

Recommendations for

Design of scales and indexes on analogue indicating instruments

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Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Power Engineering Standards Policy Committee (PEL/-) to Technical Committee PEL/13, upon which the following bodies were represented:

- Department of Energy (Electricity Division)
- Department of Trade and Industry (National Measurement Accreditation Service)
- Department of Trade and Industry (National Physical Laboratory)
- Electricity Industry in United Kingdom
- GAMBICA (BEAMA Ltd.)
- General Electric Company Ltd.
- Institution of Electrical Engineers
- Institution of Incorporated Executive Engineers

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Foreword

This British Standard has been prepared under the direction of the Power Electrical Engineering Standards Policy Committee. It supersedes BS 3693:1986, which is withdrawn.

This edition introduces technical changes to bring the standard up-to-date but it does not reflect a full review of the standard, which will be undertaken in due course. However, the Committee has agreed that geometric construction and form of digits should not be subject to standardization. Therefore BS 3693A:1964 and BS 3693B:1964 are now withdrawn.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 16, 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 Scope

This British Standard gives recommendations for the design of scales and indexes of analogue indicating instruments in which an index moves in relation to a fixed array of scale marks to display the value of a measured quantity, or in which the scale moves in relation to a fixed index. Basic designs are given for scales for single, dual and multi-range fixed or portable instruments.

This British Standard is applicable to scales with:

- a) black or dark coloured scale marks on a white or light coloured background;
- b) white or light coloured scale marks on black or dark dials;
- c) transilluminated scales.

BS 3693 can be applied in the design of both linear and non-linear scales.

No recommendations are given for the design of scales displayed on cathode ray tubes.

This British Standard can apply to non-electrical instruments.

NOTE The title of the publication referred to in this standard is given on the inside back cover.

2 Definitions

For the purposes of this British Standard the following definitions apply.

NOTE Figure 1 illustrates some of the defined terms.

2.1 scale

the ordered set of scale marks, together with any associated numbering, forming part of an indicating device

2.2 index

the fixed or movable part of an indicating device whose position with reference to scale marks enables an indicated value to be determined

NOTE Examples of an index include the following:

- a) pointer;
- b) luminous spot;
- c) liquid surface;
- d) recording pen.

2.3 dial

that part of an indicating device, fixed or moving, which carries the scale or scales

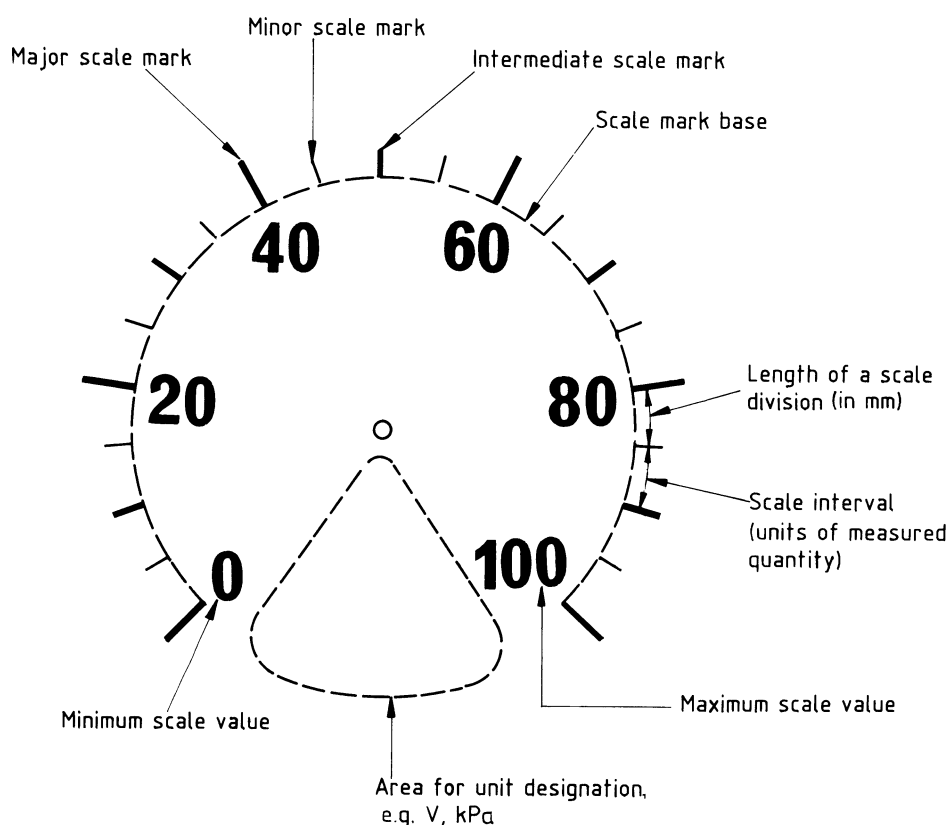


Figure 1 — Nomenclature for dials and scales

2.4**graduation**

the process of setting out a scale

NOTE The use of the word “graduation” in the sense of a “graduation mark” is deprecated, the term “scale mark” being the defined term.

2.5**scale mark**

a line or other mark on an indicating device corresponding to one or more defined values of a measurand

2.6**major scale mark**

a scale mark which is a primary divider of the scale. Major scale marks are emphasized generally by elongation relative to the minor marks, or by thickening all or part of the mark

2.7**minor scale mark**

a scale mark which is a secondary divider of the scale. Minor scale marks divide the distance between major scale marks into scale divisions (see 2.13)

2.8**intermediate scale mark**

a minor scale mark which is emphasized in order to assist reading the scale between a pair of adjacent major scale marks

2.9**scale mark base**

the actual or implied line, part circle or straight, between the extreme end scale marks, from which one end of all the scale marks emanate

2.10**index path**

the line of travel, relative to the scale, of that place on the index, or on the geometric prolongation of the index, which is effective in indicating the value of the measurand

NOTE In some instruments, the place on the index which is thus effective may vary with the position of the index.

2.11**boundary line**

a line, perpendicular to the scale marks, bounding the scale. The boundary line may be coincident with the scale mark base or it may be arranged on the opposite side of the scale

2.12**scale length**

the length of the line (curved or straight) which passes through the centres of all the shortest scale marks contained between the first and the last scale marks

NOTE The scale length is expressed in units of length.

2.13**scale division**

the part of a scale between any two successive scale marks

2.14**length of a scale division**

the distance between any two successive scale marks, measured along the scale mark base

NOTE The length of a scale division is expressed in units of length.

2.15**major scale division**

the part of a scale between any two successive major scale marks

2.16**intermediate scale division**

the part of a scale between any two successive intermediate scale marks or between an intermediate scale mark and an adjacent major scale mark

2.17**minor scale division**

the part of a scale between any two successive scale marks, one of which is a minor scale mark

2.18**scale range**

for a given scale, the set of values between the extreme scale marks

NOTE The scale range is expressed in the units marked on the scale, regardless of the units of the measurand. It is normally stated in terms of its lower and upper limits, e.g. 100 °C to 200 °C.

2.19**measuring range**

the range defined by two values of the measurand within which the limits of error of a measuring instrument are specified

2.20**minimum scale value**

the smallest value of the measurand displayed by the scale

2.21**maximum scale value**

the greatest value of the measurand displayed by the scale

2.22**scale interval**

the difference between the scale values corresponding to two consecutive scale marks

NOTE Scale interval is expressed in the units marked on the scale, regardless of the units of the measurand.

2.23**linear scale**

a scale in which the divisions between successive scale marks denoting similar increments of the measurand are intended to have the same length

2.24**non-linear scale**

a scale in which the length of a scale division is not constant throughout the scale

NOTE Examples of a non-linear scale include the following:

- a) logarithmic scale;
- b) square-law scale.

2.25**multiple scale (multi-scale)**

a dial having more than one series of scale marks, etc. with different scale mark bases and a common index

2.26**dual scale**

two scales associated with a common index and a common scale mark base, the scale marks being drawn in opposite directions on the scale mark base

2.27**multiple zone scale**

a scale in which the value of the scale interval varies in steps from one region to another

2.28**superimposed scale**

a scale provided throughout its effective length with two resolutions, one intended for close reading and fine resolution, the other being of coarser resolution and intended for reading at a distance or at a glance

2.29**interpolation**

the process of dividing a scale division by eye without the aid of scale marks

2.30**interpolated division**

one of the parts into which a minor scale division is divided by eye

2.31**scale factor**

the number, often one, by which the indication is multiplied to obtain the value of the measurand

2.32**accuracy**

the quality which characterizes the closeness of the indicated value of the measurand to the true value (conventional true value)

2.33**observation error**

the error made by the observer when reading the indication of an instrument

NOTE The term "reading error" is deprecated.

2.34**parallax**

when applied to a scale and index, the effect of the apparent change in the position of the index, relative to the scale marks, when the observer views the scale and index perpendicularly and obliquely

2.35**resolution**

the smallest change in the value of the measurand which can be meaningfully determined

2.36**interpolated resolution**

the smallest change in the value of the measurand to which a numerical value can be assigned by interpolation, i.e. by estimating the distance between the index and the nearest scale mark

NOTE 1 For the purposes of this standard, the interpolated resolution is expressed as a percentage of the scale range.

NOTE 2 Unless otherwise stated, interpolation to fifths of a scale division is assumed.

2.37**resolution factor**

a number, designated r , having the same numerical value as the interpolated resolution expressed as a percentage, e.g. interpolated resolution 0.5 %:

$$r = 0.5$$

2.38**moving element**

the moving part of an instrument, the deflection of which is observed

3 Factors influencing scale design**3.1 General****3.1.1 Interpolation to the required interpolated resolution**

It should be possible for a practised observer to interpolate a scale division to the required interpolated resolution. This resolution should be related to the accuracy class of the instrument of which the scale and index form part. The resolution factor should be equal to or less than the class index of the instrument.