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Steel flat products

# Cold reduced sheet and strip Technical delivery conditions

General purpose structural steels

DIN 1623 Part 2

Flacherzeugnisse aus Stahl; kaltgewalztes Band und Blech; technische Lieferbedingungen; allgemeine Baustähle

Supersedes January 1961 edition.

*In keeping with current practice in standards published by the International Organization for Standardization (ISO), a comma has been used throughout as the decimal marker.*

See Explanatory notes for connection with Standard ISO 4997 – 1978 published by the International Organization for Standardization (ISO).

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## 1 Field of application

1.1 This standard applies to cold reduced flat products (sheet and strip), without coating, in rolling widths not less than 600 mm and thicknesses up to and including 3 mm, made from the general purpose structural steels specified in table 1, which are predominantly used because of their mechanical properties at ambient temperature.

1.2 In addition to the details specified in this standard, the general technical delivery conditions for steel and steel products given in DIN 17 010 shall apply unless otherwise specified in the following.

1.3 This standard does not apply to

- cold reduced sheet and strip made from mild unalloyed steels for cold forming (see DIN 1623 Part 1),
- cold reduced sheet and strip made from mild unalloyed steels for enamelling (see DIN 1623 Part 3),
- cold reduced strip in rolling widths up to 650 mm made from mild unalloyed steels (see DIN 1624),
- cold reduced sheet and strip with guaranteed minimum yield strength, for cold forming (see *Stahl-Eisen-Werkstoffblatt* (Iron and steel material sheet) 093-75),
- blackplate (see DIN 1616),
- magnetic sheet and strip (see DIN 46 400 Part 1 to Part 3).

## 2 Concepts

2.1 Flat products are products which have an almost rectangular cross section with a width much greater than the thickness.

2.2 Strip is a flat product which is wound to form a coil immediately after the final rolling pass or after having passed the continuous pickling furnace or furnace installations connected to the roll. In the rolled condition, strip has slightly curved edges but can also be supplied with trimmed edges or made by slitting a wider strip.

2.3 Sheet is a flat product of unspecified edge form which is supplied on panels usually of quadrangular (square or rectangular) shape, but also of any other shape (e.g. of round shape or as specified in a drawing). Its edges are rough (e.g. slightly curved) or mechanically cut.

2.4 Flat products that have undergone a reduction in cross section of at least 25 % by cold rolling without preheating are regarded as cold reduced.

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## 3 Dimensions and permissible dimensional deviations

DIN 1541 shall apply for the dimensions and permissible dimensional deviations.

## 4 Masses

The mass of the steels specified in this standard shall be calculated taking the density as 7,85 kg/dm$^3$.

## 5 Classification into grades

5.1 This standard covers the steel grades specified in table 1.

5.2 The choice of the steel grade is left to the discretion of the purchaser. It is recommended that the supplier be consulted, if necessary, in order to decide which steel grade and which surface condition are suitable for the intended purpose and application.

## 6 Designation

6.1 The complete designation of a flat product grade complying with the requirements of this standard shall include the following:

- the symbol or material number identifying the steel grade (see table 1);
- the symbol identifying the surface appearance (see column 3 of table 2) and
- the code letter identifying the surface finish (see column 3 of table 2).

6.2 Where necessary, it shall be clearly indicated whether the product is to comply additional requirements with regard to suitability for coating (see subclause 7.7) or whether the products are to be supplied with unoiled surface (see subclause 9.2.2).

Example:

Steel grade USt 37-2 G (material number 1.0036 G) with normal cold reduced surface (O3) and "rough" (r) surface finish shall be designated:

**USt 37-2 G O3 r**

or **1.0036 G O3 r**

6.3 If the designation does not provide any information relating to the characteristics given in subclauses 6.1 and 6.2, the products specified in this standard shall be supplied as follows:

- O3 surface appearance,
- "matt" surface finish,
- oiled.

6.4 The order shall specify the quantity to be supplied, the form of product (sheet or strip), the relevant dimensional standard, the symbol or material number of the flat product grade and the dimensions required.

Example:

20 tonnes of grade USt 37-2 G O3 r sheet (material number 1.0036 G O3 r), 0,80 mm in thickness, 1000 mm in width, with trimmed edges (GK), 3000 mm in length, permissible dimensional deviations (standard deviations) as specified in DIN 1541:

**20 t sheet DIN 1541 – USt 37-2 G O3 r – 0,80 × 1000 GK × 3000**

or

**20 t sheet DIN 1541 – 1.0036 G O3 r – 0,80 × 1000 GK × 3000**

## 7 Requirements

### 7.1 Steelmaking process

The steelmaking process is left to the discretion of the manufacturer; the purchaser shall be informed, on request, of the type of process used.

### 7.2 Type of deoxidation

The type of deoxidation of the steels is specified in table 1. The type of deoxidation of St 37-2 G steel is left to the discretion of the manufacturer.

### 7.3 Chemical composition

7.3.1 The values applicable for the chemical composition (cast analysis and product analysis) are given in table 1. Moreover, it is required (except for St 50-2 G, St 60-2 G and St 70-2 G steels) that the percentages by mass of the elements not specified in table 1 of the present standard do not exceed the limit values applicable to the cast analysis given in table 1 of EURONORM 20 (September 1974 edition).

7.3.2 Any verification of the values determined in the product analysis shall be particularly agreed at the time of ordering. This does not apply for St 37-2 G steel.

### 7.4 Mechanical and technological properties

7.4.1 In the tensile test described in subclause 8.5.3, the requirements given in table 1 shall be complied with.

In the bend test as described in subclause 8.5.4, the test pieces shall withstand being bent through 180° and around the mandrel of a diameter as given in table 1, without cracking on the tension side.

7.4.2 The tensile test values and the bend test values shall apply for transverse test pieces. If the yield strength cannot be easily recognized, the yield strength values shall apply for the 0,2 % proof stress ($R_{p\,0,2}$), otherwise the values shall apply for the upper yield stress ($R_{eH}$).

### 7.5 Weldability

7.5.1 Unrestricted suitability of the steels with regard to the different welding processes cannot be ensured, as the behaviour of a steel before and after welding does not only depend on the material but also on the dimensions and shape as well as on the manufacturing and operating conditions of the structural component.

7.5.2 In general, the steels specified in table 1 of the present standard up to and including St 52-3 G steel are suitable for arc welding and gas fusion welding. In the case of St 37 steels with equal minimum yield strength, quality group 3 steel shall be preferred to quality group 2 steel.

St 50-2 G, St 60-2 G and St 70-2 G steels are not considered suitable for arc welding and gas fusion welding.

Table 1. **Classification of general purpose structural steel grades for cold reduced flat products and properties in the as delivered condition at ambient temperature between 15 and 35 °C as specified in DIN 50 014**

| Steel grade | | Type of deoxidation[1] | Chemical composition, % by mass | | | | | | | | Mechanical properties | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Cast analysis | | | | | Product analysis | | | | | | |
| Symbol | Material number | | C | P | S | N[2] | Addition of nitrogen fixing elements[3] | C | P | S | N[2] | Tensile strength $R_m$ | Yield strength ($R_{p0,2}$ or $R_{eH}$) | Elongation after fracture ($L_0$ = 80 mm) | Bend test (test piece thickness: a; bend angle: 180°)[4] |
| | | | max. | | | | | max. | | | | N/mm² | N/mm² min. | % min. | Mandrel diameter |
| St 37-2 G | 1.0037 G | Optional | 0,17 | 0,040 | 0,035 | 0,009 | – | 0,21 | 0,055 | 0,050 | 0,010 | 360 to 510 | 215 | 20 | 0,5 a |
| USt 37-2 G | 1.0036 G | U | 0,17 | 0,040 | 0,035 | 0,007 | | 0,21 | 0,055 | 0,050 | 0,009 | 360 to 510 | 215 | 20 | 0,5 a |
| St 37-3 G | 1.0116 G | RR | 0,17 | 0,040 | 0,035 | – | Yes | 0,19 | 0,050 | 0,045 | – | 360 to 510 | 215 | 20 | 0,5 a |
| St 44-3 G | 1.0144 G | RR | 0,20 | 0,040 | 0,035 | – | Yes | 0,23 | 0,050 | 0,045 | – | 430 to 580 | 245 | 18 | 1,0 a |
| St 52-3 G[5] | 1.0570 G | RR | 0,20 | 0,040 | 0,035 | – | Yes | 0,22 | 0,050 | 0,045 | – | 510 to 680 | 325 | 16 | 1,0 a |
| St 50-2 G | 1.0050 G | R | 0,40 | 0,050 | 0,050 | 0,009 | – | 0,43 | 0,060 | 0,060 | 0,010 | 490 to 660 | 295 | 14 | – |
| St 60-2 G | 1.0060 G | R | 0,50 | 0,050 | 0,050 | 0,009 | – | 0,53 | 0,060 | 0,060 | 0,010 | 590 to 770 | 335 | 10 | – |
| St 70-2 G | 1.0070 G | R | 0,65 | 0,050 | 0,050 | 0,009 | – | 0,69 | 0,060 | 0,060 | 0,010 | 690 to 900 | 365 | 6 | – |

1) U = rimming, R = killed (including semi-killed), RR = fully killed.

2) It is permitted to exceed the specified maximum value if a phosphorus content less than the maximum value specified by 0,005 % P per 0,001 % N is observed. However, the nitrogen content shall not exceed a value of 0,012 % N in the cast analysis and 0,014 % N in the product analysis.

3) For example, not less than 0,020 % $Al_{total}$.

4) See subclause 7.4.1.

5) The content shall not exceed 0,55 % Si and 1,60 % Mn in the cast analysis or 0,60 % Si and 1,70 % Mn in the product analysis.

7.5.3 All steels are generally suitable for flash butt welding and gas pressure welding; steels with a higher carbon content (St 50-2 G, St 60-2 G and St 70 G) may however require postweld heat treatment.

7.5.4 Steels with a maximum carbon content of 0,20 % as determined in the cast analysis are generally suitable for spot welding and seam welding.

### 7.6 Surface condition

#### 7.6.1 Surface appearance

7.6.1.1 Surface appearance O3 and O5 having the characteristics specified in table 2 are suitable for all steel grades listed in this standard. The surface appearance required shall be given in the designation (see clause 6).

Note. The first part of the symbol signifying the surface appearance is the letter O and not the digit 0 (nought).

7.6.1.2 Flat products with surface appearance O3 shall have this surface on both sides. Flats products ordered with surface appearance O5 may normally have one O3 surface, provided that no characteristic of the O3 surface will have a negative effect on the O5 surface; this applies also to a later processing of the products. If both sides are required to have surface appearance O5, this shall be particularly stated at the time of ordering.

#### 7.6.2 Surface finish

Flat products ordered with surface appearance O3 may be supplied with a matt or rough finish, products with surface appearance O5 may have a particularly smooth, smooth, matt or rough surface exhibiting the characteristics specified in table 2. The surface finish required shall be given in the designation (see subclause 6.3).

### 7.7 Suitability for coating

7.7.1 The processor is to make the appropriate preparations for surface coating.

7.7.2 All flat product grades and surfaces are suitable for varnish coating.

7.7.3 Both surface appearances are suitable for spray painting. The characteristics of spray painted surfaces are to correspond to those specified in table 2.

7.7.4 All flat product grades are suitable for the application of a metallic corrosion protective coating (using zinc, tin or lead, for example) by hot dip galvanizing. The purchaser shall inform the manufacturer of his intention to apply such a coating, by stating the type of process at the time of ordering.

7.7.5 In the case of surface appearance O5, suitability of the products for decorative electroplating may be

Table 2. **Symbols for and characteristics of surface appearance and surface finish (see subclause 7.6)**

| | Designation | Symbol | Characteristics |
|---|---|---|---|
| Surface appearance [1] | Normal cold reduced surface | O3 | Defects not impairing the forming process and surface coating are permitted. |
| | Best surface | O5 | As for O3. However, the better surface shall be practically free from surface defects liable to impair the uniform appearance of a high class paint finish or of an electrolytic coating (see subclause 7.7). |
| Surface finish [2], [3] | Particularly smooth | b | The surface shall have a uniformly smooth (bright) finish. Guideline value of average peak-to-valley height $R_a$: less than 0,4 µm. |
| | Smooth | g | The surface shall have a uniformly smooth finish. Guideline value of average peak-to-valley height $R_a$: less than 0,9 µm. |
| | Matt | m | The surface shall have a uniformly matt finish. Guideline value of average peak-to-valley height $R_a$: between 0,6 and 1,9 µm. |
| | Rough | r | The surface exhibits greater roughness. Guideline value of average peak-to-valley height $R_a$: greater than 1,6 µm. |

[1] See subclause 7.6.1.
[2] See subclause 7.6.2.
[3] Other guideline values or smaller ranges of average peak-to-valley height may be agreed at the time of ordering.

agreed at the time of ordering. The characteristics of decorative electroplated surface are to conform to those described in table 2.

## 8 Testing

### 8.1 Tests to be carried out and documents on materials testing

8.1.1 The purchaser may stipulate, for all steel grades specified in this standard, that one of the documents on materials testing complying with DIN 50 049 be furnished.

8.1.2 If it is agreed that a document be furnished which, in accordance with DIN 50 049, requires that tests be carried out on the consignment itself, then the specifications of subclauses 8.2 to 8.6 shall apply.

### 8.2 Acceptance units

8.2.1 The usual acceptance unit shall be 20 t or parts thereof, for all flat products of the same grade and nominal thickness. A coil greater then 20 t in mass shall be regarded as one acceptance unit.

8.2.2 Subject to particular agreement at the time of ordering, the acceptance unit may be 10 t or parts thereof, for flat products of the same grade and nominal thickness.

### 8.3 Number of tests

A series of tests comprising all the tests required for verifying the specified properties shall be carried out for each acceptance unit in accordance with subclause 8.2.

### 8.4 Sampling

8.4.1 The test pieces shall be taken at 90° to the direction of rolling of the flat products and shall not have any surface treatment on either side. In the case of strip, the test pieces shall be taken from the beginning or end of the coil. In the case of sheet, the selection of the test pieces for sampling purposes and the position of the test pieces on the sheet are left to the discretion of the person authorized for acceptance testing.

8.4.2 A deformation of the test pieces during cutting shall be avoided as far as possible. If shears or flame cutters are used, provisions shall be made for an adequate allowance; the additional material is then to be removed by machining.

8.4.3 Test pieces for product analysis (i.e., for checking the chemical composition on the product) shall be taken as described in *Stahl-Eisen-Prüfblatt* (Iron and steel test sheet) 1805.

### 8.5 Test methods to be applied

8.5.1 The chemical composition shall be determined by the methods described by the Chemists' Committee of the *Verein Deutscher Eisenhüttenleute* (Society of German Ferrous Metallurgy Engineers).

8.5.2 The mechanical and technological tests shall be carried out at ambient temperature.

8.5.3 The tensile test shall be carried out on a flat DIN 50 114 – 20 × 80 test piece as described in DIN 50 145.

The results of the tensile test shall be related to the actual dimensions of the test piece.

8.5.4 The bend test shall be carried out as described in DIN 50 111.

8.5.5 The surface roughness test shall be carried out as described in EURONORM 49.

### 8.6 Retests

The specifications of DIN 17 010 shall apply for retests.

## 9 Condition of sheet and strip on delivery

### 9.1 Marking

Unless otherwise agreed at the time of ordering, flat products shall be identified by a stamp applied on the inspected surface (see also DIN 1599). Only colours which can be easily washed off by means of aqueous alkaline solvents shall be used for this marking.

### 9.2 Oiling

9.2.1 Flat products as specified in this standard are normally supplied oiled. Both surfaces shall be given a uniform protective oil layer in order to prevent oxidation of the products for a period of three months, provided that the products are packed, transported, handled and stored under the usual conditions. This oil layer shall be capable of being removed by aqueous alkaline solvents. Further requirements shall be the subject of a particular agreement.

9.2.2 If the products are to be supplied in the unoiled condition, which shall be the subject of a particular agreement at the time of ordering, there is an increased risk of the flat products becoming scratched or scored either at the manufacturer's works or when using them. In addition, there is an increased risk of rust formation.

### 9.3 Packing

Requirements with regard to packing shall be the subject of a particular agreement at the time of ordering. The publications of the German producers of sheet metal giving guidelines on the packing of sheet and galvanized sheet in sheet form and coils shall be observed in this respect.[1])

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1) Published by *Walzstahl-Vereinigung*, Kasernenstraße 36, D-4000 Düsseldorf 1.

## Standards and other documents referred to

| | |
|---|---|
| DIN 1541 | Steel flat products; cold rolled unalloyed steel sheet and wide strip; dimensions, permissible dimensional deviations and deviations of form |
| DIN 1599 | Identification marking for steel |
| DIN 1616 | Tinplate and blackplate in sheet form; grades, dimensions and permissible deviations |
| DIN 1623 Part 1 | Steel flat products; cold rolled sheet and strip; technical delivery conditions; mild unalloyed steels for cold forming |
| DIN 1623 Part 3 | Steel flat products; cold rolled sheet and strip, technical delivery conditions; mild unalloyed steels for vitreous enamelling |
| DIN 1624 | Steel flat products; cold rolled mild unalloyed steel strip in rolling widths not exceeding 650 mm |
| DIN 17 010 | General technical delivery conditions for steel and steel products |
| DIN 46 400 Part 1 | Steel flat products with special magnetic properties; cold rolled, non-oriented, finally annealed magnetic sheet and strip; technical delivery conditions |
| DIN 46 400 Part 2 | Steel flat products with special magnetic properties; cold rolled magnetic sheet and strip without final annealing; technical delivery conditions |
| DIN 46 400 Part 3 | Steel flat products with special magnetic properties; oriented magnetic sheet and strip; technical delivery conditions |
| DIN 50 014 | Atmospheres and their technical application; standard atmospheres |
| DIN 50 049 | Documents on materials testing |
| DIN 50 111 | Testing of metallic materials; bend test |
| DIN 50 114 | Testing of metallic materials; tensile test on sheet and strip with a thickness less than 3 mm, without using an extensometer |
| DIN 50 145 | Testing of metallic materials; tensile test |
| EURONORM 20[2] | Definition and classification of grades of steel |
| EURONORM 49[2] | Roughness measurements carried out on cold rolled, non-coated steel flat products |

*Stahl-Eisen-Werkstoffblatt* 093-75[3] *Kaltgewalztes Feinblech und Band mit gewährleisteter Mindeststreckgrenze zum Kaltumformen; Gütevorschriften* (Cold reduced sheet and strip with guaranteed minimum yield strength for cold forming; quality specifications)

*Stahl-Eisen-Prüfblatt* 1805[3] *Probenahme und Probenvorbereitung für die Stückanalyse bei Stählen* (Sampling and preparation of samples for the product analysis of steels)

*Handbuch für das Eisenhüttenlaboratorium*[3] (Handbook for the ferrous metallurgy laboratory);
volume 2: *Die Untersuchung der metallischen Stoffe* (Investigation of metallic materials); Düsseldorf 1966;
volume 5 (supplementary volume): A 4.1 — *Aufstellung empfohlener Schiedsverfahren* (List of recommended arbitration procedures);
B — *Probenahmeverfahren* (Sampling procedures);
C — *Analysenverfahren* (Methods of analysis); most recent edition in each case.

*Richtlinien für die Verpackung von Feinblech und verzinktem Feinblech in Tafeln und Rollen*[4] (Guidelines on the packing of sheet and galvanized sheet in sheet form and coils).

## Previous editions

DIN 1623: 05.32; DIN 1623 Part 2: 01.61

## Amendments

The following amendments have been made in comparison with the January 1961 edition:

a) The field of application now covers cold reduced sheet and strip (code letter G).

b) The classification into grades has been amended to conform to DIN 17 100.

c) The maximum values of phosphorous and sulfur content have been reduced.

d) The specifications relating to surface appearance and surface condition have been changed.

e) The text has been completely revised (see also Explanatory notes).

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2) Obtainable from: *Beuth Verlag GmbH*, Burggrafenstraße 6, D-1000 Berlin 30.

3) Published by: *Verein Deutscher Eisenhüttenleute*; obtainable from: *Verlag Stahleisen GmbH*, Postfach 82 29, D-4000 Düsseldorf 1.

4) Published by: *Walzstahl-Vereinigung*, Kasernenstraße 36, D-4000 Düsseldorf 1.

## Explanatory notes

As hot rolled general purpose structural steel sheet and strip with a thickness less than 3 mm is now included in DIN 17 100, the field of application of the present revised edition has been limited to cover the corresponding cold reduced flat products. With the exception of St 33, RSt 37-2 and St 44-2 steels, all the other steel grades specified in DIN 17 100, January 1980 edition, have also been included in the present standard.

Owing to new technical developments and the different manufacturing processes involved (cold reducing and recrystallization annealing), the requirements to be met by the products covered by the present standard differ from the specifications for hot rolled sheet and strip given in DIN 17 100 in the following points:

- specification of maximum carbon content values for the grades St 50-2 G, St 60-2 G and St 70-2 G;
- specification of lower maximum values of the phosphorus and sulfur content for the weldable grades;
- in some cases, specification of lower minimum yield strength values (except for grade St 52-3 G, the values have been adopted from the January 1961 edition of DIN 1623 Part 2);
- in some cases, specification of higher minimum values of elongation after fracture and smaller mandrel diameters for the bend test.

As shown in table 3, ISO 4997 – 1978 Cold reduced steel sheet of structural quality (February 1978 edition) specifies considerably lower minimum values of tensile strength for specific steel grades, these values resulting in yield strength/tensile strength ratios differing from those given in the present standard.

Table 3. **Mechanical properties of cold reduced flat products made from general purpose structural steels as specified in ISO 4997 – 1978**

| Steel grade | Yield strength[1] N/mm² min. | Tensile strength[2] N/mm² min. | Elongation after fracture ($L_0$ = 80 mm) % min. | Mandrel diameter for bend test | Comparable steel grades as in DIN 1623 Part 2 |
|---|---|---|---|---|---|
| CR 220 | 220 | 300 | 20 | 1 a | St 37-2 G, USt 37-2 G St 37-3 G |
| CR 250 | 250 | 330 | 18 | 2 a | St 44-3 G |
| CR 320 | 320 | 400 | 14 | 2 a | St 52-3 G |

1) Lower yield strength.
2) The values are for information only.

The details relating to surface condition (see subclause 7.6 and table 2) have been amended to conform to the specifications for cold reduced flat products made from mild unalloyed steels for cold forming given in DIN 1623 Part 1, February 1983 edition. ISO 4997 – 1978 specifies the "matt" surface finish only.

## International Patent Classification

C 22 C 38/00
G 01 M 19/00
B 21 B 1/00