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This document is **STABILISED**. The technical content in this document is not expected to change because the document covers: *(Tick applicable motivation)*

1	A specific plant, project or solution	
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Content

Tables

1. Introduction

This standard details the generic functional and performance requirements, including type testing requirements, of multifunction protective Intelligent Electronic Devices (IEDs) for use within Eskom Holdings SOC Limited. This document supersedes corresponding requirements previously stipulated in TST 41-1062.

The requirements of this standard dealing with Electromagnetic Compatibility (EMC) are in accordance with [33] NRS 083-1.

This document shall be referenced in product/application-specific protection scheme specifications, these documents providing specific details of the required functionality for each scheme.

2. Supporting clauses

2.1 Scope

2.1.1 Purpose

This standard details the generic functional and performance requirements, including type testing requirements, of multifunction protective Intelligent Electronic Devices (IEDs) for use in new protection schemes and modules. This includes traditional multifunction protection relays and Process Interface Units (PIUs) for the acquisition of binary information. The standard presently excludes requirements for IEC 61850 sampled value merging units.

The requirements presented in this standard shall be supplemented by scheme/product-specific requirements in the detailed specifications prepared per scheme type.

2.1.2 Applicability

This standard shall apply throughout Eskom Holdings SOC Limited.

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] ISO 9001 Quality Management Systems.

[2] IEC 60068-2-1 - Environmental testing — Part 1 Cold

[3] IEC 60068-2-2 - Environmental testing — Part 2 Dry Heat

[4] IEC 60068-2-30 - Environmental testing — Part 30 Damp heat, cyclic (12 h + 12h cycle)

[5] IEC 60073 - Basic and safety principles for man-machine interface, marking and identification – Coding principles for indicators and actuators

[6] IEC 60255-1 - Measuring relays and protection equipment – Part 1: Common requirements

[7] IEC 60255-5 - Electrical relays – Part 5: Electrical relays – Insulation coordination for measuring relays and protection equipment – Requirements and tests

[8] IEC 60255-11 - Measuring relays and protection equipment – Part 11: Voltage dips, short interruptions, variations and ripple on auxiliary power supply port

[9] IEC 60255-21-1 - Electrical relays – Part 21-1: Vibration, shock, bump and seismic tests on measuring relays and protection equipment – Vibration tests (sinusoidal)

[10] IEC 60255-21-2 - Electrical relays – Part 21-2: Vibration, shock, bump and seismic tests on measuring relays and protection equipment – Shock and bump tests

[11] IEC 60255-21-3 - Electrical relays – Part 21-3: Vibration, shock, bump and seismic tests on measuring relays and protection equipment – Seismic tests

[12] IEC 60255-22-1 - Measuring relays and protection equipment – Part 22-1: Electrical disturbance tests – 1 MHz burst immunity tests

[13] IEC 60255-22-2 - Measuring relays and protection equipment – Part 22-2: Electrical disturbance tests - Electrostatic discharge tests

[14] IEC 60255-22-3 - Measuring relays and protection equipment – Part 22-3: Electrical disturbance tests – Radiated electromagnetic field immunity

[15] IEC 60255-22-4 - Measuring relays and protection equipment – Part 22-4: Electrical disturbance tests - Electrical fast transient/burst immunity test

[16] IEC 60255-22-5 - Measuring relays and protection equipment – Part 22-5: Electrical disturbance tests - Surge immunity test

[17] IEC 60255-22-6 - Electrical relays – Part 22-6: Electrical disturbance tests for measuring relays and protection equipment – Immunity to conducted disturbances induced by radio frequency fields

[18] IEC 60255-22-7 - Electrical relays – Part 22-7: Electrical disturbance tests for measuring relays and protection equipment – Power frequency immunity tests

[19] IEC 60255-24 - Measuring relays and protection equipment – Part 24: Common format for transient data exchange (COMTRADE) for power systems

[20] IEC 60255-25 - Electrical relays – Part 25: Electromagnetic emission tests for measuring relays and protection equipment

[21] IEC 60255-26 - Measuring relays and protection equipment – Part 26: Electromagnetic compatibility requirements

[22] IEC 60255-27 - Measuring relays and protection equipment – Part 27: Product safety requirements

[23] IEC 60447 - Basic and safety principles for man-machine interface, marking and identification – Actuating principles

[24] IEC 60721-3-3 - Classification of groups of environmental parameters and their severities – Stationary use at weather protected locations

[25] IEC 61850 (All parts) - [≡ SANS 61850] Communication networks and systems for power utility automation

[26] IEEE Std C37.238 - IEEE Standard Profile for Use of IEEE 1588 Precision Time Protocol in Power System Applications

[27] SANS 60529 - [≡ IEC 60529] Degrees of protection provided by enclosures (IP Code)

[28] SANS 61000-4-2 - [≡ IEC 61000-4-2] Electromagnetic compatibility (EMC) – Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test

[29] SANS 61000-4-3 - [≡ IEC 61000-4-3] Electromagnetic compatibility (EMC) – Part 4-3: Testing and measurement techniques – Electrical fast transient/burst immunity test

[30] SANS 61000-4-5 - [≡ IEC 61000-4-5] Electromagnetic compatibility (EMC) – Part 4-5: Testing and measurement techniques – Surge immunity test

[31] SANS 61000-4-6 - [≡ IEC 61000-4-6] Electromagnetic compatibility (EMC) – Part 4-6: Testing and measurement techniques – Immunity to conducted disturbances, induced by radio-frequency fields

[32] SANS 61000-4-8 - [≡ IEC 61000-4-8] Electromagnetic compatibility (EMC) – Part 4-8: Testing and measurement techniques – Power frequency magnetic field immunity test

[33] NRS 083-1 - Code of practice for the application of Electromagnetic Compatibility (EMC) standards and guidelines in electricity utility networks

[34] 240-64038621 - Specification for remote device communication requirements for engineering data retrieval and remote access

[35] 240-55410927 - Cyber security standard for operational technology

[36] 240-42066934 - IEC61850 Protocol implementation document for the purposes of substation automation

[37] 240-68107841 - Eskom IEC61850 standard requirements for PICS, PIXIT and TICs

[38] 240-68235024 - Eskom IEC61850 station bus interoperability test standard

2.2.2 Informative

[39] Cigré Working Group B5.27 - Implications and Benefits of Standardised Protection and Control Schemes

[40] 32-9 - Definition of Eskom documents

[41] 32-644 - Eskom documentation management standard

[42] 474-65 - Operating manual of the Steering Committee of Technologies (SCOT)

2.3 Definitions

2.3.1 General

Definition	Description
Common mode (test)	A test where the test voltage is applied between the port under test and earth.
Differential mode (test)	A test where the test voltage is applied between terminals of the same port.
Gatekeeper	A requirement that is a prerequisite for a tender evaluation, which if not met will result in the tender being classified as non-responsive and not subject to further consideration.
Intelligent Electronic Device (IED)	A microprocessor-based device that encompasses all or some of the following functionalities: protection, control and automation, metering, telecontrol, substation DC and auxiliary supply systems, quality of supply monitoring, and disturbance and event recording.
Port	The particular interface of the specified Equipment Under Test (EUT) with the external electromagnetic environment, including (i) auxiliary power supply port, (ii) enclosure port, (iii) input port, (iv) output port, (v) communication port and (vi) functional earth port.
Process Interface Unit (PIU)	Also referred to as a ‘digital merging unit’ or ‘binary input/output device’; an Intelligent Electronic Device (IED) that collects binary data from process devices, typically electrical primary plant equipment, by way of status contacts, and processes and publishes this data to other IEDs in a digital format (e.g. IEC 61580-based communication). The device similarly converts digital commands from other IEDs into electrical control signals to the primary equipment. PIUs are typically installed on or near the primary equipment with which they exchange data.

Definition	Description
Scheme	A set of components that work together in order to execute a specific behaviour under predefined power system conditions sensed through the scheme interface [39] Cigré Working Group B5.27. 'Scheme' is most commonly applied in the context of power system protection equipment where it historically applied to the secondary plant components associated with the protection and control of a specific primary bay. In the latest design philosophy each main or back-up protection module associated with a specific primary bay are designated as separate, independent schemes.
Secure Control	A pair of normally open non-latching contacts or inputs that each affect only one state of a control function. Each state of the control is activated by momentarily closing the contact/input allocated to that state. An example of this is a pair of push-buttons: one that opens the circuit-breaker and one that closes the circuit-breaker. If one button is activated repeatedly, it only affects that state and does not change the state of the control.
Transmission Control Protocol (TCP)/ Internet Protocol (IP)	The Internet Protocol Suite (commonly known as TCP/IP) is the set of communications protocols used for the Internet and other similar networks. It is named from two of the most important protocols it contains: the Transmission Control Protocol (TCP) and the Internet Protocol (IP), which were the first two networking protocols defined in this standard. (Information from www.wikipedia.org.)
Toggle Control	A single, normally open, non-latching contact or input that alternately affects both states of a control function. On each closure of the contact/input, the controlled output state will change.

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
ASCII	American Standard Code for Information Interchange
CAP	Committee for Accepted Products
CID	Configured IED Description
CoE	Centre of Excellence
CSV	Comma Separated Variable
DC	Direct Current
EHV	Extra High Voltage
EMC	Electromagnetic Compatibility

Abbreviation	Description
FTP	File Transfer Protocol
HMI	Human–Machine Interface
HTTP	Hypertext Transfer Protocol
ICD	IED Capability Description
IEC	International Electrotechnical Commission
IED	Intelligent Electronic Device
ILAC	International Laboratory Accreditation Cooperation
LAP	List of Accepted Products
LC	Lucent Connector
LCD	Liquid Crystal Display
LED	Light-emitting Diode
LPHD	IEC 61850 Logical Node for a Physical Device
MICS	Model Implementation Conformance Statement
MMS	Manufacturing Message Specification
MV	Medium Voltage
n/a	not applicable
PC	Personal Computer
PICS	Protocol Implementation Conformance Statement
PIU	Process Interface Unit
PIXIT	Protocol Implementation Extra Information for Testing
PTM&C	Protection, Telecommunications, Metering and Control
RMS	Root Mean Squared
SANAS	South African National Accreditation System
SANS	South African National Standard
SC	Study Committee
SCD	Substation Configuration Description

Abbreviation	Description
SED	System Exchange Description
SEF	Sensitive Earth Fault
SGM	Senior General Manager
SNTP	Simple Network Time Protocol
ST	Straight Tip
TCP/IP	Transmission Control Protocol/Internet Protocol
TICS	Technical Issues Conformance Statement
USB	Universal Serial Bus
UTC	Coordinated Universal Time

2.5 Roles and responsibilities

This document was developed, and shall be maintained via the SCOT Protection & Automation study committee.

2.6 Process for monitoring

As per Clause 3.2, IEDs provided in accordance with this standard shall be free of a requirement for planned maintenance. They shall include self-monitoring.

2.7 Related/supporting documents

This document is based on, and supersedes DSP_34-2093 “Generic Specification for Protective IEDs and Tripping relays”. The document also supersedes requirements for IEDs previously stipulated in TST 41-1062 “Standard for electronic protection and fault monitoring equipment for power systems”. The latter document was previously published under document numbers EST 32-333 and ESKASAAO4.

3. Requirements

3.1 Environmental conditions

3.1.1 IEDs shall be designed for application in ‘special’ environmental conditions as follows (adapted from Table 2 of [6] IEC 60255-1):

a) Ambient air temperature: -25 °C to +55 °C (control room installed IEDs); or -25 °C to +70 °C (IEDs installed within enclosures in the substation yard).

b) Altitude: < 2 500 m

c) Pollution: Location in urban areas with industrial activities and without special precautions to minimize the presence of sand or dust (conditions as per classes 3C2 and 3S2 in [24] IEC 60721-3-3).

d) Relative humidity (24 h average): 98%

3.1.2 IEDs will mainly be installed within a control room environment, with or without air conditioning.

3.1.3 PIUs will normally be installed within conventional steel junction boxes or primary equipment mechanism/marshalling boxes without air conditioning.

3.2 Hardware and firmware

3.2.1 It is Eskom's intention to limit the number of different types of IEDs used. To this end, suppliers are encouraged to supply IEDs from a limited number of their product families, and to standardize on specific IED types and model numbers within each family, with as few IED hardware and software variations as possible to cater for all scheme variants. The intention is also to limit the overall number of IEDs used, with the preference being to use a single IED per scheme module.

3.2.2 Tenderers are required to indicate the specific model numbers and firmware versions of all IEDs offered.

3.2.3 The IED hardware and firmware versions and versions of Personal Computer (PC) interface software supplied on/with prototype schemes and accepted by Eskom for application in production units shall not be changed or updated unless agreed in writing by Eskom's technical representative.

3.2.4 Any modification shall be subject to the complete retesting of the product as per its original acceptance by Eskom.

3.2.5 In the event of a change request being initiated by the supplier, all costs, except for those associated with witnessing/verification by Eskom staff, but including power system simulator testing (where applicable), shall be for the supplier's account.

3.2.6 The supplier shall inform Eskom of any firmware or hardware update that becomes available for IEDs used by Eskom, specifically where the update relates to a problem or deficiency which may affect its reliable or safe operation.

3.2.7 The supplier shall provide the Eskom technical representative with reasons for the change, shall provide details of the change, and shall declare all associated effects (e.g. impact on performance, communications, settings, and interoperability with previous versions).

3.2.8 Eskom shall not be obliged to undertake the evaluation of new firmware versions or new versions of hardware for each new version released by the supplier. This decision shall be taken by Eskom's appointed technical representative.

3.2.9 Updated IED firmware or hardware shall not be considered for evaluation by Eskom unless supported by an updated IED manual describing all new or altered features.

3.2.10 Details of the means to identify IEDs of differing hardware or firmware version shall be provided in scheme documentation.

3.2.11 IEDs shall not employ any method of forced cooling.

3.2.12 Except for the possible replacement of a backup battery for the real-time clock (as per 3.17), the IED hardware shall be free of any requirement for routine maintenance over its operational life.

3.2.13 IEDs shall support the attribute types of IEC 61850 Logical Node LPHD as per [36] 240-42066934. Attributes serial number, model name/number and location shall be supported.

3.2.14 IEDs shall include a self-supervision function that can detect most or all internal hardware and firmware errors and failures. The self-supervision function shall prevent inadvertent tripping due to such an error or failure.

3.3 Global ratings

3.3.1 IEDs shall be fit for application on a power system with nominal frequency of 50 Hz with an operating range of between 47 and 52 Hz.

3.4 Input energizing current (current transformer inputs)

3.4.1 Phase and earth fault current inputs shall be rated at 1 A nominal. Sensitive Earth Fault (SEF) current inputs (where applicable) shall be rated at 0.05 A.

3.4.2 Current inputs shall saturate at no less than 20 times their nominal current.

3.4.3 Current inputs shall have a continuous overload capability of 3 A, and a short time rating of 100 A for one second.

3.4.4 The burden of each current input shall not exceed 0.2 VA.

3.4.5 The supplier shall provide details of the hardware and software filtering applied to the IED's current inputs.

3.5 Input energizing voltage (voltage transformer inputs)

3.5.1 Voltage inputs shall have nominal voltages of U_{AC} 110 V phase-to-phase and U_{AC} 63.5 V phase-to-neutral.

3.5.2 Voltage inputs shall have a continuous overload capability of two times nominal, and a short time rating of 2.6 times nominal for three seconds.

3.5.3 The burden of each voltage input shall not exceed 0.1 VA.

3.5.4 The supplier shall provide details of the hardware and software filtering applied to the IED's analogue voltage inputs.

3.6 DC auxiliary energizing voltage

3.6.1 IEDs shall be powered via a Direct Current (DC) supply of nominal voltage 110 V or 220 V, indicated per scheme order.

3.6.2 The IED shall operate as per specification at supply voltages between 0.8 and 1.2 times nominal.

3.6.3 The IED's power supply shall have a quiescent burden less than 50 W.

3.7 DC binary inputs

3.7.1 IED binary inputs shall be used on DC circuits, usually at the same voltage level as the DC auxiliary energizing supply.

3.7.2 Special DC binary inputs rated for nominal supply voltages of UDC 24 V or 48 V may be required as indicated in the scheme specification.

3.7.3 Interposing auxiliary relays shall be used in cases of integrating an Alternating Current (AC) wetted contact, and for AC supply monitoring with the DC inputs of an IED.

3.7.4 IED binary inputs shall have a pick-up threshold in the range of 0.7 to 0.8 times nominal, and a drop-off threshold in the range of 0.6 to 0.7 times nominal.

3.7.5 IEDs binary inputs shall include AC immunity filters so as to comply with the power frequency immunity test of 4.2.3, yet achieving a maximum pick-up recognition time of 10 ms.

3.8 Binary outputs (output contacts)

3.8.1 Two classes of output contacts are defined:

a) High-break contacts. Contacts capable of interrupting 10 A at U_{DC} 250 V, inductive L/R = 40ms. The duty cycle shall allow three operations at rated current in three seconds. The high break capability may be native to the IED, or may be provided by an auxiliary device or snubber circuit. In the latter case, the performance of the IED and snubber circuit shall be verified by the supplier to meet Eskom's current breaking requirement.

b) Standard contacts. Contacts capable of interrupting 0.2 A at U_{DC} 250 V, inductive L/R = 40ms.

Note: High-break contacts are required for Medium Voltage (MV) circuit-breaker tripping and closing, owing to historical problems of IED contact burn-out due to circuit-breaker mechanical problems.

3.8.2 Output contacts shall be rated to make and carry 30A for 200ms, 10A for 1s and 5A continuously, all at U_{DC} 250 V.

3.8.3 Output contacts shall be capable of at least 10 000 operations under load.

3.9 Analogue transducer inputs and outputs

3.9.1 IEDs may be specified to include analogue transducer inputs and/or outputs.

3.9.2 Transducer signals shall be I_{DC} 4 to 20 mA (preferred) or 0 to 20 mA.

3.9.3 Under no circumstances shall the output current exceed twice the nominal value.

3.9.4 The analogue outputs shall be able to drive a maximum 500 Ω resistive load at nominal output current.

3.9.5 The analogue output shall have reached 80 % of the nominal output value in less than 500 ms for a step input of zero to nominal.

3.9.6 The analogue output shall have a maximum allowable error of 1 % of full scale deflection.

3.10 Indications

3.10.1 The primary local operator interface with IEDs shall be provided via a substation Human–Machine Interface (HMI). Indications provided on an IED may, however, be specified as backup.

3.10.2 Indications may be provided via Light-emitting Diodes (LEDs) or via a plain text display on a Liquid Crystal Display (LCD).

3.10.3 LEDs shall be programmable and shall support colours: Red, Green and Amber as per scheme-specific requirements.

3.10.4 All indications shall be visible by default, i.e. no external influence shall be required to view any indication.

3.10.5 Three different modes of alarm indication accumulation and resetting may be specified:

a) Following: indications shall follow the state of the actuating quantity.

b) Latching, manual only reset: indications shall accumulate until manually reset (typically used in transformer protection schemes).

c) Latching, manual and automatic reset: indications shall reflect information from the most recent fault event (including multiple trips in an auto-reclose sequence) and may be manually reset.

3.10.6 Alarm indications shall be resettable via the IED front panel and via the substation HMI (manual reset).

3.10.7 It shall be possible to test the functioning of all LED indications on an IED via a lamp check function. It shall be possible to assign the lamp check variable to an output contact so as to be able to simultaneously test lamps that are external to the IED.

3.11 Display

3.11.1 IEDs shall be equipped with an on-board, backlit display.

3.11.2 The display will be designed to function correctly over the full operational life of the IED.

3.11.3 In cases where a screen saver feature is required to achieve the required service life, this shall be stated in the IED documentation.

3.11.4 The default screen, or automatically scrolling screens, shall display measured analogue values in primary quantities: three line currents, three phase-to-phase voltages, three phase real and reactive power, and frequency.

3.11.5 The display shall include measured quantities from all instrument transformer sets supplied to the IED (e.g. both HV and LV-side currents from a power transformer; busbar and tie CTs in a breaker-and-a-half application).

3.11.6 Where an IED includes the facility for a programmable mimic/single-line diagram, it shall be possible to disable and hide this feature.

3.12 Push buttons

3.12.1 The primary local operator interface with IEDs shall be provided via a substation HMI.

3.12.2 Local controls will, however be required on a scheme panel as a backup. The preferred method of providing local controls is via integrated programmable push buttons on IEDs. An emergency trip function shall, however, always be provided via a discrete push button that is independent of any IED.

3.12.3 IED push buttons shall be configured to act as secure controls (i.e. discrete buttons are provided per operating state).

3.12.4 Toggled controls (a single button to toggle between two states) shall be subject to Eskom approval.

3.12.5 Push button pairs for the control of a function shall be oriented as per Table 1 (in accordance with [23] IEC 60447).

Table 1: Local control actuating principles and relative positions

Vertical Push Button Pair	Bottom Button	Top Button
Horizontal Push Button Pair	Left Button	Right Button
Control Action	Trip Off/Test/Isolate Open Circuit Put out of Service	Close On Close Circuit Put into Service

3.12.6 Push buttons that operate circuit-breakers or motorized isolators shall be fitted with guards to limit the possibility of inadvertent activation. Alternatively, a double action with defined timeout shall be required to operate the function (e.g. press – confirmation press within 3 s).

3.12.7 The actuators for local opening and closing of a circuit-breaker shall be identifiable by all three of the following methods:

a) By labelling reading ‘TRIP’ and ‘CLOSE’ respectively. The symbols ‘O’ and ‘I’ may be used as additional means to identify the respective trip and close controls.

b) By control position as per Table 1.

c) By colour-coding. The colours green and red shall be associated with the trip control and close control respectively. Alternatively, the controls shall be without unique colour. Note that the Eskom colour-coding convention for trip/close actuators is opposite to that specified in [5] IEC 60073 (i.e. IEC requires trip red and close green).

3.12.8 It is preferred that programmable push buttons be fitted with integrated indication lamps configurable to represent the status of the function that they are controlling.

3.13 Programmable logic

3.13.1 IEDs shall be equipped with a user-programmable logic facility suitable for their intended application. This shall include logical gates (AND, OR and NOT) as well as delayed pick-up and delayed drop-off timers, flip-flops and counters.

3.13.2 The state of flip-flops and value of counters shall be stored in non-volatile memory in the IED so as to be maintained at its previous state/value upon cycling of the auxiliary supply to the IED.

3.13.3 It shall be possible for the user to configure IED functions to operate virtual or actual output contacts in accordance with the scheme's operating philosophy.

3.14 Settings groups

3.14.1 Where specified in a detailed scheme specification, IEDs shall be equipped with multiple settings groups.

3.14.2 Settings groups shall be selectable via IEC 61850 Manufacturing Message Specification (MMS) and locally via binary inputs to the IED.

3.15 Security

3.15.1 IEDs shall support the implementation of [35] 240-55410927, Eskom's cyber security standard.

3.15.2 IEDs shall support role-based access in at least three levels:

a) Read-only access

b) Read access, writing of selected application-specific settings

c) Full read and write access

Levels (b) and (c) shall be password protected.

3.15.3 Passwords shall be settable via the rear Ethernet port.

3.15.4 It shall be possible to set passwords with a minimum of 16 characters.

3.15.5 Passwords shall support the use of alpha, numeric and "special" characters.

3.15.6 IEDs shall support the ability to detect and report changes in settings, configuration and firmware. The IED will typically be interrogated by a third party configuration management tool which will report changes to a watchdog device.

3.16 Communication ports and protocols

3.16.1 Communication ports

3.16.1.1 IEDs shall be supplied as standard with a front communications port for local engineering access. The front port may be copper Ethernet (RJ45) (preferred), Universal Serial Bus (USB) or EIA-232.

3.16.1.2 The IED shall be equipped with one or more multi-session Ethernet rear ports for simultaneous substation communication and remote engineering access on each port. The default shall be for 100BaseFX (1300nm) fibre-optic Ethernet ports with Lucent Connector (LC) (preferred) or Straight Tip (ST) connectors. 100BaseTx copper Ethernet with RJ45 connectors may be accepted in specific applications.

3.16.1.3 Separate ports shall be used for station bus-type communication (between the IED and gateway, and the IED and IEDs for other bays) and process bus-type communication (between a control-building installed IED and its bay PIUs located in the substation yard).

3.16.1.4 The front and rear Ethernet ports shall have independently settable IP addresses.

3.16.2 Communication protocols

3.16.2.1 The rear Ethernet port(s) shall support the IEC 61850 protocol.

3.16.2.2 The IED shall offer, as a minimum, the IEC 61850 implementation as per Eskom's IEC 61850 suite of protocol implementation standards: [36] 240-42066934, [37] 240-68107841, and [38] 240-68235024.

3.16.2.3 The protocol used for remote engineering access shall conform to [34] 240-64038621.

3.17 Real-time clock and time synchronization

3.17.1 The IED shall include a real-time clock and built-in calendar, suitable for an IED lifespan of at least 30 years.

3.17.2 In the absence of a time synchronizing source, the real-time clock shall not drift by more than 2 s per day.

3.17.3 The time shall be within accuracy limits across the total temperature range specification of the IED.

3.17.4 The IED time shall be maintained for a minimum period of seven days in the event of a loss of auxiliary supply.

3.17.5 Where an internal battery is used to meet this requirement, it shall have a minimum lifespan of 10 years and shall be replaceable without a need for soldering.

3.17.6 The battery type and replacement procedure shall be clearly documented in the applicable IED manual.

3.17.7 The IED shall be time synchronized for event time-stamping purposes using Simple Network Time Protocol (SNTP) version 3 or later.

3.17.8 The stamping accuracy on the IED shall be 1 ms or better.

3.17.9 IEEE Std C37.238-2011 may be offered as an alternative to SNTP.

3.17.10 The IED shall support Coordinated Universal Time (UTC) time offsetting such that the IED time is set to local South African time.

3.17.11 In the event of the time synchronization source being unavailable, it shall be possible to correct the IED time and date without resetting any other parameters in the IED.

3.18 Event recordings and oscillography

3.18.1 Each IED shall include a sequence of event recorder that logs any settings change; settings group change; protection pickup or trip operation; or change in circuit-breaker and/or input and output status.

3.18.2 The IED shall store at least 1 000 events.

3.18.3 The trigger conditions for the event recorder shall be programmable.

3.18.4 IEDs shall incorporate an oscillographic analogue and digital signal recorder.

3.18.5 The sampling rate of analogue signals shall be at least 2.5 kHz for Extra High Voltage (EHV) applications, and at least 1.6 kHz for other applications.

3.18.6 The sampling rate for digital signals shall be at least 1 kHz for EHV applications, and at least 400 Hz for other applications.

3.18.7 Recordings shall have a settable length of between 0.25 and 5 seconds.

3.18.8 The IED shall support the storage of at least 100 seconds of recordings.

3.18.9 The waveform recording shall contain all analogue signals to the IED, significant derived analogues (e.g. differential current, restraint current) and all significant digital signals (protection tripping elements, circuit-breaker status, input and output contact status, etc.). The selection of recorded channels shall be user programmable.

3.18.10 The recording shall be of measured values prior to the application of digital filtering.

3.18.11 Recordings shall be made available in COMTRADE format as per [19] IEC 60255-24.

3.18.12 The event and waveform recordings shall be stored in non-volatile memory and shall be time-stamped to the nearest millisecond.

3.19 Software

3.19.1 Software package

3.19.1.1 IEDs shall be provided with software whereby fault recordings, sequence of events, settings and configuration data may be accessed by a PC.

3.19.1.2 All software required for the setting, configuration and management of an IED shall be contained in one software suite.

3.19.1.3 It is preferred that new software offered as part of the tender is compatible with Eskom's installed base of IEDs from the same supplier.

3.19.1.4 Eskom shall be issued with a corporate software licence.

3.19.1.5 Any charges associated with the provision of software shall be factored in to the IED sales price.

3.19.1.6 Eskom shall have the right to freely copy and distribute the software for use within Eskom and by consultants contracted for Eskom projects.

3.19.1.7 The supplier shall provide software support for the full lifetime of the hardware. This shall include bug fixes and software upgrades at no additional cost to Eskom.

3.19.1.8 The supplier shall inform Eskom of any software update that becomes available for IEDs used by Eskom, specifically where the update relates to a problem or deficiency which may affect its reliable or safe operation.

3.19.1.9 The supplier shall provide the Eskom technical representative with reasons for the change, shall provide details of the change, and shall declare all associated effects (e.g. impact on performance, communications, and interoperability with previous versions of IEDs).

3.19.1.10 Eskom shall not be obliged to undertake the evaluation of new software versions for each new version released by the supplier. This decision shall be taken by Eskom's appointed technical representative.

3.19.1.11 All software shall be compatible with Microsoft Windows XP and Windows 7, 32-bit and 64-bit operating systems.

3.19.1.12 Use of the software shall not require the user to have administrator rights on the PC.

3.19.2 Software functions

3.19.2.1 The IED operating and analysis software shall have the capability to:

a) configure and set the IED in offline and online modes;

b) validate the configuration and settings;

c) hide or "grey out" settings associated with functions that are set as disabled. This requirement shall apply equally to the settings display from the IED front panel.

d) compare configuration, settings, Configured IED Description (CID) and IED HMI configuration files (where applicable) between a saved file on a PC, and the active file on an IED;

e) export an IEC61850 IED Capability Description (ICD) and CID file;

f) import IEC61850 Substation Configuration Description (SCD) and System Exchange Description (SED) files from third-party configuration software;

g) import setting and configuration files, event records and oscillographic recordings from an IED; and

h) when installed on the engineering server, have the capability to poll all the IEDs to upload and store, to a user selectable folder, all new events and fault records.

3.19.3 Setting file data exchange

3.19.3.1 The IED settings application software shall provide an import/export facility that will allow settings data to be exchanged with a third-party settings management software database.

3.19.3.2 In particular, the supplier shall demonstrate the bidirectional exchange of IED settings between the IED software and a Microsoft Excel spreadsheet.

3.19.3.3 The file format shall be open source and made available to other software developers.

3.19.3.4 Acceptable formats for the data exchange are:

a) ASCII text file;

b) *.xml file format with published style sheets;

c) Microsoft Excel file format;

d) Extended Relay Interface by Omicron (XRIO) format;

e) Comma Separated Variable (CSV) file format; and

f) Microsoft Access *.mdb table format [least preferred option].

3.19.3.5 It is not necessary that IED configuration files be exportable from Microsoft Excel, but the configuration file shall be such that a standard file can be applied to all IEDs of identical hardware configuration, without the need for any application-specific changes.

3.19.3.6 Any application-specific changes to the configuration shall be made via the device settings, and shall be implementable via the Excel settings export capability.

3.19.3.7 All settings and configuration files shall be uploaded to the IED via the same port on the front of the IED and via the rear Ethernet port.

3.19.4 Event recording and oscillography data exchange

3.19.4.1 IEDs shall support one or more of the following protocols to exchange event and disturbance record files (in order of preference):

a) IEC 61850-8-1 MMS File Services

b) Hypertext Transfer Protocol (HTTP) Server

c) File Transfer Protocol (FTP) Server

3.20 IED simulation models

3.20.1 Protection co-ordination on more complex system configurations in Eskom is done in the Electromagnetic Transient (EMT) time domain using IED software simulation models. IED models that correctly represent IED performance in the EMT time domain shall be provided, preferably in DIgSILENT PowerFactory format.

3.21 Documentation

3.21.1 The supplier shall provide Eskom with a comprehensive set of user manuals for each IED offered, including manuals covering its operation, application and communication functions.

3.21.2 The manuals shall reflect the specific model and firmware versions on offer.

3.21.3 Manuals shall be written in English.

3.21.4 Manuals shall include sufficient detail regarding the operation of all functions. Every setting of a function shall have a full description of its purpose with setting rationale provided including implications to performance of the power system as well as performance of the IED, where applicable.

3.21.5 A detailed description including formulas and diagrams of the algorithms used to perform the protection functions shall be provided to the nominated Eskom representative, possibly subject to confidentiality agreements between the parties.

3.21.6 Technical manuals and data sheets shall be provided in searchable, indexed *.pdf format.

3.21.7 Eskom shall have the right to freely distribute IED documentation internally and to consultants appointed on Eskom projects.

3.21.8 The supplier shall provide a full list of IED settings in Microsoft Excel format, with separate columns for the setting name, actual setting and setting range and step sizes.

3.21.9 The settings sheet shall be formatted for printing on A4 paper in a portrait orientation.

3.21.10 A list of settings and settings guidelines shall be provided for all functional elements and shall indicate any setting limitation and any possible conflict with any other setting.

3.22 Design life and in-service experience

3.22.1 IEDs shall be designed for a minimum operational life of 20 years.

3.22.2 Tenderers shall provide details of their IED's operating record and installation history with their offers.

3.22.3 Tenderers shall provide details regarding all hardware and firmware improvements made on all offered IEDs within the past three years.

3.22.4 The IEDs shall satisfy the following conditions:

a) Be available 'off-the-shelf'.

b) Have a proven track record in terms of an acceptable in-service record in similar applications to Eskom's in international utilities. Details of such applications shall be provided.

c) Have a minimum in-service experience of 50 equipment years at time of tender closure, with at least 25 IEDs having an in-service record of more than six months. This shall apply to the same or similar production unit version of IED on offer.

3.23 Marking, labelling and packaging

3.23.1 IEDs shall be fitted with a label indicting the specific manufacturer's serial number, hardware version and date of manufacture (e.g. week/year).

3.23.2 Labelling of user-configurable indication LEDs and programmable push buttons shall be via a printed label that slides in behind a clear screen.

3.23.3 IEDs shall be supplied to Eskom with labels applied as per the applicable scheme design.

3.23.4 IEDs shall be supplied pre-installed into schemes or other main equipment, or shall be supplied in their original packaging that provides reasonable protection against shock, vibration and normal storage conditions (environmental conditions as per 3.1).

3.24 Spares

3.24.1 Holding of IED spares by the supplier shall be addressed as part of scheme/main equipment contracts.

3.25 Repairs

3.25.1 The tenderers shall provide a schedule detailing the guaranteed turnaround time for the repair of faulty equipment.

3.25.2 If the turnaround times differ for different equipment, the schedule shall include these details.

3.25.3 Tenderers shall state the extent to which repairs can be effected at their local works, including the capability and equipment that the tenderers possesses in order to effect such repairs.

3.25.4 The tenderer shall, for all repair work, inform the purchaser of the exact nature of the failure; how such failure was remedied; and how these failures, and other similar failures, can be prevented.

4. Tests

4.1 General

4.1.1 Type testing shall consist of performing the tests listed in 4.2 on at least one sample of the IED family design.

4.1.2 The Tenderer is not required to repeat type tests already passed by its equipment, provided type test certificates are produced, including fully detailed, certified test reports.

4.1.3 The submitted certification should clearly indicate conformance.

4.1.4 The issuing testing laboratory shall hold valid accreditation from either:

a) a National accreditation body that holds valid (International Laboratory Accreditation Cooperation (ILAC) membership (e.g. South African National Accreditation System (SANAS) in South Africa); or

b) a member of a regional accreditation body that has been accredited by ILAC. Details about ILAC and its members are available from http://www.ilac.org.

4.1.5 Where type test certificates and test reports are not available for the specific model of equipment being offered, evidence of equivalent tests performed on substantially similar equipment may be accepted subject to Eskom's approval.

4.1.6 Where required, type testing will be at the Tenderer's expense.

4.2 Type test requirements

4.2.1 Product safety

4.2.1.1 IEDs shall have passed the following tests of [7] IEC 60255-5:

a) Dielectric withstand test: 2 kV RMS 50 Hz for 1 minute between all terminals to case earth, 1 kV across contacts.

b) Insulation resistance test: Insulation resistance greater than 20 MΩ when measured at U_{DC} 500 V.

c) Electrical impulse test: 5 kV 1.2/50 μs waveform, 0.5 J.

4.2.1.2 The IED enclosure shall comply with protection class IP41 from the front panel and IP1X from the rear in accordance with [27] SANS 60529.

4.2.2 Environmental

4.2.2.1 IEDs shall have passed the Cold Test Ad of [2] IEC 60068-2-1 to a temperature of -25 ˚C: 16 hours.

4.2.2.2 IEDs shall have passed the Dry Heat Test Bd of [3] IEC 60068-2-2 to a temperature of +55 ˚C for control building application and +70 ˚C for installation in outdoor enclosures: 16 hours.

4.2.2.3 IEDs shall have passed the Cyclic Temperature and Humidity Test Db of [4] IEC 60068-2-30 to a temperature of +55 ˚C: 25 ˚C and 95 % relative humidity / 55 ˚C and 95 % relative humidity, 12 + 12 hour cycle.

4.2.2.4 IEDs shall have passed the Vibration test of [9] IEC 60255-21-1 with compliance to Class 2 Response and Class 1 Endurance: Response: 1g, 10 – 150 Hz, 1 sweep, energised. Contacts should not close for longer than 2 ms. Endurance: 1g 10 – 150 Hz, 20 sweeps, un-energised. Contacts should not close for longer than 2 ms.

4.2.2.5 IEDs shall have passed the Shock test of [10] IEC 60255-21-2 with compliance to Class 1 Response and Class 1 Withstand: Response: 5 g, 11 ms, 3 pulses in each direction, energised, Withstand: 15 g, 11 ms, 3 pulses in each direction, un-energised.

4.2.2.6 IEDs shall have passed the Bump test of [10] IEC 60255-21-2 to Class 1 compliance: 10 g, 16 ms, 1000 pulses un-energised.

4.2.2.7 IEDs shall have passed the Seismic test of [11] IEC 60255-21-3 to Class 1 compliance: Test method A (single axis sine sweep test) 1 – 35 Hz, 1 sweep.

4.2.3 Electromagnetic compatibility – Immunity

4.2.3.1 IEDs shall have passed the following auxiliary power supply tests of [8] IEC 60255-11 :

a) Voltage dip: a 20 ms interruption has no effect on operation.

b) Interruption: no maloperation for a 5 s interruption.

c) Gradual start-up/shut-down: no maloperation for decaying DC to zero over 60 s, rising over 60 s.

d) AC ripple: the device shall function correctly with 12 % 100 Hz AC signal superimposed on the DC supply.

4.2.3.2 The IED enclosure shall have passed the Power Frequency Magnetic Field test of [32] SANS 61000-4-8 with compliance to Class 5: 100 A/m continuous, 1000A/m for 1 to 3 s, 50 Hz.

4.2.3.3 The IED's power supply, inputs and outputs shall have passed the 1 MHz Burst Immunity test of [12] IEC 60255-22-1 with compliance to Class 3, that is 2.5 kV common mode and 1 kV differential mode. Communication ports shall pass at 1 kV common mode and 0 kV differential mode.

4.2.3.4 The IED's enclosure shall have passed the Electrostatic Discharge test of [13] IEC 60255-22-2 with compliance to Class 3: 6 kV contact discharge and 8 kV air discharge.

4.2.3.5 The IED's enclosures shall have passed the Radiated Radio Frequency Field Immunity test of [14] IEC 60255-22-3: 10 V/m unmodulated RMS.

4.2.3.6 The IED shall have passed the Fast Transient Immunity test of [15] IEC 60255-22-4 to compliance Class B: 2 kV, 5 kHz on the power supply, inputs, outputs and enclosure; 1 kV, 5 kHz on communication ports.

4.2.3.7 The IED shall have passed the Surge Immunity test of [16] IEC 60255-22-5: 1.2/50 μs voltage and 8/20 μs current surges. 0.5, 1 and 2 kV line-to-earth and 0.5 and 1 kV line-to-line applied to the power supply, inputs and outputs. 0.5 and 1 kV line-to-earth applied to communication ports.

4.2.3.8 The IED shall have passed the Induced Radio Frequency Field Immunity test of [17] IEC 60255-22-6 to compliance Class 3: 10 V r.m.s, 150 kHz to 80 MHz.

4.2.3.9 The IED shall have passed the Power Frequency Immunity test of [18] IEC 60255-22-7 to compliance Class A: AC voltages applied to DC inputs, 300 V r.m.s common mode and 150 V RMS differential mode.

4.2.4 Electromagnetic compatibility – Emission

4.2.4.1 The IED power supply shall have passed the Conducted Emission test of [20] IEC 60255-25: 0.15 – 0.5 MHz 79 dB (μV) quasi peak, 66 dB (μV) average and 0.5 – 30 MHz 73 dB (μV) quasi peak, 60 dB (μV) average.

4.2.4.2 The IED enclosure shall have passed the Radiated Emission test of [20] IEC 60255-25: 30 – 230 MHz 40 dB (μV) quasi peak at 10 m and 230 – 1000 MHz 47dB (μV) quasi peak at 10 m.

5. Authorization

This document has been seen and accepted by:

Name and surname	Designation
Prince Moyo	GM Power Delivery Engineering
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6. Revisions

Date	Rev.	Compiler	Remarks
Nov 2013	1	SJ van Zyl	New document based on DSP 34-2093, but covering only protective IEDs (tripping relays moved to 240-62773019 Specification for Low Voltage auxiliary electrical components). Document to be applied throughout Eskom. Document number changed to 240-64685228. Schedules A and B compliance schedules added as separate document.

7. Development team

This document was developed by Stuart van Zyl with input from Thys Bower.

8. Acknowledgements

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Annex A – Technical Schedules A&B

This document stands-alone as the specification for protective IEDs for Eskom. For ease of product tendering and evaluation, the document is accompanied by Microsoft Excel-format Schedules A&B listing "scoreable" requirements of this document.

Three schedules A&B are provided:

1. Requirements per IED instance (in accordance with Section 3 of this document).
2. Requirements per IED family (in accordance with Section 3 of this document). This schedules shall be completed once per IED product family or series offered.
3. Testing requirements per IED family (in accordance with Section 4 of this document).