BRITISH STANDARD

BS 2692-3:
1990
IEC 282-3:
1976

Fuses for voltages exceeding 1000 V a.c. —

Part 3: Guide to the determination of short circuit power factor

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Power Electrical Engineering Standards Policy Committee (PEL/-) to Technical Committee PEL/78/2, upon which the following bodies were represented:

Association of Supervisory and Executive Engineers
Electrical Installation Equipment Manufacturers' Association (BEAMA Ltd.)
Electrical Power Engineers' Association
Engineering Equipment and Materials Users' Association
ERA Technology Ltd.
London Regional Transport
National Economic Development Office

The following bodies were also represented in the drafting of the standard, through subcommittees and panels:

Association of Consulting Engineers
Association of Short Circuit Testing Authorities
Ministry of Defence

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Amendments issued since publication

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Contents

National foreword

This Part of BS 2692 has been prepared under the direction of the Power Electrical Engineering Standards Policy Committee. It is identical with IEC Publication 282-3:1976, "High voltage fuses — Part 3: Determination for short-circuit power factor for testing current-limiting fuses and expulsion and similar fuses" published by the International Electrotechnical Commission (IEC).

Cross-references

International Standard	Corresponding British Standard
IEC 282	BS 2692 *Fuses for voltages exceeding 1 000 V a.c.*
Part 1:1985	Part 1:1986 *Specification for current-limiting fuses* (Identical)
Part 2:1970	Part 2:1956 *Expulsion fuses* (Technically equivalent)

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 4, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

1 General

There is no method by which the short-circuit power factor can be determined with precision, due to variation of resistance with frequency and current and of inductance with time and current. However, for the purpose of this specification, the power factor of each phase of the test circuit may be determined with sufficient accuracy by whichever of the three following methods is the more appropriate.

Method I is recommended for the determination of power factors higher than 0.3 (for example test duty 3 for current-limiting fuses and test series 4 and 5 for expulsion fuses) because it is generally not accurate for very low power factors due to difficulty in measurement of the resistance.

Method II is recommended for the determination of power factors lower than 0.3 (for example test duties 1 and 2 for current-limiting fuses and test series 1, 2 and 3 for expulsion fuses) because it is generally not accurate for power factors higher than 0.3 due to the short duration of the d.c. component and difficulty in determination of its time constant.

Method III is recommended for the determination of power factors higher than 0.5 (for example test series 5 for expulsion fuses) because it is generally not accurate in the case of power factors below 0.5 due to the necessary degree of accuracy with which phase displacements need to be measured.

2 Method I — Calculation from circuit constants

The power factor may be calculated as the cosine of an angle φ where $\varphi = \arctan X/R$, X and R being respectively the reactance and resistance of the test circuit while the short circuit exists.

R is measured in the test circuit with direct current; if the circuit includes a transformer, the resistance R_1 of the primary circuit and the resistance R_2 of the secondary circuit are measured separately and the required value R is then given by the formula:

$$R = R_2 + R_1 r^2$$

in which r is the ratio of transformation of the transformer.

X is then obtained from the formula:

$$X = \sqrt{(E/I)^2 - R^2}$$

the ratio E/I (circuit impedance) being obtained from the oscillogram as indicated in Figure 1, page 3.

Due to variation of generator reactance with current, the calibration test must be at the same excitation as the fuse test in each case.

NOTE Power factor can be obtained directly by this method by dividing resistance R by impedance E/I without reference to reactance

$$\cos \varphi = \frac{R}{E/I}$$

3 Method II — Determination from d.c. component

The angle φ may be determined from the curve of the d.c. component of the prospective asymmetrical current wave as follows (see Sub-clause **13.2.1** of IEC Publications 282-1 and 282-2).

3.1 The time constant L/R can be ascertained as follows from the formula for the d.c. component

$$i_d = I_{do}\, e^{-Rt/L}$$

where:

i_d	=	value of the d.c. component at any instant
I_{do}	=	initial value of the d.c. component
L/R	=	time constant of the circuit, in seconds
t	=	time interval, in seconds, between i_d and I_{do}
e	=	base of Napierian logarithms

a) Measure the value of I_{do} at the instant of short-circuit and the value of i_d at any other time t at which there is still a significant value of d.c. component;

b) determine the value of $e^{-Rt/L}$ by dividing i_d by I_{do};

c) from a table of values of e^{-x}, determine the value of $-x$ corresponding to the ratio i_d/I_{do};

d) the value x then represents Rt/L, from which L/R can be determined by dividing x by t.

3.2 Determine the angle φ or power factor from

$$\varphi = \arctan \omega L/R \qquad \cos \varphi = \frac{1}{\sqrt{1 + (\omega L/R)^2}}$$

where ω is 2π times the actual frequency.

When current transformers are used for this method, attention should be paid to possible errors consequent upon i) the time constant of the transformer and its burden in relation to that of the primary circuit and ii) magnetic saturation effects which can result from the transient flux conditions combined with possible remanence.

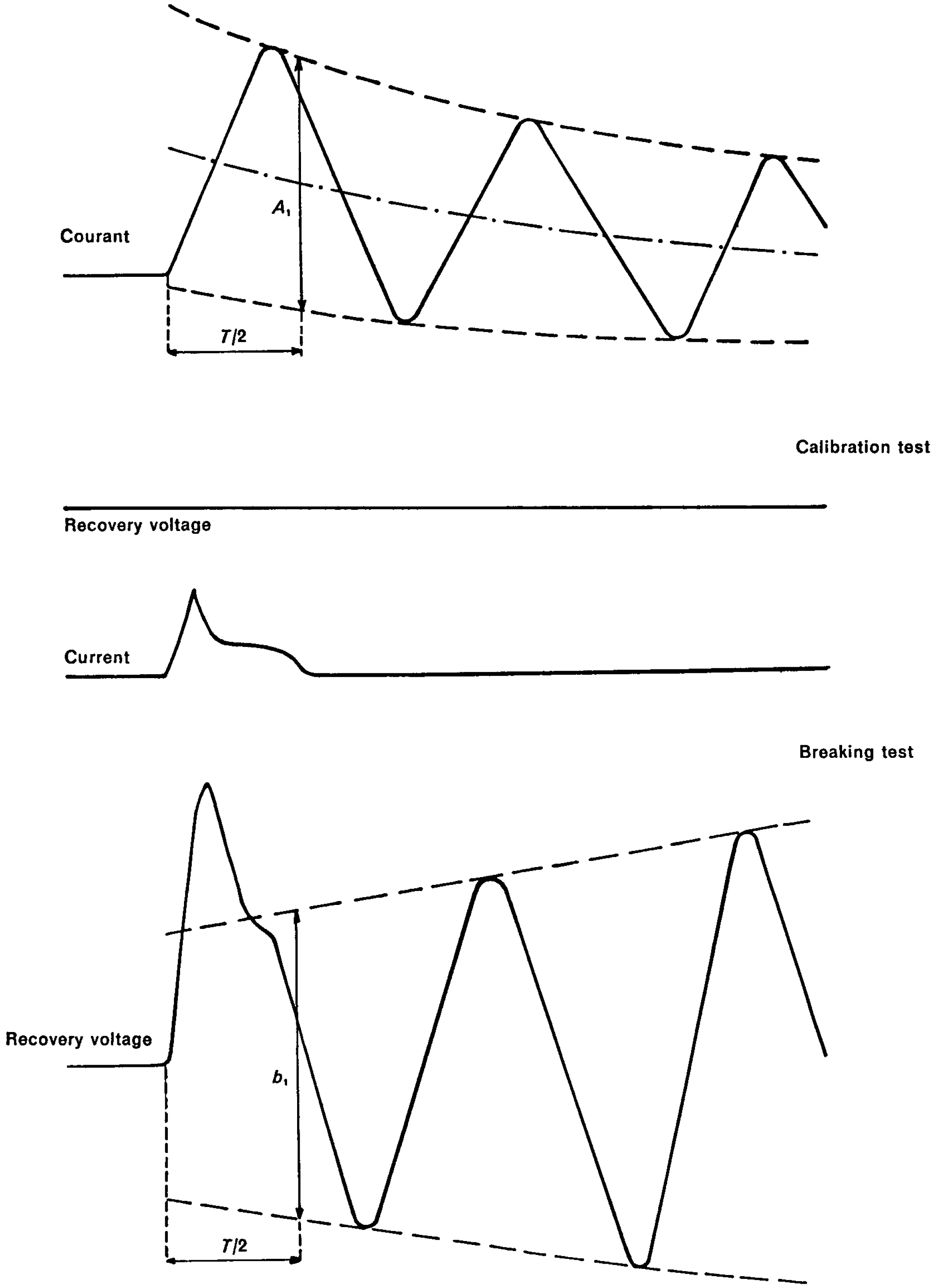
NOTE This method can be applicable also if the calibration test is made at reduced voltage and correspondingly lower current.

4 Method III — Determination with pilot generator

When a pilot generator is used on the same shaft as the test generator, the voltage of the pilot generator on the oscillogram may be compared in phase first with the voltage of the test generator and then with the current of the test generator.

The difference between the phase angles between pilot generator voltage and main generator voltage on the one hand, and pilot generator voltage and test generator current on the other hand, gives the phase angle between the voltage and current of the test generator, from which the power factor can be determined.

NOTE *Use of the wattmeter vibrator:* this method may be used as an alternative to the above methods to determine the power factor in test duty 3 for current-limiting fuses according to IEC Publication 282-1, and in test series 4 and 5 for expulsion and similar fuses according to IEC Publication 282-2.



T = duration of first power-frequency cycle following initiation of test.

Circuit impedance $\frac{E}{I} = \frac{b_1 (V)}{A_1 (A)}$

b_1 is obtained by extending the voltage envelope to the instant *T*/2.

Figure 1 — Determination of circuit impedance for calculation of power factor in accordance with Method I

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Publications referred to

See national foreword.

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