
Power transformers

Part 4. Specification for tapplings and connections

Transformateurs de puissance
Partie 4. Spécification des prises et connexions

Leistungswandler
Teil 4. Spezifikation für Anzapfstellen und Anschlußleitungen

National foreword

This revision of BS 171 : 1970, of which this is Part 4, was prepared under the direction of the Power Electrical Engineering Standards Committee. In the revision the standard has been divided into five Parts which are identical with the corresponding Parts of Publication 76 'Power transformers', of the International Electrotechnical Commission. These Parts are as follows.

IEC 76	BS 171 : 1978
76-1 : 1976 : Part 1 : General	Part 1
76-2 : 1976 : Part 2 : Temperature rise	Part 2
76-3 : — : Part 3 : Insulation levels and dielectric tests	—
76-4 : 1976 : Part 4 : Tappings and connections	Part 4
76-5 : 1976 : Part 5 : Ability to withstand short circuit	Part 5

Part 3 of IEC 76 has not yet been published, and until it is, the insulation levels and dielectric test requirements of IEC 76 : 1967 continue to apply. Therefore the publication of Part 3 of this revision of BS 171 will follow that of the other Parts, and until Part 3 is published the insulation levels and dielectric test requirements of BS 171 : 1970 continue to apply. An appropriate amendment to BS 171 : 1970 is being published. Furthermore, pending the publication of supplementary material relating to IEC 76, some of the appendices of BS 171 : 1970 are still valid for power transformers, for guidance only. This is further explained in the amendment referred to above.

NOTE. References to page numbers in the text relate to the IEC page numbers given in brackets at the bottom of each page.

Certification. Attention is drawn to the certification facilities described on the inside back cover of this standard.

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British Standard

Power transformers

Part 4. Specification for tapplings and connections

SECTION ONE — TAPPINGS

1. Scope

This standard is restricted to transformers having only one tapped winding. For auto-transformers, this means that the number of turns per phase in either the high-voltage (H.V.) or low-voltage (L.V.) winding is constant (auto-transformers with tapped neutrals are subject to agreement).

Tap changing involving a phase displacement in the voltage is not taken into account.

2. Requirements valid for all categories of voltage variation

2.1 General

Transformers are not provided with tapplings unless specifically required. When tapplings are required, it shall be stated if they are intended for off-circuit or for on-load tap-changing.

2.2 Principal tapping

Unless otherwise specified, the principal tapping (see Publication 76-1, Part 1: General, Sub-clause 3.5.1.1) is the mean tapping position if the number of tapping positions is odd, or, if this number is even, that one of the two middle tapping positions which is associated with the higher effective number of turns of the tapped winding; if the tapping so defined is not a full-power tapping, the principal tapping is the closest full-power tapping (the principal tapping being a full-power tapping according to Sub-clause 3.5.4 of Publication 76-1).

2.3 Specification of the tapping range

The tapping range of the tapped winding is expressed as follows:

- if there are both plus and minus tapplings: $\pm a\%$ or $+a\%$, $-b\%$;
- if there are only plus tapplings or only minus tapplings: $+a\%$ or $-b\%$.

2.4 Short-circuit impedance specification

The winding(s) to which the short-circuit impedance is related shall be indicated as follows:

- for a two-winding transformer, indication of the winding to which the short-circuit impedance is related will suffice (H.V. impedance, L.V. impedance);
- for a multi-winding transformer, the short-circuit impedance of the H.V./L.V. windings pair, related to the H.V. winding for instance, will be referred to as the H.V./L.V. impedance (H.V. being underlined) or as the H.V./L.V. impedance of the H.V./L.V. pair.

Dependent on system conditions, the short-circuit impedance may usually be related to either one of the windings. If the power flow is only from the H.V. winding to the L.V. winding, it is advisable to relate the short-circuit impedance to the H.V. winding.

Three-winding transformers and auto-transformers with a low voltage ratio (such as below 2) need special consideration and the following rules may not apply.

2.4.1 *Short-circuit impedance on the principal tapping*

The short-circuit impedance, in ohms per phase, related to one winding shall be specified in addition to the "impedance voltage at rated current" expressed as a percentage.

2.4.2 *Short-circuit impedance on other tapplings*

If necessary, the short-circuit impedances on other tapplings may be specified. If this is done, the extreme tapping impedances should be included.

The tolerances applicable are then defined as follows:

- a) If the principal tapping corresponds to the mean tapping position or to one of the two middle tapping positions, the tolerances applicable on this principal tapping shall be those stated in Publication 76-1, Table III, Item 3a). On any other tapping, the tolerance shall be increased by a percentage equal to one-half of the difference in percentage tapping factor between that tapping and the principal tapping.
- b) In the other cases, the tapping range shall be considered as balanced about the mid-tapping position and the tolerances shall be calculated as before but assuming that tolerances according to Publication 76-1, Table III, apply to the mid-tapping position. This may mean a tolerance on the principal tapping in excess of that in Publication 76-1, Table III, item 3a).

For a specified tapping range, the simplest method is to fix, according to the above calculation rule, only the minimum and maximum values of impedance, including the tolerances.

Note. — For tapping ranges in excess of an overall 25% or where the tolerances derived may result in unacceptable levels of impedance, tolerances shall be subject to agreement between the manufacturer and the purchaser.

2.5 *Load loss requirements*

The purchaser should state for which tapping connections, in addition to that on the principal tapping, values for load loss should be declared by the manufacturer. They usually include the extreme tapplings.

The reference current of two-winding transformers is, for any tapping, equal to the tapping current. For multi-winding transformers, the reference current or reference power should be stated.

2.6 *Requirements related to temperature rise (guarantees and tests)*

The temperature-rise limits are valid for all tapplings; except in special cases, the temperature-rise test need be carried out on only one tapping.

2.7 *Requirements related to operation at a voltage higher than the tapping voltage*

For all tapplings, requirements are the same as for the principal tapping, the words "rated voltage" and "rated current" being changed to "tapping voltage" and "tapping current". (For the principal tapping, see Publication 76-1, Sub-clause 4.4.)

3. **Definition and additional requirements for constant flux voltage variation**

3.1 *Definition of constant flux voltage variation (C.F.V.V.)*

Voltage variation when the tapping voltage is:

- rated voltage for any untapped winding;
- rated voltage multiplied by the tapping factor for the tapped winding.

Notes 1. — The magnetic flux is the same for all tapping positions, hence the name "constant flux voltage variation".

2. — Figure 1a, page 24, shows the variation of the tapping voltages as a function of the tapping factor.

3.2 *Additional requirements for constant flux voltage variation (C.F.V.V.)*

a) Specifications shall indicate (see example 1 of Appendix A):

- the category of voltage variation: C.F.V.V.;
- the rated power of the transformer, or the rated power of each winding in the case of a multi-winding transformer;
- the rated voltages;
- which winding is the tapped winding, and its tapping range;
- the number of tapping positions or the tapping step. In the first case, the tapping steps shall be supposed to be approximately equal.

Note. — In the absence of any indication of the category of voltage variation, C.F.V.V. is assumed.

b) *Tapping power and tapping currents (see Figures 1c and 1b, page 24)*

If nothing is specified, it is implied that all tapplings are full-power tapplings.

If a “maximum current tapping” is specified, it is implied that above this tapping (higher tapping factors), the tapplings are full-power tapplings, and that below this tapping the tapping current is constant for the tapped winding, hence a reduced tapping power.

Notes 1. — In the first case (only full-power tapplings), the extreme minus tapping may be called “maximum current tapping”.

2. — For transformers with separate windings (see Publication 76-1, footnote to Sub-clause 3.1.1), the tapping to use for the temperature-rise test is the “maximum current tapping”, unless otherwise specified.

3.3 *Separate winding transformers of rated power up to and including 3 150 kVA and a tapping range up to and including $\pm 5\%$*

Unless otherwise specified:

- the principal tapping is the maximum current tapping (tapping current of the tapped winding equal to rated current for all the minus tapplings);
- the guarantees of short-circuit impedance and load loss relate only to the principal tapping.

4. **Definition and additional requirements for variable flux voltage variation**

4.1 *Definition of variable flux voltage variation (V.F.V.V.)*

Voltage variation when the tapping voltage is constant for the tapped winding and equal to its rated voltage (see Figure 2a, page 25).

4.2 *Additional requirements for variable flux voltage variation (V.F.V.V.)*

a) Specifications shall indicate (see example 2 of Appendix A):

- the category of voltage variation: V.F.V.V.;
- the rated power of the transformer or the rated power of each winding in the case of a multi-winding transformer;
- the rated voltages; for each untapped winding, the extreme tapping voltages are to be specified and the rated voltage underlined;
- which winding is the tapped winding and its tapping range;
- the number of tapping positions or the tapping step.

b) *Tapping power and tapping currents (see Figures 2c and 2b, page 25)*

If nothing is specified, it is implied that all tapplings are full-power tapplings.

If a “maximum current tapping” is specified, it is implied that below this tapping (lower tapping factors) the tapplings are full-power tapplings, and that above this tapping the tapping current is constant for the untapped winding.