

---

---

**Springs — Measurement and test  
parameters —**

Part 1:  
**Cold formed cylindrical helical  
compression springs**

*Ressort - Mesures et paramètres d'essai —*

*Partie 1: Ressort hélicoïdal de compression cylindrique formé à froid*

STANDARDSISO.COM : Click to view the full PDF of ISO 22705-1:2021



STANDARDSISO.COM : Click to view the full PDF of ISO 22705-1:2021



**COPYRIGHT PROTECTED DOCUMENT**

© ISO 2021

All rights reserved. Unless otherwise specified, or required in the context of its implementation, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office  
CP 401 • Ch. de Blandonnet 8  
CH-1214 Vernier, Geneva  
Phone: +41 22 749 01 11  
Email: [copyright@iso.org](mailto:copyright@iso.org)  
Website: [www.iso.org](http://www.iso.org)

Published in Switzerland

# Contents

	Page
Foreword .....	v
<b>1 Scope</b> .....	<b>1</b>
<b>2 Normative references</b> .....	<b>1</b>
<b>3 Terms, definitions, symbols and abbreviated terms</b> .....	<b>1</b>
3.1 Terms and definitions .....	1
3.2 Symbols and abbreviated terms .....	2
<b>4 Environmental conditions</b> .....	<b>3</b>
<b>5 Qualifications of the person(s) performing the work</b> .....	<b>3</b>
<b>6 Geometries of guiding and supporting devices</b> .....	<b>4</b>
<b>7 Measuring and testing equipment</b> .....	<b>4</b>
<b>8 Measurement and test parameter for technical cold formed cylindrical compression springs</b> .....	<b>4</b>
8.1 Free length ( $L_0$ ) .....	4
8.1.1 General .....	4
8.1.2 Type of characteristic .....	4
8.1.3 Measuring and/or testing equipment .....	4
8.1.4 Conditions of measurement and testing .....	5
8.1.5 Method of measurement and testing .....	5
8.1.6 Test location on the product .....	6
8.2 Outside diameter ( $D_e$ ) .....	6
8.2.1 General .....	6
8.2.2 Type of characteristic .....	6
8.2.3 Measurement and/or testing equipment .....	7
8.2.4 Conditions of measurement and testing .....	7
8.2.5 Method of measurement and testing .....	7
8.2.6 Test location on the product .....	9
8.3 Inside diameter ( $D_i$ ) .....	10
8.3.1 General .....	10
8.3.2 Type of characteristic .....	10
8.3.3 Measuring and/or testing equipment .....	10
8.3.4 Conditions of measurement and testing .....	10
8.3.5 Method of measurement and testing .....	10
8.3.6 Test location on the product .....	12
8.4 Total number of coils ( $n_t$ ), number of active coils ( $n$ ) and coil direction .....	13
8.4.1 General .....	13
8.4.2 Type of characteristic .....	13
8.4.3 Measuring and/or testing equipment .....	15
8.4.4 Conditions of measurement and testing .....	15
8.4.5 Method of measurement and testing .....	15
8.4.6 Test location on the product .....	16
8.5 Applied end coils .....	16
8.5.1 General .....	16
8.5.2 Type of characteristic .....	16
8.5.3 Measuring and/or testing equipment .....	17
8.5.4 Conditions of measurement and testing .....	17
8.5.5 Method of measurement and testing .....	17
8.5.6 Test location on the product .....	17
8.6 Solid length ( $L_c$ )/solid force ( $F_c$ ) .....	17
8.6.1 General .....	17
8.6.2 Type of characteristics .....	17
8.6.3 Measuring and/or testing equipment .....	18
8.6.4 Conditions of measurement and testing .....	18

8.6.5	Method of measurement and testing	18
8.6.6	Test location on the product	19
8.7	Spring load ( $F$ )	19
8.7.1	General	19
8.7.2	Type of characteristic	19
8.7.3	Measuring and/or testing equipment	19
8.7.4	Conditions of measurement and testing	19
8.7.5	Method of measurement and testing	20
8.7.6	Test location on the product	20
8.8	Spring pitch ( $p$ )/distance between the coils	20
8.8.1	General	20
8.8.2	Type of characteristic	20
8.8.3	Measuring and/or testing equipment	21
8.8.4	Conditions of measurement and testing	21
8.8.5	Method of measurement and testing	21
8.8.6	Test location on the product	21
8.9	Ground surface/angle	21
8.9.1	General	21
8.9.2	Type of characteristic	22
8.9.3	Measuring and/or testing equipment	22
8.9.4	Conditions of measurement and testing	23
8.9.5	Method of measurement and testing	23
8.9.6	Test location on the product	23
8.10	Perpendicularity ( $e_1$ )	23
8.10.1	General	23
8.10.2	Type of characteristic	23
8.10.3	Measuring and/or testing equipment	24
8.10.4	Conditions of measurement and testing	24
8.10.5	Method of measurement and testing	24
8.10.6	Test location on the product	25
8.11	Parallelism ( $e_2$ )	25
8.11.1	General	25
8.11.2	Type of characteristic	25
8.11.3	Measuring and/or testing equipment	25
8.11.4	Conditions of measurement and testing	26
8.11.5	Method of measurement and testing	26
8.11.6	Test location on the product	26
8.12	Shear-off burr	26
8.12.1	General	26
8.12.2	Type of characteristic	27
8.12.3	Measuring and/or testing equipment	27
8.12.4	Conditions of measurement and testing	27
8.12.5	Method of measurement and testing	27
8.12.6	Test location on the product	28
<b>Annex A (informative) Calculation of spring rate (<math>R</math>)</b>		<b>29</b>
<b>Bibliography</b>		<b>30</b>

## 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 (see [www.iso.org/directives](http://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 (see [www.iso.org/patents](http://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 of the voluntary nature of standards, 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 [www.iso.org/iso/foreword.html](http://www.iso.org/iso/foreword.html).

This document was prepared by Technical Committee ISO/TC 227, *Springs*.

A list of all parts in the ISO 22705 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at [www.iso.org/members.html](http://www.iso.org/members.html).

STANDARDSISO.COM : Click to view the full PDF of ISO 22705-1:2021

# Springs — Measurement and test parameters —

## Part 1:

# Cold formed cylindrical helical compression springs

## 1 Scope

This document specifies the measurement and test methods for the general characteristics of cold formed helical compression springs made from round wire, excluding dynamic testing.

## 2 Normative references

There are no normative references in this document.

## 3 Terms, definitions, symbols and abbreviated terms

### 3.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

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

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

#### 3.1.1 spring

mechanical device designed to store energy when deflected and to return the equivalent amount of energy when released

[SOURCE: ISO 26909:2009, 1.1]

#### 3.1.2 compression spring

spring that offers resistance to a compressive force applied axially

Note 1 to entry: In the narrow sense, a compression spring indicates a helical compression spring.

[SOURCE: ISO 26909:2009, 1.2]

#### 3.1.3 coil spring

coil-shaped spring

[SOURCE: ISO 26909:2009, 3.11]

#### 3.1.4 helical compression spring

compression spring made of wire of circular cross-section, wound around an axis with spaces between its coils

[SOURCE: ISO 26909:2009, 3.12, modified — limited to wires with circular cross-section]

**3.1.5**

**cold formed spring**

spring formed at ambient temperature

[SOURCE: ISO 26909:2009, 1.12]

**3.1.6**

**active coils**

total number of coils less the inactive coils

Note 1 to entry: This is the number of coils used in computing the total deflection of a spring.

[SOURCE: ISO 26909:2009, 5.70, modified — extended to all inactive coils]

**3.1.7**

**test parameter**

parameter with a tolerance for which there is an immediate conclusion after the test (within tolerance or out of tolerance)

Note 1 to entry: Test can be performed without measurement (i.e. with GO/NO-GO gauges).

**3.2 Symbols and abbreviated terms**

[Table 1](#) includes the symbols and abbreviated terms used throughout this document.

**Table 1 — Symbols and abbreviated terms**

Symbols	Units	Designations
$D_e$	mm	outside diameter of spring
$D_{e,max}$	mm	maximum outside diameter of spring
$D_{e,min}$	mm	minimum outside diameter of spring
$D_i$	mm	inside diameter of spring
$D_{i,max}$	mm	maximum inside diameter of spring
$D_{i,min}$	mm	minimum inside diameter of spring
$d$	mm	diameter of wire
$d_{max}$	mm	maximum diameter of wire
$d_{wire}$	mm	actual wire diameter
$e_1$	mm	perpendicularity
$e_2$	mm	parallelism
$F$	N	spring load or force
$F_c$	N	spring load at solid length, $L_c$
$F_{max}$	N	maximum specified spring load
$F_{min}$	N	minimum specified spring load
$F_n$	N	spring load for the minimum test length, $L_n$
$F_1, F_2, \dots$	N	specified spring loads for the specified spring lengths, $L_1, L_2, \dots$
$L_c$	mm	solid length
$L_{max}$	mm	maximum specified spring length
$L_{min}$	mm	minimum specified spring length
$L_n$	mm	minimum acceptable test length for $F_n$
$L_0$	mm	free length
$L_{0,max}$	mm	maximum free length
$L_{0,min}$	mm	minimum free length
$L_1, L_2, \dots$	mm	specified spring lengths for the spring loads, $F_1, F_2, \dots$

Table 1 (continued)

Symbols	Units	Designations
$n$	–	active coils
$n_t$	–	total number of coils
$p$	mm	spring pitch
$R = \frac{\Delta F}{\Delta L} = \frac{\Delta F}{\Delta s}$	N/mm	spring rate (see Annex A)
$s$	mm	deflection of spring
$s_c$	mm	deflection of spring for the solid length, $L_c$
$s_h$	mm	deflection of the spring (stroke) between two loads, $\Delta F$
$s_n$	mm	maximum test spring deflection for the spring load, $F_n$
$s_1, s_2, \dots$	mm	specified spring deflections for the specified spring loads, $F_1, F_2, \dots$
$u$	mm	distance between the coils

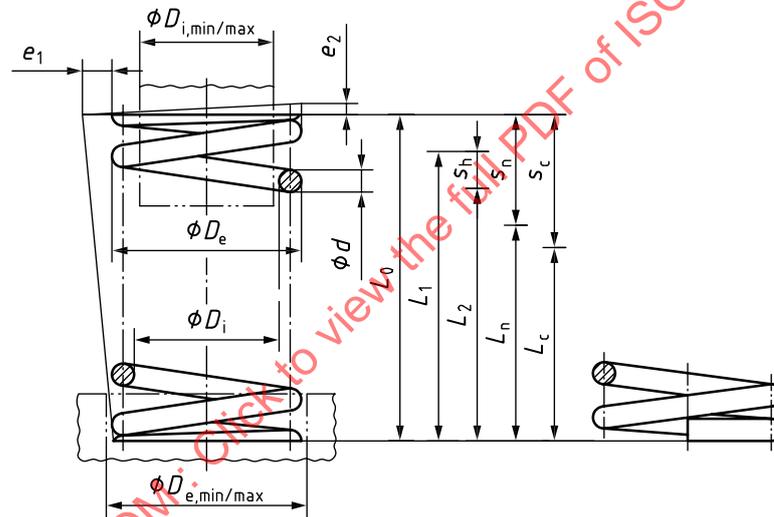


Figure 1 — Symbols for helical compression springs

#### 4 Environmental conditions

The spatial distribution and equipment of the facility shall permit a reliable implementation of the measurements and tests. Measurements and tests should be carried out at ambient temperature in a normal workshop environment. Special tests (e.g. in air-conditioned rooms or other special environments) shall be agreed upon between the manufacturer and the customer. Measuring and testing equipment should be subject to regular inspection.

#### 5 Qualifications of the person(s) performing the work

The measurements and tests shall be carried out by a person who has been instructed/trained in the use of the measuring and testing equipment, as well as regarding methods and test requirements.

The qualifications or additional knowledge and skills should be documented in appropriate qualification or training documents, depending on the requirements.

## 6 Geometries of guiding and supporting devices

If guiding and supporting devices (e.g. test pins, guide sleeves, ring grooves) are used, the properties (e.g. geometry, material) shall be agreed upon between the manufacturer and the customer to include special cases such as snapping end coils, buckling or bulging. The alignment of guiding and supporting devices is aimed to improve the reproducibility of the measurements.

## 7 Measuring and testing equipment

Suitable measuring equipment shall be selected. Measuring equipment shall conform to ISO standards, if such are available (e.g. ISO 3611 and ISO 13385-1).

If there is a customer requirement, the methods and measuring equipment shall be agreed on separately.

## 8 Measurement and test parameter for technical cold formed cylindrical compression springs

### 8.1 Free length ( $L_0$ )

#### 8.1.1 General

The free length  $L_0$  is a measurement and test parameter.

#### 8.1.2 Type of characteristic

$L_0$  is the length across the entire spring body when no load is applied and only when both ends are ground (see [Figure 2](#)); other cases should be agreed upon between the manufacturer and the customer.

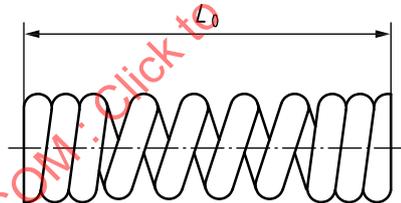


Figure 2 — Free length ( $L_0$ ) where both ends are closed and ground

#### 8.1.3 Measuring and/or testing equipment

The following measuring equipment can be used:

- micrometer gauge;
- calliper;
- dial gauge/indicating calliper;
- electronic measuring sensor;
- manual/automatic force gauge;
- optical measuring instruments/protractor/measurement microscope/camera systems.

The following testing equipment can be used:

- attributive gauges (GO/NO-GO gauges).

#### 8.1.4 Conditions of measurement and testing

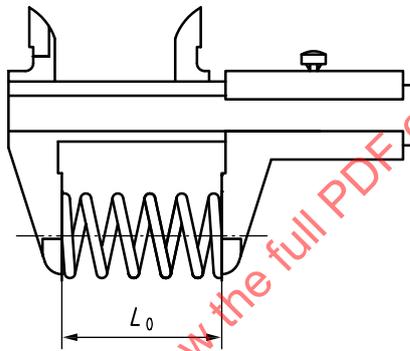
The free length  $L_0$  shall be evaluated at ambient temperature as delivered.

#### 8.1.5 Method of measurement and testing

##### a) Variable measurement

The measurement can be carried out without contact using optical procedures, capacitive or electrically by contact (with minimal force) or by contact with the measuring surfaces (at a known/unknown measuring force). Preferably, the measurement should be carried out over the entire face (see [Figure 3](#)). If this is not possible, then a second measurement can be carried out with a 90° offset. In this case, it shall be clarified whether the maximum value, the minimum value or the average value is to be specified.

When there is a spring self-weight effect, the measurement of free height should be agreed upon between the manufacturer and the customer.

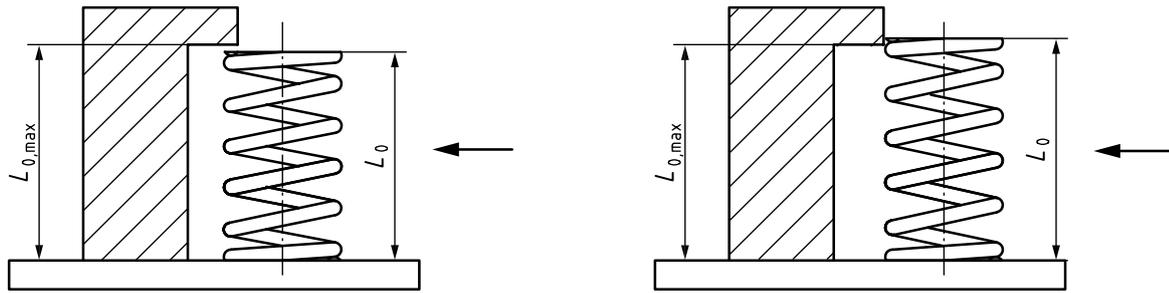


**Figure 3 — Method of measurement of the free length ( $L_0$ ) with calliper (example)**

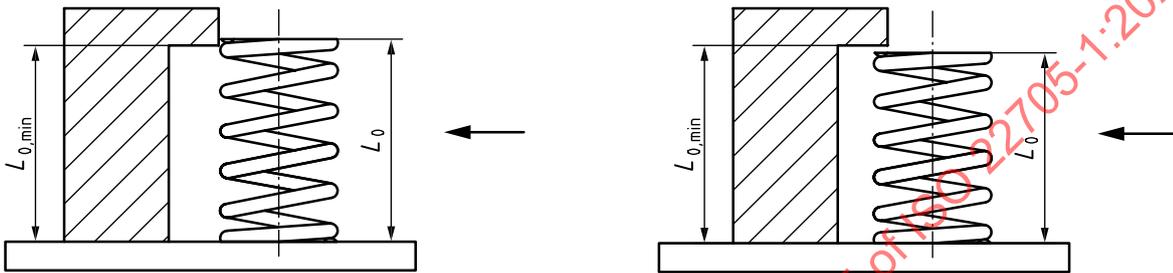
If the customer specifies a setting length for the test spring, the setting conditions for the test spring shall be agreed upon between the manufacturer and the customer.

Unless otherwise specified, springs that are not pre-set shall only be measured after the spring load test. If no spring load or force is specified, measurement can be done without any preliminary test.

##### b) Attributive testing (with GO/NO-GO gauges, see [Figure 4](#))



a) Tolerance upper limit check with gauge ( $L_0 \leq L_{0,max}$ ) (GO/within tolerance)      b) Tolerance upper limit check with gauge ( $L_0 > L_{0,max}$ ) (NO GO/out of tolerance)



c) Tolerance lower limit check with gauge ( $L_0 \geq L_{0,min}$ ) (NO GO/within tolerance)      d) Tolerance lower limit check with gauge ( $L_0 < L_{0,min}$ ) (GO/out of tolerance)

**Figure 4 — Method of testing the free length ( $L_0$ ) with gauges (examples)**

**8.1.6 Test location on the product**

The test direction is in the axial direction to the finished spring. When measuring equipment is used that induces a measuring force, then the applied force should not deflect the spring.

When optical measuring equipment (camera systems) is used, the measurement axis is perpendicular to the spring axis.

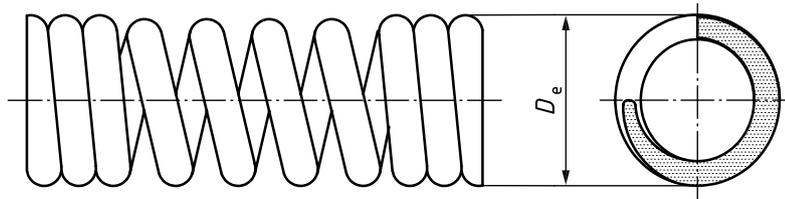
**8.2 Outside diameter ( $D_e$ )**

**8.2.1 General**

The outside diameter  $D_e$  is a measurement and test parameter.

**8.2.2 Type of characteristic**

$D_e$  is the value of the outside diameter through the whole spring body (see [Figure 5](#)).



**Figure 5 — Outside diameter ( $D_e$ )**

### 8.2.3 Measurement and/or testing equipment

The following standard measuring equipment can be used:

- micrometer gauge;
- calliper;
- dial gauge.

Alternatively, optical measuring equipment can be used.

In this case, the following testing equipment can be used:

- test sleeve;
- special gauge (part-based);
- snap gauge.

The shape and dimension of all testing equipment shall be agreed upon between the manufacturer and the customer.

### 8.2.4 Conditions of measurement and testing

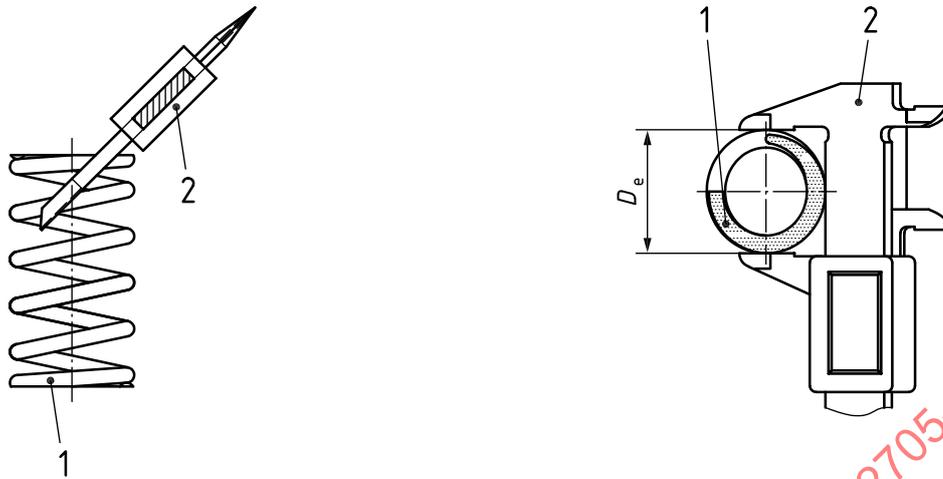
The outside diameter  $D_e$  shall be evaluated at ambient temperature as delivered.

In special cases, tests for coated and set springs should be agreed upon between the manufacturer and the customer.

### 8.2.5 Method of measurement and testing

#### a) Variable measurement (e.g. calliper)

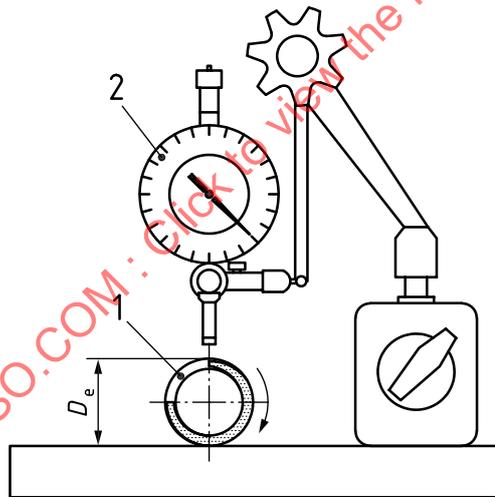
The measurement is performed at several locations on the product, at least at the beginning, in the centre ([Figure 6](#) and [Figure 7](#)) and at the end of the spring. The measurement at the end is performed in two perpendicular directions of the spring, except if the useful length of the calliper jaws is greater than the free length of the spring. Each measured value shall be within the tolerance. The maximum value shall be documented.



**Key**

- 1 spring
- 2 calliper

**Figure 6 — Method of measurement of the outside diameter ( $D_e$ ) with calliper (example)**



**Key**

- 1 spring
- 2 dial gauge

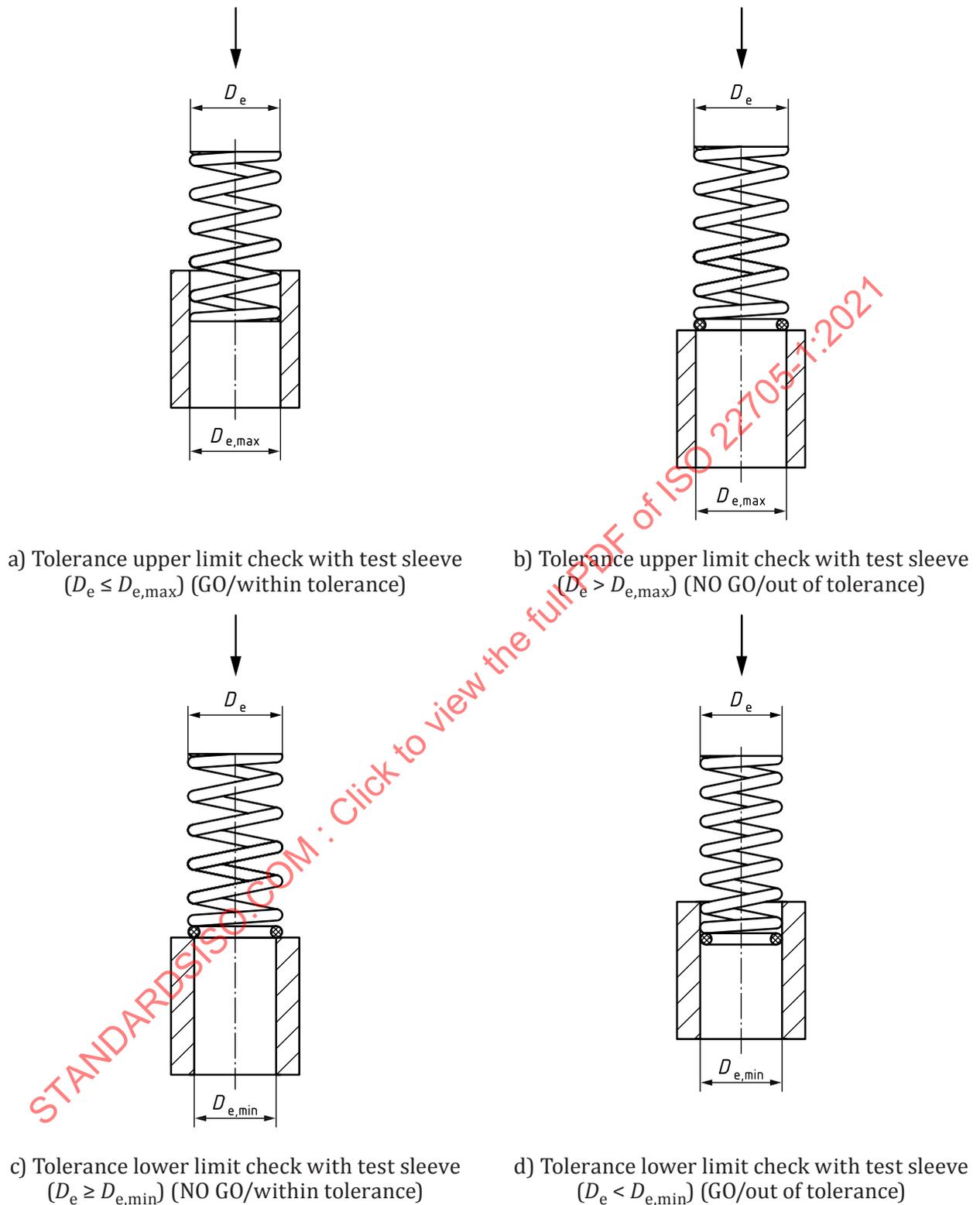
**Figure 7 — Method of measurement of the outside diameter ( $D_e$ ) with dial gauge (example)**

b) **Attributive testing** (with test sleeve as GO/NO-GO gauge, see [Figure 8](#))

The spring shall fall through the test sleeve due to its own weight at  $D_{e,max}$  (see [Figure 8a](#)).

The spring shall not fall through the test sleeve due to its own weight at  $D_{e,min}$  (see [Figure 8c](#)).

For the purpose of testing geometrical deviations (enveloping circle, curvature), a test sleeve with the length and diameter for cylindrical springs may be agreed upon between the manufacturer and the customer.



**Figure 8 — Method of testing of the outside diameter ( $D_e$ ) with test sleeve (examples)**

### 8.2.6 Test location on the product

- a) Variable measurement (e. g. calliper)

The measurement is performed at several locations on the product, at least at the beginning, in the centre and at the end of the spring with no load applied. The whole spring body should be measured.

b) **Attributive testing** (e. g. GO/NO-GO gauge)

The test is carried out over the entire length of the spring. The test sleeve length shall correspond to at least the clearance between 2 and a maximum of 4 coils.

### 8.3 Inside diameter ( $D_i$ )

#### 8.3.1 General

The inside diameter  $D_i$  is a measurement and test parameter.

#### 8.3.2 Type of characteristic

$D_i$  is the minimum value of the inside diameter through the whole spring body (see [Figure 9](#)).

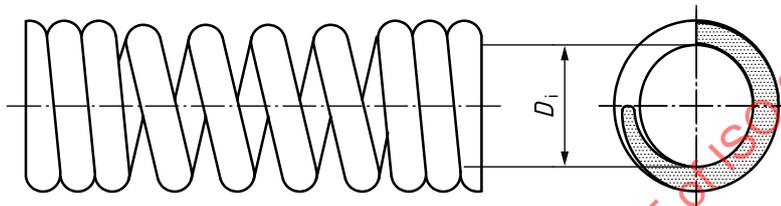


Figure 9 — Inside diameter ( $D_i$ )

#### 8.3.3 Measuring and/or testing equipment

The following measuring equipment can be used:

- calliper.

Alternatively, a micrometer screw or optical measuring equipment can be used.

The following testing equipment can be used:

- test pin;
- special gauge (part-based), e. g. GO/NO-GO gauge.

The shape and dimension of all testing equipment shall be agreed upon between the manufacturer and the customer.

#### 8.3.4 Conditions of measurement and testing

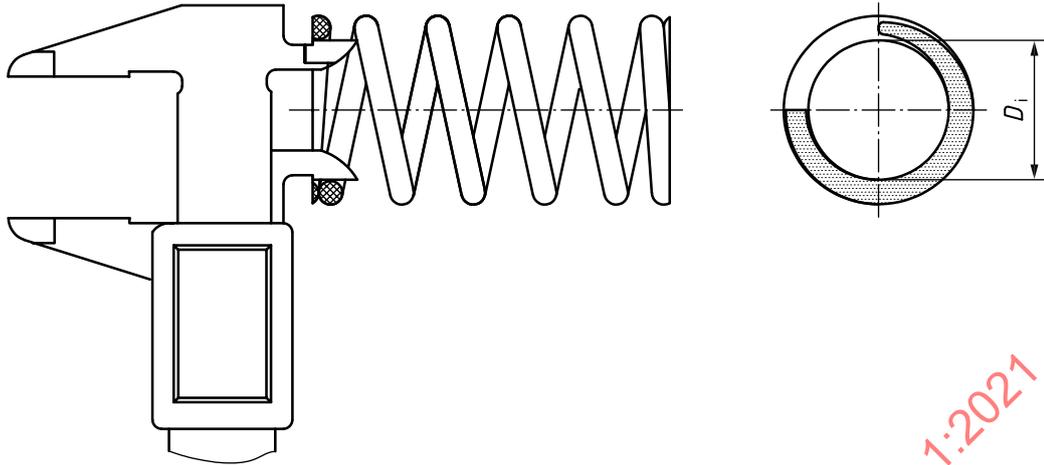
The inside diameter  $D_i$  shall be evaluated at ambient temperature as delivered.

In special cases, tests for coated and set springs should be agreed upon between the manufacturer and the customer.

#### 8.3.5 Method of measurement and testing

a) **Variable measurements** (e.g. calliper)

Take two measurements per end (in perpendicular directions at each end) of the spring (see [Figure 10](#)), unless the length of the calliper jaws is greater than the free length of spring (in this case, take only two measurements in perpendicular directions). The minimum value shall be documented.



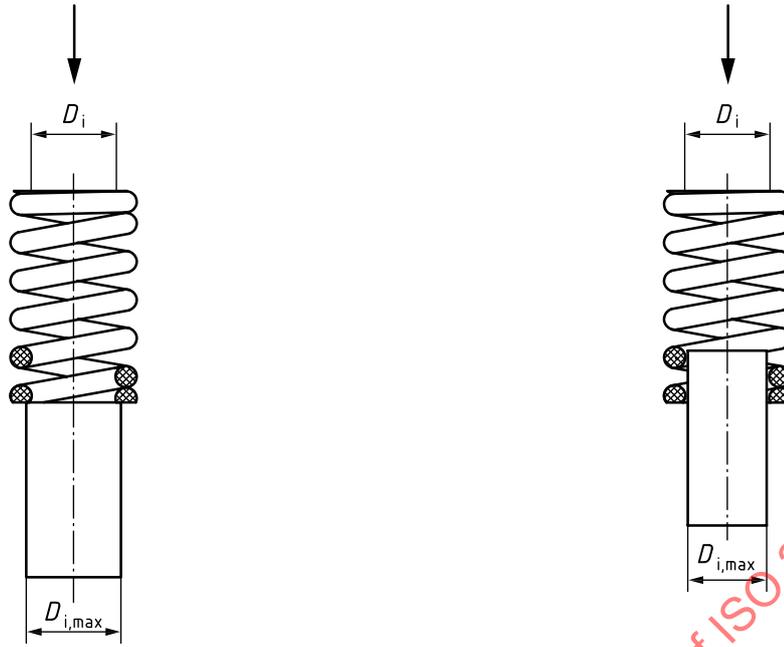
**Figure 10 — Method of measurement of the inside diameter ( $D_i$ ) with calliper (example)**

- b) **Attributive testing** (with test pin as GO/NO-GO gauge, see [Figure 11](#))

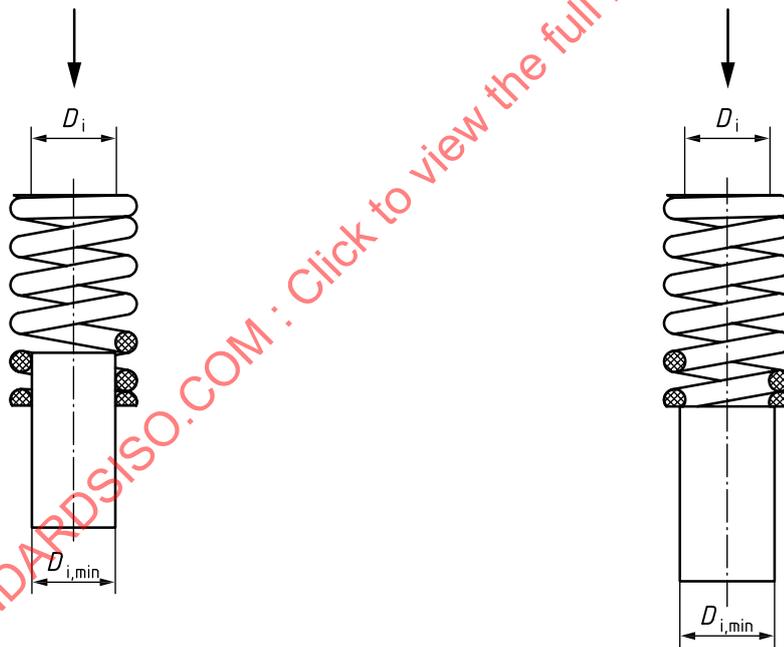
The spring shall fall over the test pin due to its own weight at  $D_{i,min}$  (see [Figure 11c](#)).

The spring shall not fall over the test pin due to its own weight at  $D_{i,max}$  (see [Figure 11a](#)).

Both of the above-mentioned criteria shall be met, regardless of which side of the spring is attached to the test pin.



a) Tolerance upper limit with test pin ( $D_i \leq D_{i,max}$ ) (NO GO/within tolerance)    b) Tolerance upper limit with test pin ( $D_i > D_{i,max}$ ) (GO/out of tolerance)



c) Tolerance lower limit with test pin ( $D_i \geq D_{i,min}$ ) (GO/within tolerance)    d) Tolerance lower limit with test pin ( $D_i < D_{i,min}$ ) (NO GO/out of tolerance)

**Figure 11 — Method of testing the inside diameter ( $D_i$ ) with test pin (examples)**

**8.3.6 Test location on the product**

a) Variable measurement

The measurement is carried out at the beginning and at the end of the spring.

In the spring centre, the inside diameter of the spring,  $D_i$ , can only be determined using [Formula 1](#).

$$D_i = D_e - 2 \times d_{\text{wire}} \quad (1)$$

where

$D_i$  is the inside diameter of the spring

$D_e$  is the outside diameter of the spring

$d_{\text{wire}}$  is the real wire diameter after the forming process (coiling/winding)

b) **Attributive gauges (GO/NO GO-gauges)**

The test is carried out over the entire length of the spring ( $L_0$ ).

For the purpose of testing geometrical deviations (enveloping circle, curvature), a test gauge can be agreed upon between the manufacturer and the customer.

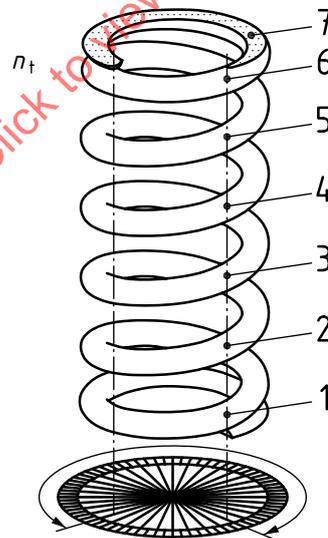
## 8.4 Total number of coils ( $n_t$ ), number of active coils ( $n$ ) and coil direction

### 8.4.1 General

The total number of coils and the coil direction are test parameters. The number of active coils is a theoretical calculation value.

### 8.4.2 Type of characteristic

The total number of coils  $n_t$  is the number of wire rotations/coils around the spring axis (see [Figure 12](#)).



#### Key

- 1 coil number 1
- 2 coil number 2
- 3 coil number 3
- 4 coil number 4
- 5 coil number 5
- 6 coil number 6
- 7 0,75 of a full coil (determined by the scale)

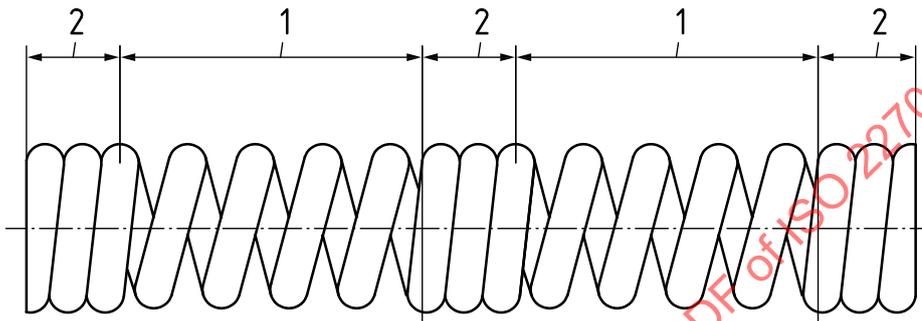
**Figure 12 — Total number of coils ( $n_t$ )**

The number of active coils,  $n$ , is a theoretical calculated value that cannot be measured geometrically. The number of active coils can only be counted approximately.

The number of active coils,  $n$ , is the total number of coils,  $n_t$ , less the number of inactive coils (see [Figure 13](#)).

Definition of inactive coils:

- a) with the end coil in contact, the number of turns is determined from the end of the wire to the last contact point with the subsequent coil.
- b) with the coils contacting in the spring body between the end coils, the number of coils in each case is determined from the first to the last contact point of two adjacent (consecutive) coils.

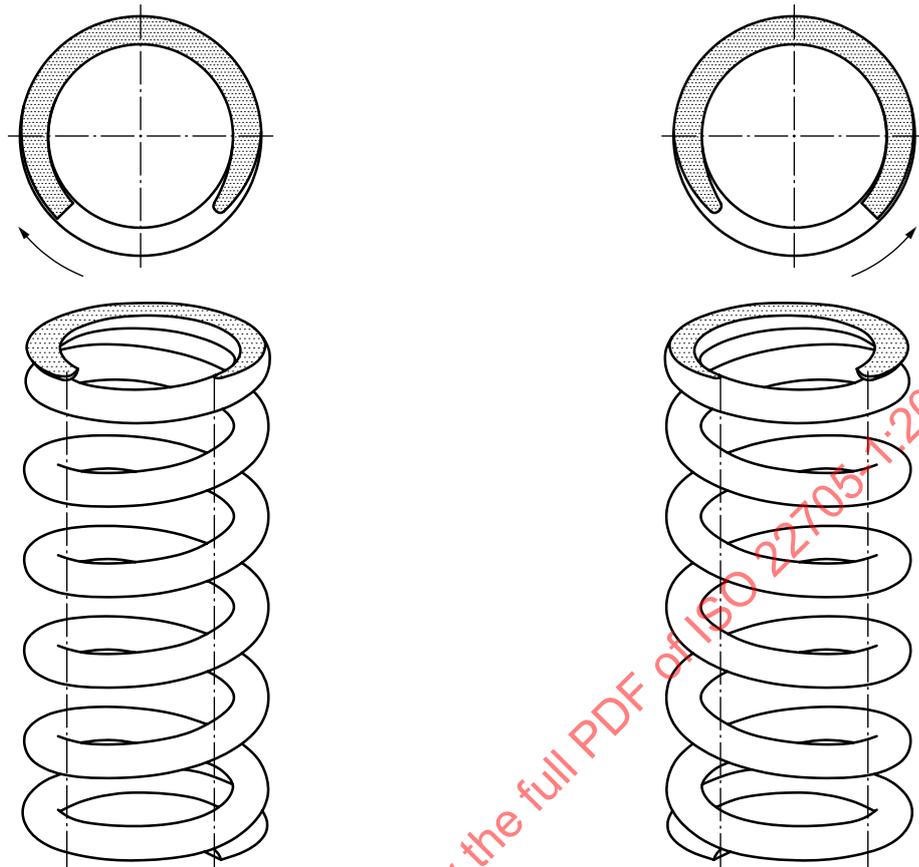


**Key**

- 1 active coils
- 2 inactive coils

**Figure 13 — Number of active coils ( $n$ )**

Depending on the winding direction during the coiling process, the spring can be coiled clockwise or counterclockwise (see [Figure 14](#)).



a) clockwise (right-handed)

b) counterclockwise (left-handed)

Figure 14 — Coil direction

### 8.4.3 Measuring and/or testing equipment

The following testing equipment can be used:

- visual inspection;
- test template;
- optical test.

### 8.4.4 Conditions of measurement and testing

The total number of coils  $n_t$  shall be evaluated at ambient temperature as delivered.

### 8.4.5 Method of measurement and testing

All tests are carried out on the unloaded spring.

Total number of coils,  $n_t$ :

The wire coil rotations shall be counted from one end of the wire (spring end) to the other. Therefore, the end of the wire in each case is the maximum point in the run-off direction of rotation (see [Figure 12](#)).

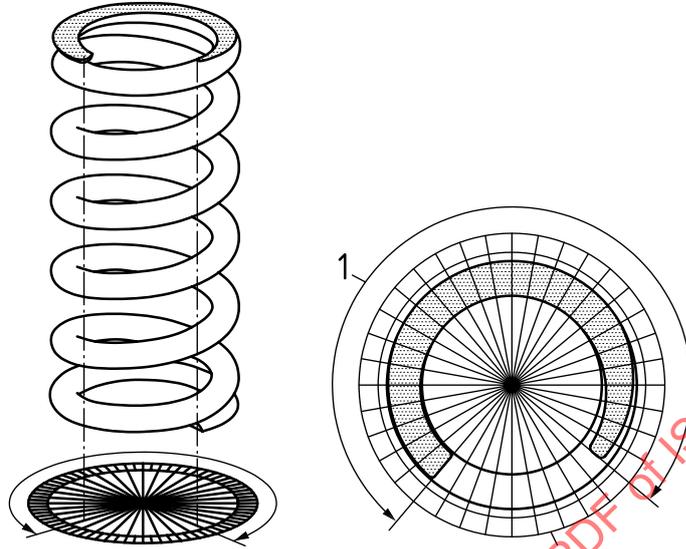
In case of open flat ends, and with open coils in the spring body,  $n = n_t$ .

Depending on the spring holding condition, there are cases of  $n \neq n_t$ .

The coil direction can be clockwise (right-handed) or counterclockwise (left-handed) (see [Figure 14](#)).

#### 8.4.6 Test location on the product

The entire spring body shall be considered (see [Figure 15](#)).



#### Key

- 1 0,75 of a full coil
- 2 angle scale

**Figure 15 — Method of measurement of the total number of coils ( $n_t$ ) with test template (example)**

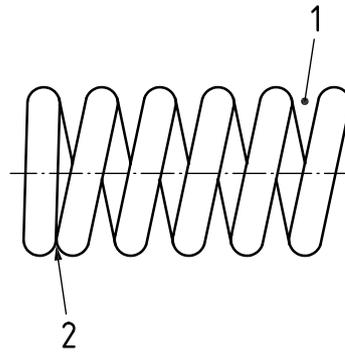
### 8.5 Applied end coils

#### 8.5.1 General

The contacting end coils are a test parameter.

#### 8.5.2 Type of characteristic

This is the condition of the spring ends. The end coils can be in contact (closed) or not (open) (see [Figure 16](#)). A minor gap is permissible if it is not relevant to the spring behaviour and cannot result in spring locking.

**Key**

- 1 open
- 2 closed

Figure 16 — End coils

**8.5.3 Measuring and/or testing equipment**

The following testing equipment can be used:

- visual inspection;
- optical test.

**8.5.4 Conditions of measurement and testing**

The contacting end coils shall be evaluated at ambient temperature as delivered.

**8.5.5 Method of measurement and testing**

The test is carried out on the unloaded spring.

The number of turns from the wire end to the last contact point of two adjacent (consecutive) coils shall be determined.

**8.5.6 Test location on the product**

The respective end coils of the spring shall be considered.

**8.6 Solid length ( $L_c$ )/solid force ( $F_c$ )****8.6.1 General**

The solid length  $L_c$  is a measurement and test parameter.

The solid force  $F_c$  is the theoretical spring force at solid length, which is not used during measurement and testing.

If the number of coils is open for production margin, this shall be taken into consideration or agreed upon when indicating the solid dimension.

**8.6.2 Type of characteristics**

The solid length  $L_c$  is the length of the spring, when the spring is loaded between two parallel test surfaces, in which all coils have contact in at least one point (see [Figure 17](#)).

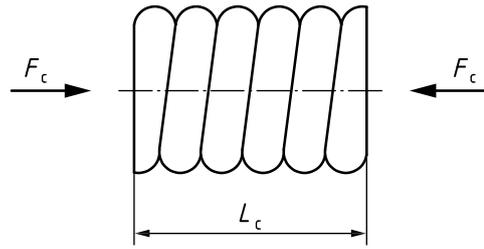


Figure 17 — Solid length ( $L_c$ )

**8.6.3 Measuring and/or testing equipment**

The following measuring and testing equipment can be used:

- spring load tester (manual or powered);
- calliper;
- dial gauge;
- block gauge;
- optical test.

**8.6.4 Conditions of measurement and testing**

The solid length  $L_c$  is evaluated at ambient temperature as delivered.

**8.6.5 Method of measurement and testing**

The spring shall not exceed a defined solid length,  $L_c$ , i.e. the solid length,  $L_c$ , shall be less than or equal to a specified value.

Measurement method for the determination of solid length,  $L_c$ :

The spring shall be compressed until all coils contact each other in at least one point (see [Figure 18](#)).

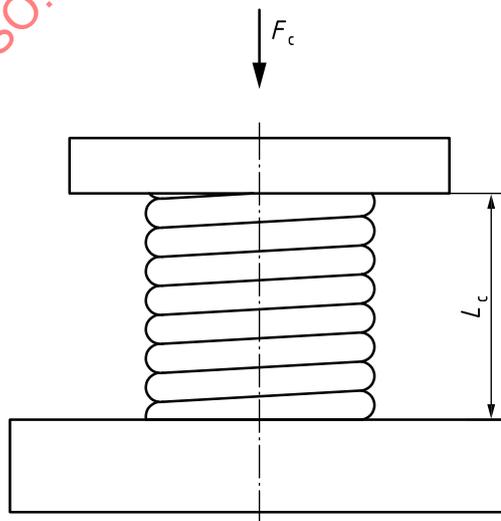


Figure 18 — Method of testing the solid length ( $L_c$ ) with a spring load tester (example)

A test force shall be agreed upon with the customer upon request.

Geometries of guiding and supporting devices (for example, test pins, guide bushings, ring groove) may be agreed upon between the manufacturer and the customer to include special cases such as snapping end coils, buckling or bulging.

### 8.6.6 Test location on the product

The entire spring body shall be considered.

The two highest points are measured in axial direction.

## 8.7 Spring load ( $F$ )

### 8.7.1 General

The spring load  $F$  is a measurement and test parameter.

### 8.7.2 Type of characteristic

$F_1, F_2, \dots$  are the assigned spring loads to the lengths of the loaded spring  $L_1, L_2, \dots$  or the assigned deflections  $s_1, s_2, \dots$

The spring load is an axial force in the direction of compression (see [Figure 19](#)).

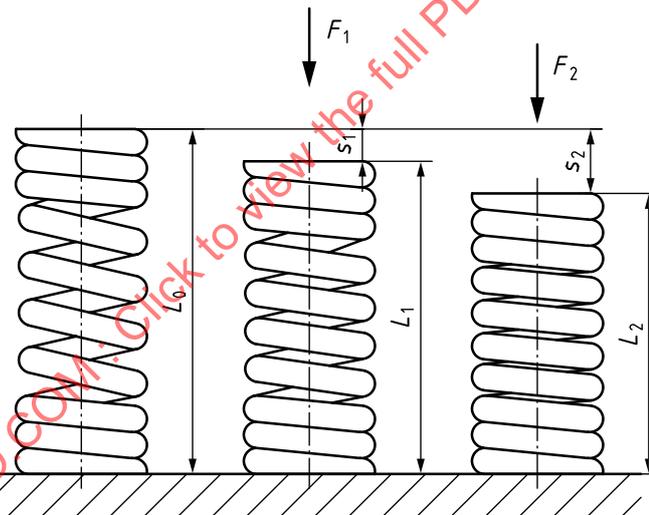


Figure 19 — Spring load ( $F$ )

### 8.7.3 Measuring and/or testing equipment

In order to test the force, a suitable, calibrated force and test gauge shall be used, which has been checked regularly between the calibrating intervals and adjusted to the required tolerance. This can be:

- a spring load tester (manual or powered);
- force measuring sensors (relationship between deformation and force) in part-specific test equipment;
- a beam balance (balancing weights).

### 8.7.4 Conditions of measurement and testing

The spring load  $F$  is evaluated at ambient temperature as delivered.

### 8.7.5 Method of measurement and testing

Unless otherwise specified, springs that are not preset are measured under force between two parallel plates, first at  $L_{\min}$  ( $F_{\max}$ ), then unloaded and then measured by decreasing deflections to  $L_{\max}$  ( $F_{\min}$ ). The spring is relieved between the individual measurements.

If the manufacturer considers the use of a test pin to be required for the spring force test, then it shall be used.

When testing with a test pin, the spring shall fall over the test pin due to its own weight at  $D_{i,\min}$ .

If the customer specifies a setting length for the test spring, the setting conditions for the test spring shall be agreed upon between the manufacturer and the customer.

Geometries of guiding and supporting devices (e.g. test pins, guide bushings, ring groove) may be agreed upon between the manufacturer and the customer to include special cases such as snapping end coils, buckling, bulging, etc.

### 8.7.6 Test location on the product

The entire spring body shall be considered.

## 8.8 Spring pitch ( $p$ )/distance between the coils

### 8.8.1 General

The spring pitch/distance between the coils is a measurement.

The (functional) spring characteristic with the corresponding tolerances should be defined, rather than specifying the spring pitch/distance between the coils ( $u$ ).

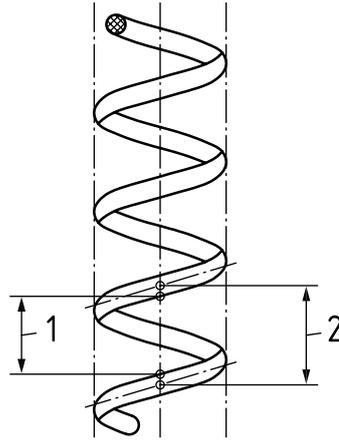
### 8.8.2 Type of characteristic

The spring pitch  $p$  is the distance between two consecutive coils in the neutral axis.

The spring pitch ( $p$ ) can be calculated by adding the distance between coils ( $u$ ) to the diameter of wire ( $d$ ):

$$p = d + u$$

[Figure 20](#) illustrates the difference between distance between coils and spring pitch.

**Key**

- 1 distance between coils,  $u$
- 2 spring pitch,  $p$

**Figure 20 — Difference between spring pitch ( $p$ ) and distance between the coils**

**8.8.3 Measuring and/or testing equipment**

The following measuring equipment can be used:

- calliper (with the corresponding dimension);
- optical measuring instruments/protractors.

The resolution of the measuring equipment shall be observed.

**8.8.4 Conditions of measurement and testing**

The spring pitch  $p$  is evaluated at ambient temperature as delivered.

**8.8.5 Method of measurement and testing**

The measurement can be performed without contact (optical) or with minimal force application (manual check).

The measurement should be performed perpendicular to the spring axis.

**8.8.6 Test location on the product**

Coils to be defined between the manufacturer and the customer.

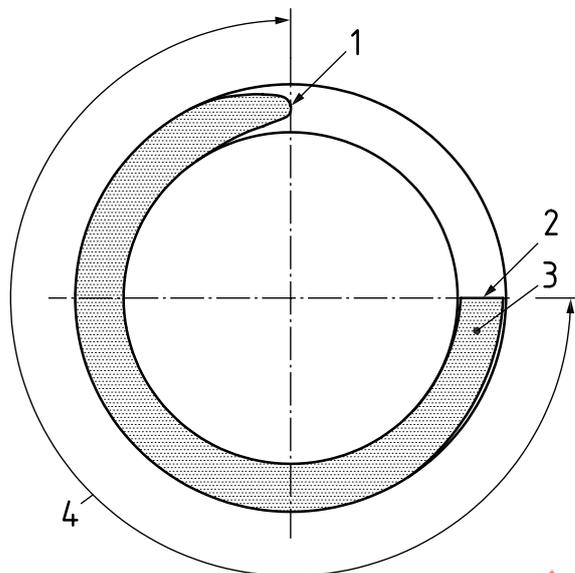
Furthermore, the measuring point should be precisely defined, since there are partly different distances between the coils in the spring.

**8.9 Ground surface/angle****8.9.1 General**

The ground surface is a measurement and test parameter, for which the angle between the beginning and the end of the ground surface is indicated in degrees (see [Figure 21](#) and [Figure 22](#)).

### 8.9.2 Type of characteristic

The inspected properties are the ground surfaces of the coil ends.



#### Key

- 1 end of grinding surface
- 2 end of coil
- 3 ground surface
- 4 grinding angle

Figure 21 — Applied and ground spring ends

### 8.9.3 Measuring and/or testing equipment

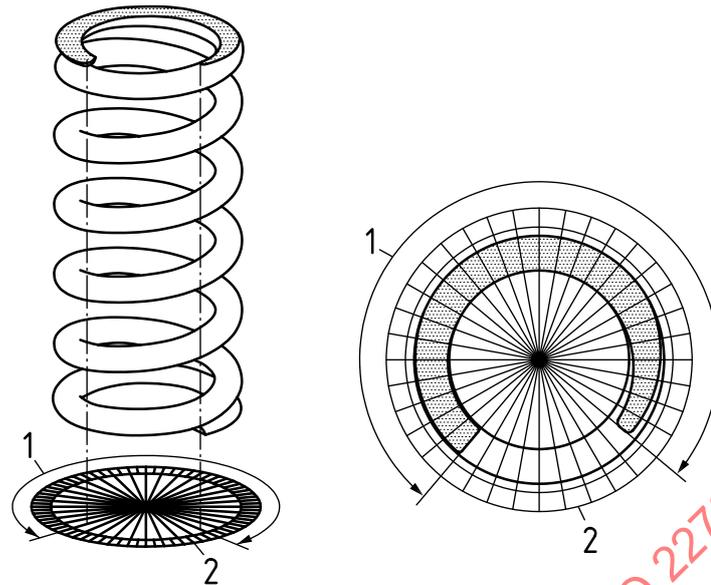
The following testing equipment should be used:

- visual inspection;
- template;
- projector;
- protractor.

The following measuring equipment should be used:

- projector with reflected light and protractor.

If the ground angle is determined by using a template, see [Figure 22](#).

**Key**

- 1 ground angle
- 2 angle scale

**Figure 22 — Method of testing the ground angle with a template (example)**

**8.9.4 Conditions of measurement and testing**

The ground surface is evaluated at ambient temperature as delivered.

**8.9.5 Method of measurement and testing**

Visual inspection: ground surface.

Profile projector: ground angle with reflected light and protractor.

**8.9.6 Test location on the product**

The test is performed at the ground end coils of the spring.

**8.10 Perpendicularity ( $e_1$ )****8.10.1 General**

The perpendicularity  $e_1$  at contacting and ground coil ends.

The perpendicularity,  $e_1$ , is a measurement and test parameter.

**8.10.2 Type of characteristic**

Perpendicularity,  $e_1$  is the variation of squareness from the vertical spring axis in mm.

[Figure 23](#) illustrates the characteristic of the perpendicularity,  $e_1$ .

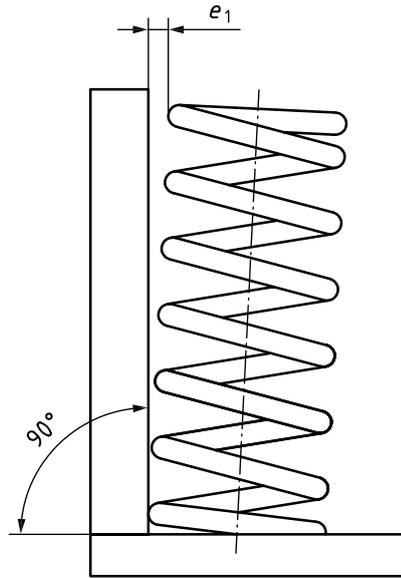


Figure 23 — Perpendicularity ( $e_1$ )

### 8.10.3 Measuring and/or testing equipment

The following measuring and testing equipment can be used:

- profile projector;
- height gauge or fixture with dial gauge;
- 3D camera systems (optical measuring system);
- steel square and feeler or pin gauge;
- protractor.

Special test procedures shall be agreed upon between the manufacturer and the customer.

### 8.10.4 Conditions of measurement and testing

The perpendicularity  $e_1$  is evaluated at ambient temperature as delivered. The test is only applicable for closed and ground springs.

### 8.10.5 Method of measurement and testing

The perpendicularity,  $e_1$ , is determined at both spring ends. The larger of the two measurement values shall be used.

a)  $e_1$  feeler gauge or dial gauge or pin gauge:

The ground spring is held, ground end against a flat surface, and lower coil against a square, while turned until the maximum offset between the lower and upper coil diameter is reached (check). The conformity to a maximum  $e_1$  acceptable value is then determined using a feeler gauge.

b)  $e_1$  profile projector:

The measurement is carried out using the coordinate system of the profile projector, without stops or devices. After orientation on the flat surface (glass plate) of the profile projector, the spring is turned to its maximum perpendicularity. This can be in the X and Y direction. The measured