via a 4 to 20 mA link the live zero alarm is provided by the data external health (EEHealth).

Table 2– Relation IEC 61850-5 and IEC 61850-7-4 for metering and measurement LNs

Functionality	Defined in part IEC 61850-5 by LN	Modelled in part IEC 61850-7-4 by LN	Comments
Measurement	MMXU	MMXU MMXN	Three-phase version Non-phase related version (single phase)
Metering	MMTR	MMTR MSTA	Metering (values) Metering (statistics)
Harmonics and interharmonics	MHAI	MHAI MHAN	Three-phase version Non-phase related version (single phase)
Advanced		MADV	Advanced measurements for power quality
Flicker		MFLK	Flicker measurements for power quality
Differential measurements		MDIF	Calculated data for differential protection

6.3.2 LN: Advanced Measurement unit Name: MADV

This LN shall be used for calculation of currents, voltages, and powers using advanced summation techniques (arithmetic and vector) for three phase quantities, and for proper representation of these quantities in non-sinusoidal and unbalanced conditions according to IEEE standard 1459. The main use is for operative applications.

MADV class				
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2).		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class.		M
EEHealth	ISI	External equipment health (external sensor)		O
Measured values				
TotVAa	MV	Arithmetic Total Apparent Power (va)		O
TotVAv	MV	Vector Total Apparent Power (va)		O
TotVAaFund	MV	Fundamental Arithmetic Total Apparent Power (va)		O
TotVAvFund	MV	Fundamental Vector Total Apparent Power (va)		O
TPF	WYE	True Power Factor (pu)		O
TPFworst	MV	Worst Phase True Power Factor (pu)		O
avgTPF	MV	Average True Power Factor (pu)		O
TotPFa	MV	Arithmetic Total Power Factor (pu)		O
TotPFv	MV	Vector Total Power Factor (pu)		O
DF	WYE	Displacement Power Factor (pu)		O
DFworst	MV	Worst Phase Displacement Power Factor (pu)		O
AvgDF	MV	Average Displacement Power Factor (pu)		O
TotDFa	MV	Arithmetic Total Displacement Power Factor (pu)		O
TotDFv	MV	Vector Total Displacement Power Factor (pu)		O
Ires	MV	Residual Current Ia + Ib + Ic (amps)		O
Inet	MV	Net Current Ia + Ib + Ic + In (amps)		O
nssN	WYE	non-active power (vars)		O
nssSn	WYE	Non-fundamental apparent power		O
nssSh	WYE	harmonic apparent power		O
nssDpi	WYE	current distortion power		O
nssDpv	WYE	voltage distortion power		O
nssDph	WYE	harmonic distortion power		O
nssSnS1	WYE	Sn / S1 ratio - harmonic pollution		O
nssIeh	MV	3 phase effective harmonic current		O
nssVeh	MV	3 phase effective harmonic voltage		O
nssSeh	MV	3 phase effective harmonic apparent power		O
nssDpei	MV	3 phase effective current distortion power		O
nssDpev	MV	3 phase effective voltage distortion power		O
nssDpeh	MV	3 phase effective harmonic distortion power		O
nssSen	MV	3 phase effective non-fundamental apparent power		O
nssSenSe1	MV	Sen / Se1 ratio - harmonic pollution		O
nssS1	WYE	fundamental apparent power (va)		O
nssP1	WYE	fundamental real power (watts)		O
nssSn	WYE	non-active apparent power (vars)		O
nssIe	MV	3 phase effective current (amps)		O
nssVe	MV	3 phase effective voltage (volts)		O
nssSe	MV	3 phase effective apparent power (va)		O

nssIe1	MV	3 phase effective fundamental current (amps)		O
nssVe1	MV	3 phase effective fundamental voltage (volts)		O
nssSe1	MV	3 phase effective fundamental apparent power (va)		O
nssTotN	MV	3 phase total non-active power (vars)		O
nssPFe	MV	3 phase effective power factor (pu)		O
nssS1p	MV	positive sequence fundamental apparent power (va)		O
nssS1u	MV	fundamental unbalanced apparent power (va)		O
nssP1p	MV	positive sequence fundamental apparent power (va)		O
nssQ1p	MV	positive sequence fundamental reactive power (var)		O
nssPF1p	MV	positive sequence fundamental power factor (pu)		O
nssS1uS1p	MV	ratio of fundamental unbalance to apparent power (pu)		O

6.3.3 LN: Flicker Measurement unit Name: MFLK

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

MFLK class				
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2).		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class.		M
EEHealth	ISI	External equipment health (external sensor)		O
Measured values				
Pst	DELTA	Pst of last complete interval		O
Plt	DELTA	Plt of last complete interval		O
PltSlide	DELTA	Sliding window Plt up to last complete Pst interval		O
PiMax	DELTA	Output 5 – Instantaneous peak P value		O
PiLPF	DELTA	Output 4 – 1 minute average of Output 5		O
PiRoot	DELTA	Output 3 – Square root of Output 5		O
PcbLsA	FLKPROB	Classifier bins of last complete short interval Phase A (or AB)		O
PcbLsB	FLKPROB	Classifier bins of last complete short interval Phase B (or BC)		O
PcbLsC	FLKPROB	Classifier bins of last complete short interval Phase C (or CA)		O
PcbLlA	FLKPROB	Classifier bins of last complete long interval Phase A (or AB)		O
PcbLlB	FLKPROB	Classifier bins of last complete long interval Phase B (or BC)		O
PcbLlC	FLKPROB	Classifier bins of last complete long interval Phase C (or CA)		O
PdmWaveA	FLKDMOD	Real time demodulated waveform Phase A (or AB)		O
PdmWaveB	FLKDMOD	Real time demodulated waveform Phase B (or BC)		O
PdmWaveC	FLKDMOD	Real time demodulated waveform Phase C (or CA)		O
PdmSpecA	FLKSPEC	Real time demodulated waveform spectra Phase A (or AB)		O
PdmSpecB	FLKSPEC	Real time demodulated waveform spectra Phase B (or BC)		O
PdmSpecC	FLKSPEC	Real time demodulated waveform spectra Phase C (or CA)		O

Note: DELTA class used for multi-phase measurements for WYE or DELTA connections since neutral is not measured for flicker.

FLKDMOD – Array of N measured values containing demodulated waveform where N is vendor dependent and discoverable

FLKSPEC – Array of N measured values containing demodulated spectra – M Hz resolution where N and M are discoverable

FLKPROB – Array of N counts representing classifier bins where N is discoverable

6.4 Logical Nodes for power quality events LN Group: Q

6.4.1 Modelling Remarks

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

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

6.4.2 LN: Voltage Variation Name: QVVR

Description of this LN see IEC 61850-5.

QVVR class				
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2).		M
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class.		
OpCntRs	INC	Resetable counter operation		O
Status Information				
Str	SPS	Start (Voltage Variation Event in progress)		M
DipStr	SPS	Start (Voltage Dip Event in progress)		O
SwlStr	SPS	Start (Voltage Swell Event in progress)		O
Op	SPS	Operate (Event finished but not Reset)	T	O
Measured Values				
Dur	MV	Voltage Variation Duration of the last completed event		O
Mag	MV	Voltage Variation Magnitude		O
TmLvl[k]	MV	Time at/or above/below Level [k]		
Area	MV	Voltage Variation Area		O
OpCnt[i]	INS	Operation counter		O
Settings				
Phs	ING	Monitored phase		O
PQStd	PQS	Power Quality Standard (PQS is new - Enumerated - UNIPEDE, NRS048, CIGRE C4.07, EPRI, IEEE, Custom)		O
DipStrVal	ASG	Voltage Dip Set Point		M
SwlStrVal	ASG	Voltage Swell Set Point		M
IntStrVal	ASG	Voltage Interruption Set Point		O
IntDtMthd	ING	Interruption Detection Method		O
LvlStrVal[k]	ASG	Time at/or above/below Voltage Level Set Point		O
Mag1[i]	ASG	Voltage Variation Event Magnitude Range Point 1		O
Mag2[i]	ASG	Voltage Variation Event Magnitude Range Point 2		O
Dur1[i]	ASG	Voltage Variation Event Duration Range Point 1 [ms]		O
Dur2[i]	ASG	Voltage Variation Event Duration Range Point 2 [ms]		O

The figures below illustrate the meaning of the different data objects included in the model.

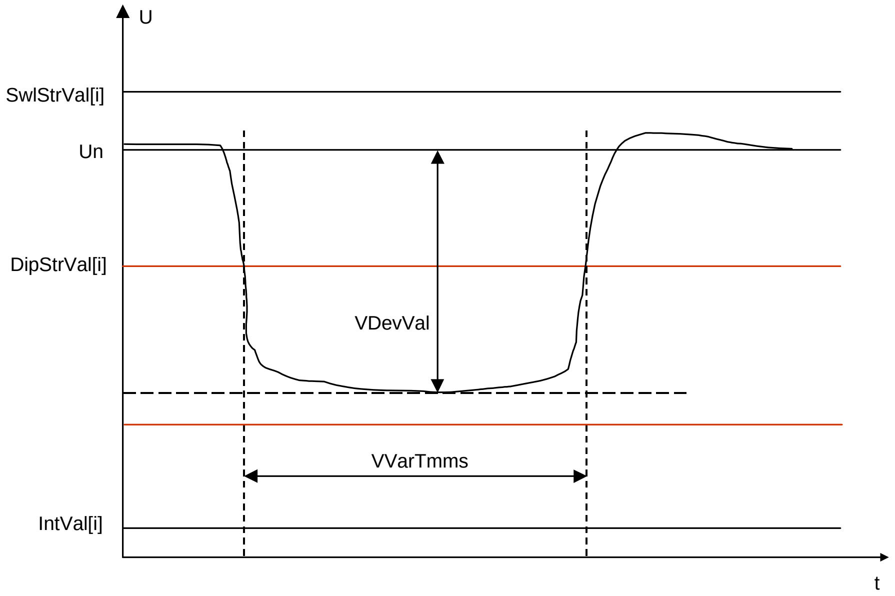


Figure 1 Voltage Variation Data Objects

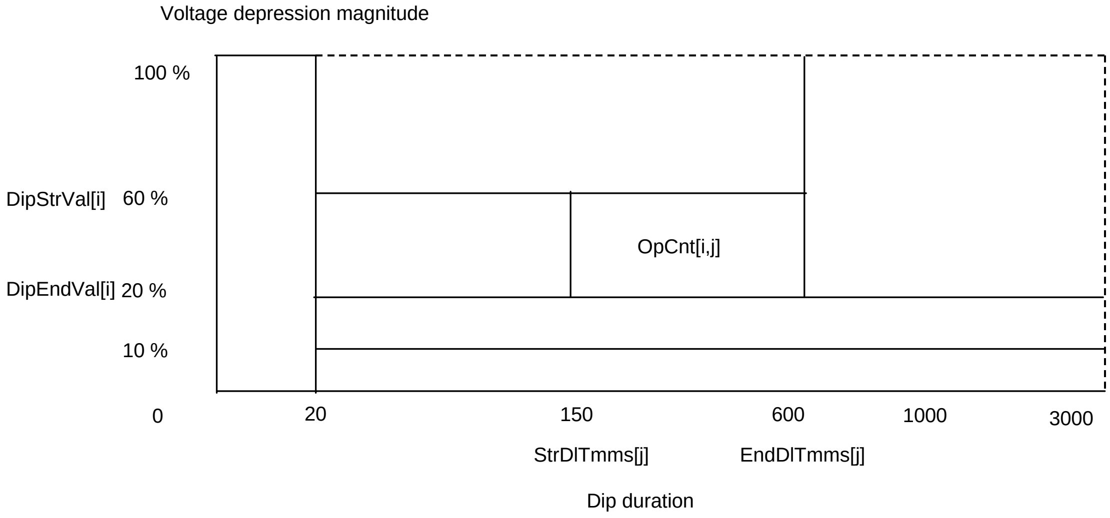


Figure 2 Voltage Variation Event Range Data Objects

6.4.3 LN: Frequency Variation Name: QFVR

Description of this LN see IEC 61850-5.

QFVR class				
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2).		M
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class.		
OpCntRs	INC	Resetable counter operation		O
Status Information				
Str	SPS	Start (Frequency Variation Event in progress)		M
UnFrqStr	SPS	Start (Underfrequency Variation Event in progress)		O
OvFrqStr	SPS	Start (Overfrequency Variation Event in progress)		O
Op	SPS	Operate (Event finished but not Reset)	T	O
Measured Values				
Dur	MV	Frequency Variation Duration of the last completed event		O
Mag	MV	Frequency Variation Magnitude		O
RteChg	MV	Rate of change of Frequency Value		O
TmLvl[k]	MV	Time at/or above/below Level [k]		O
Area	MV	Frequency Variation Area		O
OpCnt[i]	INS	Operation counter		O
Settings				
Phs	ING	Monitored phase		O
UnFrqStrVal	ASG	Underfrequency Set Point		M
OvFrqStrVal	ASG	Overfrequency Set Point		M
LvlStrVal[k]	ASG	Time at/or above/below Frequency Level Set Point		O
Mag1[i]	ASG	Frequency Variation Event Magnitude Range Point 1		O
Mag2[i]	ASG	Frequency Variation Event Magnitude Range Point 2		O
Dur1[i]	ASG	Frequency Variation Event Duration Range Point 1 [ms]		O
Dur2[i]	ASG	Frequency Variation Event Duration Range Point 2 [ms]		O

The figure below shows some of the data objects from the QFVR on a frequency profile.

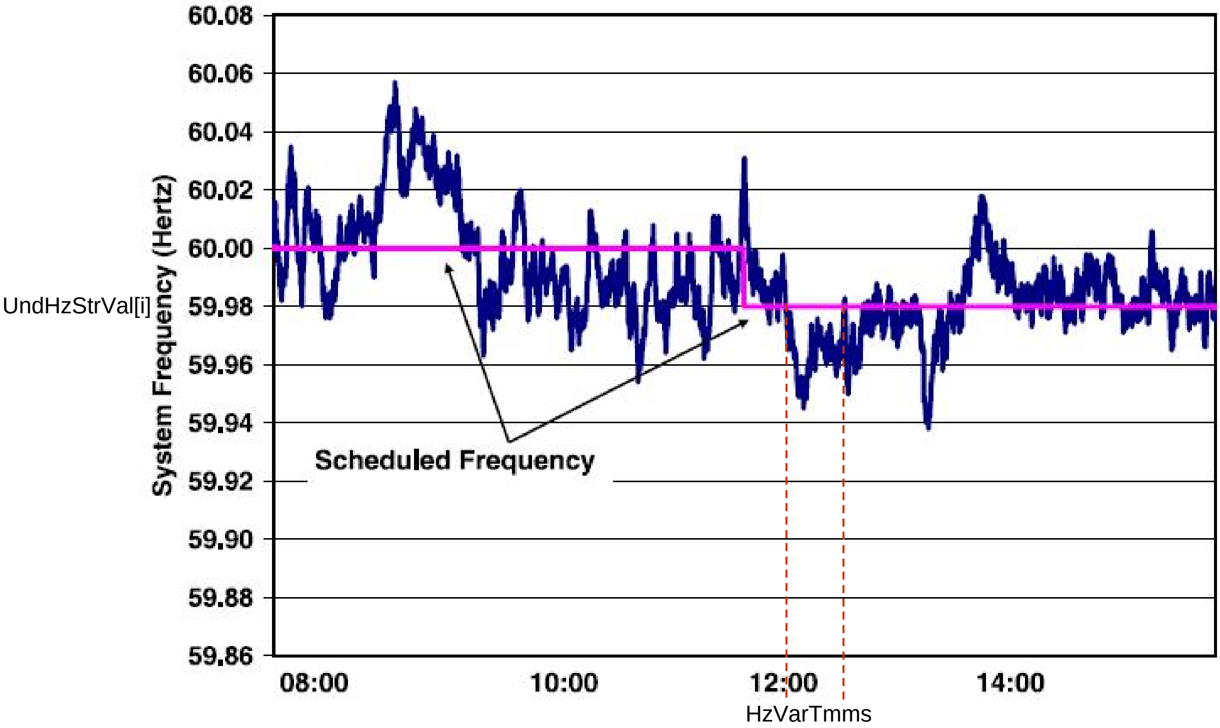


Figure 3 Frequency Variation Data Objects

6.4.4 LN: Voltage Unbalance Variation Name: QVUB

Description of this LN see IEC 61850-5.

QUNB class				
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2).		M
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class.		
OpCntRs	INC	Resetable counter operation		O
Status Information				
Str	ACT	Start		M
Op	ACT	Operate	T	O
Measured Values				
Dur	MV	Voltage Unbalance Variation Duration		O
Mag	MV	Maxmum Unbalance Deviation Value		O
OpCnt[i,j]	INS	Operation counter		O
Settings				
UnbDtMthd	ING	Unbalance Detection Method		M
StrVal	ASG	Voltage Unbalance Start Value		M
LvlStrVal[k]	ASG	Time at/or above Unbalance Level Set Point		O
Mag1[i]	ASG	Unbalance Variation Event Magnitude Range Point 1		O
Mag2[i]	ASG	Unbalance Variation Event Magnitude Range Point 2		O
Dur1[i]	ASG	Unbalance Variation Event Duration Range Point 1 [ms]		O
Dur2[i]	ASG	Unbalance Variation Event Duration Range Point 2 [ms]		O

6.4.5 LN: Current Unbalance Variation Name: QIUB

Description of this LN see IEC 61850-5.

QUNB class				
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2).		M
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class.		
OpCntRs	INC	Resetable counter operation		O
Status Information				
Str	ACT	Start		M
Op	ACT	Operate	T	O
Measured Values				
Dur	MV	Current Unbalance Variation Duration		O
Mag	MV	Maxmum Unbalance Deviation Value		O
OpCnt[i,j]	INS	Operation counter		O
Settings				
UnbDtMthd	ING	Unbalance Detection Method		
StrVal	ASG	Current Unbalance Start Value		M
LvlStrVal[k]	ASG	Time at/or above Unbalance Level Set Point		O
Mag1[i]	ASG	Unbalance Variation Event Magnitude Range Point 1		O
Mag2[i]	ASG	Unbalance Variation Event Magnitude Range Point 2		O
Dur1[i]	ASG	Unbalance Variation Event Duration Range Point 1 [ms]		O
Dur2[i]	ASG	Unbalance Variation Event Duration Range Point 2 [ms]		O

6.4.6 LN: Voltage Transient Name: QVTR

Description of this LN see IEC 61850-5.

QTRN class				
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2).		M
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class.		
OpCntRs	INC	Resetable counter operation		O
Status Information				
Str	ACT	Start		M
Op	ACT	Operate	T	O
Measured Values				
Dur	MV	Transient Duration		O
Mag	MV	Maxmum Voltage Transient Value		O
RteChg	MV	Rate of change of Voltage Transient Value		O
OpCnt[i,j]	INS	Operation counter		O
Settings				
StrVal[i]	ASG	Voltage Transient Start Value		M
Mag1[i]	ASG	Transient Event Magnitude Range Point 1		O
Mag2[i]	ASG	Transient Event Magnitude Range Point 2		O
Dur1[i]	ASG	Transient Event Duration Range Point 1 [ms]		O
Dur2[i]	ASG	Transient Event Duration Range Point 2 [ms]		O

The figure below shows some of the data objects from the QVTR on a voltage transient waveform.

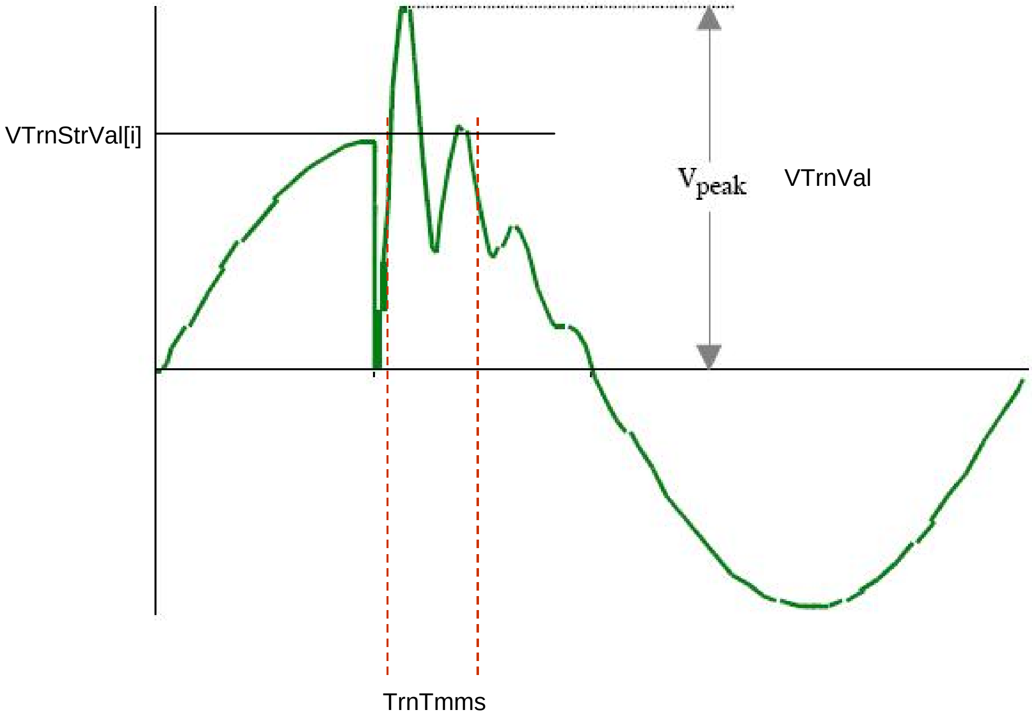


Figure 4 Voltage Transient Data Objects

6.4.7 LN: Current Transient Name: QITR

Description of this LN see IEC 61850-5.

QTRN class				
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2).		M
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class.		
OpCntRs	INC	Resetable counter operation		O
Status Information				
Str	ACT	Start		M
Op	ACT	Operate	T	O
Measured Values				
Dur	MV	Transient Duration		O
Mag	MV	Maxmum Current Transient Value		O
RteChg	MV	Rate of change of Current Transient Value		O
OpCnt[i,j]	INS	Operation counter		O
Settings				
StrVal[i]	ASG	Current Transient Start Value		M
Mag1[i]	ASG	Transient Event Magnitude Range Point 1		O
Mag2[i]	ASG	Transient Event Magnitude Range Point 2		O
Dur1[i]	ASG	Transient Event Duration Range Point 1 [ms]		O

Dur2[i]	ASG	Transient Event Duration Range Point 2 [ms]		O

6.5 Data name semantics

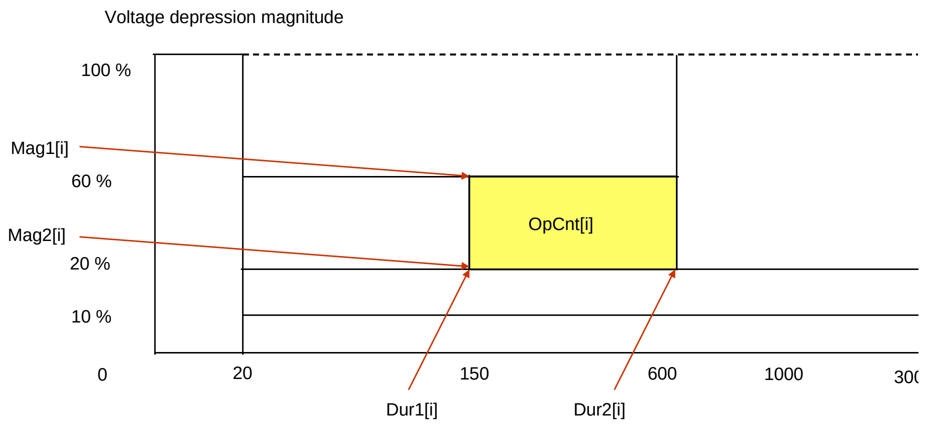
In the table below the new data objects used in the power quality logical nodes are described.

Table 3– Description of Power Quality Related Data

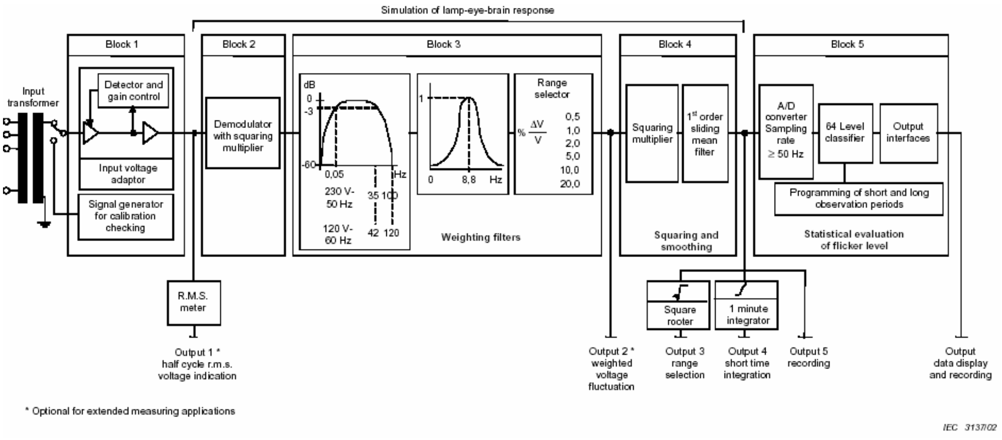
Data Name	**Semantic**
Area	The total calculated Area of a power quality event (ex. Voltage Sag in Fig. XXX)
AvgDF	Average Displacement Power Factor (pu)
avgTPF	Average True Power Factor (pu)
DF	Displacement Power Factor (pu) $P_{F1} = \frac{P_1}{S_1} = \cos\theta_1$
DFworst	Worst Phase Displacement Power Factor (pu)
DipStrVal	When the voltage in at least one phase goes below the Voltage Dip Set Point it will start the voltage variation function and the timer that will measure the duration of the voltage variation power quality event. The event ends when all monitored phase voltages return above the threshold.
Dur	The total measured or calculated Duration of power quality event, i. e. the time from the start until the end of a voltage dip (sag), swell, interruption or other event
Dur1[i]	Defines the first Duration set point [ms] for the Event Range used to detect a power quality event
Dur2[i]	Defines the second Duration set point [ms] for the Event Range used to detect a power quality event
Inet	Net Current Ia + Ib + Ic + In (amps)
IntDtMthd	Voltage Interruption Detection Method is the method used to detect the interruption condition based on measured or calculated voltages, currents or the status of the breaker auxiliary contacts.
IntStrVal	The Voltage Interruption set point. When the measured voltage goes below this value
Ires	Residual Current Ia + Ib + Ic (amps)
Mag	The measured global maximum or minimum value of the system parameter reached during the event. This is the parameter that defines the power quality event, for example the minimum voltage during a voltage dip or the maximum frequency during an overfrequency variation.

IntDtMthd values:

Voltage Interruption Detection Method	**Value**
Voltage	1
Voltage and Current	2
Voltage and Normally Open Breaker Contact	3
Voltage and Normally Closed Breaker Contact	4
Voltage and both Normally Open and Normally Closed Breaker Contacts	5
Normally Open Breaker Contact	6
Normally Closed Breaker Contact	7
Both Normally Open and Normally Closed Breaker Contacts	8

Data Name	**Semantic**
	
Mag1[i]	Defines the first Magnitude set point for the Event Range used to detect a power quality event
Mag2[i]	Defines the second Magnitude set point for the Event Range used to detect a power quality event
nssDpeh	3 phase effective harmonic distortion power $D_{eH} = \sqrt{S_{eH}^2 - P_{eH}^2}$
nssDpei	3 phase effective current distortion power $D_{eI} = 3V_{e1} I_{eH} = S_{e1}(THD_{eI})$
nssDpev	3 phase effective voltage distortion power $D_{eV} = V_{eH} I_{e1} = S_{e1}(THD_{eV})$
nssDph	harmonic distortion power $D_H = \sqrt{S_H^2 - P_H^2}$
nssDpi	current distortion power $D_1 = V_1 I_H = S_1(THD_I)$
nssDpv	voltage distortion power $D_V = V_H I_1 = S_1(THD_V)$
nssIe	3 phase effective current (amps) $I_e = \sqrt{\frac{I_a^2 + I_b^2 + I_c^2 + I_n^2}{3}}$
nssIe1	3 phase effective fundamental current (amps) $I_{e1} = \sqrt{\frac{I_{a1}^2 + I_{b1}^2 + I_{c1}^2}{3}}$
nssIeh	3 phase effective harmonic current $I_{eH} = \sqrt{I_e^2 - I_{e1}^2}$
nssN	non-active power (vars) $N = \sqrt{S^2 - P^2}$

Data Name	**Semantic**
nssP1	fundamental real power (watts) $P_1 = \frac{1}{kT}\int_{\tau}^{\tau+kT} v_1 i_1 dt = V_1 I_1 \cos\theta_1$
nssP1p	positive sequence fundamental apparent power (va) $P_1^+ = 3V_1^+ I_1^+ \cos\theta_1^+$
nssPF1p	positive sequence fundamental power factor (pu) $P_{F1}^+ = \frac{P_1^+}{S_1^+}$
nssPFe	3 phase effective power factor (pu) $P_{Fe} = \frac{P}{S_e}$
nssQ1p	positive sequence fundamental reactive power (var) $Q_1 = \frac{\omega_1}{kT}\int_{\tau}^{\tau+kT} v_1[\int v_1 dt]dt = V_1 I_1 \sin\theta_1$
nssS1	fundamental apparent power (va)
nssS1p	positive sequence fundamental apparent power (va) $S_1^+ = \sqrt{\left(P_1^+\right)^2 + \left(Q_1^+\right)^2}$
nssS1u	fundamental unbalanced apparent power (va) $S_{U1} = \sqrt{S_{e1}^2 - (S_1^+)^2}$
nssS1uS1p	ratio of fundamental unbalance to apparent power (pu)
nssSe	3 phase effective apparent power (va) $S_e = 3V_e I_e$
nssSe1	3 phase effective fundamental apparent power (va) $S_{e1} = 3V_{e1} I_{e1}$
nssSeh	3 phase effective harmonic apparent power $S_{eH} = V_{eH} I_{eH} = S_{e1}(THD_{eI})(THD_{eV})$
nssSen	3 phase effective non-fundamental apparent power $S_{eN} = \sqrt{S_e^2 - S_{e1}^2}$
nssSenSe1	Sen / Se1 ratio - harmonic pollution
nssSh	harmonic apparent power $S_H = V_H I_H = S_1(THD_I)(THD_V)$
nssSn	Non-fundamental apparent power $S_N = \sqrt{S^2 - S_1^2}$
nssSn	non-active apparent power (vars)
nssSnS1	Sn / S1 ratio - harmonic pollution

Data Name	**Semantic**
nssTotN	3 phase total non-active power (vars)
nssVe	3 phase effective voltage (volts) $V_e = \sqrt{\frac{1}{18}\left[3\left(V_a^2 + V_b^2 + V_c^2\right) + V_{ab}^2 + V_{bc}^2 + V_{ca}^2\right]}$ For a three wire system: $V_e = \sqrt{\frac{V_{ab}^2 + V_{bc}^2 + V_{ca}^2}{3}}$
nssVe1	3 phase effective fundamental voltage (volts) $V_{e1} = \sqrt{\frac{1}{18}\left[3\left(V_{a1}^2 + V_{b1}^2 + V_{c1}^2\right) + V_{ab1}^2 + V_{bc1}^2 + V_{ca1}^2\right]}$
nssVeh	3 phase effective harmonic voltage $V_{eH} = \sqrt{V_e^2 - V_{e1}^2}$
OpCnt[i,j]	Operations counter – counts the number of times that a power quality event detected by the logical node occurred
OvFrqStrVal	When the measured system frequency goes above the Overfrequency Set Point it will start the frequency variation function and the timer that will measure the duration of the frequency variation power quality event. The event ends when the frequency returns below the threshold.
Pxxx - Flicker	Flicker related items based on following block diagram:  * Optional for extended measuring applications IEC 3137/02
PcbLIA	Classifier bins of last complete long interval Phase A (or AB)
PcbLIB	Classifier bins of last complete long interval Phase B (or BC)
PcbLIC	Classifier bins of last complete long interval Phase C (or CA)
PcbLsA	Classifier bins of last complete short interval Phase A (or AB)
PcbLsB	Classifier bins of last complete short interval Phase B (or BC)
PcbLsC	Classifier bins of last complete short interval Phase C (or CA)
PdmSpecA	Real time demodulated waveform spectra Phase A (or AB)
PdmSpecB	Real time demodulated waveform spectra Phase B (or BC)
PdmSpecC	Real time demodulated waveform spectra Phase C (or CA)
PdmWaveA	Real time demodulated waveform Phase A (or AB)
PdmWaveB	Real time demodulated waveform Phase B (or BC)

Data Name	**Semantic**
PdmWaveC	Real time demodulated waveform Phase C (or CA)
Phs	Monitored phase (PHS is new - Enumerated - Total, 1, 2, 3, Ph-Ph, etc.)
Phs	Defines one or more phase-to-neutral or phase-to-phase parameters used by the logical node to detect the power quality event. **Monitored Phase** – **Value** Total – 1 Phase 1 – 2 Phase 2 – 3 Phase 3 – 4 Phase 1-2 – 5 Phase 2-3 – 6 Phase 3-1 – 7 Other – 8
PiLPF	Output 4 – 1 minute average of Output 5
PiMax	Output 5 – Instantaneous peak P value
PiRoot	Output 3 – Square root of Output 5
Plt	Plt of last complete interval
PltSlide	Sliding window Plt up to last complete Pst interval
PQStd	Power Quality Standard (PQS is new - Enumerated - UNIPEDE, NRS048, CIGRE C4.07, EPRI, IEEE, Custom)
Pst	Pst of last complete interval
RteChg	The rate of change of the system parameter, for example the rate of change the frequency
SwlStrVal	When the voltage in at least one phase goes above the Voltage Swell Set Point it will start the voltage variation function and the timer that will measure the duration of the voltage variation power quality event. The event ends when all monitored phase (or phase-to-phase) voltages return below the threshold.
TmLvl[k]	Measured time at/or above/below Voltage Level Set Point
TotDFa	Arithmetic Total Displacement Power Factor (pu)
TotDFv	Vector Total Displacement Power Factor (pu)
TotPFa	Arithmetic Total Power Factor (pu)
TotPFv	Vector Total Power Factor (pu)
TotVAa	Arithmetic Total Apparent Power (va) $S_e = 3V_e I_e$
TotVAaFund	Fundamental Arithmetic Total Apparent Power (va) $S_{e1} = 3V_{e1} I_{e1}$
TotVAv	Vector Total Apparent Power (va)
TotVAvFund	Fundamental Vector Total Apparent Power (va)
TPF	True Power Factor (pu)
TPFworst	Worst Phase True Power Factor (pu)
TrnStrVal[i]	
UnbDtMthd	Unbalance Detection Method is the method used to detect the unbalanced condition based on measured or calculated phase or sequence components of the monitored by the logical node system parameters. **Unbalance Detection Method** – **Value** Negative Sequence – 1 Zero Sequence – 2 Negative Sequence / Positive Sequence – 3 Zero Sequence / Positive Sequence – 4 Phase vectors comparison – 5 Other 1 – 6 Other 2 – 7 Other 3 – 8

Data Name	**Semantic**
UnFrqStrVal	When the measured system frequency goes below the Underfrequency Set Point it will start the frequency variation function and the timer that will measure the duration of the frequency variation power quality event. The event ends when the frequency returns above the threshold.