Eskom	Standard	Technology

Title: **Specification for Electrical Terminal Blocks used in Eskom's panels**

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COE Acceptance

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

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

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Content

Executive Summary

This document provides a technical specification for electrical terminal blocks to be used by the Eskom Division in Protection, DC, Telecontrol, Telecommunications, Metering panels, junction boxes, AC/DC distribution boards and within power plant equipment: typically transformer marshalling interface boxes, tap change drives, isolator mechanism terminal boxes, circuit-breaker mechanism boxes and current and voltage transformer terminal boxes. Thus any equipment or plant that Control Plant wiring is terminated to.

1. Introduction

The document details the technical requirements for terminal blocks and accessories used in the Control Plant discipline. Any Control Plant product or interface (for example circuit breaker mechanism box etc.) to which wiring is terminated to, shall specify the terminal block requirement in terms of this document. This document thus shall be part of any equipment specification to which Control Plant interfaces with.

2. Supporting clauses

2.1 Scope

This document serves to specify the technical requirements for electrical terminal blocks as used in control panels, junction boxes, and for wiring interfaces between control plant and power plant equipment (e.g. isolator mechanism terminal boxes, circuit-breaker mechanism boxes, current and voltage transformer terminal boxes and transformer marshalling interface boxes).

This standard is applicable to all control plant schemes and junction boxes and all power plant wiring interfaces to control plant schemes to be used in the Eskom Division.

The document defines the technical specification for electrical terminal blocks as used in the Eskom Division.

2.1.1 Purpose

The specification ensures that equipment suppliers understand the terminal block requirement of Eskom. The specification ensures that the correct type and quality of terminal block is used.

2.1.2 Applicability

This document shall apply throughout the Eskom Division.

2.2 Normative/informative references

Eskom documents:

Buyer's Guide drawing D-DT-9217.

2.2.1 Normative

International and national standards:

[1] EN50022, Low voltage switchgear and control gear for industrial use; mounting rails for fixing terminal blocks.

[2] IEC 60947-1, Low-voltage switchgear and control gear – Part 1: General rules.

[3] IEC 60947-7-1, Ancillary equipment – Terminal blocks for copper conductors.

[4] SANS 1433-1, Standard specification for Electrical terminals and connectors, Part 1: Terminal Blocks having screw and screwless terminals.

2.2.2 Informative

[1] Eskom documents: Buyer's Guide drawing D-DT-9217

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
A.C.	Alternating current
D.C. or d.c.	Direct current
IARC	Industry Association Resource Centre (Department of Resources & Strategy, Eskom)
IDC	Insulation Displacement Connector
ILAC	International Laboratory Accreditation Cooperation
SANAS	South African National Accreditation System

2.5 Roles and responsibilities

The document shall be distributed to all Control and Power plant personnel to utilise with any equipment specification which utilises terminal block interfaces to interface with Control Plant equipment. Examples are current and voltage transformers, junction boxes, isolator mechanism boxes, circuit breaker mechanism boxes and Power Transform marshalling interface boxes.

2.6 Process for monitoring

NA.

2.7 Related/supporting documents

Terminal block custodian to keep a database of all approved terminal blocks specifying the manufacturer, part no. and part number of each terminal block. This shall preferably be an Excel spread sheet and items to be listed on the list of accepted products.

3. Requirements

3.1 Introduction

The following types of terminal blocks are required:

a) Stud-type power terminals;

b) Screw clamp, spring loaded insertion;

c) Screw clamp, spring loaded insertion with disconnector;

d) Insulation displacement/screw clamp with disconnector;

e) Earthing; and

f) Special types: fuse, resistor, diode terminal blocks.

Terminal blocks of different types to those listed above may be required in certain specific applications. These shall be stipulated in the relevant product specification, and shall adhere to the generic requirements indicated hereunder. Should the terminal block be used regularly by Eskom, the product shall be evaluated to become part of the accepted product listing.

Generic requirements applicable to all terminal blocks and specific requirements for each type of terminal are described below.

3.2 Generic requirements

The following requirements shall apply to all terminal block types:

3.2.1 Safety

Terminal blocks and terminal block rail assemblies used in electrical equipment for Eskom shall comply with IP20 ingress protection or higher. This IP rating ensures that a person's finger shall not make inadvertent contact with live parts of a terminal block or terminal block rail assembly (i.e. full penetration of a 12,5 mm sphere is not allowed). As an example, fitting of un-insulated cross-connects between terminal blocks may become a problem if not fitted with an appropriate insulated barrier. The additional protection must be added as standard or insulated cross-connects shall be used. Heavy duty (power) terminal blocks shall have the appropriate safety covers and warning signs fitted.

Terminal screws shall be captive within the mouldings and the heads shall not project above the moulding when fully released.

3.2.2 Clamping unit types

The terminal blocks for most A.C. and D.C. control and communication circuit wiring applications shall be of the spring loaded screw clamp type. The spring is located vertically under the screw clamp and ensures that the screw clamp is held firmly against the conducting bar of the terminal block. This arrangement ensures that connections inadvertently left unfastened would still make a good electrical connection. Insulation displacement-type connections shall be provided on terminal blocks interfacing with twisted pair telephone cables for supervisory alarms, controls and indications. In cases where a spring loaded screw clamp terminal block of a specific type is not available, a non-spring loaded terminal block may be used subject to Eskom approval.

Springs shall be aged and shall withstand corrosion that might affect performance during their working life. Springs shall not carry current.

Terminals in which the screw or the means of applying the securing pressure bears directly on the termination or conductor (as found on domestic electrical fittings) are not acceptable.

Eskom is often approached by terminal block manufacturers interested in offering alternative terminal block technologies such as the spring clamp, insulation displacement or flex screw clamp terminal blocks. Eskom is interested in alternative technologies that will enhance equipment reliability and reduce costs. At the time of producing this specification Eskom has not identified an alternative terminal block technology to pursue. This does not however preclude the possibility of investigating and including such technology in a revision of this specification.

3.2.3 Materials and construction

Moulding materials shall be self-extinguishing and resistant to flame propagation, substantially non-hygroscopic, and shall preferably not carbonize when tested for tracking. The mouldings shall be dimensionally stable and shall have high impact strength.

Mouldings shall be mechanically robust, and shall withstand the maximum possible torque that may be applied to the terminal screws.

Steel parts, other than stainless steel, shall be plated and passivated. Current carrying parts shall be non-ferrous and plated. All plating shall be compatible with other parts and terminations.

Tapped holes shall have not less than three full threads. Separate terminals shall be provided on each unit for incoming and outgoing connections, and their contact pressures shall be independent of each other.

Manufacturers shall nominate the maximum and minimum torque to be applied to the terminal screws. Notwithstanding this nomination, the terminal block shall pass the tightening torque test of Section 5.2.

Terminal covers or shrouds, where required, shall be of insulation material, self-extinguishing or resistant to flame propagation and shall preferably clip onto the moulding.

3.2.4 Mounting

The terminal blocks shall be suitable for mounting on a DIN3 rail of dimensions 35 mm (w) x 7.5mm (h) x 1 mm (thick) as well as the heavy duty DIN3 rail of dimensions 35 mm (w) x 15 mm (h) x 2.3 mm (thick) (as per EN50022). The DIN rail shall be corrosion resistant for at least 20 years in all South African climatic conditions. Whilst the DIN rail shall not be exposed to fresh or sea water, it will come into contact with moist and chemically corrosive air as is typical with South African climatic and pollution environments. Terminal rails used in outdoor applications (junction boxes or similar) shall be manufactured from stainless steel or aluminium.

The terminal blocks mounted on a DIN rail shall be secured with end blocks. The exposed side of the terminal block shall be closed off completely by an adjacent terminal block, or by a terminal block cover. Additional spacers or barriers can be specified where there is a change in terminal voltage or function.

It shall be possible to replace any unit in an assembly without dismantling adjacent units. Retention of any component from the rear of the mounting rail is not acceptable.

3.2.5 Ratings

Unless indicated otherwise, all terminal blocks shall be rated in accordance with Table 1 below:

Table 1: Rated characteristics of terminal blocks

Item	Characteristic	Reference	Rating
1	Minimum rated operational voltage	IEC 60947-1 Section 4.3.1.1	500V
2	Minimum insulation voltage	IEC 60947-1 Section 4.3.1.2	500V
3	Minimum rated impulse withstand voltage	IEC 60947-1 Section 4.3.1.3	6 kV 4 kV for IDC combination terminals.
4	Rated operational current	IEC 60947-1 Section 4.3.2.3 and 8.3.2.2.1	As per section 4.3
5	Short time withstand current	IEC 60947-7-1 Section 4.3.2	120 A/mm^2
6	Environmental pollution degree	IEC 60947-1 Section 6.1.3.2	Degree 3

3.2.6 Terminal block and mounting rail markers

Terminal block markers shall use black lettering on a white background. The labels for all terminals blocks used in a particular product shall use the same font. The lettering shall be made with high quality continuous black indelible ink. It shall not be possible to rub off the lettering by hand. Terminal block markers shall be firmly clipped onto the terminal blocks and shall not be easily dislodged.

Where multiple rows of terminal blocks mounted on DIN rails are present in any equipment, each row shall be uniquely identified with a legible label as per Eskom drawings. Typically this is labelled from X1 to Xn, from top to bottom or left to right. Please consult the relevant Eskom drawing or product custodian should clarification be required.

3.2.7 Electrical continuity

All of the metal parts directly associated with the electrical connection assembly, including springs and fastening screws shall remain in contact at all times. In the extreme case where the screw clamp fastening screws are fully released, the screws shall still make a good electrical connection with the rest of the clamping unit and the conductive part of the terminal block. The fastening screw shall not separate from the terminal block when fully loosened. This is not stipulated in the relevant IEC/SANS specification but is an Eskom requirement. The terminal block shall pass an electrical continuity test as stipulated in Section 4.1.

3.2.8 Lugs used with terminal blocks

Terminal blocks shall be used with the following types of crimped lugs:

Table 2 Typical lugs to be used with terminal blocks

Lug type	**Wire cross sectional area (mm^2)**	**Typical blade/pin dimensions (mm)**	**Terminal block technology**
Red Hook Blade	1,5	4,6 (w) x 14 (l), 1 mm hook or 3 (w) x 14 (l), 1 mm hook	Spring clamp
Blue Hook Blade	2,5		Spring clamp
Yellow Hook Blade	4		Spring clamp
Red Blade	1,5	4,6 x 10, 3 x 10 or 2 x 10	Spring clamp/IDC
Blue Blade	2,5		Spring clamp/IDC
Yellow Blade	4		Spring clamp/IDC
Ring Tongue	4 or 16	Typically 8 or 10 mm aperture	Heavy duty stud type terminal block

Special lugs may be used where approved by the relevant product custodian.

3.2.9 Sourcing

It is preferred that the terminals blocks used in the manufacture of a product are sourced from a single terminal block manufacturer. Where specialised terminal blocks such as fused or slide link terminal blocks are required, but are not available in the specific supplier's range, terminal blocks from a competing supplier may be used subject to Eskom approval.

3.3 Type-specific requirements

3.3.1 Stud-type terminal blocks

This terminal block type provides excellent mechanical strength and withstands the forces imparted by larger cross-section conductors due to the mass and rigidity characteristics of the conductor.

The terminal block shall include two terminal studs, and these shall be of sufficient length to accommodate two ring tongue or flanged spade terminations in addition to a full nut and all necessary plain and spring washers. The typical conductor size is 16 mm^2 and up.

Studs shall be M6 or M8 and shall be manufactured from brass, phosphor bronze or stainless steel. Solid studs only shall be provided.

The terminal block shall be fully enclosed to avoid inadvertent contact with dangerous voltages. The terminal block enclosure shall have the relevant high voltage warning label attached to it. The enclosure shall have a small opening to allow measurement of electrical quantities without needing to lift the protective cover.

Barriers of insulation material, self-extinguishing or resistant to flame propagation and substantially non-hygroscopic shall be provided between terminal ways. These barriers shall project at least 3 mm above the studs.

Stud-type terminals are typically used for heavy duty supplies, for example AC/DC board main incoming supplies, and DC loops between batteries and chargers.

The following standard stud-type terminal blocks shall be used:

SAP No.	Lug type/size	Current rating
0224632	M6 stud for ring (for 16 mm^2 wire)	72A
0224633	M8 stud for ring (for 16 mm^2 wire)	72A

3.3.2 Screw clamp, spring loaded insertion terminal blocks

The spring loaded screw clamp terminal block arrangement is used in conjunction with wiring terminated with hook blade lugs. The most commonly used hook blade lug is the blue insulated 2,5 mm^2 lug. The yellow insulated 4 mm^2 lug and red insulated 1,5 mm^2 and smaller lugs are also used. Typical blade widths are 4,6 mm and 3 mm.

Each terminal block shall carry two wires per termination where necessary, terminated with the mentioned hook blade lugs. When two lugs are utilised in one end of the terminal block the lugs are inserted back to back, that is with one lug hook pointing down and the other pointing up. The terminal block shall not snag the hook of the hook blade or deform it in any way when inserting, removing or fastening the screw clamp screw. When the terminal block fastening screws are fully loosened the hook blade lug terminated conductor shall not be able to be pulled out of the connection. Thus the hook anchors the conductor inside the terminal block. The pull-out force shall be as specified in IEC 60947-7-1.

Terminals used in this application shall make provision that a test socket be fitted between the two fastening screws that can accommodate a 4 mm diameter test plug. Typically this is a barrel that screws into the centre of the terminal between the two fastening screws. Should this barrel protrude above the terminal block and present the possibility of human contact with the live parts it shall be fully insulated. This requirement would only be for certain terminal blocks as specified by the relevant Eskom specification and/or product custodian.

The 10 mm (wide) screw clamp spring loaded terminal blocks are the standard type used to interface cables to a control panel, or to interface control cabling with Power plant. The 8 mm terminal block shall be used by exception, typically where there are space constraints, or where terminal blocks are required within the module of a particular scheme.

The following standard screw clamp, spring loaded insertion terminal blocks shall be used:

SAP No.	Terminal Block width	Largest Lug Size/Type	Current rating
0224634	10 mm	Yellow Hook blade	32A
0224633	8 mm	Blue Hook blade	24A

3.3.3 Screw clamp, spring loaded insertion terminals with disconnector

These terminals shall be as per the screw clamp spring loaded terminal described in Section 4.3.2, but shall include a sliding link-type disconnect. The disconnector shall be secured in place by a captive fastening screw. The link shall be slid downwards to close the circuit. This is to ensure that the link remains closed should the fastening screw become loose or if it is inadvertently left unfastened.

It is required that the terminal blocks are fitted with 4 mm test plugs on either side of the disconnector. Where conductive parts of the test socket protrude from the terminal block, these shall be fully insulated.

This terminal should only be used with the blue insulated 2,5 mm^2 hook blade lug or the red insulated 1,5mm^2 hook blade lug.

These types of terminals shall typically be used on current transformer and voltage transformer circuits for isolation and testing of the applied voltage and current, or to provide a means of isolation of the earth connections. Sliding link type terminals are also used as a means to isolate tripping circuits and breaker fail outputs.

The following standard screw clamp, spring loaded insertion terminal blocks with disconnectors shall be used:

SAP No.	Terminal Block width	Largest Lug Size/Type	Current rating
0224636	8 mm	Blue Hook Blade	24 A

3.3.4 Insulation Displacement/Screw clamp terminals with disconnector

These terminals shall include connectors of the insulation displacement type on one side, and a screw clamp termination on the other side. The screw clamp termination need not be spring assisted. The IDC part of the terminal block shall thus securely connect a 0,5 mm diameter conductor into the terminal block.

Note: Telephone cable of nominal diameter 0,5 mm varies in diameter from 0.49 mm to 0.61 mm which equates to 0,18 to 0,29 mm^2.

This type of terminal block shall be used for the interface of supervisory indications and controls to the scheme.

Certain types of IDC terminal blocks require special tools to make and disconnect the connection. The supplier shall keep stock of the tools required.

SAP No.	Terminal Block width	Largest wire diameter (IDC)	Largest Lug Size/Type (screw clamp)	Current rating
0224637	5 mm	0,5 mm	Red blade	10 A
0224638	8 mm	0,5 mm	Blue hook blade	24 A

3.3.5 Earthing terminals

These terminals shall include screw clamp terminations on each side. The terminations need not be spring assisted. The conductive part of the terminal block shall be internally electrically connected to the mounting rail. These terminal blocks shall be coloured yellow and green to identify them as being earth terminals.

Earthing terminals shall be applied to earth components in a panel to the terminal mounting rail, and to bond the mounting rail to earth. The terminal shall accept at minimum a blue hook blade lug with a 4,6 mm blade.

The following standard earthing terminal blocks shall be used:

SAP No.	Largest Lug Size/Type (screw clamp)	Current rating
0224639	Blue Hook blade	24 A

3.3.6 Special terminal blocks

These terminals shall include screw clamp terminations on each side. The terminations need not be spring assisted. These terminals shall typically be used to mount fuses or electronic components (diodes, resistors etc.) within schemes as required.

The terminal block with integrated screw cap fuse holder shall be compatible with a 5 x 20/25 mm cylindrical cartridge type fuse. Typical fuse rating shall not exceed 6A.

The following special terminal blocks shall be used:

SAP No.	Component	Largest Lug Size/Type	Current rating
0224640	Fuse	Blue Hook blade	24 A

3.4 Accessories

Terminal block test sockets shall accommodate test plugs with a 4 mm diameter.

No permanent terminal block accessory that decreases the electrical capability of the terminal block shall be used unless specifically approved by Eskom.

The following terminal block accessories shall be used:

SAP No.	Item
0224641	4 mm test socket to be used with screw clamp, spring loaded insertion-type terminal blocks
0224642	IDC application tool

3.5 Acceptance

At least ten samples of each terminal block type shall be submitted to Eskom for acceptance. The set of samples shall be accompanied by the relevant test certificates which indicate the compliance of the terminal block with the relevant IEC standards.

All products offered shall carry valid certification indicating tested compliance with the relevant technical standard by an independent 3rd party certification body/laboratory. The submitted certification should clearly indicate conformance.

The issuing testing laboratory shall hold valid accreditation from either,

a) A National accreditation body which holds valid ILAC (International Laboratory Accreditation Cooperation) membership (e.g. SANAS in South Africa), or,

b) A member of a regional accreditation body which has been accredited by ILAC.

Note: Details about ILAC and its members are available from: http://www.ilac.org/

Terminal block suppliers submitting certificates to Eskom do so accepting full liability to all claims arising from products found to be non-compliant due to invalid certification. Thus it is important to verify the certificate's compliance before submitting to Eskom.

3.6 List of accepted products

All terminal blocks suitable for use by the Eskom Division, both from a Control Plant and Power Plant perspective (i.e. the Power Plant equipment interfacing with Control Plant equipment) shall be included on the List of Accepted Products (LAP) that is administered by IARC.

4. Tests

All terminal blocks shall have passed all relevant type tests as stipulated in IEC 60947-7-1. The following additional tests shall be conducted:

4.1 Electrical continuity test

In addition to the above, the electrical continuity requirement of Section 4.2.7 of this document shall be tested using the following procedure:

a) Mount ten randomly chosen examples of the terminal block to be tested onto a DIN rail

b) Ensure that all fastening screws (electrical conductor fastening screws, usually 2 per terminal block) are fully released, and that the DIN rail is lying with the screws pointing vertically upwards.

c) Use a standard digital multi-meter which has been calibrated by the relevant calibration authority and select it on the ohms scale. (The continuity voltage applied by the multi-meter shall not exceed four volt d.c.)

d) The specimen terminal blocks shall be said to comply with the Eskom requirement if it is possible to use a mentioned handheld digital multi-meter with the standard supplied leads to measure the continuity across each terminal block in turn. The continuity reading shall be less than one ohm. The test leads shall be applied to the terminal block screw clamp fastening screws. The pressure exerted by the test leads onto the fastening screws should only be that due to the weight of the test probe and lead.

e) Repeat the test for all ten terminal blocks.

f) A particular type of terminal block shall be found to be compliant with the above requirement if ten randomly chosen samples all pass the test.

Note: The purpose of the test is to ensure that when field staff do continuity checks that the terminal block conductor fastening screw always makes electrical contact with the inserted conductor.

4.2 Fastening torque test

The following fastening torque test shall be conducted on all M3 and M3,5 fastening screws:

a) The test shall be conducted using a suitable torque driver that has a valid SANAS accredited calibration certificate. Experience indicates that two tools are needed. Strengthened high quality driver bits shall be used.

b) Mount the terminal blocks onto the required DIN rail with suitable end stops. Fasten the DIN rail onto a sturdy, immovable surface.

c) Terminate wires onto each terminal block to be tested. The wires shall be those typically used in applications (e.g. 2.5mm^2 copper) and terminated using hook blade lugs of appropriate size.

d) Using the torque driver fitted with the correct size bit, fasten the screw(s) to the required fastening torques:

- 1,5 Nm for a M3 screw
- 2 Nm for a M3,5 screw

Note 1: In practise it has been found that 1 Nm is not easily exceeded with a typical screw driver.

Note 2: Note the torque value specified above are more onerous than most manufacturer's recommended fastening torques. The higher torque is specified to ensure a safety margin. From experience quality terminal blocks survive the test relatively unscathed. Some degree of distortion is permissible, however the connection must still be sound and the insulated casing must remain intact.

Important: Take care when performing this test as the specified torque is not easily applied to a slotted screw. The driver may "cam-out" of the screw head resulting in damage to the driver bit and/or test person. Sub-standard screws can also shear relatively easy and cause an injury.

e) A successful outcome is where the screw does not shear off, the screw slot is still sound and that no serious mechanical damage has been suffered (conductors, screws and casing). A sample of ten randomly chosen terminal blocks should be tested and a pass rate of at least 80% shall be obtained. Under no circumstances shall a sheared screw be acceptable; here the pass rate is 100%.

5. Marking

Terminal block markings shall be as per IEC 60947-7-1.

6. Spares

All equipment fitted with terminal blocks shall be supplied with at least two spares of each terminal block type used. The spare terminals shall be mounted at the end of each terminal rail whith the specific type.

7. Authorization

This document has been seen and accepted by:

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8. Revisions

Date	Rev.	Compiler	Remarks
April 2014	1	PA Gerber	Compile old Distribution specification for terminal blocks for use Eskom wide. (DSP 34-253) Make minor corrections.

9. Development team

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

- Paul Gerber, Standards Implementation GOU, Group Technology
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10. Acknowledgements

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