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Meters for irrigation water

Compteurs pour l'eau d'irrigation

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Foreword

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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).

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

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 23, *Tractors and machinery for agriculture and forestry*, Subcommittee SC 18, *Irrigation and drainage equipment and systems*.

Meters for irrigation water

1 Scope

This International Standard applies to water meters intended for irrigation use (herein after referred to as water meters), regardless of the water quality used for this purpose, and specifies the requirements and certification procedures for water meters, irrespective of the design technologies used to meter the actual volume of cold water or heated water flowing through a fully charged closed conduit. These water meters incorporate devices which indicate the integrated volume.

This International Standard also applies to water meters based on electrical or electronic principles and to water meters based on mechanical principles, incorporating electronic devices used to meter the actual volume flow of cold water. It provides metrological requirements for electronic ancillary devices when they are subject to metrological control. As a rule, the ancillary devices are optional. However national or international regulations make some ancillary devices mandatory in relation to the utilization of the water meter.

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.

ISO 4064-1:2005, *Measurement of water flow in fully charged closed conduits — Meters for cold potable water and hot water — Part 1: Specifications*

ISO 4064-2:2005, *Measurement of water flow in fully charged closed conduits — Meters for cold potable water and hot water — Part 2: Installation requirements*

ISO 9644, *Agricultural irrigation equipment — Pressure losses in irrigation valves — Test method*

ISO 286-2, *Geometrical product specifications (GPS) — ISO code system for tolerances on linear sizes — Part 2: Tables of standard tolerance classes and limit deviations for holes and shafts*

ISO 228-1, *Pipe threads where pressure-tight joints are not made on the threads — Part 1: Dimensions, tolerances and designation*

ISO/IEC Guide 98-3, *Uncertainty of measurement — Part 3: Guide to the expression of uncertainty in measurement (GUM:1995)*

3 Terms and definitions

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

3.1
water meter
instrument intended to measure continuously, store, and display the volume of water passing through the measurement transducer at metering conditions

Note 1 to entry: A water meter includes at least a measurement transducer, a calculator (including adjustment or correction devices, if present), and an indicating device. These three devices may be in different housings.

[SOURCE: OIML R49-1:2006, 2.1.1, modified — The second note is not included here.]

3.2
indicating device
part of the meter that provides an indication corresponding to the volume of water passing through the meter

3.3
actual volume
V_a
total volume of water passing through the meter

Note 1 to entry: The actual volume is calculated from a reference volume as determined by a suitable measurement standard taking into account differences in metering conditions, as appropriate.

[SOURCE: OIML R49-1:2006, 2.2.1, modified — The phrases "disregarding the time taken" and "This is the measurand" have been removed from the definition.]

3.4
indicated volume
V_i
volume of water indicated by the meter, corresponding to the actual volume

[SOURCE: OIML R49-1:2006]

3.5
flow rate
Q
volume of water flowing through a device per unit time

3.6
minimum flow rate
Q_1
lowest flow rate at which the meter is required to operate within the maximum permissible error

3.7
transitional flow rate
Q_2
flow rate between the permanent flow rate ≥ 100 ≥ 10 and the minimum flow rate ≥5 that divides the flow rate range into two zones, the "upper zone" and the "lower zone", each characterized by its own maximum permissible error

3.8
permanent flow rate
Q_3
highest flow rate under normal service conditions at which the meter is required to operate in a satisfactory manner within the maximum permissible error

3.9
overload flow rate
Q_4
highest flow rate at which the water meter is designed to operate for a short period of time within its maximum permissible error, whilst maintaining its metrological performance when it is subsequently operated under normal service conditions

3.10
test flow rate
mean flow rate during a test, calculated from the indications of a calibrated reference device

3.11
error
measured quantity value minus a reference quantity value

$$\frac{V_\mathrm{i} - V_\mathrm{a}}{V_\mathrm{a}} \times 100\,(\%)$$

3.12
maximum permissible error
MPE
extreme value of error permitted by this International Standard

3.13
working pressure
P_w
average water pressure in the pipe measured upstream of the meter

3.14
durability
ability of a meter to maintain its performance characteristics over a period of use

3.15
metering conditions
conditions of the water, the volume of which is to be measured, at the point of measurement

EXAMPLE Water temperature, water pressure.

3.16
maximum admissible pressure
MAP
maximum internal pressure that the meter can withstand permanently, within its rated operating conditions, without deterioration of its metrological performance

Note 1 to entry: MAP is equivalent to Nominal Pressure (PN).

3.17
working temperature
T_w
average water temperature in the pipe, measured upstream and downstream of a water meter

[SOURCE: OIML R49-1:2006]

3.18
minimum and maximum admissible temperature
mAT, MAT
minimum and maximum water temperatures that a meter can withstand permanently, within its rated operating conditions, without deterioration of its metrological performance

Note 1 to entry: mAT and MAT are respectively the lower and upper of the rated operating conditions (ROC).

[SOURCE: OIML R49-1:2006, 2.3.7]

3.19
pressure loss
difference in pressure due to water flow between two specified points in a system or in part of a system

3.20
limiting condition
extreme condition that a meter is required to withstand without damage, and without degradation of its specified metrological properties, when it is subsequently operated under its rated operating conditions

3.21
nominal diameter
DN
numerical designation used to indicate the size of a gated pipe approximately equal to the outside diameter of the pipe

3.22
influence variable
quantity that, in a direct measurement, does not affect the quantity that is actually measured, but affects the relation between the indication and the measurement result

3.23
influence factor
influence variable having a value within the rated operating conditions specified for a water meter

3.24
rated operating condition
ROC
operating condition that must be fulfilled during measurement in order that a meter performs as designed

Note 1 to entry: The rated operating conditions specify intervals for the flow rate and for the influence parameters for which the errors are required to be within the maximum permissible errors.

[SOURCE: ISO/IEC Guide 99:2007, 4.9, modified — In the definition, the phrase “measuring instrument or measuring system” has been changed to “meter”. The note is different.]

3.25
reed contact unit
assembly containing contact blades, some or all of magnetic material, hermetically sealed in an envelope and controlled by means of externally generated magnetic field (e.g. a pulse generator)

3.26
measuring state
state when the switch is closed

3.27
bounce
momentary re-opening of a contact after initial closing, or a momentary closing after initial opening

3.28
bounce time
interval of time between the instant of the first closing (or opening) and the instant of the final closing (or opening) of the reed contact unit

3.29
operate position time
interval of time between the instant the reed contact unit is in the operate position and the instant of the removal of the applied magnetic field to the contact

Note 1 to entry: It includes the closing bounce time in a normally open contact or the opening bounce time in a normally closed contact.

4 Metrological characteristics

4.1 Maximum permissible error (MPE)

4.1.1 Formulation

The error is expressed as a percentage, and is equal to:

$$\varepsilon = \frac{(V_i - V_a)}{V_a} \times 100 \ (\%) \tag{1}$$

where

V_i is the indicated volume;

V_a is the actual volume.

4.1.2 Limits

The maximum permissible error, positive or negative, on volumes delivered at flow rates (Q) between the minimum flow rate (Q_1) (included) and the transitional flow rate (Q_2) (excluded) is 5 %.

The maximum permissible error, positive or negative, on volumes delivered at flow rates between the transitional flow rate (Q_2) (included) and the overload flow rate (Q_4) (included) is 2 %.

— $Q_1 \leq Q < Q_2$, MPE ≤ 5 %

— $Q_2 \leq Q \leq Q_4$, MPE ≤ 2 %

If all the errors within the measuring range of the water meter have the same sign, at least one of the errors shall be less than one half of the maximum permissible error.

When any accessory part is sold with the water meter, as for instance a control valve, the error shall be calculated for any position of the accessory, not altering the metrological characteristics of the water meter.

The maximum permissible error declared by the manufacturer is intended for any recommended installation configuration.

4.2 Metrological characteristics

4.2.1 Permanent flow rate (Q_3)

The value of Q_3, in (m^3/h), shall be chosen from the following list:

1,0	1,6	2,5	4,0	6,3
10	16	25	40	63
100	160	250	400	630
1 000	1 600	2 500	4 000	6 300

This list may be extended to higher or lower values in the series.

4.2.2 Measuring range

The measuring range for the flow rate is defined by the ratio Q_3/Q_1. The values shall be chosen from the following list:

10	12,5	16	20	25	31,5	40	50	63	80
100	125	160	200	250	315	400	500	630	800

This list may be extended to higher values in the series.

4.2.3 Relationship between permanent flow rate (Q_3) and overload flow rate (Q_4)

The overload flow rate is defined by:

$$Q_4/Q_3 = 1{,}25 \tag{2}$$

4.2.4 Relationship between transitional flow rate (Q_2) and minimum flow rate (Q_1)

The transitional flow rate is defined by:

$$Q_2/Q_1 = 1{,}6 \tag{3}$$

e.g. $Q_3 = 100$; $Q_3/Q_1 = 10$ (R10); $Q_2/Q_1 = 1{,}6$; $Q_4/Q_3 = 1{,}25$

where

Q_3 = 100 m^3/h;

Q_1 = 10 m^3/h;

Q_2 = 16 m^3/h;

Q_4 = 125 m^3/h.

5 Technical characteristics

5.1 General specifications

The water meters shall be made so that they

a) guarantee their design useful lifetime and exclude fraud possibility, and

b) fulfil the requirements of this International Standard, under rated operating conditions.

Additional specifications are the following.

— A water meter measures continuously, records and displays the integrated volume of water passing through the measurement transducer.

NOTE A water meter includes at least a measurement transducer, a calculator, and an indicating device.

— The manufacturer shall specify in the instruction manual the conditions in which the meter can operate in the event of reversal of the flow direction.

— Other ancillary functions of output and input of information (remote reading, prepayment, etc.) may be included provided they do not affect the performance of the meters as defined in this International Standard.

— The meter will preferably be designed in such a way as to present as little disturbance as possible to the water flow and any solid materials it may transport.

— The meter shall be designed such that its operation cannot be affected by a magnetic field as defined in ISO 4064-1:2005, 7.2.7.

5.2 Rated operating conditions

The rated operating conditions for a water meter shall be as follows:

a) ambient temperature range (T_{amb}): 0,1 °C ≤ T_{amb} < 50 °C;

b) pressure (P): P < MAP (maximum admissible pressure);

c) water temperature range [working temperature (T_w)]: 0,1 °C ≤ T_w < 30 °C;

d) flow rate range (Q): Q_1 (minimum flow rate) < Q ≤ Q_3 (permanent flow rate);

e) power supply voltage (mains a.c.): nominal voltage (U_{nom}) ± 5 %;

f) power supply frequency: nominal frequency (f_{nom}) ± 2 %;

g) power supply voltage (battery): a voltage, U, in the range; U_{bmin} ≤ U ≤ U_{bmax}.

5.3 Materials

The water meter shall be fabricated with materials with a resistance and stability suitable for its use.

The meter shall be fabricated using materials which are resistant to internal and external corrosion, and, if required, will be protected by the application of an appropriate surface treatment.

Water temperature variations within the working temperature range will not adversely affect the materials used.

5.4 Indicating device

5.4.1 Function

The indicating device shall always guarantee easy reading of volumes without ambiguity.

5.4.2 Unit of measurement

The indicated volume of water shall be expressed in cubic metres. The symbols m^3 shall appear on the dial or immediately adjacent to the numbered display.

5.4.3 Indicating range

This requirement is set in Table 1:

Table 1 — Indicating range

Q_3 m³/h	**Indicating range (minimum values)** m³
$Q_3 \leq 6{,}3$	9 999
$6{,}3 < Q_3 \leq 63$	99 999
$63 < Q_3 \leq 630$	999 999
$630 < Q_3 \leq 6\,300$	9 999 999

5.4.4 Colour coding for indicating devices

The colour black shall be used to indicate the cubic metre and its multiples.

The colour red shall be used to indicate sub-multiples of a cubic metre.

These colours shall be applied to the pointers, indices, numbers, wheels, discs, dials, or aperture frames.

It is allowed to use other manner of indicating the volume for electronic water meters, provided the volume is expressed in cubic metres, and there is no ambiguity in distinguishing between the primary indication and alternative displays, e.g. sub-multiples for verification and testing.

5.5 Reverse flow

For meters designed to measure reverse flow, the permanent flow rate and the measuring range may be different in each direction.

The manufacturer shall specify whether the meter is designed to measure reverse flow. If it is, the reverse flow volume shall either be subtracted from the indicated volume, or it shall be separately recorded. The maximum permissible error of 4.1.2 shall be met for forward and reverse flow.

Water meters not designed to measure reverse flow shall either prevent it or they shall be capable of withstanding an accidental reverse flow without any deterioration or change in their metrological properties for forward flow, and without modification of the cumulated volume.

5.6 Sealing and security

5.6.1 Meter security and protection against manipulations

Considerations of water meter security and protection against fraud concern only the water meter including primary indications.

5.6.2 Mechanical protection devices

Water meters shall incorporate protective devices, such as seals, that prevent the water meter from being disassembled or altered without permanently damaging the seal or the protective device.

5.6.3 Electronic sealing devices

When access to modify parameters that influence the determination of the results of measurements is not protected by mechanical sealing devices, the protection shall fulfil the provisions described in ISO 4064-1:2005, 5.8.3.

5.7 Other devices

Water meters can incorporate other devices as, for example, reed switches. In such case, the manufacturer shall ensure that the devices don't affect the metrological characteristics of the water meter and that such devices have full compatibility with the water meter.

For example, in order to ensure full compatibility between a reed contact unit and a water meter, the manufacturer can carry out the tests described in Annex A.

6 Metrological requirements

6.1 Indicating error

The water meters shall be designed so that their indicating errors do not exceed the MPE defined in 4.1.2, under rated operating conditions.

6.2 Internal pressure

The water meters shall withstand the internal pressure they are designed to, while in service, without any significant influence on the performance characteristics, leaks, exudation, or permanent deformation. This pressure value is named maximum admissible pressure.

The water meters are classified in function of the MAP declared by the manufacturer, as shown in Table 2:

Table 2 — Water pressure classes

Class	Maximum admissible pressure	
	(MPa)	(bar)
Maximum admissible pressure 6	0,6	6
Maximum admissible pressure 10	1,0	10
Maximum admissible pressure 16	1,6	16
Maximum admissible pressure 25	2,5	25
Maximum Admissible pressure 40	4,0	40

6.3 Flow profile sensitivity classes

The water meter shall be able to withstand the influence of abnormal velocity profiles as defined in the test procedures of 7.5. During the application of these flow disturbances, the error shall meet the requirements of 4.1.2.

The water meter manufacturer shall specify the flow profile sensitivity class in accordance with Tables 3 and 4, based on the results of the relevant tests specified in 7.5.

Any flow conditioning section, including straightener and/or straight pipe lengths to be used, shall be entirely defined by the manufacturer and is considered to be an auxiliary device linked to the type of the water meter examined.

Table 3 — Sensitivity to the irregularity in the upstream velocity profiles classes (U)

Class	Required straight pipe lengths (x DN)	Straightener needed
U0	0	No
U3	3	No
U5	5	No
U10	10	No
U15	15	No
U0S	0	Yes
U3S	3	Yes
U5S	5	Yes
U10S	10	Yes

Table 4 — Sensitivity to the irregularity in the downstream velocity profiles classes (D)

Class	Required straight pipe lengths (x DN)	Straightener needed
D0	0	No
D3	3	No
D5	5	No
D0S	0	Yes
D3S	3	Yes

6.4 Pressure loss

The maximum pressure loss within rated operating conditions shall not exceed 63 kPa (0,63 bar), between Q_1 and Q_3. This includes pressure loss in any filter or strainer.

The pressure loss class is selected by the manufacturer from values taken from the following table:

Table 5 — Pressure-loss classes

Class	Maximum pressure-loss	
	(KPa)	(bar)
ΔP 63	63	0,63
ΔP 40	40	0,40
ΔP 25	25	0,25
ΔP 16	16	0,16
ΔP 10	10	0,10

NOTE Maximum head loss can differ and be higher to the Q_3 corresponding head loss.

7 Performance tests

7.1 General conditions for the tests

7.1.1 Water quality

Conduct water meter tests using water from the public clean water supply or water that meets the same requirements.

Ensure that the water does not contain anything capable of damaging the water meter or adversely affecting its operation. Avoid entrapped air.

7.1.2 Reference conditions

Table 6 — Reference conditions

Condition	Admissible range
Water temperature range	4 °C to 35 °C
Working (water) pressure range	0,03 MPa to 1 MPa except DN > 500 that is 0,6 MPa
Ambient temperature range	4 °C to 35 °C
Ambient relative humidity range	35 % to 75 %
Ambient atmospheric pressure range	86 kPa to 106 kPa (0,86 bar to 1,06 bar)

7.1.3 Pressure

Ensure that the water pressure upstream of the water meter does not vary, during the test, by more than 10 %.

Ensure that the pressure at the entrance to the water meter does not exceed the maximum admissible working pressure (P_W) for the water meter.

During the test, the pressure at the water meter outlet shall be, at least, 0,03 MPa (0,3 bar).

The maximum uncertainty in the measurement of pressure (or pressure loss) shall be ± 5 % of the measured value.

The estimated uncertainty shall be made according to Reference [4] in measurement with a coverage factor, $k = 2$.

7.1.4 Flow rate

Ensure that the relative variation in the flow rate during each test (not including starting and stopping) does not exceed:

— ±2, 5 % from Q_1 to Q_2 (not inclusive);

— ±5, 0 % from Q_2 (inclusive) to Q_4.

The average flow rate value is the actual volume passed during the test divided by the time.

7.1.5 Temperature

Ensure that the temperature of the water during the test does not change by more than 5 °C.

Ensure that the maximum uncertainty in the measurement of temperature does not exceed ± 1 °C.

The estimated uncertainty shall be made according to Reference [4] in measurement with a coverage factor, k = 2.

7.2 Static pressure test

7.2.1 Object of test

To verify that the water meter can withstand the specified hydraulic test pressure for the specific time, without leakage or damage.

7.2.2 Preparation

a) Install the water meters in the test bench either individually or in groups.

b) Bleed the test bench pipe-work and the water meter of air.

c) Ensure that the test bench is free from leaks.

d) Ensure that the supply pressure is free from pressure pulsations.

7.2.3 Test procedure

a) Increase the hydraulic pressure to 1,6 times the maximum admissible pressure of the water meter and hold it for 15 min.

b) Examine the water meters for physical damage, for external leaks and for leaks into the indicating device.

c) Increase the hydraulic pressure to twice the maximum admissible pressure and hold it for 1 min. Ensure that the flow rate is zero during the test.

d) Examine the water meters for physical damage, for external leaks and for leaks into the indicating device.

Additional requirements:

e) Increase and decrease the pressure gradually without pressure surges.

7.2.4 Acceptance criteria

There shall be no leakage from the water meter or leakage into the indicating device, or physical damage, resulting from any of the pressure tests.

7.3 Determination of errors

7.3.1 Object of test

The object of the test is to verify that the water meter complies with the requirements in 4.1.2 and to determine the effects of the water meter orientation on the error.

7.3.2 Preparation

The method described here for determining the water meter errors is the so-called “collection” method, in which the quantity of water passed through the water meter is collected in one or more collecting vessels and that quantity is determined volumetrically or by weighing. Other methods may be used, provided the requirements of uncertainty are met.

The error is checked by comparing the volume indications given by the water meter under reference conditions against a calibrated reference device.

For the purpose of these tests, the water meter should be tested without its temporary supplementary devices attached (if any).

7.3.2.1 Orientation of water meter(s)

Ensure that the position of the water meter (spatial orientation) is as indicated by the manufacturer and that the meters are mounted in the test rig as appropriate.

a) If the water meters are marked “H”, mount the connecting pipework with the flow axis in the horizontal plane during the test (indicating device positioned on top).

b) If the water meters are marked “V”, mount the connecting pipework with the flow axis in the vertical plane during the test.

c) If the water meters are not marked either “H” or “V”:

   1) mount at least one water meter from the sample with the flow axis vertical, with flow direction from bottom to top;

   2) mount at least one water meter from the sample with the flow axis vertical and flow direction from top to bottom;

   3) mount at least one water meter from the sample with the flow axis at an intermediate angle to the vertical and horizontal (chosen at the discretion of the approving authority);

   4) mount the remaining water meters from the sample with the flow axis horizontal;

   5) where the water meters have an indicating device which is integral with the body of the water meter, at least one of the horizontally mounted water meters shall be oriented with the indicating device positioned at the side and the remaining water meters shall be oriented with the indicating device positioned at the top.

d) Ensure that the tolerance on the position of the flow axis for all water meters, whether horizontal, vertical or at an intermediate orientation is ±5°.

7.3.3 Test procedure

a) Determine the intrinsic errors of the water meter (in the measurement of the actual volume), for at least the following six flow rates:

   1) between Q_1 and 1,1 Q_1;

   2) between Q_2 and 1,1 Q_2;

   3) between 0,33 ($Q_2 + Q_3$) and 0,37 ($Q_2 + Q_3$);

   4) between 0,67 ($Q_2 + Q_3$) and 0,74 ($Q_2 + Q_3$);

   5) between 0,9 Q_3 and Q_3;

   6) between 0,95 Q_4 and Q_4.

b) Measure the errors at other flow rates if required, depending on the shape of the error curve;

c) Calculate the relative error for each flow rate.

7.3.4 Acceptance criteria

a) The errors observed for each of the six flow rates shall not exceed the maximum permissible errors. If the error observed for one or more meters is greater than the maximum permissible error at one flow rate only, repeat the test at that flow rate. The test shall be declared satisfactory if two out of the three results lie within the maximum permissible error and the arithmetic mean of the results for the three tests at that flow rate is less than or equal to the maximum permissible error.

b) If all the errors of the water meter have the same sign, at least one of these errors shall not exceed one half of the maximum permissible error. In all cases, this requirement shall be applied equitably with respect to the water supplier and the consumer.

c) The standard deviation for 7.3.3 a) 1), 2), and 5) shall not exceed one third of the maximum permissible error given in 4.1.2.

d) When a test is conducted, the expanded uncertainty in the determination of the actual volume passing through the water meter shall not exceed one-fifth of the applicable maximum permissible error.

NOTE The uncertainty of the measured actual volume does not include a contribution from the water meter.

The estimated uncertainty shall be made according to ISO/IEC Guide 98-3 (GUM) in measurement with a coverage factor, $k = 2$.

7.4 Pressure loss test

7.4.1 Object of test

The object of the test is to determine the maximum pressure loss through the water meter at any flow rate between Q_1 and Q_3 and verify that the water meter complies with the requirements in 6.4.

To determine the maximum pressure loss through the water meter at any flow rate between Q_1 and Q_3. To verify the maximum pressure loss is less than 0,063 MPa (0,63 bar). The pressure loss is defined as the pressure lost by the flowing fluid passing through the water meter under test, the water meter consisting of the meter and connections but excluding the pipework making up the test section. The test is required for forward flow and where appropriate for reverse flow.

7.4.2 Preparation

The installations conditions are described in ISO 9644.

7.4.3 Test procedure

Install the water meter in the measuring section in the test facility. Establish the flow and purge all air from the test section. Ensure that the downstream static pressure is enough to prevent cavitation in the meters or air release. Ensure that all air is removed from the pressure taps and transmitter connection pipes. Ensure that the water is allowed to stabilize at the required temperature. While monitoring the differential pressure, vary the flow between Q_1 and Q_3. Record the flow rate showing the largest pressure loss, Q_t, along with the measured pressure loss and water temperature. Normally, Q_t will be found to be equal to Q_3.

The maximum pressure loss should be measured with a maximum expanded uncertainty of 5 %, with a coverage factor of $k = 2$.

7.4.4 Acceptance criteria

The pressure loss measurement at any flow rate within the rated operating conditions shall not exceed the maximum value of the pressure loss corresponding to the class declared by the manufacturer.

7.5 Flow disturbance tests

Some kinds of water meters, for instance volumetric water meters, are considered insensitive to installation conditions, so this test is not to be applied.

The manufacturer shall specify the flow profile disturbance sensitivity class for the water meter. This class will never imply lengths longer than 15 DN upstream, and 5 DN downstream.

7.5.1 Object of the test

The object of the test is to verify that the water meter complies with the requirements in 6.3 of this International Standard.

NOTE 1 The effects on the error of a water meter, of the presence of specified, common types of disturbed flow upstream and downstream from the water meter are measured.

NOTE 2 Types 1 and 2 disturbance devices are used in the tests to create left-handed (sinistrorsum) and right-handed (dextrorsum) rotational velocity profiles (swirl), respectively. The flow disturbance is of a type usually found downstream from two 90° bends directly connected. A type 3 disturbance device creates an asymmetric velocity profile usually found downstream from a protruding pipe joint or a gate valve not fully opened.

7.5.2 Preparation

In addition to the installation and operational requirements described in 7.3.2, the conditions described in 7.5.3 also apply.

7.5.3 Test procedure

a) Using the Types 1, 2, and 3 flow disturbers specified in Annex B, determine the error of the water meter at a flow rate between 0,9 Q_3 and Q_3, for each one of the six installation conditions specified in Figure 1.

b) During each test, hold all other influence factors at the reference conditions of 7.1.2.

Additional requirements:

c) For water meters installations where the manufacturer has specified installation lengths of straight pipe of at least 15 × DN upstream and 5 × DN downstream from the water meter, no external flow straighteners are allowed.

d) When a minimum straight pipe length of 5 × DN downstream from the water meter is specified by the manufacturer, perform only tests for installation conditions 1, 3, and 5 shown in Figure 1.

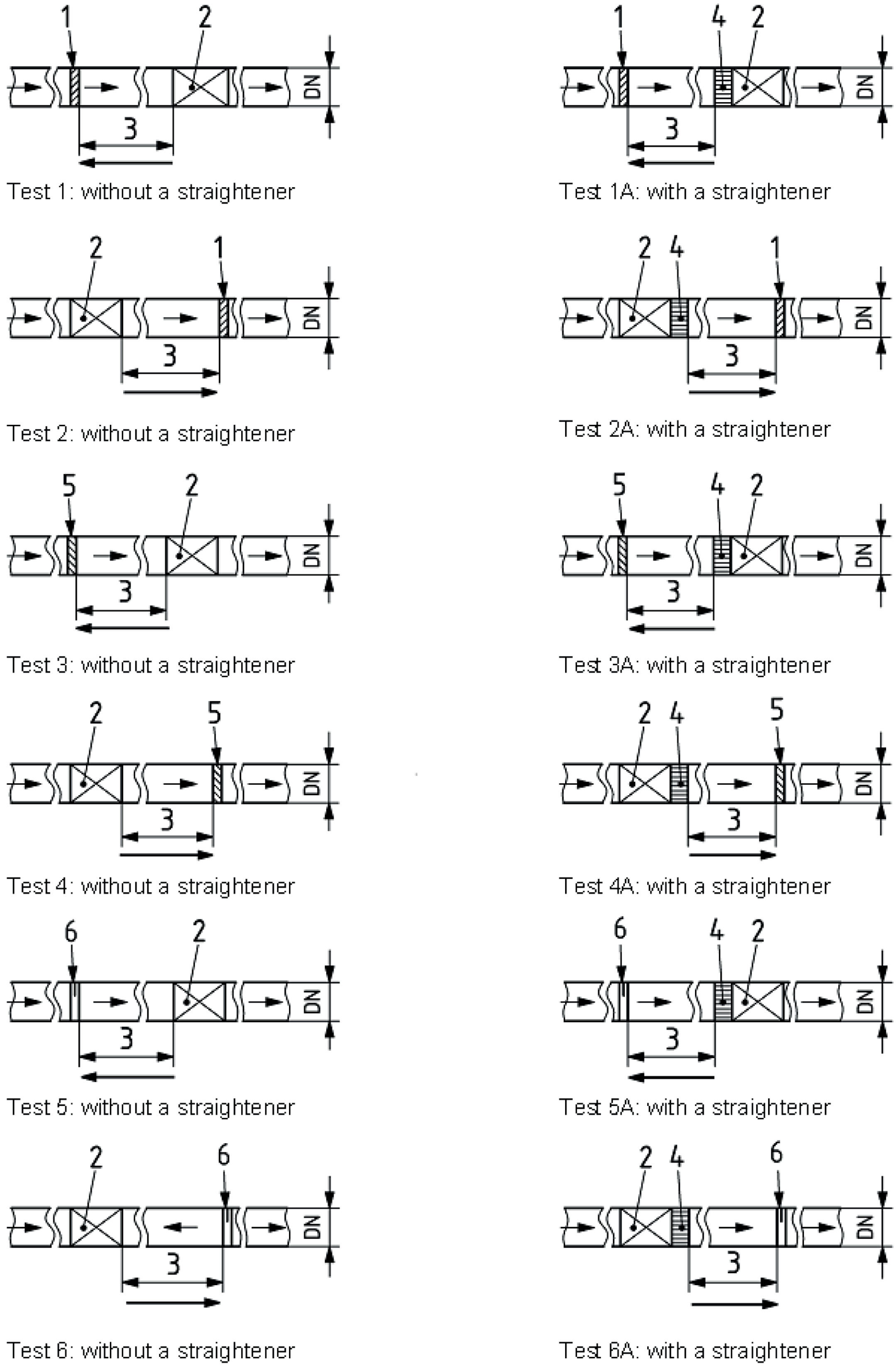
e) Where water meter installations with external flow straighteners are to be used, the manufacturer shall specify and deliver the straightener together with the water meters to accommodate testing of its technical characteristics and its position in the installation relative to the water meter.

f) A device within a water meter having flow straightening functions is not considered to be a “straightener” in the context of these tests.

g) The straight lengths upstream and downstream of the meter depend on the flow profile sensitivity class of the meter and shall be in accordance with Tables 3 and 4 respectively.

7.5.4 Acceptance criteria

The relative error of the meter shall not exceed the applicable maximum permissible error for any of the flow disturbance test.


1
2
3
DN
Test 1: without a straightener
1
4
2
3
DN
Test 1A: with a straightener
2
1
3
DN
Test 2: without a straightener
2
4
1
3
DN
Test 2A: with a straightener
5
2
3
DN
Test 3: without a straightener
5
4
2
3
DN
Test 3A: with a straightener
2
5
3
DN
Test 4: without a straightener
2
4
5
3
DN
Test 4A: with a straightener
6
2
3
DN
Test 5: without a straightener
6
4
2
3
DN
Test 5A: with a straightener
2
6
3
DN
Test 6: without a straightener
2
4
6
3
DN
Test 6A: with a straightener

Key

1 type 1 disturber
2 water meter
3 straight lengths
4 straightener
5 type 2 disturber
6 type 3 disturber

Figure 1 — Flow disturbance scheme

7.6 Reverse flow test

7.6.1 Object of the test

To verify that the meter satisfies the requirement of 5.5 in this International Standard when reverse flow occurs.

Meters which are designed to measure reverse flow shall record the reverse flow volume accurately.

Meters which allow reverse flow, but which are not designed to measure it, shall be subjected to reverse flow. The error shall subsequently be measured for forward flow, to check that there is no degradation in metrological performance caused by reverse flow.

Meters which are designed to prevent reverse flow (e.g. by means of an integral non-return valve) are subjected to the application of the maximum admissible pressure of the meter applied to the outlet connection and the measurement errors are subsequently measured for forward flow to ensure that there is no degradation in metrological performance caused by the pressure acting on the meter.

7.6.2 Preparation

The installation and operational requirements described in 7.3.2 shall apply.

7.6.3 Test procedure

7.6.3.1 Meters designed to measure reverse flow

a) Measure the error of at least one meter at each of the following reverse flow rates:

   1) Between Q_1 and 1,1 Q_1;

   2) Between Q_2 and 1,1 Q_2;

   3) Between 0,9 Q_3 and Q_3.

b) During each test, all other influence factors shall be maintained at reference conditions.

c) Calculate the error for each flow rate.

d) In addition, the following tests shall be carried out: pressure loss test (7.4), flow disturbance test (7.5) and endurance test (7.7).

7.6.3.2 Water meters not designed to measure reverse flows

a) Subject the meter to a reverse flow of 0,9 Q_3 for 1 min.

b) Measure the error of at least one meter at each of the following forward flow rates:

   1) Between Q_1 and 1,1 Q_1;

2) Between Q_2 and 1,1 Q_2;

3) Between 0,9 Q_3 and Q_3.

c) During each test, all other influence factors shall be maintained at reference conditions.

d) Calculate the error for each flow rate.

7.6.3.3 Water meters which prevent reverse flows

a) Meters which prevent reverse flow should be subjected to the maximum admissible pressure in the reverse flow direction for 1 min.

b) Check that there is no significant leak past the valve.

b) Measure the error of at least one meter at each of the following forward flow rates:

1) Between Q_1 and 1,1 Q_1;

2) Between Q_2 and 1,1 Q_2;

3) Between 0,9 Q_3 and Q_3.

c) During each test, all other influence factors shall be maintained at reference conditions.

d) Calculate the relative error for each flow rate.

7.6.4 Acceptance criteria

In the tests described in 7.6.3.1, 7.6.3.2, and 7.6.3.3, the error of the water meter shall not exceed the applicable maximum permissible error.

7.7 Endurance tests

7.7.1 Durability test

Table 7 — Endurance test

Temperature class	Permanent flow rate (Q_3)	Test flow rate	Test water temperature ±5 °C	Type of test	Number of interruptions	Duration of pauses	Period of operation at test flow rate	Duration of start up and run down
T30 y T50	$Q_3 \leq 16$ m^3/h	Q_3	20 °C	Discontinuous	100 000	15 s	15 s	0,15 [Q_3] [a] s with a minimum of 1 s
		Q_4	20 °C	Continuous	–	–	100 h	–
	$Q_3 > 16$ m^3/h	Q_3	20 °C	Continuous	–	–	800 h	–
		Q_4	20 °C	Continuous	–	–	200 h	–

a [Q_3] is the number equal to the value of Q_3 expressed in m^3/h.

Table 7 *(continued)*

Temperature class	Permanent flow rate (Q_3)	Test flow rate	Test water temperature ±5 °C	Type of test	Number of interruptions	Duration of pauses	Period of operation at test flow rate	Duration of start up and run down
All other classes	$Q_3 \leq 16$ m^3/h	Q_3	50 °C	Discontinuous	100 000	15 s	15 s	0,15 [Q_3] [a] s with a minimum of 1 s
		Q_4	0,9 x MAT	Continuous	–	–	100 h	–
	$Q_3 > 16$ m^3/h	Q_3	50 °C	Continuous	–	–	800 h	–
		Q_4	0,9 x MAT	Continuous	–	–	200 h	–

a [Q_3] is the number equal to the value of Q_3 expressed in m^3/h.

7.7.1.1 Continuous flow test

7.7.1.1.1 Object of the test

The object of the test is to verify that the water meter is durable when subjected to continuous, permanent and overload flow conditions.

The test consists of subjecting the water meter to a constant flow rate of even Q_3 or Q_4 as set out in 7.7.1, Table 7.

7.7.1.1.2 Preparation

In addition to the water meter or water meters to be tested, the pipework comprises:

a) a flow-regulating device;

b) one or more isolating valves;

c) a device for measuring the water temperature at the water meter inlet;

d) means for checking the flow rate and duration of the test;

e) devices for measuring pressure at the inlet and outlet.

The various devices shall not cause cavitation.

7.7.1.1.3 Test procedure

a) Before commencing the continuous endurance test, measure the errors of the meters as described in 7.3 and at the same flow rates.

b) Mount the water meters either individually or in batches in the test rig in the same orientations as those used in the determination of the intrinsic error tests.

c) Carry out the following tests:

  1) for water meters with $Q_3 \leq 16$ m^3/h, run the meter at a flow rate of Q_4 for a period of 100 h;

2) for water meters with Q_3 > 16 m^3/h, run the meter at a flow rate of Q_3 for a period of 800 h then at Q_4 for a period of 200 h.

d) During the endurance tests, hold the water meters within their rated operating conditions and ensure that the pressure at the outlet of each meter is high enough to prevent cavitation.

e) After the continuous endurance test, measure the errors of the water meters as described in 7.3 and at the same flow rates.

f) Calculate the relative errors for each flow rate.

g) For each flow rate, subtract the error obtained before the test [step a)] from the error obtained after the test [step f)].

7.7.1.1.3.1 Tolerance on flow rate

Keep the flow rate constant throughout the test at a predetermined level.

Ensure that the relative variation of the flow rate values during each test shall not exceed ±10 % (except when starting and stopping).

7.7.1.1.3.2 Tolerance on test timing

The specified duration of the test is a minimum value.

7.7.1.1.3.3 Tolerance on discharged volume

The volume indicated at the end of the test shall not be less than that determined from the product of the specified flow rate of the test and the specified duration of the test.

To satisfy this condition, monitor to the flow rate frequently. The water meters on test may be used to check the flow rate.

7.7.1.1.3.4 Test readings

During the test, record the following readings from the test rig at least once every 24 h period, or once for every shorter period if the test is so divided.

a) Water pressure upstream from the water meter(s).

b) Water pressure downstream from the water meter(s).

c) Water temperature upstream from the water meter(s).

d) Flow rate.

e) Readings of the test water meter(s).

f) Volume passed through the water meter(s).

7.7.1.1.4 Acceptance criteria

After the continuous endurance test:

a) The variation in the error curve shall not exceed

— ±3 % for flow rates in the lower zone ($Q_1 \leq Q < Q_2$), and

— ±1, 5 % for flow rates in the upper zone ($Q_2 \leq Q \leq Q_4$).

For the purpose of determining these requirements, the mean values of the errors at each flow rate, shall apply.

b) The error curves shall not exceed a maximum error limit of

— ±6 % for flow rates in the lower zone ($Q_1 \leq Q < Q_2$), and

— ±2, 5 % for flow rates in the upper zone ($Q_2 \leq Q \leq Q_4$).

7.7.1.2 Discontinuous flow test

This test is applied only to water meters with $Q_3 \leq 16$ m^3/h and combination water meters.

7.7.1.2.1 Object of test

The object of the test is to verify that the water meter is durable when subjected to cyclic flow conditions.

The test consists of subjecting the water meter to the specified number of starting and stopping flow rate cycles of short duration, the constant test flow rate phase of each cycle being kept at the specified flow rate (Q_3) throughout the duration of the test.

7.7.1.2.2 Preparation

The water meters can be arranged in series or in parallel, or the two systems can be combined.

The piping system consists of

a) one flow-regulating device (per line of water meters in series, if applicable),

b) one or more isolating valves,

c) device for measuring the temperature of the water upstream of the water meters,

d) means for checking the flow rate, the duration of cycles, and the number of cycles,

e) one flow-interrupting device for each line of water meters in series, and

f) devices for measuring pressure at the inlet and outlet.

The various devices shall not cause cavitation or other types of wearing due to the test procedure of the water meter(s).

Bleed air from the water meter(s) and connecting pipe.

Ensure that flow variation during the repeated opening and closing operations is progressive, to prevent water hammer.

7.7.1.2.3 Flow rate cycles

A complete cycle includes the following four phases.

a) Period from zero to test flow rate Q_3.

b) Period at constant test flow rate Q_3.

c) Period from the test flow rate Q_3 to zero.

d) Period at zero flow rate.

The test program shall specify the number of flow rate cycles, the duration of each of the four phases of a cycle, and the total volume to be discharged.

7.7.1.2.4 Test procedure

7.7.1.2.4.1 For all types of meters

a) Before commencing the discontinuous endurance test, measure the errors of the water meters as described in 7.3 and at the same flow rates.

b) Mount the water meters either individually or in batches in the test rig in the same orientations as those used in the determination of the intrinsic error tests.

c) During the tests, hold the water meters within their rated operating conditions and with the pressure downstream of the meters high enough to prevent cavitation in the meters.

d) Adjust the flow rate to within the specified tolerances.

e) Run the water meters at the conditions shown in Table 7.

f) Following the discontinuous endurance test, measure the final errors of the water meters as described in 7.3 and at the same flow rates.

g) Calculate the relative errors for each flow rate.

h) For each flow rate, subtract the value of intrinsic error obtained before the test [step a)] from the error obtained after the test [step g)].

7.7.1.2.4.2 Tolerance on flow rate

The relative variation of the flow values shall not exceed ± 10 % outside the opening, closing and stopped periods.

The water meters on test may be used to check the flow rate.

7.7.1.2.4.3 Tolerance on test timing

The tolerance on the specified duration of each phase of the flow cycle shall not exceed ± 10 %.

The tolerance on the total test duration shall not exceed ± 5 %.

7.7.1.2.4.4 Tolerance on the number of cycles

The number of cycles shall not be less than that stipulated, but shall not exceed this number by more than 1 %.

7.7.1.2.4.5 Tolerance on discharged volume

The volume discharged throughout the test shall be equal to half the product of the specified nominal test flow times the total theoretical duration of the test (operating periods plus transient and stopped periods with a tolerance of ±5 %).

This precision can be obtained by closely monitoring the instantaneous flows and operating periods and making adjustments, if required.

7.7.1.2.4.6 Test readings

During the test, record the following readings from the test rig at least once every 24 h period or once for every shorter period if the test is so divided.

a) Water pressure upstream from the water meter(s).

b) Water pressure downstream from the water meter(s).

c) Water temperature upstream from the water meter(s).

d) Flow rate.

e) Duration of the four phases of the cycle of the discontinuous flow test.

f) Number of cycles.

g) Readings of the test water meter/s.

h) Volume passed by the water meters.

7.7.1.2.5 Acceptance criteria

After the cyclic endurance test:

a) The variation in the error curve shall not exceed

— ±3 % for flow rates in the lower zone ($Q_1 \leq Q < Q_2$), and

— ±1,5 % for flow rates in the upper zone ($Q_2 \leq Q \leq Q_4$).

For the purpose of determining these requirements the mean values of the errors at each flow rate, shall apply.

b) The error curves shall not exceed a maximum error limit of

— ±6 % for flow rates in the lower zone ($Q_1 \leq Q < Q_2$), and

— ±2,5 % for flow rates in the upper zone ($Q_2 \leq Q \leq Q_4$).

7.7.2 Resistance to solid particles test

7.7.2.1 Object of test

The object of the test is to prove that a water meter is able to withstand a water flow carrying solid particles passing through it, without showing damage.

Those water meters which do not have any mechanical moving part used in the process of metering, will not need to carry out this test.

7.7.2.2 Test conditions

Resistance to solid particles test must be arranged following the conditions described in Table 9, using the water quality described in Table 8.

Table 8 — Particle characterization

Shape	Spheres
Density	2, 5-3 Mg/m^3
Hardness	6
Quantity	10 g/l – 20 g/l
Size	80 % of the particles between 100 and 300 µm

Table 9 — Test conditions

Flow rate	Test type	Duration
Q_3	Constant flow rate	600 h

Testing procedure is similar to the one put forward in 7.7.1.1 for continuous flow rate endurance tests.

7.7.2.3 Acceptance criteria

Following the resistance to solid particles test, measure the final errors of the water meters as described in 7.3 and at the same flow rates.

Calculate the relative errors for each flow rate.

For each flow rate, subtract the value of intrinsic error obtained before the test [step a)] from the error obtained after the test [step g)].

a) The variation in the error curve shall not exceed

— ±3 % for flow rates in the lower zone ($Q_1 \leq Q < Q_2$), and

— ±1,5 % for flow rates in the upper zone ($Q_2 \leq Q \leq Q_4$).

For the purpose of determining these requirements the mean values of the errors at each flow rate, shall apply.

b) The error curves shall not exceed a maximum error limit of

— ±6 % for flow rates in the lower zone ($Q_1 \leq Q < Q_2$), and

— ±2,5 % for flow rates in the upper zone ($Q_2 \leq Q \leq Q_4$).

7.7.2.4 Water meters classification

Water meters will be classified according to the result of the current test:

— Class A: If they pass the resistance test;

— Class B: If they fail the resistance test.

8 Tests related to the influence quantities and perturbations

The aim of these tests is to verify that the water meters work as expected in a specified ambient temperature and under established conditions.

These tests, according to their type, shall be conducted according to the procedures and requirements established in ISO 4064-2:2005, Clause 8. It shall be considered that a meter for irrigation water works in:

— an environmental classification B and C;

— an electromagnetic environment E1.

The tests for each water meter type are as defined in that clause.

9 Marking

A place shall be provided on water meters for affixing the main verification mark, which shall be visible without dismantling the water meter.

The water meter shall be clearly and indelibly marked with the following information, either grouped or distributed on the casing, the indicating device dial, an identification plate, or on the meter cover if it is not detachable:

— nominal diameter (DN);

— name or trademark of the manufacturer;

— year of manufacture (last 2 digits) and serial number (as near as possible to the indicating device);

— unit of measurement: cubic meter;

— numerical value of $Q_3 \geq 100 \geq 10$;

— ratio $Q_3 \geq 100 \geq 10/Q_1 \geq 5$ (preceded by “R”, for example “R10”);

— maximum admissible pressure if it differs from 1 MPa (10 bar) or 0,6 MPa for DN ≥ 500;

— direction of flow (shown on both sides of the body or on one side only provided the direction of flow arrow will be easily visible under all circumstances);

— letter V or H, if the meter can only be operated in the vertical or horizontal position;

— pressure loss class, where it differs from 1 MPa (10 bar) or 0,6 MPa for DN > 500;

— classes on sensitivity to irregularity in upstream and downstream velocity profile sensitivity classes;

— resistance to solid particles class.

The meters will carry protective devices that can be sealed in order to avoid, both before and after the correct installation of the meter, the dismantling or modification of the meter or the regulating device, without breaking the seals of guarantee.

Annex A
(informative)

Pulse input solutions

A.1 General

When the signals generated by the flow sensor are in the form of pulses, each pulse representing a volume. The pulse generation, transportation and counting shall meet the requirements of A.2.

NOTE A pulse generator is considered as a reed contact unit.

A.2 Tests

A.2.1 Correct counting of pulses

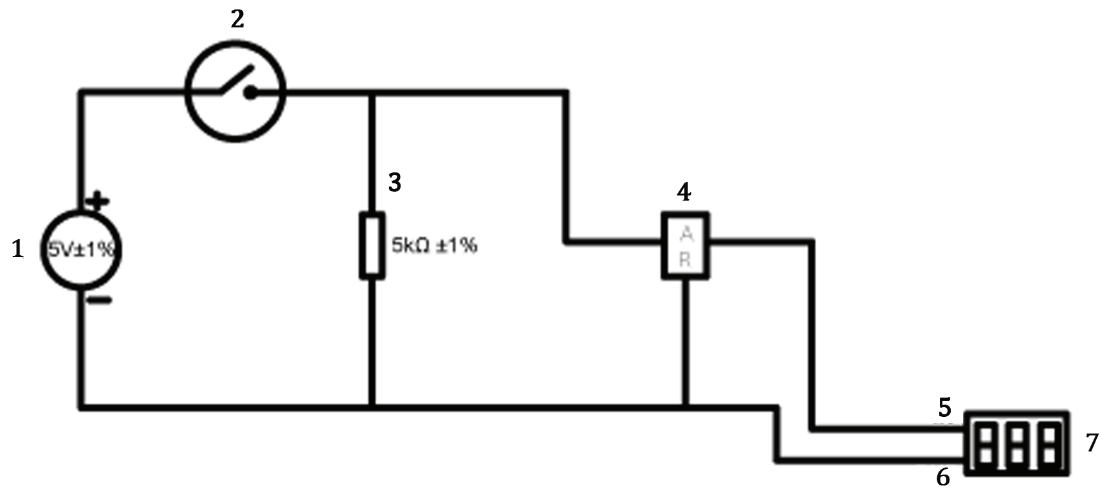
A.2.1.1 Object of the test

The object of this test is to check the correct operation of a pulses generator associated to a water meter.

A.2.1.2 Test conditions

Install the water meter together with the pulses generator as set out in the manufacturer's recommendations, in the same system used for carrying out the precision test.

Install a digital totalizer as shown in Figure A.1 in order to count the total number of pulses.



Key

1 power supply

2 pulse generator under test

3 resistor

4 filter, 50ms

5 in

6 ground

7 digital totalizer

Figure A.1 — Connection diagram

Conduct the test under the test conditions set out in Table A.1:

Table A.1 — Test conditions

Test flow rates	Number of pulses
Q_4	50
Q_3	50

The total number of pulses given by the digital totalizer is equal to the difference between the number of pulses at any point in time and the number of pulses at the beginning of the test.

Carry out the test twice for each flow rate.

Parameters to be taken down are the following:

— water meter identification;

— pulse generator identification;

— test flow rate;

— volume/pulse ratio;

— difference between initial and final volume of water shown in the water meter;

— number of pulses in the digital totalizer;

— difference between the number of pulses displayed in the totalizer and the real value of pulses that should be indicated (calculated according to the difference between initial and final volume of water shown in the water meter and the ratio Volume/Pulse).

A.2.1.3 Validity criteria for the correct counting of pulses

Test result shall be considered satisfactory when the number of pulses displayed in the totalizer is equal to the real value of pulses that should be indicated (calculated as the difference between initial and final volume of water shown in the water meter and the volume/pulse ratio).

A.2.2 Determination of the operate position time

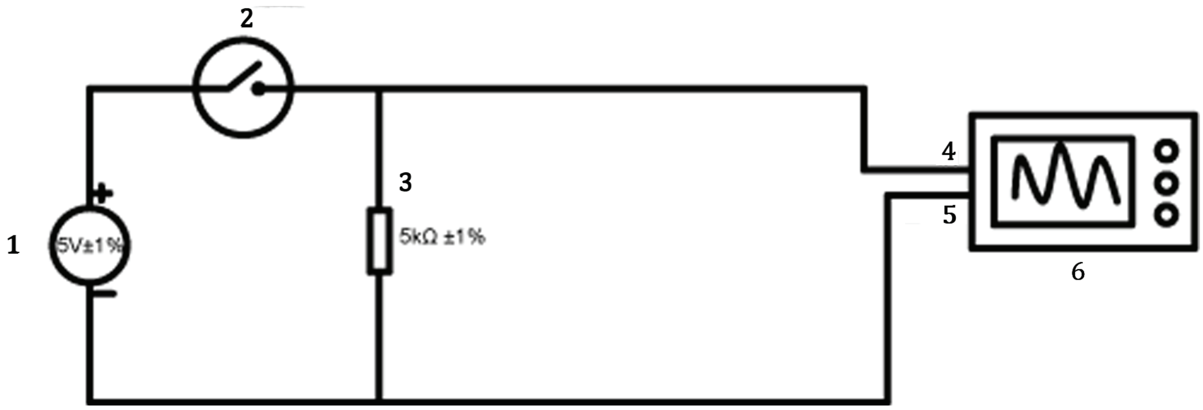
A.2.2.1 Object of the test

The object of the test is to determine the operate position time.

A.2.2.2 Test conditions

Install the water meter, together with the pulses generator, as set out in the manufacturer's recommendations, in the same system used for carrying out the precision test.

Connect the oscilloscope, the resistor, the adjustable water source, and the pulse generator as shown in Figure A.2.



Key

1 power supply
2 pulse generator under test
3 resistor
4 in
5 ground
6 oscilloscope

Figure A.2 — Connection diagram

Record data when the oscilloscope's screen displays two rising flanks of a pulse. Measure both the period and the amplitude of the pulse.

Capture the screens for the flow rates Q_4, Q_3, and Q_1.

Conduct the test under the test conditions set out in Table A.2:

Table A.2 — Test conditions

Test flow rates	Number of pulses
Q_4	10
Q_3	10

Run the test employing the flying-start-and-finish method (test with readings taken under stable flow conditions and diversion flow) so as to guarantee getting complete pulses.

For the average flow rate, calculate the operate position time in relation to the period of one full pulse, expressed as a percentage (t_{ON}/t).

Record the following parameters:

— water meter identification;

— pulse generator identification;

— test flow rate;

— number of measurements or repetitions carried out under the same conditions;

— operate position time and period of one pulse.

And, for every flow rate:

— t_{ON} minimum;

— t_{ON} maximum;

— t_{ON} average.

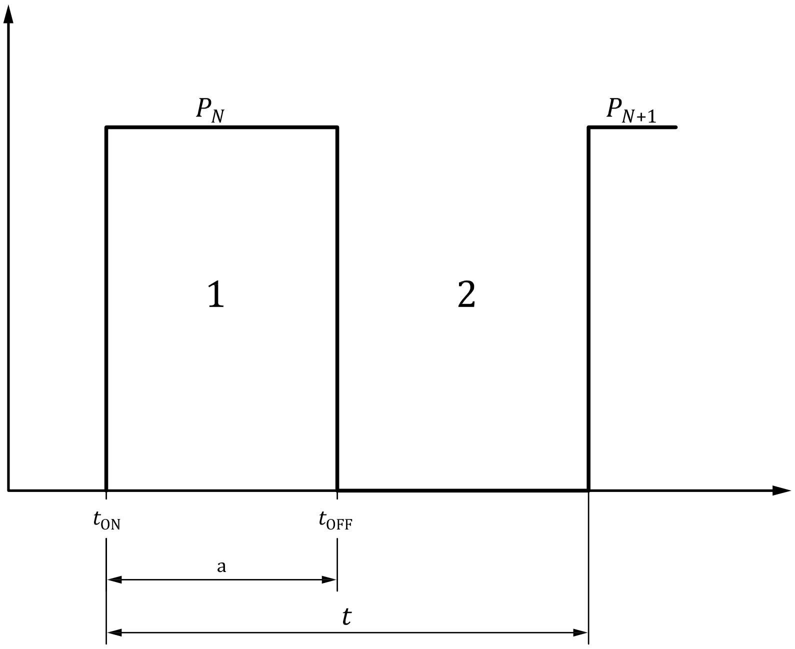
Compute each value for (t_{ON}/t), as a percentage.

A.2.2.3 Validity criteria for the determination of the operate position time

The relation t_{ON}/t, expressed as a percentage, shall remain within the following limits:

— maximum: 50 %;

— minimum: 10 %.



Key

1 on

2 off

a 10 % ≤ t_{ON}/t ≤ 50 %

Figure A.3 — Determination of the time during which the socket is closed

A.2.3 Determination of electrical bounce time

A.2.3.1 Object of the test

The object of the test is to determine the duration of the electrical bounce, that is, the time elapsed from the start of the first flank of the pulse until it stabilizes.

A.2.3.2 Test conditions

Install the water meter, together with the pulse generator is installed as set out in the manufacturer's recommendations, in the same system used for carrying out the precision test.

Connect the oscilloscope as shown in Figure A.2.

Record data when the oscilloscope's screens display rising or falling flanks of a pulse.

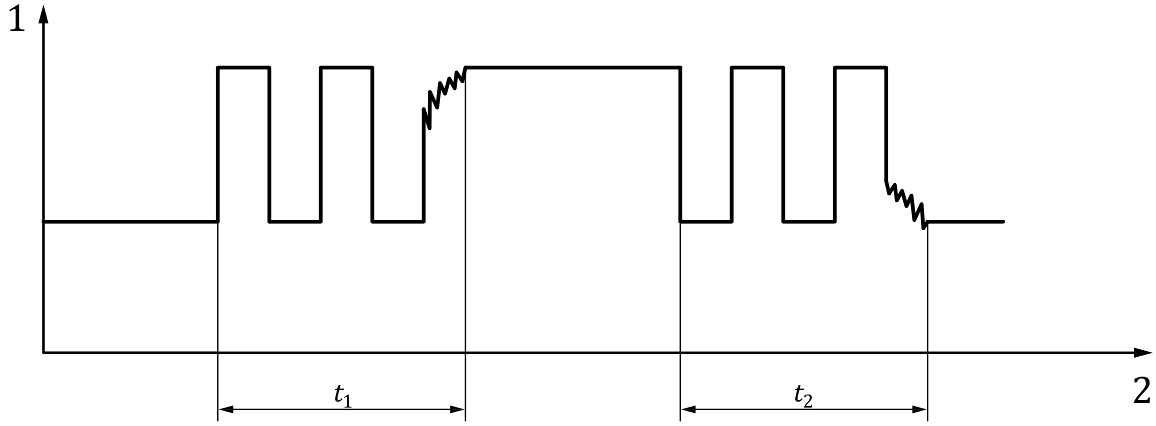
Ensure that the record of the screens is captured for the flow rates Q_4, $Q_{3,}$ and Q_1.

Conduct the test under the test conditions set out in Table A.3:

Table A.3 — Test conditions

Test flow rate	Number of pulses
Q_4	10
Q_3	10
Q_1	5

For each case, obtain the duration of the rebounds, both for the rising and the falling flanks. Record the elapsed time from the beginning of the first rising flank of the pulse until the signal is stabilized on the top (stabilized electrical shut off) and the elapsed time from the beginning of the first falling flank of the pulse until the signal is stabilized on the bottom (stabilized electrical opening).



Key

1 voltage, *U*

2 time, in seconds

Figure A.4 — Bounce time

Record the following parameters:

— water meter identification;

— pulses generator.

And, for each flow rate:

$$\text{Pulse rising flank}\begin{cases} t_1 \text{ minimum} \\ t_1 \text{ maximum} \\ t_1 \text{ medium} \end{cases}$$

$$\text{Pulse falling flank}\begin{cases} t_2 \text{ minimum} \\ t_2 \text{ maximum} \\ t_2 \text{ medium} \end{cases}$$

A.2.3.3 Validity criteria for determining the bounce time

The duration of the rebounds (t_1 and t_2) shall not exceed 0,1 % of the shortest time between pulses.

A.2.4 Classification according to the covering or the socket

— Type 1: Without any special covering

— Type 2: With gold covering

Non-covered relays need at least 1 mA electrical current to be capable of transmitting the electrical signals, whereas it is considered that those relays with gold covering are capable of transmitting electrical current whenever there is mechanical contact.

A.3 Other technologies

For other technologies, checking facilities providing equivalent levels of security remain to be developed.

Annex B
(normative)

Flow disturbers

B.1 Irregularity in water velocity profile

Some water meters are affected by flow disturbances if the meter is not preceded and followed by certain straight lengths of piping, with the same nominal diameter as the meter.

A flow can be influenced by two types of disturbances: swirl and velocity profile distortion.

Swirl may be caused in several ways. For example, by two or more bends of the pipe in different planes, by centrifugal pumps, by tangential inlet of supply line into the main line in which the irrigation water meter is installed, etc.

Velocity profile distortion is typically caused by an obstruction partially blocking the pipe, for example, the presence of a single bend, a partly closed valve, a butterfly valve, a check valve, an orifice, a flow or pressure regulator, etc. Maximum velocity zones may be found either at the centre of the section, or in one or several zones tangents to the circumference of the section.

Both two types of disturbances can be controlled by ensuring adequate straight lengths of pipe, upstream and downstream from the water meter. The length of these straight lengths of pipe can be decreased by installing a flow straightener or a flow conditioner.

When a flow straightener is installed, upstream or downstream from the water meter, it is necessary to mount a specified length of straight pipe of uniform internal diameter between the flow straightener and the water meter.

B.2 Flow disturbers

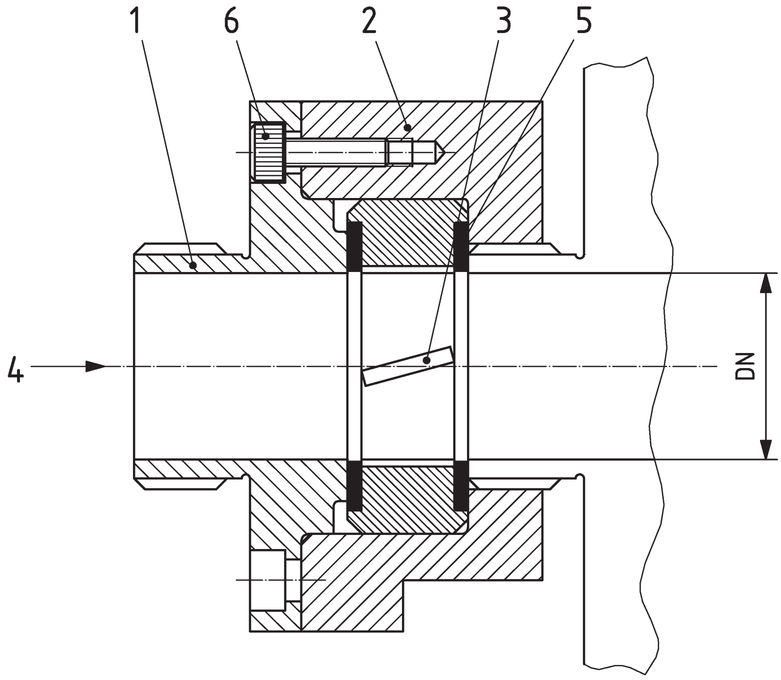
Figures B1 to B4 show the types of flow disturber to be used in the tests described in 7.5. The following figures show flow disturber types to be used in tests as described in 7.5.

All dimensions shown in the figures are in millimetres unless otherwise stated.

Machined dimensions are to ±0,25 mm unless otherwise specified.

B.3 Threaded type disturbance generators

Figure B.1 shows an arrangement of swirl generator units for a threaded type disturbance generator.



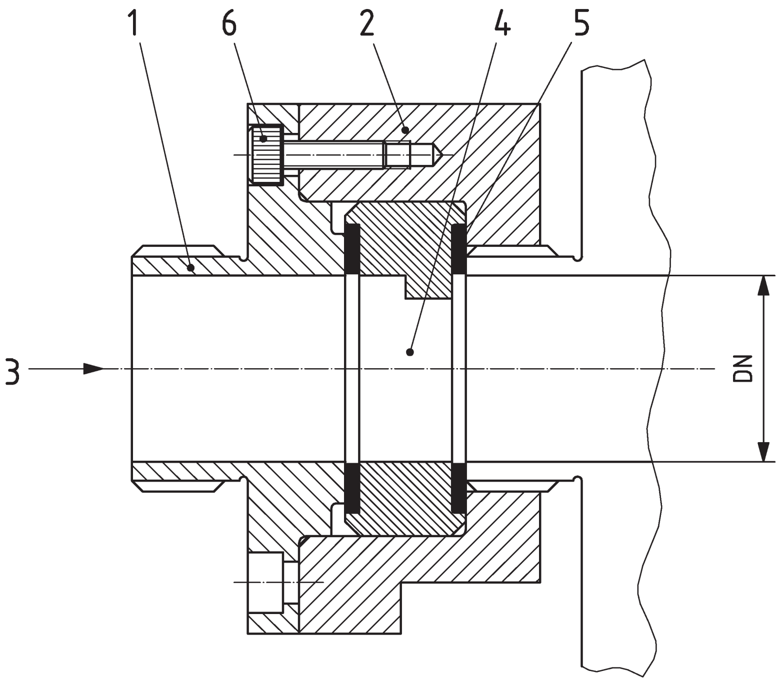
Item	Description	Qty.	Material
1	Cover	1	Stainless steel
2	Body	1	Stainless steel
3	Swirl generator	1	Stainless steel
4	Flow	–	–
5	Gasket	2	Fibre
6	Hexagon socket head cap screw	4	Stainless steel

Type 1 disturber — Swirl generator sinistrorsum

Type 2 disturber — Swirl generator dextrorsum

Figure B.1 — Threaded type disturbance generators — Arrangement of swirl generator units

Figure B.2 shows an arrangement of velocity profile disturbance units for a threaded type disturbance generator.

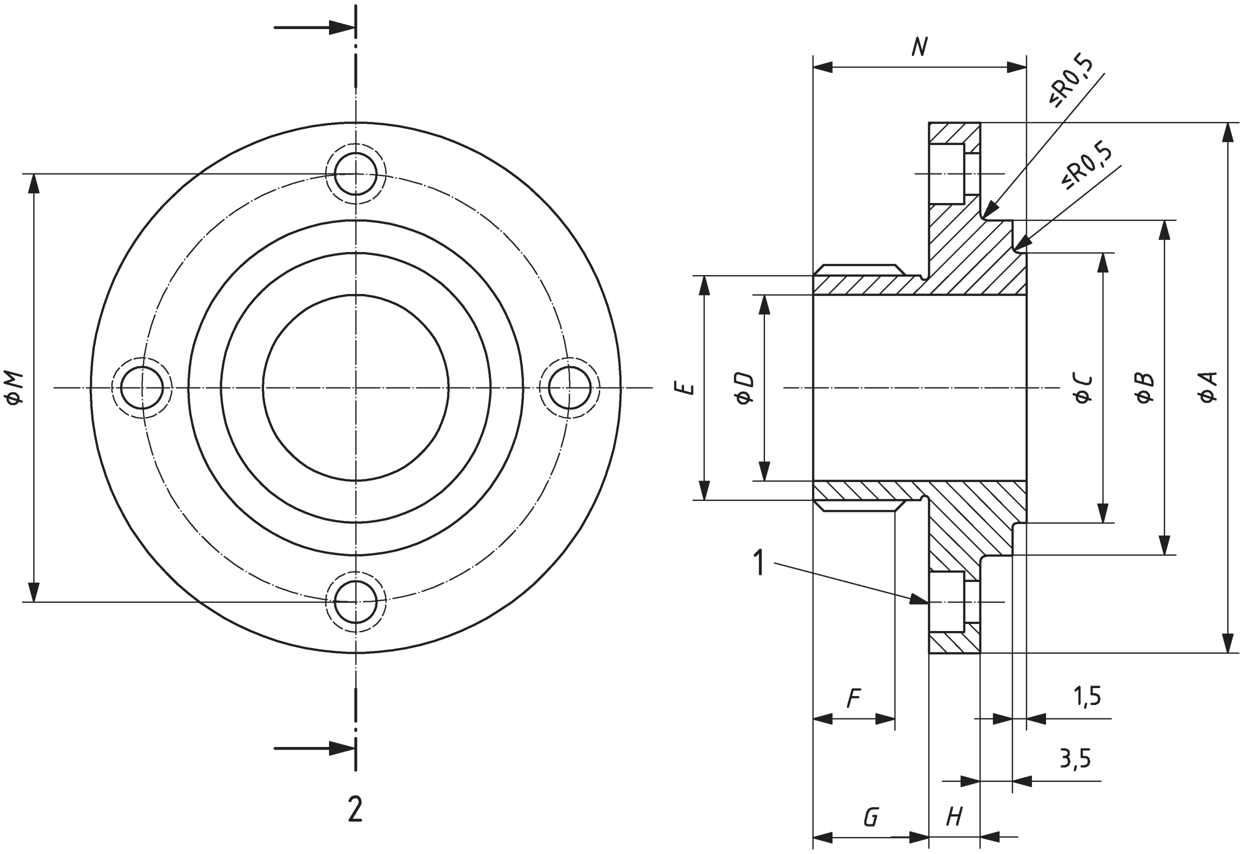


Item	Description	Qty.	Material
1	Cover	1	Stainless steel
2	Body	1	Stainless steel
3	Flow	–	–
4	Flow disturber	1	Stainless steel-
5	Gasket	2	Fibre
6	Hexagon socket head cap screw	4	Stainless steel

Type 3 disturber — Velocity profile flow disturber

Figure B.2 — Threaded type disturbance generator — Arrangement of velocity profile disturbance units

Figure B.3 illustrates the cover of a threaded type disturbance generator, with dimensions as set out in Table B.1.



Key

1 4 holes ØJ bore ØK × *L*

2 machine surface roughness 3,2 µm all over

Figure B.3 — Cover for a threaded type disturbance generator, with dimensions as set out in Table B.1

Table B.1 — Dimensions for the cover for a threaded type disturbance generator (see Figure B.3)

DN	Threaded connection	A	Be9 [a]	C	D	E[b]	F	G	H	J	K	L	M	N
15	G 3/4” B	52	29,960 29,908	23	15	3/4” BSP	10	12,5	5,5	4,5	7,5	4	40	23
20	G 1” B	58	35,950 35,888	29	20	1” BSP	10	12,5	5,5	4,5	7,5	4	46	23
25	G 1 1/4” B	63	41,950 41,888	36	25	1 1/4” BSP	12	14,5	6,5	5,5	9,0	5	52	26
32	G 1 1/2” B	76	51,940 51,866	44	32	1 1/2” BSP	12	16,5	6,5	5,5	9,0	5	64	28

[a] See ISO 286-2.

[b] See ISO 228-1.

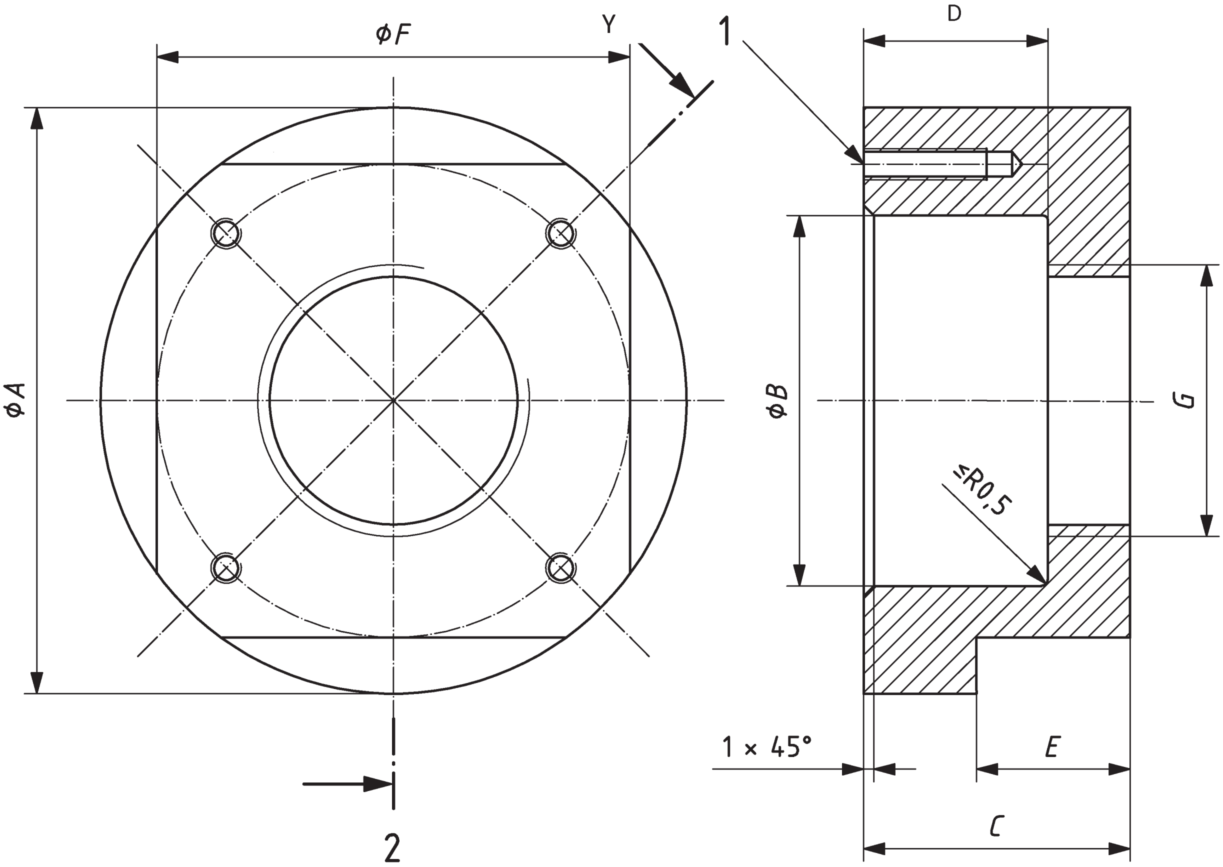
Table B.1 *(continued)*

DN	Threaded connection	A	Be9 [a]	C	D	E[b]	F	G	H	J	K	L	M	N
40	G 2" B	82	59,940 59,866	50	40	2" BSP	13	18,5	6,5	5,5	9,0	5	70	30
50	G 2 1/2" B	102	69,940 69,866	62	50	2 1/2" BSP	13	20,0	8,0	6,5	10,5	6	84	33

a See ISO 286-2.

b See ISO 228-1.

Figure B.4 illustrates the body of a threaded type disturbance generator, with dimensions as set out in Table B.2.



Key

1 4 holes ØH × J deep tap K thread × *L*

2 machine surface roughness 3,2 µm all over

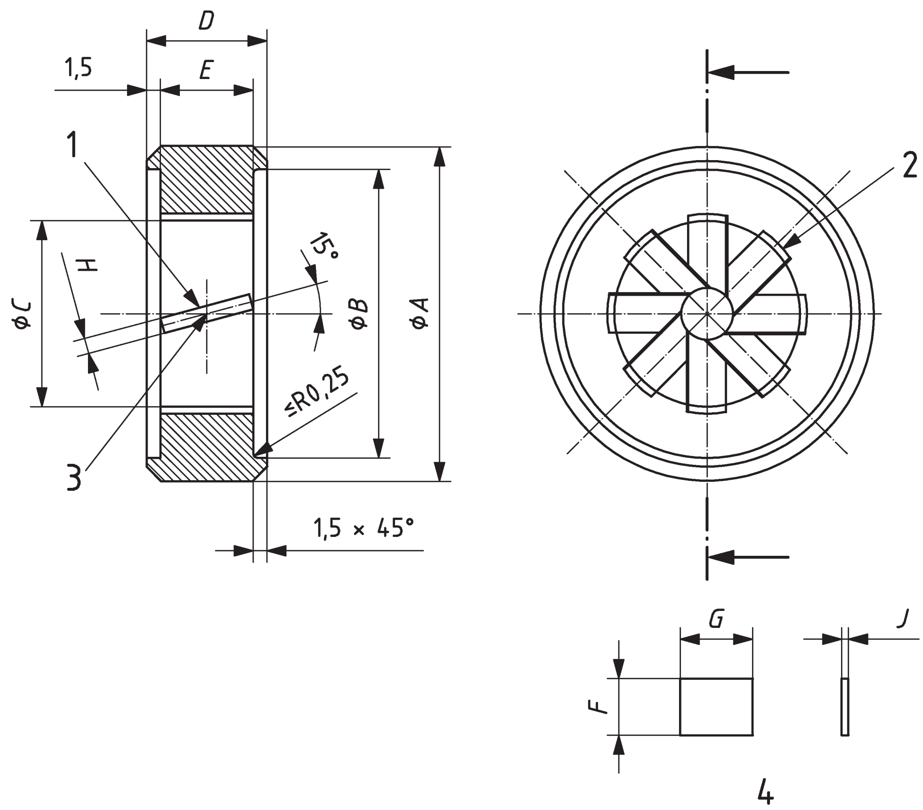
Figure B.4 — Body of a threaded type disturbance generator, with dimensions as set out in Table B.2

Table B.2 — Dimensions for the body of a threaded type disturbance generator (see Figure B.4)

DN	A	B^{H9} [a]	C	D	E	F	G	H	J	K	L	M
15	52	30,052 30,000	23,5	15,5	15	46	3/4" BSP	3,3	16	M4	12	40
20	58	36,062 36,000	26,0	18,0	15	46	1" BSP	3,3	16	M4	12	46
25	63	42,062 42,000	30,5	20,5	20	55	1 1/4" BSP	4,2	18	M5	14	52
32	76	52,074 52,000	35,0	24,0	20	65	1 1/2" BSP	4,2	18	M5	14	64
40	82	60,074 60,000	41,0	28,0	25	75	2" BSP	4,2	18	M5	14	70
50	102	70,074 70,000	47,0	33,0	25	90	2 1/2" BSP	5,0	24	M6	20	84

[a] See ISO 286-2.

Figure B.5 illustrates the swirl generator of a threaded type disturbance generator, with dimensions as set out in Table B.3.



Key

1 8 slots equally spaced to locate blades
2 locate blades in slots and welding
3 depth of slot at centre = 0,76
4 blade detail

Machined surface roughness 3,2 µm all over

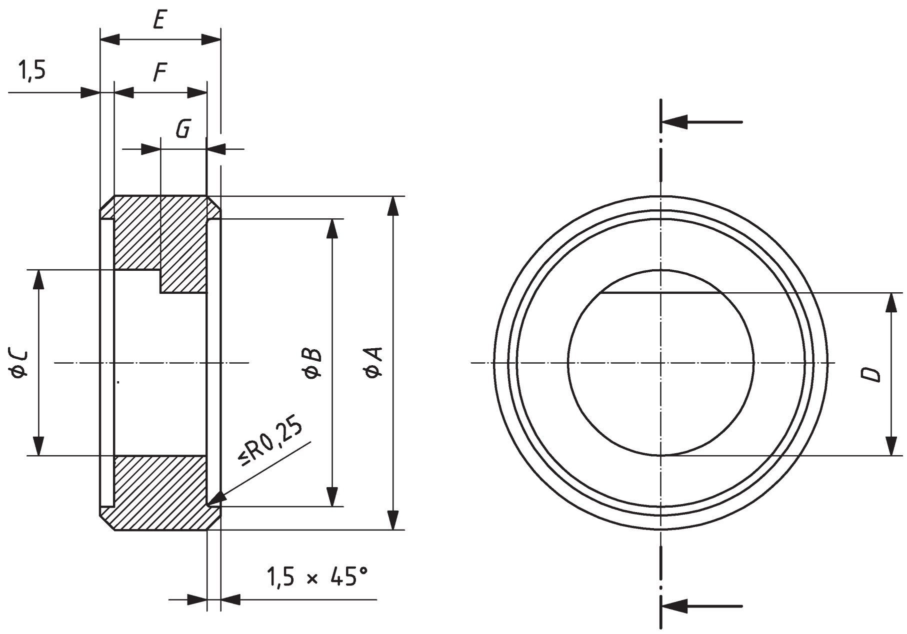
Figure B.5 — Swirl generator for a threaded type disturbance generator, with dimensions as set out in Table B.3

Table B.3 — Dimensions for the swirl generator of a threaded type disturbance generator (see Figure B.5)

DN	A^{d9} [a]	B	C	D	E	F	G	H	J
15	29,935 29,851	25	15	10,5	7,5	6,05	7,6	0,57 0,52	0,50
20	35,920 35,820	31	20	13,0	10,0	7,72	10,2	0,57 0,52	0,50
25	41,920 41,820	38	25	15,5	12,5	9,38	12,7	0,82 0,77	0,75
32	51,900 51,780	46	32	19,0	16,0	11,72	16,4	0,82 0,77	0,75
40	59,900 59,780	52	40	23,0	20,0	14,38	20,5	0,82 0,77	0,75
50	69,900 69,780	64	50	28,0	25,0	17,72	25,5	1,57 1,52	1,50

a See ISO 286-2.

Figure B.6 illustrates the flow disturber of a threaded type disturbance generator, with dimensions as set out in Table B.4.



Machined surface roughness 3,2 µm all over

Figure B.6 — Flow disturber for a threaded type disturbance generator, with dimensions as set out in Table B.4

Table B.4 — Dimensions for the flow disturber of a threaded type disturbance generator (see Figure B.6)

DN	Ad9 [a]	B	C	D	E	F	G
15	29,935 29,851	25	15	13,125	10,5	7,5	7,5
20	35,920 35,820	31	20	17,500	13,0	10,0	5,0
25	41,920 41,820	38	25	21,875	15,5	12,5	6,0
32	51,900 51,780	46	32	28,000	19,0	16,0	6,0
40	59,900 59,780	52	40	35,000	23,0	20,0	6,0
50	69,900 69,780	64	50	43,750	28,0	25,0	6,0

[a] See ISO 286-2.

Figure B.7 illustrates the gasket for a threaded type disturbance generator, with dimensions as set out in Table B.5.

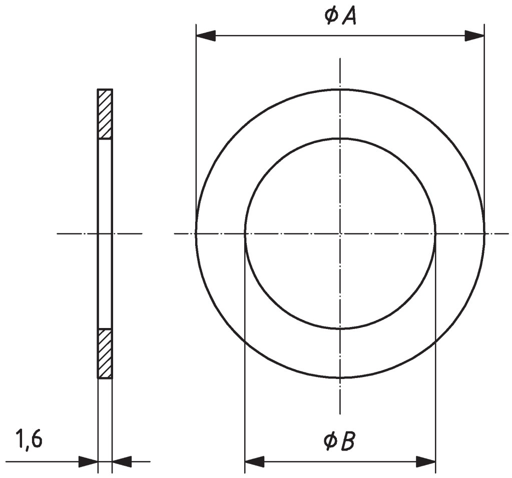


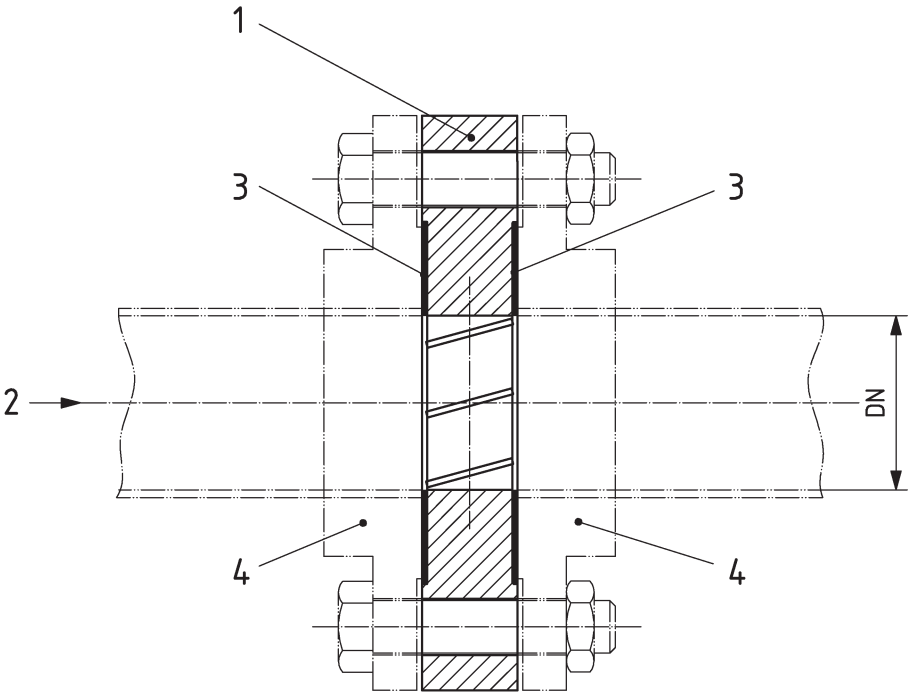
Figure B.7 — Gasket for a threaded type disturbance generator, with dimensions as set out in Table B.5

Table B.5 — Dimensions for the gasket of a threaded type disturbance generator (see Figure B.7)

DN	A	B
15	24,5	15,5
20	30,5	20,5
25	37,5	25,5
32	45,5	32,5
40	51,5	40,5
50	63,5	50,5

B.4 Wafer type disturbance generator

Figure B.8 shows an arrangement of swirl generator units for a wafer type disturbance generator.



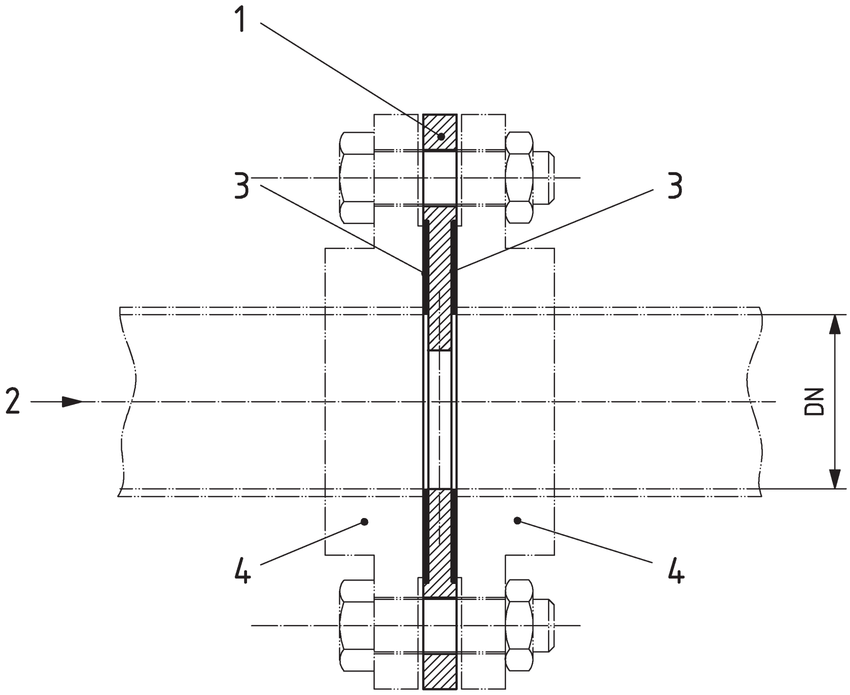
Item	Description	Qty.	Material
1	Swirl generator	1	Stainless steel
2	Flow	–	–
3	Gasket	2	Fibre
4	Straight length with flange (ISO 7005-2 or 3)	2	Stainless steel

Type 1 disturber — Swirl generator sinistrorsum

Type 2 disturber — Swirl generator dextrorsum

Figure B.8 — Wafer type disturbance generators — Arrangement of swirl generator units

Figure B.9 shows an arrangement of velocity profile disturbance units for a wafer type disturbance generator.

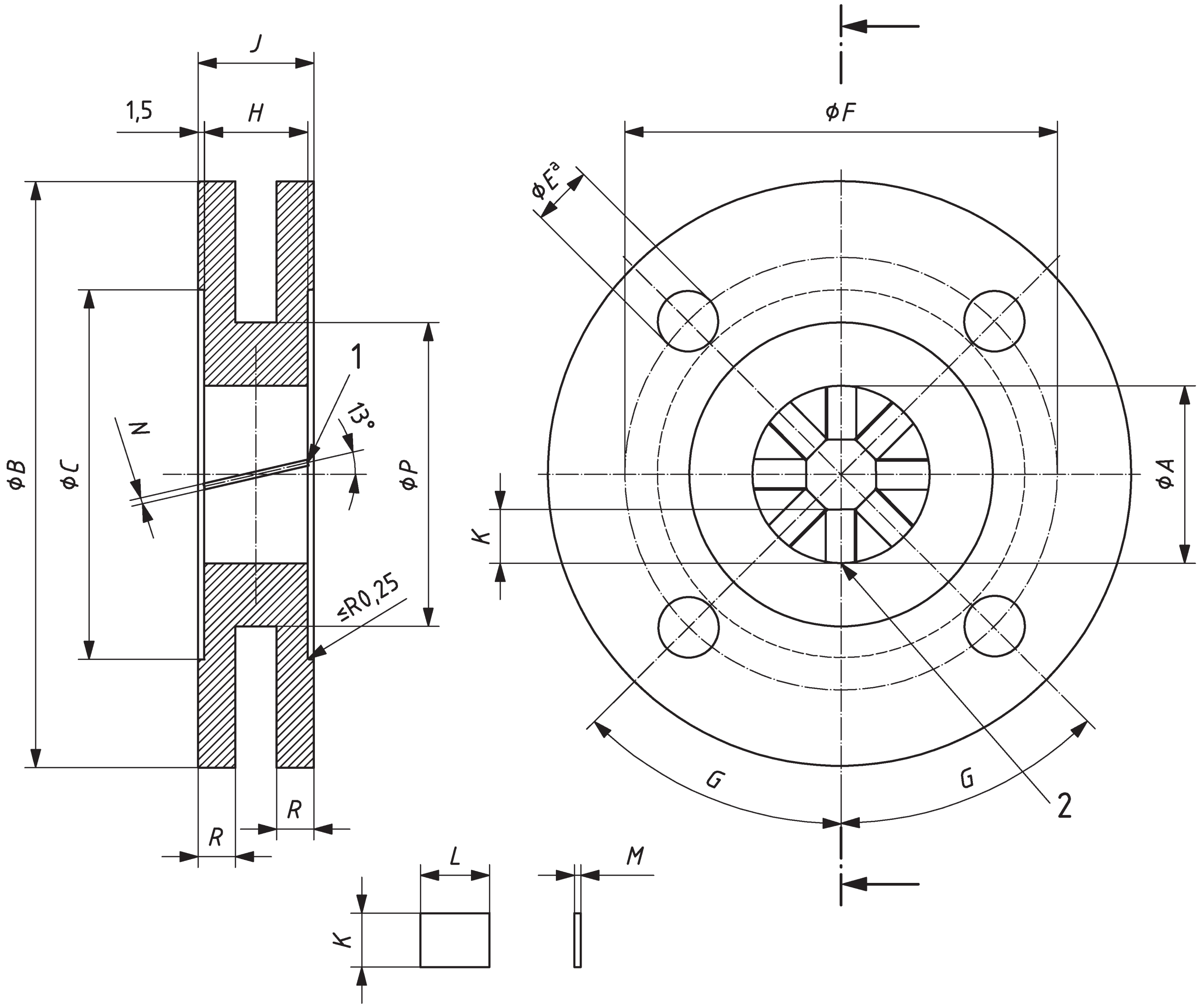


Item	Description	Qty.	Material
1	Flow disturber	1	Stainless steel
2	Flow	–	–
3	Gasket	2	Fibre
4	Straight length with flange (ISO 7005-2 or 3)	2	Stainless steel

Type 3 disturber — Velocity profile flow disturber

Figure B.9 — Wafer type disturbance generator — Arrangement of velocity profile disturbance units

Figure B.10 illustrates the swirl generator of a wafer type disturbance generator, with dimensions as set out in Table B.6.



Key

1 8 slots equally spaced to locate blades

2 blades to be fixed in (welding)

Figure B.10 — Swirl generator for a wafer type disturbance generator, with dimensions as set out in Table B.6

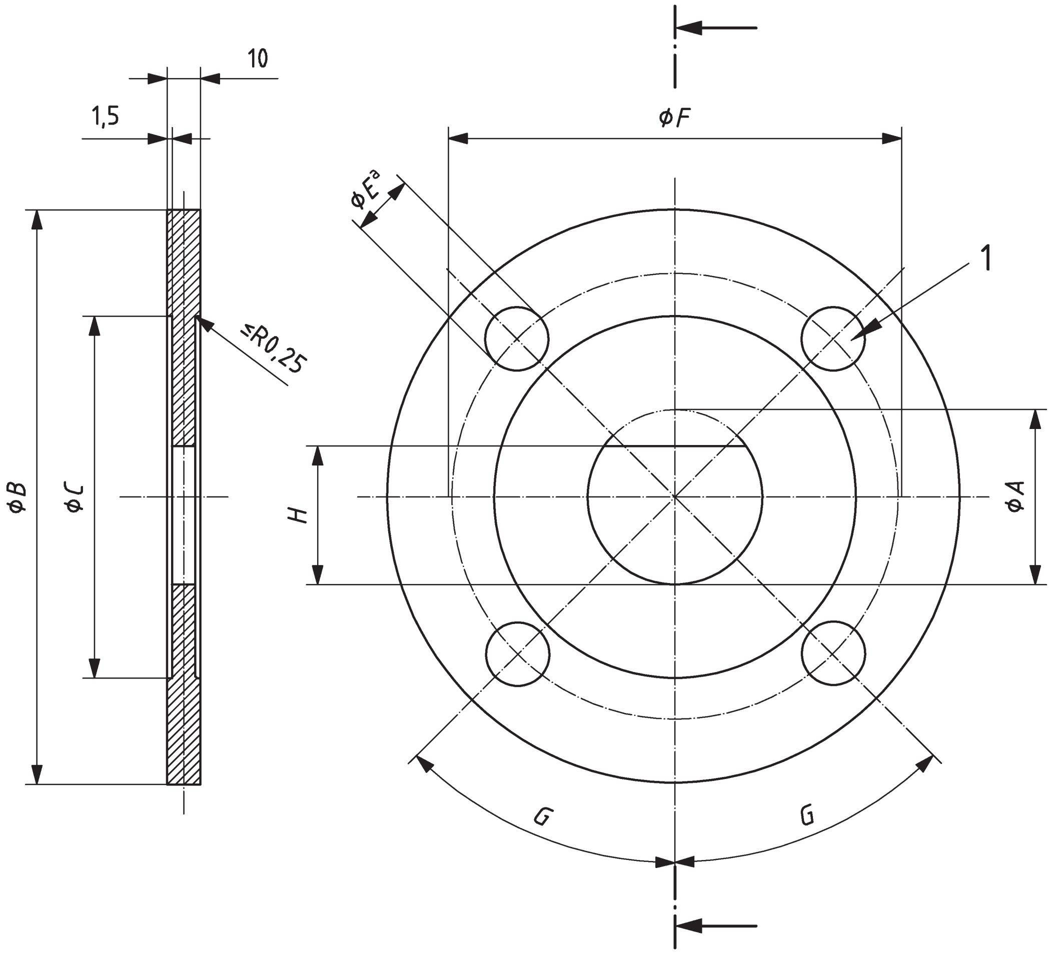
Table B.6 — Dimensions for the swirl generator of a wafer type disturbance generator (see Figure B.10)

DN	A	B	C	D	E	F	G	H	J	K	L	M	N	P	R
50	50	165	104	4	18	125	45°	25	28	16,9	25,5	1,5	1,57 1,52	–	–
65	65	185	124	4	18	145	45°	33	36	21,9	33,4	1,5	1,57 1,52	–	–
80	80	200	139	8	18	160	22 1/2°	40	43	26,9	40,6	1,5	1,57 1,52	–	–
100	100	220	159	8	18	180	22 1/2°	50	53	33,6	50,8	1,5	1,57 1,52	–	–

Table B.6 *(continued)*

DN	A	B	C	D	E	F	G	H	J	K	L	M	N	P	R
125	125	250	189	8	18	210	22 1/2°	63	66	41,9	64,1	1,5	1,57 1,52	–	–
150	150	285	214	8	22	240	22 1/2°	75	78	50,3	76,1	3,0	3,07 3,02	195	22
200	200	340	269	8	22	295	22 1/2°	100	103	66,9	101,6	3,0	3,07 3,02	245	24
250	250	395	324	12	22	350	15°	125	128	83,6	127,2	3,0	3,07 3,02	295	26
300	300	445	374	12	22	400	15°	150	153	100,3	152,7	3,0	3,07 3,02	345	28
400	400	565	482	16	27	515	11 1/4°	200	203	133,6	203,8	3,0	3,07 3,02	445	30
500	500	670	587	20	27	620	9°	250	253	166,9	255,0	3,0	3,07 3,02	545	32
600	600	780	687	20	30	725	9°	300	303	200,3	306,1	3,0	3,07 3,02	645	34
800	800	1 015	912	24	33	950	7 1/2°	400	403	266,9	408,3	3,0	3,07 3,02	845	36

Figure B.11 illustrates the flow disturber for a wafer type disturbance generator, with dimensions as set out in Table B.7.



Key

1 D holes ø E

a Wafer type disturbance generator — Item 1: Swirl generator.

Figure B.11 — Flow disturber of a wafer type disturbance generator, with dimensions as set out in Table B.7

Table B.7 — Dimensions for the flow disturber of a wafer type disturbance generator (see Figure B.11)

DN	A	B	C	D	E	F	G	H
50	50	165	104	4	18	125	45	43,8
65	65	185	124	4	18	145	45	56,9
80	80	200	139	8	18	160	22 1/2	70,0
100	100	220	159	8	18	180	22 1/2	87,5
125	125	250	189	8	18	210	22 1/2	109,4
150	150	285	214	8	22	240	22 1/2	131,3
200	200	340	269	8	22	295	22 1/2	175,0
250	250	395	324	12	22	350	15	218,8
300	300	445	374	12	22	400	15	262,5
400	400	565	482	16	27	515	11 1/4	350,0
500	500	670	587	20	27	620	9	437,5

Table B.7 *(continued)*

DN	A	B	C	D	E	F	G	H
600	600	780	687	20	30	725	9	525,0
800	800	1 015	912	24	33	950	7 1/2	700,0

Figure B.12 illustrates the gasket of a wafer type disturbance generator, with dimensions as set out in Table B.8.

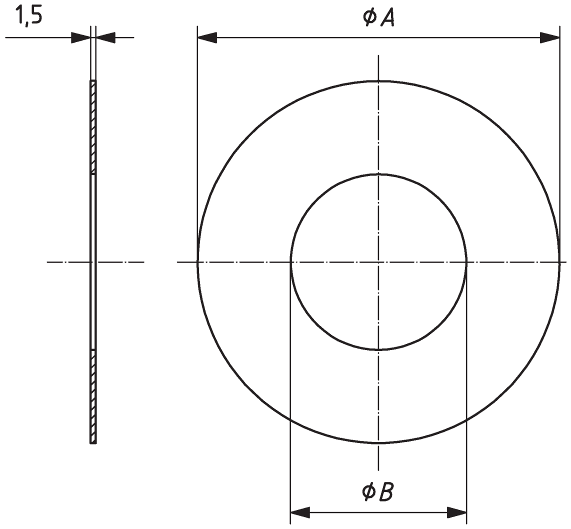


Figure B.12 — Gasket of a wafer type disturbance generator, with dimensions as set out in Table B.8

Table B.8 — Dimensions for the gasket of a wafer type disturbance generator (see Figure B.12)

Wafer type disturbance generator — Item 3: gasket		
DN	**A**	**B**
50	103,5	50,5
65	123,5	65,5
80	138,5	80,5
100	158,5	100,5
125	188,5	125,5
150	213,5	150,5
200	268,5	200,5
250	323,5	250,5
300	375,5	300,5
400	481,5	400,5
500	586,5	500,5
600	686,5	600,5
800	911,5	800,5

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[2] OIML V-1. *International vocabulary of terms in legal metrology*. VIML, 2000

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