

Dial thermometers

English version of DIN EN 13190

DIN
EN 13190

ICS 17.200.20

Supersedes DIN 16203 to
DIN 16206, February 1988
editions.

Zeigerthermometer

European Standard EN 13190 : 2001 has the status of a DIN Standard.

A comma is used as the decimal marker.

National foreword

This standard has been prepared by CEN/TC 141 'Pressure gauges' (Secretariat: France).
The responsible German body involved in its preparation was the *Normenausschuss Technische Grundlagen* (Fundamentals in Technology Standards Committee).

Amendments

DIN 16203 to DIN 16206, February 1988 editions, have been superseded by the specifications of EN 13190.

Previous editions

DIN 16203: 1988-02; DIN 16204: 1988-02; DIN 16205: 1988-02; DIN 16206: 1988-02.

EN comprises 18 pages.

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English version

Dial thermometers

Thermomètres à cadran

Zeigerthermometer

This European Standard was approved by CEN on 2001-09-28.

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Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Management Centre or to any CEN member.

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CEN

European Committee for Standardization
Comité Européen de Normalisation
Europäisches Komitee für Normung

Management Centre: rue de Stassart 36, B-1050 Brussels

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Foreword

This European Standard has been prepared by Technical Committee CEN/TC 141 "Pressure gauges - Thermometers - Means of measuring and/or recording temperature in the cold chain", the secretariat of which is held by AFNOR.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by May 2002, and conflicting national standards shall be withdrawn at the latest by May 2002.

This document includes a Bibliography.

Annex A is informative.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

1 Scope

This European Standard specifies requirements and testing for dial indicating thermometers using sensing methods of gas expansion (symbol **GE**), liquid expansion (symbol **LE**) and bimetallic strip (symbol **BM**). Nominal sizes are from 40 to 160, and temperature measurement from -100 °C to +700 °C.

Thermometers specified have circular scales, and are for industrial use only.

Thermometers of square form are also covered by this standard except for case, scale and pointer dimensions.

Annex A includes recommendations for selection and installation.

This standard does not apply to thermometers for medical use nor to thermometers with electrical limit contact devices.

2 Normative references

This European Standard incorporates by dated or undated references, provisions from other publications. These normative references are cited at the appropriate places in the text, and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

ANSI/ASME B1.20.1, *Pipe threads – General purpose (inch)*.

EN 22768-1, *General tolerances – Part 1: Tolerances for linear and angular dimensions without individual tolerance indications (ISO 2768-1 : 1989)*.

ISO 68-1, *ISO general purpose screw threads – Basic profile – Part 1: Metric screw threads*.

ISO 228-1, *Pipe threads where pressure-tight joints are not made on the threads – Part 1: Dimensions, tolerances and designation*.

ISO 10102, *Assembly tools for screws and nuts – Double-headed open-ended engineers' wrenches*.

International vocabulary of basic and general terms in metrology (VIM). BIPM, IEC, IFCC, ISO, IUPAC, IUPAP, OIML, 2nd. Edition 1993.

3 Terms and definitions

For the purpose of this European Standard the terms and definitions given in the International vocabulary of basic and general terms in metrology (VIM) and the following terms and definitions apply.

3.1

dial indicating thermometer

instrument consisting of head and temperature detecting element or stem connected together by a rigid stem or, except for a bimetallic thermometer, by a flexible capillary

3.2

bimetallic thermometer (BM)

dial indicating thermometer operated by differential expansion strip, helix or coil

3.3

gas expansion thermometer (GE)

dial indicating thermometer operating on the principle of change in pressure of a fixed volume of gas in response to temperature change

3.4

liquid expansion thermometer (LE)

dial indicating thermometer operating on the principle of liquid volume expansion in response to temperature change

3.5

temperature detecting element

that part of a thermometer which supports and includes the sensitive portion

3.6

sensitive portion of temperature detecting element

that part of the temperature detecting element which contains the major portion of the temperature sensitive fluid or bimetal strip

3.7
thermometer insertion length

distance that temperature detecting element is inserted into process medium

3.8
thermometer movement

assembly by means of which the expansion of the fluid used or bimetallic strip are transformed and enlarged into an angular variation

3.9
thermometer connection

part by which the dial indicating thermometer can be coupled to the temperature tapping of the plant, pipework or equipment

3.10
thermometer compensation

apparatus fitted inside head and/or capillary to minimise errors due to ambient temperature variations

3.11
adjustable pointer
pointer with an adjustable device

3.12
nominal size (thermometer)
conventional alpha-numerical designation relating to the size of the thermometer

4 Nominal sizes

Nominal sizes of the thermometers are as follows: 40, 50, 63, 80, 100, 130, 150 and 160.

See Table 1 for dimensions.

5 Nominal ranges

The degree Celsius abbreviated to °C is the preferred unit of temperature measurement. The following nominal ranges are specified:

from 0 °C to 60 °C	from -20 °C to +40 °C
from 0 °C to 80 °C	from -20 °C to +60 °C
from 0 °C to 100 °C	from -20 °C to +120 °C
from 0 °C to 120 °C	from -30 °C to +30 °C
from 0 °C to 160 °C	from -30 °C to +50 °C
from 0 °C to 200 °C	from -30 °C to +70 °C
from 0 °C to 250 °C	from -40 °C to +40 °C
from 0 °C to 300 °C	from -40 °C to +60 °C
from 0 °C to 400 °C	from -100 °C to +60 °C
from 0 °C to 500 °C	
from 0 °C to 600 °C	
from 0 °C to 700 °C	
from 50 °C to 650 °C	
from 100 °C to 700 °C	

NOTE Not all types of thermometer are suitable for all ranges (see also Table A.1).

6 Accuracy classes

The following accuracy classes are defined: class 1 and class 2.

Class 1 may be used with nominal sizes 63 to 160, class 2 may be used with nominal sizes 40 to 160.

7 Dimensions

7.1 General tolerances

General tolerances: Tolerance class m according to EN 22768-1

7.2 Cases and flanges

The user will have to determine the dimensions for panel cut-out according to the manufacturer's data.

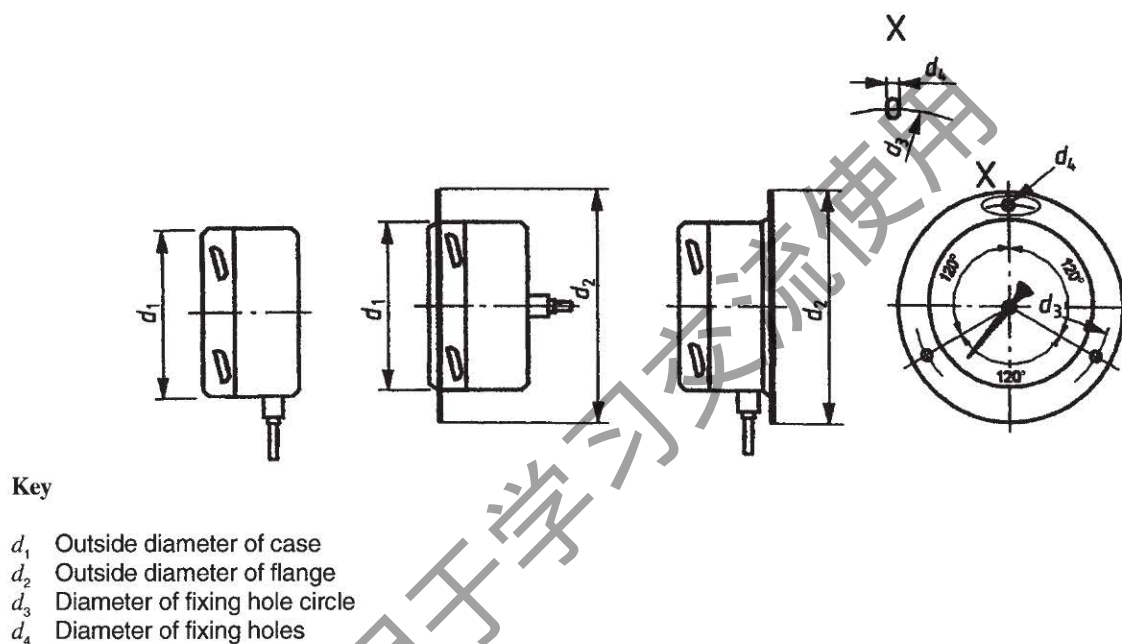


Figure 1 - Dimensions of thermometer cases and flanges

Table 1 - Dimensions

Nominal size	d_1 min. mm	d_2 max. mm	d_3 mm	d_4 mm
40	38	61	51	3,6
50	48	71	60	3,6
63	61	86	75	3,6
80	77	110	95	5
100	97	134	118	6
130	125	—	—	—
150	147	186	168	6
160	157	196	178	6

NOTE Elongated holes can be accepted to ensure interchangeability with previous standards.

7.3 Thermometer connection

The type of connections in Figure 2 are used for both rigid stem thermometers and thermometers with capillary. The connections in Figure 3 are for rigid stem thermometers only. The length of " l_5 " of thermometer connection form 4 depends of the length of the threaded part of its thermowell and shall be longer than the latter.

The minimum height of the hexagon, square or flats shall be compatible with use of standard spanners according to ISO 10102.

7.3.1 Screw threads

Parallel pipe threads (symbol G) according to ISO 228-1.

Taper pipe threads (symbol NPT) according to ANSI/ASME B1.20.1.

ISO general purpose metric screw threads (symbol M) having basic profile according to ISO 68-1.

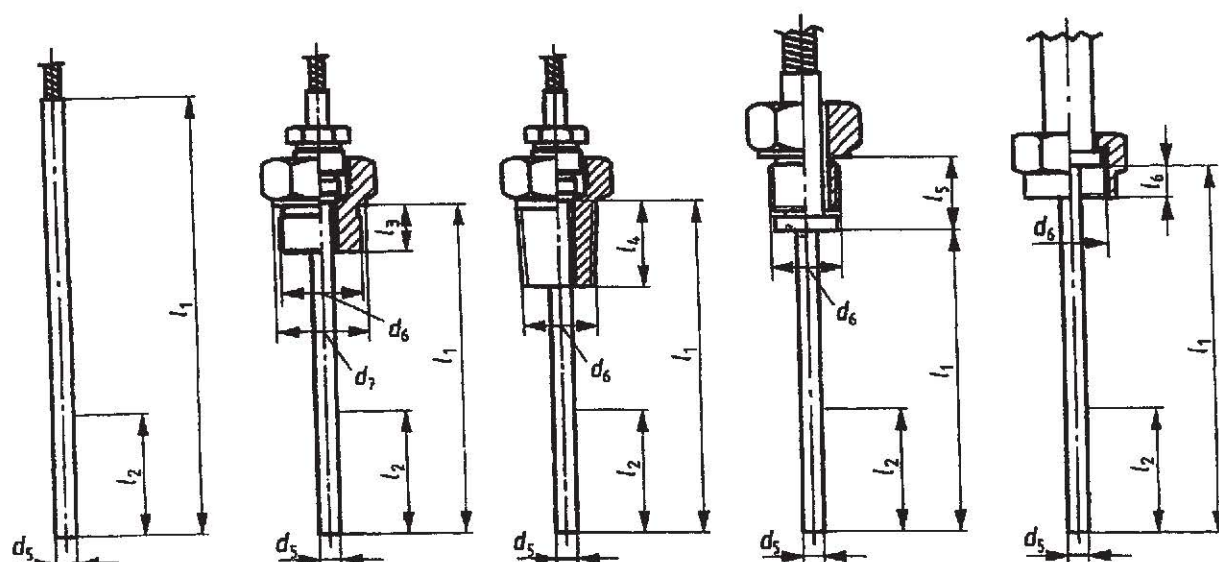
Other threads specific to certain industries are acceptable.

7.3.2 Temperature detecting element

The diameter of the temperature detecting element " d_5 " and its length " l_1 " (see Figures 2 and 3) will be at manufacturer's discretion or should be by agreement between purchaser and supplier.

7.3.3 Sensitive portion of the temperature detecting element

The length of the sensitive portion of the temperature detecting element " l_2 " (see Figures 2 and 3) shall be stated by the manufacturer.



Form 1
Plain stem

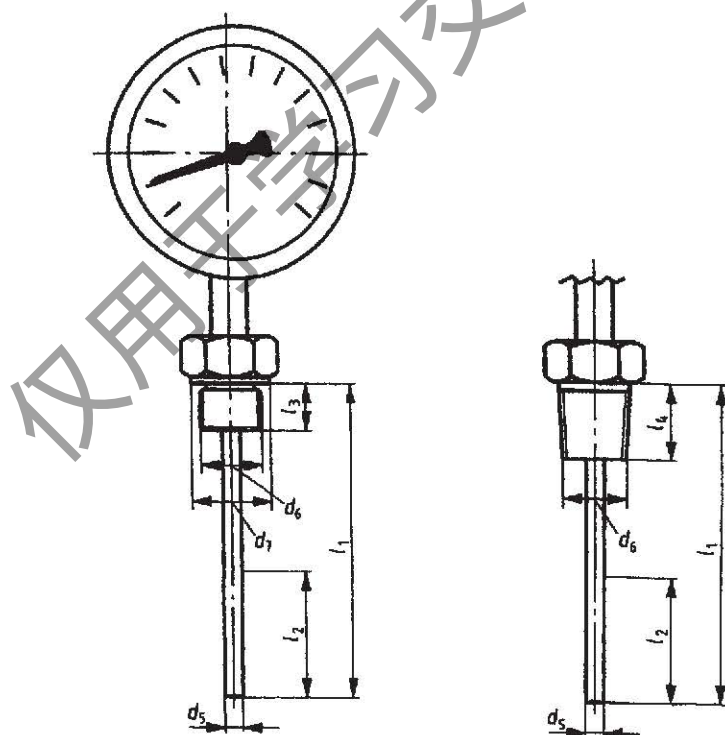
Form 2
Adjustable compression
fitting parallel thread
($l_{1min} > l_2 + l_3$)

Form 3
Adjustable compression
fitting taper thread
($l_{1min} > l_2 + l_4$)

Form 4
Loose nut
(External thread,
 l_5 shall be stated by
the manufacturer)

Form 5
Union nut

Figure 2 - Connections of rigid stem thermometer and capillary type thermometer



Form 6
Fixed hexagon with parallel thread

Form 7
Fixed hexagon with taper thread

Figure 3 - Connections of rigid stem thermometer

Table 2 - Dimensions of threaded connections

Dimensions in millimetres

Form	Thread size d_6	d_7 min.	l_3 min.	l_4	l_6 min.			
2 and 6	G 1/2 B	25	13	—	—			
	G 3/4 B	30	16					
	G 1 B	39	18					
	M20 × 1,5	24	13					
	M24 × 1,5	27	14					
	M27 × 2	30	16					
3 and 7	1/4-18 NPT EXT	—	—	according to ANSI/ASME 8.1.20.1				
	1/2-14 NPT EXT							
	3/4-14 NPT EXT							
4	G 1/2 B			—		—	—	
	G 3/4 B							
5	G 1/2, M20 × 1,5			—		—	—	8,5
	G 3/4, M24 × 1,5							10,5
	M27 × 2							12,5
	G 1							12,5

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7.4 Types of mounting and connection position

Table 3 - Rigid stem thermometer

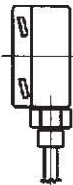
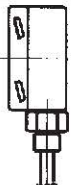
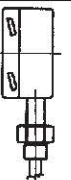
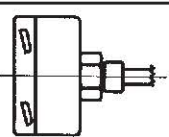
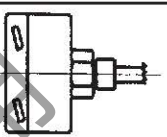
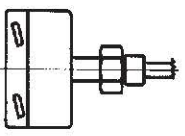
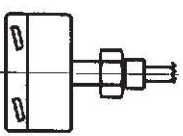
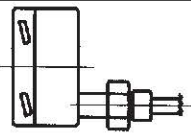
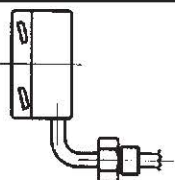
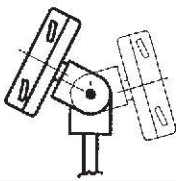
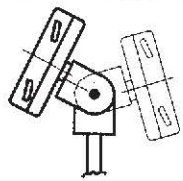
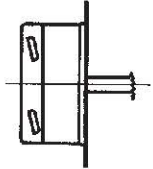
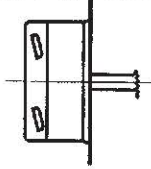
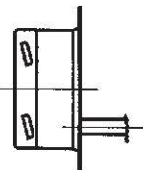
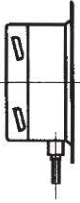
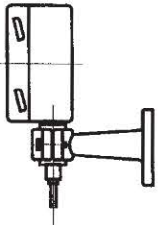
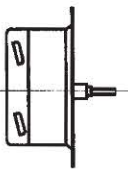
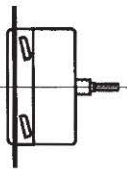
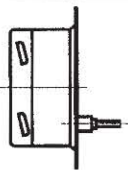
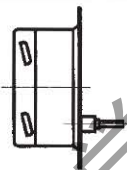
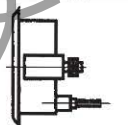
Form	Connection	Bimetallic	Liquid or gasfilled
1	Radial		
2	Radial with necktube		
3	Centre back		
4	Centre back with neck tube		
5	Offset back with neck tube		
6	Angle stem		
7	Adjustable angle stem		
8	Back flange		
9	Back flange offset		

Table 4 - Capillary type thermometer

	Type of mounting			
Connection	Surface mounting	Flush mounting		Wall bracket
Form	10	3 hole fixing	Clamp fixing	11
Radial		—	—	
Form	12	13	14	
Centre back				—
Form	15	16	17	
Offset back				—

8 Requirements

The test methods for these requirements are given in clause 9.

8.1 Accuracy

The limits of error in Table 5 correspond to the measuring range of the thermometer and shall apply in the range $\pm 2\text{ }^{\circ}\text{C}$ above and below the reference value given for the ambient temperature and for the mounting attitude specified in 8.5.

The hysteresis error shall not exceed half the value specified for the limits of error in Table 5.

The reference value of the ambient temperature is $23\text{ }^{\circ}\text{C}$, but reference temperatures other than $23\text{ }^{\circ}\text{C}$, or a reference temperature range, are permitted if the customer so specifies.

The measuring range of dial thermometers is the set of values of the measurand for which the errors of measurement must lie within the specified or agreed limits of error. It is a part of the nominal range and may be coincident with it.

Table 5 - Maximum permissible errors

Nominal range °C	Measuring range °C	Limits of error ± °C	
		Class 1	Class 2
-20 to +40	-10 to +30	1	2
-20 to +60	-10 to +50	1	2
-20 to +120	-10 to +110	2	4
-30 to +30	-20 to +20	1	2
-30 to +50	-20 to +40	1	2
-30 to +70	-20 to +60	1	2
-40 to +40	-30 to +30	1	2
-40 to +60	-30 to +50	1	2
-100 to +60	-80 to +40	2	4
0 to 60	10 to 50	1	2
0 to 80	10 to 70	1	2
0 to 100	10 to 90	1	2
0 to 120	10 to 110	2	4
0 to 160	20 to 140	2	4
0 to 200	20 to 180	2	4
0 to 250	30 to 220	2,5	5
0 to 300	30 to 270	5	10
0 to 400	50 to 350	5	10
0 to 500	50 to 450	5	10
0 to 600	100 to 500	10	15
0 to 700	100 to 600	10	15
50 to 650	150 to 550	10	15
100 to 700	200 to 600	10	15

The measuring range shall extend over at least two-thirds of the nominal range.

If the upper limit of the nominal range agreed exceeds that of the nearest equivalent range in Table 5, then the limits of error for the next highest range shall apply.

The upper and lower limits of the measuring range shall be defined by triangular marks located on the edge of the scale, the height of the triangles being at least equal to the length of the shortest scale mark. This marking is not required when the measuring range coincides with the nominal range.

Other nominal ranges and measuring ranges may be agreed; if so, the limits of error for the nominal range concerned should be in line with those given in Table 5 for the nominal range to which it most closely corresponds.

8.2 Design

8.2.1 Temperature detecting element

The design of the temperature detecting element shall be such as to ensure that, when operated within its nominal effective range, the specified limits of error are maintained for an agreed period but at least for a period of one year.

The user shall check whether the materials as specified by the manufacturer are resistant both to the medium to be measured and to the conditions in the service environment, and whether provision of protective tubing is required.

8.2.2 Maximum temperature of temperature detecting element

After the sensitive portion of the temperature detecting element has been subjected for 24 hours either to the temperature corresponding to the maximum scale value or to +60 °C, whichever is the greater, the limits of error specified in Table 5 shall still be maintained. If the sensitive portion of the detecting element is to be subjected to a temperature higher than that specified here, this shall be agreed between customer and manufacturer.

8.2.3 Protection against ingress of water and foreign particles (degree of protection)

Recommended minimum protection ratings according to EN 60529:

- for indoor use IP 41
- for outdoor use IP 65

8.3 Range of ambient temperature

The range of ambient temperature within which the thermometer maintains its accuracy class shall be stated by the manufacturer. The effect of ambient temperatures outside this range shall also be stated.

If the temperature of a substantial part of the capillary is the same as that of the temperature detecting element itself, then the length of capillary concerned shall be designated as the immersion depth.

NOTE The results of measurement of bimetallic thermometers are not affected by ambient temperature.

Gas and liquid expansion thermometers with remote sensor units are susceptible to the influence of ambient temperature on the case, on the lead from the sensor unit, and on both the case and the lead from the sensor unit.

The results obtained from gas and liquid expansion thermometers with rigid stem are affected by the influence of ambient temperature on the case.

8.4 Temperature limits for storage and transport

During storage and transport, dial thermometers shall be capable of withstanding temperatures between $-20\text{ }^{\circ}\text{C}$ and $+60\text{ }^{\circ}\text{C}$ without detriment to their metrological properties.

8.5 Mounting attitude

No significant variation in indication shall occur when the dial is mounted $\pm 5^{\circ}$ within the nominal effective range specified for the attitude. The variation of indication due to attitude in the case of thermometers which can be operated in any mounting attitude shall not exceed half the value specified for the limits of error in Table 5.

8.6 Dial and pointer

8.6.1 Scale angle

The scale length shall be $270^{\circ} \pm 20^{\circ}$.

8.6.2 Scale interval

The scale interval shall be chosen from: $1\text{ }^{\circ}\text{C}$, $2\text{ }^{\circ}\text{C}$, $5\text{ }^{\circ}\text{C}$ and $10\text{ }^{\circ}\text{C}$.

For examples of dial design see Figures 4 to 7.

8.6.3 Pointer overtravel

Motion of the pointer beyond the minimum and maximum scale values shall not be obstructed over a distance corresponding to 5 % of the span.

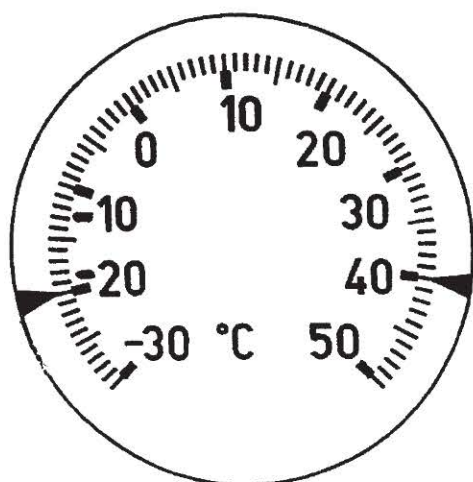


Figure 4 - Scale interval: 1 °C
Nominal range: -30 °C to +50 °C
Measuring range: -20 °C to +40 °C

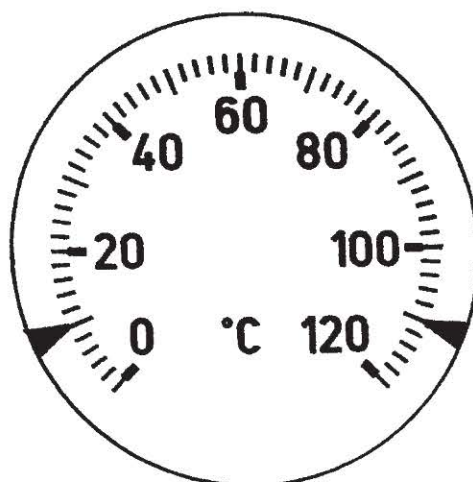


Figure 5 - Scale interval: 2 °C
Nominal range: 0 °C to 120 °C
Measuring range: 10 °C to 110 °C

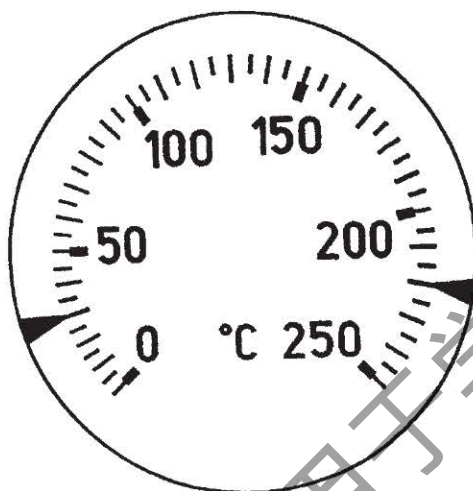


Figure 6 - Scale interval: 5 °C
Nominal range: 0 °C to 250 °C
Measuring range: 30 °C to 220 °C

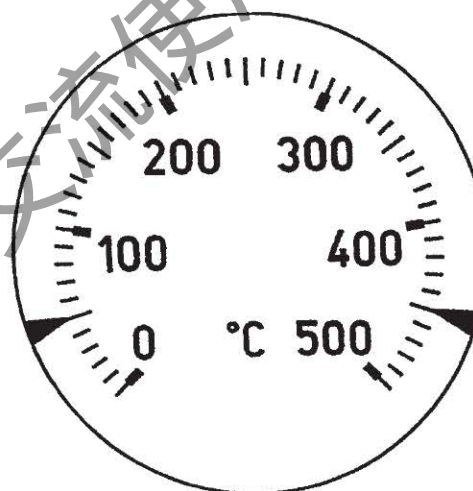


Figure 7 - Scale interval: 10 °C
Nominal range: 0 °C to 500 °C
Measuring range: 50 °C to 450 °C

8.6.4 Minimum lengths of pointer

The pointer shall cover between 1/10th and 9/10ths of the length of the shortest line of the minor scale marks.

The minimum lengths of the pointer from axis to tip are shown in Table 6.

Table 6 - Minimum lengths of pointer

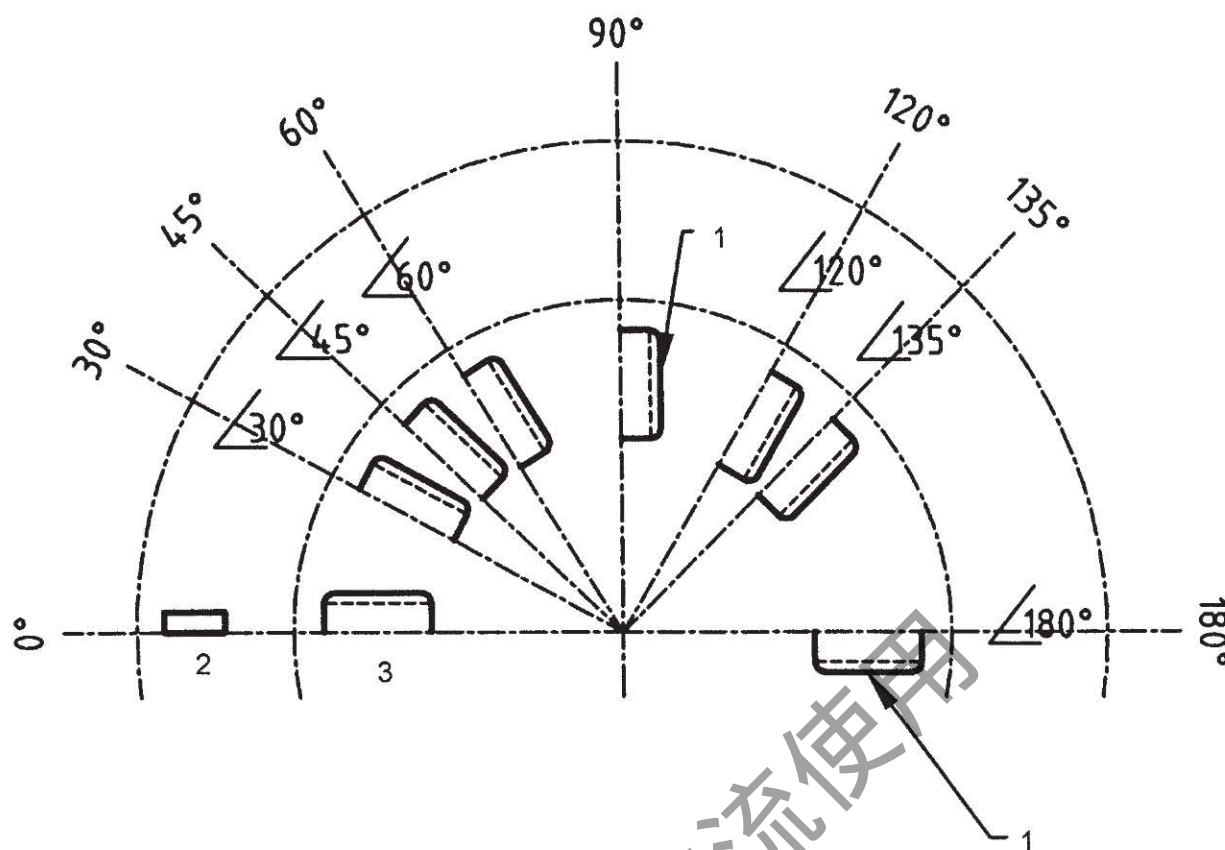
Thermometer nominal size	Minimum length of pointer mm
40	14
50	18
63	23
80	28
100	36
130	43
150	57
160	62

8.6.5 Scale marks

- The scale spacing shall not be smaller than 1 mm.
- The scale spacing shall be as constant as possible. The difference between the longest and shortest spacing shall not exceed 1/5 th of the latter.
- The thickness of the scale marks shall not exceed 1/5 of scale spacing.

8.6.6 Information on dial

- a) Unit of temperature shall be marked.
- b) Accuracy class shall be marked, preferably at the end of the scale.
- c) The EN number of this standard may be marked.
- d) The name or logo of the manufacturer and/or supplier shall be marked.
- e) The symbol for the dial plane (see Figure 8) shall be marked when the manufacturer is required to calibrate the thermometer other than in vertical position. Marking is not required for adjustable angle stem thermometers.



Key
1 Dial
2 Symbol
3 Meaning

Figure 8 - Symbols denoting mounting attitude

9 Testing

9.1 General

If acceptance testing is to be carried out by the customer or his representative, then the test conditions and the scope of the test shall be agreed at the time of ordering.

Testing shall be carried out using a test instrument with an accuracy of at least four times better than the accuracy of the thermometer to be tested. The test instrument shall be traceable to a national or international standard.

In order to minimize systematic errors during the test, due consideration shall be given to the corrections specified in the calibration certificates.

9.2 Test procedure

The following tests may be carried out as random tests.

- a) The temperature detecting element under test shall be exposed for 20 min to a temperature corresponding to its maximum scale value, or +60 °C, whichever is the greater.
- b) The thermometer shall then be tested for accuracy and hysteresis using at least three temperatures selected at uniform intervals over the measuring range. The test shall be carried out under reference conditions, both up and down the scale.
- c) In the case of thermometers which can be mounted at any angle, the variation in indication occurring when the thermometer is turned through 90° in its longitudinal and transverse axes shall be determined.

10 Designation

	Thermometer	EN 13190	BM	100	1	G 1/2 B	6	0/100	1	200	8
Description											
Standard main number											
Type of thermometer											
Nominal size											
Type of mounting (see Tables 3 and 4)											
Thread size											
Form of connection (see Figures 2 and 3)											
Nominal range °C (without plus and minus sign)											
Accuracy class											
Length l_1											
Diameter d_5											

NOTE When thermometer is of the capillary type, the length of capillary (in metres) should be stated at the end of the designation, separated by a dash.

Annex A (informative)

Selection and installation recommendations

A.1 General

Any temperature measuring device can only indicate the temperature of its temperature-sensitive part, i. e. the temperature sensor. In the process the temperature of the substance to be measured at the measuring point is detected only approximately. The reason for this is that, firstly, the heat transfer between the substance to be measured and the temperature sensor is impeded and, secondly, that heat can also be transmitted to or taken from the sensor by conduction and radiation from parts other than the substance to be measured and the surrounding area.

Correct measurements require good heat transfer between the substance to be measured and the temperature sensor. Any further (interfering) exchange of heat shall as far as possible be avoided. The indication response delay of the temperature sensor shall be matched to the rate of change of the temperature of the process to be measured.

The following types of dial indicating thermometers are usually used in industry:

- Bimetallic thermometer, operated by differential expansion of bimetallic strips, in the form of a helix or a coil.
- Gas expansion thermometer, operating on the principle of change in pressure of a fixed amount of gas in response to temperature change.
- Liquid expansion thermometer, operating on the principle of liquid volume expansion in response to temperature change.

In order to get a correct measurement, not only the recommendations of this annex should be observed but also the instructions of the manufacturer concerning the correct and safe mounting and the correct use of the devices.

A.2 Selection

If the conditions of use are not observed, this may result in incorrect functions and wrong indications of the device. The result will be more maintenance work or a reduced durability of the device.

In order to choose the correct measuring device information concerning the conditions of use shall be considered, for example data relating to the substance to be measured and its temperature, pressure, flow-rate as well as vibrations, pulsations, material of the sensor, fitting length etc. (see criteria of Table A.1).

Due to the reasons mentioned above, the use of thermowells should be considered. In this case, it shall be taken into consideration that the response time will increase correspondingly. It will be an advantage to have a close fit between stem and thermowell. It is also worthwhile using a transmission oil or a heat conduction paste.

Table A.1 - Selection criteria

Criteria	Type of thermometer		
	Bimetallic	Gas expansion	Liquid expansion
range of indication	from -100 °C up to +600 °C	from -200°C up to +700 °C	from -50 °C up to +250 °C
accuracy classes	class 1 and class 2		
influence of ambient temperature	no influence	yes	yes
compensation	not necessary	partial compensation	complete compensation
dependence of location	no	no	yes
resistance to vibration by means of damping	moderate	good	good
length of detecting element	~ 2000 mm	no limit	no limit
design with capillary possible	no	yes	yes
environmental compatibility	good	good	not so good due to some liquids, partially not compatible

A.3 Installation

The manufacturer's instructions concerning installation should be observed.

When installing the thermometer, it is important to choose the right location, having in mind possible limited access

- when mounting/ removing/ maintaining
- when reading.

Thermally "dead locations" shall be avoided.

The influence of the ambient temperature shall be limited by suitable measures so that the ambient temperature remains within the nominal range for ambient temperature. Ambient temperatures outside this range, affect the measuring result and lead to differences in indication.

Whenever possible, thermometers should be mounted in locations where there is little or no vibration.

In the case of thermometers with capillary, the latter shall not be kinked. The manufacturer's indications concerning the smallest bending radius shall be observed.

Bibliography

EN 60529:1991, *Degrees of protection provided by enclosures (IP-Code)*(IEC 60529:1989).