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Specification for

**Motor starters for voltages up to
and including 1000 V a.c. and 1200 V d.c.**

**Part 4. Reduced voltage a.c. starters,
two-step auto-transformer starters**

Spécification des démarreurs de moteur pour les tensions inférieures
et égales à 1000 V en courant alternatif et 1200 V en courant continu
Partie 4. Démarreurs sous tension réduite en courant alternatif,
démarreurs par autotransformateurs à deux étapes

Spezifikation für Motorstarter für Spannungen bis und einschließlich
1000 V Wechselstrom und 1200 V Gleichstrom
Teil 4. Motorstarter zum Einschalten unter verminderter Spannung,
zweistufige Anlasstransformatoren

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Foreword

This British Standard has been prepared under the direction of the Power Electrical Engineering Standards Committee. It is identical with Publication 292 'Low-voltage motor starters', Part 4 'Reduced voltage a.c. starters : Two-step auto-transformer starters' published by the International Electrotechnical Commission (IEC). It supersedes those requirements of BS 587 : 1957 'Motor starters and controllers' that relate to reduced voltage a.c. starters, two-step auto-transformer starters for voltages up to and including 1000 V a.c.

Cross references. For each of the following references to other IEC Publications that are given in the text, there is an equivalent British Standard; these are as listed below:

Reference to IEC Publication

IEC Publication 76 : 1967 Power transformers

IEC Publication 144 : 1963 Degrees of protection of enclosures for low-voltage switchgear and controlgear

IEC Publication 158 Low-voltage controlgear
Part 1 : 1970 Contactors

IEC Publication 292 Low-voltage motor starters
Part 1 : 1969 Direct-on-line (full voltage) a.c. starters

IEC Publication 292-1A : 1971 First supplement to Publication 292-1

IEC Publication 337 Control switches (low-voltage switching devices for control and auxiliary circuits, including contactor relays)
Part 1 : 1970 General requirements

Additional information. In 4.8.1 reference is made to a specified-time all-or-nothing relay as a type of automatic change-over device.

The term 'all-or-nothing relay' is defined (number 103 2103) in Group 03, Relay terminology, of Part 1 'Terms common to power, telecommunications and electronics' of BS 4727 'Glossary of electrotechnical, power, telecommunication, electronics, lighting and colour terms' as:

'A relay having no specified accuracy and intended to be energized by a quantity having a value either higher than that at which it picks up or lower than that at which it drops out.'

Furthermore, a specified-time all-or-nothing relay is an all-or-nothing relay of which one or more of the times that characterize it, e.g. the operating time, are subject to specification.

Equivalent British Standard

BS 171 : 1970 Power transformers

BS 5420 : 1977 Degrees of protection of enclosures of switchgear and controlgear for voltages up to and including 1000 V a.c. and 1200 V d.c.

BS 5424 Controlgear for voltages up to and including 1000 V a.c. and 1200 V d.c.
Part 1 : 1977 Contactors

BS 4941 Motor starters for voltages up to and including 1000 V a.c. and 1200 V d.c.

Part 1 : 1973 Direct-on-line (full voltage) a.c. starters

Appendix C to BS 4941 : Part 1 Co-ordination with short-circuit protective devices

BS 4794 Control switches (switching devices, including contactor relays, for control and auxiliary circuits up to and including 1000 V a.c. and 1200 V d.c.)

Part 1 : 1973 General requirements

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LOW-VOLTAGE MOTOR STARTERS

Part 4: Reduced voltage a.c. starters: Two-step auto-transformer starters

1. General

1.1 Scope

This standard applies to two-step auto-transformer starters for industrial use, intended to start, in the starting position, and accelerate an a.c. induction motor to normal speed and to provide means for the protection of the motor and its associated circuits against operating overloads, and to cause the motor to stop intentionally.

Note. — Auto-transformer starters with more than two steps are considered as special cases subject to agreement between manufacturer and user.

This standard is additional to IEC Publication 292-1, Low-voltage Motor Starters, Part 1: Direct-on-line (Full Voltage) A.C. Starters, which also applies provided it is not amended by the present standard.

The auto-transformer starters dealt with in this standard are not intended for inching duty or reversing motors rapidly and, therefore, utilization category AC-4 does not appear. Moreover, they are not designed to interrupt short-circuit currents; therefore, suitable short-circuit protection should form part of the installation but not necessarily in the starter (see Appendix C of IEC Publication 292-1).

This standard applies only to starters the main contacts of which are intended to be connected to circuits the rated voltage of which does not exceed 1 000 V a.c.

The clauses of this standard relating to overload protection are not applicable to starters operating in conjunction with over-temperature protective devices built into the motors.

Note. — In the starting position, the current in the line and the torque of the motor related to the motor starting with rated voltage are reduced approximately as the square of the ratio (starting voltage)/(rated voltage). Therefore, auto-transformer starters are used when the inrush current due to the starting is to be limited, or when the driven machine requires a limited torque for starting. The figure on page 43 indicates typical curves of starting current, of starting torque of the motor, and of torque of the driven machine.

1.2 Object

The object of this standard is to state:

1. the characteristics of auto-transformer starters;
2. the conditions with which starters shall comply with reference to:
 - a) their operation and behaviour;
 - b) their dielectric properties;
 - c) the degrees of protection provided by their enclosures;
3. the tests intended for confirming that these conditions have been met, and the methods to be adopted for these tests;
4. the data to be marked on the apparatus.

2. Definitions

For the purpose of this standard, the following definitions shall apply.

2.1 Starter

See IEC Publication 292-1*.

* Whenever reference is made to IEC Publication 292-1, the clause with the same clause number in the first edition (1969) applies, in some instances modified by the text which follows.

2.1.1 *Auto-transformer starter*

A starter for an induction motor which uses for starting one or several reduced voltages derived from an auto-transformer.

2.2 *Direct-on-line starter*

See IEC Publication 292-1.

2.3 *Reversing starter*

See IEC Publication 292-1.

2.4 *Manual starter*

See IEC Publication 292-1.

2.5 *Electromagnetic starter*

See IEC Publication 292-1.

2.6 *Motor operated starter*

See IEC Publication 292-1.

2.7 *Pneumatic starter*

See IEC Publication 292-1.

2.8 *Electro-pneumatic starter*

See IEC Publication 292-1.

2.9 *Over-current*

See IEC Publication 292-1.

2.10 *Overload*

See IEC Publication 292-1.

2.11 *Short-circuit current*

See IEC Publication 292-1.

2.12 *Overload relay or release*

See IEC Publication 292-1.

2.13 *Thermal overload relay or release*

See IEC Publication 292-1.

2.14 *Current setting of an overload relay or release*

See IEC Publication 292-1.

2.15 *Current setting range of an overload relay or release*

See IEC Publication 292-1.

2.16 *Undercurrent relay*

A measuring relay which operates when the current through it is reduced below the operating value.

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2.17 *Auto-transformer* (Clause 4.1.2 of IEC Publication 76 (1967), Power Transformers).

A transformer in which at least two windings have a common part.

2.18 *Two-step starter*

A starter in which there is only one intermediate accelerating position between the OFF and FULL ON positions.

2.19 *Starting time* t_s (of an auto-transformer starter)

The length of time while the auto-transformer carries current.

2.20 *Open transition*

A circuit arrangement such that the current to the motor is interrupted when changing over from one step to another.

2.21 *Closed transition*

A circuit arrangement such that the current to the motor is not interrupted (even momentarily) when changing over from one step to another.

Note. — The transition stage is not considered an additional step.

3. **Classification**

3.1 (See IEC Publication 292-1.)

3.2 (See IEC Publication 292-1.)

3.3 (See IEC Publication 292-1.)

3.4 According to the degree of protection provided by the enclosure, distinction is made in accordance with IEC Publication 144, Degrees of Protection of Enclosures for Low-voltage Switchgear and Controlgear.

3.5 According to the method of changing from the starting position to the FULL ON position, auto-transformer starters are designated as:

- automatic change-over (i.e. independent of the operator), e.g. controlled by a timer or an undercurrent relay;
- non-automatic change-over (i.e. dependent on the operator), e.g. controlled by hand or by push-buttons.

3.6 According to the method of connecting the auto-transformer, auto-transformer starters are classified as open transition starters or closed transition starters (see diagrams on page

3.7 According to the method of cooling the auto-transformer, auto-transformer starters are designated as:

- having the auto-transformer air cooled by convection;
- having the auto-transformer cooled by immersion in oil.

4. **Characteristics of auto-transformer starters**

In an auto-transformer starter, the starting position is transitional only. If, for special applications, the starting position is not transitional but on the contrary is a normal operating position, an agreement concerning these special characteristics shall be reached between manufacturer and user.

[IEC page 11]

4.1 *Summary of characteristics*

The characteristics of an auto-transformer starter shall be stated in the following terms, where such terms are applicable:

- Type of switching devices (see Clause 4.2).
- Type and characteristics of automatic change-over devices (see Clause 4.8).
- Type and characteristics of relays and releases (see Clause 4.3) and number of these devices.
- Degrees of protection provided by enclosures (see IEC Publication 144).
- Rated values (see Clause 4.4).
- Control circuits and air-supply systems (see Clause 4.5).
- Auxiliary circuits (see Clause 4.6).
- Type and characteristics of the auto-transformer (see Clause 4.9).
- Co-ordination with short-circuit protective devices (see IEC Publication 292-1A (1971): First supplement to Publication 292-1).

4.2 *Types of switching devices*

See IEC Publication 292-1.

4.2.1 *Number of poles*

4.2.2 *Interrupting medium (air, oil, etc.)*

4.2.3 *Method of operation*

See IEC Publication 292-1.

4.3 *Types and characteristics of relays and releases*

See IEC Publication 292-1.

4.3.1 *Types*

1. Release with shunt coil (shunt trip).
2. Under-voltage opening relay or release.
3. Overload time-delay relay, the time lag of which is:
 - a) substantially independent of previous load (e.g. time-delay magnetic overload relay);
 - b) dependent on previous load (e.g. thermal overload relay).
4. Instantaneous over-current relay or release (when applicable).
5. Other relays or releases (e.g. phase unbalance relay, control switch associated with devices for the thermal protection of the starter).

Note. — Types referred to in Items 4 and 5 require consultation between manufacturer and user according to the particular application.

4.3.2 *Characteristics*

1. Release with shunt coil and under-voltage opening relay or release:
 - rated voltage;
 - rated frequency.
2. Overload relay:
 - either the associated motor full-load current or the ultimate trip current (see Clause 7.5.3.2);
 - rated frequency (when necessary);
 - current setting (or range of settings);

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- time-current characteristics (or range of characteristics), when necessary;
- number of poles;
- nature of the relay: thermal or magnetic.

Notes 1. — Depending on the nature of the relay, the opening conditions are given in Clause 7.5.3.2 or in Clause 7.5.3.3.

- 2.* — The starting auto-transformer is normally designed for use during the starting period only; as a result, it cannot be efficiently protected by the overload relay in the event of faulty starting. Protection of the auto-transformer shall be the subject of specific agreement between manufacturer and user (see Clause 7.1.1).

4.3.3 *Designation and current settings of overload relays*

See IEC Publication 292-1.

4.3.4 *Time-current characteristics of overload relays*

See IEC Publication 292-1.

4.3.5 *Influence of ambient air temperature*

See IEC Publication 292-1.

4.4 *Rated values*

See IEC Publication 292-1.

4.4.1 *Rated voltages*

See IEC Publication 292-1.

4.4.1.1 *Rated operational voltages*

See IEC Publication 292-1.

4.4.1.2 *Rated insulation voltage*

See IEC Publication 292-1.

4.4.1.3 *Rated starting voltage*

The rated starting voltage of an auto-transformer starter is the reduced voltage derived from the transformer.

Preferred values of rated starting voltage are 50%, 65% or 80% of the rated operational voltage.

4.4.2 *Rated currents*

An auto-transformer starter is defined by the following rated currents; except in the case of the special applications quoted in Clause 4, all these rated currents relate to the FULL ON position (since the starting position is a transitional one).

4.4.2.1 *Rated thermal current*

See IEC Publication 292-1.

4.4.2.2 *Rated operational currents or rated operational powers*

See IEC Publication 292-1.

4.4.3 *Rated frequency*

See IEC Publication 292-1.

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