
**Springs — Measurement and test
parameters —**

**Part 2:
Cold formed cylindrical helical
extension springs**

Ressort - Mesures et paramètres d'essai —

Partie 2: Ressort hélicoïdal de traction cylindrique formé à froid

STANDARDSISO.COM : Click to view the full PDF of ISO 22705-2:2023



STANDARDSISO.COM : Click to view the full PDF of ISO 22705-2:2023



COPYRIGHT PROTECTED DOCUMENT

© ISO 2023

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
Website: www.iso.org

Published in Switzerland

Contents

	Page
Foreword.....	v
1 Scope.....	1
2 Normative references.....	1
3 Terms, definitions, symbols and abbreviated terms.....	1
3.1 Terms and definitions.....	1
3.2 Symbols and abbreviated terms.....	2
4 Environmental conditions.....	3
5 Qualifications of the person(s) performing the work.....	3
6 Geometries of guiding and supporting devices.....	3
7 Measuring and testing equipment.....	3
8 Measurement and test parameter for technical cold formed cylindrical extension springs.....	4
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.....	4
8.1.5 Method of measurement and testing.....	4
8.1.6 Test location on the product.....	7
8.2 Body length (L_B).....	7
8.2.1 General.....	7
8.2.2 Type of characteristic.....	7
8.2.3 Measuring and/or testing equipment.....	8
8.2.4 Conditions of measurement and testing.....	8
8.2.5 Method of measurement and testing.....	8
8.2.6 Test location on the product.....	10
8.3 Spring hook length (L_H).....	10
8.3.1 General.....	10
8.3.2 Type of characteristic.....	10
8.3.3 Measuring and/or testing equipment.....	11
8.3.4 Conditions of measurement and testing.....	11
8.3.5 Method of measurement and testing.....	11
8.3.6 Test location on the product.....	13
8.4 Hook opening (m).....	13
8.4.1 General.....	13
8.4.2 Type of characteristic.....	13
8.4.3 Measuring and/or testing equipment.....	14
8.4.4 Conditions of measurement and testing.....	14
8.4.5 Method of measurement and testing.....	14
8.4.6 Test location on the product.....	15
8.5 Outside diameter (D_o).....	15
8.5.1 General.....	15
8.5.2 Type of characteristic.....	15
8.5.3 Measurement and/or testing equipment.....	16
8.5.4 Conditions of measurement and testing.....	16
8.5.5 Method of measurement and testing.....	16
8.5.6 Test location on the product.....	20
8.6 Inside diameter (D_i).....	20
8.6.1 General.....	20
8.6.2 Type of characteristic.....	20
8.6.3 Measuring and/or testing equipment.....	20
8.6.4 Conditions of measurement and testing.....	20

8.6.5	Method of measurement and testing	21
8.6.6	Test location on the product	23
8.7	Total number of coils (n_t), number of active coils (n) and coil direction	23
8.7.1	General	23
8.7.2	Type of characteristic	23
8.7.3	Measuring and/or testing equipment	25
8.7.4	Conditions of measurement and testing	25
8.7.5	Method of measurement and testing	25
8.7.6	Test location on the product	26
8.8	Bending radius (r)	26
8.8.1	General	26
8.8.2	Type of characteristic	26
8.8.3	Measuring and/or testing equipment	27
8.8.4	Conditions of measurement and testing	27
8.8.5	Method of measurement and testing	27
8.8.6	Test location on the product	27
8.9	Spring load (F)	28
8.9.1	General	28
8.9.2	Type of characteristic	28
8.9.3	Measuring and/or testing equipment	28
8.9.4	Conditions of measurement and testing	28
8.9.5	Method of measurement and testing	28
8.9.6	Test location on the product	29
8.10	Spring pitch (p) / distance between the coils (u)	29
8.10.1	General	29
8.10.2	Type of characteristic	29
8.10.3	Measuring and/or testing equipment	30
8.10.4	Conditions of measurement and testing	30
8.10.5	Method of measurement and testing	30
8.10.6	Test location on the product	30
8.11	Loop/ Hook position	31
8.11.1	General	31
8.11.2	Type of characteristic	31
8.11.3	Measuring and/or testing equipment	31
8.11.4	Conditions of measurement and testing	32
8.11.5	Method of measurement and testing	32
8.11.6	Test location on the product	32
8.12	Shear-off burr	32
8.12.1	General	32
8.12.2	Type of characteristic	32
8.12.3	Measuring and/or testing equipment	33
8.12.4	Conditions of measurement and testing	33
8.12.5	Method of measurement and testing	33
8.12.6	Test location on the product	34
Annex A (Informative) Calculation of spring rate R		35
Annex B (Informative) Calculation of initial tension force (F_i)		36
Annex C (Informative) Types of hooks		38

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).

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).

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.

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.

STANDARDSISO.COM : Click to view the full PDF of ISO 22705-2:2023

Springs — Measurement and test parameters —

Part 2: Cold formed cylindrical helical extension springs

1 Scope

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

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 3611, *Geometrical product specifications (GPS) — Dimensional measuring equipment: Micrometers for external measurements — Design and metrological characteristics*

ISO 13385-1, *Geometrical product specifications (GPS) — Dimensional measuring equipment — Part 1: Design and metrological characteristics of callipers*

ISO 16249, *Springs — Symbols*

ISO 26909, *Springs — Vocabulary*

3 Terms, definitions, symbols and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 26909 and the following apply.

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

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

3.1.1

helical extension spring

extension spring normally made of wire of circular cross-section, wound around an axis, with or without spaces between its coils (open or closed wound)

[SOURCE: ISO 26909:2009, 3.13, modified — limited to wires with circular cross-section]

3.1.2

test parameter

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

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

3.2 Symbols and abbreviated terms

For the purposes of this document, the symbols given in ISO 16249, Figure 1 and [Table 1](#) apply.

Table 1 — Symbols and abbreviated terms

Symbols	Units	Designations
D_e	mm	outside diameter of spring
D_i	mm	inside diameter of spring
d	mm	diameter of wire
$d_{\max}$	mm	maximum diameter of wire
d_{wire}	mm	actual wire diameter
F	N	spring load or force
$F_i = F_1 - s_1 R$	N	initial tension force (preload) (see Annex B)
$F_1, F_2, \dots$	N	specified spring loads for the specified spring lengths, $L_1, L_2, \dots$
F_n	N	maximum permissible spring force for the maximum permissible spring length L_n
$F_{\max}$	N	maximum specified spring load
$F_{\min}$	N	minimum specified spring load
L_0	mm	free length
L_n	mm	maximum acceptable spring length measured spring hooks inner radii for F_n
$L_1, L_2, \dots$	mm	specified spring lengths for the spring loads, $F_1, F_2, \dots$
L_H	mm	distance from inner radius of loop to spring body
L_B	mm	body length when unloaded but subject to initial tension force
$L_{\max}$	mm	maximum specified spring length
$L_{\min}$	mm	minimum specified spring length
m	mm	hook opening
n	–	number of 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)
r	mm	bending radius
s	mm	deflection of spring
s_n	mm	maximum test spring deflection for the spring loads, F_n
$s_1, s_2, \dots$	mm	specified spring deflections for the specified spring loads, $F_1, F_2, \dots$
s_h	mm	deflection of spring (stroke) between two loads
u	mm	distance between the coils

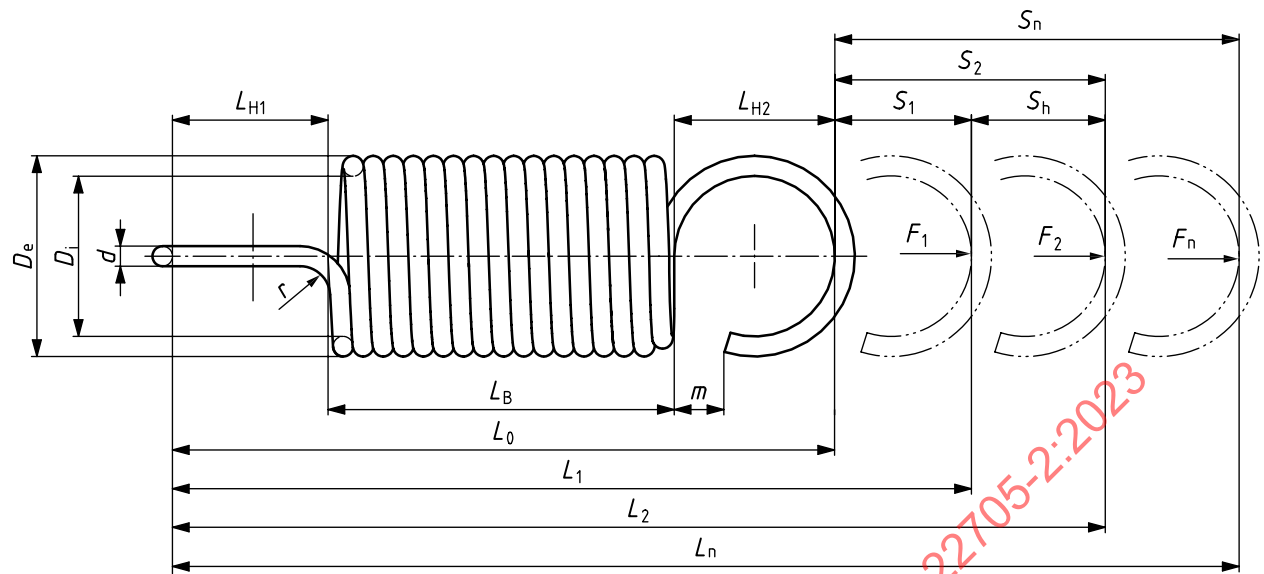


Figure 1 — Symbols for helical extension spring

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. The alignment of guiding and supporting devices is aimed to improve the reproducibility of the measures (e.g. diameter of pins inserted inside the hooks to measure the loads).

7 Measuring and testing equipment

Suitable measuring equipment shall be selected. Measuring equipment shall conform to 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 extension 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

The free length L_0 is the length between the two internal hooks when no load is applied (see Figure 2); other cases should be agreed upon between the manufacturer and the customer. If it's not possible to measure L_0 inside the hooks, it shall be measured outside the hooks minus two times wire diameter ($2d$).

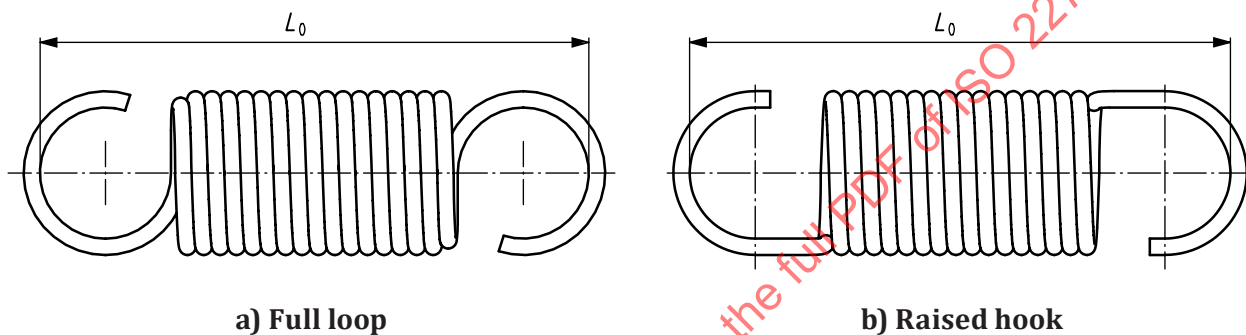


Figure 2 — Free length (L_0)

8.1.3 Measuring and/or testing equipment

The following measuring equipment can be used:

- micrometer gauge;
- calliper;
- electronic measuring sensor;
- manual/automatic force gauge;
- optical measuring instruments/ 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

The measurement can be carried out without contact using optical procedures, capacitive or electrically by contact (with minimal force) without deflection or by contact with the measuring surfaces (at a known/unknown measuring force).

When there is a spring self-weight effect, the measurement of free length should be carried out in horizontal position on an appropriate flat surface.

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

NOTE Generally, extension springs do not have a setting process because it reduces the initial tension force.

Calliper: the unloaded spring is held with the inner measuring legs of the calliper between the highest points of the inner edges of the loops (see [Figure 3](#)).

GO/NO GO gauges can be used as shown in [Figure 4](#).

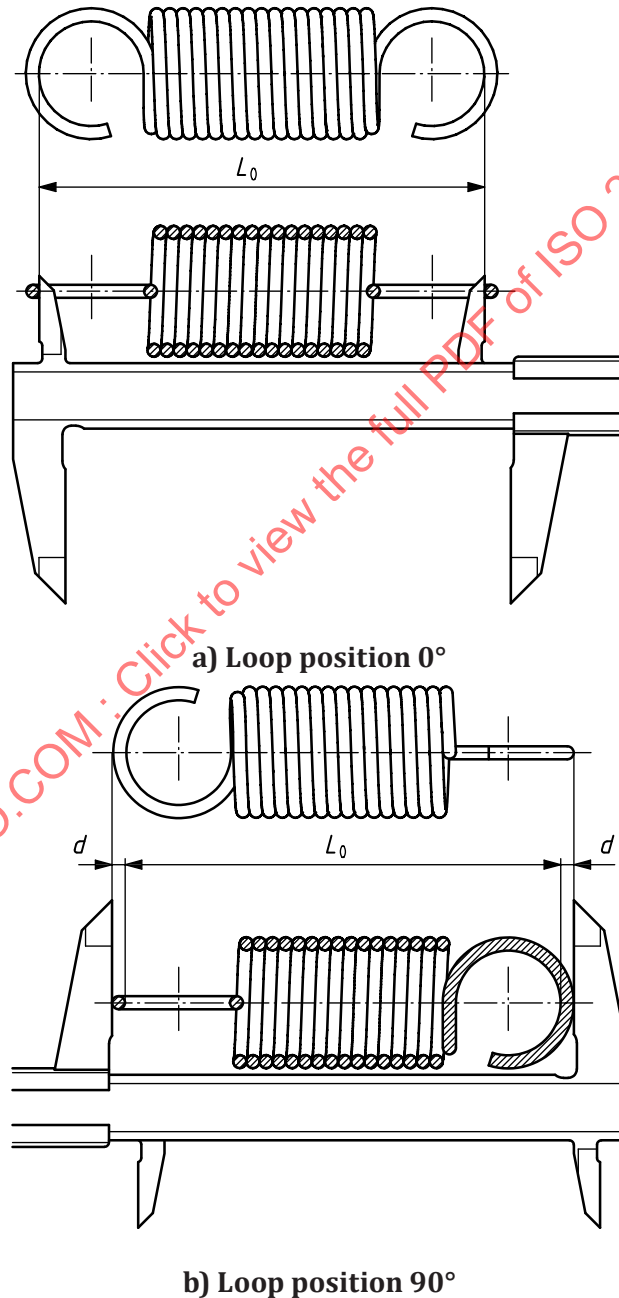
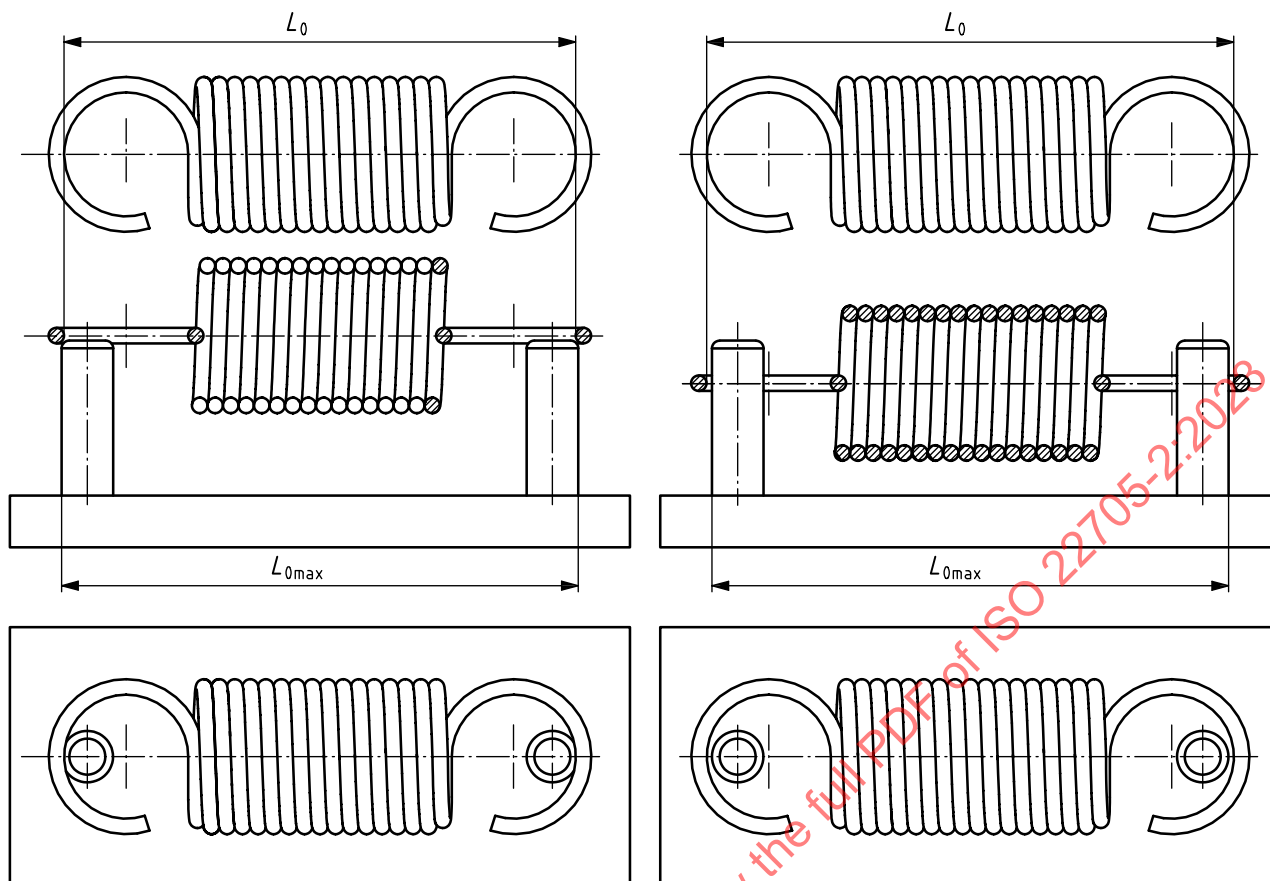


Figure 3 — Method of measurement with calliper (example)



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

b) Tolerance upper limit check with gauge
 $(L_0 > L_{0max})$ GO/out of tolerance

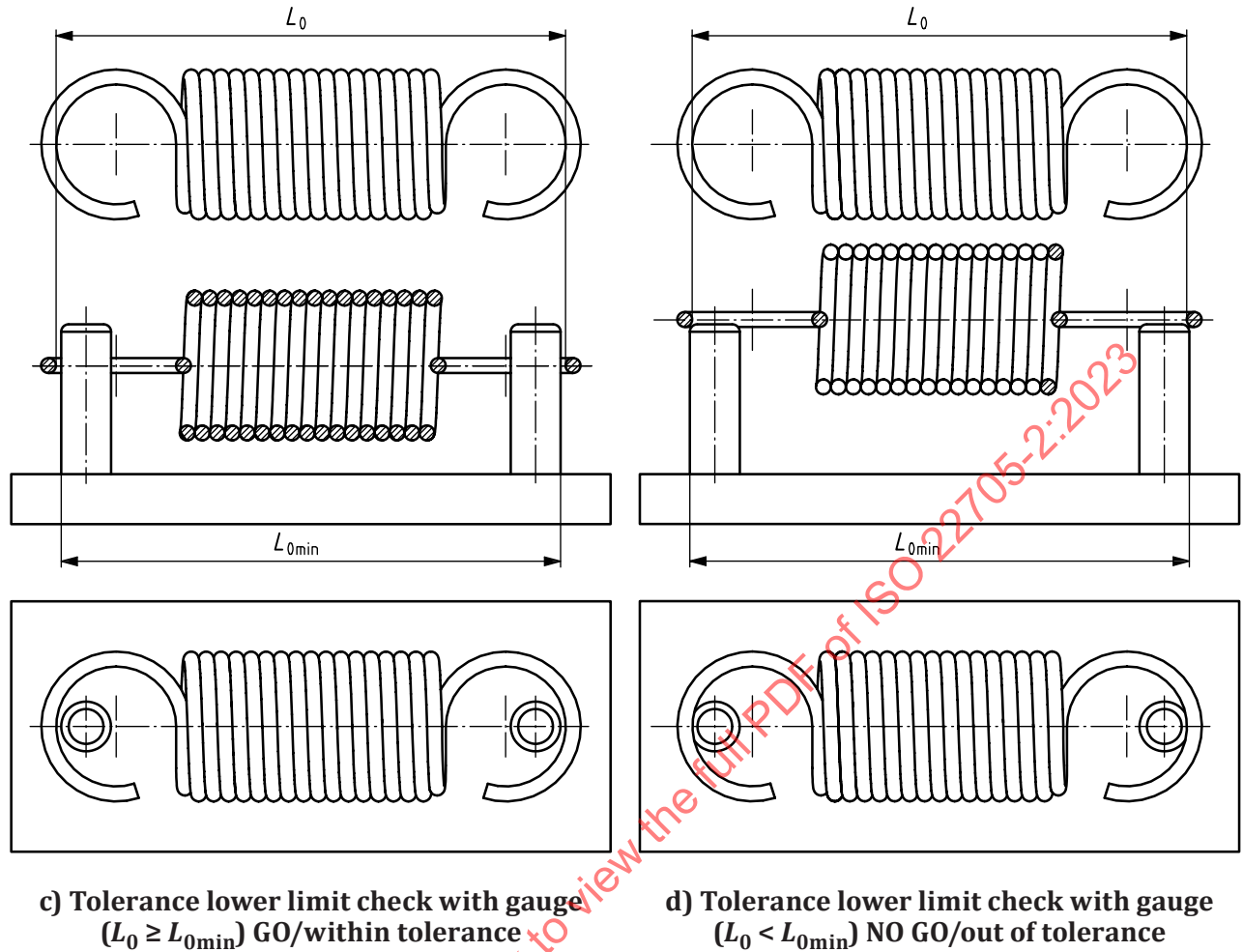


Figure 4 — Method of testing the free length (L_0) with gauges (examples)

8.1.6 Test location on the product

The test direction is in the axial direction of 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 Body length (L_B)

8.2.1 General

The body length L_B is a measurement and test parameter.

8.2.2 Type of characteristic

The body length L_B is the maximum overall length of the entire spring body (excluding hooks), measured perpendicular to the axis of the spring when no load is applied (see [Figure 5](#)).

Where it is not possible to measure the L_B the following formula is applied: $L_B = L_0 - L_{H1} - L_{H2}$

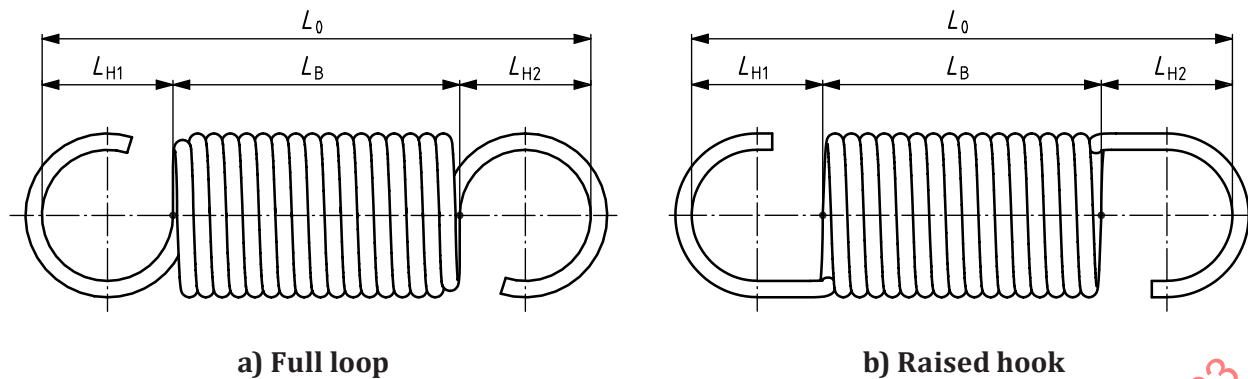


Figure 5 — Body length (L_B)

8.2.3 Measuring and/or testing equipment

The following measuring equipment can be used:

- calliper;
- electronic measuring sensor;
- optical measuring instruments / profile projector / measurement microscope / camera systems;

The following testing equipment can be used:

- attributive gauges (GO/NO GO gauges)

8.2.4 Conditions of measurement and testing

The body length L_B shall be evaluated at ambient temperature as delivered.

8.2.5 Method of measurement and testing

The measurement can be carried out without contact using optical procedures, capacitive or electrically by contact (with minimal force) without deflection or by contact with the measuring surfaces (at a known/unknown measuring force) see [Figure 6](#).

When there is a spring self-weight effect, the measurement of body length should be carried out in horizontal position on an appropriate flat surface.

GO/NO GO gauges can be used as shown in [Figure 7](#).

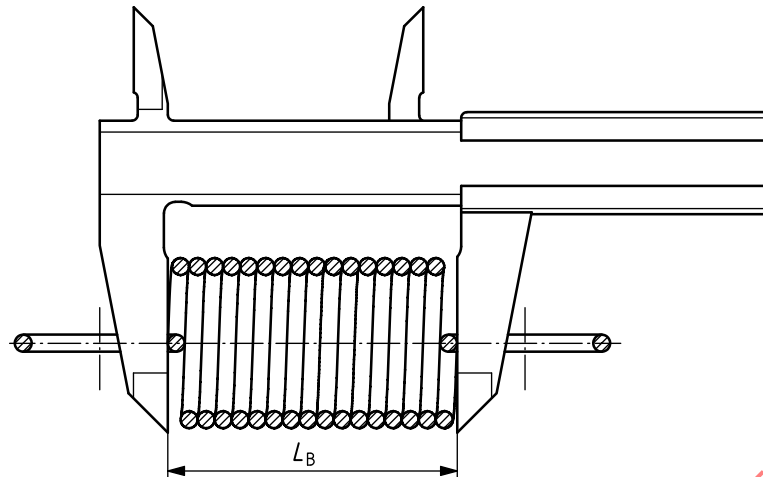
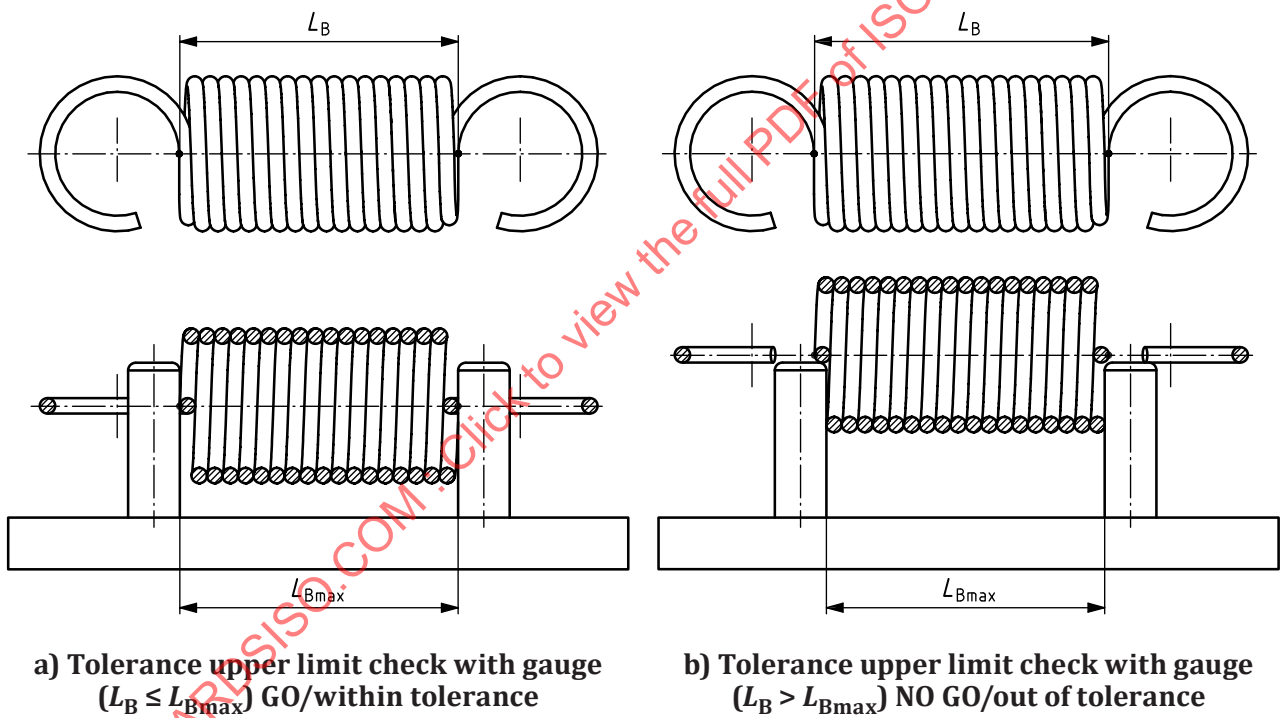


Figure 6 — Method of measurement of body length (L_B) with calliper



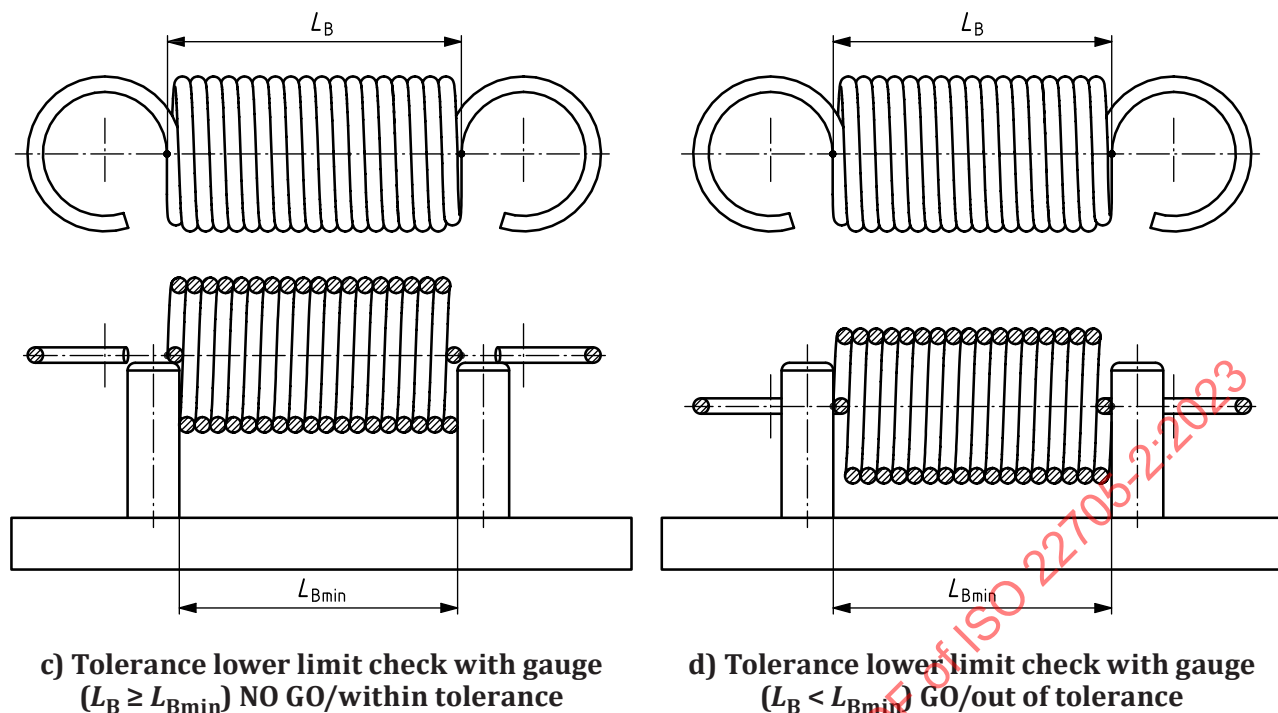


Figure 7 — Method of testing of body length (L_B) with gauges (example)

8.2.6 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.

8.3 Spring hook length (L_H)

8.3.1 General

The spring hook length L_H is a measurement and test parameter.

8.3.2 Type of characteristic

The spring hook length L_H is the length between the internal hook and the last coil parallel to the spring axis measured along the spring axis when no load is applied (see [Figure 8](#)). The hook length may be different in each hook of the spring (different hooks).

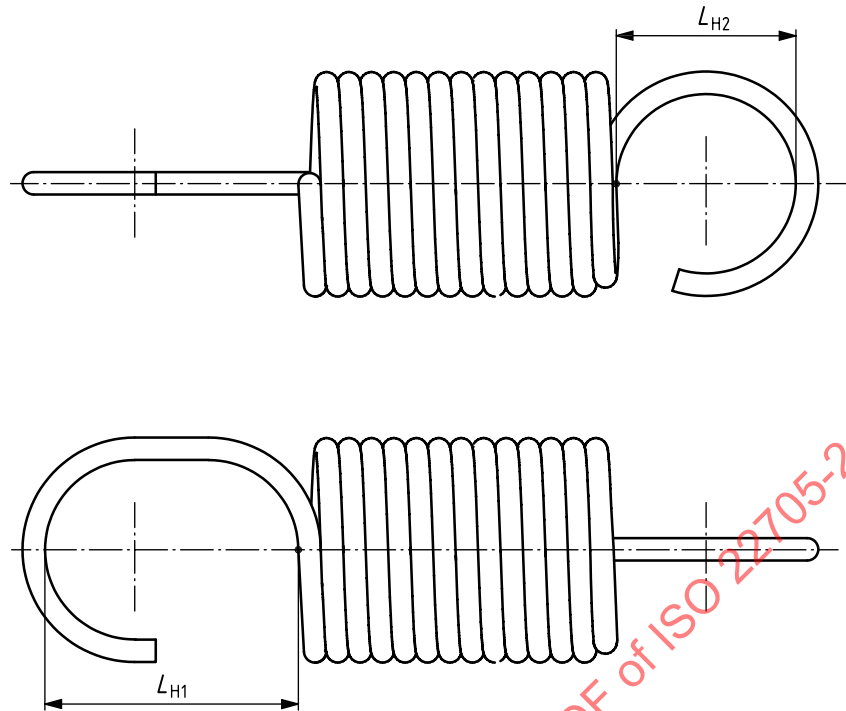


Figure 8 — Spring hook length (L_H)

8.3.3 Measuring and/or testing equipment

The following measuring equipment can be used:

- calliper;
- electronic measuring sensor;
- optical measuring instruments/measurement microscope/camera systems;

The following testing equipment can be used:

- attributive gauges (GO/NO GO gauges)

8.3.4 Conditions of measurement and testing

The spring hook length L_H shall be evaluated at ambient temperature as delivered.

8.3.5 Method of measurement and testing

The measurement should be made on the side where the body is closest to the hook, without contact using optical procedures, capacitive or electrically by contact (without a hook/loop deflection/deformation) or by contact with the measuring surfaces (at a known/unknown measuring force).

Calliper: measurements are taken with the inner measuring legs of the calliper from the highest point of the loop – inner edge perpendicular to the spring body. The measurement is made on the side higher by the pitch (see [Figure 9](#)).

GO/NO GO gauges can be used as shown in [Figure 10](#).

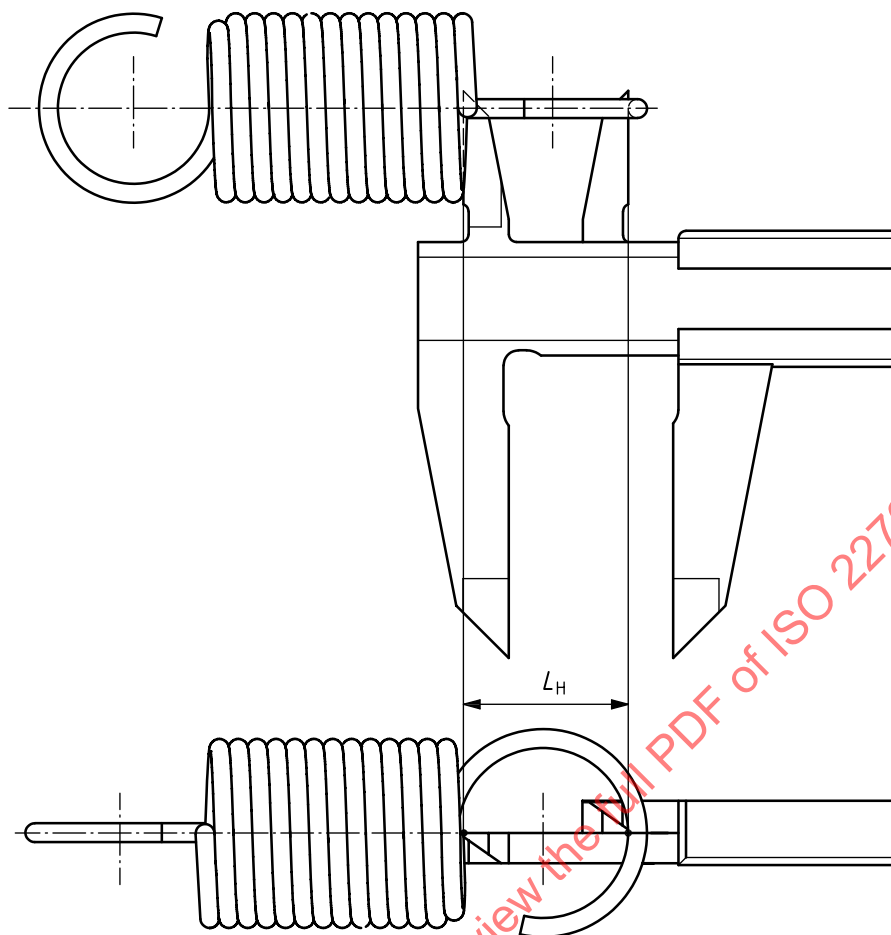
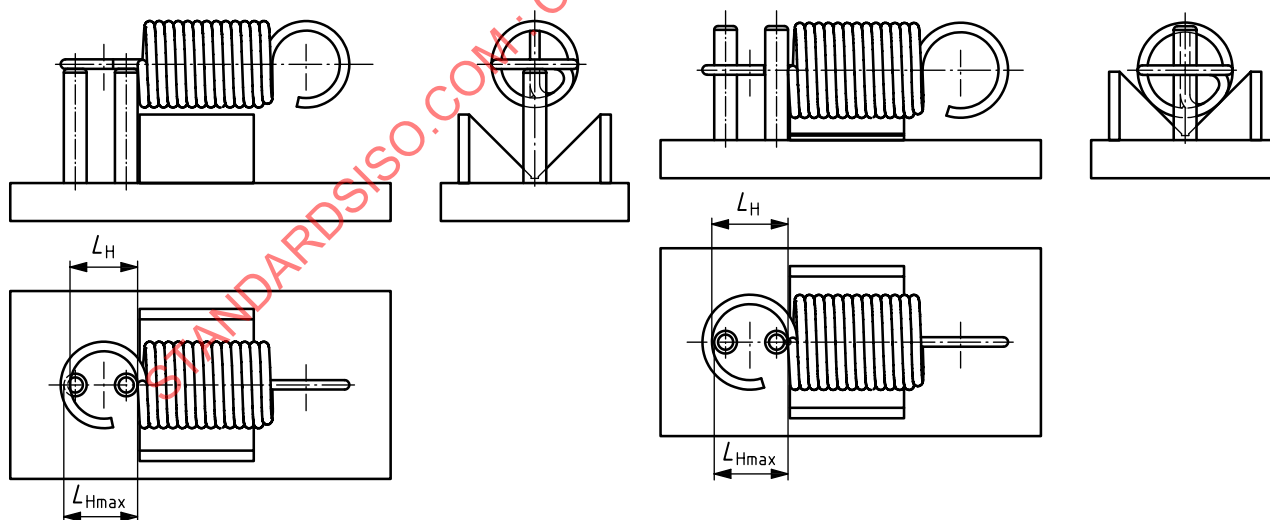
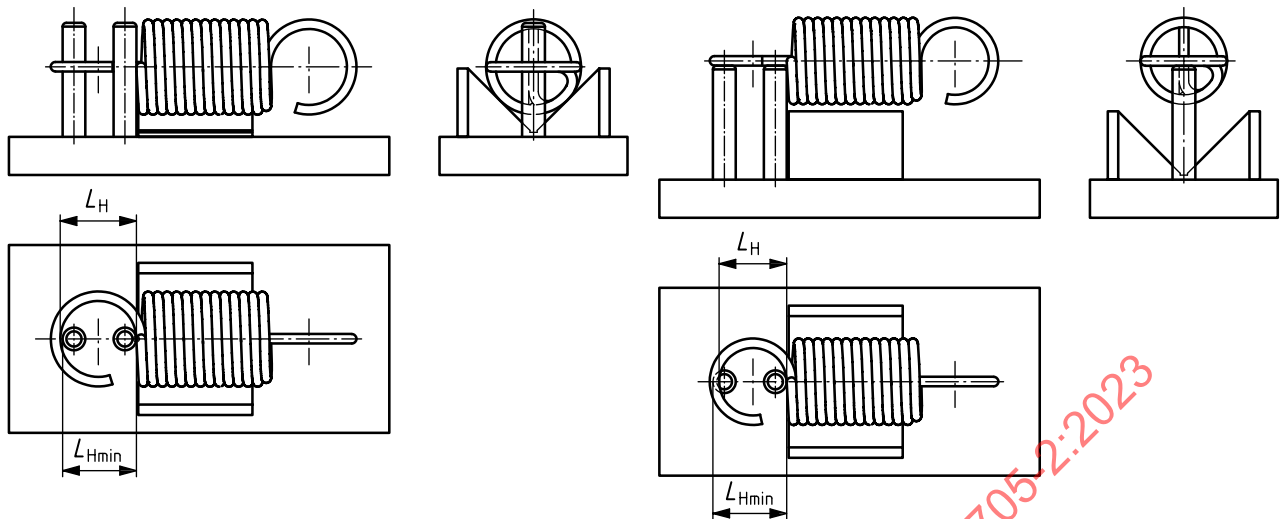


Figure 9 — Method of measurement the spring hook length L_H with calliper (example)



a) Tolerance upper limit check with gauge,
($L_H \leq L_{Hmax}$) (NO GO/within tolerance)

b) Tolerance upper limit check with gauge,
($L_H > L_{Hmax}$) (GO/ out of tolerance)



c) Tolerance lower limit check with gauge ($L_H \geq L_{Hmin}$) (GO/within tolerance)

d) Tolerance lower limit check with gauge ($L_H < L_{Hmin}$) (NO GO/out of tolerance)

Figure 10 — Method of testing the spring hook length L_H with gauges (examples)

8.3.6 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.

8.4 Hook opening (m)

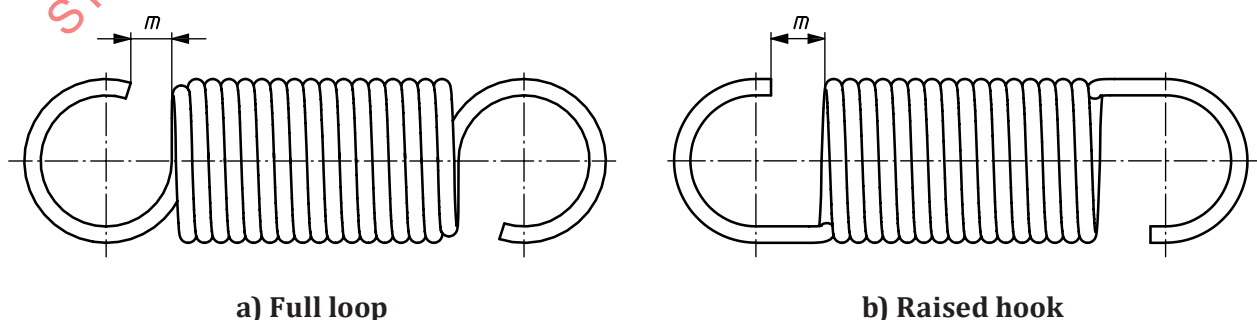
8.4.1 General

The hook opening m is a measurement and test parameter.

8.4.2 Type of characteristic

The hook opening m is taken perpendicular to the body axis from the end of the hook and the body when no load is applied (see Figure 11).

The hook opening may be different in each hook of the spring (m).



a) Full loop

b) Raised hook

Figure 11 — Hook opening (m)

8.4.3 Measuring and/or testing equipment

The following measuring equipment can be used:

- calliper;
- electronic measuring sensor;
- optical measuring instruments/ profile projector/measurement microscope/camera systems;

The following testing equipment can be used:

- attributive gauges (GO/NO GO gauges)

8.4.4 Conditions of measurement and testing

The hook opening m shall be evaluated at ambient temperature as delivered.

8.4.5 Method of measurement and testing

The measurement can be carried out without contact using optical procedures, capacitively or electrically by contact (with minimal force) or by contact with the measuring surfaces (at a known/unknown measuring force) (see [Figure 12](#)).

GO/NO GO gauges can be used as shown in [Figure 13](#).

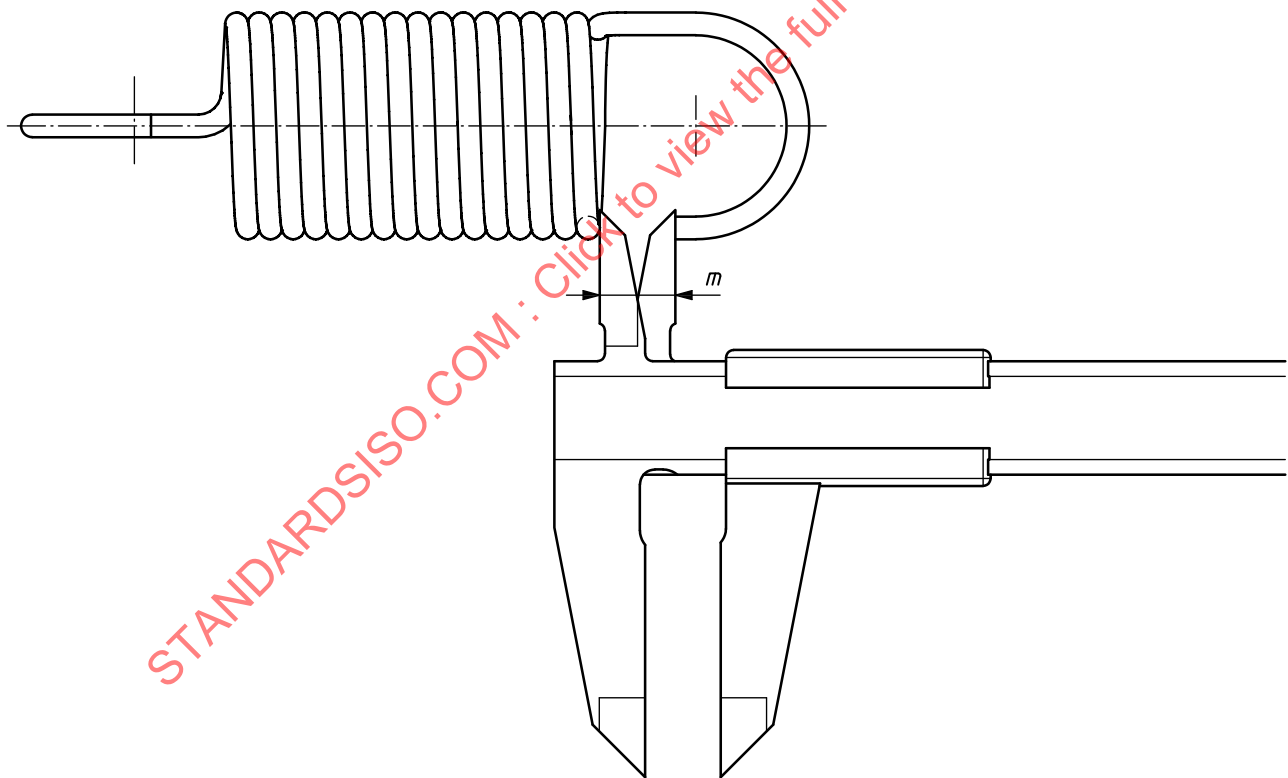


Figure 12 — Method of measurement of hook opening (m) with calliper (example)

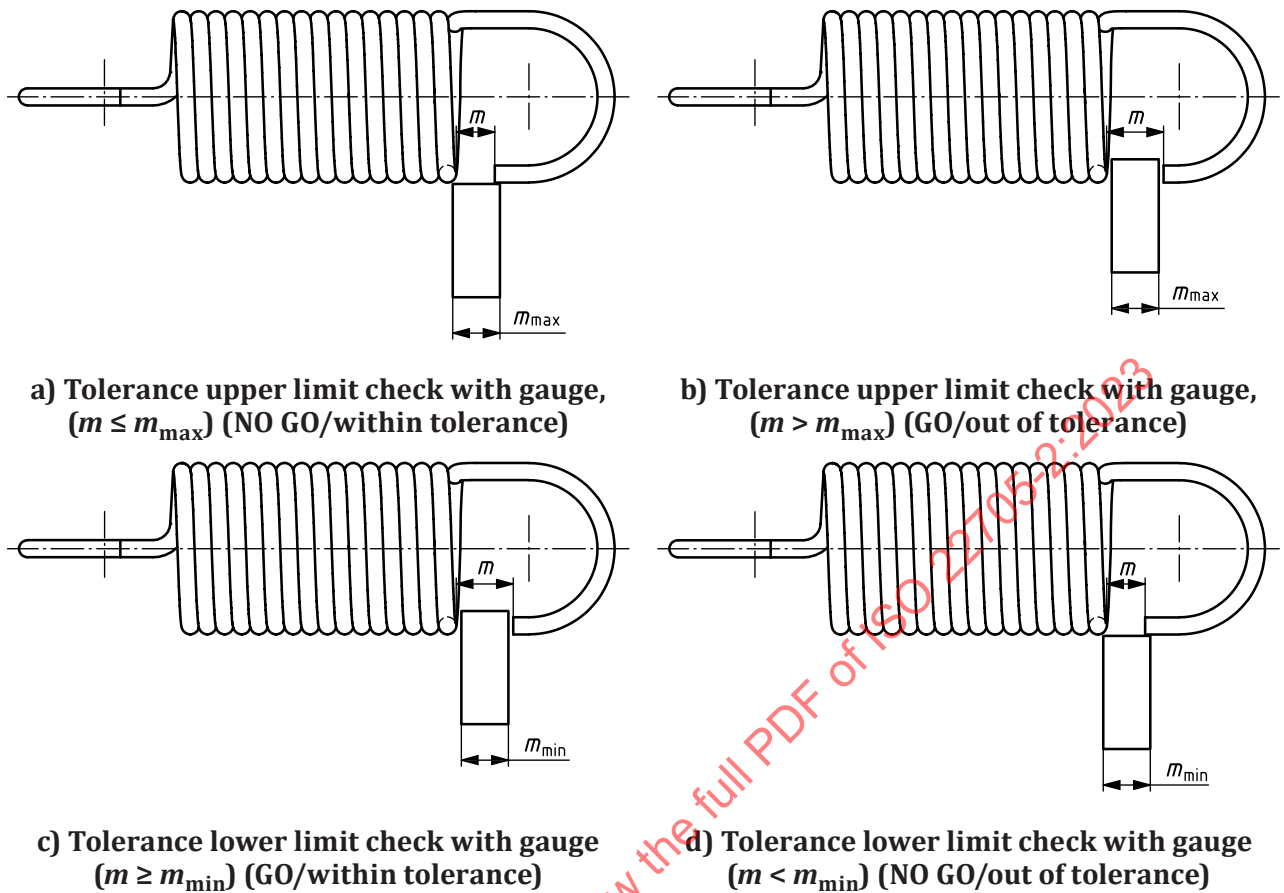


Figure 13 — Method of testing of hook opening (m) with gauges (examples)

8.4.6 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.

8.5 Outside diameter (D_e)

8.5.1 General

The outside diameter D_e is a measurement and test parameter.

8.5.2 Type of characteristic

The outside diameter D_e is the value of the outside diameter through the whole spring body (see [Figure 14](#)).

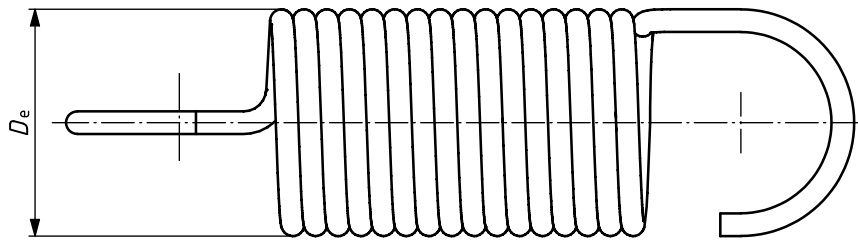


Figure 14 — Outside diameter (D_e)

8.5.3 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.

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.

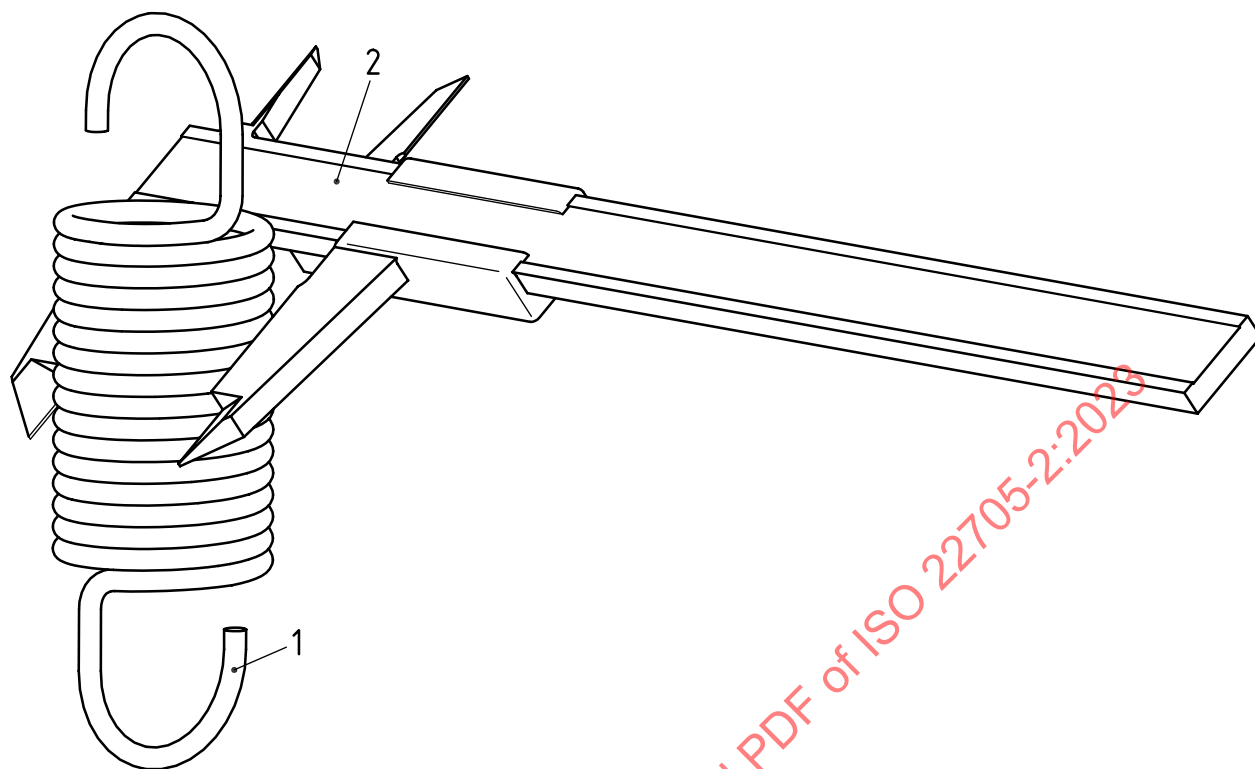
8.5.4 Conditions of measurement and testing

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

8.5.5 Method of measurement and testing

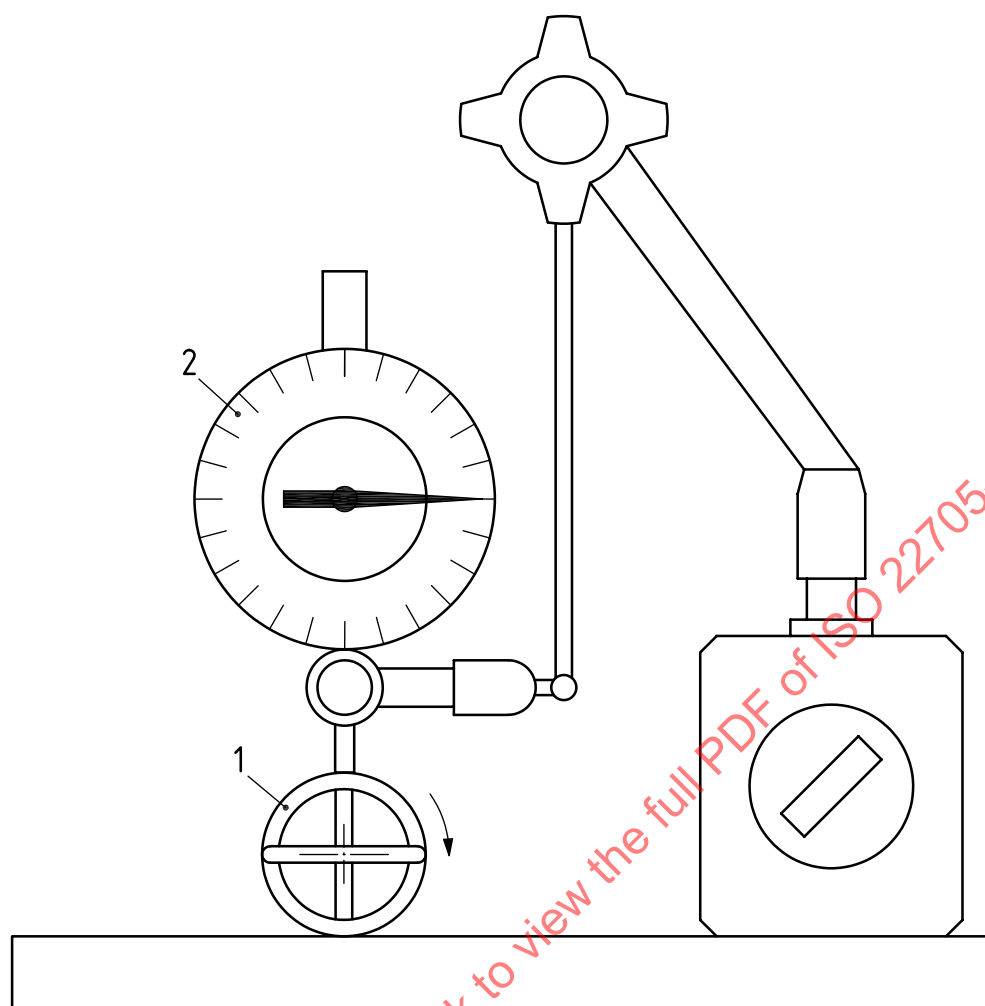
- a) Variable measurement (e.g. calliper).

The measurements are performed at several locations on the product, at least at the beginning, in the centre (Figure 15 and Figure 16) and at the end of the spring. The measurements at the end is performed in two perpendicular directions of the spring, except if calliper jaws useful length is greater than body length of spring. Each measured value shall be within the tolerance. The maximum value shall be documented.

**Key**

- 1 spring
- 2 calliper

Figure 15 — Method of measurement of outside diameter (D_e) with calliper (example)



Key

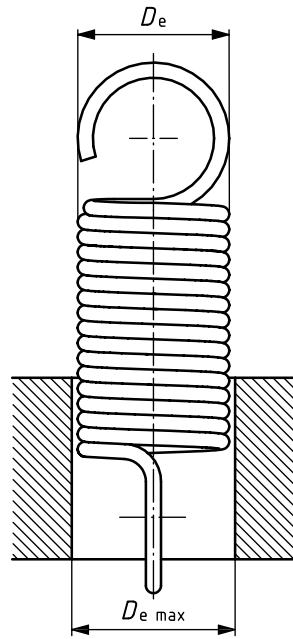
- 1 spring
- 2 dial gauge

Figure 16 — Method of measurement of outside diameter (D_e) with dial gauge (example)

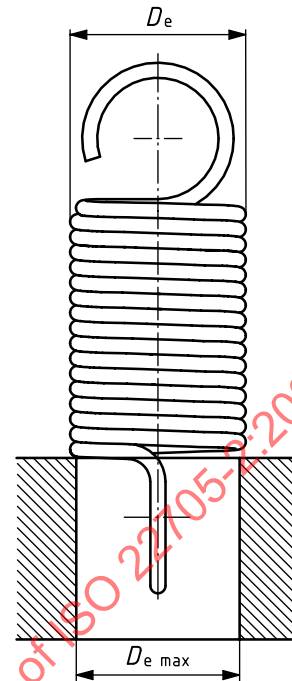
b) **Attributive testing** (with test sleeve as GO/NO GO gauge see [Figure 17](#)).

The spring shall fall through the test sleeve due to its own weight at $D_{e,max}$.

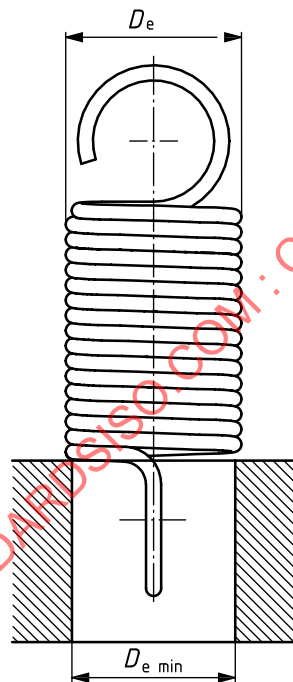
The spring shall not fall through the test sleeve due to its own weight at $D_{e,min}$.



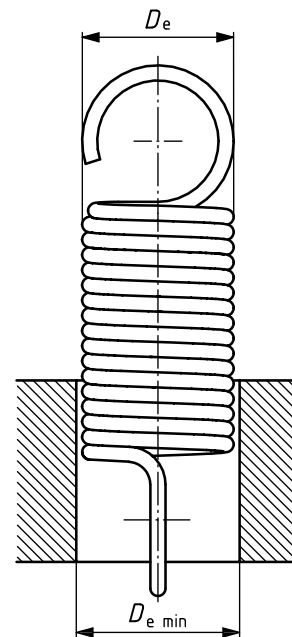
a) Tolerance upper limit check with gauge
($D_e \leq D_{e,max}$) (GO/within tolerance)



b) Tolerance upper limit check with gauge
($D_e > D_{e,max}$) (NO GO/out of tolerance)



c) Tolerance lower limit check with gauge
($D_e \geq D_{e,min}$) (NO GO/within tolerance)



d) Tolerance lower limit check with gauge
($D_e < D_{e,min}$) (GO/out of tolerance)

Figure 17 — Method of testing of outside diameter (D_e) with test sleeve (example)

8.5.6 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. The characteristic shall be evaluated at ambient temperature as delivered and not under load.

b) Attributive testing (e.g. good/bad/test sleeve, only for cylindrical springs)

The test is carried out over the entire length of the spring. For the purpose of testing geometrical deviations (enveloping circle, curvature), a test sleeve with the length and diameter for cylindrical springs can be agreed upon between the manufacturer and the customer.

8.6 Inside diameter (D_i)

8.6.1 General

The inside diameter D_i is a measurement and test parameter.

8.6.2 Type of characteristic

D_i is the minimum value of the inside diameter through the whole spring body applicable just to extension springs excluding the hooks (see [Figure 18](#)).

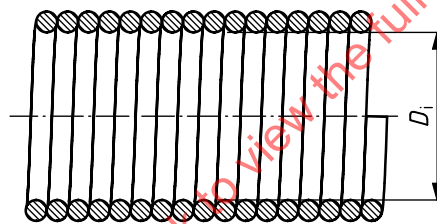


Figure 18 — Inside diameter (D_i)

8.6.3 Measuring and/or testing equipment

The following measuring equipment can be used:

- calliper.

Alternatively, micrometre screws 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.

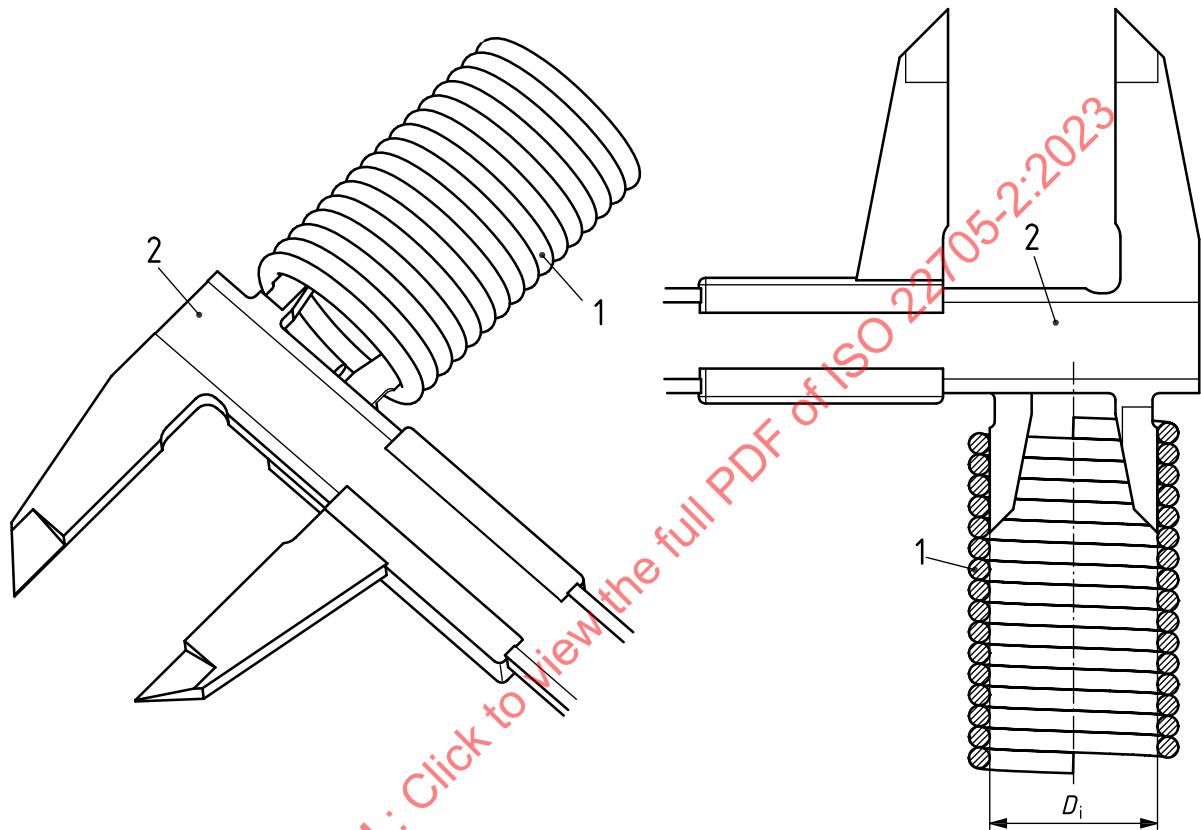
8.6.4 Conditions of measurement and testing

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

8.6.5 Method of measurement and testing

a) Variable measurement (e.g. calliper – see [Figure 19](#))

Two measurements per end (in two perpendicular direction per end) of spring, except if calliper jaws useful length is greater than body length of spring (in this case, only two measurements in perpendicular directions). Each measured value shall be within the tolerance. The minimum value shall be documented.



Key

- 1 spring
- 2 calliper

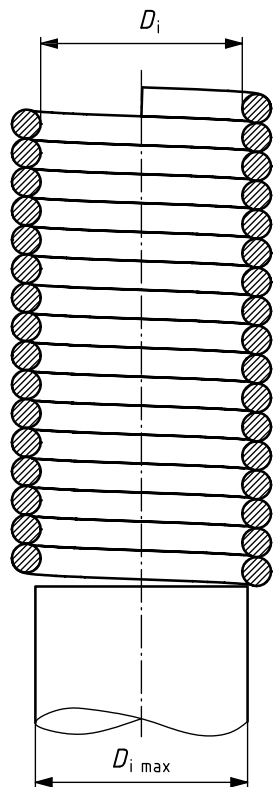
Figure 19 Method of measurement of inside diameter (D_i) with calliper (example)

b) Attribute testing (GO/NO GO on test pin, see [Figure 20](#))

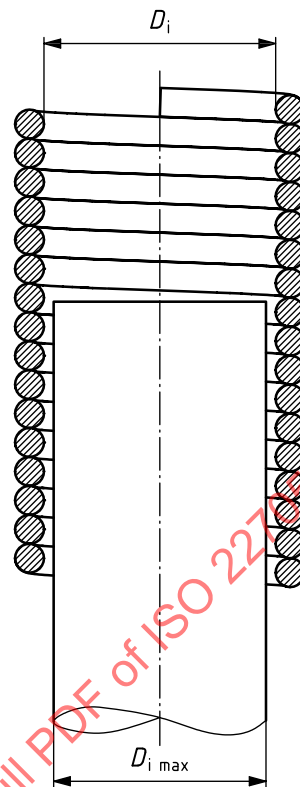
The spring shall fall over the test pin due to its own weight at $D_{i,min}$.

The spring shall not fall over the test pin due to its own weight at $D_{i,max}$.

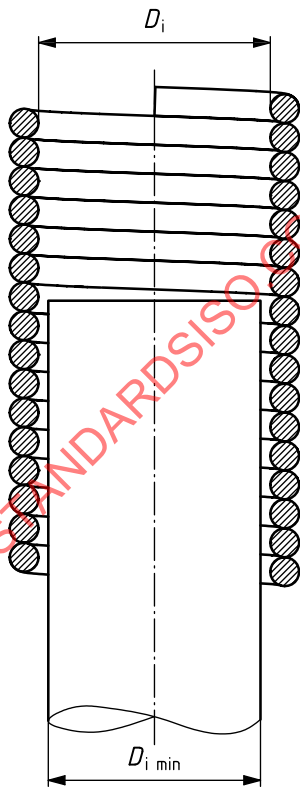
Both of the above mentioned criteria shall be met, regardless of which side of the spring is attached to the test pin.



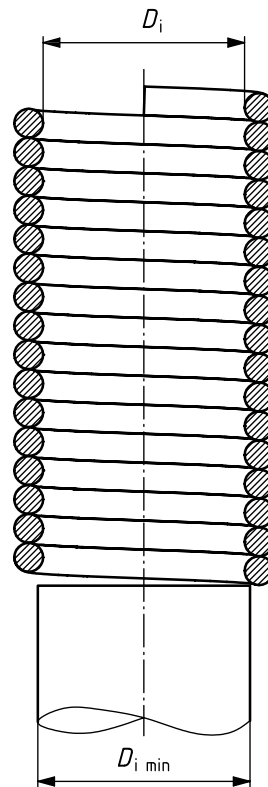
a) Tolerance upper limit check with test pin
($D_i \leq D_{i\max}$) (NO GO/within tolerance)



b) Tolerance upper limit check with test pin
($D_i > D_{i\max}$) (GO/out of tolerance)



c) Tolerance lower limit check with test pin
($D_i \geq D_{i\min}$) (GO/within tolerance)



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

Figure 20 — Method of testing of inside diameter (D_i) with test pin (example)

8.6.6 Test location on the product

a) Variable measurement

Where the spring has the hooks the measurement is carried out on the outside diameter and the value can be calculate by the following formula

$$D_i = D_e - 2 \times d_{\text{wire}}$$

b) Additive gauges (GO, NO GO-gauges)

The test is carried out over the entire length of the spring (L_0) if the spring have no hooks.

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

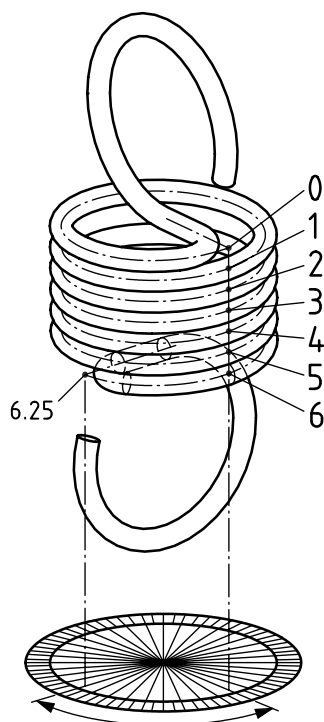
8.7 Total number of coils (n_t), number of active coils (n) and coil direction

8.7.1 General

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

8.7.2 Type of characteristic

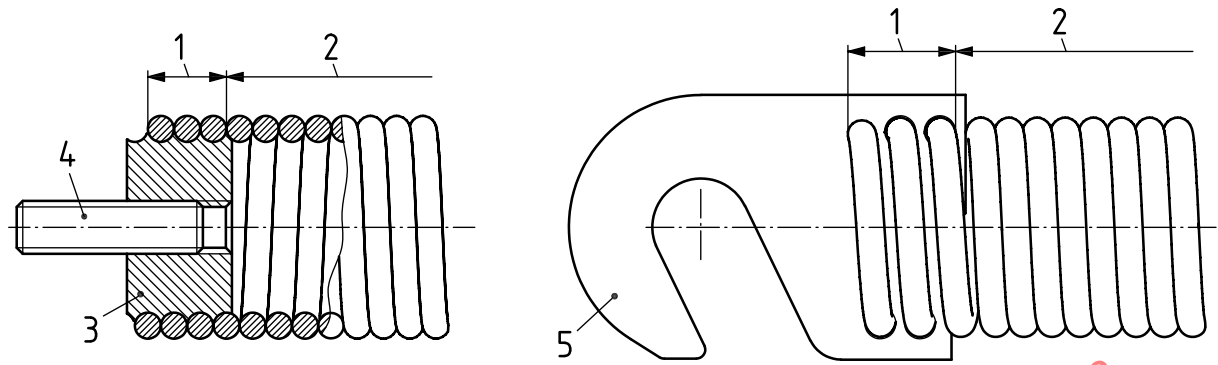
Total number of coils (n_t) is the number of wire rotations/coils around the spring axis (see [Figure 21](#)).

**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
- 6,25 total coils

Figure 21 — Total number of coils (n_t)

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 22](#)).

**Key**

- 1 inactive coils
- 2 active coils
- 3 threaded plug
- 4 screw
- 5 hook plate

NOTE Inactive coils are blocked by the plug/hook plate so that they do not work

Figure 22 — Number of active coils (n)

8.7.3 Measuring and/or testing equipment

The following test equipment can be used:

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

8.7.4 Conditions of measurement and testing

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

8.7.5 Method of measurement and testing

All tests are carried out on the unloaded spring.

The wire coil rotations shall be counted from one end of the wire (spring body end) to the other. The winding direction can be clockwise (right-handed, see [Figure 23a](#)) or counterclockwise (left-handed, see [Figure 23b](#)).

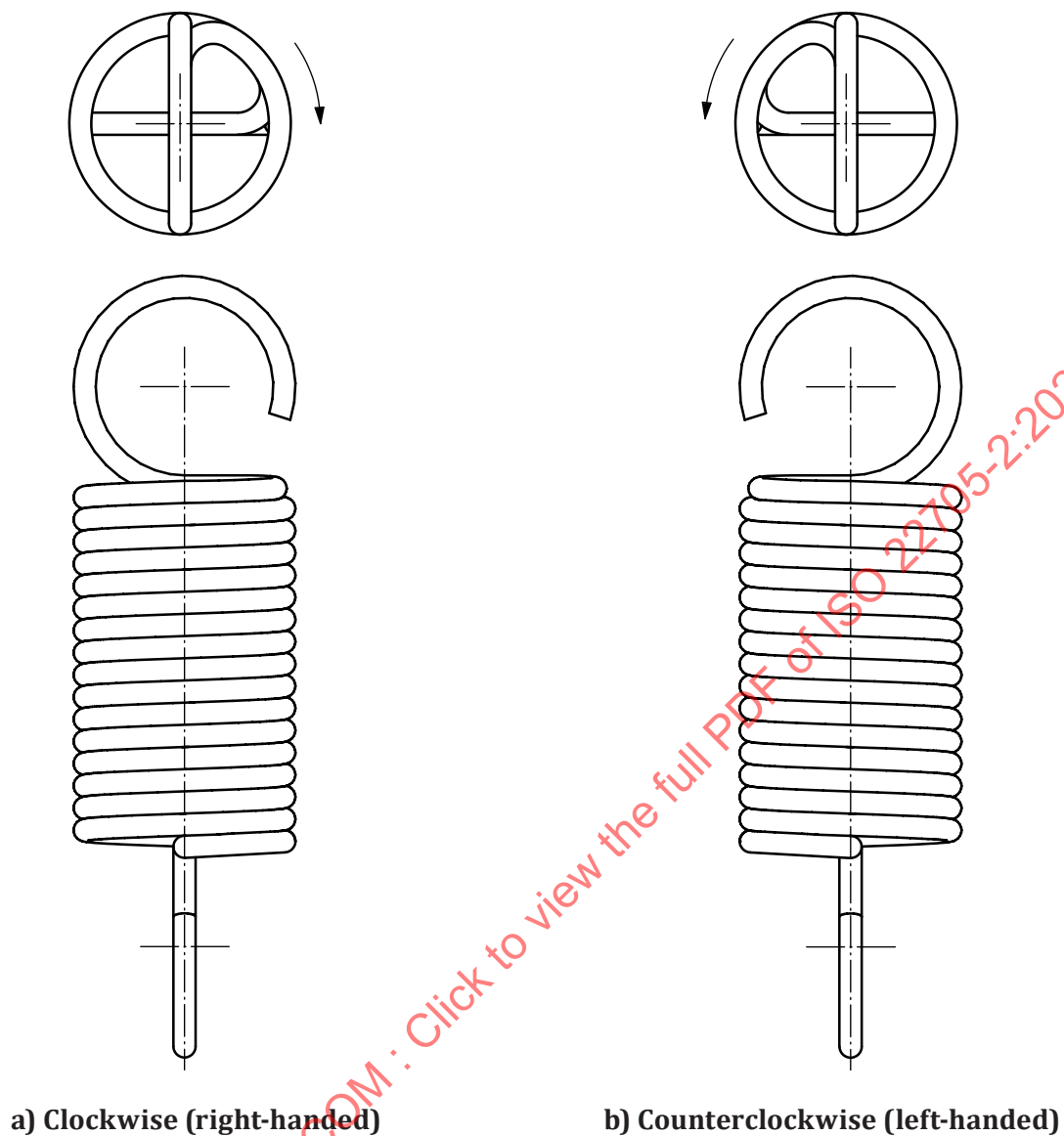


Figure 23 — Coil direction

8.7.6 Test location on the product

The entire spring body shall be considered.

8.8 Bending radius (r)

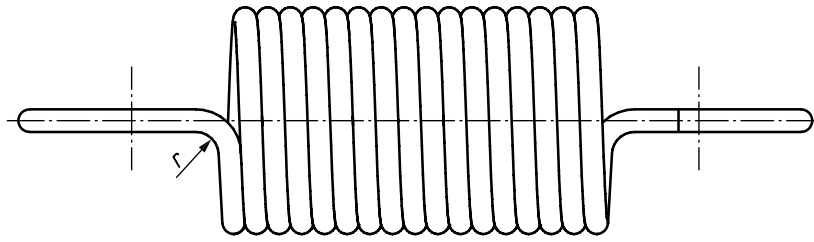
8.8.1 General

The bending radius r is a test parameter.

8.8.2 Type of characteristic

The bending radius r is the inside radius that connect the spring body with spring hooks (see [Figure 24](#)).

The value of r can be different at each end of the spring.

Figure 24 — Bending radius (r)

8.8.3 Measuring and/or testing equipment

The following testing equipment can be used:

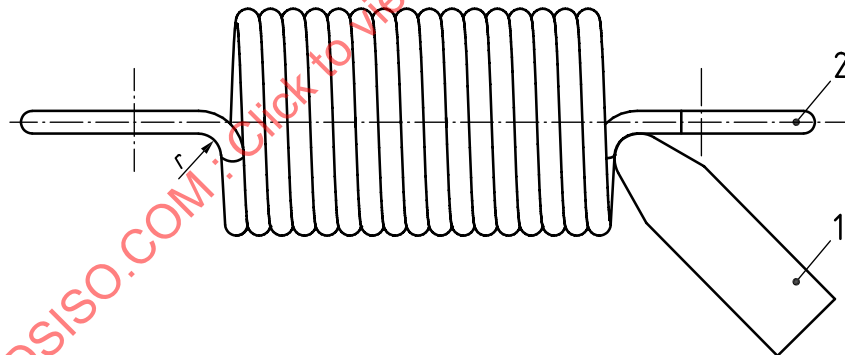
- visual inspection (e.g. radius gauge);
- optical test;
- optical measuring instruments/ profile projector/measurement microscope/camera systems.

8.8.4 Conditions of measurement and testing

The bending radius r shall be evaluated at ambient temperature as delivered.

8.8.5 Method of measurement and testing

The test is carried out on the unloaded spring (see [Figure 25](#)).



Key

- 1 gauge
- 2 spring

Figure 25 — Method of testing of radius (r) with radius gauge(example)

8.8.6 Test location on the product

When optical measuring equipment (camera system) is used, the test direction is in the axial direction to the finished spring. When using pin type radius gauges, the pins are applied perpendicular to the wire axis.

8.9 Spring load (F)

8.9.1 General

The spring load F is a measurement and test parameter.

8.9.2 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 to the assigned deflections $s_1, s_2, \dots$ (see [Figure 26](#)).

The spring load is an axial force in the direction of extension.

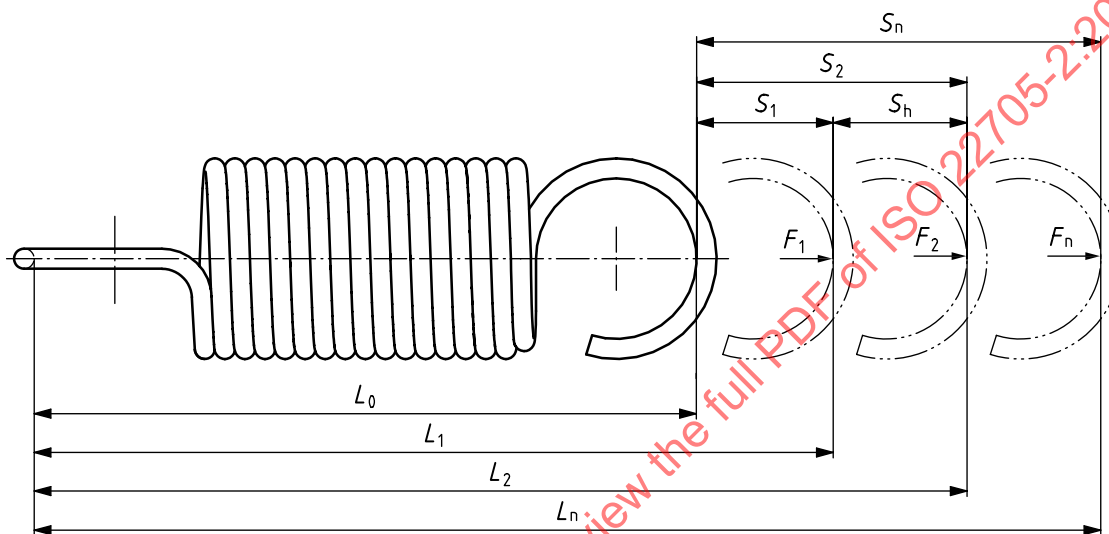


Figure 26 — Spring load (F)

8.9.3 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:

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

8.9.4 Conditions of measurement and testing

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

8.9.5 Method of measurement and testing

Extension springs shall be measured under force between two points in axis first at $L_{\max}(F_{\max})$ where $L_{\max}(F_{\max})$ is the maximum requested length/force required on the drawing, then unloaded to a length between L_0 and L_1 and then measured by increasing lengths from $L_1(F_1)$ to $L_{\max}(F_{\max})$ (see [figure 27](#)). Most extension springs are not preset, because preset reduces the initial tension force. If the customer specifies a setting length before the spring test, the setting condition before the spring test shall be agreed upon between the manufacturer and the customer. In this case, standard testing procedure shall

include a first step with extension up to setting length, followed by release back to L_0 , unless individual setting is made before for all the spring batch.

If other conditions are requested by the customer or the manufacturer, they shall be agreed upon between the manufacturer and the customer (e.g. measuring by increasing without stabilization or decreasing lengths / loads).

Geometries of guiding and supporting devices shall possibly be agreed upon between the manufacturer and the customer to include special cases.

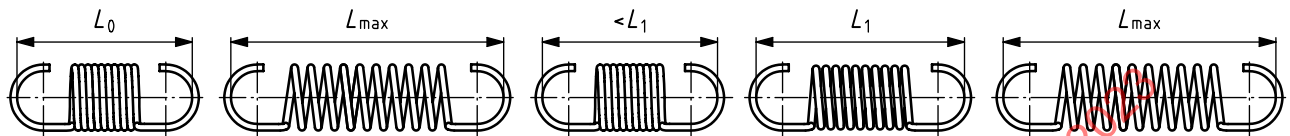


Figure 27 — Method of testing of spring load (F)

8.9.6 Test location on the product

The entire spring shall be considered.

8.10 Spring pitch (p) / distance between the coils (u)

8.10.1 General

The distance between two consecutive coils in the direction of the spring axis is (u).

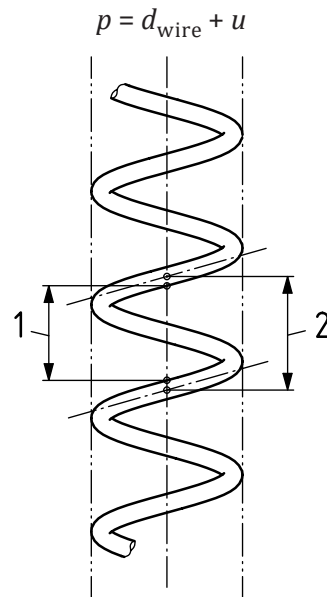
The spring pitch (p) can be calculated with the distance between coils and the diameter of the wire (d wire)

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

8.10.2 Type of characteristic

The distance between two consecutive coils in the direction of the spring axis is (u) see [Figure 28](#).

The spring pitch (p) can be calculated with the distance between coils and the diameter of the wire (d wire):



Key

- 1 distance between coils (u)
- 2 spring pitch (p)

Figure 28 — Difference between spring pitch (p) and distance between the coils (u)

8.10.3 Measuring and/or testing equipment

The following indirect measuring equipment can be used:

- calliper (with the corresponding dimension);
- optical measuring instruments;
- sample rod;
- feeler gauge.

8.10.4 Conditions of measurement and testing

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

8.10.5 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.

8.10.6 Test location on the product

The test location is to be defined between the manufacturer and the customer because there may be different distances between coils at different locations in the spring.

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