Eskom	Standard	Technology

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1. Introduction

Power quality instruments currently in the market have different characteristics and capabilities. This standard is needed to ensure the facilitation of choices as an end-user in terms of factors such as measurement, safety and interpretation of indications. This document provides a basis by which such devices can be specified and described, and their performance evaluated.

This standard must be read in conjunction with IEC 62586 and IEC 61000-4-30 standards.

This standard (ESP 32-1132) shall be read in conjunction with [30] IEC 61000-4-30 and [37] IEC 62586 standards.

This standard utilizes [30] IEC 61000-4-30 as a basis for power quality instrumentation such that it provides a common basis for application by both international and local instrument manufacturers.

Where local requirements differ from the International Electrotechnical Commission (IEC) standard, this forms a specific requirement in addition to the IEC standard.

2. Supporting clauses

2.1 Scope

2.1.1 Purpose

The purpose of this standard is to specify product requirements for instruments whose functions include measuring and monitoring of power quality parameters in Alternating Current (AC) power systems and whose measuring methods are defined in [30] IEC 61000-4-30. This standard does not cover the application of existing Quality of Supply (QoS) meters installed.

These requirements are applicable in single, dual (split phase) and three-phase AC power supply systems at 50 Hz.

These instruments can be used, for example:

- In the transmission and distribution of electricity and related telecommunication systems, e.g. inside a substation.
- At the interface point between the installation and the network, e.g. in order to check the compliance with the connection agreement with a network operator.

These instruments might also be used for other applications, e.g. inside commercial/industrial installations, especially when comparable measurements are needed, e.g. data centres or petrochemical plants.

Measurement methods are described for each relevant type of parameter. These methods will make it possible to obtain reliable, repeatable and comparable results regardless of the compliant instrument being used, and regardless of its environmental conditions. This standard addresses instrumentation performance standards for on-site measurements.

Measurements of parameters covered by this standard are limited to those phenomena that can be conducted in a power system. These include the voltage and/or current parameters, as appropriate.

2.1.2 Applicability

This document shall apply to the following divisions/departments/sections

- Technology
- Transmission
- Distribution

2.2 Normative/informative references

Parties using this document shall apply the most recent edition of the documents listed in the following paragraphs.

2.2.1 Normative

[1] IEC 60050-161, International Electrotechnical Vocabulary (IEV) Chapter 161, IEC, Edition 1.0

[2] IEC 60060, High-voltage test techniques, IEC, Latest

[3] IEC 60060-1, High voltage test techniques — Part 1: General definitions and test requirements, IEC, Latest

[4] IEC 60060-2, High voltage test techniques — Part 2: Measuring systems, IEC, Latest

[5] IEC 60068-1, Environmental testing – Part 1: General and guidance**,** IEC, Latest

[6] IEC 60068-2-1, Environmental testing — Part 2: Tests — Tests A — Cold, IEC, Latest

[7] IEC 60068-2-2, Environmental testing — Part 2: Tests — Tests B — Dry heat, IEC, Latest

[8] IEC 60068-2-6, Environmental testing — Part 2: Tests — Test Fc: Vibration (sinusoidal), IEC, Latest

[9] IEC 60068-2-14, Environmental testing – Part 2-14 Tests – Test N: Change of temperature**,** IEC, Latest

[10] IEC 60068-2-27, Environmental testing — Part 2: Tests — Test Ea and guidance: Shock, IEC, Latest

[11] IEC 60068-2-30, Environmental testing — Part 2: Tests — Test Db and guidance: Damp heat, cyclic (12 +12 hour cycle), IEC, Latest

[12] IEC 60068-2-31, Environmental testing – Part 2-31: Tests – Test Ec: Rough handling shocks, primarily for equipment-type specimens., IEC, Latest

[13] IEC 60068-2-52, Environmental testing – Part 2-52: Tests – Test Kb: Salt mist, cyclic (sodium chloride solution)., IEC, Latest

[14] IEC 60068-2-57, Environmental testing – Part 2-57: Tests – Test Ff: Vibration – Time-history and sine-beat method, IEC, Latest

[15] IEC 60068-2-63, Environmental testing — Part 2: Test methods — Test Eg: Impact, spring hammer., IEC, 1991

[16] IEC 60068-2-78, Environmental testing – Part 2-78: Tests – Test Cab: Damp heat, steady state, IEC, Latest

[17] IEC 60529, Degrees of protection provided by enclosures (IP Code)**,** IEC, Latest

[18] IEC 60654-1, Industrial-process measurement and control equipment – Operating conditions – Part 1: Climatic conditions , IEC, Latest

[19] IEC 60664-1, Insulation coordination for equipment within low-voltage systems – Part 1: Principles, requirements and tests**,** IEC, Latest

[20] IEC 60695-2-1/1, Fire hazard testing — Part 2: Test methods — Section 1/Sheet 1: Glow-wire end-product test and guidance, IEC, Latest

[21] IEC 60721-3-1, Classification of environmental conditions – Part 3: Classification of groups of environmental parameters and their severities – Section 1: Storage**,** IEC, Latest

[22] IEC 60721-3-2, Classification of environmental conditions – Part 3: Classification of groups of environmental parameters and their severities – Section 2: Transportation**,** IEC, Latest

[23] IEC 60721-3-3, Classification of environmental conditions – Part 3: Classification of groups of environmental parameters and their severities – Section 3: Stationary use at weather protected locations, IEC, Latest

[24] IEC 61000-4-2, Electromagnetic compatibility (EMC) — Part 4: Testing and measurement techniques — Section 2: Electrostatic discharge immunity test — Basic EMC publication, IEC, Latest

[25] IEC 61000-4-3, Electromagnetic compatibility (EMC) — Part 4: Testing and measurement techniques — Section 3: Radiated, radio frequency, electromagnetic field immunity test, IEC, Latest

[26] IEC 61000-4-4, Electromagnetic compatibility (EMC) — Part 4: Testing and measurement techniques — Section 4: Electrical fast transient/burst immunity test — Basic EMC publication, IEC, Latest

[27] IEC 61000-4-5, Electromagnetic compatibility (EMC) — Part 4: Testing and measurement techniques — Section 5: Surge immunity test, IEC, Latest

[28] IEC 61000-4-7, Electromagnetic compatibility (EMC) — Part 4: Testing and measurement techniques — Section 7: General guide on harmonics and inter-harmonics measurements and instrumentation, for power supply systems and equipment connected thereto.

[29] IEC 61000-4-15, Electromagnetic compatibility (EMC) — Part 4: Testing and measurement techniques — Section 15: Flicker meter – Functional and design specifications, IEC, Latest

[30] IEC 61000-4-30, Electromagnetic compatibility (EMC) — Part 4: Testing and measurement techniques — Section 30: Power quality measurement methods, IEC, Edition 2

[31] IEC 61010-1, Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 1: General requirements, IEC, Latest

[32] IEC 61010-2-030, Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 2-030: Particular requirements for testing and measuring circuits, IEC, Latest

[33] IEC 62052-11, General requirements, tests and test conditions –Part 11 Metering equipment, IEC, Latest

[34] IEC 62053-22, Electricity metering equipment (a.c.) - Particular Requirements — Part 22: Static meters for active energy (classes 0, 2 S and 0, 5 S) ..., IEC, Latest

[35] IEC 62053-23, Electricity metering equipment (a.c.) - Particular Requirements — Part 23: Static meters for reactive energy (classes 2 and 3), IEC, Latest

[36] IEC 62262, Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts (IK code), IEC, Latest

[37] IEC 62586-1, Power quality measurement in power supply systems – Part 1: Power quality instruments (PQI) , IEC, Latest

[38] IEC 62586-2, Power quality measurement in power supply systems – Part 2: Functional tests and uncertainty requirements , IEC, Latest

[39] IEEE 1588, Time and frequency synchronization, ..., IEEE, 1998

[40] CISPR 22, Information technology equipment – Radio disturbance characteristics – Limits and methods of measurement, CISPR, Latest

[41] Act 103 of 1996, Telecommunication Act, -, 1996

[42] NRS 048-2, Electricity supply - quality of supply - part 2: Voltage characteristics, compatibility levels, limits and assessment ..., NRS, Latest

[43] SANS 222/CISPR 22 (SABS CISPR 22), Limits and methods of measurement of radio disturbance characteristics of information technology equipment, SANS/NRS, Latest

[44] SANS/IEC 60529 (SABS IEC 60529), Degrees of protection provided by enclosures (IP Code)., SANS/NRS, Latest

[45] NRS 048-2, Electricity supply – Quality of supply – Part 2: Voltage characteristics, compatibility levels, limits and assessment methods, NRS, Edition 3, 2007

[46] 240-64038621, Remote Device Communication Standard for Data Retrieval and Remote Access , E Luwaca, Revision 2,2017

[47] 240-76625081, Cellular Modem Standard, E Luwaca, Revision 1, 2014

[48] 240-82534274, Definition Of The Eskom Power Quality Data Import Format (EPQDIF), D Maharaj, Revision 1, 2015

2.2.2 Informative

[49] 32-9, Definition of Eskom documents, Eskom Document Centre, Latest

[50] 32-644, Eskom documentation management standard, Eskom Document Centre, Latest

[51] 474-65, Operating manual of the Steering Committee of Technologies (SCOT), Vinod Singh, Latest

2.3 Definitions

2.3.1 General

Definition	Description
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 two conductors. Phase refers to a single conductor. On polyphase systems, a channel may be between two phases, or between a phase and neutral, or between a phase and earth.
Declared input voltage, Udin	Value obtained from the declared supply voltage by a transducer ratio.
Declared supply voltage, Uc	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.
Dip threshold	Voltage magnitude specified for the purpose of detecting the start and the end of a voltage dip.
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 marked. **Note:** For some applications, this 'marked' or 'flagged' data may be excluded from further analysis.
Flicker	Impression of unsteadiness of visual sensation induced by a light stimulus whose luminance or spectral distribution fluctuates with time [IEV 161-08-13].
Fundamental component	Component whose frequency is the fundamental frequency [IEV 101-14-49, modified].
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 number of poles and speed of rotation of the synchronous generator(s) feeding the system.
Hysteresis	Difference in magnitude between the start and end thresholds. **Note 1:** This definition of hysteresis is relevant to Power Quality (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.

Definition	Description
Influence quantity	Any quantity which may affect the working performance of measuring equipment [IEV 311 06 01, modified]. **Note:** This quantity is generally external to the measurement equipment.
Inter-harmonic component	Component having an inter-harmonic frequency [IEC 61000-2-2, definition 3.2.6]. **Note:** Its value is normally expressed as an rms value. For brevity, such a component may be referred to simply as an inter-harmonic.
Inter-harmonic 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 inter-harmonic order is the ratio of an inter harmonic frequency to the fundamental frequency. This ratio is not an integer (recommended notation m). **Note 2:** In the case where m < 1, the term sub-harmonic frequency may be used.
Interruption	Phenomenon that occurs when one or more phases of a supply to a customer or group of customers are disconnected for a period exceeding 3 s.
Interruption threshold	Voltage magnitude specified for the purpose of detecting the start and the end of a voltage interruption.
Measurement uncertainty	Parameter, associated with the result of a measurement, that characterizes the dispersion of the values that could reasonably be attributed to the measurand [IEV 311-01-02, VIM 3.9].
Nominal voltage, Un	Voltage by which a system is designated or identified.
Over-deviation	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.
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.
Range of influence quantities	Range of values of a single influence quantity
Reference channel	One of the voltage measurement channels designated as the reference channel for polyphase measurements.
Residual voltage, Ures	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.
rms (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].
rms voltage refreshed each half-cycle, Urms(1/2)	Value of the rms voltage measured over one cycle, commencing at a fundamental zero crossing, and refreshed each half-cycle. **Note 1:** This technique is independent for each channel and will produce rms 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.

Definition	Description
Sliding reference voltage, Usr	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.
Swell threshold	Voltage magnitude specified for the purpose of detecting the start and the end of a swell.
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.
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.
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 or depression. The two terms are considered interchangeable; however, this standard will only use the term voltage dip.
Voltage swell	Temporary increase of the voltage at a point in the electrical system above a threshold.
Voltage unbalance	Condition in a polyphase system in which the rms values of the line voltages (fundamental component), or the phase angles between consecutive line voltages, are not all equal [IEV 161-08-09, modified].

2.3.2 Disclosure classification

Controlled disclosure: controlled disclosure to external parties (either enforced by law, or discretionary).

2.4 Abbreviations

Abbreviation	Description
AC	Alternating Current
BRCB	Buffered Report Control Block
CAP	Committee for Accepted Products
DAS	Data Acquisition Software
DC	Direct Current
FIFO	First In, First Out
FTP	File Transfer Protocol
GPRS	General Packet Radio Service
GSE	Generic Substation Event
GSM	Global System for Mobile communication
HF	High Frequency

Abbreviation	Description
IEC	International Electrotechnical Commission
IEV	International Electrotechnical Vocabulary
IP	Ingress Protection
IP	Internet Protocol
IXIT	Protocol Implementation eXtra Information for Testing
LAP	List of Accepted Products
n/a	not applicable
NTP	Network Time Protocol
PC	Personal Computer
PQ	Power Quality
PQDIF	Power Quality Data Interchange Format
PTM&C	Protection, Telecoms, Metering and Control
PTP	Precision Time Protocol
QoS	Quality of Supply
rms	root mean square
RTC	Real-time Clock
SABS	South African Bureau of Standards
SC	Steering Committee
SNTP	Simple Network Time Protocol
TCP	Transmission Control Protocol
THD	Total Harmonic Distortion
TICS	Technical Issues Implementations Conformance Statement
URCB	Unbuffered Report Control Block
USB	Universal Serial Bus
UTC	Coordinated Universal Time
VT	Voltage Transformer

2.5 Roles and responsibilities

Not applicable.

2.6 Process for monitoring

The standard will be revised every 3 years. The process for monitoring entails Power Quality Care Group meetings to discuss relevant changes to be made based on business requirements. Also, the Metering and Measurement Steering Committee will provide input in the revision of the standard.

2.7 Related/supporting documents

Not applicable.

3. Eskom Specified Requirements

3.1 Requirements

Three types of instruments are defined within the scope of this standard, according to table 1.

Table 1: Types of instruments

Instrument Type	Description	Declared voltage(Udin)	IP Rating	Frequency
PQ monitoring instrument – investigation, surface mount	PQI-A-PO-H	230V (4 wire) √3*230V (3wire)	IP 52	50 Hz
PQ monitoring instrument – permanent non-substation, surface mount	PQI-A-PO-H	230V (4 wire) √3*230V (3wire)	IP 52	50 Hz
PQ monitoring instrument – permanent substation, 19" rack mounted	PQI-A-FI2-H	230V (4 wire) √3*230V (3wire)	IP 40	50 Hz

The accessories that must come with the instrument are tabulated in table 2 below

Table 2: Instrument accessories

Item	Substation Incl. (qty)	Non-Substation Incl. (qty)	Investigation Incl. (qty)
GPS Antenna	(1)	(1)	(1)
19” 3U Rack mounting plates	(1)		
Panel mounting plates		(1)	
Modem shall comply with [47] 240-76625081	(1)	(1)	(1)
0-5A (range) Micro Clamp compatible with instrument	(3) - Optional	(3) - Optional	(3)
250/500/1000:5A – Current Clamps			(3)
Carry Case			(1)
Current Harness			(1)
Voltage Harness & Clips			(1)
Power Harness			(1)

4. Requirements

4.1 Measurement requirements

4.1.1 Evaluation of an interruption

a) The definition of an interruption is the primary consideration taken into account when evaluating an interruption. Reference [30] IEC 61000-4-30 defines an interruption across three phases. Individual countries (e.g. South Africa) may differ in their definition of an interruption as the loss of a single phase may result in single-phase customers being interrupted.

b) An instrument shall allow the user to select an interruption mode between the [30] IEC 61000-4-30 definition of all phases and the loss of a single phase of a polyphase system defined as follows:

1) A voltage interruption begins when the $U_{rms}(1/2)$ voltage of one or more channels falls below the voltage interruption threshold and ends when the U_{rms} (1/2) voltage of all voltage channels is equal to, or greater than, the voltage interruption threshold.

2) The voltage interruption threshold shall be user-definable.

c) The following shall be noted:

1) Hold-off – an instrument requires an adjustable range from 0 ms to 30 ms that includes zero.

2) Consecutive voltage dips – in the event that a voltage dip ends and another voltage dip is initiated, one event is recorded when the second voltage dip initiates within 30 ms of the first one ending.

4.2 Mechanical requirements

4.2.1 Rating plates

a) All rating plates shall be in accordance with [33] IEC 62052-11, and [34] IEC 62053-22 and [35] IEC 62053-23 as well as the following: All markings shall be indelible, distinct and legible on the outside of the meter.

b) Every meter shall preferably be indelibly marked with a diagram of connections. If this is not possible, reference shall be made to a connection diagram. For polyphase meters, this diagram shall also show the phase sequence for which the meter is intended. It is permissible to indicate the connection diagram by an identification figure in accordance with national standards.

4.2.2 Size

a) Surface mount devices shall have a maximum volume of 6 000 cm3.

4.3 Electrical requirements

4.3.1 General

a) Voltage and current measurements are required to be performed on single-phase or multiphase supply systems.

b) Voltage and current measurements are required to be done on a three-wire (delta) and four-wire (star) basis, and the device shall be appropriately configurable.

c) It is preferable that the configuration for three-wire or four-wire is done entirely via the configuration software.

4.3.2 Power supply

4.3.2.1 Operational voltage

a) The instrument shall be capable of continuous operation within a supply voltage range of 90 V to 270 V AC and DC.

b) An instrument should be able to derive its operating power from the phase(s) being measured.

4.3.2.2 Power from measured terminals

a) If the instrument takes power from the measured terminals of a Voltage Transformer (VT), the instrument shall not alter the characteristics of the voltage on the measured terminals (e.g. surge protective devices, harmonic current).

b) In this event, the instrument should not place a burden of more than 10 VA on the phase(s) providing supply.

c) The harmonic content of the current being drawn by the instrument shall be limited to 10% for each individual harmonic current component.

d) The peak current drawn by the instrument when supplied by the VT shall not exceed 0,7 A.

e) Auxiliary supply inputs shall be separate from measurement inputs.

4.3.2.3 Power supply unit

a) The switch mode power supply unit shall be located within the instrument case for all instruments.

4.3.3 Mains supply frequency

a) The mains supply frequency range shall be 50 Hz ±5 Hz for all instruments.

4.3.4 Supply protection requirements

a) In the event of an instrument developing an internal electrical fault or if the supply voltage exceeds the specified operational voltage level, it shall disconnect itself (internally) from the external power supply, or should not exceed 20 VA burden in the case of a fault.

4.4 Communication

4.4.1 General

a) The device shall comply with [46] 240-64038621

b) Modem communication can be achieved with either an integrated or external modem. Integrated modems shall conform to [46] 240-64038621. External Modems shall conform to [47] 240-76625081

c) For investigation instruments, the following requirements are a minimum: Manufacturers shall demonstrate a fully working data acquisition system link via Eskom's communications infrastructure (as required).

4.4.2 Communication technologies supported

a) The interface shall support the communication technologies specified in [46] 240-64038621 and [47] 240-76625081. In addition the following shall be supported:

1) High Speed Downlink Packet Access (HSDPA).

2) Transmission Control Protocol (TCP)/Internet Protocol (IP).

4.4.3 Available ports

a) The minimum requirements for ports that shall be available for temporary and permanently installed monitoring instruments are as follows:

1) At least one 10/100Base Tx port

4.4.4 Protocols

The following protocols shall be supported for the remote retrieval of measurement and event data:

a) IEC61850 (MMS Server) – Shall conform to [46] 240-64038621.

b) File Transfer Protocol (FTP) server (compulsory) – Shall conform to [46] 240-64038621. Additionally the following shall apply:

1) A minimum size of 100MB

2) Support for PQDIF file format

c) DNP3 – Refer to Annex B of [46] 240-64038621

1) Available over Ethernet – level 3 implementation; this is a requirement for all Distribution installations.

The following data shall be available via IEC61850, FTP and DNP3:

- 10 min rms voltages and currents;
- 10 min harmonics (individual and THD) shall be simultaneously available;
- 10 minute voltage unbalance;
- status of signalling relays;
- 10 ms rms voltage dip profile;
- event trigger/flag;
- flicker – Pst and Plt (every 10 min).

The data shall also be made available in an Eskom specified file format, as specified in [48] 240-82534274.

Furthermore, it shall be preferable for the FTP File Server to also store the configuration data of the unit. This file shall be available in a read-only state. A mechanism shall be available to upload a new configuration file to the device through the FTP file server. Once the file has been validated as containing no errors, the configuration of the device will be changed and the active file then be made available within the FTP server.

4.4.5 Signalling relay

A minimum of two input and two output relays shall be available for signalling supply conditions.

4.5 Functional requirements

4.5.1 Memory capacity

a) All measurable QoS parameters shall be recordable simultaneously.

b) The minimum requirement for memory usage is FIFO; optional is ‘stop when full’; recording intervals shall be selectable between 10 min and 3 s:

1) Type M instrument: All measurable QoS parameters simultaneously at 10 min intervals for a period of six weeks.

2) Type I instrument: 3 s values for all measured parameters for 2 h.

4.5.2 Sampling rate and lock

a) The instrument shall sample all input channels simultaneously at a sampling rate of at least 512 samples per cycle.

b) The sampling frequency shall be locked to the fundamental component input frequency.

c) Suitable anti-aliasing filters shall be used in all the measurements.

4.5.3 Start-up and Ride-through requirements

a) The fundamental requirement on start-up of the instrument is that it resumes the pre-shutdown operation without the requirement for human intervention.

b) If the maximum start-up time is 30 s then ride-through should be 15 s.

c) If the maximum start-up time exceeds 30 s then ride-through should be 120 s.

4.5.4 Data retention on power loss

a) The instrument shall be designed not to lose data if without power for a period of at least 50 days.

b) The instrument shall not lose its configuration or set-up information if not energized for a period of at least six months.

4.5.5 Effective shutdown

a) Loss of auxiliary power events shall be recorded separately with date and time stamping for both power up and power down times.

b) During shutdown, the instrument shall not lose any information including any set-up, configuration and firmware.

4.5.6 Calibration parameter retention on power loss

The instrument shall be designed not to lose calibration parameters if not energized for a period of five years.

4.5.7 Clock accuracy retention on power loss

The clock shall be designed not to lose functionality and accuracy if not energized for a period of at least 50 days.

4.5.8 Timing synchronization

Timing accuracy and synchronization of the instrument's internal clock shall:

a) Support GPS time synchronization

b) Support the function to set the clock via its configuration software connected locally to within 1 ms of the Personal Computer's (PC's) clock.

c) Be equipped with a battery backed-up Real-time Clock (RTC) with leap year support.

d) Support a clock precision of 1 ms or better, i.e. CCYY/MM/DD hh:mm:ss.ttt.

e) Support a Simple Network Time Protocol (SNTP) server as a time source.

f) Support a Network Time Protocol (NTP) server as a time source.

g) Preferably support Precision Time Protocol (PTP) version 2 (PTP v2 as defined in [39] IEEE 1588).

h) Support the South African time zone offset of UTC/GMT + 02:00.

4.5.9 Internal energy source

a) The life expectancy of the internal energy source for ride-through shall be at least five years under normal operating conditions, unless it can be replaced on site by a technician.

b) In the case of the latter, the energy source shall have a life expectancy of at least two years.

c) The internal energy source for maintaining non-volatile memory shall have a life expectancy of at least 10 years.

4.5.10 Operational indicators

The following indicators shall be provided on the instrument:

a) Power.

b) Recording.

c) Status Warning.

d) Communications indicator – connecting or not connecting.

4.6 Data acquisition software

4.6.1 Instruments

a) Instruments shall:

1) Be accessible via a single Data Acquisition Software (DAS) package for user interface, unitizing the protocol selected in 4.4.4, for configuration of instrument as well as downloading of device information and data.

2) Automatically backup the user-definable site information, as defined in 4.6.2, whenever changes to this information occur.

3) Automatically backup the complete database daily to a predetermined location (e.g. external hard drive) and restore the backup on demand.

b) Manufacturers shall demonstrate a fully working data acquisition system via Eskom's communications infrastructures (as required).

c) The data acquisition software shall be able to manage downloads from a minimum of 200 instruments.

d) Instrument firmware shall be upgradeable via remote telecommunication.

4.6.2 Configuration and set-up

a) Configuration refers to common information related to measurement standards (e.g. 10 min measure, dip thresholds) while set-up information is site-specific information.

b) The DAS shall:

1) Allow the creation and common use of configuration files for consistent setup of QoS meter points throughout the utility measurement programme. For example, a configuration file that can be transferred from one user to the next via email and applied to a different instrument at a different location.

2) Provide user-definable fields for documenting/storage of site information. The following fields are recommended:

i. Meter number

ii. Site name

iii. Panel

iv. Feeder replace with bay

v. Operator

vi. Contact details

vii. Meter point number

viii. Declared voltage

ix. Nominal voltage

x. Cellphone number/TCP IP address

3) Provide the user with the ability to select QoS measurement parameters.

4) Provide the user with the ability to set up trigger thresholds for individual QoS parameters (also within the configuration file).

5) Provide password security access covering access to upgrading, configuration, uploading data and viewing of data.

6) Provide the user with the ability to conduct real-time configuration:

i. Measurements to ensure correct installation on site.

ii. This shall include all defined parameters and phase vector angles.

iii. Event indicator in configuration window (in order to ensure that constant triggering does not take place, e.g. surge threshold is at 115 V and nominal voltage is at 120 V).

7) Provide the user with the ability to configure thresholds by providing declared voltage and nominal voltage (nominal voltage being the default setting).

8) Update all real real-time measurements at least every 3 s.

9) Provide near real-time on-screen display of instantaneous voltage vectors during configuration and set-up of instrument.

10) Provide the ability to view configuration parameters associated with that particular measurement.

11) Provide the reference for completeness of data uploaded from the instrument. This data uploading shall be done in a synchronized manner.

4.6.3 Viewing functionality of data acquisition software

The DAS shall:

a) Have the ability to graphically display all QoS parameters, including a voltage dip profile.

b) Provide user-definable templates for graphical viewing.

c) Provide graphical editing functions, e.g. line colours, line thickness, line type, panning, zooming, cross-hair.

d) Provide zooming functionality on all graphs with axis labels allocated to discretely rounded time/date intervals, e.g. a 24 h profile that starts at 00:00 and axis labels are every hour only.

e) Provide an event list including voltage dips, surges and interruptions.

f) Report on the following for events: date, time, NRS 048 classification, phases affected, event duration, deviation from nominal (declared) and deviation from sliding reference.

g) Provide the ability to select/highlight event(s) in the event list to display the event profile graph.

h) Provide a scatter plot in accordance with the current version of [42] NRS 048-2; the dips displayed on the scatter plot shall be individually selectable from the voltage dip list.

i) Provide a voltage dip profile with a user-selectable Y2 axis.

j) Have the ability to provide graphs that are printable and exportable, i.e. copy and paste and save as images file, e.g. jpg, bitmap and windows metafile.

k) Have the ability to export the raw data for all graphs, e.g. as a text file or similar.

l) Provide pre-event and post-event data that is (1) selectable and (2) has a user-specified time duration.

m) Display all parameter values to the second decimal.

n) Label all axes with relevant parameter units.

o) Display Y-axes on graphs that are user-selectable for actual, per unit and percentage of nominal, percentage of declared parameter.

p) Provide the ability to view all configuration parameters (e.g. site information).

q) Display measured values where the number of decimal points shall be accurate relevant to the measurement accuracy of the instrument.

r) Store data on an open database.

4.6.4 Downloading/export functionality of data acquisition software

4.6.4.1 Automatic downloading

a) The data acquisition software shall have the ability to:

1) Execute a grouped downloading schedule that allows adjustable download intervals and times (e.g. daily, weekly,hourly) and group or individual switch on/off.

2) Preferred option: Automatically push data from the instrument right through to a power quality database as a new event is registered on the instrument.

3) Export data into Power Quality Data Interchange Format (PQDIF) format or schedule-specified format.

4) Track and only export data that has not been previously exported from the instrument memory.

5) Allow individual/group site selection of downloading register.

6) Register download history on the client software.

4.6.4.2 Manual downloading

a) Data should be downloadable directly to a PC

b) Data shall be viewable on site, either directly on the instrument or via a connected laptop.

4.7 Labelling and packaging

4.7.1 Labelling

The following labels shall be clearly visible:

a) All operational indicators as described in 4.5.10

b) Any points that may affect the operation of the instrument or safety of the operator when connecting the instrument.

c) Appropriate connecting diagrams, e.g. three wire vs four wire.

d) All terminal connections and communication interfaces.

4.7.2 Packaging

a) Instruments shall be made available for both permanent and investigation installations with requirements as detailed in b)

b) The following packing options shall be required (appropriate requirements will be specified in the user requirement schedule):

1) An option shall be available to incorporate the instrument in a 19″ (3U or less) format; or

2) Surface-mounted instrument packages with maximum volume < 6 000 cm^3.

3) A DIN rail may be required where specified in the schedule.

4.8 Spares and support

a) Manufacturers shall provide support and maintenance; and a full stock of spares for all instruments shall be available for a minimum period of five years after purchase of the last instrument.

b) The ability to support the equipment shall be clearly stated. This includes but is not limited to:

1) Details of dedicated support staff who are available.

2) Response time to replace and/or repair equipment.

3) Willingness to enter into support/service level agreements based on guaranteed response.

4) Time; the Purchaser requires a response time of 48 h after notification of a failure for an exchange of any device. Any implications to the Purchaser of such agreements should be specified

5) A predefined minimum stockholding shall be in place for each component.

6) A high level of after-sales support and the promptness of that support will be important criteria in evaluating the tender.

4.9 Training

The instrument supplier shall conduct the necessary training for staff to operate the instruments.

5. Marking and operating instructions

5.1 General

Marking and operating instructions shall comply with IEC 61010-1, additional requirements are specified below.

5.2 Marking

Each instrument shall bear the following information, in permanent and legible marking, on the outer side:

a) manufacturer’s name or trade mark;

b) serial number, model no and type;

c) supply voltage range, frequency and maximum VA consumption;

d) input measurement range; and

e) clear marking of the supply and measurement terminals.

5.3 Operating instructions

The manufacturer shall specify the instrument characteristics according to Table 3.

Table 3: Characteristics specification template

Function symbols	Function	Class according to IEC 61000-4-30 (A or S) or Not Applicable	Range	Additional information
f	Power frequency			
U	Magnitude of the supply Voltage		(Expressed as a range of *U*din) [a]	(Expressed as a range of voltage)
Pst, Plt	Flicker			
Udip, Uswl	Supply voltage dips and swells		N.A.	
Uint	Supply voltage interruptions			
u0, u2	Supply voltage unbalance			
Uh	Voltage harmonics			
Uih	Voltage inter-harmonics			
Msv	Mains signalling voltage			
Under/over	Under/over deviation			
I	Magnitude of current			
i_0, i_2	Current unbalance			
I_h	Current harmonics			
I_{ih}	Current inter-harmonics			

It is strongly recommended that all functions are listed, and only existing ones are specified.

[a] For example, an instrument specified for range of U_{din} = [100 V to 400 V] shall meet the uncertainty requirement for at least 10 V to 600 V for class A, 20 V to 480 V for class S.

6. Functional, environmental and safety type tests

6.1 General

Functional, environmental and safety type tests shall be performed according to requirements specified in this Clause 6.

6.2 Reference conditions for type tests

All type tests shall be carried out under reference conditions specified in 4 unless otherwise specified.

Table 4: Reference conditions for testing

Conditions	Reference conditions
Operating temperature	23 °C ± 2 °C or otherwise specified by manufacturer
Relative humidity (RH)	40 % to 60 % RH
Auxiliary supply voltage	rated power supply voltage ±1 %
Phases	three phases available [a]
External continuous magnetic field	≤ 40 A/m d.c. ≤ 3 A/m a.c. at 50/60 Hz
D.C. component on voltage and current	none
Waveform	sinusoidal
Frequency	f_{nom} = 50 Hz ±0,5 Hz or 60 Hz ±0,5 Hz [b c]
Voltage magnitude	U_{din} ±1 % [b]
Flicker	$P_{st} < 0,1$ [b]
Unbalance	100 % ±0,5 % of U_{din} on all channels. Unless otherwise noted, use phase angles of 0° ± 0,05° (Channel 1), -120° ± 0,05° (Channel 2), 120° ± 0,05° (Channel 3) (equivalent to $u0$ = 0 %, $u2$ = 0 %) [b]
Harmonics	0 % to 3 % of U_{din} [b]
Interharmonics	0 % to 0,5 % of U_{din} [b]
a Required only in the case of three-phase systems. b According to Testing state 1 of Table 2 of IEC 61000-4-30:2008 c f_{nom} shall be selected by the manufacturer.	

6.3 Safety tests

Safety tests shall be conducted according to IEC 61010-1.

6.4 EMC tests

6.4.1 Emissions

Emission tests shall be conducted according to CISPR 22.

6.4.2 Immunity

EMC tests shall be conducted according to IEC 61000-6-5, taking into account the performance criteria defined for the "Measurement" category.

PQI-x-xx shall comply with immunity requirements defined for “power station” and interface type 2.

PQI-x-xx-H shall comply with immunity requirements defined for “substation” and interface type 3.

In addition to IEC 61000-6-5, the following performance criteria shall apply for the measurements:

Table 5: Measurements performance criteria

Steady state Measurements (if provided by the device under test)	Performance criteria for continuous EMC phenomena	Performance criteria for transient EMC phenomena (with high or low occurrence)
Power frequency, 10 sec measurement	Performance criteria A as defined in IEC 61000-6-5 applies. In addition the PQI continues to provide accurate steady-state measurements, both during and after the time when continuous EMC phenomena are applied	Performance criteria B as defined in IEC 61000-6-5 applies. In addition the PQI continues to provide "accurate steady-state measurements" after the time when continuous EMC phenomena are applied (but not necessarily during the time when they are applied).
Magnitude of the supply voltage, 150/180 cycles measurements		
Supply voltage unbalance, 150/180 cycles measurements		
Voltage harmonics, 150/180 cycles measurements		
Voltage inter-harmonics, 150/180 cycles measurements		
Current maqnitude, 150/180 cycles measurements		
Current unbalance, 150/180 cycles measurements		
Current harmonics, 150/180 cycles measurements		
Current inter harmonics, 150/180 cycles measurements		
Note: In all cases, when applying the performance criteria, the references to "accurate steady-state measurements" shall be interpreted as referring to the measuring uncertainty specified in IEC 61000-4-30 for the applicable steady-state measurements		

Measuring inputs and mains inputs shall fulfil the applicable performance criteria for the surge test according to IEC 61000-6-5, but in addition with the level of rated measurement category as defined in IEC 61010-2-30 and rated measurement category as defined in IEC 60664-1:2007, Table 1 (Rated impulse voltage for equipment energized directly from the low-voltage mains).

Note: For example, a PQI compliant to IEC 60664-1, for 600 V working voltage with overvoltage category IV shall withstand an 8 kV surge. The isolation test voltage depends on isolation system type of voltage inputs (base, reinforced, double), see table K.104 in 61010-2-030.

6.5 Climatic tests

Requirements of Table 6 shall be achieved.

Table 6: Climatic requirements

Climatic test, in operation	**Standard and level**	**Test requirements** [b]	**Temperature limits according to environments**			
			FI [c]	**FO** [c]	**PI** [c]	**PO** [c]
Cold	IEC 60068-2-1:2007 Test Ad	96 h	–25 °C	[d]	–5 °C	[d]
Dry heat	IEC 60068-2-2:2007 Test Bd	96 h	+55 °C	[d]	+45 °C	[d]
Damp heat	IEC 60068-2-78:2012 Test Cab	93 % RH, 4 days	+40 °C	+55 °C	+40 °C	+55 °C
Temperature changes with a specified variation speed	IEC 60068-2-14:2009 Test Nb	0 °C to maximum temperature, 1 °C / min, t1 = 2 h, 5 cycles	+55 °C	+70 °C	+45 °C	+70 °C
Salt mist	IEC 60068-2-52:1996 Test Kb, level 2	3 spray periods of 2 h each with a storage of 22 h after each	This test shall be made only for Outdoor applications.			
Climatic test, de-energized	**Standard and level**	**Test requirements**	**Temperature limits according to environments**			
			FI [c]	**FO** [c]	**PI** [c]	**PO** [c]
Cold	IEC 60068-2-1:2007 Test Ab	96 h	–40 °C	–40 °C	–40 °C	–40 °C
Dry heat	IEC 60068-2-1:2007 Test Ab	96 h	+70 °C	+70 °C	+70 °C	+70 °C
Temperature changes with a specified variation speed	IEC 60068-2-14:2009 Test Nb	–40 °C to maximum temperature, 3 °C / min, t1 = 2 h, 5 cycles	+70 °C	+70 °C	+70 °C	+70 °C

a For tests with de-energised equipment, the product functions shall remain in their specifications after the test.

b For tests with equipment in operation, the product functions shall remain in their specifications during the test.

c Guidance for ambient temperature shall be found in IEC 60068-1.

d According to manufacturer specification.

6.6 Mechanical tests

6.6.1 Product mechanical robustness

Requirements of 7 shall be fulfilled as type-tests.

Table 7: Product mechanical requirements

Mechanical robustness, in operation test	Standard and level	Test requirement for fixed installed equipment [a]	Test requirement for portable equipment [a]
Behaviour to vibrations	IEC 60068-2-6 Test Fc	Frequency range: 10 Hz to 150 Hz Sweeping frequency range: 58 Hz to 60 Hz 0,075 mm, 2 Hz to 9 Hz, 20 cycles 0,5 *g*n, 9 Hz to 150 Hz, 20 cycles	Frequency range: 10 Hz to 150 Hz Sweeping frequency range: 58 Hz to 60 Hz 0,075 mm, 2 Hz to 9 Hz, 20 cycles 0,5 *g*n, 9 Hz to 150 Hz, 20 cycles
Behaviour to shocks [d]	IEC 60068-2-27 Test Ea	---	10 *g*n / 11 ms, 3 pulses
Behaviour to earthquakes [d]	IEC 60068-2-57	1-35 Hz, Zero period acceleration = 1 *g*n horizontal, 0,5 *g*n vertical	---
Mechanical robustness, de-energised test (transport)	Standard and level	Test requirement for fixed installed equipment [b]	Test requirement for portable equipment [b]
Endurance to vibrations	IEC 60068-2-6 Test Fc	Frequency range: 5 Hz to 150 Hz Sweeping frequency range: 8 Hz to 9 Hz 7,5 mm, 2 Hz to 9Hz, 20 cycles 2 *g*n, 9 Hz to 150Hz, 20 cycles	Frequency range: 5 Hz to 150 Hz Sweeping frequency range: 8 Hz to 9 Hz 7,5 mm, 2 Hz to 9Hz, 20 cycles 2 *g*n, 9 Hz to 150Hz, 20 cycles
Resistance to shocks	IEC 60068-2-27 Test Ea	15 *g*n / 11 ms, 3 pulses	30 *g*n / 11 ms, 3 pulses
Free fall tests	IEC 60068-2-31 Test Ec, free fall procedure 1	The test shall be conducted with equipment in the transport packaging [c] Free fall 500 mm Number of stresses: 2 each side	The test shall be conducted with equipment in the transport packaging Free fall 1 000 mm Number of stresses: 2 each side

a For tests with an equipment in operation, the product functions shall remain in their specifications during the test.

b For tests with de-energised equipment, the product functions shall remain in their specifications after the test.

c The test shall be conducted without changing the packaging between tests.

d The requirement can also be met by placing the instrument into an adequate enclosure / cabinet

6.6.2 Degree of protection provide by enclosures for electrical equipment against external mechanical impacts (IK code)

Tests shall be achieved according to IEC 62262.

6.6.3 Degree of protection by enclosure (IP code)

Tests shall be achieved according to IEC 60529.

6.7 Functional and uncertainty tests

Functional type tests shall be performed according to requirements specified in IEC 62586-2.

7. Tests

7.1 Ride-through test

7.1.1 General

The ride-through test, illustrated in 11, is a star-connected measurement with auxiliary supply via VT phase:

a) Type M test duration: 14 s.

b) Type I instrument: 29 s.

7.1.2 Successful outcomes

a) The instrument remains functional throughout the test.

b) The instrument does not initiate the boot-up process at the end of the interruption.

c) The measurement of dips is correct and is reported via client software.

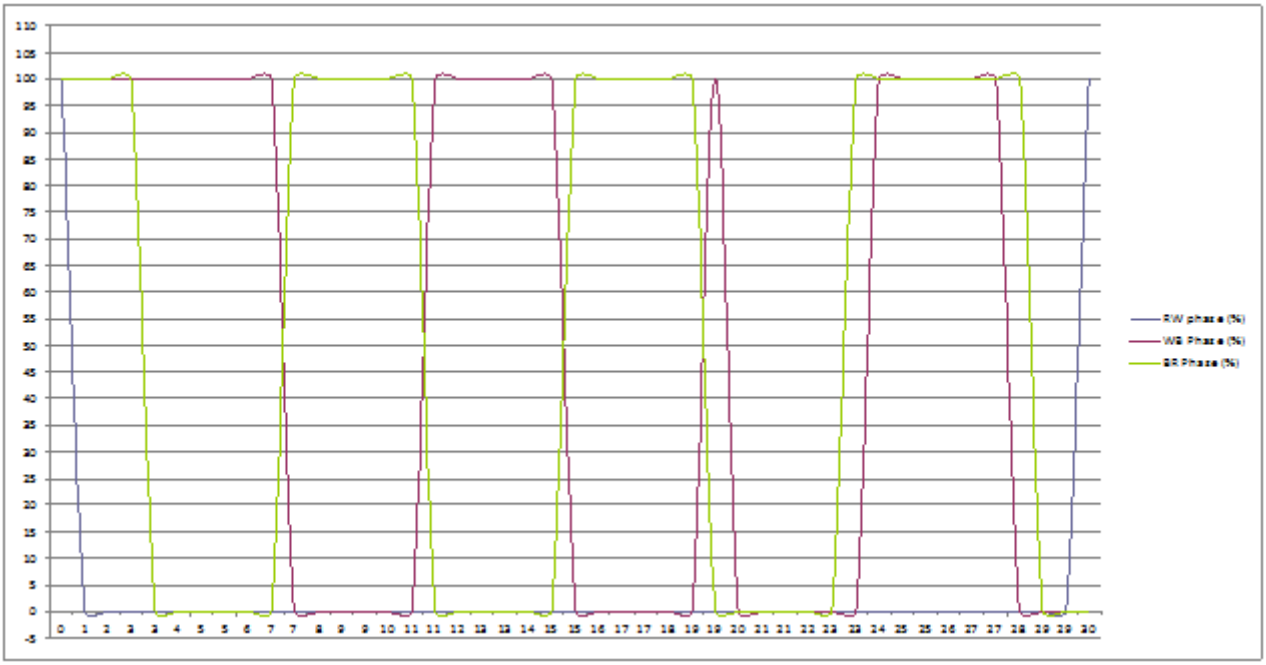

Figure 1: Ride-through test

8. Routine tests

8.1 General

Routine tests shall be performed according to requirements specified in this Clause 8.

8.2 Protective bonding test

PQI shall be tested in accordance with IEC 61010-1:2010, Annex F.

8.3 Dielectric strength test

PQI shall be tested in accordance with IEC 61010-1:2010, Annex F.

8.4 Intrinsic uncertainty test

The manufacturer shall perform a routine test on intrinsic uncertainty on 100 % of equipment produced. This routine test aims at detecting specific hardware non conformity during manufacturing, and shall include at least the magnitude of supply voltage function.

Any of the 10/12 cycle value or aggregated values may be used to verify the requirement.

It is strongly recommended that the results of this test should be recorded.

9. Certificates and declarations

Note 1: An example of template is provided in IEC 62586-2.

Note2: A certificate is delivered by a third part assessor (e.g. a test lab) while a declaration is delivered by the manufacturer itself.

10. Re-calibration and re-verification

The manufacturer shall provide guidance for re-calibration and re-verification.

11. Authorization

This document has been seen and accepted by:

Name and surname	Designation
M.Van Rensburg	Senior Manager (Transmission Grids)
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12. Revisions

Date	Rev	Compiler	Remarks
April 2018	1	T Kgosiemang	Document have a new number and on new template.
Feb 2013	0	U J Minnaar	First issue of 32-1132

13. Development team

This document was developed by:

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