BS EN 10139:2016

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Cold rolled uncoated low carbon steel narrow strip for cold forming — Technical delivery conditions

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National foreword

This British Standard is the UK implementation of EN 10139:2016. It supersedes BS EN 10139:1998 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee ISE/109, Coated and Uncoated Flat Products to be Used for Cold Forming.

A list of organizations represented on this committee can be obtained on request to its secretary.

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Published by BSI Standards Limited 2016

ISBN 978 0 580 83661 9

ICS 77.140.50

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 29 February 2016.

Amendments/corrigenda issued since publication

Date	Text affected

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 10139

February 2016

ICS 77.140.50

Supersedes EN 10139:1997

English Version

Cold rolled uncoated low carbon steel narrow strip for cold forming - Technical delivery conditions

Feuillards non revêtus laminés à froid en aciers à bas carbone pour formage à froid - Conditions techniques de livraison

Kaltband ohne Überzug aus weichen Stählen zum Kaltumformen - Technische Lieferbedingungen

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Ref. No. EN 10139:2016 E

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European foreword

This document (EN 10139:2016) has been prepared by Technical Committee ECISS/TC 109 “Coated and uncoated flat products to be used for cold forming”, 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of an identical text or by endorsement, at the latest by August 2016, and conflicting national standards shall be withdrawn at the latest by August 2016.

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1 Scope

1.1 This European Standard applies to cold rolled narrow strip in coils and cut lengths in thicknesses up to 10 mm and of widths less than 600 mm, made from low carbon, unalloyed and alloyed steels in accordance with Table 1.

These products are suitable for cold forming. They are also suitable for surface coating. On the other hand, they are not suitable for hardening treatment followed by tempering.

1.2 This European Standard does not cover cold rolled flat products for which a separate standard already exists, particularly the following products:

— cold rolled non-oriented electrical steel sheet and strip delivered in the fully processed state (EN 10106);

— grain-oriented electrical steel sheet and strip delivered in the fully processed state (EN 10107);

— cold rolled electrical non-alloy and alloy steel sheet and strip delivered in the semi-processed state (EN 10341);

— cold rolled narrow steel strip for heat treatment (EN 10132-1 to −4);

— cold rolled steel flat products with higher yield strength for cold forming (EN 10268);

— cold rolled low carbon steel flat products for cold forming (EN 10130);

— cold reduced blackplate in coil form for the production of tinplate or electrolytic chromium/chromium oxide coated steel (EN 10205);

— cold rolled low carbon steel flat products for vitreous enamelling (EN 10209).

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 10020, *Definition and classification of grades of steel*

EN 10021, *General technical delivery conditions for steel products*

EN 10027-1, *Designation systems for steels - Part 1: Steel names*

EN 10027-2, *Designation systems for steels - Part 2: Numerical system*

EN 10049, *Measurement of roughness average Ra and peak count RPc on metallic flat products*

EN 10079, *Definition of steel products*

EN 10140:2006, *Cold rolled narrow steel strip - Tolerances on dimensions and shape*

EN 10204, *Metallic products - Types of inspection documents*

EN ISO 377, *Steel and steel products - Location and preparation of samples and test pieces for mechanical testing (ISO 377:2013, Corrected version 2015-06-01)*

EN ISO 6507 (all parts), *Metallic materials — Vickers hardness test (ISO 6507)*

EN ISO 6892-1:2009, *Metallic materials - Tensile testing - Part 1: Method of test at room temperature (ISO 6892-1:2009)*

ISO 10113, *Metallic materials — Sheet and strip — Determination of plastic strain ratio*

ISO 10275, *Metallic materials — Sheet and strip — Determination of tensile strain hardening exponent*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 10079 apply.

4 Classification and designation

4.1 This European Standard specifies the grades listed in Table 1. In the case of steel grade DC01, the deoxidation method shall be left to the manufacturer's discretion. Steel grades DC03, DC04, DC05, DC06 and DC07 shall be supplied fully killed.

4.2 Products manufactured from these steels may be ordered and supplied in different delivery conditions (see Table 1) and with different surface characteristics (see 6.4 and Table 2).

4.3 For the purposes of the specifications of this European Standard, the selection of steel grade, delivery condition and surface characteristics are of the responsibility of the purchaser.

NOTE 1 In case of narrow widths, strip complying with this European Standard can also be wound in layers and supplied in the form of a bobbin wound coil.

NOTE 2 After uncoiling and shearing, strip can be supplied in cut lengths.

5 Designation

The symbol designation of the steel grades in this European Standard is in accordance with EN 10027-1 and the numerical designation is allocated in accordance with EN 10027-2.

The standard designation consists of the words narrow strip or cut lengths, followed in order by:

a) reference to this European Standard, EN 10139;

b) the symbol DC, followed by the grade designation (01, 03, 04, 05, 06 and 07);

c) the symbol for delivery condition (see Table 1);

d) the symbol for surface appearance (MA, MB or MC, see Table 2);

e) the symbol for surface finish where appropriate (RN, RL, RM or RR, see 6.4.3 and Table 2).

EXAMPLE 1 Designation of cold rolled narrow strip, 1,50 mm thick, having a normal tolerance on the nominal thickness, a width of 200 mm, having a normal tolerance on the nominal width, slit edges (GK) and made from

steel grade DC04, in a lightly skin-passed condition (LC) with a smooth and uniform surface appearance (MB) and a "matt" surface finish (RM):

Narrow strip EN 10140:2006 — 1,50 × 200 — GK
Steel EN 10139 — DC04 + LC — MB — RM

EXAMPLE 2 Designation of cold rolled narrow strip, 2,00 mm thick, having a normal tolerance on the nominal thickness, a width of 450 mm, having a normal tolerance on the nominal width, slit edges (GK) and made from steel grade DC03, in the annealed condition (A), with a bright, metallically clean surface appearance (MA) and a smooth surface finish (RL):

Narrow strip EN 10140:2006 — 2,00 × 450 — GK
Steel EN 10139 — DC03 + A — MA — RL

6 Properties

6.1 Steel making process and chemical composition

6.1.1 The steel making process shall be left to the discretion of the manufacturer.

6.1.2 The chemical composition based on ladle analysis shall be as given in Table 1.

6.2 Choice of properties

The products covered by this European Standard shall comply with the specifications given in Table 1. If agreed separately, they may be supplied with a special suitability for making a particular part; in this case, a maximum percentage of processing scrap may be fixed by common agreement and acceptance tests on the basis of the mechanical properties shall not apply.

6.3 Mechanical and technological properties

6.3.1 The mechanical and technological properties of the products are given in Table 1. These properties are guaranteed for the periods specified in Table 1 with effect from the date that the products are made available for delivery. The purchaser shall be informed of this date when the products are to be made available, with a warning appropriate to the guarantee of mechanical properties. Storage of grade DC01 products for more than 3 months may cause a change in the mechanical properties likely to give rise to a reduction in the suitability for forming and drawing.

6.3.2 The usual test for checking the mechanical properties given in Table 1 is the tensile test. However, if agreed at the time of ordering, hardness values may be specified instead of tensile test properties, but not both.

6.3.3 The tensile test values shall apply to longitudinal test pieces.

6.4 Surface characteristics

6.4.1 General

Surface characteristics concern surface appearance and surface finish. These shall be specified by the purchaser at the time of ordering. Unless otherwise specified at the time of ordering, the products shall be supplied with a surface appearance MA and a smooth surface finish RL ($Ra \leq 0{,}6$ µm).

6.4.2 Surface appearance

6.4.2.1 Cold rolled flat products covered by this European Standard may be supplied with surface appearances MA, MB or MC as described in Table 2.

The required surface appearance shall be stated in the designation (see Clause 5).

6.4.2.2 The characteristics indicated in Table 2 apply to the surface actually inspected, which is generally the outside surface of coils and the top surface of lengths. The appearance of the uninspected surface shall correspond at least to surface appearance MA.

These characteristics shall not apply to the first two inner and outer laps of coil or to lengths cut from them.

6.4.3 Surface finish

6.4.3.1 The surface finish may be rough, matt, smooth or mirror finish, as given in Table 2.

Products with surface appearances MA and MB are generally supplied with a smooth surface finish (RL). If rough (RR) or matt (RM) finishes are required, the corresponding symbol shall be given in the designation (see Clause 5).

The surface appearance MC shall only be supplied with a “mirror” finish (RN).

6.4.3.2 The different surfaces finishes are characterized by the following reference values of mean roughness R_a:

RR: rough: $R_a \geq 1{,}5$ µm;

RM: matt: $0{,}6$ µm $< R_a \leq 1{,}8$ µm;

RL: smooth: $R_a \leq 0{,}6$ µm;

RN: mirror finish: $R_a \leq 0{,}2$ µm.

6.5 Stretcher strain marks

The tendency towards the formation of fractures or stretcher strain marks during forming may be eliminated for a time by light skin-passing (LC) after annealing. It is in the purchaser interest to form the products as soon as possible as the tendency to form such marks may reappear a certain time after the skin-pass.

The guarantee period of freedom from stretcher strain marks is three months for grade DC01 and six months for grades DC03, DC04 and DC05, from the agreed date when the product is available for delivery.

Products of grades DC06 and DC07 do not exhibit stretcher strain marks, whether delivered skin-passed or non-skin-passed.

6.6 Suitability for the application of surface coating

6.6.1 The products covered by this European Standard are suitable for surface coatings taking into account the following requirements:

a) all the products shall be suitable for organic coating;

b) all the products shall be suitable for the application of a metallic coating, e.g. zinc, tin or lead by means of hot dipping or thermal spraying;

c) all the products with surface appearances MB or MC shall be suitable for electrolytic coating.

6.6.2 The application of surface coatings requires that the surface be suitably prepared before-hand by the processor. The type of coating shall be agreed at the time of ordering if the types of coatings described in 6.6.1 b) and c) are to be used.

6.6.3 If a metallic coating is to be applied in accordance with 6.6.1 b), it shall be noted that for delivery conditions C290 to C690, recovery or recrystallization caused by higher temperatures could have an effect on the mechanical properties of the product.

6.7 Weldability

All steel grades and delivery conditions shall be suitable for welding using appropriate methods. For delivery conditions C290 to C690, it should be noted that the temperature rises during the welding operation could affect the mechanical properties and the microstructure.

6.8 Dimensions, mass, permissible tolerances

6.8.1 For the dimensions and the tolerances on dimensions and shape, see EN 10140:2006.

6.8.2 A density of 7,85 kg/dm^3 shall be assumed for calculating the masses for all types of steel covered by this European Standard.

7 Testing

7.1 Agreement on acceptance testing

7.1.1 If a test is specified by a purchaser, he shall specify at the time of tendering and ordering:

— the type of test (specific or non-specific) (see EN 10021);

— the type of inspection document (see EN 10204).

7.1.2 The specific test shall be carried out in conformity with the requirements of 7.2 to 7.5.

7.2 Acceptance units and number of tests

7.2.1 The acceptance unit is 5 t or fraction of 5 t of products of the same steel grade, the same delivery condition and with the same surface characteristics and nominal thickness. Coils weighing more than 5 t shall be regarded as one acceptance unit.

All products belonging to one acceptance unit shall be from the same cast.

7.2.2 For each acceptance unit a tensile test shall be carried out and if specified at the time of ordering, where appropriate a determination of the plastic strain ratio r and the tensile strain hardening exponent n (see Table 1, ISO 10113 and ISO 10275). Alternatively, if specified at the time of ordering, a hardness test shall be carried out.

7.3 Sampling and preparation of test pieces

7.3.1 A sample of adequate size for all the tests to be carried out shall be taken from the products comprising the acceptance unit from any position on the strip or cut length. In cases of dispute, this sample shall be taken from a position at least 3 m from one of the ends of the coil.

7.3.2 The tensile test pieces shall be taken from samples complying with 7.3.1, parallel to the direction in which the product was rolled. The test pieces should not be further worked on either surface.

7.3.3 When cutting the test pieces from the samples, as little deformation as possible shall be caused. If shears or cutting torches are used, an adequate surplus shall be allowed, which will then be further worked (see EN ISO 377).

7.4 Test methods to be followed

7.4.1 All mechanical and technological tests shall be carried out at ambient temperature.

7.4.2 The tensile test shall be carried out in accordance with EN ISO 6892-1:2009 (see also 6.3.2).

7.4.3 If agreed separately at the time of ordering, the Vickers hardness test shall be carried out in accordance with EN ISO 6507 (all parts).

7.4.4 If agreed separately at the time of ordering, surface roughness shall be determined in accordance with EN 10049.

7.4.5 If agreed at the time of ordering, the determination of plastic strain ratio *r* and tensile hardening exponent *n* shall be carried out in accordance with ISO 10113 and ISO 10275.

7.5 Re-tests

7.5.1 If the results obtained from a correctly selected sample do not meet the specified requirements, two further samples from the same acceptance unit shall be tested for each unsatisfactory test in accordance with EN 10021 and both these shall meet the specified requirements.

7.5.2 The manufacturer shall be entitled to submit unsatisfactory acceptance units for re-testing after suitable rectification treatment has been carried out.

8 Marking

Marking of the products in line with the specifications of EN 10021 may be agreed at the time of ordering.

9 Oiling

9.1 For all delivery conditions, apart from A, the products are usually covered with traces of rolling oil during the finishing process. However, this does not always provide adequate protection against corrosion.

9.2 The products are normally supplied oiled. In this case, both sides are protected by a coat of non-drying neutral oil, free from foreign bodies and spread uniformly so that under the normal packing, transport, loading and storage conditions there will be no corrosion after three months.

If the transport and storage conditions make special corrosion protection necessary, the user shall inform the manufacturer of this at the time of ordering.

The oil film shall be removable by an alkaline solution or other normal solvents.

The selection of protection oils may be the subject of a separate agreement.

9.3 If the product is to be supplied with the surface degreased at a separate operation, this shall also be agreed at the time of ordering.

9.4 If the product is to be supplied in the as-rolled condition, or without oil, there is an increased risk of scratching and rust formation during transportation and storage.

10 Packing

The packing conditions shall be agreed separately at the time of ordering.

11 Information to be supplied by the purchaser

To comply adequately with the requirements of this European Standard, tenders and orders shall include the following information:

a) the complete designation of the product (see Clause 5);

b) if necessary, the delivery condition required, noting the suitability of the product for making a particular part (see 6.2);

c) the suitability for the application of surface coatings (see 6.6);

d) whether the product is to be supplied with an oiled or an unoiled surface (see 9.1 through 9.4);

e) the nominal dimensions (see 6.8);

f) the quantity to be supplied;

g) the type of acceptance tests required (see 7.1.1);

h) if necessary, the type of inspection document wanted (see 7.1.1);

i) the marking requirements (see Clause 8);

j) the packing requirements, including the limits on mass and dimensions of coils and individual bundles (see Clause 10).

12 Disputes

The provisions of EN 10021 shall apply to disputes and their settlements.

Table 1 — Mechanical characteristics and chemical composition (1/2)

Designation		Classification according to EN 10020	Type of deoxidation	Validity of the mechanical properties	Delivery condition	Symbol	R_e [e] MPa	R_m MPa
According to EN 10027-1	According to EN 10027-2							
DC01	1.0330	Non-alloyed quality steel [l]	At the discretion of the manufacturer	3 months	Annealed	A	-	270 – 390
					Skin passed	LC	max. 280 [a, d]	270 - 410[d]
					Work hardened	C290	200 - 380	290 – 430
						C340	min. 250	340 – 490
						C390	min. 310	390 – 540
						C440	min. 360	440 – 590
						C490	min. 420	490 – 640
						C590	min. 520	590 – 740
						C690	min. 630	min. 690 [j]
DC03	1.0347	Non-alloyed quality steel [l]	Fully killed	6 months	Annealed	A	-	270 – 370
					Skin passed	LC	max. 240 [a, d]	270 - 370[d]
					Work hardened	C290	210 - 355	290 – 390
						C340	min. 240	340 – 440
						C390	min. 330	390 – 490
						C440	min. 380	440 – 540
						C490	min. 440	490 – 590
						C590	min. 540	min. 590
DC04	1.0338	Non-alloyed quality steel [l]	Fully killed	6 months	Annealed	A	-	270 – 350
					Skin passed	LC	max. 210 [a, c, d]	270 - 350[d]
					Work hardened	C290	220 - 325	290 – 390
						C340	min. 240	340 – 440
						C390	min. 350	390 – 490
						C440	min. 440	440 – 540
						C490	min. 490	490 – 590
						C590	min. 590	590 – 690
DC05	1.0312	Non-alloyed quality steel [l]	Fully killed	6 months	Skin passed	LC	max. 180 [a, d]	270 - 330[d]
DC06	1.0873	Alloy quality steel	Fully killed	No limit	Skin passed	LC	max. 170 [a, d, f]	270 - 330[d]
DC07	1.0898	Alloy quality steel	Fully killed	No limit	Skin passed	LC	max. 150 [a, d, f]	270 - 310[d]

NOTE 1 MPa = 1 N/mm^2

[a] If the yield point is not pronounced, the yield strength values apply to the 0,2 % proof stress, otherwise to the lower yield strength (R_{eL}). For thicknesses less than or equal to 0,7 mm, but greater than 0,5 mm, 20 MPa higher maximum values are permitted for the yield strength. In the same way, the HV values increase by 5 units. For thicknesses less than or equal to 0,5 mm, 40 MPa higher maximum values are permitted for the yield strength. In the same way, the HV values increase by 10 units.

[b] When the thickness is less than or equal to 0,7 mm and greater than 0,5 mm, the minimum value for the elongation after fracture is reduced by 2 units.
When the thickness is less than or equal to 0,5 mm and greater than 0,25 mm, the minimum value is reduced by 4 units.
When the thickness is less than or equal to 0,25 mm, and greater than 0,15 mm, the minimum value is reduced by 6 units.
For thicknesses less than or equal to 0,15 mm, the minimum value is reduced by 8 units.

[c] For thicknesses lower than 1,5 mm, a maximum value of 235 MPa is permitted.

Table 1 — Mechanical characteristics and chemical composition (2/2)

Designation according to EN 10027-1	Symbol	Elongation after fracture		r_{90} [h, i]	n_{90} [h]	Hardness [k] *HV*		Chemical composition (ladle analysis) Mass %, max.				
		A_{80} %	A_{50} %									
		min.	min.	min.	min.	min.	max.	C	P	S	Mn	Ti
DC01	A	28	30	m	m	m	105					m
	LC	28 [b, d]	30 [b, d]	m	m	m	115 [d]					
	C290	18	20	m	m	95	125					
	C340					105	155					
	C390					117	172	0,12 [j]	0,045	0,045	0,60 [j]	
	C440	m	m	m	m	135	185					
	C490					155	200					
	C590					185	225					
	C690					215	m					
DC03	A	34	36	m	m	m	100					m
	LC	34 [b, d]	36 [b, d]	1,3	m	m	110 [d]					
	C290	22	24	m	m	95	117					
	C340					105	130					
	C390					117	155	0,10	0,035	0,035	0,45	
	C440	m	m	m	m	135	172					
	C490					155	185					
	C590					185	m					
DC04	A	38	40	m	m	m	95					m
	LC	38 [b, d]	40 [b, d]	1,6	0,180	m	105 [d]					
	C290	24	26	m	m	95	117					
	C340					105	130					
	C390					117	155	0,08	0,030	0,030	0,40	
	C440	m	m	m	m	135	172					
	C490					155	185					
	C590					185	215					
DC05	1.0312	40 [b, d]	42 [b, d]	1,9	0,200	m	100 [d]	0,06	0,025	0,025	0,35	m
DC06	1.0873	38 [b, d]	40 [b, d]	2,1	0,220	m	m	0,02	0,020	0,020	0,25	0,3 [g]
DC07	1.0898	40 [b, d]	42 [b, d]	2,5	0,230	m	m	0,01	0,020	0,020	0,20	0,2 [g]

NOTE 1 MPa = 1 N/mm²

[d] The values given in the Table 1 apply only to surface appearance MA. For surface appearances MB and MC, the yield strength and tensile strength values increase by 20MPa and the elongation after fracture values fall by two units. In the same way, the *HV* values increase by 5 units.

[e] For calculation purposes, a minimum yield strength value (R_e) of 140 MPa may be assumed for steel grades DC01, DC03, DC04 and DC05 in delivery conditions A and LC.

[f] For calculation purposes, a minimum yield strength value (R_e) of 120 MPa may be assumed for steel grade DC06 and 100 MPa for DC07.

[g] Titanium may be replaced by niobium. Carbon and nitrogen shall be fully fixed.

[h] These values apply only to thicknesses greater than 0,50 mm and to strip widths greater than 250 mm. The *r* and *n* values may be determined by agreement at the time of ordering.

[i] For thicknesses greater than 2 mm, the value of r_{90} is reduced by 0,2.

[j] For grade DC01 in the delivery condition C690, the C and Mn contents may be exceeded.

[k] See 6.3.2.

[l] Unless otherwise agreed at the time of enquiry and order, grades DC01, DC03, DC04 and DC05 may be supplied as alloy steels (for example with boron or titanium).

[m] Not required.

Table 2 — Surface appearances and finishes

Surface appearance (see also 6.4.1)			
Symbol	**Characteristics**	**Field of application**	**Surface finish (see 6.4.3)**
MA	Bright, metallically clean surface; pitting grooves and scratches are permitted.	All thicknesses and delivery conditions.	RR, RM, RL [b]
MB	Bright, metallically clean surface, pitting grooves and scratches are permitted as long as the uniform smooth appearance is not substantially impaired when viewed with the naked eye.	Thicknesses ≤ 2,0 mm [a] all delivery conditions except A.	RM, RL [b]
MC	Bright, metallically clean surface, pitting grooves and scratches are permitted as long as the uniform appearance of the mirror surface is not impaired.	Thicknesses ≤ 1,0 mm [a] all conditions except A.	RN [b]
[a] The supply of products of greater thicknesses with this surface appearance shall be agreed separately.			
[b] The code letters need not to be given in the designation.			

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