
Specification for On-load tap-changers

Spécification des changeurs de prises en charge

Spezifikation für Stufenschaltern

National foreword

This revision of BS 4571 : 1970 has been prepared under the direction of the Power Electrical Engineering Standards Committee. It is identical with Publication 214 'On-load tap-changers' of the International Electrotechnical Commission.

Terminology and conventions. The text of the international standard has been approved for publication, without deviation, as a British Standard. Some terminology and certain conventions are not identical with those used in British Standards; attention is especially drawn to the following.

Wherever reference is made to 'IEC standard(s)', it should be interpreted as 'British Standard(s)'.

Wherever page numbers are quoted in relation to this British Standard, they are IEC page numbers.

NOTE. Textual error. When adopting the text of the international standard, the following error was noticed. It has been corrected in this British Standard.

In the note to 11.11, '50 Nm' has been replaced by '50 N m'.

Cross-references. The following international standards are referred to in the text and for each there is a corresponding British Standard; these are as listed below:

International standard	Corresponding British Standard
IEC 60	BS 923 : 1972 Guide on high voltage testing techniques (Technically equivalent)
IEC 76	BS 171 Power transformers
IEC 76-1 : 1976	BS 171 : Part 1 : 1978 General (Identical)
IEC 137 : 1973	BS 223 : 1956 High-voltage bushings NOTE. For the purposes of the application of test voltages (see 8.6.5 of this standard) the requirements of BS 223 are applicable
IEC 144 : 1963	BS 5420 : 1977 Specification for degrees of protection of enclosures of switchgear and controlgear for voltages up to and including 1000 V a.c. and 1200 V d.c. (Identical)
IEC 354 : 1972	CP 1010 : 1975 Loading guide for oil-immersed transformers (Technically equivalent)
IEC 542 : 1976	BS 5611 : 1978 Application guide for on-load tap-changers (Identical)

CAUTION. Concerning the reference to synthetic insulating liquids in the note to clause 1, attention is drawn to the fact that because of environmental considerations the use of synthetic insulating liquids containing polychlorinated biphenyls is deprecated.

CONTENTS

	Page
NATIONAL FOREWORD	Inside front cover
Cooperating organizations	Back cover

SECTION ONE — GENERAL

Clause		Page
1. Scope		2
2. Service conditions		2
3. Information required with tenders and orders		3

SECTION TWO — DEFINITIONS

4. Definitions relating to on-load tap-changers (excluding motor-drive mechanisms)	3
5. Definitions relating to motor-drive mechanisms	6

SECTION THREE — REQUIREMENTS FOR ON-LOAD TAP-CHANGERS

6. Rating	7
6.1 Rated characteristics	7
6.2 Rated through-current	7
6.3 Maximum rated through-current	7
6.4 Rated step voltage	8
6.5 Rated frequency	8
6.6 Rated insulation level	8
7. Design and construction	8
7.1 Limiting devices for the protection of tap-changers against transient overvoltages	8
7.2 Oil level gauges	8
8. Type tests	8
8.1 Temperature rise of contacts	8
8.2 Switching tests	9
8.3 Short-circuit current test	11
8.4 Transition impedance test	12
8.5 Mechanical tests	13
8.6 Dielectric tests	13
8.7 Type test certificate	16
9. Routine tests	16
9.1 Mechanical test	16
9.2 Sequence test	17
9.3 Auxiliary circuits insulation test	17
10. Nameplate	17

SECTION FOUR — REQUIREMENTS FOR MOTOR-DRIVE MECHANISMS FOR ON-LOAD TAP-CHANGERS

11. Design and construction	17
11.1 Compliance of component parts with IEC standards	17
11.2 Permissible variation of auxiliary supply	17
11.3 Step-by-step control	17
11.4 Tap position indicator	18
11.5 Tap-change in progress indication	18
11.6 Limiting devices	18
11.7 Parallel control devices	18
11.8 Direction of rotation protection	18
11.9 Overcurrent blocking device	18
11.10 Operation counter	18
11.11 Manual operation of the motor-drive mechanism	18
11.12 Motor-drive cubicle	18
12. Type tests	19
12.1 Mechanical load test	19
12.2 Overrun test	19
12.3 Degree of protection of motor-drive cubicle	19
13. Routine tests	19
13.1 Mechanical tests	19
13.2 Auxiliary circuits insulation test	19
14. Nameplate	20
APPENDIX A — Supplementary information on switching duty relating to tap-changers with resistor transition only	21
APPENDIX B — Method of determining the equivalent temperature of the transition resistor using power pulse currents	25
APPENDIX C — Simulated circuits for service duty and breaking capacity tests	26

British Standard Specification for
On-load tap-changers

SECTION ONE — GENERAL

1. Scope

This standard applies to on-load tap-changers* for power transformers, and their motor-drive mechanisms. It relates mainly to oil-immersed tap-changers, but air-insulated tap-changers are not excluded and the conditions should be suitably modified.

Note. — For the purpose of this standard, a synthetic insulating liquid, e.g. askarel, is regarded as an oil. This does not imply that a synthetic insulating liquid can be used in any oil-immersed tap-changer regardless of whether it is designed for it.

Tap-changers for transformers for railway rolling stock are excluded from this standard.

In selecting a tap-changer for a particular application, reference should be made to IEC Publication 542, Application Guide for On-load Tap-changers.

2. Service conditions

a) *Temperature of tap-changer environment*

Unless more onerous conditions are specified by the purchaser, tap-changers are regarded as suitable for operation over the ranges of temperature given in Table I.

TABLE I
Temperature of tap-changer environment

Tap-changer environment	Temperature	
	Minimum	Maximum
Air	−25 C	40 C
Oil	−25 C	100 C

Notes 1. — The tap-changer environment is the medium immediately surrounding the complete tap-changer i.e., if the latter is enclosed in a separate external container, intended for mounting outside the transformer tank, the tap-changer environment is “Air”; if the complete tap-changer is intended for mounting inside the main transformer tank and not in a separate external container, then the tap-changer environment is “Oil” (i.e. the oil in the transformer tank).

2. — The value of 100 °C quoted above is based on a maximum ambient temperature of 40 °C as specified in IEC Publication 76, Power Transformers.

*See Note to Sub-clause 4.1.

b) Temperature of motor-drive mechanism environment

Unless more onerous conditions are specified by the purchaser, motor-drive mechanisms are regarded as being suitable for operation in any ambient temperature between -25°C and 40°C .

c) Overload conditions

Tap-changers subjected to overload conditions in accordance with IEC Publication 354, Loading Guide for Oil-immersed Transformers, shall generally be restricted to the occasional overload conditions stated in IEC Publication 76-1, Part 1: General, Sub-clause 4.2, if not specifically ordered for other overload conditions by the transformer manufacturer (see IEC Publication 542, Sub-clause 2.3.2).

Note. — Tap-changers, like other switching devices, usually have a shorter thermal time constant than electromagnetic devices of the same current ratings.

3. Information required with tenders and orders

For the information required with tenders and orders, see IEC Publication 542, Clause 5.

SECTION TWO — DEFINITIONS

4. Definitions relating to on-load tap-changers (excluding motor-drive mechanisms)

For the purpose of this standard, the following definitions apply:

4.1 On-load tap-changer

A device for changing the tapping connections of a winding, suitable for operation whilst the transformer is energized or on load. Generally, it consists of a diverter switch (see Sub-clause 4.3) with a transition impedance (see Sub-clause 4.6) and a tap selector (see Sub-clause 4.2) which can be with or without a change-over selector (see Sub-clause 4.5), the whole being operated by the driving mechanism (see Sub-clause 4.7). In some forms of tap-changers, the functions of the diverter switch and the tap selector are combined in a selector switch (see Sub-clause 4.4).

Note. — As the whole of this standard deals only with on-load tap-changers, the expression is shortened to “tap-changer” in the remainder of this publication.

4.2 Tap selector

A device designed to carry, but not to make or break, current, used in conjunction with a diverter switch, to select tapping connections.

4.3 Diverter switch

A switching device used in conjunction with a tap selector to carry, make and break currents in circuits which have already been selected.

Note. — Diverter switches of spring-operated type include an independent means of storing energy for their operation.

4.4 *Selector switch*

A switching device capable of making, carrying and breaking current, combining the duties of a tap selector and a diverter switch.

4.5 *Change-over selector*

A device designed to carry, but not to make or break, current, used in conjunction with a tap selector or selector switch to enable its contacts, and the connected tapplings, to be used more than once when moving from one extreme position to the other.

4.6 *Transition impedance*

A resistor or reactor consisting of one or more units bridging the tapping in use and the tapping next to be used, for the purpose of transferring load from one tapping to the other without interruption or appreciable change in the load current, at the same time limiting the circulating current for the period that both tapplings are used.

4.7 *Driving mechanism*

The means by which the drive to the tap-changer is actuated.

Note. — The mechanism may include an independent means of storing energy to control the operation.

4.8 *Set of contacts*

A pair, or combination of pairs, of individual fixed and moving contacts, operating substantially simultaneously.

4.9 *Main contacts and main switching contacts*

4.9.1 *Main contacts*

Any set of through-current carrying contacts which has no transition impedance between the transformer winding and the contacts and does not switch any current.

4.9.2 *Main switching contacts*

Any set of contacts which has no transition impedance between the transformer winding and the contacts and breaks the current.

4.10 *Transition contacts*

Any set of contacts where a transition impedance is in series between the transformer winding and the contacts.

Note. — In the case of reactor transition tap-changers, this set of contacts is used, in many instances, to carry the through-current in the full tap position.

4.11 *Circulating current*

That part of the current which flows through the transition impedance at the time when two tapplings are bridged during a tap-change operation and which is due to the voltage difference between the tapplings.

4.12 *Switched current*

The prospective current to be broken during switching operation by each set of main switching or transition contacts incorporated in the diverter switch or selector switch.

4.13 *Recovery voltage*

The power-frequency voltage which appears across each set of main switching or transition contacts of the diverter switch or selector switch after these contacts have broken the switched current.

4.14 *Tap-change operation*

A complete sequence of events from the initiation to the completion of the transition of the through-current from one tap of the winding to an adjacent one.

4.15 *Cycle of operation*

The movement of the tap-changer from one end of its range to the other and the return to its original position.

4.16 *Insulation level*

The withstand values of the impulse and power-frequency test voltages to earth, and where appropriate between the phases, and between those parts where insulation is required.

4.17 *Rated through-current (I_u)*

The current flowing through the tap-changer towards the external circuit, which the apparatus is capable of transferring from one tapping to the other at the relevant rated step voltage and which can be carried continuously while meeting the requirements of this standard.

Note. — Concerning the relationship between a rated through-current and the relevant step voltage, see Sub-clause 6.2.

4.18 *Maximum rated through-current (I_{um})*

The rated through-current for which both the temperature rise of the contacts (Sub-clause 8.1) and the service duty test (Sub-clause 8.2.1) apply.

4.19 *Rated step voltage (U_i)*

For each value of rated through-current, the highest permissible voltage between terminals which are intended to be connected to successive tappings of a transformer.

Note. — If a rated step voltage is given in connection with a rated through-current, it is called “relevant rated step voltage”.

4.20 *Maximum rated step voltage (U_{im})*

The highest value of the rated step voltage for which the tap-changer is designed.

4.21 *Rated frequency*

The frequency of the alternating current for which the tap-changer is designed.

4.22 *Number of tapping positions of the tap-changer*

4.22.1 *Number of inherent tapping positions*

The highest number of tapping positions for half a cycle of operation for which a tap-changer can be used according to its design.

4.22.2 *Number of service tapping positions*

The number of tapping positions for half a cycle of operation for which a tap-changer is used in a transformer.

Note to Sub-clauses 4.22.1 and 4.22.2

These terms are generally given as the $\pm$ values of the relevant numbers, e.g. ± 11 positions; they are in principle valid also for the motor-drive mechanism.

When using the term "number of tapping positions" in connection with a transformer, this always refers to the number of service tapping positions of the tap-changer.

4.23 *Type test*

A test made on a tap-changer or the components of a tap-changer, or a range of tap-changers or components all based on the same design, to prove compliance with the standard.

Note. — A range of tap-changers is a number of tap-changers based on the same design and having the same characteristics, with the exception of the insulation levels to earth and possibly between phases, the number of steps and the value of the transition impedance.

4.24 *Routine test*

A test made on each completed tap-changer, the design of which has been verified by type test, to establish that the tap-changer is without manufacturing defects.

5. **Definitions relating to motor-drive mechanisms**

5.1 *Motor-drive mechanism*

A driving mechanism as in Sub-clause 4.7 of this standard which incorporates an electric motor and control circuit.

5.2 *Step-by-step control*

Electrical and mechanical devices stopping the motor-drive mechanism after completion of a tap-change, independently of the operating sequence of the control switch.

5.3 *Tap position indicator*

An electrical and/or mechanical device for indicating the tap position of the tap-changer.

5.4 *Tap-change in progress indication*

A device indicating that the motor-drive mechanism is running.

5.5 *Limiting devices*

5.5.1 *Limit switches*

Electro-mechanical devices preventing operation of the tap-changer beyond either end position, but allowing operation towards the opposite direction.

5.5.2 *Mechanical end stop*

A device which physically prevents operation of the tap-changer beyond either end position, but allows operation towards the opposite direction.

5.6 *Parallel control devices*

Electrical control devices to move, in the case of parallel operation of several transformers with tapplings, all tap-changers to the required position and to avoid divergence of the respective motor-drive mechanisms.

Note. — Such devices would be necessary also in the case of single-phase transformers forming a three-phase bank when each single-phase tap-changer is fitted with its own motor-drive mechanism.

5.7 *Emergency tripping device*

An electrical and/or mechanical device for stopping the motor-drive mechanism at any time in such a way that a special action must be performed before the next tap-change operation can be started.

5.8 *Overcurrent blocking device*

An electrical device preventing or interrupting operation of the motor-drive mechanism for the period in which an overcurrent exceeding a preset value is flowing in the transformer winding.

Note. — Where diverter switches are actuated by spring energy systems, interruption of the operation of the motor-drive mechanism will not prevent operation of the diverter switch if the spring release has been actuated.

5.9 *Operation counter*

A device indicating the number of tap changes accomplished.

5.10 *Manual operation of motor-drive mechanism*

Operation of the tap-changer manually by a mechanical device, blocking at the same time operation by the electric motor.

5.11 *Motor-drive cubicle*

A cubicle housing the motor-drive mechanism.

SECTION THREE — REQUIREMENTS FOR ON-LOAD TAP-CHANGERS

(excluding requirements for motor-drive mechanisms)

6. **Rating**

6.1 *Rated characteristics*

The characteristics of a tap-changer that shall be used to determine the rating are as follows:

6.2 *Rated through-current*

The rated through-current is interrelated with a relevant rated step voltage. Therefore, a tap-changer may have different combinations of rated through-current and relevant rated step voltage.

6.3 *Maximum rated through-current*

Preferred values of maximum rated through-current are:

100, 200, 400, 800, 1250, 1600, 2000, 2500, 3150 A

but adoption of other values does not invalidate compliance with this standard.

6.4 Rated step voltage

6.5 Rated frequency

6.6 Rated insulation level

7. Design and construction

7.1 Limiting devices for the protection of tap-changers against transient overvoltages

For tap-changers which incorporate limiting devices for transient overvoltages, the manufacturer of the tap-changer shall give full details of the protective characteristics, together with any limitations which will be imposed during tests on the completed transformer.

When spark gaps are used, care has to be taken to ensure that after spark-over, the discharge is quenched automatically.

7.2 Oil level gauges

If diverter or selector switches are located in separate oil containers breathing freely to the atmosphere, oil level gauges should be provided.

8. Type tests

The following type tests shall be performed on samples of the relevant tap-changer or components after their final development:

- temperature rise of contacts (Sub-clause 8.1);
- switching tests (Sub-clause 8.2);
- short-circuit current test (Sub-clause 8.3);
- transition impedance test (Sub-clause 8.4);
- mechanical tests (Sub-clause 8.5);
- dielectric tests (Sub-clause 8.6).

8.1 Temperature rise of contacts

Tests shall be performed to verify that the temperature rise above the medium surrounding each type of contact which carries current continuously in service does not exceed the values given in Table II when the contacts have reached a steady temperature after carrying the maximum rated through-current.

TABLE II
Contact temperature-rise limits

Contact material	In air	In oil
Plain copper	35°C	20°C
Silver-faced copper	65°C	20°C
Other materials	To be agreed	20°C