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**Technical product documentation —
Heat-treated ferrous parts —
Presentation and indications**

*Documentation technique de produits — Produits ferreux traités
thermiquement — Présentation et indications*



Reference number
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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2. www.iso.org/directives

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received. www.iso.org/patents

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see the following URL: www.iso.org/iso/foreword.html.

The committee responsible for this document is Technical Committee ISO/TC 10 *Technical product documentation*, Subcommittee SC 6, *Mechanical engineering documentation*.

This second edition of ISO 15787 cancels and replaces the first edition (ISO 15787:2001), which has been technically revised.

In addition to a number of editorial revisions, the following main changes have been made with respect to the previous edition:

- addition of an indication of both states of the part: 1) after the heat treatment (before final machining); and 2) after the final machining ([Figure 16](#) and [Figure 30](#));
- addition of examples representing the hardness values and their limiting deviations ([Table 1](#));
- addition of line types for the indication of local areas and their applications ([Table 2](#));
- addition of line type 07.2 (dotted wide line) for carburized, carbonitrided, nitrided or nitrocarburized workpieces to indicate areas where heat treatment is not allowed;
- replacement of the representation of hardness values, hardness depths, layer thicknesses and limiting deviations by their values and limiting deviations ([Tables 1, 3, 4](#) and [5](#));
- addition of marking of slip zones ([5.5.2](#)), key for the allocation test point and nominal value ([5.6](#)), indication of local areas ([5.7](#)), oxide layer thickness (OLT) ([5.11](#)), heat-treatment order (HTO) ([5.14](#)), heat-treatment document (HTD) ([5.15](#));
- replacement of the title of “Drawings providing specific indication of heat treatment” by “Heat-treatment sketch” ([6.4](#));
- deletion of the former [6.4 surface fusion hardening](#) in the 2001 edition;
- deletion of the [Annex A](#) tables present in the 2001 edition;
- addition of graphical symbols ([Annex A](#)).

Introduction

Technical drawings of workpieces are the most important documents

- for construction, development and production,
- for the assembling, and
- for the use of the final products.

Generally, a drawing provides information about the workpiece, its shape and design, the material used, the dimensions, surface behaviour, permitted abbreviations, inspection data, and more.

Workpieces made from steel and iron often have to withstand severe conditions to resist wear and corrosion.

To attain the required properties, the workpieces are heat-treated in most applications. A drawing is a very important document as it also informs the heat-treater about the parameters to be aware of for a successful heat-treatment. For that, he should know the material used, the required heat-treatment, the required hardness and hardness depth, the expected or permitted microstructure, the required testing method and the test points for testing the heat-treated workpiece.

In this time of global production, it is essential to dispose of an International Standard for technical product documentation, especially for the presentation and indication of heat-treated parts. Therefore, ISO 15787:2001 was revised to help to improve the quality of heat-treated workpieces.

Technical product documentation — Heat-treated ferrous parts — Presentation and indications

1 Scope

This document specifies the manner of presenting and indicating the final condition of heat-treated ferrous parts in technical drawings.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 128-24:2014, *Technical drawings — General principles of presentation — Part 24: Lines on mechanical engineering drawings*

ISO 4885, *Ferrous products — Heat-treatments — Vocabulary*

ISO 6506-1, *Metallic materials — Brinell hardness test — Part 1: Test method*

ISO 6507-1, *Metallic materials — Vickers hardness test — Part 1: Test method*

ISO 6508-1, *Metallic materials — Rockwell hardness test — Part 1: Test method (scales A, B, C, D, E, F, G, H, K, N, T)*

ISO/TS 8062-2, *Geometrical product specifications (GPS) — Dimensional and geometrical tolerances for moulded parts — Part 2: Rules*

ISO 81714-1, *Design of graphical symbols for use in the technical documentation of products — Part 1: Basic rules*

3 Terms, definitions

For the purposes of this document, the terms and definitions given in ISO 4885 apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

4 Abbreviated terms

For the purposes of this document, the following abbreviated terms apply.

| | |
|-----|----------------------------------|
| CHD | Case-hardening hardness depth |
| CD | Carburizing depth |
| CLT | Compound layer thickness |
| NHD | Nitriding hardness depth |
| SHD | Surface-hardening hardness depth |
| HTO | Heat-treatment order |
| HTD | Heat-treatment document |
| IOD | Internal oxidation depth |
| OLT | Oxide layer thickness |

5 Indications in drawings

5.1 General

Indications in drawings concerning the heat-treatment condition can relate to the assembly or final condition as well as to the condition directly after heat-treatment. This difference has to be observed implicitly, as heat-treated parts are often subsequently machined (e.g. by grinding). By this, the hardness depth is reduced, especially with case-hardened, surface-hardened and nitrided parts, as is the compound layer thickness of nitrided and nitrocarburized parts. The machining allowance shall therefore be taken into account appropriately during heat-treatment. If no separate drawing is made for the condition of the heat-treated part before the subsequent machining or finishing, it is necessary to give information about the machining allowance. For this, indications should be made for both states of the part: 1) after the heat-treatment (before final machining); and 2) after the final machining.

NOTE This can be done, for example, by indicating the heat-treated state and the finished state in accordance with ISO/TS 8062-2, by an additional representation, or by adding the words “before grinding” or “after grinding” (see [Figures 16](#) and [30](#)).

The words indicating the heat-treated condition, the hardness and the hardness depth data shall be placed near the title block of the drawing.

For some applications, it might be necessary to keep special data on the heat-treatment process to make sure that the required properties after the heat treatment are attained.

- In this case, a heat-treatment order (HTO) should be used. If an HTO exists, in the drawing, a reference shall be given by the wording “see HTO number ...”. Examples are given in [Figures 11, 12, 25, 29](#) and [42](#).
- To document the heat-treatment process carried-out in the heat-treatment workshop, a heat-treatment document (HTD) should be used.

5.2 Material data

Regardless of the heat-treatment method, generally the drawing shall identify the material used for the heat-treated part (name of the material, reference to the bill of materials, etc.).

5.3 Heat-treatment condition

The heat-treated condition shall be specified in words, such as “quench-hardened”, “quench-hardened and tempered”, “case-hardened”, “surface-hardened”, “nitrided”, etc.

If more than one heat-treatment is required, these treatments shall each be identified in words in the sequence of their execution, for example, “quench-hardened and tempered”. Indications by wording shall be chosen in accordance with ISO 4885. See [Clause 7](#) for practical examples.

The heat-treatment condition can be achieved in different ways. As a result, the performance characteristics can differ. Particulars of the technical process shall be specified in supplementary documents (e.g. HTO, HTD) where this is of importance for the heat-treated condition.

5.4 Hardness data

5.4.1 Surface hardness

The surface hardness shall be indicated

- as Rockwell hardness in accordance with ISO 6508-1,
- as Vickers hardness in accordance with ISO 6507-1, or
- as Brinell hardness in accordance with ISO 6506-1.

Additional hardness values shall be given in instances where the parts in the heat-treated condition have areas with different hardnesses (see [Clause 6](#)).

For case-hardened, surface-hardened, nitrided or nitrocarburized parts, the hardness decreases downwards from the surface to the core. A test of the hardness in a cross section of a part from the surface until the core yields a hardness profile; this profile can be used, for instance, in accordance with ISO 2639 to specify the hardness depth. The surface hardness value depends on the hardness profile, the hardness depth and the test load. Therefore, if the surface hardness is indicated for case-hardened or surface-hardened parts, the test load shall be adjusted according to the hardness depth and the expected surface hardness.

5.4.2 Core hardness

The core hardness shall be indicated in the drawing where a specification is given that it is to be tested. The core hardness shall be given

- as Rockwell hardness in accordance with ISO 6508-1,
- as Vickers hardness in accordance with ISO 6507-1, or
- as Brinell hardness in accordance with ISO 6506-1.

5.4.3 Hardness value and limit deviations

All hardness values shall be toleranced. They can be written as shown in the examples in [Table 1](#).

Table 1 — Examples of how to represent hardness values and their limiting deviations

| Written mode | Lower and upper limit |
|---|-------------------------|
| (62 ±2) HRC | 60 HRC up to 64 HRC |
| (64 0/-4) HRC | |
| (60 +4/0) HRC | |
| $\left(60 \begin{smallmatrix} +4 \\ 0 \end{smallmatrix} \right)$ HRC | |
| (61 +3/-1) HRC | |
| (750 ±75) HV10 | 675 HV10 up to 825 HV10 |
| (825 0/-150) HV10 | |
| (675 +150/0) HV10 | |
| (700 +125/-25) HV10 | |
| $\left(700 \begin{smallmatrix} +125 \\ -25 \end{smallmatrix} \right)$ HV10 | |

Tolerances should be as large as functionality permits.

5.5 Markings

5.5.1 Marking of test points

If it is necessary to mark the test point in the drawing, the symbol for the test point shall be indicated according to [Figure 1](#). The graphical symbol for the test point shall be drawn in accordance with [A.2](#).



Figure 1 — Symbol for the test point

The precise position of the symbol shall be placed according to [Figure 2](#).

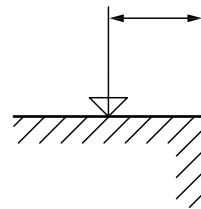


Figure 2 — General dimensioning of a test point

If there is more than one test point, the symbol shall be directly combined with an identification number for each test point according to [Figure 3](#). The graphical symbol for the test point with its identification number shall be drawn in accordance with [A.3](#).

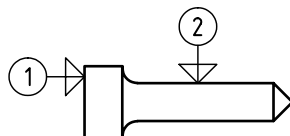


Figure 3 — Identification number for each test point

If a section of the heat-treated part is cut off in order to test the heat-treated state, marking shall be as shown in [Figure 4](#). If there is a section of a piece that should be cut off after the heat-treatment, this section should be marked by a long-dashed double-dotted narrow line of type 05.1 in accordance with ISO 128-24 (see [Figure 4](#)).

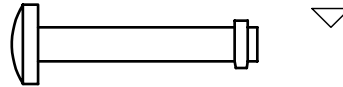


Figure 4 — Marking of a section where the heat-treated part is cut off

5.5.2 Marking of slip zones

A slip zone is a zone of a surface-hardened workpiece, where the surrounding surface-hardening operation has to be stopped to avoid the reheating the area where the surface-hardening operation began.

It should be decided where the slip zone can be placed without affecting the functional properties of the workpiece. If it is necessary to mark the slip zone in the drawing, the symbol for the slip zone shall be indicated according to [Figure 24](#). The graphical symbol for the slip zone shall be drawn in accordance with [A.4](#). The length of the slip zone and its position shall be dimensioned as shown in [Figure 25](#).

5.6 Key for the allocation test point and nominal value

If more than one test point is allocated, the number of the measuring point should be written together with the nominal values of the hardness or of the hardness depth. See the example in [Figure 12](#).

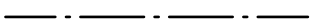
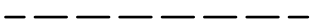
5.7 Indication of local areas

In some cases, it is necessary to indicate local areas of a part which have the following special conditions:

- a) surface-hardened areas of surface-hardened parts;
- b) areas of a part where heat-treating may be allowed;
- c) not heat-treated areas of a quench-hardened, carburized, carbonitrided, nitrided or nitrocarburized part;
- d) indication of expected or wished spread of a hardened area.

Parts which will have the mentioned special conditions in [5.7](#) a), b) and c) shall be marked in accordance with [Table 2](#).

Table 2 — Line types for the indication of local areas and their applications

| Line according to ISO 128-24 | | Application |
|------------------------------|---|---|
| No. | Description and representation | |
| 04.2 | Long-dashed dotted wide line  | For surface-hardened or case-hardened workpieces: to indicate the areas that should be surface-hardened or case-hardened |
| 02.2 | Dashed wide line  | For surface-hardened or case-hardened workpieces: to indicate the areas that may be surface-hardened or case-hardened |
| 07.2 | Dotted wide line | For carburized, carbonitrided, nitrided or nitrocarburized workpieces: to indicate the areas where the heat-treatment is not allowed |
| 04.1 | Long-dashed dotted narrow line | For surface-hardened workpieces: to indicate the expected or wished spread of the surface-hardened areas |

5.8 Hardness depth

The hardness depth shall be given as surface-hardening hardness depth (SHD), case-hardening hardness depth (CHD) or nitriding hardness depth (NHD) according to the heat-treatment method.

Hardness depth values shall be toleranced and should be written as shown in the examples in [Table 3](#). The tolerance should be as large as functionality permits.

Table 3 — Examples of how to represent hardness depths and their limiting deviations

| Written mode | Lower and upper limit |
|----------------------------------|-----------------------|
| 1,0 ±0,3 | 0,7 mm up to 1,3 mm |
| 1,3 0/-0,6 | |
| 0,7 +0,6/0 | |
| 0,7 ^{+0,6} ₀ | |
| 0,9 +0,4/-0,2 | |

5.9 Carburizing depth (CD)

The CD is determined from the carbon content profile with the carbon content, expressed as percentage by mass as a limiting characteristic (see ISO 4885). The carbon content limit shall then be added as a suffix (subscript) to the symbol.

EXAMPLE A carbon content limit of 0,35 of carbon percentage by mass is indicated by “CD_{0,35}”.

The carburizing depth shall be toleranced and should be written as shown in the examples in [Table 4](#). Tolerances should be as large as functionality permits.

Table 4 — Examples of how to represent carburizing depths and their limiting deviations

| Written mode | Lower and upper limit |
|---|-----------------------|
| 2,0 ±0,5 | 1,5 mm up to 2,5 mm |
| 2,5 0/-1,0 | |
| 1,5 +1,0/0 | |
| 1,5 $\begin{smallmatrix} +1,0 \\ 0 \end{smallmatrix}$ | |
| 1,8 +0,7/-0,3 | |

In the case of carburizing or case-hardening, it might be necessary to indicate the internal oxidation in accordance with its depth. For the depth of internal oxidation, the abbreviation IOD should be used. This depth shall be toleranced and should be written like the examples in [Table 5](#), with the dimension micrometre.

5.10 Compound layer thickness (CLT)

The CLT is the thickness of the outer area of the nitrided layer (see also ISO 4885). It is usually determined by light-microscopy. The abbreviation of compound layer thickness is CLT.

NOTE Destruction of, or damage to, a workpiece is inevitable when testing. If necessary, testing can be carried out on a reference sample heat-treated together with the workpieces for this purpose.

The compound layer thickness shall be toleranced and should be written like the examples in [Table 5](#). The tolerances should be as large as functionality permits.

Table 5 — Examples for representation the CLT and their limiting deviations

| Written mode | Lower and upper limit |
|---|-----------------------|
| (15 ±5) μm | 10 μm up to 20 μm |
| (20 0/-10) μm | |
| (10 +10/0) μm | |
| $\left(10 \begin{smallmatrix} +10 \\ 0 \end{smallmatrix}\right)$ μm | |
| (12 +8/-2) μm | |

The wording “compound layer” can also be used for the boride layer of borided workpieces.

5.11 Oxide layer thickness (OLT)

The OLT is the thickness of the oxide layer after nitrocarburizing to optimize the corrosion resistance. It is usually determined by light microscopy. The abbreviation of oxide layer thickness is OLT.

The oxide layer thickness shall be toleranced and can be written as shown in the examples in [Table 5](#). The tolerances should be as large as functionality permits.

5.12 Strength data

Strength values are only indicated

- a) if it is necessary and
- b) if the shape and dimensions of the part are such that the heat-treated probe can be used to test the strength.

If necessary, the place and its location from which the cut section is to be taken shall be indicated. Indication of the core hardness is unnecessary in such instances.

The strength values are to be toleranced and can be written in the same manner like hardness values or hardness depths. The tolerances should be as large as functionality permits.

5.13 Microstructure

If necessary, the information on the hardness and hardness depth may be supplemented by information on the microstructure of the heat-treated parts. For example, this information might include the maximum amount of retained austenite, the quantity, size or layout of carbides, the length of the martensite needles or other important criterions.

NOTE For investigation of the microstructure, destruction of, or (at least) damage to, the workpiece is inevitable. It can be sufficient, however, to carry out investigation on a reference sample heat-treated together with the workpieces for this purpose.

5.14 Heat-treatment order (HTO)

An HTO is a document which accompanies the drawing of a heat-treated part. It contains details of the required heat-treatment process which could not be tested on the heat-treated part. The HTO provides the heat-treatment workshop with instructions about the heat-treatment process in order to make sure that the indicated hardness, hardness depth, etc. will be reached.

5.15 Heat-treatment document (HTD)

An HTD is a document about the heat-treatment process which contains the specific data such as the furnace used, the adjusted furnace temperature, the carbon level, the carburizing medium, the quenching oil, etc. With the HTD, the user can follow how the heat-treatment process was applied.

6 Graphical representation

6.1 General

6.1.1 The heat-treated condition shall be indicated by:

- a) textual information (e.g. “surface-hardened”), as described in [5.3](#);
- b) measurable dimensions and test points for the following material conditions:
 - 1) hardness;
 - 2) hardness depth;
 - 3) carburizing depth;
 - 4) compound layer thickness;
 - 5) local heat-treatment.

6.1.2 The graphical representation of a heat-treatment condition can be supplemented by:

- a) marking of test points;
- b) heat-treatment sketch;
- c) strength data;
- d) information on structural condition.

6.1.3 Graphical representations of heat-treatment requirements shall be as shown in [Figures 7 to 44](#).

6.2 Heat-treatment of the entire part

6.2.1 Uniform condition

The heat-treated condition shall be specified in words indicating the heat-treatment. Examples are shown in [Figures 7 to 11, 27 to 29, 38, 39, 41, 42 and 44](#).

6.2.2 Areas with different conditions

If a workpiece is to have different values in different areas, this shall be represented as follows:

- a) the respective areas shall each be given a specific identity to indicate the heat-treated condition and the extent of its area;
- b) characteristic numbers shall be repeated below the information, in words according to [5.3](#), together with the required values (see [Figures 12, 20, 22, 26, 32 and 34](#));
- c) if appropriate, specified test points shall be marked according to [5.5](#).

6.3 Local heat-treatment

6.3.1 General

It should be considered in each instance whether it is practical to locally limit the heat-treatment, as this can mean additional expenditure compared with the treatment of the entire part. Otherwise, transitions with a lower hardness/strength would be created and breaks could be promoted.

The size of the transition between heat-treated and non-heat-treated areas depends on the method of heat-treatment, and the material and shape of the part to be heat-treated. It is therefore appropriate to specify the dimensions and tolerances for the size and position of the areas to be heat-treated in agreement with the hardening workshop.

If a workpiece is to have different values in different areas, this shall be represented by characteristic numbers that shall be repeated below the information in words and according to 5.3 together with the required values (see Figures 20, 22, 23, 26, 32 and 34).

6.3.2 Areas requiring heat-treatment

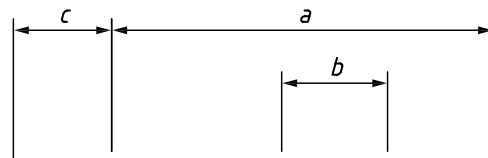
Those areas of a part that are to be heat-treated shall be marked in the graphical representation by a type 04.2 long-dashed dotted wide line, in accordance with Table 2, outside the body outlines of the part. For parts with rotational symmetry, it shall be sufficient to indicate one relevant surface line (the “generatrix”), if this is not misleading, for the purposes of simplification (e.g. Figure 15). If necessary, the size and position of these areas shall be specified by dimensions and tolerances.

The transition between heat-treated and non-heat-treated areas lies, in principle, outside the nominal size for the length of the heat-treated area.

6.3.3 Areas that may be heat-treated

Apart from those areas that shall be heat-treated, information should also be given on areas which may be heat-treated, as this can facilitate the execution of local heat-treatment and reduce distortion.

Areas which may be heat-treated shall be marked by a type 02.2 dashed wide line, in accordance with Table 2, outside the body outlines and, if necessary, shall be dimensioned. Indications of tolerance are generally not required for these areas (see Figures 5 and 14).



Key

- a* heat-treated area
 - b* length of the area that may be heat-treated
 - c* distance between the left end of the axle and the beginning of zone “*a*”
- Area *a* shall be dimensioned.

Figure 5 — Marking of areas that may be heat-treated

6.3.4 Areas that shall not be heat-treated

Areas where no heat-treatment is allowed shall be marked by a dotted wide line of type 07.2, in accordance with Table 2 (see Figure 6).

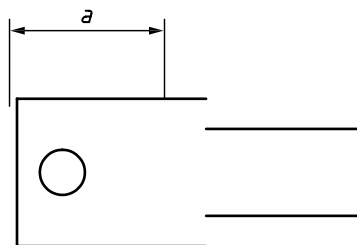


Figure 6 — Marking of areas that shall not be heat-treated

6.4 Heat-treatment sketch

If the representation of a part would become unclear by adding an instruction on heat-treatment or if confusion with other methods of treatment would be possible, a heat-treatment sketch shall be included. In this sketch (which may be a detail drawing), drafting details not required for heat-treatment shall be omitted. It shall be designated “heat-treatment sketch” and contain all the necessary instructions indicating the heat-treatment condition (see [Figure 23](#)).

A true-to-scale representation is not necessary. The heat-treatment sketch shall be placed near the title block of the drawing.

7 Practical examples

7.1 General

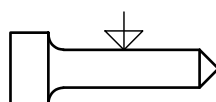
The figures and the associated instructions in this clause are practical examples. The suitability of the instruction to be given shall be determined on the basis of the technical details of the heat-treatment process.

Unless otherwise specified, all dimensions are in millimetres.

7.2 Quench-hardening, quench-hardening and tempering, austempering

7.2.1 Heat-treatment of the entire part — All over uniform requirements

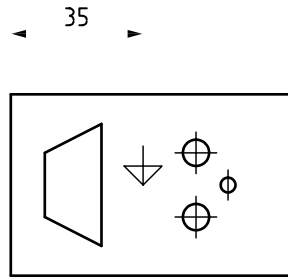
The quench-hardened condition of the part illustrated by [Figure 7](#) shall be designated by the wording “quench-hardened”, by indicating the hardness value with its permissible deviation, and by marking the test point. The symbol for the test point without any indication of a precise position allows the hardness test at an optional point of the indicated geometric element.



quench-hardened
(62 ±2) HRC

Figure 7 — Marking of a part with quench-hardened condition

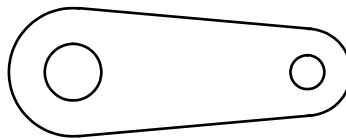
If tempering is carried out after hardening, “quench-hardened” is not sufficient to designate the quench-hardened and tempered condition unambiguously. In such instances, the full wording “quench-hardened and tempered” shall be given in accordance with [5.3](#) (see [Figure 8](#)).



quench-hardened and tempered
(61 ±2) HRC

Figure 8 — Marking of a part in quench-hardened and tempered condition

The part shown in [Figure 9](#) is to be quench-hardened and tempered. The designation shall read “quench-hardened and tempered”. No test point is indicated; therefore, the hardness can be tested at any point.

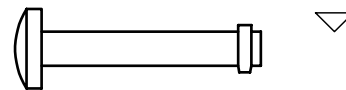


quench-hardened and tempered
(375 ±25) HBW2,5/187,5
(quench-hardened: (62 ±2) HRC)

Figure 9 — Marking of a part in quench-hardened and tempered condition

For quench-hardened and tempered parts, where the tempering is done at a higher temperature to achieve high toughness, it is necessary to control the hardness before tempering would be started. This avoids a too low quenching rate and a too slow tempering temperature. Therefore, the hardness should be tested after quench-hardening and before tempering (see [Figure 9](#)).

If a section of the heat-treated part is cut off in order to test the quench-hardened and tempered state by a tensile test, marking shall be as shown in [Figure 10](#). It is recommended to use a section with the same diameter as the workpiece to be tested.



quench-hardened and tempered
 $R_m = (1\ 150 \pm 50) \text{ N/mm}^2$
 $R_{p0,2} \geq 900 \text{ N/mm}^2$
 $A \geq 9 \%$

Figure 10 — Marking of a heat-treated part where a section is cut off for testing

The part shown in [Figure 11](#) is austempered. The designation shall read “austempered”. If the heat-treatment is to be carried out in accordance with a heat-treatment order (HTO), a reference shall be made to the HTO, see [Figure 11](#).



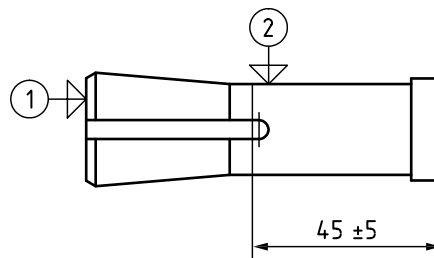
austempered, see HTO...
(60 ±1) HRC

Figure 11 — Marking of an austempered part

7.2.2 Heat-treatment of the entire part — Areas with different hardnesses

If a part is to have different hardness values for individual areas and heat-treatment is to be carried out in accordance with a heat-treatment order (HTO), the areas of different hardnesses shall be marked and, if necessary, dimensioned. In addition, reference shall be made to the HTO (see [Figure 12](#)).

Dimensions in millimetres



quench-hardened and tempered, see HTO...
1: (60 ±2) HRC
2: (43 ±2) HRC

Figure 12 — Marking of a part with different hardness values

7.2.3 Local heat-treatment

The part shown in [Figure 13](#) is to be locally heat-treated. The heat-treated area shall be marked by a type 04.2 long-dashed dotted wide line, in accordance with [Table 2](#), and with dimensional data according to [6.3](#). The test point shall be marked in accordance with [5.5](#).



Figure 13 — Marking of a part which is locally heat-treated

When heat-treating a workpiece, for reasons of processing, it may be more convenient to harden a larger area than required. If this is done, the additionally quench-hardened area shall be marked by a type 02.2 dashed wide line, in accordance with [Table 2](#), and with dimensional data indicating the position of the heat-treated area (see [Figure 14](#)).

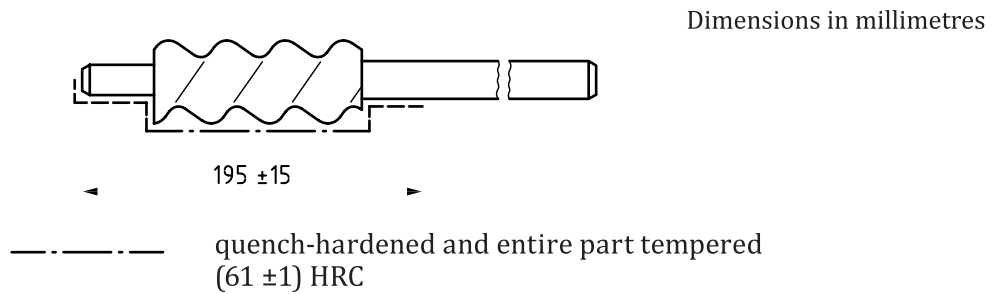


Figure 14 — Marking of a part with an additionally quench-hardened area

7.3 Surface-hardening

7.3.1 General

Surface-hardening is normally locally limited. Consequently, the requirements given in [6.3](#) shall be applied.

7.3.2 Specification of surface hardness

When specifying the test method for the determination of the surface hardness of surface-hardened parts, a careful adaptation of the test load to SHD shall be observed.

7.3.3 Specification of surface-hardening hardness depth (SHD)

The abbreviation of the surface-hardening hardness depth is SHD. It shall be appended the numerical value for the limiting hardness, normally tested as Vickers hardness HV1. The limiting hardness in normal case is 80 % of the minimum surface hardness.

The hardness depth is given as a nominal dimension in millimetres and the value shall be toleranced and can be written as shown in [Table 3](#). The tolerance should be as large as functionality permits.

7.3.4 Practical examples

7.3.4.1 Generally applicable examples

In the simplest instance, a type 04.2 long-dashed dotted wide line, in accordance with [Table 2](#), shall be used for marking the surface-hardened area (see [Figure 15](#)) and keyed with the wording “surface-hardened”. The surface hardness and the surface-hardening hardness depth are characteristic for the surface-hardened state.

The transition between the surface-hardened and non-surface-hardened area lies, in principle, outside the nominal dimension for the length of the surface-hardened area. The transition width depends on the depth of hardening, the surface-hardening method, and the material and shape of the workpiece.

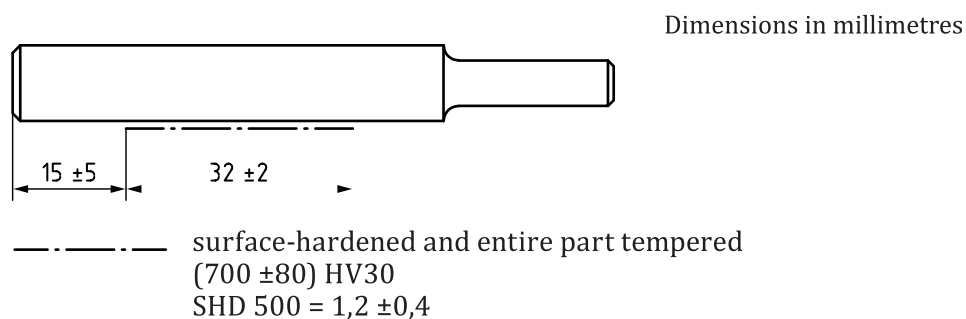


Figure 15 — Marking of a part which is surface-hardened

In most cases, surface-hardened parts have to be finished by grinding. Thereby, the surface hardness and the surface-hardening hardness depth will be reduced. If it is necessary to present both states in a drawing, this shall be indicated

- by adding the words “before grinding” and “after grinding” [see the left caption “a)” of [Figure 16](#)], or
- by adding symbols in accordance with ISO/TS 8062-2 and adding the data that have to be tested [see the right caption “b)” of [Figure 16](#)]. The written mode on the right is explained in ISO 10135.

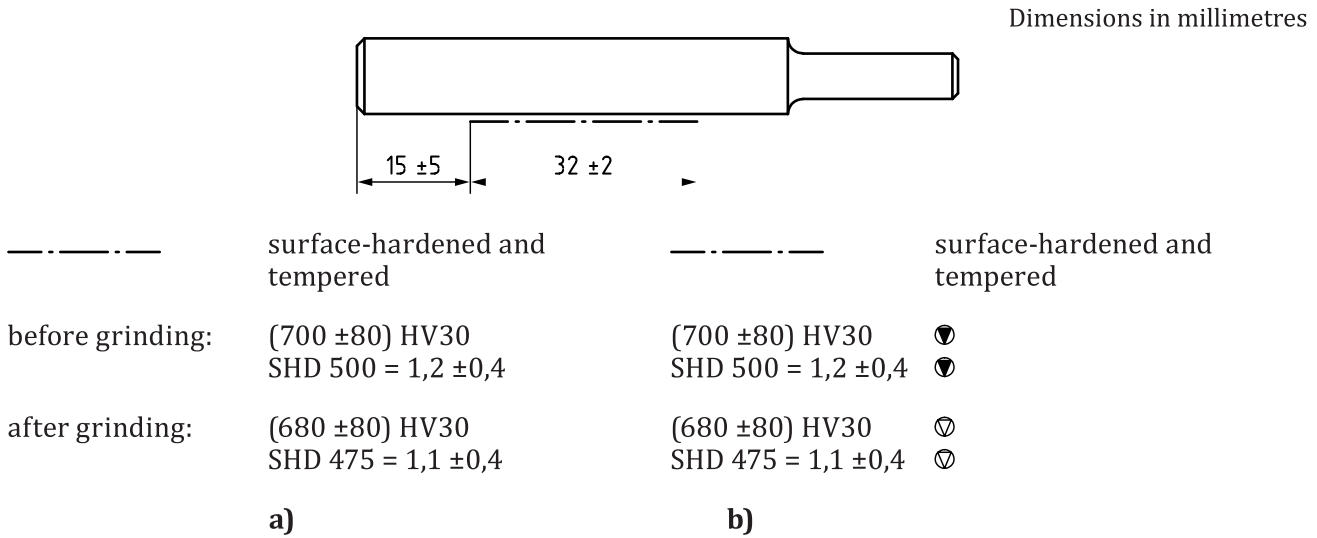


Figure 16 — Marking of a surface-hardened part with two states: before and after grinding

If a part is surface-hardened, for processing reasons, it may be more convenient to harden a larger area than required. If this is done, the additionally hardened area shall be marked by a type 02.2 dashed wide line, in accordance with [Table 2](#), together with dimensional data indicating the position of the surface-hardened area (see [Figure 17](#)).

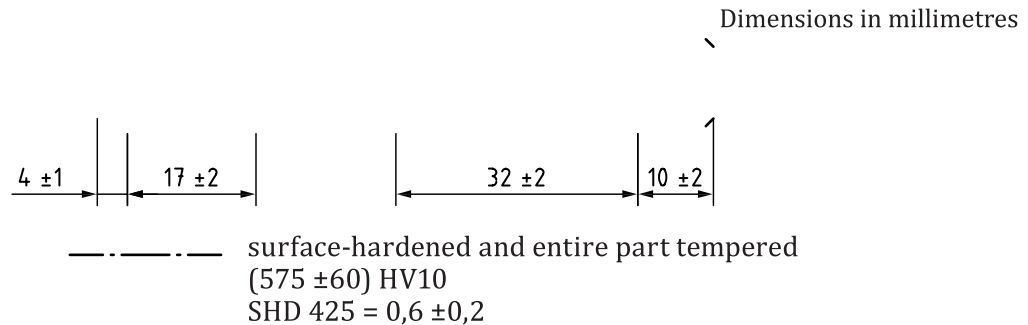


Figure 17 — Marking of a part which is surface-hardened with a larger area than required

If for surface hardening of a part it is not necessary that the hardened surface layer extends to the edge (of considerable value in reducing the danger of spalling at the edges), this shall be specified by appropriate dimensioning. See [Figure 18](#).

The workpiece should not be tempered after surface hardening. Therefore, the word “tempering” is not used. In order to reduce the danger of cracks at the edges, it is practicable to dimension the chamfers as large as needed and to have an adequate distance of the surface-hardened area to the edges. The distances have to be adjusted to the possibilities of the heat-treatment process. The surface-hardened area is marked by a type 04.2 long-dashed dotted wide line in accordance with [Table 2](#).

Dimensions in millimetres

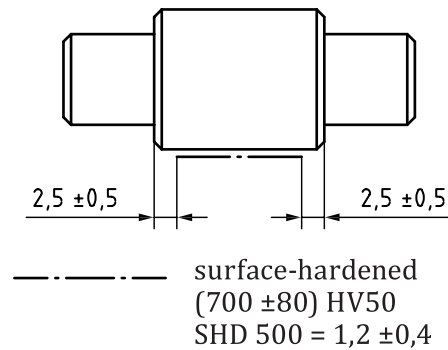


Figure 18 — Marking of a part which is surface-hardened and where the hardened surface layer should not extend to the edges

Where the surface-hardened layer extends to the edge, the configuration of the zone shall be indicated by a type 04.1 long-dashed dotted narrow line, in accordance with [Table 2](#), within the workpiece outlines (as it is for the right-hand cam of the part shown in [Figure 19](#)). On the left cam, only the cylindrical area is surface hardened. So in the chamfer area is a lower SHD allowed in accordance to the long dashed dotted narrow line. Where the hardened surface layer extends to the edge, it is permissible to have a lower SHD value directly adjacent to the edge (end of the hardened zone); this shall also be indicated by the long-dashed dotted narrow line (see the left-hand cam in [Figure 19](#)).

NOTE In both instances, the edges are provided with a chamfer in order to reduce the danger of cracking.

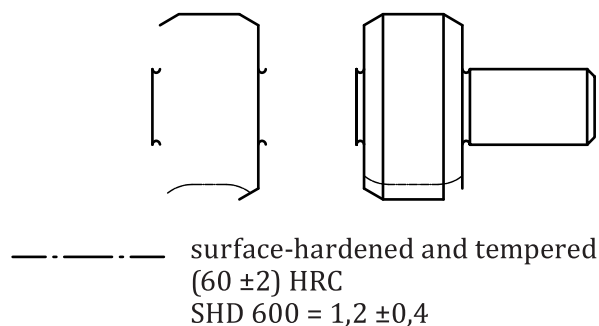


Figure 19 — Marking of a part which is surface-hardened and where the surface-hardened layer should extend to the edge

7.3.4.2 Heat-treatment pictures for gears

7.3.4.2.1 General

Where the configuration and the position of the hardened surface layer is of importance for the performance characteristics (e.g. surface-hardening of the tooth flanks including the tooth bottom in respect of gears), this shall be indicated by a type 04.1 long-dashed dotted narrow line, in accordance with Table 2, within the workpiece outlines (see Figures 20, 21 and 22).

7.3.4.2.2 Full tooth hardening

A type 04.2 long-dashed dotted wide line, in accordance with Table 2, at the periphery of the gear and a type 04.1 long-dashed dotted narrow line, in accordance with Table 2, shall be used to show that the teeth are fully hardened (see Figure 20).

NOTE Depending on the nature of the process, different hardness values will occur over the tooth height. Test of the hardness depth makes no sense in this example.

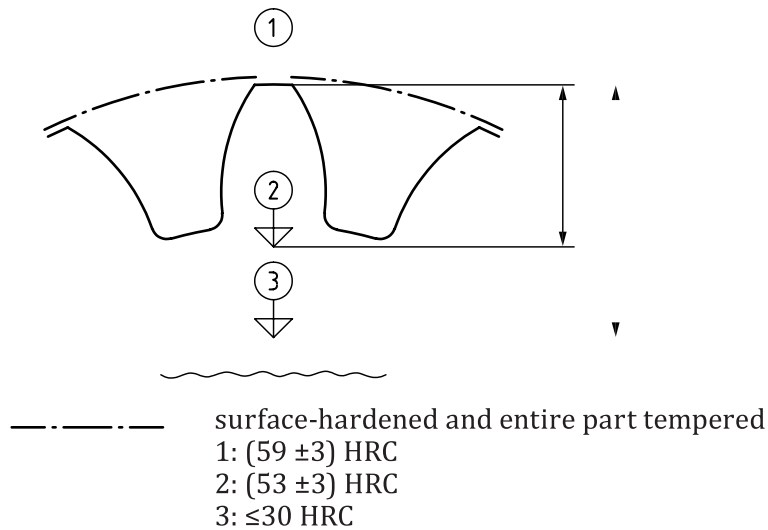


Figure 20 — Marking of a gear where the teeth are fully surface-hardened

7.3.4.2.3 Tooth flank surface-hardening

A type 04.2 long-dashed dotted wide line, in accordance with Table 2, outside the body outlines shall be used to mark the surface-hardened area. A type 04.1 long-dashed dotted narrow line, in accordance with Table 2, shall be used to set off its position and configuration (see Figure 21). Because of the required configuration of the hardened layer, measuring points for the surface-hardening hardness depth shall be defined.

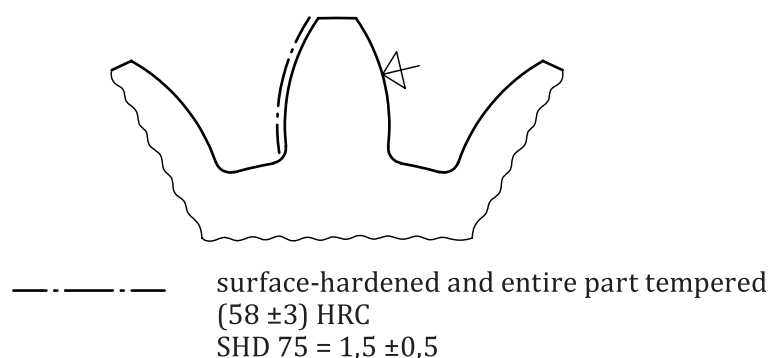


Figure 21 — Marking of a part with a surface-hardened tooth flank

7.3.4.2.4 Tooth bottom surface-hardening

A type 04.2 long-dashed dotted wide line, in accordance with [Table 2](#), outside the body edges shall be used to mark the surface-hardened area, and a type 04.1 long-dashed dotted narrow line, in accordance with [Table 2](#), shall be used to mark its position and configuration. Because of the configuration of the hardened surface layer, test points for the hardness depth shall be defined (see [Figure 22](#)).

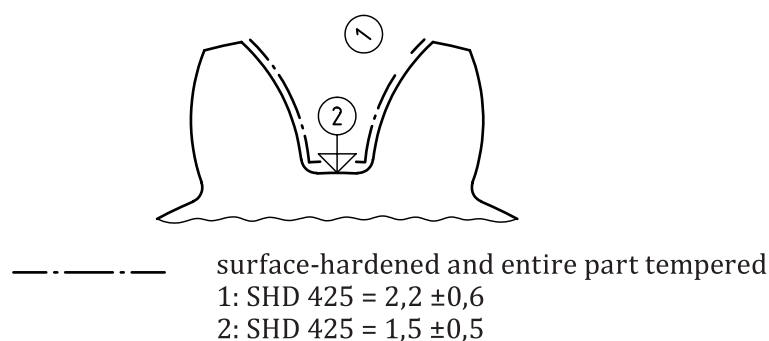


Figure 22 — Marking of a part where the ground between the teeth is surface-hardened

7.3.4.3 Differing surface-hardening hardness depths

In the individual areas of the part, shown in [Figure 23](#), differing values are required for the hardness depths. In addition, dimensioning of the hardened zones is necessary. These additional indications may make the representation of the part unclear. For this reason, a heat-treatment sketch has been included at the top of [Figure 23](#) for details Y and Z. A type 04.1 long-dashed dotted narrow line, in accordance with [Table 2](#), shall be used to indicate the configuration of the hardened surface layer. The size and position shall be specified by dimensioning.

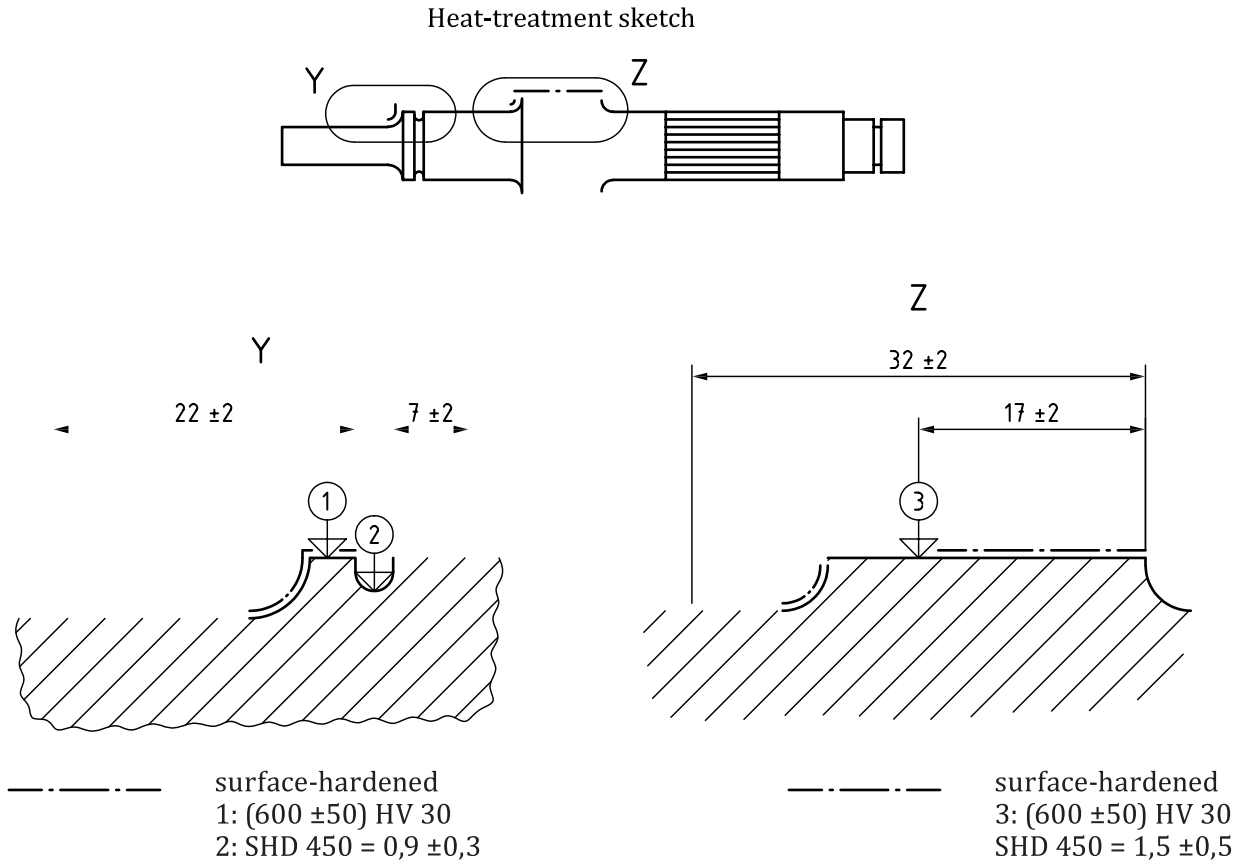


Figure 23 — Marking of a part with different surface-hardening hardness depths

7.3.4.4 Surface-hardening treatment with slip zone

In the case of surface-hardening treatment by surrounding a workpiece, it might be more efficient to leave a small area untreated, depending of the heat-treatment process and the required properties of the piece. In this area, called a “slip zone”, the hardness would be as low as before the heat treatment. It is necessary to define, where a permitted slip zone may be located and how long it is. Additional data shall be given in an HTO to which reference shall be made.

The symbol to be used for a slip zone is shown in [Figure 24](#). The length of the slip zone shall be dimensioned as shown in [Figure 25](#). The graphical symbol for the slip zone shall be drawn in accordance with [A.4](#).



Figure 24 — Symbol for a slip zone

Dimensions in millimetres

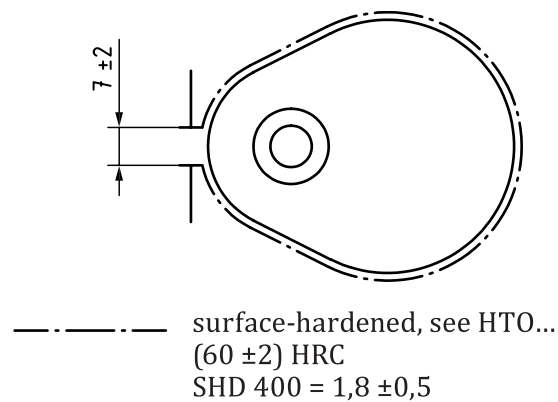


Figure 25 — Marking of a surface-hardened part with a slip zone

7.3.4.5 Example with more than one test point

The surface-hardened part (see Figure 26) shall have the given values in areas marked by type 04.2 long-dashed dotted wide lines, in accordance with Table 2, and by dimensioning (the process can be achieved by, for example, additional local tempering).

Dimensions in millimetres

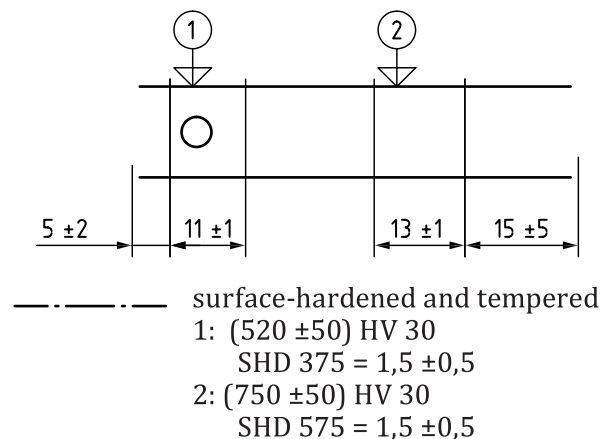


Figure 26 — Marking of a part with more than one measuring point

7.4 Case-hardening

7.4.1 Specification of surface hardness

When specifying the surface hardness of case-hardened parts, a careful adaptation of the test load determining the CHD shall be observed to avoid the eggshell effect.

7.4.2 Specification of case-hardening hardness depth (CHD)

The abbreviation of the case-hardening hardness depth is CHD. The limiting hardness to define the CHD is normally 550 HV1 in accordance with ISO 2639.

The case-hardening hardness depth is given as a nominal dimension in millimetres. The value shall be toleranced and should be written as shown in the examples in Table 3. The tolerance should be as large as functionally possible.

7.4.3 Specification of carburizing depth (CD)

Specification of carburizing depth is required in instances where the workpiece has to be tested after carburizing and before a quench-hardening treatment. The abbreviation CD, used for the carburizing depth, shall be appended a suffix designating the limiting characteristic specified for the determination of the carburizing depth (see [Figures 36](#) and [37](#)).

It is a general rule to use a carbon percentage by mass of 0,35 as a limiting characteristic. However, it is also permissible to specify other, differing values.

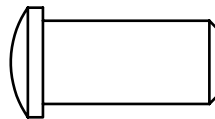
The carburization depth is given as a nominal dimension in millimetres. The value shall be tolerated and can be written as shown in [Table 4](#). The tolerance should be as large as functionally possible.

7.4.4 Practical examples

7.4.4.1 Allover case-hardening

Allover case-hardening shall be indicated by the wording “case-hardened” (see [Figures 27](#) to [31](#)).

In the simplest instance, marking shall be as shown in the example in [Figure 27](#), indicating the heat-treatment condition, the surface hardness and the case-hardening hardness depth, and, in each case, the permissible deviation (see [Figure 27](#)).



case-hardened and tempered
 (62 ±2) HRC
 CHD = 1 ±0,2

Figure 27 — Marking of an allover case-hardened part

If a limiting hardness or test load, or both, other than that or those specified in the regular instance (see ISO 2639) is to be applied when testing the case-hardening hardness depth, this shall be indicated by specifying the CHD (see [Figure 28](#)).



case-hardened and tempered
 (750 ±50) HV 30
 CHD 600 HV 3 = 0,6 ±0,1

Figure 28 — Marking of an allover case-hardened part with a hardness and a test load other than those specified in the regular instance (see ISO 2639)

If specific provisions need to be observed during heat-treatment (e.g. regarding the data of the time/temperature curve), these provisions shall be taken from the heat-treatment order (HTO) or the heat-treatment document (HTD). A reference shall be made to that document in the drawing (see [Figure 29](#)).



case-hardened and tempered, see HTO ...
 (750 ±50) HV 30
 CHD 600 HV 3 = 0,6 ±0,1

Figure 29 — Marking of an allover case-hardened part where specific provisions are to be observed in the heat-treatment process

In most cases, case-hardened parts have to be finished by grinding. Thereby, the surface hardness and the surface-hardening hardness depth will be reduced. If it is necessary to present both states in a drawing, this shall be indicated

- by adding the words “before grinding” and “after grinding” [see the left caption “a)” of [Figure 30](#)], or
- by adding symbols in accordance with ISO/TS 8062-2 and adding the data that have to be tested [see the right caption “b)” of [Figure 30](#)]. The written mode on the right is explained in ISO 10135.



| | case-hardened and tempered | case-hardened and tempered | |
|------------------|----------------------------------|----------------------------------|--------|
| before grinding: | (750 ±50) HV30 CHD = 0,6 ±0,1 | (750 ±50) HV30 CHD = 0,6 ±0,1 | ▼ ▼ |
| after grinding: | (750 ±50) HV30 CHD = 0,5 ±0,1 | (750 ±50) HV30 CHD = 0,5 ±0,1 | ▽ ▽ |
| | a) | b) | |

Figure 30 — Marking of an allover case-hardened part with two states: before and after grinding

7.4.4.2 Allover case-hardening with differing surface hardness or hardness depth

7.4.4.2.1 General

Allover case-hardened parts with areas in which the values for the surface hardness or the hardness depth, or both, differ from the rest of the area shall be marked as shown in [Figures 31](#) and [32](#).

7.4.4.2.2 Differing surface hardness

The part shown in [Figure 31](#) shall have the given hardness values in the area identified as the test points 1 and 2. The entire part is tempered, but the area for which a hardness value ≤ 550 HV10 is given is tempered at a higher temperature to achieve the lower hardness value than in the area identified as the test point 1.

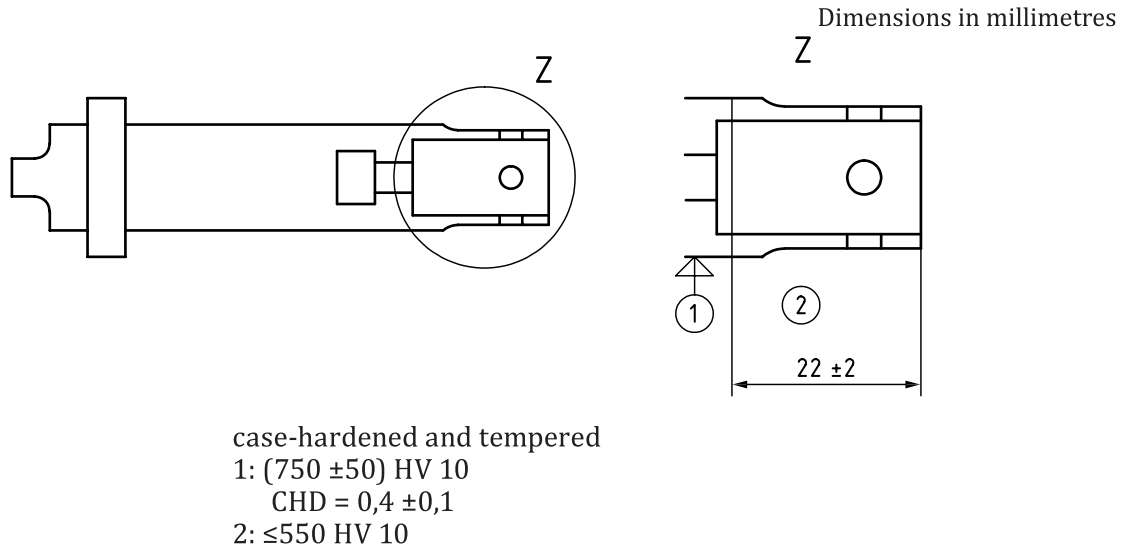


Figure 31 — Marking of a part with different surface hardness

7.4.4.2.3 Differing case-hardening hardness depth

The gear shown in [Figure 32](#) is all over case-hardened and tempered. In the area of test points, the values specified for surface hardness and for the case-hardening hardness depth shall be present.

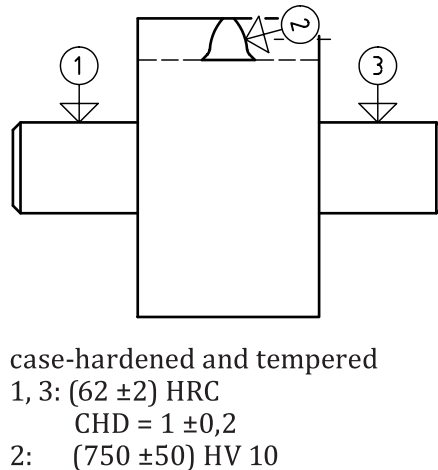


Figure 32 — Marking of a case-hardened and tempered part with different hardnesses and hardness depths

7.4.4.3 Local case-hardening

7.4.4.3.1 General

The marking of case-hardened and non-case-hardened areas shall be in accordance with 6.3.

The transition between case-hardened and non-case-hardened areas lies, in principle, outside the nominal dimension for the length of the case-hardened area. The transition width depends on the carburizing depth after carburizing, the method of case hardening, the material, the shape of the workpiece and the way in which local case hardening is carried out.

7.4.4.3.2 Case-hardening with not carburized areas

The area on a case-hardened part that shall not be carburized should be marked by a type 07.2 dotted wide line in accordance with Table 2. The wording “not carburized” behind the dotted wide line should be added (see Figures 33 and 34). The entire part is quench-hardened after carburizing.

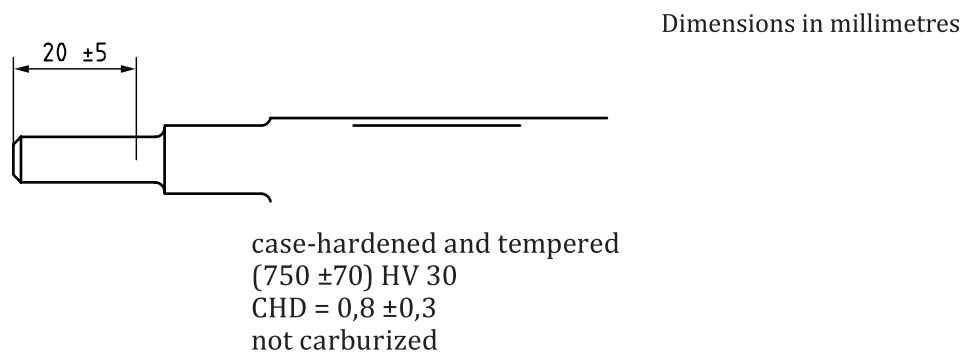


Figure 33 — Marking of a case-hardened part with a “not carburized” area

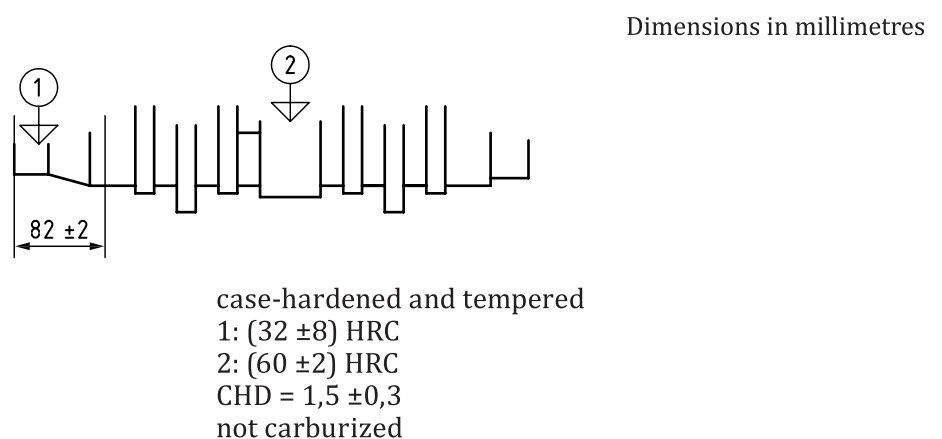


Figure 34 — Marking of a case-hardened part with a “not carburized” area

7.4.4.3.3 Local case-hardening, entire part carburized

The case-hardened area on an entire carburized part should be marked by a type 04.2 long-dashed dotted wide line, in accordance with [Table 2](#). The wording “entire part carburized” should be added to make clear the advance of the heat-treatment (see [Figure 35](#)).

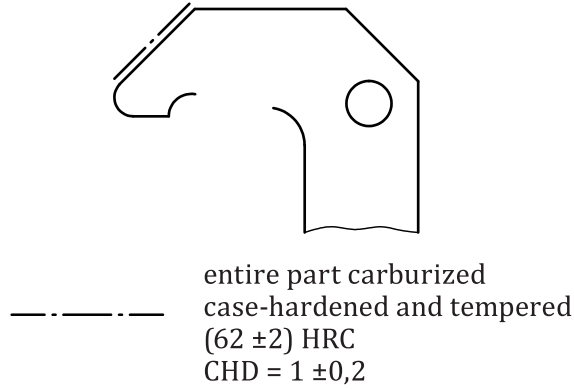


Figure 35 — Marking of an entire carburized and local case-hardened part

7.4.4.4 Examples for carburized parts

7.4.4.4.1 Allover carburization

Allover carburization shall be indicated by the wording “carburized” (see [Figure 36](#)).

In the simplest case, the carburized condition shall be marked with the wording “carburized” and by indicating the carburizing depth with the permissible deviation (see [Figure 36](#)).

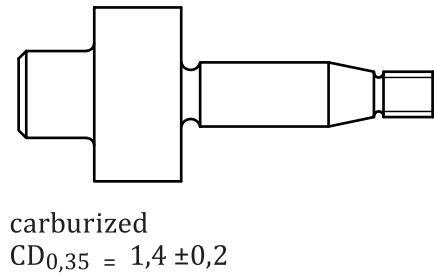


Figure 36 — Marking of an allover carburized part

7.4.4.4.2 Local carburizing

The marking of the carburized and non-carburized areas shall be in accordance with [6.3](#).

The transition between carburized and non-carburized areas lies, in principle, outside the nominal dimension for the length of the carburized area. The transition width depends on the carburizing depth, the carburizing method, the material and shape of the workpiece, and the way in which local carburizing is carried out.

The carburized area is marked by a long-dashed dotted wide line, type 04.2 in accordance with [Table 2](#). The carburized condition shall be designated by the word “carburized”. If testing the carburizing depth before the quench-hardening, the depth and abbreviation should be indicated (see [Figure 37](#)).

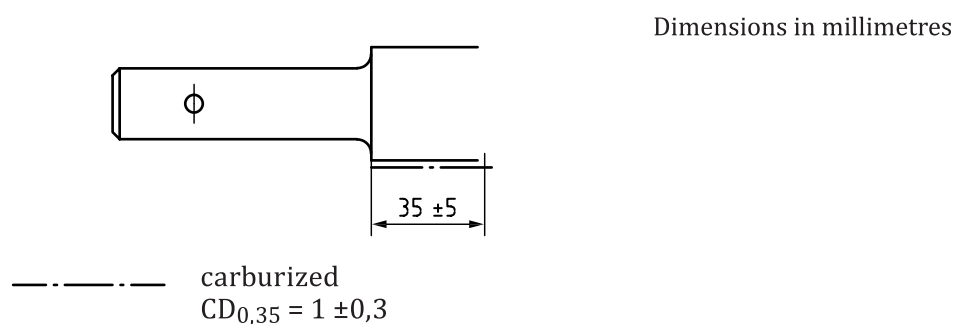


Figure 37 — Marking of a local carburized part

7.5 Nitriding and nitrocarburizing

7.5.1 Specification of nitriding hardness depth (NHD)

For the nitriding hardness depth, the abbreviation NHD shall be used. The limiting hardness is by default actual core hardness plus 50 HV.

The nitriding hardness depth is given as a nominal dimension in millimetres. The value shall be toleranced. Examples of the written mode are given in [Table 3](#). The tolerance should be as large as functionally possible.

7.5.2 Specification of compound layer thickness (CLT)

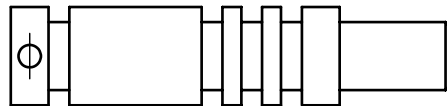
For the thickness of the compound layer, the abbreviation CLT should be used. The CLT and its tolerance are given in micrometres. The value shall be toleranced. Examples of the written mode are given in [Table 4](#). The tolerance should be as large as functionally possible.

7.5.3 Practical examples

7.5.3.1 Allover nitriding

In its simplest instance, the nitrided condition shall be designated by the word “nitrided” and by indicating the nitriding hardness depth with the permissible deviation (see Figure 38).

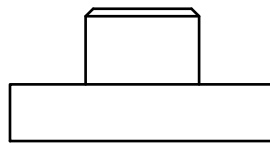
If the nitriding is to be carried out in “gas”, the word “gas” shall appear before the word “nitrided” in accordance with ISO 4885. Likewise, if the nitriding is to be carried out in “plasma”, the word “plasma” shall appear before the word “nitrided”. An example of the “plasma” case is shown in Figure 38.



plasma nitrided
 NHD = 0,30 ±0,05
 ≥950 HV 10

Figure 38 — Marking of an allover plasma-nitrided part

When testing of the nitriding hardness depth is carried out with a test load other than HV0,5 for instance, this shall be indicated when specifying NHD, as shown in the key of example of [Figure 39](#).



nitrided
 NHD HV 0,3 = 0,12 ±0,02
 ≥800 HV 3

Figure 39 — Marking of an allover nitrided part, where the hardness profile is tested with a test load of HV0,3

7.5.3.2 Local nitriding

A line of type 07.2 in accordance with [Table 2](#) shall be used to mark the non-nitrided areas. The words “not nitrided” should be added behind the dotted wide line (see [Figure 40](#)).

The transition between nitrided and non-nitrided areas lies, in principle, outside the nominal dimension for the length of the nitrided area. The transition width depends on the nitriding depth and the nitriding process, the material and shape of the workpiece, and the way in which local nitriding is carried out.

Dimensions in millimetres

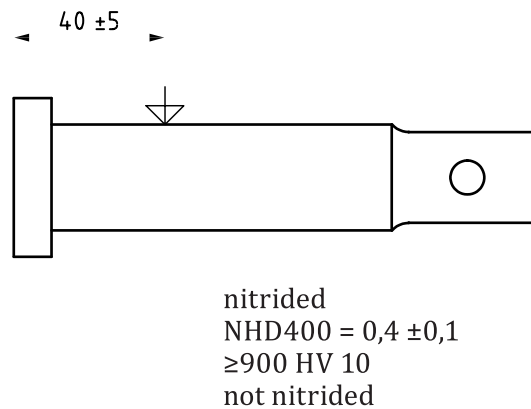


Figure 40 — Marking of a local limited nitrided part

7.5.3.3 Allover nitrocarburizing

In its simplest instance, the nitrocarburized condition shall be indicated by the word “nitrocarburized” and by indicating the compound layer thickness (CLT) with its tolerance in micrometres (see [Figure 41](#)). The value shall be toleranced and can be written as shown in [Table 4](#). The tolerance should be as large as functionally possible.

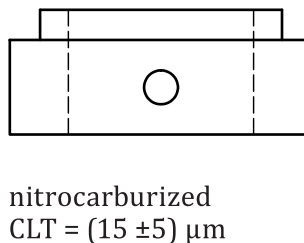


Figure 41 — Marking of an allover nitrocarburized part

If nitrocarburizing is carried out in a specific medium, the wording of the indication of the process shall be supplemented accordingly (see ISO 4885). If necessary, reference shall be made to additional information (see [Figure 42](#)).

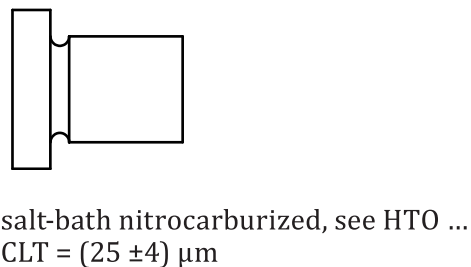


Figure 42 — Marking of an allover nitrocarburized part, where the nitrocarburizing is carried out in a salt bath as specified in an HTO

7.5.3.4 Local nitrocarburizing

A dotted wide line of type 07.2 in accordance with [Table 2](#) shall be used marking the non- nitrocarburized area (see [Figure 43](#)).

The transition between the nitrocarburized and non-nitrocarburized areas lies, in principle, outside the nominal dimension for the length of the nitrocarburized area. The transition width depends on the thickness of the compound layer, the nitrocarburizing method, the material and shape of the workpiece, and the way in which local nitrocarburizing is carried out.

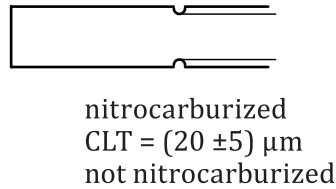


Figure 43 — Marking of a local nitrocarburized part

7.6 Boriding

In its simplest instance, the borided condition shall be indicated by the word “borided” and by indicating the compound layer thickness (CLT) with its tolerance in micrometres (see [Figure 44](#)). The value shall be toleranced and can be written as shown in [Table 4](#). The tolerance should be as large as functionally possible.

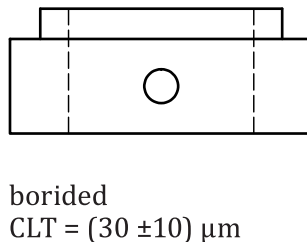


Figure 44 — Marking of a borided part

7.7 Annealing

The annealed-state condition shall be indicated by the word “annealed”, with an additional designation specifying the annealing method more precisely (see ISO 4885), such as

- “stress relieved”,
- “soft annealed”,
- “spheroidized”,
- “recrystallized”, or
- “normalized”.

In addition, hardness data or further data on the structural condition shall be given as necessary.

Annex A (normative)

Graphical symbols

A.1 General

In order to harmonize the sizes of the graphical symbols specified in this document with those of the other inscriptions on the drawing (dimensions, tolerances, etc.), apply the rules given in ISO 81714-1. The height of the identification number in [Figure A.2](#) shall be larger than the normal lettering on the technical drawing by a factor of $\sqrt{2}$.

A.2 Test point

See [Figure A.1](#).

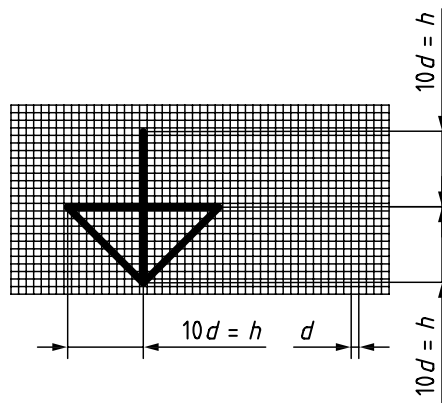


Figure A.1 — Graphical symbol for test point

A.3 Test point with identification number

See [Figure A.2](#).

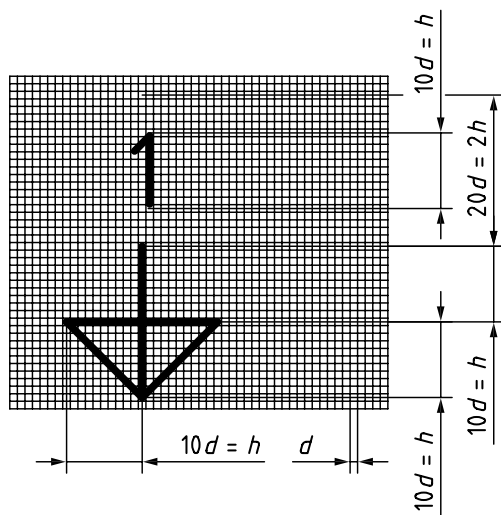


Figure A.2 — Graphical symbol for measuring point with identification number

For double-digit numbers, the circle for the identification number can be enlarged if needed.

A.4 Slip zone

See [Figure A.3](#).

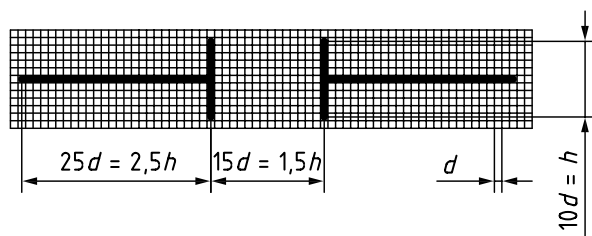


Figure A.3 — Graphical symbol for slip zone

Bibliography

- [1] ISO 2639, *Steels — Determination and verification of the depth of carburized and hardened cases*

