

Australian Standard[®]

**Low voltage switchgear and
controlgear—protection of electric
motors**

**Part 1: Built-in thermal detectors
and associated control units**

This Australian standard was prepared by Committee EL/6, Industrial Switchgear and Controlgear. It was approved on behalf of the Council of the Standards Association of Australia on 20 February 1985 and published on 7 June 1985.

The following interests are represented on Committee EL/6:

Australian–British Chamber of Commerce
Australian Electrical and Electronic Manufacturers Association
Bureau of Steel Manufacturers of Australia
Confederation of Australian Industry
Department of Defence
Department of Defence Support
Electrical Contractors Association of Australia
Electricity Supply Association of Australia
Institution of Engineers Australia
Metropolitan Water Sewerage and Drainage Board, Sydney
Railways of Australia Committee
Testing Authorities

Representatives of the following interests also participated in the drafting of this standard:

Department of Public Works, N.S.W.
State Rail Authority of NSW

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and associated control units**

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PREFACE

This edition of this standard was prepared by the Association's Committee on Industrial Switchgear and Controlgear to supersede AS 1023, Part 1–1971, Thermal Protection of Electric Motors–Built–in Thermal Detectors and Associated Control Units. AS 1023 is a three–part standard, the other two Parts being as follows:

Part 2–1972 Thermal Overload Protection Devices*

Part 3–1972 Inherent Overheat Protectors.

In this standard two types of protection are provided–

- (a) Type TP1–where the motor is protected against overheating only when running on load; and
- (b) Type TP2–where the motor is protected both when running on load and when stalled.

In the preparation of this standard, consideration was given to the following IEC documents and acknowledgment is made of the assistance received therefrom:

IEC 34 Rotating Electrical Machines
34–11, Part 11: Built–in Thermal Protection
Chapter 1: Rules for Protection of Rotating Electrical Machines

IEC document 2(Central Office)492
Draft–Publication 34: Part 11: Built–in Thermal Protection:
Chapter II–Section One: General Rules for Thermal Detectors and Control Units
used in Thermal Protection Systems

IEC document 2(Central Office)493
Draft–Publication 34: Part 11: Built–in Thermal Protection:
Chapter II–Section Two: The Characteristics of a Particular Interchangeable
Thermal Protection System Utilizing PTC Thermistor Protectors and Control
Units.

This standard does not follow the above IEC documents since AS 1023, Part 1–1971 has served the industry well and its simpler approach in comparison with the IEC documents has been found to be more suitable. In particular, this opinion applies to the use herein of the same reference temperature (T_T) for thermistors, thermostats and system operating temperature values. However the above IEC documents have considerably influenced this edition in the performance requirements and tests specified in Section 4–Thermistors, Section 5–Thermistor Control Unit and Section 7– Thermostats. In consequence this edition represents a considerable expansion of AS 1023, Part 1–1971.

* In course of revision. Title to be 'Current Sensing Protection Devices'.

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STANDARDS ASSOCIATION OF AUSTRALIA

Australian Standard

for

**LOW VOLTAGE SWITCHGEAR AND CONTROLGEAR—
PROTECTION OF ELECTRIC MOTORS****PART 1—BUILT-IN THERMAL DETECTORS AND ASSOCIATED CONTROL UNITS**

FOREWORD

The requirements of this standard are based on the need to provide a simple yet effective means of protecting an electric motor against damage by overheating but at the same time permitting maximum utilization of its capabilities.

With current-operated protective schemes the level of protection can be related to the rated load of the motor and generally can be adjusted, but with the thermal protection scheme covered by this standard, the degree of protection is governed by the thermal endurance of the winding insulation and the level is not adjustable.

Devices covered by this standard are intended as far as possible to protect the motor from damage due to the excessive overheating (short term) resulting from stalling and single phasing as well as the overheating (long term) caused by persistent overloading, impaired ventilation, etc. This involves a compromise since the level of protection must not be set so low as to cause nuisance tripping, e.g. when there is a temporary reduction in the supply voltage and the rated motor current is exceeded. The requirements in themselves are not intended to guarantee 'normal' motor life but rather to avoid premature thermal ageing. Normal motor life can only be assured by correct selection, application and maintenance of the motor in conjunction with the proper application of thermal protection.

It should not be assumed that the thermal protection specified is effective for all motors against all fault or abnormal conditions, as the degree of protection depends upon a number of factors including the rate of rise of temperature of the motor winding. The greatest rate of rise of temperature will usually occur under stalled conditions and it may not be possible to protect all machines against these, particularly when the machine is initially cold, while retaining a proper level of protection against other conditions. It is for this reason that the concepts of Type TPI and Type TP2 have been introduced in Clause 1.4.

In addition to the rate of rise of temperature of the motor winding, there are other factors which affect the performance of thermal protection and these are as follows:

- (a) The temperature characteristic and thermal time constant of the device.
- (b) The location of and the method of installation of the device within the motor and the number of devices used.
- (c) The tolerances on the temperatures at which the operating conditions are attained.
- (d) The tolerances on the control system to which the devices are connected.

With thermal protection, the margin between the protection level and the rated load conditions depends on the difference between the actual and permitted temperature rise of the protected winding and the difference between the actual and specified cooling air temperature. As the temperature settings of these built-in thermal devices are not adjustable, the level has to be chosen to accommodate the hottest cooling air condition and the maximum permissible temperature rise. It is thus possible that motors with this form of protection will operate for long periods at elevated temperatures close to the protection level if the driven equipment is able to demand substantial overloads for long periods.

While such conditions, within reason, should not give rise to any undue concern for the motor, there are two points which should be appreciated:

1. The effective life of the winding insulation is approximately halved for every 8°C to 10°C increase in continuous operating temperature.
2. Where the motor is working in a low ambient temperature, the possible overload on the motor is such that special attention may be required to ensure that the driven apparatus and/or the supply and control gear are capable of handling the overload.

SECTION 1. SCOPE AND GENERAL

1.1 SCOPE. This standard sets out the conditions to be met by thermal detectors, such as thermistors or thermostats, built into or onto motor windings and sensitive to winding temperatures, together with their control units, if any, as part of a system of thermal protection of electric motors, having a rated voltage not exceeding 1000 V.

The standard applies to devices which are responsive to motor temperature only and excludes devices which are -

- (a) sensitive to current;
- (b) sensitive to both current and temperature; and
- (c) designed to carry the motor current.

It covers connection of the devices to the motors, tests on motors fitted with the devices, and the specific requirements of the devices and their control units.

NOTE: The thermal detectors and control units may be of the automatically resetting or manually resetting types.

1.2 REFERENCED DOCUMENTS. The following standards are referred to in this standard:

- AS 1202 A.C. Motor Starters (Up to and including 1000V)
Part 5: Semiconductor (Solid State) Starters
- AS 1359 General Requirements for Rotating Electrical Machines
1359.32 Temperature Limits and Measurements of Temperature
1359.60 Tests
- AS 1431 Control Switching Devices for Voltages up to 650 V a.c. and 250 V d.c.
Part 1: General Requirements
- AS 2768 Electrical Insulating Materials - Evaluation and Classification Based on Thermal Endurance
- IEC 34.11 Rotating Electrical Machines

1.3 DEFINITIONS. For the purpose of this standard, the following definitions apply:

1.3.1 Thermistor - a thermally sensitive semiconductor resistor whose primary function is to exhibit an important change in electrical resistance with a change in body temperature.

1.3.2 Thermostat - a thermally sensitive mechanical switching device.

1.3.3 Reference temperature (T_r) - the nominal temperature of the thermal detector at which it is required to cause the protection system to operate.

1.3.4 Control unit - a device which responds to the resistance change in the thermistor circuit to open or close the switching device controlling the motor or to initiate an alarm circuit.

1.3.5 Rated thermal deviation current (I_{td}) of a thermostat - the value of current, declared by the manufacturer, that the thermostat can carry without lowering its reference temperature by more than that specified in Clause 7.9.

1.4 APPLICATION OF DEVICE. Suitably elected thermal detectors, having characteristics in accordance with Clause 4.2 or Clause 7.2, shall be positioned in or on the motor windings so that the detector resistance or state will change so as to cause -

- (a) the supply to the motor to be disconnected; or
 - (b) the operation of an alarm;
- before the temperature of the winding exceeds the appropriate value given in Table 1.1.

When thermal detectors are provided to initiate a warning signal on steady overload conditions:

- (c) their reference temperature is recommended to be 20°C lower than the reference temperature of detectors providing the drop-off (tripping) function; and
- (d) the devices for both functions shall be mounted in adjacent or equivalent positions in or on the windings.

The device shall be placed in intimate contact with the winding and in a position where the temperature will be as close as possible to the average temperature of the winding, i.e. as measured by the resistance method in accordance with AS 1359.32.

Built-in thermal detectors can be designed to give a warning signal only at a temperature below the tripping level. When they are used to monitor the load condition and it is anticipated that they will operate frequently, this fact should be made known to the manufacturer of the control unit since special arrangements may be necessary.

NOTE: Due to differences in arrangements and construction of windings and methods of cooling, it is not practicable to specify reference temperatures for the detectors and these are to be the subject of agreement between the motor manufacturer and the device manufacturer.

For thermistors, recommended values are given in Table 1.2 but for thermostats, variations such as differences in the size and types available for this application render recommendations of little practical value.

1.5 PROTECTION TYPE CLASSIFICATION. The following protection type classification shall apply:

- (a) Type TPI - where the motor is protected against overheating only when running on load.
- (b) Type TP2 - where the motor is protected against overheating both when running on load and when stalled.

NOTE: For small cage machines with a power output less than 50 kW, it is usually possible to provide protection against thermal overloads with slow variation and thermal overloads with rapid variation (TP2).

On larger machines, protection against thermal overloads with slow variation is normal, but protection against thermal overloads with rapid variation may not be possible, especially in the case of a machine with a wound rotor or rotating armature. For cage machines, protection against rapid thermal overloads usually depends upon the use of enamelled wires on the stator windings and on the suitability of the rotor design.

1.6 MARKING. The following information shall be legibly and indelibly marked on the motor rating plate or on a separate plate attached to the motor:

- (a) The protection type classification (see Clause 1.5).
- (b) The identification code of the thermistors or thermostats as required by Clauses 4.1 and 6.1 respectively.
- (c) The nominal resistance at T_r for thermistors.

NOTE: Electric motor manufacturers who use thermal detectors which comply with this standard may refer to the number of this standard on the rating plates of motors containing these devices.