

Australian/New Zealand Standard™

Tunnel type terminal neutral bars for low voltage switchboards—Requirements for termination of copper conductors up to 50 mm²



AS/NZS 5112:2015

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PREFACE

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee EL-004, Electrical Accessories.

The objective of this Standard is to provide requirements and methods of test for tunnel type terminal neutral bars for low voltage switchboards for termination of copper conductors up to 50 mm².

The Standard is suitable for referencing in AS/NZS Standards associated with low voltage installations.

The essential safety requirements in AS/NZS 3820, *Essential safety requirements for electrical equipment* that could be applicable to terminals for low voltage switchboard circuits are covered by this Standard.

The term 'informative' has been used in this Standard to define the application of the appendices to which it applies. An 'informative' appendix is only for information and guidance.

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STANDARDS AUSTRALIA/STANDARDS NEW ZEALAND

Australian/New Zealand Standard**Tunnel type terminal neutral bars for low voltage switchboards—
Requirements for termination of copper conductors up to 50 mm²****1 SCOPE**

This Standard specifies requirements and methods of test for tunnel type terminal neutral bars for low voltage switchboards for termination of copper conductors up to 50 mm². It applies to bars of the tunnel terminal type for connection to copper conductors—

- (a) of the rigid, stranded or flexible type; and
- (b) with a cross-sectional area of 1.0 mm² up to and including 50 mm².

NOTES:

- 1 Preferred current ratings are 63 A, 80 A, 100 A and 125 A.
- 2 This Standard is for tunnel terminal type neutral bars for use as components in switchboards, panel boards, load centres, meter boxes and the like.
- 3 The current ratings in this Standard apply to bars with a maximum temperature rise of 45 K when tested at ambient temperature in open air.

The ratings obtained in this Standard are applicable to switchboards with an internal air temperature rise of up to 25 K.

NOTE: Refer to Appendix A of this document for further details.

2 NORMATIVE REFERENCES

The following are the normative documents referred to in this Standard:

NOTE: Documents for informative purposes are listed in the Bibliography.

AS/NZS

1567	Copper and copper alloys—Wrought rods, bars and sections
3000	Wiring Rules
3100	Approval and test specification—General requirements for electrical equipment
60695	Fire hazard testing
60695.2.11	Part 2.11: Glowing/hot wire based test methods—Glow-wire flammability test method for end-products (IEC 60695-2-11:2000, MOD)

3 TERMS AND DEFINITIONS

For the purpose of this Standard, the terms and definitions given in AS/NZS 3000 and AS/NZS 3100 and the following apply.

3.1 Conductor, prepared

A conductor which has been cut and the insulation of which has been removed over a certain length and fitted with an eyelet, cable lug, shoelace ferrule or the like.

3.2 Conductor, unprepared

A conductor which has been cut and the insulation of which has been removed over a certain length for insertion into a terminal.

NOTE: A conductor, the shape of which is arranged for introduction into a terminal, is considered to be an unprepared conductor, e.g. the strands may be twisted or formed into a 'U' shape.

3.3 Main earthing conductor

The connection to the installation earth electrode.

3.4 Main neutral conductor

The incoming supply conductor which is a combined Protective Earth and Neutral (PEN) conductor which is connected to the main neutral bar.

3.5 Maximum connecting capacity

The size of the largest unprepared stranded copper conductor in Table 1 that can be clamped.

3.6 Multiple earthed neutral (MEN) connection

The MEN connection is the connection in the main switchboard between the main neutral bar and the main earthing bar or conductor.

3.7 MEN system

A system of earthing in which the parts of an electrical installation required to be earthed are connected together to form an equipotential bonded network and this network is connected to both the neutral conductor of the supply system and the general mass of earth.

NOTE: The MEN system is similar in principle but not in detail to an IEC TN-C-S system.

3.8 Screw-type terminal

Terminal for the connection and subsequent disconnection of one conductor or the interconnection of two or more conductors capable of being dismantled, the connections being made, directly or indirectly, by means of screws or nuts of any kind.

NOTE: Refer to Table 2.

3.9 Tunnel terminal

A terminal in which the conductors are inserted into a hole or cavity, where they are clamped by a screw or screws.

The clamping pressure may be applied to the conductor directly by the screw(s) in direct contact with the conductor [refer to Figure 1(a)] or indirectly by the screw(s) through a plate or ferrule [refer to Figure 1(b)].

A tunnel terminal bar includes the type where the outgoing conductors are in tunnels and the incoming conductor is connected by other means such as a cable lug or a saddle terminal.

A saddle terminal is regarded as a tunnel terminal for the purpose of this Standard.

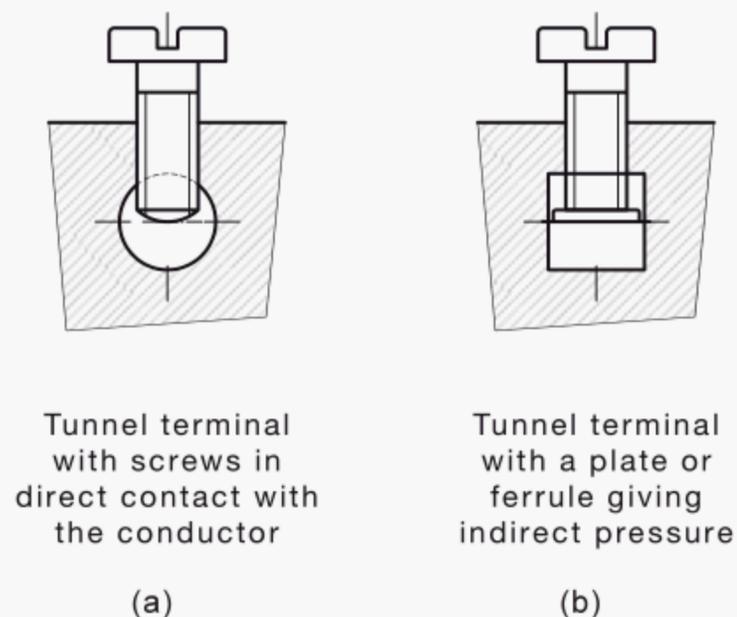


FIGURE 1 TUNNEL TERMINAL TYPES

4 COMPLIANCE WITH AS/NZS 3100

Tunnel type terminal bars shall comply with the relevant requirements of AS/NZS 3100.

5 MARKING

5.1 Required marking

The following marking information shall be provided:

- (a) Type reference (e.g. a catalogue number).
- (b) Manufacturer's or responsible vendor's name or trade mark or identification mark.
- (c) The rated current in amps, e.g. 63 A.
- (d) Terminals:
 - (i) The terminal for the MEN connection to the main earth, the letter 'E' or the symbol .
 - (ii) The terminal for the supply main neutral connection, the letter 'N'.
 - (iii) Every other terminal, from 1 in numerical sequence (see Note).

Exception: The marking of the MEN (E) and main neutral terminal (N) is not required if the MEN connection is at one extremity and the main neutral is the next adjacent terminal.

NOTE: Conventionally the terminals are marked in sequence from the left hand end or from the main neutral.

- (e) AS/NZS 5112 (the number of this Standard).
- (f) Rated connecting capacity.

5.2 Location of marking

The marking shall be clearly discernible from the outside after the bar has been fixed as in normal use, but, if necessary, after removal of a cover.

Items (b), (c) and (d) shall be on the bar itself or may be on the bar support if the bar is supplied integral with a complete assembly (e.g. moulded into the support or by labelling).

Items (a), (e) and (f) may be in the manufacturer's or responsible vendor's data.

5.3 Method of marking

The marking shall be legible and durable and shall be in accordance with AS/NZS 3100.

5.4 Manufacturer's instructions and data

Instructions shall be provided with the product or in the manufacturer's data for the following:

- (a) The maximum connecting capacity, in mm².
- (b) Any requirements for prepared conductors, e.g. shoelace ferrules for flexible cables, lug sizes for bolted terminals. Conductors solidified by solder are not permitted.

The following recommendations apply:

- (i) It is recommended that Table 1 be supplied to show cable sizes for connection limits.
- (ii) It is recommended that Table 2 be supplied to show the maximum torques with a note that the torque must not be below 2/3 of these values.

6 REQUIREMENTS

6.1 General

The bars shall be provided with clamping facilities for securely terminating the conductors used in normal service.

The clamping of conductors shall be secure, not loosen in normal service and not exceed the allowable temperatures.

6.2 Range of conductors and connection requirements

6.2.1 *Range of conductors to be connected*

The bars shall be provided with means to clamp stranded, solid and flexible copper conductor as shown in Table 1. The conductors shall be unprepared and prepared conductors in accordance with the manufacturer's instructions.

The maximum size of an unprepared conductor to be clamped shall be at least one size larger than the conductor with a current rating in Table 4 corresponding to the rated current of the neutral bar.

Compliance shall be established in accordance with Clauses 7.3.1.1 and 7.3.1.2.

NOTE: The test of 7.10 is carried out on the cable size corresponding to the rated current in Table 4, e.g. A 250A test is carried out on a 35 mm² in Table 4, and not on the maximum connecting capacity of 50 mm² which relates to Table 1, Clause 6.2.2 and 7.3.2.

6.2.2 *Maximum connecting capacity*

The maximum connecting capacity is the largest unprepared stranded copper conductor size in Table 1 that can be clamped.

Compliance shall be established in accordance with Clause 7.3.2.

6.2.3 *Separate terminals for individual conductors*

The bars shall be provided with separate terminals for connecting each individual incoming and outgoing cable.

Compliance shall be established in accordance with Clause 7.3.3.

6.2.4 *Tunnel terminal types*

One or more of the following tunnel terminal types, as defined in Clause 3.9, may be used:

- (a) Tunnel terminal with screws in direct contact with the conductors.
- (b) Tunnel terminal with a ferrule or plate giving indirect pressure on the conductors from the screw.
- (c) Saddle terminals for incoming conductors.

Compliance shall be established in accordance with Clause 7.3.4.

TABLE 1
CONDUCTOR SIZE DATA FOR CONDUCTOR CONNECTING CAPACITY

Conductor size mm ²	Typical number of strands/strand diameter, in mm		Approximate theoretical maximum overall diameter of copper conductor, in mm	
	Stranded conductors	Flexible cords and cables	Stranded conductors	Flexible cords and cables
1	1/1.13 (see Note)	32/0.20	1.13 (see Note)	1.5
1.5	7/0.50	30/0.25	1.7	1.8
2.5	7/0.67	50/0.25	2.2	2.3
4	7/0.85	56/0.3	2.7	2.9
6	7/1.04	84/0.3	3.3	3.9
10	7/1.35	77/0.4	4.2	5.1
16	7/1.70	126/0.4	5.3	6.3
25	19/1.35	209/0.4	6.6	7.8
35	19/1.53		7.9	
50	19/1.78		9	

NOTE: 1 mm² is a solid conductor.

6.3 Material for bar

The bar shall be a brass material containing at least 50% copper and comply with AS/NZS 1567.

Compliance shall be established in accordance with Clause 7.4.

6.4 Material for screws and type of threads

Screws shall be of a metal having, under the conditions occurring in the equipment, mechanical strength, electrical conductivity and resistance to corrosion adequate for their intended use. The threads shall be metric.

NOTE: Typical examples of suitable metals, when used within the permissible temperature range and under normal conditions of chemical pollution, are as follows:

- (a) An alloy containing at least 50% copper (brass). These may be specified in some tropical areas.
- (b) Steel provided with an electroplated coating of zinc with coating having a thickness of at least 5 µm.
- (c) Steel provided with an electroplated coating of nickel and chromium having a thickness of at least 20 µm.
- (d) Steel provided with an electroplated coating of tin having a thickness of at least 12 µm.
- (e) Steel provided with an electroplated coating of copper, nickel and brass having a thickness of approximately 10 µm.

Compliance shall be established in accordance with Clause 7.5.

6.5 Characteristics of screws

6.5.1 Shape of screw ends

The end of the screws in direct contact with the conductor shall be shaped to prevent undue damage and the cutting of solid, stranded or flexible conductors, e.g. cupped end screws with sharp protruding 'rings' are not considered to comply. Screw ends that are slightly convex may be required.

NOTE: Refer to Appendix B for examples.

Compliance shall be established in accordance with Clause 7.6.1.

6.5.2 *Tunnel entries*

The entry into each tunnel shall be clean and free from all burring to prevent mechanical damage to conductor strands.

Compliance shall be established in accordance with Clause 7.6.2.

6.5.3 *Diameter of single screws in direct contact with a conductor*

A single screw which is in direct contact with a conductor shall have a nominal diameter of at least 80% of the tunnel diameter.

If two screws are supplied the nominal diameter as a percentage of the tunnel diameter is not specified.

Refer to Appendix B for guidance.

Compliance for single screws shall be established in accordance with Clause 7.6.3.

6.5.4 *Screws for tunnel terminals and saddle terminals*

6.5.4.1 *Number and spacing of screws in direct contact with a conductor*

If screws are in direct contact with a conductor, two screws shall be used for the following:

- (a) The main incoming neutral, sub main neutral or connections joining one bar to another.
- (b) The main earthing conductor (minimum size 4 mm²).
- (c) The neutral bar to earth bar or main earth connection (MEN connection).
- (d) A PEN (protective earth neutral), e.g. to an outbuilding.

Exception: One screw with a nominal diameter of at least 80% of the tunnel diameter.

The screws shall be spaced far enough apart and the bar sufficiently wide enough to enable access to the screw heads by normal hand tools to allow screws to be tightened to the torques values in Table 2.

Grub screws shall have sufficient length to ensure effective thread purchase and not fall into the tunnel when no conductor is present, e.g. 8.5 mm diameter tunnel, M8 grub screw x 10.2 mm long.

Compliance shall be established in accordance with Clause 7.6.4.

6.5.4.2 *Number of screws for tunnel terminals with a plate or ferrule giving indirect pressure and for saddle terminals*

6.5.4.2.1 *Tunnel terminals with a plate or ferrule giving indirect pressure*

Tunnel terminals with a plate or ferrule giving indirect pressure may have one screw for the connections specified in Clause 6.5.4.1.

6.5.4.2.2 *Saddle terminals*

The saddle of a saddle terminal shall be positioned to clamp the conductor across the full diameter of the conductor by a screw on each side of the conductor position.

Compliance shall be established in accordance with Clause 7.6.4.2.

6.6 Mechanical characteristics of screws and bars

6.6.1 *General*

When screws are tested in accordance with Clause 7.7.1, there shall be no undue damage to the screws or bars and the screw length will ensure the screw reaches the bottom of the tunnel.

6.6.2 *Undue damage to screws and the bar*

When screws are tested in accordance with Clause 7.7.2, there shall be no undue damage that will impair the further use of the terminal. The screw threads shall not strip, the screw heads shall remain intact, and the bar section shall not crack or fracture.

Compliance shall be established in accordance with Clause 7.7.2.

6.6.3 *Length of screws*

The screw length for clamping unprepared conductors shall be such that the thread will have remaining after contacting the bottom of the tunnel—

- (a) a minimum of one turn remaining under the head of the screw; or
- (b) a minimum of three threads remaining for screws without heads (e.g. grub screws).

Compliance shall be established in accordance with Clause 7.7.3.

6.7 Mechanical requirements for clamping

6.7.1 *Distance from the edge of a single screw to the end of a blind hole*

The distance from edge of a single screw to the end of blind hole shall be sufficient to ensure that all strands at the end of an unprepared conductor are clamped.

The distance shall be at least half the tunnel hole diameter.

NOTES:

- 1 The strands at the end of an unprepared conductor may be unequal lengths which require a distance to ensure all strands are clamped.
- 2 The holes in tunnel terminals are normally through holes where the conductor enters on one side and exits on the other side.

A hole drilled within a bar, with no exit, is a blind hole.

A through hole which is blocked by an external barrier is regarded as a blind hole.

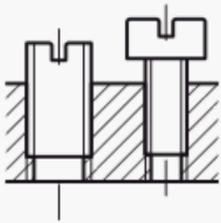
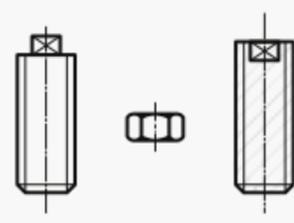
Compliance shall be established in accordance with Clause 7.8.1.

6.7.2 *Escape of strands, severed strands and undue damage*

When tested in accordance with Clause 7.8.2, the strands shall remain under the clamping means and the strands shall not be severed or have undue damage.

Compliance shall be established in accordance with Clause 7.8.2.

TABLE 2
SCREW TIGHTENING TORQUE VALUES

Nominal diameter of screw metric ISO thread (see Note 1)	Torque Nm screws with or without heads that protrude	
	Screws tightened by a screwdriver (see Note 2) 	Screws tightened by means other than a screwdriver (see Note 2) 
4	1.2	1.2
5	2.0	2.0
6	2.5	3.0
8	3.5	6.0
10	4.0	10.0

NOTES:

- 1 For other types and sizes, refer to Table 102 of AS/NZS 60998.2.1.
- 2 Head types are not specified. Typical types are slotted, Philips, posidrive, socket and hexagon.

6.8 Clamping of conductors

When tested in accordance with Clause 7.9, the conductors shall not move noticeably and strands shall not escape.

Compliance shall be established in accordance with Clause 7.9.

6.9 Temperature rise at rated current

The bar's smallest cross-section, the terminal connections and the terminals for conductors used for joining bars together shall have a maximum temperature rise of 45 K when tested in accordance with Clause 7.10, in open air with the marked rated current flowing through the bar and test conductors.

Compliance shall be established in accordance with Clause 7.10.

6.10 Resistance of insulating materials to abnormal heat and fire

If supplied with insulating materials for support of the bar in position, the insulating material shall comply with the glow wire test (GWT) of AS/NZS 60695.2.11, 'Resistance of insulating materials to abnormal heat and fire', at 960°C.

7 TESTS

7.1 General

The tests set out in this Standard are type tests.

Unless otherwise specified, the samples are tested as delivered and installed as in normal use, at an ambient temperature of 20°C ±5°C.

The tests are carried out in the order of the Clauses below.

Newly stripped conductors or newly prepared conductors shall be used for each test.

7.2 Number of samples

If a test failure occurs, and unless otherwise specified, a suitably modified sample shall be submitted to all tests which may be affected by the modification, and any other tests which may be affected by these repeat tests; all tests being carried out in the correct order. Where the submission of a suitably modified sample is not made, three additional samples shall be required to withstand all tests relevant to the failure.

7.3 Range of conductors and connection requirements

7.3.1 Range of conductors to be connected

7.3.1.1 Unprepared solid and stranded conductors

Samples of unprepared solid and stranded conductors of each size of each type shown in Table 1 shall be inserted with normal hand force into the appropriate tunnel.

The smallest and largest size able to be inserted in each size tunnel shall be recorded.

The largest size of unprepared conductor shall be recorded as the maximum connecting capacity.

7.3.1.2 Flexible conductors

Samples of flexible conductors of each size of each type and of the conductors shown in Table 1 shall be inserted with normal hand force into the appropriate tunnel. If prepared conductors are submitted, the type of preparation shall be recorded. The smallest and largest size shall be recorded.

7.3.2 Maximum connecting capacity

Compliance shall be established in accordance with Clause 7.3.1.

7.3.3 Separate terminals for individual conductors

Separate terminals shall be provided for each individual conductor.

Compliance shall be established by inspection of marking.

7.3.4 Tunnel terminal types

The type of tunnel terminal shall be recorded.

7.4 Material for bars

Compliance shall be established by inspection, manufacturer's data and, if necessary, by chemical analysis.

7.5 Material for screws and type of threads

Compliance shall be established by inspection, manufacturer's data and, if necessary, by chemical analysis.

7.6 Characteristics of screws and tunnels

7.6.1 Shape of screw ends

The ends of screws in direct contact with conductors shall be inspected.

Compliance of ends shall be established in accordance with Clause 6.5.1, subject to the test of Clause 7.7.

7.6.2 Tunnel entries

The entry into each tunnel terminal shall be free of burrs.

Compliance shall be established by inspection.

7.6.3 *Diameter of single screws in direct contact with a conductor*

The outside diameter of each of the screws shall be measured to verify the nominal diameter. The inside diameter of each tunnel shall be measured.

The ratio shall be calculated and recorded.

The ratio shall not be less than 80%.

7.6.4 *Screws for tunnel terminals and saddle terminals*

7.6.4.1 *Number and spacing of screws in direct contact with a conductor*

If screws are in direct contact with a conductor, there shall be two screws for the connections specified in Clause 6.5.4.1.

A suitable hand tool shall be used to tighten each screw without being restricted by the adjacent screw.

Compliance shall be established by inspection.

7.6.4.2 *Number of screws for saddle terminals*

The saddle of a saddle terminal shall have a screw on each side of the conductor position.

Compliance shall be established by inspection.

7.7 Mechanical characteristics of screws and bars

7.7.1 *Test*

Screws are tightened to the torque values in Table 2 without any conductor inserted.

7.7.2 *Undue damage to screws and the brass bar*

The test shall be repeated five times.

Compliance shall be established in accordance with Clause 6.6.2 by noting the performance and by visual inspection.

7.7.3 *Length of screws*

The thread remaining when the screw end contacts the bottom of the tunnel shall be inspected.

Compliance shall be established in accordance with Clause 6.6.3, by visual inspection.

7.8 Mechanical requirements for clamping

7.8.1 *Distance from the edge of a single screw to the end of a blind hole*

The test is carried out without a conductor inserted.

The diameter and depth of a blind hole, if present, shall be measured. The distance to the edge of the screw closest to the end of the blind hole shall be measured.

The distance measured shall be at least half the tunnel diameter.

7.8.2 *Escape of strands, severed strands and undue damage*

Unprepared conductors of the maximum and minimum sizes that can be inserted are inserted until the ends of the conductor strands protrude from the opposite face of the bar or until the conductor reaches the full depth of the blind hole and is in the most likely position for the wire to escape.

The screws are tightened to 2/3 of the torque in Table 2.

The strands shall remain under the clamping means and the strands shall not be severed or have undue damage. Conductors are considered to be unduly damaged if they show deep and sharp indentations such that if bent once the conductor would break.

Compliance shall be established by inspection.

7.9 Clamping of conductors

Unprepared stranded copper conductors of the smallest and largest cross-sectional areas as determined during the test of Clause 7.3.1 are inserted into the relevant size tunnel.

The terminal screws are then tightened with a torque equal to 2/3 of that shown in Table 2.

Each conductor is then subjected to a pull of the value, in Newtons, shown below in Table 3. The pull is applied without jerks, for 1 min, in the direction of the axis of the conductor space.

TABLE 3
PULLING FORCE IN NEWTONS FOR PULL OUT TEST

Cross-section of the conductor inserted in the terminal mm²	1, 1.5, 2.5, 4	6	10	16	25, 35, 50
Pull N	50	60	80	90	100

During the test, the conductor shall not loosen or move noticeably in the terminal and there shall be no escape of strands.

NOTE: 'Move noticeably' is deemed to be a longitudinal movement by 2 mm or more either before the direct pull reaches the specified value or during the time that the pull is maintained.

Compliance shall be established by observation and measurement.

7.10 Temperature rise at rated current

The bar shall be mounted on a wooden base at least 25 mm thick.

If supplied with insulating materials for support of the bar in position, the insulating material shall be mounted on a wooden base at least 25 mm thick.

A PVC insulated unprepared single core stranded copper test conductor, with a size corresponding to the rating in Table 4, shall be connected to the main neutral conductor terminal [refer to Clause 5.1(c) and (d)] and to the terminal at the furthest extremity of the bar.

If bars are provided with a conductor for joining bars together this joining conductor is to be included.

If there are no appropriate size tunnels at the extremity then smaller cables may be progressively connected from the furthest extremity until the rated current of the bar is reached.

No cables are connected in other tunnel terminals.

The cables shall be at least 2 m long.

The terminal screws are tightened with a torque equal to 2/3 of that shown in Table 2.

The test current for each conductor size is as per Table 4.

NOTE: The maximum connecting capacity conductor is one size larger than the test conductors in Table 4 and in accordance with Clauses 6.2.1 and 7.3.2 is not tested for temperature rise.

TABLE 4
TEST CONDUCTOR SIZE
AND TEST CURRENT

Test conductor size mm ²	Test currents*
2.5	25
4	32
6	40
10	63
16	80
25	100
35	125

* Test currents are AS/NZS 3000, Table C5 'unenclosed in air' values.

The ambient air temperature will be measured at approximately 1 m from the bar and at a level the same as the bar. This ambient measurement is used to calculate the temperature rise of the bar under test.

Measurement of temperature shall be made at the terminal connections of the test conductors and at a point near the midpoint of the bar where the cross-section, after allowing for the tunnel hole, is the smallest.

Temperature rise measurements are made when the device under test has reached thermal equilibrium. It is generally accepted that the temperature is stable when the temperature of the part under test does not increase by more than 1 Kelvin per hour.

Compliance: The temperature rise shall not exceed 45 K at the terminals of the test conductors and the bar.

APPENDIX A

RATED CURRENT OF NEUTRAL BARS WHEN MOUNTED INSIDE
SWITCHBOARD ENCLOSURES

(Informative)

A1 RATED CURRENT VALIDITY WHEN USED IN A SWITCHBOARD

The rated current determined in accordance with this Standard is valid for a neutral bar mounted inside a switchboard enclosure when the temperature rise of the inside air over the outside air does not exceed 25 K as follows.

A2 TEST TEMPERATURE RISE VALUE

This Standard allows a temperature rise on terminals for outgoing conductors of 45 K above the air surrounding the bar to determine the rated current.

This is the rated current as a component.

A3 COMPARISON OF TEMPERATURE RISE TO THIS STANDARD AND THE TEMPERATURE RISE IN SWITCHBOARDS

The AS/NZS 3439 series and the AS/NZS 61439 series which cover switchboards, allow a temperature rise on terminals for outgoing conductors of 70 K over the outside air surrounding the enclosure. The temperature of the air inside an enclosure will be higher than the outside air surrounding the enclosure.

The 70 K limit is not exceeded for the sum of a temperature rise of the inside air over the outside air of 25 K plus the bar temperature rise over the inside air of 45 K,

i.e.—

$$70 \text{ K} = 25 \text{ K} + 45 \text{ K}$$

APPENDIX B
EXAMPLES OF TUNNEL TERMINAL BARS
(Informative)

B1 GENERAL

This Appendix provides examples that supplement the requirements of Clause 6.

These examples are for information only and construction to these figures does not overcome the need to test to this Standard.

B2 TWO SCREWS PER TUNNEL—EXAMPLE 1

B2.1 General

An example of two screws per tunnel is shown in Figure B1.

B2.2 Screw diameter/tunnel ratio

The ratio is not specified when two screws are used, but needs to be adequate to prevent escape of strands. The ratio in this example is >80%.

B2.3 Screw end shape

The screws have a radius on the end and are unlikely to cut strands.

B2.4 Screw length

The screws touch the bottom of the tunnel and are likely to clamp small strands.

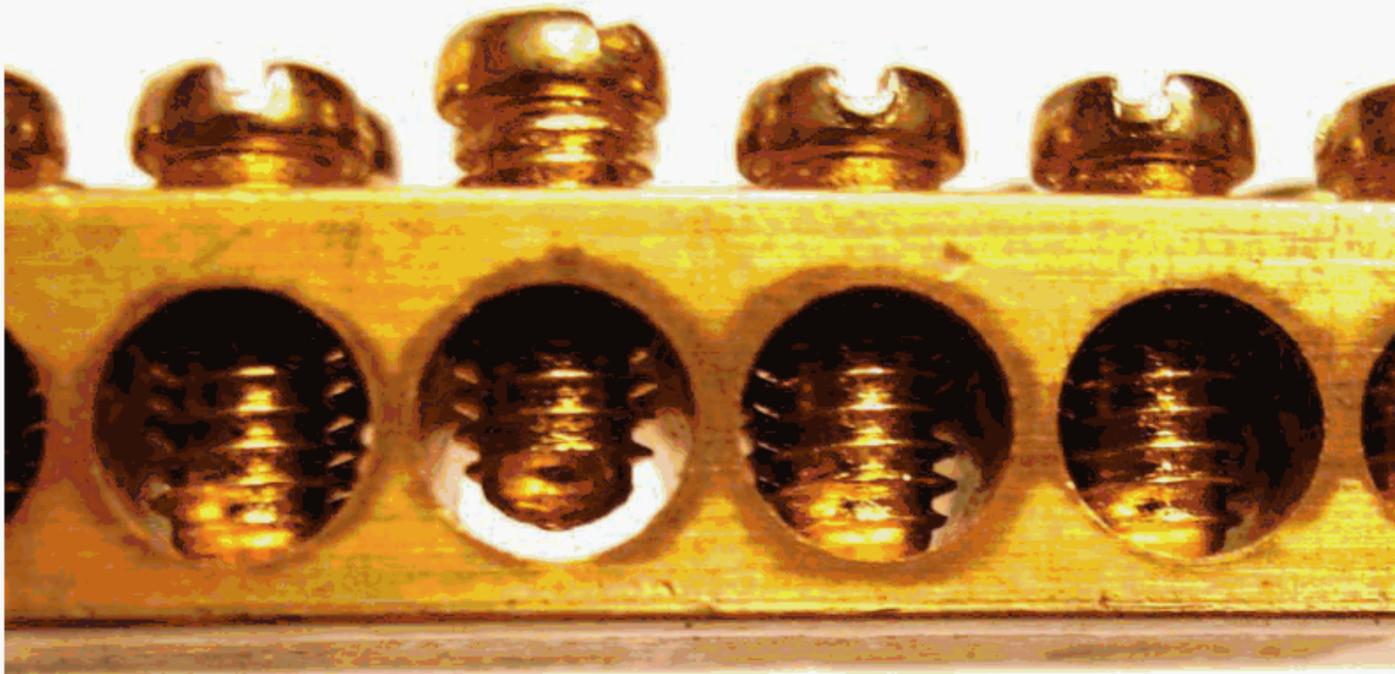


FIGURE B1 TWO SCREWS PER TUNNEL—EXAMPLE 1

B3 TWO SCREWS PER TUNNEL—EXAMPLE 2

B3.1 General

Another example of two screws per tunnel is shown in Figure B2.

B3.2 Screw diameter/tunnel ratio

The ratio is not specified when two screws are used, but needs to be adequate to prevent escape of strands. The ratio in this example is 75% and may be adequate subject to test.

B3.3 Screw end shape

The screws have a bevel on the end and are unlikely to cut strands.

B3.4 Screw length

The screws touch the bottom of the tunnel and are likely to clamp small strands.

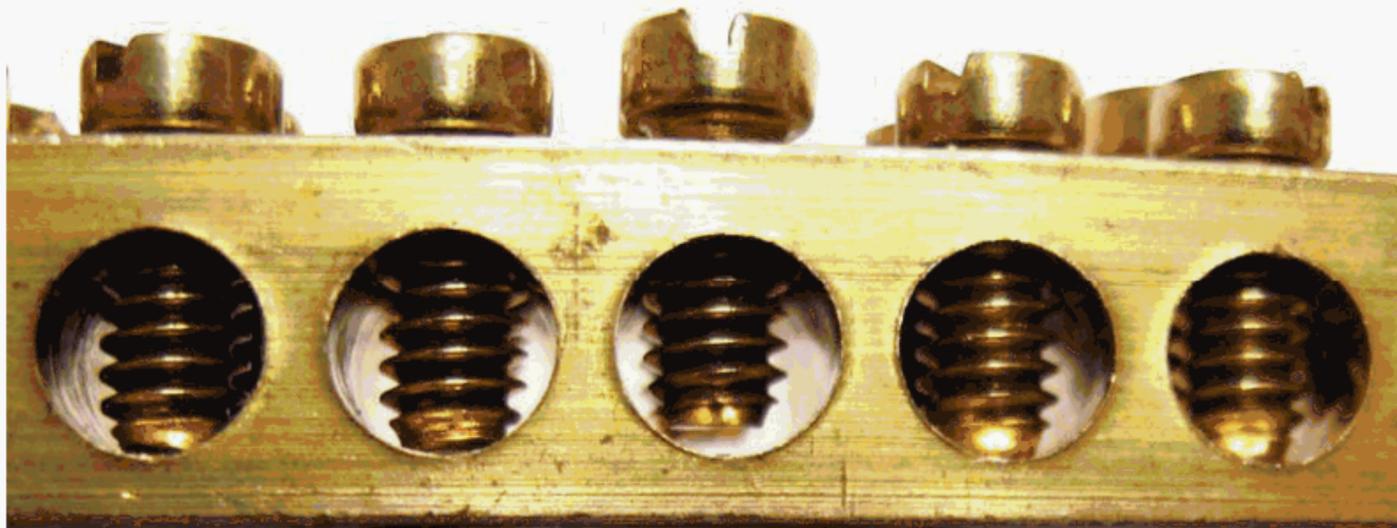


FIGURE B2 TWO SCREWS PER TUNNEL—EXAMPLE 2

B4 ONE SCREW PER TUNNEL—EXAMPLE 1

B4.1 General

An example of one screw per tunnel is shown in Figure B3.

B4.2 Screw diameter/tunnel ratio

The ratio is specified at a minimum of 80% when one screw is used.

The ratio in this example is >80% and complies.

B4.3 Screw end shape

The sharp protruding ring on the screw end is likely to cut strands (see detail in Figure B4) and is not considered to comply with Clause 6.5.1.

B4.4 Screw length

The screw ends do not contact the bottom of the tunnel and are unlikely to clamp small strands.

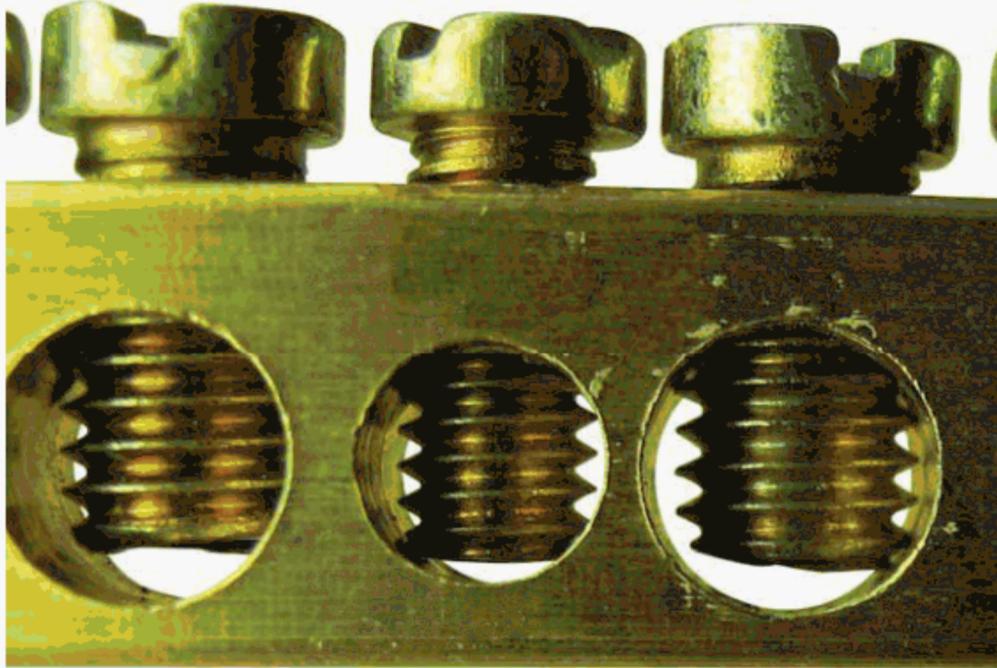


FIGURE B3 ONE SCREW PER TUNNEL—EXAMPLE 1

B5 ONE SCREW PER TUNNEL—EXAMPLE 2

B5.1 General

Another example of one screw per tunnel is shown in Figure B4.

B5.2 Screw diameter/tunnel ratio

The ratio is specified at a minimum of 80% when one screw is used.

The ratio in this example is <80% and does not comply.

B5.3 Screw end shape

The sharp protruding ring on the screw end is likely to cut strands (see Figure B6) and is not considered to comply with Clause 6.5.1.

B5.4 Screw length

The screw length is inadequate as the ends do not contact the bottom of the tunnel, and are unlikely to clamp small strands.

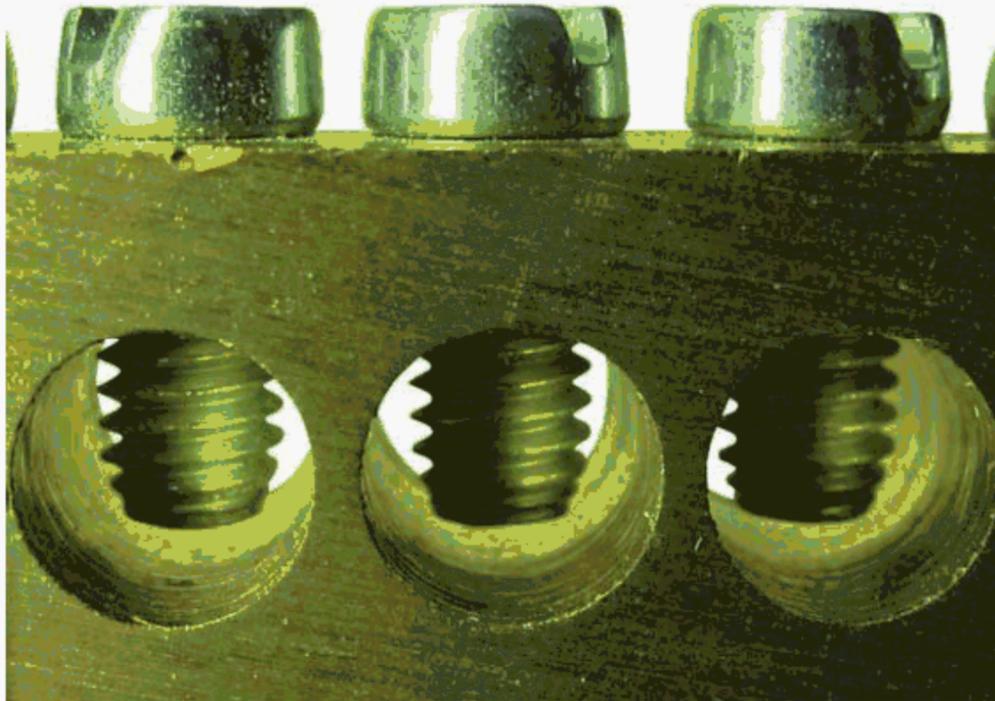


FIGURE B4 ONE SCREW PER TUNNEL—EXAMPLE 2

B6 ONE SCREW PER TUNNEL—EXAMPLE 3

B6.1 General

A third example of one screw per tunnel is shown in Figure B5.

B6.2 Screw diameter/tunnel ratio

The ratio is specified at a minimum of 80% when one screw is used.

The ratio in this example is 80% and complies.

B6.3 Screw end shape

Screw threads removed near screw ends and screws have a flat end and are unlikely to cut strands.

B6.4 Screw length

The screw length is adequate but the screw ends do not contact the bottom of the tunnel and are unlikely to clamp small strands.

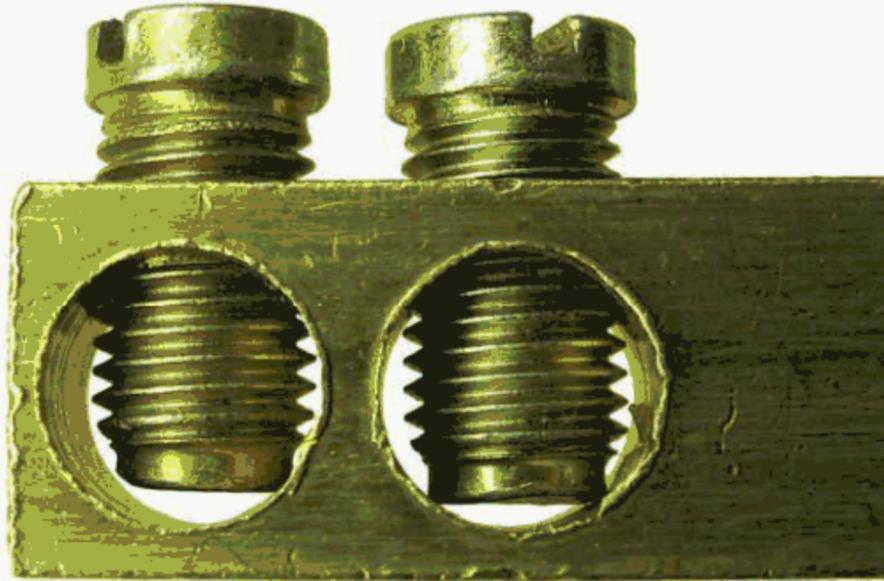


FIGURE B5 ONE SCREW PER TUNNEL—EXAMPLE 3

B7 SHAPE OF SCREW ENDS

B7.1 General

Clause 6.5.1 requires that the end of the screws in direct contact with the conductor shall be shaped to prevent undue damage and the cutting of solid, stranded or flexible conductors.

B7.2 Screws with sharp protruding rings on the ends

An example of cupped end screws with sharp protruding ‘rings’ is shown in Figure B6 and is not considered to comply with Clause 6.5.1.

Cupped end screws with sharp protruding ‘rings’ on the ends are also shown in Figures B3 and B4.



FIGURE B6 CUPPED END SCREWS WITH SHARP PROTRUDING ‘RINGS’

B8 SADDLE TERMINAL

B8.1 General

An example of a saddle terminal is shown in Figure B7.

B8.2 Screws

Screws are not in direct contact with conductors.

One screw on each side of the clamping plate is specified. This sample complies.

The relevant tests for tunnel terminals apply.

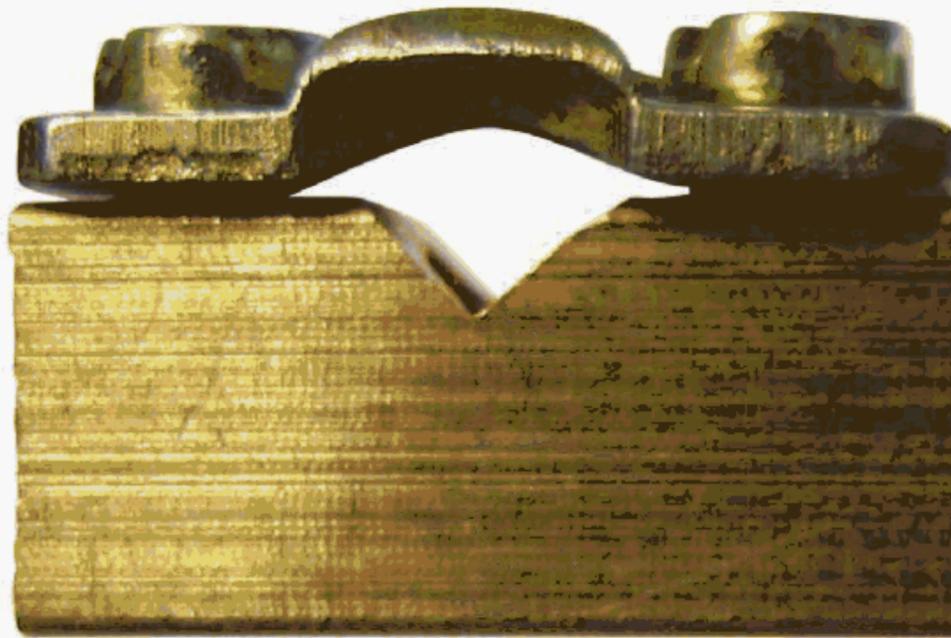


FIGURE B7 SADDLE TERMINAL

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NOTES

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