Eskom	Standard	Technology

Title: **TELECONTROL REQUIREMENTS FOR RING MAIN UNITS**

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Compiled by	Approved by	Authorized by
George Daniel	**Steven Papadopoulos**	**Richard McCurrach**
Standards Implementation	**PTM&C Control and Automation Manager**	**Senior Manager PTM&C**
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Supported by SCOT/SC

M Sukhnandan.

Marlini Sukhnandan

SCOT/SC Chairperson

Date: 8/02/2016

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SCOT Study Committee Number/Name: **Telecontrol and SCADA Study Committee**

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1. Introduction

Providing visibility to the Ring Main Units (RMUs) and Miniature substations (Mini Subs) is essential for maximising the efficiency of the operational network. This standard document details the minimum telecontrol requirements to enable such visibility of RMUs and Mini Subs.

2. Supporting Clauses

2.1 Scope

This specification covers Eskom Distribution Division's telecontrol requirements for medium voltage metal-enclosed RMUs with integrated remote telecontrol which also applies to Mini Subs.

2.1.1 Purpose

The document aids the *Supplier* with the necessary telecontrol requirements for the RMUs. Furthermore, this document also applies to the Mini Subs.

2.1.2 Applicability

This document shall apply throughout Eskom Distribution.

2.2 Normative/Informative References

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

2.2.1 Normative

[1] 1815-2012 - IEEE Standard for Electric Power Systems Communications— Distributed Network Protocol (DNP3)

[2] DNP3 IED Certification Procedure Subset Level 2 Rev 2.6 20090315

[3] IEC 60870-2-2:1996, Telecontrol Equipment and Systems - Part 2: Operating Conditions – Section 2: Environmental Conditions (climatic, mechanical and other non-electrical influences)

[4] NRS 083-1:2007, Code of Practice for the Application of Electromagnetic Compatibility (EMC) Standards and Guidelines in Electricity Utility Networks – Equipment Standards

[5] SANS (IEC) 61000-4-4:2004, Electromagnetic compatibility (EMC): Testing and measurement techniques – Electrical fast transient/burst immunity test

[6] SANS 1507-2, Electric cables with extruded solid dielectric insulation for fixed installations (300/500 V to 1 900/3 300 V) Part 2: Wiring cables

[7] SANS 1874:2009, Switchgear – Metal-enclosed ring main units for rated A.C. voltages above 1 kV an up to and including 36 kV

[8] SANS 60947-2:2007, Low-voltage switchgear and control gear – Part 2: Circuit Breakers

[9] IEC 60898:2003, Electrical accessories – Circuit breakers for over-current protection for household and similar installations

[10] 32-9: Definition of Eskom documents

[11] 32-644: Eskom documentation management standard

[12] 240-75670959: Steering Committee of Technologies (SCOT): Operating Manual

[13] 240-70413291: Rev 1, Specification for Electrical Terminal Blocks

[14] 240-53114248: Rev 2, Thyristor and Switch Mode Chargers, AC/DC To DC/AC Converters and Inverter/Uninterruptible Power Supplies Standard

[15] DST_34-1299: Rev 1, Minimum Reliability and Capacity Requirements of Essential DC Power Supplies for Various Equipment at Distribution Sites

[16] 240-56030406: Free standing metal enclosed ring main units for systems with nominal voltages from 11kV to 33kV standard

[17] 240-56062752: Medium-Voltage Miniature Substation for systems with nominal voltages of 11 KV and 22 KV standard

[18] 240-86457202: Rev 1, DNP3 Device Acceptance Test Procedure

[19] 240-64038621: Rev 0, Remote Device Communication Standard for Data Retrieval and Remote Access

2.2.2 Informative

[20] 441-14-20 - International Electrotechnical Vocabulary

2.3 Definitions

2.3.1 General

Definition	Description
Circuit Breaker	A mechanical switching device, capable of making, carrying and breaking currents under normal circuit conditions and also making, carrying for a specified time and breaking currents under specified abnormal circuit conditions such as those of short circuit. [20].
Complementary 2-output Control	A control having two virtual or physical outputs namely trip and close. Each output is set active momentarily depending upon which command is received. [1].
Complementary Latch Control	A control having a single virtual or physical output that remains latched in an active or non-active state depending upon which command is received [1].
Data Terminal Equipment (DTE)	Equipment which serves as the source and/or destination point for transmitted data.
Switch-Disconnector	A mechanical switching device, capable of making, carrying and breaking load currents under normal circuit condition.

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
DC	Direct Current
DNP3	Distributed Network Protocol
DTE	Data Terminal Equipment
EFI	Earth Fault Indicator

Abbreviation	Description
EMC	Electromagnetic Compatibility
GPRS	General Packet Radio Service
I/O	Input/Output
IEC	International Electrotechnical Committee
IRTU	Integrated Remote Terminal Unit
LV	Low Voltage
MCB	Miniature Circuit Breaker
Mini Sub	Miniature Substation
PC	Personal Computer
PVC	Polyvinyl Chloride
RMU	Ring Main Unit
SCADA	Supervisory Control and Data Acquisition
SIM	Subscriber Identity Module
TIA	Telecommunications Industry Association
XML	eXtensible Markup Language

2.5 Roles and responsibilities

Not applicable.

2.6 Process for monitoring

Not applicable.

2.7 Related/supporting documents

Not applicable.

3. Requirements

The requirements listed hereunder, shall only apply to the telecontrol equipment embedded within the RMU and Mini Sub that facilitates supervisory control and data acquisition. Requirements listed in this document shall therefore in no way be interpreted so as to contradict the requirements listed in 240-56030406: Free standing metal enclosed ring main units for systems with nominal voltages from 11kV to 33kV standard or 240-56062752: Medium-Voltage Miniature Substation for systems with nominal voltages of 11 KV and 22 KV standard.

The term IRTU has been used in this document with an understanding that the primary equipment (RMU or Mini Sub) shall be supplied as a complete solution comprising both the primary equipment and the remote terminal unit.

3.1 Hardware requirements

3.1.1 Environmental Conditions

3.1.1.1 Class C3 or sheltered locations, with air temperatures from -40 °C to 70 °C, of the IRTU shall be applied in accordance with IEC 60870-2-2:1996.

3.1.1.2 The IRTURMU shall have been type tested in accordance with SANS (IEC) 61000-4-4:2004 Electromagnetic compatibility (EMC), Part 4-4: Testing and measurement techniques – Electrical fast transient/burst immunity test.

3.1.2 Power Supply

3.1.2.1 The IRTU shall be fed from a DC power supply source comprising of a standby battery and battery charger which is provided by the Supplier.

3.1.2.2 Mechanical switching of the switchgear shall in no way compromise the continuous supply of power feeding the IRTU during normal operating conditions.

3.1.2.3 The battery charger shall be able to perform temperature compensation of the batteries, where the output voltage is controlled in relation to the battery temperature to ensure that the batteries are optimally charged.

3.1.2.4 The AC input shall be internally protected against overload and short circuit by a suitably rated AC fuse. Similarly, the DC output shall be internally protected against overload and short circuit from the battery circuit by a suitably rated DC mains circuit breaker.

3.1.2.5 The battery charger shall be capable of recharging the battery from 0% to 80% of its capacity in a minimum of 15 hours while supplying the IRTU.

3.1.2.6 Provision shall be made for a 12 VDC output to supply Eskom free-issue communications devices.

3.1.2.7 The DC power supply source shall be sufficiently rated to cater for the following items during simultaneous operation:

a) IRTU

b) One free-issue communications device that draws 1A continuous and a maximum of 5A short duration with an input voltage range of 10VDC- 16VDC.

c) Power operation of RMU or Mini Sub switching devices (e.g. mechanism spring-charging motors or independent unlatched power operation of mechanisms – where applicable)

3.1.2.8 The battery shall be capable of supplying the loads as detailed in 3.1.2.7 for a 6 hour standby period during loss of the charger AC supply and shall not be discharged by more than 50% of its rated capacity.

3.1.2.9 An effort shall be made to conceal the battery to prevent vandalism and theft to the equipment.

3.1.3 Wiring and Circuit Terminations

3.1.3.1 DC supply to the IRTU shall be supplied through suitably rated MCBs for grading and isolation purposes.

3.1.3.2 The 12 VDC output supply specified in 3.1.2.6 shall be completely pre-wired using PVC-insulated multi-strand 600/1000 V cable, with a cross-sectional area of at least 2.5 mm2 and complies with the requirements of SANS 1507-2.

3.1.3.3 The 12 VDC supply specified in 3.1.2.6 shall be wired through to a spring-loaded insertion terminal blocks.

3.1.3.4 All terminal blocks shall comply with the requirements of 240-70413291: Rev 1, Specification for Electrical Terminal Blocks.

3.1.3.5 All MCB's shall comply to the requirements of SANS 60947-2:2007, Low-voltage switchgear and control gear – Part 2: Circuit Breakers and IEC 60898:2003, Electrical accessories – Circuit breakers for over-current protection for household and similar installations (Parts 1 and/or 2 as appropriate)

3.1.3.6 All MCB's shall be wired with the source supply at the top, and the load side at the bottom.

3.1.4 Communication Interfaces

3.1.4.1 The IRTU shall be equipped with the following to facilitate DNP3 data and preferably DNP3/IP communication:

a) A 100Base-Tx Ethernet port.

b) Two serial ports that is fully configurable for EIA-232 and EIA-485 with 2kV isolation. This EIA-232 and EIA-485 port shall support fully configurable hardware flow control.

3.1.4.2 The IRTU shall be equipped with a fully configurable EIA-232 serial port or a USB port to configure the IRTU. The EIA-232 port shall support fully configurable hardware flow control.

3.1.4.3 The IRTU shall be equipped with a 100Base-Tx Ethernet and preferably two 100Base-Fx (single mode) ports to configure the IRTU.

3.1.4.4 The EIA ports stated in 3.1.4.1 and 3.1.4.2 shall support baud rates from 2400 up to 115200 bits per second.

3.1.4.5 All communication interfaces shall be easily accessible and sufficient space shall be made available to connect the appropriate interface cable.

3.1.4.6 The EIA-232 interface cable for 3.1.4.1 and 3.1.4.2 and 100Base-Tx Ethernet interface cable shall be provided by the Supplier.

3.1.4.7 All equipment interfaces shall be accompanied by full documentation.

3.1.5 External Antenna

3.1.5.1 The RMU shall allow for an Eskom free-issue antenna to be mounted external to the RMU or the Mini Sub.

3.1.5.2 Provision for concealed routing of the antenna cable shall be provided.

3.1.5.3 Entry and exit holes on any metal part of the RMU or Mini Sub for antenna connections shall be bottom-entry only. A 20mm diameter secured knock-outs shall be provided for cable glands.

3.1.6 Additional Mounting Space

3.1.6.1 A DIN rail mounting plate shall be provided by the Supplier, on which to mount the Eskom free-issue data communications device with dimensions as indicated in Table 1 below.

3.1.6.2 Sufficient space shall be provided to mount the communication device such that the devices status indication lights are at all times clearly visible (after opening the relevant enclosure).

Table 1: Dimensions of communication device

Measurand	Length (millimetres)
Width	151
Height	190
Depth	50

3.1.7 Real-time Clock

3.1.7.1 A real-time clock shall be available and have the capability of being synchronised by the master station using the DNP3 protocol.

3.1.7.2 The real-time clock shall not lose its synchronised time when the IRTU is restarted.

3.1.7.3 The real-time clock shall have a timestamp resolution of 10ms or better.

3.1.7.4 The real-time clock battery shall provide at least 7 days of total standby time.

3.1.7.5 The battery should not need replacing more often than every 10 years under normal operating conditions.

3.1.7.6 It is preferable if Simple Network Time Protocol over Ethernet is also available.

3.1.8 DNP3 Security

3.1.8.1 If DNP3/IP is supplied then the Supplier shall comply with the DNP3 Secure Authentication functionality as documented in [1] IEEE1815-2012, Chapter 7.

3.1.8.2 If DNP3/IP is supplied and does not support the DNP3 Secure Authentication currently, the Supplier shall ensure that all mandatory requirements as per [1] IEEE1815, Chapter 7 is successfully implemented within the Development Phase of the contract.

3.1.8.3 If DNP3/IP is supplied Supplier shall specifically indicate what security optional requirements as per [1] IEEE1815 have been implemented contract.

3.2 Software Requirements

3.2.1 PC Configuration Software

The IRTU shall be supplied with configuration software that meets the following requirements:

3.2.1.1 The software shall be compatible with Microsoft Windows 7 64 bit.

3.2.1.2 The software shall provide the facility to save and retrieve configuration files to and from the disk. It is preferred to have the configuration files in a Comma-separated values (CSV) format.

3.2.1.3 All software supplied with the system shall be documented.

3.2.1.4 A list of minimum computer hardware requirements shall be provided.

3.2.1.5 The Supplier shall provide release notes of new firmware and only Eskom approved firmware to be installed in the IRTU.

3.2.1.6 The Tenderer shall supply all terms and conditions related to the distribution of the software in the offer.

3.2.2 IRTU Configuration

3.2.2.1 Configuration parameters sent to the IRTU shall be stored in non-volatile memory,

3.2.2.2 Configuration parameters sent to the IRTU shall take effect once the new parameters are perceived as being valid.

3.2.3 Event Logging

3.2.3.1 The IRTU shall store at least 50 real-time clock events in non-volatile memory to allow for post event processing.

3.2.3.2 The IRTU shall allow for event data to be downloaded from the IRTU using the PC software configuration tool.

3.3 Telecontrol Protocol

3.3.1 Level 2 DNP3 Implementation

3.3.1.1 Both unsolicited report-by-exception and polled report-by-exception shall be supported.

3.3.1.2 Mechanisms to resolve network medium contention shall be supported. Details of the channel contention algorithm shall be provided.

3.3.1.3 The IRTU slave implementation of DNP3 shall meet the Level 2 DNP 3 implementation as stipulated in IEEE 1815-2012.

3.3.1.4 The Tenderer shall provide all relevant information on their DNP3 implementation, including the DNP3 device profile, clearly defining what objects, function codes and qualifiers contained in the subset are not supported. It shall also be indicated which technical bulletins have been implemented in the device. Any deviations from the subset shall be clearly documented in the proposal.

3.3.1.5 Event count and event delays for class 1, 2, 3 DNP3 messages shall be configurable per index point.

3.3.1.6 Unsolicited event retry cycles parameters shall be configurable.

3.3.1.7 XML representation of the DNP3 device profile is preferred to be supported and provided by the Tenderer for testing.

3.3.1.8 Proof of independent testing and verification of Level 2 protocol functionality shall be provided with the tender submission furthermore, Level 2 testing from an accredited DNP3 user group test facility shall also be submitted.

3.3.1.9 Proof of support of at least two masters using any combination of serial port and Ethernet port shall be provided.

3.3.2 DNP3 Data Maps (General)

3.3.2.1 The DNP3 data maps shall be fully configurable through software.

3.3.2.2 The IRTU shall support individual DNP3 class assignment.

3.3.2.3 Binary inputs shall be time-stamped with an accuracy of 10ms or better.

3.3.2.4 The IRTU shall provide the ability to invert the status of individual binary input points through the PC configuration software.

3.3.2.5 The IRTU shall support both Direct Operate and Select-Before-Operate DNP3 type controls.

3.3.3 DNP3 Data Maps (Binary Inputs)

3.3.3.1 Status indications shall be provided for all switching devices of the relevant switchgear functional units.

3.3.3.2 Indications provided for the switching devices shall be double bit to indicate switchgear fully opened, switchgear fully closed and switchgear transit states.

3.3.3.3 A single local supervisory isolation switch shall be provided to disable all SCADA controls. An alarm shall be reported to indicate when this switch is in the “Supervisory OFF” position when the controls are isolated.

3.3.3.4 Alarms shall be reported for any abnormality that is associated with the IRTU, i.e. power supplies and battery charger as detailed in Table 2. Details of which shall be supplied by the Tenderer at the tender stage.

3.3.3.5 Alarms shall be reported to indicate switchgear unhealthy conditions. These are conditions which could prevent any of the switchgear from operating safely and correctly. The Tenderer shall provide details of these conditions at tender stage.

3.3.3.6 Binary indication inputs that can sense the state of a potential free contact shall be provided as indicated in Table 2. The IRTU should therefore have the ability to sense and report, via the communications protocol, the status of an external third-party device such as an earth fault indicator, temperature monitor, etc. Suppliers shall provide information about these inputs such as the wetting voltage and how that voltage source is derived etc. at tender stage.

3.3.3.7 The charger AC supply fail alarm shall have a delay of 120s before it is reported and a 20s delay before a de-asserted state of AC alarm is reported. This is to avoid chattering alarms when power goes on and off.

3.3.3.8 The indications and alarms as discussed above are tabulated below and shall apply where applicable.

Table 2: Requirements for remote indications and alarms

Item	Status	Remarks
Switch-disconnector	Switch-disconnector Open/Closed	Applied per switch-disconnector
	Switch-disconnector Earthed/Unearthed	Applied per switch-disconnector
	Switch-disconnector Not Healthy	Applied per switch-disconnector
Switch-fuse combination	Switch-fuse combination Open/Closed	Applied per switch-fuse combination
	Switch-fuse combination Earthed/Unearthed	Applied per switch-fuse combination
	Fuse-operated indication	Applied per switch-fuse combination
Circuit-breaker	Circuit breaker Open/Closed	Applied per circuit breaker
	Circuit breaker Earthed/Unearthed	Applied per circuit breaker
	Circuit breaker Not Healthy	Applied per circuit breaker
	Protection trip	Applied per circuit breaker
	Protection Relay Fail (RFI)	Applied per circuit breaker
Remote alarms	Door Open	
	Supervisory Isolate Switch OFF	
	Auxiliary AC Supply Fail	
	Battery Charger Fail	
	DC Low	
	SF6 Gas Low	
	Earth Fault Indicator Operated	From external hardwired EFI
	TRFR Temperature Trip	For miniature substation
	Spare	
	Spare	
	Spare	
	Spare	

3.3.4 DNP3 Data Maps (Binary Outputs)

3.3.4.1 To facilitate network automation, binary outputs that allow for remote control over all components of switchgear shall be made available.

3.3.4.2 The minimum requirements for controls are tabulated below in Table 3 and shall apply where applicable.

Table 3: Requirements for binary outputs

Item	Control	Remarks
Switch-disconnector	Switch disconnector Open/Close	Complementary 2-output control
Switch-fuse combination	Switch of switch-fuse combination Open/Close	Complementary 2-output control
Circuit breaker	Circuit breaker Open/Close	Complementary 2-output control

3.3.5 DNP3 Data Maps (Analogue Inputs)

3.3.5.1 Analogue inputs, from slave DNP3 Level 2 devices, shall be supported by the IRTU via the EIA-232 and EIA-485 communication interfaces of 3.1.4.1.

3.4 Documentation

3.4.1 Technical Manuals

The following technical manuals shall be submitted.

3.4.1.1 Hardcopy and softcopy manuals covering all components applied in the IRTU, i.e. charger, power supplies, RTU and its configuration software, etc.

3.4.1.2 The I/O point DNP3 database assignments

3.4.1.3 Detailed schematics of the IRTU and associated subsystems shall be provided

3.5 Tests

a) The successful Suppliers will be required to demonstrate the basic operation of the IRTU to Eskom SCADA using the free issued communication equipment before being awarded a contract for supply to Eskom.

b) All equipment shall undergo thorough functional and performance testing at the contractor's premises by representatives from Eskom after awarding the contract and before delivery of any units to Eskom.

c) Test equipment to test all functionality as specified shall be made available during testing.

3.6 Marking, Labelling and Packaging

a) See 240-56030406: Free standing metal enclosed ring main units for systems with nominal voltages from 11kV to 33kV standard.

b) 240-56062752: Medium-Voltage Miniature Substation for systems with nominal voltages of 11 KV and 22 KV standard.

4. Authorization

This document has been seen and accepted by:

Name and surname	Designation
Busi Green	Gx Representative
Colin Charles	WCOU SI
Danie Du Plessis	Tx Grid Representative
Ian Naicker	Chief Engineer: PTM&C – Control and Automation
Jason Hector	Senior Engineer: PTM&C – Control and Automation

Name and surname	Designation
Kashveer Jagdaw	KZNOU SI
Kenneth Brown	Senior Engineer: PTM&C Control & Automation
Niel Myburgh	FSOU SI
Simphiwe Mbanga	ECOU SI
Tertius Hyman	Engineer: Distribution - WCOU
Thendo Ramulondi	LOU SI
Thys Moller	GM Distribution
Tjaart Van Der Walt	NCOU SI

5. Revisions

Date	Rev	Compiler	Remarks
Feb 2016	1	G Daniel	Document DSP_32-2123 is replaced by new number 240-97690165 Clause 2 of document DSP_32-2123: Replaced DNP3 Spec with 1815-2012 - IEEE Standard for Electric Power Systems Communications—Distributed Network Protocol (DNP3) Clause 4.1.2.4 of document DSP_32-2123: Replaced fuse with MCB Clause 4.1.2.7 of document DSP_32-2123: Increased current rating to 5 A Clauses from document DSP_32-2123: Removed 4.1.2.8, 4.1.2.9, 4.1.2.10, 4.1.5.3, 4.1.6.3, 4.2.1.2, 4.2.1.4, 4.2.1.6 and 4.3.3.2 Clause 4.3.2.3 of document DSP_32-2123: Changes accuracy from 1ms to 10ms. Clause 4.5b of document DSP_32-2123: was removed 100baseT Ethernet port included for configuration and DNP3 communication Included interface cables to be provided by the *Supplier* Included configurable parameters for DNP3 Included Analogue Inputs via the EIA ports Included real-time clock 120s delay included for AC Fail before it is reported.

Date	Rev	Compiler	Remarks
July 2012	0	F Ismail	New document number DSP_32-2123 Addressed comments received Added 2 DC documents Added temperature compensated charging clause and overcurrent protection clause Support for configurable flow control added Sizes increased to accommodate UHF radio Simplified numbering True double bit switch indication requirement added.

6. Development team

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

- Peter Almeida - Standards Implementation GOU
- George Daniel - Standards Implementation GOU

7. Acknowledgement

Not applicable