Eskom	Standard	Technology

Title: **Requirements for Wiring of Outdoor Circuit Breakers up to and including 132kV Standard**

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Date: 09/04/2021

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

1	A specific plant, project or solution	
2	A mature and stable technical area/technology	x
3	Established and accepted practices.	x

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1. INTRODUCTION

Control and auxiliary circuit design and wiring requirements have traditionally been included in each equipment specification with sometimes contradictory and opposing requirements between these specifications. The aim of this document is to ensure a standardised approach and philosophy for the design and wiring of outdoor switchgear control and auxiliary circuits. It was decided that the wiring requirements for indoor application and outdoor application would be split into two separate documents.

2. SUPPORTING CLAUSES

2.1 SCOPE

This is a national standard covering the design philosophies for control and auxiliary circuits as well as the requirements for the wiring and terminal numbering of all types of outdoor switchgear and, where applicable, associated instrument transformers. This standard is applicable to all:

- outdoor circuit-breakers used in systems having nominal operating voltages from 6.6 kV up to and including 132 kV where the protection scheme pertaining to the circuit-breaker is housed at a remote location to the circuit-breaker, usually in a control room.
- outdoor mixed technology (hybrid) switchgear including circuit-breakers, disconnectors, earthing switches and CTs – used in systems having nominal operating voltages from 44 kV up to and including 132 kV where the protection scheme and metering panel pertaining to the switchgear are housed at a remote location to the switchgear, usually in a control room
- outdoor kiosk circuit-breakers with integrated CTs used in systems having nominal operating voltages from 6.6 kV up to and including 33 kV where the protection scheme and metering panel pertaining to the circuit-breaker are housed at a remote location to the circuit-breaker, usually in a control room.

NOTE: Live-tank and dead-tank type outdoor switchgear are covered by this standard.

2.1.2 Purpose

See 2.1 *Scope* above.

2.1.3 Applicability

This document shall apply throughout Eskom Holdings Limited Divisions.

2.2 NORMATIVE/INFORMATIVE REFERENCES

2.2.1 Normative

Eskom Standards:

[1] DSP 32-308, Distribution Standard Part 17: Specification for metering and measurements panel wiring.

[2] DSP 34-253, Distribution Standard Part 15: Distribution specification for electrical terminal blocks.

[3] DSP 34-1687, Distribution Standard Part 7: Specification for 11 kV, 22 kV and 33 kV outdoor kiosk circuit-breakers.

[4] 240-56063756 Outdoor Circuit Breakers for System with Nominal Voltages from 6.6kV Up To and Including 765kV

IEC Standards:

[5] IEC 60617-2, Graphic symbols for diagrams - Part 2: Symbol elements, qualifying symbols and other symbols having general application.

[6] IEC 60617-8, Graphic symbols for diagrams - Part 8: Measuring instruments, lamps and signalling devices.

[7] IEC 60898-1, Electrical accessories - Circuit-breakers for overcurrent protection for household and similar installations - Part 1: Circuit-breakers for a.c. operation.

[8] IEC 60898-2, Electrical accessories - Circuit-breakers for overcurrent protection for household and similar installations - Part 1: Circuit-breakers for a.c. and d.c. operation.

SANS Standards:

[9] 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.

[10] SANS 1507-3, Electric cables with extruded solid dielectric insulation for fixed installations (300/500 V to 1 900/3 300 V) – Part 3: PVC distribution cables.

[11] SANS 60050-441, International electrotechnical vocabulary Chapter 441: Switchgear, controlgear and fuses SANS 60529, Degrees of protection provided by enclosures (IP Code).

[12] SANS 60947-2, Low-voltage switchgear and controlgear – Part 2: Circuit-breakers.

[13] SANS 60947-4-1, Low-voltage switchgear and controlgear – Part 4-1: Contactors and motor-starters – Electromechanical contactors and motor-starters.

[14] SANS 62271-1, High-voltage switchgear and control gear - Part 1: Common specifications.

[15] SANS 62271-100, High-voltage switchgear and control gear - Part 100: High voltage alternating-current circuit-breakers.

[16] SANS 62271-102, High-voltage switchgear and control gear - Part 102: High-voltage alternating current disconnectors and earthing switches.

Eskom Drawings:

[17] D-DT-5407 – Various sheets

[18] D-DT-5414 – Control Plant Cell Library (CC)

NOTE: When an enquiry is issued based on this standard, the editions of the normative references that are current at the date of issue of the enquiry shall apply, unless otherwise agreed with Eskom. However in special cases, the responsible engineer may rule that the editions of one or more normative references applicable at the effective date of the Eskom standard shall apply.

2.2.2 Informative

None

2.3 DEFINITIONS

The definitions given in SANS 60050-441 and the following shall apply

Definition	Description
Spring limit switch	A limit switch that is operated by the moving circuit-breaker mechanism spring when it reaches a predetermined position

2.3.1 Disclosure Classification

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

2.4 ABBREVIATIONS

Abbreviation	Description
AIS	Air Insulated Switchgear
CB	Circuit-breaker
CT	Current Transformer
GIS	Gas Insulated Switchgear
SLS	Spring Limit Switch

2.5 ROLES AND RESPONSIBILITIES

None

2.6 PROCESS FOR MONITORING

None

2.7 RELATED/SUPPORTING DOCUMENTS

None

2.8 KEYWORDS

wiring, outdoor circuit-breakers, auxiliary circuits, control circuits

3. REQUIREMENTS FOR WIRING OF OUTDOOR CIRCUIT BREAKERS UP TO AND INCLUDING 132KV STANDARD

3.1 GENERAL

a. The requirements for control and auxiliary circuits shall be in accordance with the relevant parts of SANS 62271-1, SANS 62271-100, SANS 62271-102 and the requirements of this standard. Where conflicting requirements exist, the requirements of this standard shall take precedence.

b. The convention applied to schematic wiring diagrams and the requirements of this standard shall be that limit switches, pressure switches, relay contacts etc. are shown assuming the following reference conditions:

- circuit-breaker main contacts are open;
- springs are discharged;
- gas compartments are without pressure (where applicable);
- relay coils are de-energised;
- no a.c. or d.c. supplies are connected;
- earthing switches not applied (where applicable); and
- disconnectors in the closed position (where applicable).

The schematic wiring diagrams submitted to Eskom for approval shall comply with this convention and shall state it on the drawings.

c. The interface for all internal switchgear wiring to Eskom shall be via terminal strips X1 and X2 in accordance with D-DT-5407. All terminal strips shall be located in the mechanism enclosure.

d. In case where the design of the switchgear makes use of multiple mechanisms to operate the individual poles (e.g. single pole operated three mechanism circuit-breakers), the mechanisms shall be wired in a master-to-slave configuration. The connections between the slave mechanisms and the master mechanism shall be pre-wired and tested in the factory. The central operating mechanism enclosure (master) shall form the single access point for the Eskom control cables from remote equipment.

NOTE: Eskom will connect all control cables to the master mechanism enclosure.

e. The closing and opening devices (coils), mechanism motors and motors contactor coils to be supplied with the switchgear shall be suitable for operation at either 110 V d.c. or 220 V d.c. as specified in schedule A of the relevant equipment specification. It shall be possible to change the d.c. control voltage at which the switchgear operates by only replacing the opening and closing coils, mechanism motors and motor contactor coils.

NOTES:

- Switchgear shall only be required to operate at one d.c. control voltage i.e. the closing and opening devices; mechanism motors and motor contactor coils to be supplied with the switchgear are required to be suitable for operation at either 110 V d.c. or 220 V d.c. as specified in the relevant equipment specification.
- The default rated d.c. supply voltage is 110 V.
- The use of resistors to achieve voltage reduction of the control voltage is not acceptable.
- Unless specifically stated in the specific switchgear tender, it will be assumed that the unit prices of the switchgear will remain the same irrespective of the d.c. control voltage.

f. All d.c. MCBs shall be rated for use on 220 V d.c. systems (i.e. rated at 250 V d.c.).

g. The 110 V or 220 V d.c. and 230 V a.c. power supplies required for the switchgear will be provided by Eskom via the terminals allocated in accordance with D-DT-5407.

h. Power supplies will be provided from the protection schemes located in the control room. The protection schemes include a 5 A (curve C) 2-pole or 1-pole and neutral MCB for a.c. circuit protection and a 20 A (curve C) 2-pole MCB for d.c. circuit protection. The MCBs are in accordance with SANS 60947-2. Any additional MCBs provided for switchgear LV circuit protection or isolation shall discriminate with these upstream MCBs. Provision shall be made for each sub-circuit dedicated to a particular function (e.g. heater circuit, racking motor circuit, mimic indication circuits, spring charging control circuit, etc.) to be locally isolated from the incoming supply without the need to disconnect any wires.

i. MCBs shall comply with the requirements of SANS 60947-2 and IEC 60898 (Parts 1 and/or 2 as appropriate). In particular:

- breaking capacities shall be in accordance with IEC 60898 ($_{Icn/Ics}$) and SANS 60947-2 (Icu = Ics) and shall be at least 5 kA;
- the utilisation category shall be ‘A’ (SANS 60947-2);
- the maximum service voltage shall be at least VN + 20%;
- the pollution degree shall be ‘3’ or higher (SANS 60947-2);
- the MCB shall be suitable for isolation (SANS 60947-2); and
- the protection curve shall be ‘C’ (SANS 60947-2 and IEC 60898).

j. All MCBs shall be wired with the source supply at the top, and the load supply at the bottom. Where MCBs are polarity sensitive, polarity markings shall be provided on the front of the MCB in accordance with IEC 60898-2. Additionally, the manufacturer shall provide their schematic wiring diagrams indicating the correct wiring polarity with the source supply at the top.

k. Motor contactors shall comply with SANS 60947-4-1, and shall be rated to break the maximum motor current.

3.2 CIRCUIT-BREAKER SPRING CHARGING MOTOR CONTROL CIRCUITS

a. The motor control circuit shall include thermal overload and short-circuit protection via a suitably rated MCB. Refer to clause 3.8 for alarm contact requirements.

b. Motor control contactors shall be provided in all cases and contactor coils shall have their current interrupted by the spring limit switches (normally-closed spring limit switch contact).

c. The spring charging motor shall be suitable for operating at any d.c. voltage between 85 % and 110 % of the nominal control voltages measured at the device terminals. The maximum continuous current drawn by the spring charging motor (per mechanism) shall be 10 A for circuit-breakers up to and including 132 kV. The spring charging time shall not be greater than 10 s. The motor starting current shall be less than 3 times the continuous current rating with a duration not greater than 100 ms.

d. The motor control circuit shall include protection against continual motor running (over-run) in case of a mechanical failure of the mechanism (e.g. by the interrupting of motor supply after a predetermined time). The specific method used to achieve this requirement shall be indicated on the schematic wiring diagrams submitted to Eskom. All contacts in motorised controls shall be capable of interrupting the maximum current drawn by the device being operated in their respective branch of the circuit.

e. Automatic re-charging of closing springs shall be provided by means of an interlock arranged via a normally-closed spring limit switch contact.

f. In addition to the spring limit switch contacts required for motor control, spare contacts of the type and quantity specified in D-DT-5407 shall be provided. One of the normally-open spring limit switch contacts may be used for sequential starting of spring charging motors in the other poles or circuit-breakers. The rating of this contact shall be adequate for such duty. If the rating of this contact is not adequate, a control contactor that is under command of this contact shall be provided.

g. In the case of motor control circuits for multiple mechanism breakers, sequential re-charging of springs shall be applied to limit the maximum simultaneous current drawn by the motors.

3.3 MOTORISED DISCONNECTOR AND EARTHING SWITCH MOTOR CONTROL CIRCUITS (WHERE APPLICABLE)

a. The switchgear shall be provided with disconnector and earthing switch motor control circuits that accept pulsed operating (e.g. open/close) signals and which ensure that the required operation is fully completed.

b. The pulsed operating signals are provided via a remote switch interfaced via terminals which shall be provided in accordance with D-DT-5407.

c. The motor control circuit shall include thermal overload and short-circuit protection via a suitably rated MCB. Refer to clause 3.8 for alarm contact requirements.

d. Motor control contactors shall be provided in all cases.

e. The motor shall be suitable for operating at any d.c. voltage between 85 % and 110 % of the nominal control voltages measured at the device terminals.

f. The motor control circuit shall include protection against continual motor running (over-run) in case of a mechanical failure of the mechanism (e.g. by the interrupting of motor supply after a predetermined time). The specific method used to achieve this requirement shall be indicated on the schematic wiring diagrams submitted to Eskom. All contacts in motorised controls shall be capable of interrupting the maximum current drawn by the device being operated in their respective branch of the circuit.

3.4 CIRCUIT-BREAKER CONTROL CIRCUITS

3.4.1 Closing control circuit

a. Shunt closing coils shall be suitable for operating at any d.c. voltage between 85 % and 110 % of the nominal control voltages measured at the coil terminals.

b. The circuit-breaker shall close correctly when an electrical closing pulse of 100 ms duration is applied to the closing coil.

c. When closing all phases simultaneously, the total power drawn by the closing coil(s) of the circuit-breaker shall not exceed 500 W for three-pole operated single mechanism circuit-breakers and 1500 W for single-pole operated three mechanism circuit-breakers (i.e. 500 W per mechanism) unless otherwise approved.

d. For closing coils rated less than 200 W, the closing coils shall not operate if a 10 µF capacitor, charged to 1,5 times the nominal d.c. control voltage, is discharged through the closing coil. The closing coils shall have an L/R time constant of less than 20 ms.

e. Each closing coil shall be wired in series with the following contacts:

- a normally-closed control contact, to allow closing only when the circuit-breaker is open.
- a normally-open spring limit switch contact to prevent damage to the closing coil if a sustained closing pulse is applied when the closing springs are not fully charged.

f. Closing coils shall be clearly marked with the manufacturer's name and part number. The manufacturer shall submit data sheets indicating the operating voltage, current and actual resistance value at 20 °C.

3.4.2 Tripping control circuits

a. Shunt tripping coils shall be suitable for operation at any d.c. voltage between 70 % and 110 % of the nominal voltages, measured at the coil terminals. Satisfactory operation shall be possible at, but not lower than, 70 % of the nominal supply voltage measured at the coil terminals.

b. Each circuit-breaker shall be equipped with two shunt-tripping coils and associated electrical tripping control circuits. The two tripping control circuits shall be electrically and physically separated in order to allow for independent control systems to be applied to each system. Neither tripping coil shall influence the operation of the other if one is damaged. Tripping coils shall not have a particular polarity, nor shall they affect operation when energised simultaneously.

c. The tripping control circuits shall be monitored individually. The tripping coils shall be rated to carry a continuous 20 mA d.c. current for monitoring purposes without overheating or burning out.

d. When tripping all phases simultaneously, the total power drawn by the tripping coil(s) of the circuit-breaker shall not exceed 500 W for three-pole operated single mechanism circuit-breakers and 1500 W for single-pole operated three mechanism circuit-breakers (i.e. 500 W per mechanism) unless otherwise approved.

e. For tripping coils rated less than 200 W, the tripping coils shall not operate if a 10 µF capacitor, charged to 1,5 times the nominal d.c. control voltage, is discharged through the tripping coil. The tripping coils shall have an L/R time constant of less than 20 ms.

f. A normally-open auxiliary switch control contact shall be provided in series with the tripping coil to interrupt the tripping control circuit current when the circuit-breaker is open. Duplicate normally-open contacts shall be provided for each tripping control circuit.

g. Tripping coils shall be clearly marked with the manufacturer's name and part number. The manufacturer shall submit data sheets indicating the operating voltage, current and actual resistance value at 20 °C.

3.4.3 Anti-pumping

All circuit-breakers shall be equipped with anti-pumping circuitry to prevent repeated tripping and closing of a circuit-breaker in the event that the tripping and closing pulses are sustained. Anti-pumping arrangements shall be subject to Eskom's written approval and shall be demonstrated as part of the routine and site-testing procedures. The anti-pumping control relay shall continue to operate at a supply voltage below the minimum operating voltage of the closing coil.

3.5 HEATER CONTROL CIRCUITS

a. Suitably rated electric heaters shall prevent moisture from condensing and being deposited inside the mechanism enclosures. Heaters shall maintain a dew-point greater than the ambient temperature and shall circulate the air constantly to all parts of the enclosure.

b. The heaters shall be permanently connected and shall not be de-energized when the switchgear is in service.

c. Heaters shall be placed to avoid damage to temperature-sensitive components. Heater elements shall be shrouded and leads, which are heated by the conduction of heat from the element, shall be insulated by heat-resistant insulating material, e.g. ceramic beads or silicone rubber.

d. The electrical supply for heaters shall be single-phase 230 V a.c.

e. The total power drawn by heaters shall not exceed 400 W (per mechanism enclosure), unless otherwise approved. Where multiple heaters are applied the first 100 W shall be permanently connected. The heater power drain larger that 100 W shall be switched via a pre-set thermostat or humidistat to prevent the mechanism enclosure from overheating.

f. Heater circuits shall not be equipped with local isolating switches, but shall be protected by a single-pole and neutral MCB with gang operation of the two poles.

g. The heaters shall be equipped with suitable temperature-activated alarm contacts to indicate failure thereof or loss of supply to the heater circuit. The heater fail alarm shall be wired to terminals in accordance with D-DT-5407. Refer to clause 3.8 for alarm contact requirements.

h. A readily accessible (i.e. without the need to remove external packaging) 230 V a.c. external temporary supply connection point for the heater circuit during storage shall be provided and wired to the Eskom side of the terminal strip in the factory. This shall consist of an electrical cord wired to a screw-type connection block for the connection of the temporary a.c. supply used during storage. No internal wiring should need to be modified to remove the temporary supply leads.

3.6 ANCILLARY FUNCTIONS

3.6.1 DC isolation control switch

All circuit-breakers and motorised disconnectors/earthing switches shall be fitted with a d.c. isolation control switch that will isolate all tripping/opening and closing pulses coming in externally to the switchgear. The d.c. isolation control switch shall isolate the d.c. supply to the spring charging motor control circuit, but shall not isolate the remaining d.c. circuits in the switchgear. This control switch shall be labelled as follows:

OFF Maintenance Position	**ON** In-service Position

When the control switch is in the “OFF/Maintenance Position” this condition is to be alarmed to the switchgear common alarm terminals provided in accordance with D-DT-5407 (for circuit-breaker not healthy indication). Refer to clause 3.8 for alarm contact requirements.

3.6.2 Auxiliary switches

a. Auxiliary switches shall faithfully reproduce the main contact position. In addition to the auxiliary switch control contacts required for control interlocking, the number and type of auxiliary contacts required for each mechanism shall cover the requirement specified in D-DT-5407. Each auxiliary circuit indicated in D-DT-5407 shall be independent of one another (i.e. changeover contacts shall not be used). Auxiliary switch contacts shall reproduce main contact timing to acceptable limits approved by Eskom. If possible, auxiliary contact timing shall permit adjustment within limits to be provided by the supplier at the time of tendering.

b. All spare auxiliary contacts shall be wired independently to the terminals in accordance with D-DT-5407. The use of auxiliary relays to multiply the number of auxiliary contacts is not acceptable.

c. Auxiliary switch contacts shall be protected against ingress of dust particles to degree IP 55 in accordance with SANS 60529. Where Eskom considers it necessary, dust guards shall be fitted at no extra cost. Cascading of auxiliary switches via mechanical means is acceptable provided that mechanical endurance testing has been satisfactorily carried out. Proof of this shall be submitted at the tendering stage.

d. For single-pole operated circuit-breakers, the first two sets of normally-open and first two sets of normally-closed auxiliary switch contacts of each phase shall be wired in series and in parallel respectively, to the terminals in accordance with D-DT-5407, in order to provide for a common switchgear open/close status indication. The remaining sets of normally-open and normally-closed auxiliary switch contacts for each phase shall be wired separately to the terminals.

3.6.3 Spring limit switches (SLS)

a. Spring limit switches shall faithfully reproduce the charge status of the mechanism spring. In addition to the spring limit switch contacts required for control interlocking, the number and type of spring limit switch contacts required for each mechanism shall cover the requirement specified in D-DT-5407.

b. A normally-open spring limit switch contact of each mechanism shall be used to block an electrical close operation.

c. The use of auxiliary relays to multiply the number of spring limit switch contacts required is not preferred but can be done if sufficient physical spring limit switch contacts cannot be provided.

d. For single pole operated circuit-breakers the first set of normally-open and normally-closed spring limit switch contacts of each phase shall be wired in series to the terminals in order to provide for a common spring limit status indication. The remaining sets of normally-open and normally-closed spring limit switch contacts for each phase shall be wired separately to the terminals.

3.6.4 Condition monitoring contacts

a. A normally-open auxiliary contact shall be provided for the purposes of condition monitoring. This contact shall faithfully reproduce the main contact position.

b. The condition monitoring contacts shall be wired to the terminals provided in accordance with D-DT-5407.

3.6.5 Auxiliary and control relays

All auxiliary and control relays shall be standard products that are freely available on the commercial market and shall be labelled in accordance with the schematic wiring diagram for the circuit-breaker. The location of the label shall be on the backing plate where the relays are fixed in order to retain the labelling should the relay be changed during the switchgear's lifetime.

3.6.6 Operation counters

a. Each circuit-breaker shall be provided with an operation counter that is advanced each time the circuit-breaker main contacts open. Mechanical operation counters are preferred, but electrical counters are also acceptable. The circuit-breaker operation counter shall be non-resettable.

b. The counter shall have a minimum capability of counting up to 99 999 operations. The supplier shall submit full details of the operation counter on request by Eskom.

3.7 CIRCUIT-BREAKER CONTROL CIRCUIT INTERLOCKS

3.7.1 Spring charging motor control circuit interlocks

a. Where the design of the mechanism allows for manual charging of the mechanism spring, the supply voltage to the spring charging motor shall be disconnected when the spring charge handle is inserted for manual charging of the spring. This is to prevent possible injury to the operator should the motor start running while the manual charging handle is inserted onto the mechanism.

b. When the spring charge handle is inserted into the mechanism, a circuit-breaker unhealthy alarm status shall be activated. Refer to clause 3.8 for alarm contact requirements.

c. A direct means to achieve the following functions shall be provided:

- the closing operation shall be possible only when the closing spring is fully charged;
- the closing spring can only be released when the main contacts are fully open; and
- a device shall be employed to block overcharging of the closing spring when the manual charging facility is employed.

3.7.2 Sulphur hexafluoride (SF_6) alarm auxiliary circuits and control circuit blocking interlocks

a. SF_6 gas-filled compartment(s) shall be provided with a density switch (which may be incorporated into a gauge indicating pressure compensated for temperature) having contacts which shall operate in two stages as follows:

- on reaching the non-urgent alarm / warning level (i.e. only gas replenishment is necessary).
- on reaching the lockout level (i.e. circuit-breaker to be taken out of service).

NOTES

- It shall be possible to verify the correct operation of gas density/pressure switches in situ without having to disconnect wiring or having to perform gas-handling operations on the switchgear.
- The use of pressure switches without temperature compensation for the initiation of these functions will not be permitted.

b. The contacts of these switches, on reaching these levels, shall operate relays, which in turn shall provide:

- electrically separated normally-closed contacts for alarm indication purposes as per the requirements of 3.8 (Low Gas Alarm); and
- lockout alarm level: Normally-open contacts which shall be wired into all tripping and closing control circuits to block the operation of the switchgear.

c. The blocking contacts for the tripping control circuits and the alarm contacts for the auxiliary circuits shall be derived directly from the density meter or pressure gauge and not via auxiliary relays. Blocking/enabling of the tripping control circuits shall not be dependent on the presence of the auxiliary d.c. supply.

d. The blocking contact for the close control circuit shall share a common actuator to the low gas block indication auxiliary circuits (i.e. all three contacts shall be derived directly from the density meter or pressure gauge, or all three shall be derived from the same auxiliary relay).

e. Where auxiliary relays are used to multiply the alarm or blocking contacts, the circuit design shall be such as to indicate the alarm / block condition in the event of a loss of auxiliary d.c. supply or circuit failure. The relays shall continue to operate at a supply voltage below the minimum operating voltage of the tripping coils.

3.8 ALARM CIRCUITS

a. All switchgear alarms shall be wired to separate terminals provided in accordance with D-DT 5407.

b. All alarms circuits shall be designed to have a normally-closed connectivity to allow for complete circuit monitoring. This enables any fault in the wiring (such as loose connections or damaged wiring) to be detected as well as prevents the alarm contacts from being disconnected in order to cancel an alarm.

c. Three alarm circuits shall be provided for:

- ***Circuit-breaker not healthy common alarm:***

  This alarm shall monitor and indicate an abnormal state of the switchgear. This alarm is activated under any of the following conditions:

  ii. motor over-run protection is activated, or

  iii. d.c. isolation control switch is selected to “OFF”, or

  iv. spring charging motor control circuit MCB trips , or

  v. manual spring charge handle left engaged in the mechanism.

  NOTE: This alarm is not raised by the SF_6 gas pressure alarms, or the spring in the discharged state, or for a heater failure.

- ***Low gas alarm:*** This alarm shall monitor and indicate the level of SF_6 gas inside the switchgear.

  This alarm is activated under the following conditions:

  i. non-urgent or warning alarm level: Two electrically separate, normally-closed contacts shall be provided for indicating this condition.

  ii. lockout alarm level: Two electrically separate, normally-closed contacts shall be provided for indicating this condition.

- ***Switchgear heater alarm:***

  This alarm shall monitor and indicate the status of the heater circuit(s). This alarm is activated when the temperature threshold is reached (i.e. when heaters cool down due to failure thereof or loss of a.c. supply). Tripping of a heater supply MCB (where provided) shall raise the circuit-breaker heater alarm.

3.9 CT WIRING REQUIREMENTS (KIOSK CIRCUIT-BREAKERS)

a. Four CT cores shall be provided in all kiosk circuit-breaker applications: 2 x Protection and 2 xMeasurement. The position and orientation of the CT cores relative to the busbar and circuit-breaker shall be as indicated in Figure 1 below.

b. The position, orientation and associated terminal numbering for the CT cores shall be done in accordance with the relevant sheets of D-DT-5407.

c. The switchgear shall be supplied with the CT secondaries shorted and earthed (from the Eskom side of the CT terminal strip (X1)) using insulated wire jumpers in accordance with D-DT-5407.

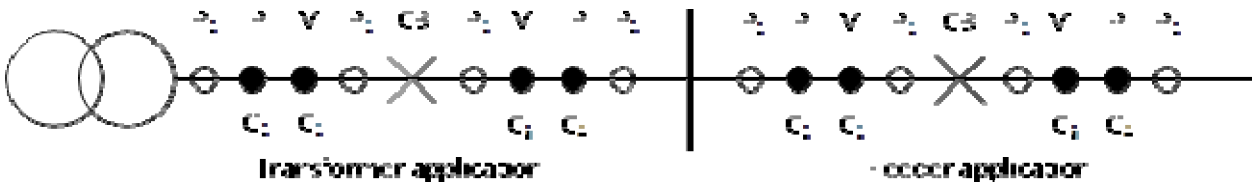

Figure 1: CT Positioning for Kiosk Circuit-Breaker Applications

3.10 CT WIRING REQUIREMENTS (MIXED TECHNOLOGY / HYBRID SWITCHGEAR)

a. Six CT cores shall be provided for mixed technology circuit-breaker applications: 2 x Protection, 2 x Bus-zone and 2 x Measurement. For transformer and feeder applications (single and double busbar), the position and orientation of the CT cores relative to the busbar and circuit-breaker shall be as indicated in Figure 2 or Figure 3 below. For bus-section and bus-coupler applications, the position and orientation of the CT cores relative to the circuit-breaker shall be as indicated in Figure 4 below.

   NOTE: Measurement cores should not be positioned underneath the heavy protection cores as this can distort their cores and affect the accuracy.

b. The position, orientation and associated terminal numbering for the CT cores shall be done in accordance with the relevant sheets of D-DT-5407.

c. The switchgear shall be supplied with the CT secondaries shorted and earthed (from the Eskom side of the CT terminal strip (X1)) using insulated wire jumpers in accordance with D-DT-5407.

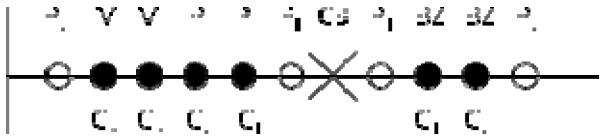

Figure 2: CT Positioning for Mixed Technology Switchgear (Transformer and Feeder Applications)

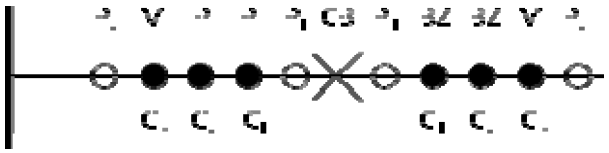

Figure 3: Alternative CT Positioning for Mixed Technology Switchgear (Transformer and Feeder Applications)

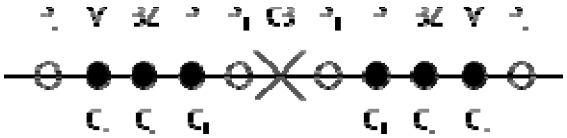

Figure 4: CT Positioning for Mixed Technology Switchgear (Bus-Section Applications)

3.11 WIRING, TERMINAL BLOCKS AND TERMINAL STRIPS

3.11.1 General wiring requirements

a. All internal wiring requiring connection to external equipment shall be wired to terminal strips X1 and X2 provided in the mechanism enclosure.

b. The details and location of control cable gland plates shall be as per the relevant switchgear specification.

3.11.2 Terminal blocks and terminal strips

a. Each mechanism enclosure shall be provided with not less than 6 spare terminals.

b. The arrangement of the terminal strips in the mechanism enclosure shall facilitate the entry of the incoming control cables in the bottom-entry configuration.

c. Secondary terminals shall comply with DSP 34-253. The terminal blocks shall be of the screw clamp, spring loaded insertion type. The terminal width of 10 mm is preferred. Terminal widths less than 8 mm will not be accepted. The terminal blocks shall be capable of accepting back-to-back insulated hook blade lugs without damaging or deforming the lugs. Only Eskom accepted terminal blocks shall be used.

d. Control cabling applied by Eskom to interface with the circuit-breaker will be multi-core, PVC insulated, single-wire armoured and PVC sheathed in accordance with SANS 1507-3.

e. The terminal strip spacing shall be such that the person cabling the circuit-breaker can easily access the terminals to insert the wiring. The spacing shall be such as to accommodate a ferrule of length up to 20 mm.

f. Trunking shall be provided on both sides of each terminal rail and shall easily accommodate the wiring. Trunking shall be of the ‘fine’ tooth type (tooth width 6,1 mm as opposed to 12,0 mm). 60 mm x 60 mm trunking is preferred.

g. In general and where applicable, all wiring is to be stripped of as much slack as possible so as to leave maximum trunking space for Eskom wiring..

3.11.3 Wiring, terminations and identification

a. Wiring shall comply with the requirements for insulated wire in accordance with SANS 1507-2 and shall have a rated operating voltage of 600/1000 V (phase-to-earth/phase-to-phase).

NOTE: SANS 1507-2 requires that wiring insulated for 1000 V phase-to-phase shall withstand 2000 V for 10 minutes.

b. Wiring for CTs and motor control circuits shall be carried out using stranded copper conductor with a minimum nominal cross-sectional area of 2,5 mm^2.

c. Wiring for control and other auxiliary circuits shall be carried out using stranded copper conductor with a minimum nominal cross-sectional area of 1,5 mm^2.

d. All a.c. wiring (including CTs, heater circuit, etc.) shall be black in colour. Earth wires shall be green/yellow. All other d.c. wiring shall be grey.

e. Secondary wiring shall be identified at both ends in an approved manner (e.g. by ferruling) in accordance with DSP 32-308, and shall present a neat appearance. It shall be braced, placed in plastic trunking, clipped and/or laced to prevent chafing due to vibration. All secondary equipment, terminals, labels and so on shall be completely accessible after the wiring and cabling has been completed.

f. All wires shall be terminated using suitable lug terminations. The terminating method shall ensure that the numbered ferrule may not fall off when disconnecting the wire. In this regard, the use of one or more strands of wire to retain the ferrule is not acceptable.

g. Secondary cabling (e.g. inter-pole cabling) provided by the manufacturer shall be UV-stable and shall preferably be run in the ground, in which case steel wire armoured cable shall be used. In the case where Eskom support structures are provided, all inter-pole secondary cabling shall be run in the ground, unless otherwise approved by Eskom.

h. Where applicable, wiring shall be routed in the corners of compartments, avoiding any screw studs or sharp objects that protrude into the compartment.

i. Where applicable, wiring supports shall be riveted or screwed in position. No stick-on wiring supports (e.g. using mirror tape or double-sided adhesive tape) shall be used.

j. Where applicable, connections to equipment on swing doors or frames shall be so arranged as to give the conductor(s) a twisting motion and not a bending motion (e.g. arranged vertically over the hinge).

3.11.4 Standard terminal strip layout

a. The terminal strips used for interfacing with external cabling shall be numbered, and interfacing wires ferruled in accordance with D-DT-5407 (all applicable sheets) and shall be designated as defined in D-DT-5407.

b. All status and spring limit switch contacts as indicated on D-DT-5407 shall be provided (as applicable to the switchgear type).

c. If a particular function/alarm is not applicable, then the required terminals shall be provided but shall be left unwired. Alternative functions/alarms shall not be wired to standard terminals designated for another function/alarm.

d. Any spare status, spring limit switch and/or alarm contacts available in addition to the basic requirements of D-DT-5407 shall be wired to additional terminal blocks as shown on D-DT-5407.

3.12 SCHEMATIC WIRING DIAGRAMS AND LAYOUT DRAWINGS

a. All diagrams and drawings shall be labelled and annotated in English.

b. The schematic wiring diagram shall indicate the convention applied as defined in clause 3.1.

c. A schematic wiring diagram shall be provided detailing the specific wiring of the control, alarm and indication circuits. The diagram shall use the standard symbols of IEC 60617 (specifically Parts 2 & 8) and shall include a key to any abbreviations or device codes used. Refer to D-DT-5414. Particular attention shall be paid to the correct orientation of the symbols.

d. A separate sheet shall indicate for each component used on the schematic diagram the designation, make, type and rating of all control equipment (switches, auxiliary relays, heaters, motors, trip/close coils, terminal blocks, MCBs, fuses, etc.)

e. Diagrams shall show the relative timing of main and auxiliary switch contacts and if applicable, operating levels of pressure switches, reducing and safety valves and so forth on increasing and decreasing pressure.

f. A general arrangement drawing of the mechanism enclosure shall be provided showing the relative positions of the terminals strips, gland plates, contactors, coils, motor, MCBs, heaters, overall dimensions, etc. The drawing shall clearly show the space (clearance) provided on either side of the terminal strips for easy access to insert the wiring (refer to 3.11.2 e).

g. Where applicable, circuitry provided to ensure that the minimum required time interval between repeated CO operations is adhered to shall be indicated in the schematic wiring diagrams.

4. AUTHORISATION

This document has been seen and accepted by:

Name & Surname	Designation
	This Document has been approved by TDAC ROD 13 February 2013

5. REVISIONS

Date	Rev.	Compiler	Remarks
November 2012	0	J. Cebekhulu Senior Engineer	Draft document for Review created from 34-1692
May 2013	1	J. Cebekhulu Senior Engineer	Final Document for Publication

6. DEVELOPMENT TEAM

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7. ACKNOWLEDGEMENTS

- None