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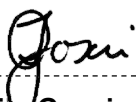
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Executive Summary

Teleprotection and Power Line Carrier (PLC) systems carry essential signals that aid protection relays to trip and isolate primary plant equipment. The stand-alone teleprotection equipment utilises either Eskom Telecommunications (ET) network or dedicated fibre optic cables and forms part of the protection system or scheme.

This specification details the requirements for the stand-alone teleprotection equipment which is installed in a substation environment and includes the telecommunication and protection interface requirements.

1. Introduction

The specification is required to detail the requirements for the correct operation of the teleprotection equipment and to ensure the teleprotection equipment interfaces correctly to the protection, telecontrol and telecommunications equipment.

2. Supporting clauses

2.1 Scope

This specification specifies Eskom's requirements for teleprotection equipment for use on various telecommunications interfaces and mediums including dedicated optical fibres.

This specification covers the manufacture, development of user documentation, supply, delivery and off-loading of teleprotection equipment.

2.1.1 Purpose

This specification specifies Eskom's requirements for teleprotection equipment for use on digital telecommunication channels and dedicated optical fibres for Eskom's teleprotection signalling requirements on the HV and EHV protection feeder schemes.

2.1.2 Applicability

This document shall apply throughout Eskom Transmission.

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 60834-1: Performance and testing of Teleprotection equipment.
- [2] IEC 870-5-1: Telecontrol Equipment and Systems – Transmission Protocols.
- [3] SANS/IEC 61000-4-2: Electromagnetic Compatibility (EMC) – Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test.
- [4] SANS/IEC 61000-4-3: Electromagnetic Compatibility (EMC) – Part 4-3: Testing and measurement techniques – Radiated, radio-frequency, electromagnetic field immunity test.
- [5] SANS/IEC 61000-4-4: Electromagnetic Compatibility (EMC) – Part 4-4: Testing and measurement techniques – Electrical fast transient/burst immunity test.
- [6] SANS/IEC 61000-4-5: Electromagnetic Compatibility (EMC) – Part 4-5: Testing and measurement techniques – Surge immunity test.
- [7] SANS/IEC 61000-4-8: Electromagnetic Compatibility (EMC) – Part 4-8: Testing and measurement techniques – Power frequency magnetic field immunity test.
- [8] IEC 61000-4-18: Electromagnetic Compatibility (EMC) – Part 4-18: Testing and measurement techniques – Damped oscillatory wave immunity test.
- [9] IEC 61850: Communication Networks and Systems in Substations.
- [10] ITU-T G703: Physical/Electrical Characteristics of Hierarchical digital interfaces
- [11] ITU-T G821: Error performance of an International Digital connection forming part of an Integrated Digital Network

- [12] ITU-T G823: The control of Jitter and Wander Within Digital Networks which are based on the 2048 kBit/s hierarchy
- [13] ITU-T G.956: Digital line systems based on the 2048 kBit/s hierarchy on optical fibre cables
- [14] ITU-T X.21: Interface between DTE and DCE Equipment for Synchronous Operation on Public Data Networks
- [15] ITU-T G652: Characteristics of a single mode optical fibre cable
- [16] 240-64685228: Eskom Standard: Generic Specification for Protection Intelligent Electronic Devices (IEDS).
- [17] QM-58: Eskom Standard: Supplier Contract Quality Requirements Specification.
- [18] TST41-634: Drawing Office Standard
- [19] 240-42066934: IEC 61850 Protocol Implementation Document for the purposes of Substation Automation.
- [20] 240-68235024: Eskom IEC 61850 Station Bus Interoperability Test Standard.
- [21] 240-68107841: Eskom IEC61850 Standard Requirements for PICS, PIXIT and TICS.
- [22] 240-55410927: Eskom's cyber security standard.
- [23] IEC 60255-5: Electrical relays – Part 5: Electrical relays – Insulation coordination for measuring relays and protection equipment – Requirements and tests.
- [24] IEC 60255-22-5: Measuring relays and protection equipment – Part 22-5: Electrical disturbance tests - Surge immunity test
- [25] IEC 60255-25: Electrical Relays – Part 25: Electromagnetic emission tests for measuring relays and protection equipment
- [26] IEC 60068-2-1: Environmental testing – Part 1 Cold
- [27] IEC 60068-2-2: Environmental testing – Part 1 Dry Heat

2.2.2 Informative

None

2.3 Definitions

2.3.1 General

None

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
BER	Bit error rate
CM	Common Mode
DC	Direct Current

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Abbreviation	Description
DM	Differential Mode
HMI	Human Machine Interface
IDF	Intermediate Distribution Frame
IED	Intelligent Electronic Device
LAN	Local Area Network
LC	Lucient Connector
LED	Light Emitting Diode
PC	Personal Computer
PDF	Portable Document Format
RTU	Remote Terminal Unit
Rx	Receive
TPE	Teleprotection Equipment
Tx	Transmit
USB	Universal Serial Bus

2.5 Roles and responsibilities

The responsibility for implementation of this document is with Eskom Transmission.

2.6 Process for monitoring

Not applicable.

2.7 Related/supporting documents

This specification has been updated from the Eskom Transmission specification, TSP41-131, "Teleprotection Equipment for use on Digital Telecommunications Channels or Dedicated Optical Fibre" and was also based on the [1] IEC 60834-1 standard, "Performance and testing of Teleprotection equipment".

3. Teleprotection Equipment

3.1 Background

The teleprotection equipment shall be able to cater for conventional interfaces to the protection equipment (i.e. trip inputs and trip output contacts) and the telecontrol equipment (i.e. alarm contacts). In addition, the implementation of the IEC 61850 standard on the teleprotection device shall be an option but the teleprotection device must be able to cater for both the conventional interfaces (trip input, trip output and alarm contacts) and the IEC 61850 implementation simultaneously.

3.2 Teleprotection Equipment Requirements

3.2.1 General

- a) The teleprotection equipment is required to operate over digital telecommunications channels and fibre optic channels, and shall use digital signalling techniques.

- b) Each teleprotection signal consists of a command signal linked to an input on the local teleprotection unit, which operates the corresponding output contact at the remote unit. With permissive and direct intertrip protection systems, the command signal causes or assists the protection at the distant terminal to trip the associated circuit-breaker.
- c) If the IEC 61850 standard has been implemented, then the link between the protection scheme and the teleprotection units would be via the multimode fibre optic cables with LC connectors (detailed in section 3.2.10).
- d) The teleprotection equipment shall be suitable for operating in permissive, direct transfer trip or blocking protection mode.
- e) Any related software or firmware must perform fault-free in the processing of date and date-related data (including, but not limited to, calculating, comparing and sequencing) with all hardware and software products delivered under any contract based on this specification, individually and in combination, upon installation. In addition, the teleprotection equipment that is IEC 61850 compliant must be able to transfer, receive, process and interpret the information correctly between the other IEC 61850 compliant IEDs (protection relays and the RTU/bay processor).
- f) The IEC 61850 compliant teleprotection unit must also allow for converting the IEC 61850 standard into binary values (conventional contacts) and vice versa to ensure that the IEC 61850 standard and binary values in the teleprotection device are interchangeable. The reason is that there could be instances where only one part of the protection scheme at the substation is upgraded and the protection relays at the distant substation are not upgraded. Therefore the protection relays and RTU device could communicate with the teleprotection device through IEC 61850 at one substation and at the distant substation might be required to convert from the IEC 61850 standard to binary values (contacts) to allow signals to be sent or received between the teleprotection device and the existing protection relays and RTUs within the distant substation.

3.2.2 Environmental conditions

The equipment shall operate as specified under the following ambient conditions:

- a) Indoors : Ambient conditions: IEC 60721-3-3, Class3K5
- b) Altitude : 0m to 2000m
- c) Temperature : Maximum : +55°C
Minimum : 0°C
- d) Humidity : 95 % below : +35°C
75 % above : +35°C
- e) Barometric pressure : 70kP to 106kP
- f) Lightning : Extremely severe
- g) IEDs will mainly be installed within a control room environment, with or without air conditioning.

3.2.3 Equipment Design

- a) The equipment shall be designed so that a single component failure cannot produce a false command output. In the event of an active component failure, the command output shall be blocked and an alarm given. This also applies to the IEC 61850 implementation where the logical nodes that are in place of the conventional input and output contacts are continuously monitored and if these nodes fail, then the nodes simulating the function of the input and output contacts to the protection relay and telecommunications link should be blocked and an alarm should be activated.

- b) The teleprotection equipment shall consist of a minimum of three bi-directional channels for permissive, direct intertrip or blocking applications. Each channel must have the capability of being individually configured for one of the three specific applications detailed. Selection of the individual channel application shall be either by strapping options within the equipment or by local intervention by means of a PC terminal. In the latter case suitable software is to be provided as part of the contract. The operating system used for configuration shall be the Microsoft Windows 10 or later versions of the Microsoft® operating systems with the preferred 64-bit configuration.
- c) The teleprotection equipment shall use a secure communications protocol as outlined in IEC 60834-1.
- d) The teleprotection unit shall have a self-testing ability with alarm notification for any device failure. In the event of any device failure, ALL the output contacts shall be blocked. As discussed in section 3.2.3 a) for any device (node) failure in the IEC 61850 implementation, the nodes that simulate the function of the input and output contacts to the protection relay shall be blocked and an alarm should be activated.
- e) The communication channel shall be monitored continuously and an alarm given if the channel fails or the BER exceeds 1×10^{-5} . In the event of communication channel failure or the BER exceeds 1×10^{-5} , ALL the output contacts shall be blocked.
- f) The alarm output contacts shall have normally open and normally closed contacts for flexibility. If the IEC 61850 standard is implemented, then the alarms would be sent to the bay processor/RTU via an ethernet LAN switch (detailed in section 3.2.10).
- g) If galvanic contacts are provided for the trip outputs, they shall be a type approved by Eskom. Dry reed contacts are not acceptable.
- h) The teleprotection equipment shall have loop-back facilities. When performing loop-back functions, ALL the output contacts shall be blocked to prevent the equipment from acting on its own message.
- i) The teleprotection channel shall be 'transparent' insofar as timing is concerned. The output trip pulse length at the remote unit shall not exceed the input trip pulse length at the local unit by more than 2 ms.
- j) The teleprotection equipment must be provided with user selectable unique addressing facilities to ensure that no maloperation can occur if the end-to-end channel between two units protecting a line is inadvertently incorrectly routed. The minimum number of addresses to be available shall be 255.

3.2.4 End-to-end and local test facilities

- a) The system shall be monitored continuously and an alarm given in the event of an active component failure.
- b) Test plugs, relays or switches that can be used to interrupt the connection to the protection relay panel are not acceptable.
- c) Local test facilities which can be used to initiate a command over the teleprotection channel shall be interlocked by an approved means to avoid inadvertent generation of a genuine trip signal.

3.2.5 Management, alarms and test facilities

A service interface shall be provided to connect a management console (PC) to the equipment for status information retrieval, configuration, and to integrate the equipment into a management system. Password protection and terminal addressability shall be provided. The following management functions shall be available:

3.2.5.1 Functions required

- a) Logging of local and remote alarm information.
- b) Logging of local and remote operational status information.

- c) Programming of local and remote operational parameters.
- d) Chronological register of alarms and events.
- e) Communication with the remote terminal shall be established through an integrated service channel.

3.2.5.2 HMI interface standards/ requirements

- a) The preferred HMI communications port for local engineering access is the Ethernet (RJ45). The multimode fibre optic port for the IEC 61850 application should also allow for remote access for the HMI. The other acceptable interface is the EIA-232.
- b) All software shall be compatible with the Microsoft Windows 10 or later versions of the Microsoft® operating systems with the preferred 64-bit configuration.
- c) Adaptors required to connect the equipment to PC ports e.g. USB to RS-232 , and proven to be compatible with the equipment, shall be specified and shall be included as an option on a price schedule.
- d) If web interfaces are used, these interfaces must not be required to change the web interface parameters (e.g. IP addresses, etc) on the PC's web software as this might create problems on the user's Eskom (Operating System) account.
- e) All HMI and enabling software shall be provided as part of the equipment supplied and updates shall be provided free of charge for the lifespan (OEM recommendation) of the equipment.
- f) The event and alarm logs shall be easily exportable in a Microsoft Excel™, PDF or similar format.

3.2.5.3 Cyber Security

- a) IEDs shall support the implementation of [22] 240-55410927, Eskom's cyber security standard.
- b) IEDs shall support role-based access in at least three levels:
 - 1) Read-only access
 - 2) Read access, writing of selected application-specific settings
 - 3) Full read and write access
- c) Levels (2) and (3) shall be password protected.
- d) Passwords shall be settable via the HMI.
- e) It shall be possible to set passwords with a minimum of 10 characters.
- f) Passwords shall support the use of alpha, numeric and "special" characters.
- g) IEDs shall support the ability to detect and report changes in settings, configuration and firmware.
- h) The IED will typically be interrogated by a third party configuration management tool which will report changes to a watchdog device.

3.2.5.4 Alarms

- a) Each teleprotection unit shall have an alarm circuit associated with the unit self-test status and communication channel status.
- b) Each input contact and output contact shall have a LED on the unit faceplate to indicate its status. For an IEC 61850 compliant teleprotection device, the virtual input contacts and output contacts (logical nodes) shall also have a LED on the unit faceplate to indicate its status.
- c) The two alarms described in 3.2.5.4 b) shall each provide two potential free change-over contacts for external use by Eskom.
- d) All alarm relays shall be operated in the healthy state and shall release on loss of power or on a valid alarm condition.

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- e) For an IEC 61850 compliant teleprotection device, the alarm messages would be sent to the bay processor/RTU via the multimode fibre optic port for the IEC 61850 application (detailed in section 3.2.10).

3.2.6 Power Supplies

- a) The teleprotection equipment shall be capable of operating continuously on any one of the following power sources. It is accepted that different power supply modules may be required.
- 1) 48 V DC (42 V DC to 57.6 V DC)
 - 2) 110 V DC. (91 V DC to 124.8 V DC)
 - 3) 220 V DC (182 V DC to 249.6 V DC)
- b) Specifications for Eskom's standard chargers, that would be used for the DC supplies mentioned, permit a ripple of 10% peak-to-peak of the rated nominal voltage.
- c) The equipment shall operate to specification with the voltage variations specified in 3.2.6 a).
- d) Equipment to be supplied from a DC source shall be suitable for operation from a high impedance centre-earthed DC supply.
- e) Teleprotection systems shall not maloperate if the DC supply to the unit is switched "off" and "on" repeatedly at a random rate.
- f) The power supply of the teleprotection system shall comply with the Insulation and Electromagnetic Compatibility requirements from Table 1 of this specification.
- g) If the teleprotection equipment is to be supplied from a 48 V dc source, the noise measured across the power supply terminals of the equipment shall not exceed 3 mV measured psophometrically or 10 mV peak-to-peak, when tested as described in 3.4.4(r).
- h) The equipment shall not malfunction or the power supply suffer damage if the battery voltage decays below the minimum level as specified in 3.2.6(a) e.g. as could occur in the case of a battery charger failure. The power supply should be self-resetting when normal voltage levels are restored.
- i) The equipment shall be designed so that despite any interruptions which occur in the supply, no damage results; and any change in the output of the equipment, both during and whilst recovering from the interruption, shall be negligible.
- j) The equipment shall recover to the required operating conditions within 500ms of the restoration of the supply.
- k) For interruptions of up to 10 ms, the equipment shall perform as if no interruption had occurred.
- l) Equipment which performs a successful power down and restart during supply interruptions shall retain historical trip and fault data history and the equipment shall return to its state prior to the interruption.
- m) The power supply shall have a switch to turn the supply 'on' or 'off'.

3.2.7 Interface with Eskom's protection relay equipment

For an IEC 61850 compliant teleprotection device, the interface to the protection relay equipment is detailed in section 3.2.10.

- a) All protection systems detailed in this section initiate a command signal at the input contact of the local teleprotection unit, when the external contact in the protection relay closes. The remote teleprotection unit in turn shall close its output contact when a command signal is received.
- b) The teleprotection equipment shall be provided in two basic interfaces, system A and system C described below. The choice of interface shall be field selectable.
- c) System A:

-
- 1) Eskom will provide separate contacts, operating from either a 110 V DC or 220 V DC source, to initiate the command signal at the binary inputs of the teleprotection unit. The teleprotection command input circuit shall not impose a load greater than 100 VA, with a maximum voltage of 264 V and a maximum current of 2 A, on the protection relay initiating contacts when making, carrying and breaking the command circuit. The maximum burden shall preferably be the minimum required to comply with 3.2.7 (c) 4 and 3.2.7 (c) 6.
 - 2) The input keying voltage to the teleprotection unit shall be as follows:

Nominal voltage	Input keying voltage
110 V DC	88 V DC to 132 V DC
220 V DC	176 V DC to 264 V DC
 - 3) The minimum pick up voltage for the teleprotection unit inputs shall be as follows:

Nominal Voltage	Input Keying Voltage
110 V DC	66 V DC
220 V DC	132 V DC
 - 4) The teleprotection equipment shall not issue an output command if a 2 μ F capacitor, charged to 1.5 times the binary input nominal voltage, is discharged through the command-input circuit. The protection circuit used to achieve this shall not result in an inrush current exceeding the ratings of the protection relay contacts given in 3.2.7 c) 1.
 - 5) The output contacts of the teleprotection unit for connection to Eskom's protection equipment shall be potential free. Capacitance spark quench circuits across the output contacts are not acceptable.
 - 6) The current flowing in the initiating loop when a trip command is transmitted shall be not less than 10mA.
 - 7) The Teleprotection Command Interface Module shall be able to withstand reversed polarity protection commands without damage.
 - 8) The Teleprotection Command Interface Module shall be able to withstand ≥ 100 repetitive input commands of 200ms duration at 1 second intervals at the rated voltage without damage.
- d) System C
- 1) A set of contacts in the protection relay panel shall be used to initiate the command signal to the binary inputs of the teleprotection unit. These binary inputs are interrogated externally to the teleprotection equipment.
 - 2) The binary inputs shall operate from a galvanically isolated 48V DC supply provided by Eskom. For distribution level application, the interrogating supply may be grounded.
 - 3) The input keying voltage to the teleprotection unit shall be as follows:

Nominal Voltage	Input Keying Voltage
48V DC	38.4V DC to 57.6V DC
 - 4) The minimum pick up voltage for the teleprotection unit inputs shall be 28.8V DC.
 - 5) The teleprotection command input circuit shall not impose a load greater than 10 VA, with a maximum voltage of 57.6V DC and maximum current of 0.5A, on the protection relay initiating contacts when making, carrying and breaking the command circuit.
 - 6) The teleprotection equipment shall not issue an output command if a 0.2 μ F capacitor, charged to 1.5 times the input contact nominal voltage, is discharged through the command-input circuit.

-
- 7) The current flowing in the initiating loop when a trip command is transmitted shall be not less than 10mA.
 - 8) The teleprotection unit shall be provided with potential-free output contacts. These contacts will be interrogated by the same power supply described in 3.2.7.d) 3.
 - 9) The teleprotection command output circuit shall be capable of making, carrying and breaking a minimum load of 10VA, with a minimum voltage of 57.6 V DC and a minimum current of 0.5A. Capacitance spark quench circuits across the output contacts are not acceptable.
 - 10) The Teleprotection Command Interface Module shall be able to withstand reversed polarity protection commands without damage.
 - 11) The Teleprotection Command Interface Module shall be able to withstand ≥ 100 repetitive input commands of 200ms duration at 1 second intervals at the rated voltage without damage.
- e) The basic requirements of Systems A and C are shown schematically in Annex B, of this specification.

3.2.8 Channel and Performance Requirements

The teleprotection equipment shall be capable of operating directly into a pair of standard single mode optical fibres and into standard interfaces for digital telecommunications channels. In the latter case, G.703 (2048 kbit/s), X.21 (64 kbits/s) and Ethernet electrical interfaces shall be provided.

- a) Dedicated ("Dark fibre") Fibre Operation
 - 1) The equipment shall operate in the wavelength region of 1310nm and 1550nm over single-mode fibre conforming to ITU-T Recommendation G.652 [15]. If the equipment operates in another wavelength facilitating longer ranges (greater than 120km fibre length), the supplier to specify and provide details.
 - 2) The required optical budget shall be capable of operating over a distance up to 120 km. If the equipment is capable of operating over a distance greater than 120km, the supplier to specify and provide details. It is accepted that different modules may be required.
 - 3) The optical receiver shall not overload if the output of the transmitter is connected directly to the receiver input. This requirement is to facilitate testing.
- b) Digital X.21 (64 kbit/s) and G.703 (64/2048 kbit/s) Channel
 - 1) The communication channel shall have physical and electrical characteristics that comply with ITU-T Recommendations X.21 [14] and G.703 [10].
 - 2) The teleprotection equipment shall operate to specification over a 64/2048 kBit/s telecommunications channel engineered to meet ITU-T G.821 [11] standards.
 - 3) The equipment shall conform to ITU-T Recommendation G-823 [12] with regard to Jitter Tolerance and Intrinsic Jitter.
- c) Ethernet

The Ethernet communication channel shall be specified for a minimum 10/100 Mbps with auto negotiation. The interface shall be RJ45. An option for an optical interface could be provided and should cater for both the 850 nm multimode 50/125 μ m fibre optic cores as well as the 1310nm single mode fibre optic cores. The preferred fibre connector type for the 850 nm multimode fibre optic core is LC.
- d) Teleprotection reliability
 - 1) The minimum requirement for security and dependability performance is specified in Annex A.

e) Back-to-Back Operate Time

- 1) The back-to-back operate time over both a dedicated fibre optic link and a 64/2048 kbit/s X.21 /G 703/Ethernet channel shall be as follows:
 - Permissive and blocking protection systems: 6ms max.
 - Direct transfer trip protection systems: 10ms max.
- 2) These back-to-back operate times shall be met using the interface systems specified in 3.2.8.

3.2.9 Voltage withstand and Electromagnetic Capability Requirements

The inputs and outputs of the equipment shall comply with the levels specified in Table 1 and points a) to e) of this section 3.2.9.

Table 1: Insulation and Electromagnetic Compatibility Requirements

Modules	Dielectric Withstand Tests – [23] IEC 60255-5	Impulse Voltage Tests – [23] IEC 60255-5	Insulation Resistance – [23] IEC 60255-5	Damped oscillatory wave immunity test: [8] IEC 61000-4-18	Electrical fast transient/ bursts [5] IEC 61000-4-4	Impulse Voltage Test, 1.2/50us 0.5 J [6] IEC 61000-4-5
Power Supply						
Power Supply <60VDC	1 kV	5 kV	> 20 MΩ	CM: 2.5kV; DM: 1kV	2kV	CM: 2kV; DM: 1kV
Power Supply >60VDC	2.5 kV	5 kV	> 20 MΩ	CM: 2.5kV; DM: 1kV	2kV	CM: 2kV; DM: 1kV
Telecommunication interfaces						
X.21	1 kV	1 kV	> 20 MΩ	CM: 1kV	1 kV	CM: 1kV; DM: 1kV
G703.1	1 kV	1 kV	> 20 MΩ	CM: 1kV	1 kV	CM: 1kV; DM: 1kV
Ethernet	1 kV	1 kV	> 20 MΩ	CM: 1kV	1 kV	CM: 1kV; DM: 1kV
Protection equipment interfaces						
System A contacts (input/output)	2.5 kV	5 kV	> 20 MΩ	CM: 2.5kV; DM: 1kV	2kV	CM: 2.5kV; DM: 2.5kV
System C contacts (input/output)	2.5 kV	5 kV	> 20 MΩ	CM: 1kV; DM: 0.5kV	2kV	CM: 1kV; DM: 1kV
Alarm contacts	2.5 kV	5 kV	> 20 MΩ	CM: 1kV; DM: 0.5kV	2kV	CM: 1kV; DM: 1kV
Other interfaces						
RS 232 Serial	500 V	1 kV	> 20 MΩ	CM: 1kV	1 kV	CM: 1kV; DM: 1kV
IRIG-B input	500 V	1 kV	> 20 MΩ	CM: 1kV	1 kV	CM: 1kV; DM: 1kV
GPS Sync Input	500 V	1 kV	> 20 MΩ	CM: 1kV	1 kV	CM: 1kV; DM: 1kV
CM (Common Mode): The relative terminals of each input/output (not connected to earth) are to be connected together. Each one is to be tested to earth, as well as each one to every other.						
DM (Differential Mode): Test is to be performed between relative terminals of the same circuit.						

- a) The IED enclosure shall have passed the Power Frequency Magnetic Field test of [7] SANS/IEC 61000-4-8 with compliance to Level 4: 30 A/m continuous, 300A/m for 1 to 3 s, 50 Hz.
- b) The IED's enclosure shall have passed the Electrostatic Discharge test of [3] SANS/IEC 61000-4-2 with compliance to level 3: 6 kV contact discharge and 8 kV air discharge.
- c) The IED shall have passed the Radiated Electromagnetic Field Requirements test of [4] SANS/IEC 61000-4-3 to compliance Level 3: 10 V/m.
- d) The IED power supply shall have passed the Conducted Emission test of [25] IEC 60255-25: 0.15–0.5 MHz 79 dB (uV) quasi peak, 66 dB (uV) average and 0.5 – 30 MHz 73 dB (uV) quasi peak, 60 dB (uV) average.
- e) The equipment shall neither suffer damage nor maloperate (e.g. output change from “guard” to “trip”) when any of the tests called for in Table 1 and section 3.4.4 of this specification are performed. After completion of the tests, the equipment shall again be checked for correct operation.
- f) The IEC/SANS standards shall be specified for the tests in Table 1 and section 3.2.9, however if the teleprotection unit complies with other equivalent standards from the IEC, SANS, ITU-T and CISPRES standards, the details of these standards and tests shall be provided by the supplier to Eskom for evaluation.

3.2.10 IEC 61850 Standard Implementation

The IEC 61850 standards combine the ethernet based communication standards with the functionality of the substation IEDs (e.g. protection, teleprotection, telecontrol, etc). These standards facilitate communication between the teleprotection unit and RTU and between the teleprotection unit and protection scheme using multimode fibre optic cables connected to an ethernet compatible LAN switch.

The LAN switch facilitates communication, using the IEC 61850 standards, between the teleprotection device and the protection relays. Virtual trip signals between these devices simulate the trip inputs and trip outputs on the conventional teleprotection scheme. The LAN switch would also facilitate communication, using the IEC 61850 standards, between the teleprotection device and the RTU/bay processor thereby replacing the contacts (and IDF) on the current setup.

If the IEC 61850 standard is implemented on teleprotection equipment, then the IEC 61850 implementation shall comply with the following:

- a) All the [9] IEC 61850 standards, latest edition.
- b) The teleprotection transceiver shall support an IEC 61850-based interface to protection IEDs. Teleprotection signalling between the transceiver and protective IED shall be achieved via GOOSE messaging.
- c) For an IEC 61850 compliant teleprotection unit, the IP address allocation shall follow a minimum of IPv4 and shall be configurable.
- d) Eskom standard, [20] 240-68235024: “Eskom IEC 61850 Station Bus Interoperability Test Standard.”
- e) Eskom standard, [21] 240-68107841: “Eskom IEC61850 Standard Requirements for PICS, PIXIT and TICS.”
- f) The IEC 61850 implementation must follow the Logical Nodes description as detailed in the Eskom standard [19] 240-42066934, “IEC 61850 Protocol Implementation Document for the purposes of Substation Automation”:
- g) In addition, the following logical node ITPC (Teleprotection Communication Interfaces) of IEC 61850-7-4 (latest edition) shall be included in the implementation (Table 2).

Table 2: ITPC class Logical Node

ITPC class				
Attribute Name	Attribute Type	Explanation	M/X/I	Remarks
Data objects				
Status Information				
Beh	ENS	Behaviour	M	
EEHealth	ENS	External equipment health	I	
Settings				
NumTxCmd	ING	Number of used binary transmit commands	I	
NumTxCmd	ING	Number of used binary transmit commands	I	
TpcTxMod1	ENG	Teleprotection application mode in transmit direction for each command (Unused, Blocking, Permissive, Direct)	I	TpcTxMod 1 to TpcTxMod 8 are allowed in NSD570
TpcRxMod1	ENG	Teleprotection application mode in receive direction for each command (Unused, Blocking, Permissive, Direct)	I	TpcRxMod 1 to TpcRxMod 8 are allowed in NSD570
M: Mandatory I: Informative				

- h) The fibre optic standard used in a protection bay with multiple IEC 61850 devices (protection and teleprotection IEDs) will use multimode 50/125µm fibre cables. The transceiver shall include a 100BaseFX fibre optic Ethernet port with Lucient Connector (LC) (preferred) connectors for IEC 61850 communication.
- i) The port in section 3.2.10 (h) shall support multi-session communication for simultaneous IEC 61850 communication and remote engineering access, each implemented on separate VLANs.
- j) Where the port in section 3.2.10 (i) cannot be achieved, a second rear multimode 50/125 µm fibre optic port shall be provided in accordance with a port as described in section 3.2.10 (h) for remote engineering access via a VLAN.
- k) IEC61850-based communication shall not be affected by simultaneous remote engineering access to the device.
- l) If there are any other items or detail that is required for either the normal operation or an improvement of the IEC 61850 implementation, then the supplier can provide the proposal but is subject to Eskom's approval.

3.3 General Requirements

3.3.1 Housing of equipment and cabling facilities

- a) The teleprotection equipment shall be supplied in a Standard 19" sub-rack with front flange mounting. The height of the equipment is limited to 3U.
- b) Equipment terminals for protection cable terminations shall be suitable for conductors having a cross-sectional area of up to 2.5 mm². Stud type terminals and terminals of the type where clamping screws are in direct contact with the wire are not acceptable. Porcelain terminal blocks or strips are not acceptable.
- c) Equipment terminals for power supply cables shall be suitable for accommodating at least two 4mm² conductors. Stud type terminals and terminals of the type where clamping screws are in direct contact with the wire are not acceptable.
- d) Ground points shall be provided on the sub-rack, utilising a compression type terminal or equivalent, to permit connection to a common earthing bar in the cabinet.
- e) The teleprotection sub-rack or faceplates shall have a facility for labels where the labels could be easily changed if required. The labels shall detail the TPE number, protected line designation and direction. This information shall be inserted at the factory, based on the details in the equipment order. This information must be clearly visible from the front of the relevant panel and enable identification without ambiguity.
- f) Each item of equipment shall be permanently engraved, in a position which cannot be affected by module changes, with the following information:
 - 1) Factory serial number
 - 2) Eskom order and item number
 - 3) Type Number
 - 4) DC Supply voltage
- g) Teleprotection sub-racks are required for fixed frame mounting, and shall be provided with an Eskom approved terminal strip(s) fitted along the rear of the sub-rack. The terminals are to be clearly marked with identification numbers.

3.3.2 Drawings and Instruction Manuals

- a) Drawings shall be marked-up in English.
- b) Duplicate copies of a schedule listing all drawings and circuit diagrams applicable to all equipment included in the contract, shall be supplied with or before the notification of readiness for acceptance testing, as per [18] TST41-634.
- c) The following drawings shall be submitted in duplicate, for all the equipment included in the contract, before contract establishment.
 - 1) Block schematic diagram showing the functional arrangement of the equipment.
 - 2) Detailed schematic diagram showing the interconnection between the teleprotection equipment and Eskom's protection relays.
 - 3) Functional drawing showing the overall operation of the equipment, including any test points.
 - 4) Module and sub-rack wiring including functions and designations of the terminal blocks.
 - 5) Details of terminals and terminal blocks.
 - 6) Outline dimensions and mounting details of teleprotection shelves.

-
- d) Where changes to the equipment are envisaged, either by the manufacturer or by Eskom during the contract period, the manufacturer shall submit details of these changes in writing, together with the modified drawings for Eskom's approval, before proceeding with the implementation of these changes. An electronic copy shall be supplied for each new drawing approved.
- e) The instruction book shall only cover the actual equipment variant supplied to Eskom, typical circuit diagrams and descriptions are not acceptable. The diagrams shall correspond in exact detail with the equipment delivered.
- f) The instruction books shall have a hard-covered ring file construction and they shall open flat at any page. Folders which do not comply with these requirements are not acceptable. Different sections of the handbooks shall be separated by means of thumb-tab separators.
- g) The equipment handbooks shall basically consist of the following sections:
- 1) Index.
 - 2) Electrical and mechanical specifications and parameters of the equipment.
 - 3) Basic description of the equipment and its operation.
 - 4) Basic mechanical design of the equipment and the cabinet and inter-sub-rack wiring. Description, block schematic and wiring schematic of the complete equipment.
 - 5) Sub-rack mechanical design and wiring. Description and wiring schematics of individual sub-racks.
 - 6) Individual modules description, parts layout, electrical schematic and parts list.
 - 7) Installation, commissioning and maintenance procedures.
- h) The instruction book shall contain a master key or block schematic which shall clearly indicate the reference number of the individual detailed circuit diagrams against the appropriate blocks.
- i) Block schematics of the complete equipment shall indicate clearly the interconnections between the various units. Wiring schematics with cable harnesses are not acceptable for this purpose.
- j) The individual module description shall contain a written description of the operation of the modules, the module testing procedure, if applicable, and the technical ratings of the unit. This shall be followed by the module schematic, the component layout and a component list giving the component values, rating, tolerance and manufacturer. The module schematic shall detail the nominal DC and AC voltages on the semiconductor devices, the function of the various input and output points shall be given on the schematic.
- k) Handbook drawings and descriptions shall conform to the international A4 series (295 x 220 mm). Larger drawings, which cannot be accommodated on this size, shall be folded into a single A4 panel, along the 295 mm axis of the standard A4 series. Handbook drawings which must be unfolded in two directions are not acceptable.
- l) The handbooks, complete with drawings, shall also be provided on a CD, using Microsoft Office or Acrobat format, in addition to the hard copies requested.

3.3.3 Tools, Test Equipment and Software

- a) The supplier shall detail any test equipment or tools that may be required to commission and maintain the equipment. Prices of the various items are to be included in the price schedule.
- b) In the event of any of the equipment used having the capability of being remotely accessed via a communication link, all details of the interface, including hardware, software, logical, and protocol details shall be made available to Eskom so as to allow the equipment to be interfaced to a bay processor or equivalent equipment. The protocol shall be open for limited distribution by Eskom to a third party (the supplier of bay processor or equivalent equipment). The protocol must be well documented and these documents must be available to Eskom.
- c) Software and interfacing cables for equipment with serial interfaces whereby fault recordings, sequence of event, settings and marshalling can be controlled via PC, shall be made freely available as it is deemed to be part of the equipment. Eskom will freely copy the software and reproduce the manuals for exclusive use within Eskom.

The supplier shall, on request from Eskom, provide Eskom with the necessary software detail when required for interfacing with the future or existing computer systems.
- d) The software has been formally verified to ensure that it matches its specification.
- e) Unit Firmware: Any firmware (EPROM or FLASH ROM) of equipment supplied to Eskom, will not be changed unless Eskom requested the modification or Eskom gives written approval to the supplier to do the proposed modifications. Such modification will be subject to testing and verification in writing by Eskom prior to the supplier placing the altered firmware into operation.

3.3.4 Quality Assurance and System Reliability

- a) Eskom's Quality Assurance requirements as specified in [17] QM-58 are applicable.
- b) If any unit, sub-unit or module exhibits a failure rate of 0.10 (i.e. 10% fail) or higher during the defects period, as defined in the contract, the contractor shall remove all such units, sub-units or modules from the system, whether failed or not, and replace them with units, sub-units or modules satisfactory to Eskom. This shall be done without cost to Eskom. The period of warranty for portions of the works affected by such replacement shall then be accordingly extended.

3.3.5 Statement of Compliance or Deviation

The tenderer must state compliance with, or deviation from, all the requirements of this specification, on a section by section and clause by clause basis.

3.4 Tests

3.4.1 Test Certificates

- a) The following routine test certificates in English shall be available as soon as possible, but not later than the delivery date of the equipment.
 - 1) One copy of the routine test certificate shall be supplied with each equipment.
 - 2) One copy of the routine test certificate shall be retained by the manufacturer for reference by Eskom if required.
- b) Each routine test certificate shall detail the Eskom order number and item number and the manufacturer's serial number.
- c) All type test certificates and a representative set of routine test certificates, in English, shall be submitted to Eskom before contract has been established.

3.4.2 Witnessing of Tests

- a) Eskom reserves the right to appoint a representative to inspect the equipment at any stage of manufacture, or to be present at any of the specified tests. Such inspection shall not relieve the manufacturer of his responsibility for meeting the requirements of the specification, and it shall not prevent subsequent rejection if such material or equipment is later found to be defective.
- b) Each routine test and type test certificate shall clearly state the type of test being performed and cross refer to the appropriate test section number listed in section 3.4.3 and 3.4.4.

3.4.3 Routine Tests

Equipment supplied in compliance with this specification shall be subjected to the routine tests listed below:

- a) Soak test (burn-in of equipment)
- b) Equipment shall be subjected to a 100 hour soak test prior to the commencement of any routine tests. During the soak test the equipment shall be operated at the maximum temperature of the range stated in Schedule A/B. During these tests the supply shall be maintained at the upper tolerance limit. The following routine tests will follow the 100 hour soak test.
- c) The equipment shall be subjected to the manufacturer's standard works test.
- d) The equipment shall be operated at its nominal supply voltage.
- e) The operation of alarm indications and functions and alarm contacts up to the cabinet terminal block shall be checked.
- f) The transmitter and receiver shall be connected back to back and the signal transfer time measured.
- g) The blocking of the command output and the operation of the appropriate alarms shall be checked under the following conditions:
 - 1) When there is a sudden failure in the telecommunications path
 - 2) Removal of any module
 - 3) Failure of the critical functions of the logical nodes in the IEC 61850 implementation.

3.4.4 Type Tests

- a) Type tests shall be carried out on one teleprotection link of each type or rating.
- b) If evidence is available of type tests on identical equipment, this may be accepted in lieu of these tests. If type test data in accordance with the specification is not available, an indication shall be given of the date on which such tests will be made.
- c) Each teleprotection unit to which it is intended to apply the type test shall first be routine tested. It is required that all type tests be carried out on the same teleprotection unit.
- d) The IED shall have passed the Cold Test Ad of [26] IEC60068-2-1 to a temperature of 0 °C: 16 hours.
- e) The IED shall have passed the Cyclic Temperature and Humidity Test Db of [27] IEC60068-2-2 to a temperature of + 55 °C for control building applications: 16 hours.
- f) The IED shall have passed the Dielectric Withstand Tests of [23] IEC 60255-5 complying with parameters in Table 1 of this document.
- g) The IED shall have passed the Impulse Voltage Tests of [23] IEC 60255-5 complying with parameters in Table 1 of this document.
- h) The IED shall have passed the Insulation Resistance Tests of [23] IEC 60255-5 complying with parameters in Table 1 of this document.
- i) The IED shall have passed the Damped oscillatory wave immunity Tests of [8] IEC 61000-4-18 or equivalent standard complying with parameters in Table 1 of this document.

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- j) The IED shall have passed the Electrical Fast Transient Bursts Tests of [5] SANS/IEC 61000-4-4 complying with parameters in Table 1 of this document.
- k) The IED shall have passed the Impulse Voltage Tests (1.2/50 us 0.5J) of [6] SANS/IEC 61000-4-5 complying with parameters in Table 1 of this document.
- l) The IED enclosure shall have passed the Power Frequency Magnetic Field test of [7] SANS/IEC 61000-4-8 with compliance to Level 4: 30 A/m continuous, 300A/m for 1 to 3 s, 50 Hz.
- m) The IED's enclosure shall have passed the Electrostatic Discharge test of [3] SANS/IEC 61000-4-2 with compliance to Level 3: 6 kV contact discharge and 8 kV air discharge.
- n) The IED shall have passed the Radiated Electromagnetic Field Requirements test of [4] SANS/IEC 6100-4-3 to compliance Level 3: 10 V/m.
- o) The IED power supply shall have passed the Conducted Emission test of [25] IEC 60255-25: 0.15–0.5 MHz 79 dB (uV) quasi peak, 66 dB (uV) average and 0.5 – 30 MHz 73 dB (uV) quasi peak, 60 dB (uV) average.
- p) Supply variations:
- 1) Measurements of equipment performance and maximum VA consumption shall be made, for supply voltage and frequency variations in all possible combinations of upper limit, normal and lower limit as detailed in 3.2.6a). During these tests the equipment shall function in accordance with its specification.
- q) Supply Interruptions:
- 1) The supply input to the equipment under test shall be interrupted for periods of 5 ms, 10 ms, 20 ms, 50 ms, 100 ms, 200 ms and 500 ms as required by Eskom.
 - 2) The test shall be performed 3 times for DC supplies, covering all modes of equipment operation.
 - 3) All outputs of the equipment shall be monitored throughout this test to ensure that no malfunction occurs and that for such interruptions the equipment either continues to operate successfully or powers-down successfully without loss of historical trip and fault data history.
- r) Reflected noise: The teleprotection equipment, when required to operate from a 48V dc supply, shall be checked for compliance with clause 3.2.6(g). Annex C shows the circuit to be used to perform the required measurement
- s) The input burden and inrush current of the teleprotection transmitter input interface circuit shall be measured to prove compliance with clause 3.2.7(c).1 for System A and 3.2.7(d).5 for System C interface. In addition, for a System A interface, a 2µF capacitor, charged to 1.5 times the input interface nominal voltage, shall be discharged through the loaded operating coil circuit, as described in clause 3.2.7(c).4. A 0.2µF capacitor charged to 1.5 times the input interface nominal voltage is used for System C, clause 3.2.7(d) 6.
- t) The security and dependability characteristics of the teleprotection equipment shall be measured at various bit error rates of the telecommunication path in accordance with [1] IEC60834-1, when configured for permissive, blocking and direct intertrip operation.
- u) The jitter tolerance and intrinsic Jitter of the equipment shall be tested for conformance with [12] ITU-T RECOMMENDATION G.823, when fitted with an electrical interface.
- v) When fitted with optical interfaces, the equipment shall be proved to operate to specification if an attenuator set to the optical budget limit is connected between transmitting and receiving ports.
- w) Type tests shall be performed in accordance with the [9] IEC 61850 standard. These tests shall form part of an official FAT (Field Acceptance Testing) with an appropriate ATP (Acceptance Test Procedure) document.

3.5 Marking, labelling and packaging

- a) The equipment shall be protectively packed in such a way that it can be safely transported, handled and stored.
- b) Equipment and spares shall be packed in heat sealed plastic, to protect the equipment against the ingress of moisture. Adequate static protection must be applied to equipment that is static sensitive. Static sensitive practices must be practised when handling static sensitive equipment.
- c) Equipment supplied against a specific order item number shall be packed in a single case or carton. The combining of several different sets of equipment in the same case or carton is not acceptable. Different sets of equipment can be packed in a single case, provided the individual sets of equipment are packed in individually marked cartons.
- d) If sub-components are packed separately in individual packing, separate from the main rack or sub-rack, each sub-item shall carry the serial number of the associated rack or sub-rack to which the module belongs.
- e) The design of the equipment packaging shall be such that if the case or carton is dropped from a height of one metre onto a flat surface, no damage to the equipment shall occur.
- f) Eskom will only accept equipment for delivery at the destinations specified in the contract. Where equipment is off loaded at intermediate points, the storing and transshipping shall be the responsibility of the equipment supplier.
- g) Equipment packaging shall be clearly stencilled with paint, with the Eskom delivery address, and Eskom's order and item number. If an item consists of more than one package, each package shall be further identified, i.e. Box 1 of 4.
- h) Packages containing spares shall be clearly marked "Spares".
- i) A packing list detailing all items of equipment included in the package shall be affixed to the case or carton under a metal plate or transparent plastic folder clearly marked "Packing List".

3.6 Spares

- a) Each teleprotection unit delivered shall be supplied with a set of spare fuses, if incorporated in the equipment, the cost of which shall be included in the price of the unit.
- b) The supplier is to supply a comprehensive list of spares which shall, at minimum include one of each of the cards used, as well as empty sub-racks, plugs and sockets, and consumable items if any. The supplier may also include on the lists of spares any other recommended spares necessary for the proper maintenance of the equipment. The spares items shall be priced individually and the lists shall include a description of the item, a reference number and the pricing details. All spares shall be delivered in approved cases suitable for storing such parts over a period of years without damage or deterioration.
- c) Spares for the units must be available from the successful tenderer for a period of at least 10 years subsequent to the expiry of the Contract.
- d) All spares are to be handled in accordance with static precautions. The spares are to be packaged in the required static protection packaging. All static sensitive spares are to be marked with the appropriate markers as to indicate their sensitivity.

4. Authorization

This document has been seen and accepted by:

Name and surname	Designation
Aletta Mashao	Senior Manager – PTM&C Dx
Alison Maseko	Senior Manager – Eskom Telecommunications
Johan Pieterse	Chief Engineer – Tx Works Planning and Centralized Services
Lenah Mothata	Senior Manager – Grids
Prudence Madiba	Senior Manager – Gx Engineering
Richard McCurrach	Senior Manager (Acting) - Tx Information Management
Sikelela Mkhabela	Senior Manager – Dx Network Operations
Sithembile Songo	Senior Manager – Information Security

5. Revisions

Date	Rev.	Compiler	Remarks
June 2022	3	Tejin Gosai	Document required revision.
April 2018	2	Tejin Gosai	Revised the document to update IEC 61850 requirements and include the Ethernet telecommunication interface.
June 2014	1	Tejin Gosai	Revised the IEC 61850 requirements.

6. Development team

The following people were involved in the development of this document:

- Ashley van der Poel
- Riyaz Gangat
- Zakhele Dlamini

7. Acknowledgements

Not applicable.

Annex A – Teleprotection Reliability

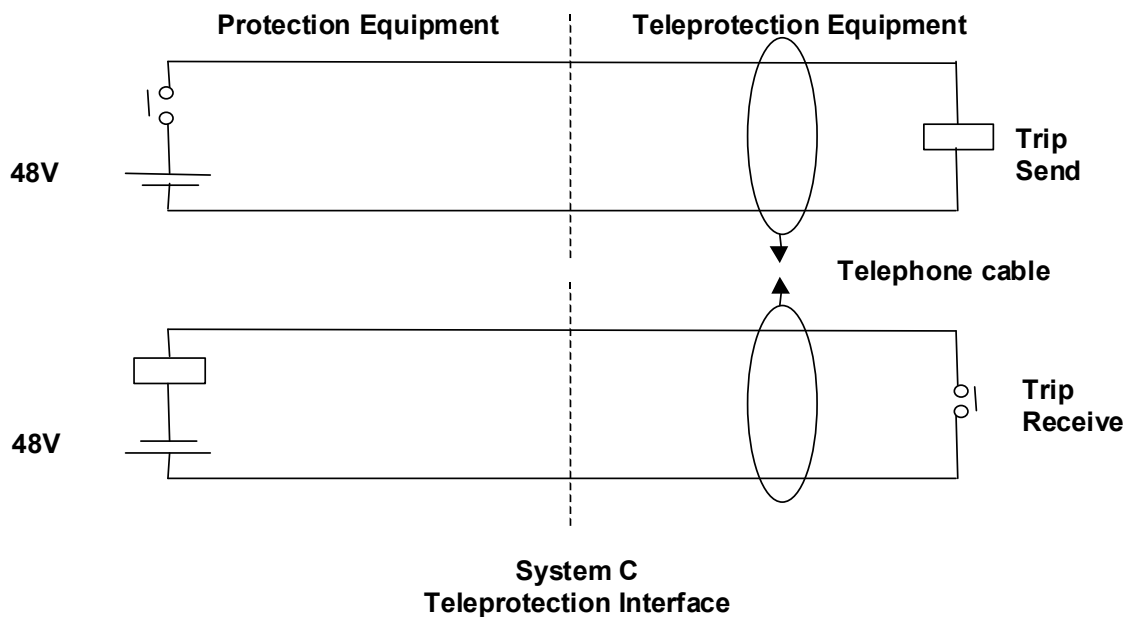
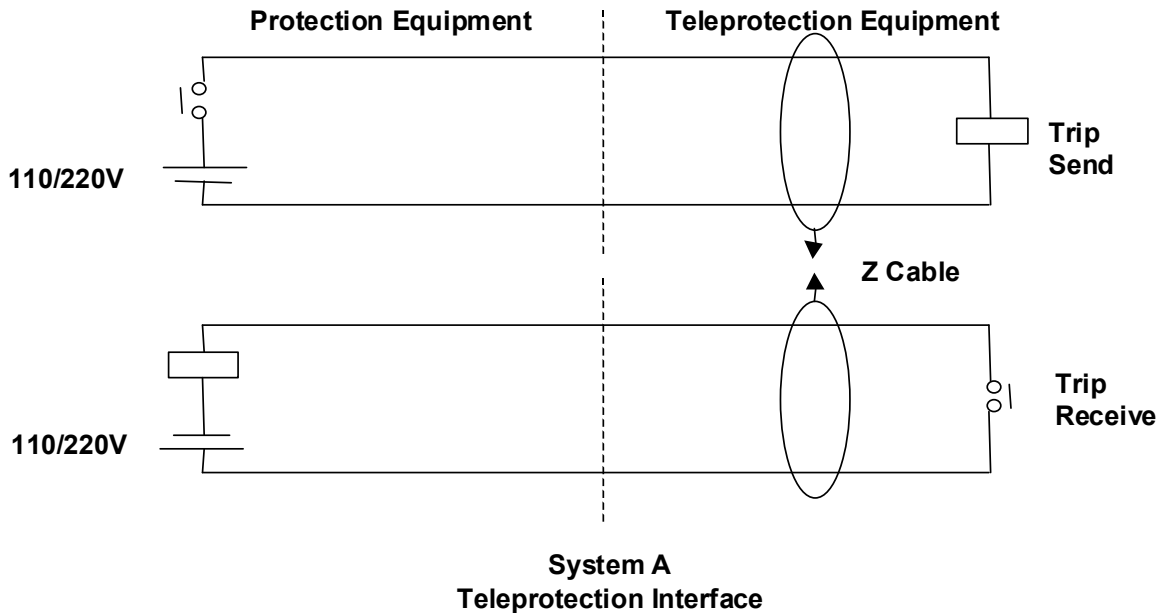
Table A.1: Minimum requirements for security and dependability performance according to IEC 60834-1

Protection Type	Dependability		Security	
	Failure Probability ($< 1.3T_0$)	BER (of 64 kbit/s channel)	False Trip Probability	BER (of 64 kbit/s channel)
Permissive Intertrip	$< 1 \times 10^{-2}$	$< 1 \times 10^{-6}$	$< 1 \times 10^{-7}$	$< 1 \times 10^{-3}$
Direct Intertrip	$< 1 \times 10^{-4}$	$< 1 \times 10^{-6}$	$< 1 \times 10^{-8}$	$< 1 \times 10^{-3}$
Blocking Protection	$< 1 \times 10^{-3}$	$< 1 \times 10^{-6}$	$< 1 \times 10^{-4}$	$< 1 \times 10^{-3}$

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Annex B – - Teleprotection Interfaces

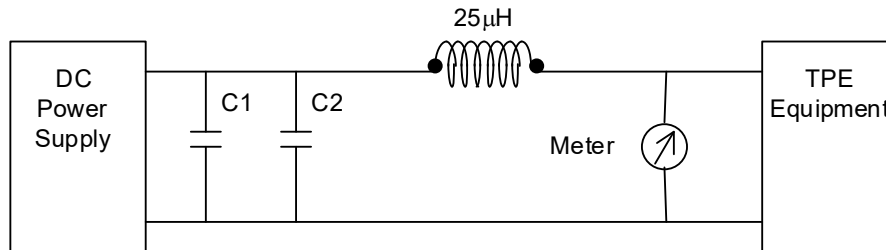
System A and System C Teleprotection Interfaces



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Annex C – Test Circuit for Reflected Noise

Test Circuit for Measuring Reflected Noise



Note : C1 = 1µF Paper Capacitor
C2 = 10 000µF Electrolytic Capacitor

Annex D – Technical Schedules A/B

The supplier shall state clearly, for each clause that requires a statement of compliance in the Technical Schedules A/B. If a clause in the Technical Schedules A/B requires a statement of compliance and additional information, the supplier shall state clearly "Comply" and shall provide detail information or state "Do not Comply" and shall provide detail information. Suppliers are to substantiate their statement of compliance or partial compliance to the requirements in the "Provide evidence or the location in the tender documentation for evidence" column in the Technical Schedules A/B.

Schedule A: Purchaser's specifications

Schedule B: Guarantees, compliance and technical particulars of equipment offered

Numbering	Section numbering	Description	Schedule A	Schedule B	Provide evidence or the location in the tender documentation for evidence	Comments
1	1	Manufacturer	Specify			
2	2	Manufacturer's type reference	Specify			
3	3	Teleprotection Equipment				
3.1.1	3.1	Background				
3.1.1a)	3.1.	Conventional interfaces to protection and telecontrol equipment	Comply			
3.1.1b)	3.1	IEC 61850 standard and conventional interfaces to protection and telecontrol equipment	Comply			
3.2	3.2	Teleprotection Equipment Requirements				
3.2.1	3.2.1	General				
3.2.1a)	3.2.1a)	a) Comply with clause 3.2.1a) of this specification	Comply			
3.2.1b)	3.2.1b)	b) Comply with clause 3.2.1b) of this specification	Comply			
3.2.1c)	3.2.1c)	c) Comply with clause 3.2.1c) of this specification	Comply			
3.2.1d)	3.2.1d)	d) Comply with clause 3.2.1d) of this specification	Comply			
3.2.1e)	3.2.1e)	e) Comply with clause 3.2.1e) of this specification	Comply			
3.2.1f)	3.2.1f)	f) Comply with clause 3.2.1f) of this specification	Comply			
3.2.2	3.2.2	Environmental conditions				

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3.2.2a)	3.2.2a)	a) Comply with clause 3.2.2a) of this specification	Comply			
3.2.2b)	3.2.2b)	b) Comply with altitude from 0 to 2000m	Comply			
3.2.2c)	3.2.2c)	c) Temperature: Maximum +55 °C	Comply			
3.2.2c)	3.2.2c)	d) Temperature: Minimum 0 °C	Comply			
3.2.2d)	3.2.2d)	e) Comply with clause 3.2.2d) of this specification	Comply			
3.2.2e)	3.2.2e)	f) Comply with clause 3.2.2e) of this specification	Comply			
3.2.2f)	3.2.2f)	g) Comply with clause 3.2.2f) of this specification	Comply			
3.2.3	3.2.3	Equipment Design				
3.2.3a)	3.2.3a)	a) Comply with clause 3.2.3a) of this specification	Comply			
3.2.3b)	3.2.3b)	b) Comply with clause 3.2.3b) of this specification	Comply			
3.2.3c)	3.2.3c)	c) Comply with clause 3.2.3c) of this specification	Comply			
3.2.3d)	3.2.3d)	d) Comply with clause 3.2.3d) of this specification	Comply			
3.2.3e)	3.2.3e)	e) Comply with clause 3.2.3e) of this specification	Comply			
3.2.3f)	3.2.3f)	f) Comply with clause 3.2.3f) of this specification	Comply			
3.2.3g)	3.2.3g)	g) Comply with clause 3.2.3g) of this specification	Comply			
3.2.3h)	3.2.3h)	h) Comply with clause 3.2.3h) of this specification	Comply			
3.2.3i)	3.2.3i)	i) Comply with clause 3.2.3i) of this specification	Comply			
3.2.3j)	3.2.3j)	j) Comply with clause 3.2.3j) of this specification	Comply			
3.2.4	3.2.4	End-to-end and local test facilities				
3.2.4a)	3.2.4a)	a) Comply with clause 3.2.4a) of this specification	Comply			
3.2.4b)	3.2.4b)	b) Comply with clause 3.2.4b) of this specification	Comply			
3.2.4c)	3.2.4c)	c) Comply with clause 3.2.4c) of this specification	Comply			
3.2.5	3.2.5	Management, Alarms and test facilities				
3.2.5.1	3.2.5.1	Functions required				

3.2.5.1a)	3.2.5.1a)	a) Comply with clause 3.2.5.1a) of this specification	Comply			
3.2.5.1b)	3.2.5.1b)	b) Comply with clause 3.2.5.1b) of this specification	Comply			
3.2.5.1c)	3.2.5.1c)	c) Comply with clause 3.2.5.1c) of this specification	Comply			
3.2.5.1d)	3.2.5.1d)	d) Comply with clause 3.2.5.1d) of this specification	Comply			
3.2.5.1e)	3.2.5.1e)	e) Comply with clause 3.2.5.1e) of this specification	Comply			
3.2.5.2	3.2.5.2	HMI interface standards/requirements				
3.2.5.2a)	3.2.5.2a)	a) Comply with clause 3.2.5.2a) of this specification	Comply			
3.2.5.2b)	3.2.5.2b)	b) Comply with clause 3.2.5.2b) of this specification	Comply			
3.2.5.2c)	3.2.5.2c)	c) Comply with clause 3.2.5.2c) of this specification	Comply			
3.2.5.2d)	3.2.5.2d)	d) Comply with clause 3.2.5.2d) of this specification	Comply			
3.2.5.2e)	3.2.5.2e)	e) Comply with clause 3.2.5.2e) of this specification	Comply			
3.2.5.2f)	3.2.5.2f)	f) Comply with clause 3.2.5.2f) of this specification	Comply			
3.2.5.3	3.2.5.3	Cyber Security				
3.2.5.3a)	3.2.5.3a)	a) Comply with clause 3.2.5.3a) of this specification	Comply			
3.2.5.3b)	3.2.5.3b)	b) Comply with clause 3.2.5.3b) of this specification	Comply			
3.2.5.3c)	3.2.5.3c)	c) Comply with clause 3.2.5.3c) of this specification	Comply			
3.2.5.3d)	3.2.5.3d)	d) Comply with clause 3.2.5.3d) of this specification	Comply			
3.2.5.3e)	3.2.5.3e)	e) Comply with clause 3.2.5.3e) of this specification	Comply			
3.2.5.3f)	3.2.5.3f)	f) Comply with clause 3.2.5.3f) of this specification	Comply			
3.2.5.3g)	3.2.5.3g)	g) Comply with clause 3.2.5.3g) of this specification	Comply			
3.2.5.3h)	3.2.5.3h)	h) Comply with clause 3.2.5.3h) of this specification	Comply			
3.2.5.4	3.2.5.4	Alarms				

3.2.5.4a)	3.2.5.4a)	a) Comply with clause 3.2.5.4a) of this specification	Comply			
3.2.5.4b)	3.2.5.4b)	b) Comply with clause 3.2.5.4b) of this specification	Comply			
3.2.5.4c)	3.2.5.4c)	c) Comply with clause 3.2.5.4c) of this specification	Comply			
3.2.5.4d)	3.2.5.4d)	d) Comply with clause 3.2.5.4d) of this specification	Comply			
3.2.5.4e)	3.2.5.4e)	e) Comply with clause 3.2.5.4e) of this specification	Comply			
3.2.6	3.2.6	Power Supplies				
3.2.6a)	3.2.6a)	a) Comply with clause 3.2.6a) of this specification	Comply			
3.2.6b)	3.2.6b)	b) Comply with clause 3.2.6b) of this specification	Comply			
3.2.6c)	3.2.6c)	c) Comply with clause 3.2.6c) of this specification	Comply			
3.2.6d)	3.2.6d)	d) Comply with clause 3.2.6d) of this specification	Comply			
3.2.6e)	3.2.6e)	e) Comply with clause 3.2.6e) of this specification	Comply			
3.2.6f)	3.2.6f)	f) Comply with clause 3.2.6f) of this specification	Comply			
3.2.6g)	3.2.6g)	g) Comply with clause 3.2.6g) of this specification	Comply			
3.2.6h)	3.2.6h)	h) Comply with clause 3.2.6h) of this specification	Comply			
3.2.6i)	3.2.6i)	i) Comply with clause 3.2.6i) of this specification	Comply			
3.2.6j)	3.2.6j)	j) Comply with clause 3.2.6j) of this specification	Comply			
3.2.6k)	3.2.6k)	k) Comply with clause 3.2.6k) of this specification	Comply			
3.2.6l)	3.2.6l)	l) Comply with clause 3.2.6l) of this specification	Comply			
3.2.6m)	3.2.6m)	m) Comply with clause 3.2.6m) of this specification	Comply			
3.2.7	3.2.7	Interface with Eskom's protection relay equipment				
3.2.7a)	3.2.7a)	a) Comply with clause 3.2.7a) of this specification	Comply			
3.2.7b)	3.2.7b)	b) Comply with clause 3.2.7b) of this specification	Comply			
3.2.7c)	3.2.7c)	System A				

3.2.7c)1)	3.2.7c)1)	c) Comply with clause 3.2.7c)1) of this specification	Comply			
3.2.7c)2)	3.2.7c)2)	d) Comply with clause 3.2.7c)2) of this specification	Comply			
3.2.7c)3)	3.2.7c)3)	e) Comply with clause 3.2.7c)3) of this specification	Comply			
3.2.7c)4)	3.2.7c)4)	f) Comply with clause 3.2.7c)4) of this specification	Comply			
3.2.7c)5)	3.2.7c)5)	g) Comply with clause 3.2.7c)5) of this specification	Comply			
3.2.7c)6)	3.2.7c)6)	h) Comply with clause 3.2.7c)6) of this specification	Comply			
3.2.7c)7)	3.2.7c)7)	i) Comply with clause 3.2.7c)7) of this specification	Comply			
3.2.7c)8)	3.2.7c)8)	j) Comply with clause 3.2.7c)8) of this specification	Comply			
3.2.7d)	3.2.7d)	System C				
3.2.7d)1)	3.2.7d)1)	k) Comply with clause 3.2.7d)1) of this specification	Comply			
3.2.7d)2)	3.2.7d)2)	l) Comply with clause 3.2.7d)2) of this specification	Comply			
3.2.7d)3)	3.2.7d)3)	m) Comply with clause 3.2.7d)3) of this specification	Comply			
3.2.7d)4)	3.2.7d)4)	n) Comply with clause 3.2.7d)4) of this specification	Comply			
3.2.7d)5)	3.2.7d)5)	o) Comply with clause 3.2.7d)5) of this specification	Comply			
3.2.7d)6)	3.2.7d)6)	p) Comply with clause 3.2.7d)6) of this specification	Comply			
3.2.7d)7)	3.2.7d)7)	q) Comply with clause 3.2.7d)7) of this specification	Comply			
3.2.7d)8)	3.2.7d)8)	r) Comply with clause 3.2.7d)8) of this specification	Comply			
3.2.7d)9)	3.2.7d)9)	s) Comply with clause 3.2.7d)9) of this specification	Comply			
3.2.7d)10)	3.2.7d)10)	t) Comply with clause 3.2.7d)10) of this specification	Comply			
3.2.7d)11)	3.2.7d)11)	u) Comply with clause 3.2.7d)11) of this specification	Comply			
3.2.8	3.2.8	Channel and Performance Requirements				

3.2.8a)	3.2.8a)	a) Comply with clause 3.2.8a) of this specification	Comply			
3.2.8b)	3.2.8b)	b) Comply with clause 3.2.8b) of this specification	Comply			
3.2.8c)	3.2.8c)	c) Comply with clause 3.2.8c) of this specification	Comply			
3.2.8d)	3.2.8d)	d) Specify "Dependability" requirements for the "Permissive Intertrip" according to clause 3.2.8d) of this specification	Specify			
3.2.8e)	3.2.8d)	e) Specify "Dependability" requirements for the "Direct Intertrip" according to clause 3.2.8d) of this specification	Specify			
3.2.8f)	3.2.8d)	f) Specify "Dependability" requirements for the "Blocking Protection" according to clause 3.2.8d) of this specification	Specify			
3.2.8g)	3.2.8d)	g) Specify "Security" requirements for the "Permissive Intertrip" according to clause 3.2.8d) of this specification	Specify			
3.2.8h)	3.2.8d)	h) Specify "Security" requirements for the "Direct Intertrip" according to clause 3.2.8d) of this specification	Specify			
3.2.8i)	3.2.8d)	i) Specify "Security" requirements for the "Blocking Protection" according to clause 3.2.8d) of this specification	Specify			
3.2.8j)	3.2.8e)1) & 3.2.8e)2)	j) Specify "Back-toBack Operate" times for the "Permissive and Blocking Protection" systems according to clause 3.2.8e)1) and 3.2.8e)2) of this specification	Specify			
3.2.8k)	3.2.8e)1) & 3.2.8e)2)	k) Specify "Back-toBack Operate" times for the "Direct Transfer Trip Protection" systems according to clause 3.2.8e)1) and 3.2.8e)2) of this specification	Specify			
3.2.9	3.2.9	Voltage withstand and Electromagnetic Capability Requirements				

3.2.9.1	3.2.9 Table 1	Power Supply <60VDC				
3.2.9.1a)	3.2.9 Table 1	a) Specify the "Dielectric Withstand" voltages according to Table 1 for "Power Supply <60V DC" of this specification.	Specify			
3.2.9.1b)	3.2.9 Table 1	b) Specify the "Impulse Voltage" values according to Table 1 for "Power Supply <60V DC" of this specification.	Specify			
3.2.9.1c)	3.2.9 Table 1	c) Specify the "Insulation Resistance" values according to Table 1 for "Power Supply <60V DC" of this specification.	Specify			
3.2.9.1d)	3.2.9 Table 1	d) Specify the CM and DM voltage values for the "Damped oscillatory wave immunity test" according to Table 1 for "Power Supply <60V DC" of this specification.	Specify			
3.2.9.1e)	3.2.9 Table 1	e) Specify the "Electrical fast/transient bursts" voltages according to Table 1 for "Power Supply <60V DC" of this specification.	Specify			
3.2.9.1f)	3.2.9 Table 1	f) Specify the CM and DM voltage values for the "Impulse Voltage Test 1.2/50us" test according to Table 1 for "Power Supply <60V DC" of this specification.	Specify			
3.2.9.2	3.2.9 Table 1	Power Supply >60VDC				
3.2.9.2a)	3.2.9 Table 1	a) Specify the "Dielectric Withstand" voltages according to Table 1 for "Power Supply >60V DC" of this specification.	Specify			
3.2.9.2b)	3.2.9 Table 1	b) Specify the "Impulse Voltage" values according to Table 1 for "Power Supply >60V DC" of this specification.	Specify			
3.2.9.2c)	3.2.9 Table 1	c) Specify the "Insulation Resistance" values according to Table 1 for "Power Supply >60V DC" of this specification.	Specify			
3.2.9.2d)	3.2.9 Table 1	d) Specify the CM and DM voltage values for the "Damped oscillatory wave immunity test" according to Table 1 for "Power Supply >60V DC" of this specification.	Specify			

3.2.9.2e)	3.2.9 Table 1	e) Specify the "Electrical fast/transient bursts" voltages according to Table 1 for "Power Supply >60V DC" of this specification.	Specify			
3.2.9.2f)	3.2.9 Table 1	f) Specify the CM and DM voltage values for the "Impulse Voltage Test 1.2/50us" test according to Table 1 for "Power Supply >60V DC" of this specification.	Specify			
3.2.9.3)	3.2.9 Table 1	Telecommunication Interfaces - X.21				
3.2.9.3a)	3.2.9 Table 1	a) Specify the "Dielectric Withstand" voltages according to Table 1 for "X.21" of this specification.	Specify			
3.2.9.3b)	3.2.9 Table 1	b) Specify the "Impulse Voltage" values according to Table 1 for "X.21" of this specification.	Specify			
3.2.9.3c)	3.2.9 Table 1	c) Specify the "Insulation Resistance" values according to Table 1 for "X.21" of this specification.	Specify			
3.2.9.3d)	3.2.9 Table 1	d) Specify the CM voltage values for the "Damped oscillatory wave immunity test" according to Table 1 for "X.21" of this specification.	Specify			
3.2.9.3e)	3.2.9 Table 1	e) Specify the "Electrical fast/transient bursts" voltages according to Table 1 for "X.21" of this specification.	Specify			
3.2.9.3f)	3.2.9 Table 1	f) Specify the CM and DM voltage values for the "Impulse Voltage Test 1.2/50us" test according to Table 1 for "X.21" of this specification.	Specify			
3.2.9.4	3.2.9 Table 1	Telecommunication Interfaces - G703.1				
3.2.9.4a)	3.2.9 Table 1	a) Specify the "Dielectric Withstand" voltages according to Table 1 for "G703.1" of this specification.	Specify			
3.2.9.4b)	3.2.9 Table 1	b) Specify the "Impulse Voltage" values according to Table 1 for "G703.1" of this specification.	Specify			
3.2.9.4c)	3.2.9 Table 1	c) Specify the "Insulation Resistance" values according to Table 1 for "G703.1" of this specification.	Specify			

3.2.9.4d)	3.2.9 Table 1	d) Specify the CM voltage values for the "Damped oscillatory wave immunity test" according to Table 1 for "G703.1" of this specification.	Specify			
3.2.9.4e)	3.2.9 Table 1	e) Specify the "Electrical fast/transient bursts" voltages according to Table 1 for "G703.1" of this specification.	Specify			
3.2.9.4f)	3.2.9 Table 1	f) Specify the CM and DM voltage values for the "Impulse Voltage Test 1.2/50us" test according to Table 1 for "G703.1" of this specification.	Specify			
3.9.5	3.2.9 Table 1	Telecommunication Interfaces Ethernet				
3.2.9.5a)	3.2.9 Table 1	a) Specify the "Dielectric Withstand" voltages according to Table 1 for "Ethernet" of this specification.	Specify			
3.2.9.5b)	3.2.9 Table 1	b) Specify the "Impulse Voltage" values according to Table 1 for "Ethernet" of this specification.	Specify			
3.2.9.5c)	3.2.9 Table 1	c) Specify the "Insulation Resistance" values according to Table 1 for "Ethernet" of this specification.	Specify			
3.2.9.5d)	3.2.9 Table 1	d) Specify the CM voltage values for the "Damped oscillatory wave immunity test" according to Table 1 for "Ethernet" of this specification.	Specify			
3.2.9.5e)	3.2.9 Table 1	e) Specify the "Electrical fast/transient bursts" voltages according to Table 1 for "Ethernet" of this specification.	Specify			
3.2.9.5f)	3.2.9 Table 1	f) Specify the CM and DM voltage values for the "Impulse Voltage Test 1.2/50us" test according to Table 1 for "Ethernet" of this specification.	Specify			
3.2.9.6	3.2.9 Table 1	Protection equipment Interfaces - System A contacts				
3.2.9.6a)	3.2.9 Table 1	a) Specify the "Dielectric Withstand" voltages according to Table 1 for "System A contacts (inputs/outputs)" of this specification.	Specify			
3.2.9.6b)	3.2.9 Table 1	b) Specify the "Impulse Voltage" values according to Table 1 for "System A	Specify			

		contacts (inputs/outputs)" of this specification.				
3.2.9.6c)	3.2.9 Table 1	c) Specify the "Insulation Resistance" values according to Table 1 for "System A contacts (inputs/outputs)" of this specification.	Specify			
3.2.9.6d)	3.2.9 Table 1	d) Specify the CM and DM voltage values for the "Damped oscillatory wave immunity test" according to Table 1 for "System A contacts (inputs/outputs)" of this specification.	Specify			
3.2.9.6e)	3.2.9 Table 1	e) Specify the "Electrical fast/transient bursts" voltages according to Table 1 for "System A contacts (inputs/outputs)" of this specification.	Specify			
3.2.9.6f)	3.2.9 Table 1	f) Specify the CM and DM voltage values for the "Impulse Voltage Test 1.2/50us" test according to Table 1 for "System A contacts (inputs/outputs)" of this specification.	Specify			
3.9.7	3.2.9 Table 1	Protection equipment Interfaces - System C contacts				
3.2.9.7a)	3.2.9 Table 1	a) Specify the "Dielectric Withstand" voltages according to Table 1 for "System C contacts (inputs/outputs)" of this specification.	Specify			
3.2.9.7b)	3.2.9 Table 1	b) Specify the "Impulse Voltage" values according to Table 1 for "System C contacts (inputs/outputs)" of this specification.	Specify			
3.2.9.7c)	3.2.9 Table 1	c) Specify the "Insulation Resistance" values according to Table 1 for "System C contacts (inputs/outputs)" of this specification.	Specify			
3.2.9.7d)	3.2.9 Table 1	d) Specify the CM and DM voltage values for the "Damped oscillatory wave immunity test" according to Table 1 for "System C contacts (inputs/outputs)" of this specification.	Specify			
3.2.9.7e)	3.2.9 Table 1	e) Specify the "Electrical fast/transient bursts" voltages according to Table 1 for "System C contacts (inputs/outputs)" of this specification.	Specify			

3.2.9.7f)	3.2.9 Table 1	f) Specify the CM and DM voltage values for the "Impulse Voltage Test 1.2/50us" test according to Table 1 for "System C contacts (inputs/outputs)" of this specification.	Specify			
3.2.9.8	3.2.9 Table 1	Protection equipment Interfaces - Alarm contacts				
3.2.9.8a)	3.2.9 Table 1	a) Specify the "Dielectric Withstand" voltages according to Table 1 for "Alarm contacts" of this specification.	Specify			
3.2.9.8b)	3.2.9 Table 1	b) Specify the "Impulse Voltage" values according to Table 1 for "Alarm contacts" of this specification.	Specify			
3.2.9.8c)	3.2.9 Table 1	c) Specify the "Insulation Resistance" values according to Table 1 for "Alarm contacts" of this specification.	Specify			
3.2.9.8d)	3.2.9 Table 1	d) Specify the CM and DM voltage values for the "Damped oscillatory wave immunity test" according to Table 1 for "Alarm contacts" of this specification.	Specify			
3.2.9.8e)	3.2.9 Table 1	e) Specify the "Electrical fast/transient bursts" voltages according to Table 1 for "Alarm contacts" of this specification.	Specify			
3.2.9.8f)	3.2.9 Table 1	f) Specify the CM and DM voltage values for the "Impulse Voltage Test 1.2/50us" test according to Table 1 for "Alarm contacts" of this specification.	Specify			
3.2.9.9	3.2.9 Table 1	Other Interfaces - RS 232 Serial				
3.2.9.9a)	3.2.9 Table 1	a) Specify the "Dielectric Withstand" voltages according to Table 1 for "RS 232 serial" of this specification.	Specify			
3.2.9.9b)	3.2.9 Table 1	b) Specify the "Impulse Voltage" values according to Table 1 for "RS 232 serial" of this specification.	Specify			
3.2.9.9c)	3.2.9 Table 1	c) Specify the "Insulation Resistance" values according to Table 1 for "RS 232 serial" of this specification.	Specify			

3.2.9.9d)	3.2.9 Table 1	d) Specify the CM voltage values for the "Damped oscillatory wave immunity test" according to Table 1 for "RS 232 serial" of this specification.	Specify			
3.2.9.9e)	3.2.9 Table 1	e) Specify the "Electrical fast/transient bursts" voltages according to Table 1 for "RS 232 serial" of this specification.	Specify			
3.2.9.9f)	3.2.9 Table 1	f) Specify the CM and DM voltage values for the "Impulse Voltage Test 1.2/50us" test according to Table 1 for "RS 232 serial" of this specification.	Specify			
3.2.9.10	3.2.9 Table 1	Other Interfaces - IRIG-B input				
3.2.9.10a)	3.2.9 Table 1	a) Specify the "Dielectric Withstand" voltages according to Table 1 for "IRIG-B input" of this specification.	Specify			
3.2.9.10b)	3.2.9 Table 1	b) Specify the "Impulse Voltage" values according to Table 1 for "IRIG-B input" of this specification.	Specify			
3.2.9.10c)	3.2.9 Table 1	c) Specify the "Insulation Resistance" values according to Table 1 for "IRIG-B input" of this specification.	Specify			
3.2.9.10d)	3.2.9 Table 1	d) Specify the CM voltage values for the "Damped oscillatory wave immunity test" according to Table 1 for "IRIG-B input" of this specification.	Specify			
3.2.9.10e)	3.2.9 Table 1	e) Specify the "Electrical fast/transient bursts" voltages according to Table 1 for "IRIG-B input" of this specification.	Specify			
3.2.9.10f)	3.2.9 Table 1	f) Specify the CM and DM voltage values for the "Impulse Voltage Test 1.2/50us" test according to Table 1 for "IRIG-B input" of this specification.	Specify			
3.2.9.11	3.2.9 Table 1	Other Interfaces - GPS Sync Input				
3.2.9.11a)	3.2.9 Table 1	a) Specify the "Dielectric Withstand" voltages according to Table 1 for "GPS Sync Input" of this specification.	Specify			
3.2.9.11b)	3.2.9 Table 1	b) Specify the "Impulse Voltage" values according to Table 1 for "GPS Sync Input" of this specification.	Specify			

3.2.9.11c)	3.2.9 Table 1	c) Specify the "Insulation Resistance" values according to Table 1 for "GPS Sync Input" of this specification.	Specify			
3.2.9.11d)	3.2.9 Table 1	d) Specify the CM voltage values for the "Damped oscillatory wave immunity test" according to Table 1 for "GPS Sync Input" of this specification.	Specify			
3.2.9.11e)	3.2.9 Table 1	e) Specify the "Electrical fast/transient bursts" voltages according to Table 1 for "GPS Sync Input" of this specification.	Specify			
3.2.9.11f)	3.2.9 Table 1	f) Specify the CM and DM voltage values for the "Impulse Voltage Test 1.2/50us" test according to Table 1 for "GPS Sync Input" of this specification.	Specify			
3.2.9.12	3.2.9	General				
3.2.9.12a)	3.2.9a)	a) Comply with clause 3.2.9a) of this specification	Comply			
3.2.9.12b)	3.2.9b)	b) Comply with clause 3.2.9b) of this specification	Comply			
3.2.9.12c)	3.2.9c)	c) Comply with clause 3.2.9c) of this specification	Comply			
3.2.9.12d)	3.2.9d)	d) Comply with clause 3.2.9d) of this specification	Comply			
3.2.9.12e)	3.2.9e)	e) Comply with clause 3.2.9e) of this specification	Comply			
3.2.10	3.2.10	IEC 61850 Standard Implementation				
3.2.10a)	3.2.10a)	a) Comply with clause 3.2.10a) of this specification	Comply			
3.2.10b)	3.2.10b)	b) Comply with clause 3.2.10b) of this specification	Comply			
3.2.10c)	3.2.10c)	c) Comply with clause 3.2.10c) of this specification	Comply			
3.2.10d)	3.2.10d)	d) Comply with clause 3.2.10d) of this specification	Comply			
3.2.10e)	3.2.10e)	e) Comply with clause 3.2.10e) of this specification	Comply			
3.2.10f)	3.2.10f)	f) Comply with clause 3.2.10f) of this specification	Comply			
3.2.10g)	3.2.10g)	g) Comply with clause 3.2.10g) of this specification	Comply			

3.2.10h)	3.2.10h)	h) Comply with clause 3.2.10h) of this specification	Comply			
3.2.10i)	3.2.10i)	i) Comply with clause 3.2.10i) of this specification	Comply			
3.2.10j)	3.2.10j)	j) Comply with clause 3.2.10j) of this specification	Comply			
3.2.10k)	3.2.10k)	k) Comply with clause 3.2.10k) of this specification	Comply			
3.2.10l)	3.2.10 Table 2	l) Confirm if the "ITPC class Loginal Node" is implemented in the IEC 61850 implementation on the Teleprotection Equipment	Comply			
3.3	3.3	General Requirements				
3.3.1	3.3.1	Housing of equipment and cabling facilities				
3.3.1a)	3.3.1a)	a) Comply with clause 3.3.1a) of this specification	Comply			
3.3.1b)	3.3.1b)	b) Comply with clause 3.3.1b) of this specification	Comply			
3.3.1c)	3.3.1c)	c) Comply with clause 3.3.1c) of this specification	Comply			
3.3.1d)	3.3.1d)	d) Comply with clause 3.3.1d) of this specification	Comply			
3.3.1e)	3.3.1e)	e) Comply with clause 3.3.1e) of this specification	Comply			
3.3.1f)	3.3.1f)	f) Comply with clause 3.3.1f) of this specification	Comply			
3.3.1g)	3.3.1g)	g) Comply with clause 3.3.1g) of this specification	Comply			
3.3.2	3.3.2	Drawings and Instruction Manuals				
3.3.2a)	3.3.2a)	a) Comply with clause 3.3.2a) of this specification	Comply			
3.3.2b)	3.3.2b)	b) Comply with clause 3.3.2b) of this specification	Comply			
3.3.2c)	3.3.2c)	c) Comply with clause 3.3.2c) of this specification	Comply			
3.3.2d)	3.3.2d)	d) Comply with clause 3.3.2d) of this specification	Comply			
3.3.2e)	3.3.2e)	e) Comply with clause 3.3.2e) of this specification	Comply			
3.3.2f)	3.3.2f)	f) Comply with clause 3.3.2f) of this specification	Comply			

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3.3.2g)	3.3.2g)	g) Comply with clause 3.3.2)g) of this specification	Comply			
3.3.2h)	3.3.2h)	h) Comply with clause 3.3.2)h) of this specification	Comply			
3.3.2i)	3.3.2i)	i) Comply with clause 3.3.2)i) of this specification	Comply			
3.3.2j)	3.3.2j)	j) Comply with clause 3.3.2)j) of this specification	Comply			
3.3.2k)	3.3.2k)	k) Comply with clause 3.3.2)k) of this specification	Comply			
3.3.2l)	3.3.2l)	l) Comply with clause 3.3.2)l) of this specification	Comply			
3.3.3	3.3.3	Tools, Test Equipment and Software				
3.3.3a)	3.3.3a)	a) Comply with clause 3.3.3)a) of this specification	Comply			
3.3.3b)	3.3.3b)	b) Comply with clause 3.3.3)b) of this specification	Comply			
3.3.3c)	3.3.3c)	c) Comply with clause 3.3.3)c) of this specification	Comply			
3.3.3d)	3.3.3d)	d) Comply with clause 3.3.3)d) of this specification	Comply			
3.3.3e)	3.3.3e)	e) Comply with clause 3.3.3)e) of this specification	Comply			
3.4	3.4	Tests				
3.4.1	3.4.1	Test Certificates				
3.4.1a)	3.4.1a)	a) Comply with clause 3.4.1)a) of this specification	Comply			
3.4.1b)	3.4.1b)	b) Comply with clause 3.4.1)b) of this specification	Comply			
3.4.1c)	3.4.1c)	c) Comply with clause 3.4.1)c) of this specification	Comply			
3.4.2	3.4.2	Witnessing of Tests				
3.4.2a)	3.4.2a)	a) Comply with clause 3.4.2)a) of this specification	Comply			
3.4.2b)	3.4.2b)	b) Comply with clause 3.4.2)b) of this specification	Comply			
3.4.3	3.4.3	Routine Tests				
3.4.3a)	3.4.3a)	a) Comply with clause 3.4.3)a) of this specification	Comply			
3.4.3b)	3.4.3b)	b) Comply with clause 3.4.3)b) of this specification	Comply			

3.4.3c)	3.4.3c)	c) Comply with clause 3.4.3)c) of this specification	Comply			
3.4.3d)	3.4.3d)	d) Comply with clause 3.4.3)d) of this specification	Comply			
3.4.3e)	3.4.3e)	e) Comply with clause 3.4.3)e) of this specification	Comply			
3.4.3f)	3.4.3f)	f) Comply with clause 3.4.3)f) of this specification	Comply			
3.4.3g)	3.4.3g)	g) Comply with clause 3.4.3)g) of this specification	Comply			
3.4.4	3.4.4	Type Tests				
3.4.4a)	3.4.4a)	a) Comply with clause 3.4.4)a) of this specification	Comply			
3.4.4b)	3.4.4b)	b) Comply with clause 3.4.4)b) of this specification	Comply			
3.4.4c)	3.4.4c)	c) Comply with clause 3.4.4)c) of this specification	Comply			
3.4.4d)	3.4.4d)	d) Comply with clause 3.4.4)d) of this specification	Comply			
3.4.4e)	3.4.4e)	e) Comply with clause 3.4.4)e) of this specification	Comply			
3.4.4f)	3.4.4f)	f) Comply with clause 3.4.4)f) of this specification	Comply			
3.4.4g)	3.4.4g)	g) Comply with clause 3.4.4)g) of this specification	Comply			
3.4.4h)	3.4.4h)	h) Comply with clause 3.4.4)h) of this specification	Comply			
3.4.4i)	3.4.4i)	i) Comply with clause 3.4.4)i) of this specification	Comply			
3.4.4j)	3.4.4j)	j) Comply with clause 3.4.4)j) of this specification	Comply			
3.4.4k)	3.4.4k)	k) Comply with clause 3.4.4)k) of this specification	Comply			
3.4.4l)	3.4.4l)	l) Comply with clause 3.4.4)l) of this specification	Comply			
3.4.4m)	3.4.4m)	m) Comply with clause 3.4.4)m) of this specification	Comply			
3.4.4n)	3.4.4n)	n) Comply with clause 3.4.4)n) of this specification	Comply			
3.4.4o)	3.4.4o)	o) Comply with clause 3.4.4)o) of this specification	Comply			

3.4.4p)	3.4.4p)	p) Comply with clause 3.4.4)p) of this specification	Comply			
3.4.4q)	3.4.4q)	q) Comply with clause 3.4.4)q) of this specification	Comply			
3.4.4r)	3.4.4r)	r) Comply with clause 3.4.4)r) of this specification	Comply			
3.4.4s)	3.4.4s)	s) Comply with clause 3.4.4)s) of this specification	Comply			
3.4.4t)	3.4.4t)	t) Comply with clause 3.4.4)t) of this specification	Comply			
3.4.4u)	3.4.4u)	u) Comply with clause 3.4.4)u) of this specification	Comply			
3.4.4v)	3.4.4v)	v) Comply with clause 3.4.4)v) of this specification	Comply			
3.4.4w)	3.4.4w)	w) Comply with clause 3.4.4)w) of this specification	Comply			
3.5	3.5	Marking, labelling and packaging				
3.5a)	3.5a)	a) Comply with clause 3.5)a) of this specification	Comply			
3.5b)	3.5b)	b) Comply with clause 3.5)b) of this specification	Comply			
3.5c)	3.5c)	c) Comply with clause 3.5)c) of this specification	Comply			
3.5d)	3.5d)	d) Comply with clause 3.5)d) of this specification	Comply			
3.5e)	3.5e)	e) Comply with clause 3.5)e) of this specification	Comply			
3.5f)	3.5f)	f) Comply with clause 3.5)f) of this specification	Comply			
3.5g)	3.5g)	g) Comply with clause 3.5)g) of this specification	Comply			
3.5h)	3.5h)	h) Comply with clause 3.5)h) of this specification	Comply			
3.5i)	3.5i)	i) Comply with clause 3.5)i) of this specification	Comply			
3.6	3.6	Spares				
3.6a)	3.6a)	a) Comply with clause 3.6)a) of this specification	Comply			
3.6b)	3.6b)	b) Comply with clause 3.6)b) of this specification	Comply			
3.6c)	3.6c)	c) Comply with clause 3.6)c) of this specification	Comply			
3.6d)	3.6d)	d) Comply with clause 3.6)d) of this specification	Comply			