BS ISO 16399:2023+A1:2025

BSI Standards Publication

Agricultural irrigation equipment — Meters for irrigation water

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National foreword

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Agricultural irrigation equipment — Meters for irrigation water

Matériel d'irrigation agricole — Compteurs pour l'eau d'irrigation

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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).

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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 23, *Tractors and machinery for agriculture and forestry*, Subcommittee SC 18, *Irrigation and drainage equipment and systems*.

This second edition cancels and replaces the first edition (ISO 16399:2014), which has been technically revised.

The main changes are as follows:

— the range of pressure regulators sizes has been extended up to DN 100 (4");

— the water temperature of the irrigation system has been harmonized to 60 °C;

— the normative references have been updated;

— the terms and definitions have been updated;

— the testing water temperature range has been updated to 4 °C to 35 °C;

— the face-to-face distance of the flanged bodies of the pressure regulators has been updated to ±4 mm for plastics-body regulators.

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.

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Agricultural irrigation equipment — Meters for irrigation water

1 Scope

This document 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. It applies to water meters intended for irrigation use (herein after referred to as water meters), regardless of the water quality used for this purpose.

This document 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.

NOTE Clean water meters are different from irrigation water meters. This document is based on clean water meters standards but, it is important to develop a specific standard for irrigation water meters indicating their specific requirements.

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 4064-1:2014, *Water meters for cold potable water and hot water — Part 1: Metrological and technical requirements*

ISO 4064-2:2014, *Water meters for cold potable water and hot water — Part 2: Test methods*

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

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.

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

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
actual volume
total volume of water passing through the meter, disregarding the time taken

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.

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3.2
adjustment device
part of the meter that allows adjustment of the indicated values such that the error curve of the meter is generally shifted parallel to itself to find in the envelope of *maximum permissible errors* (3.17)

3.3
ancillary device
device intended to perform a specific function, directly involved in elaborating, transmitting or displaying measured values

Note 1 to entry: The main ancillary devices are:

a) zero-setting device;

b) price-indicating device;

c) repeating indicating device;

d) printing device;

e) memory device;

f) tariff control device;

g) pre-setting device;

h) self-service device;

i) flow sensor movement detector (for detecting movement of the flow sensor before this is clearly visible on the indicating device);

j) remote reading device (which may be incorporated permanently or added temporarily).

3.4
bounce
momentary re-opening of a contact after initial closing, or a momentary closing after initial opening

3.5
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* (3.28)

3.6
calculator
part of the meter that transforms the output signals from the measurement transducer(s) and, possibly, form associated measuring instruments and, if appropriate, stores the results in memory until they are used

Note 1 to entry: The gearing is considered to be the calculator in a mechanical meter.

Note 2 to entry: The calculator may be capable of communicating both ways with ancillary devices.

3.7
correction device
device connected to or incorporated in the meter for automatic correction of the volume of water at metering conditions, by taking into account the *flow rate* (3.10) and/or the characteristics of the water to be measured and the pre-established calibration curves

3.8
durability
ability of a meter to maintain its performance characteristics over a period of use

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3.9
error
measured quantity value minus a reference quantity value

$$\frac{V_i - V_a}{V_a} \times 100\ (\%)$$

3.10
flow rate
volume of water flowing through the meter per unit time

3.11
indicating device
part of the meter that provides an indication corresponding to the volume of water passing through the meter

3.12
indicated volume
volume of water indicated by the meter, corresponding to the *actual volume* (3.1)

3.13
influence factor
influence variable (3.14) having a value within the *rated operating conditions* (3.27) specified for a *water meter* (3.32)

3.14
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

3.15
maximum admissible pressure
maximum internal pressure that the meter can withstand permanently, within its *rated operating conditions* (3.27), without deterioration of its metrological performance

Note 1 to entry: MAP is equivalent to nominal pressure (PN).

3.16
maximum admissible temperature
MAT
maximum water temperatures that a meter can withstand permanently, within its *rated operating conditions* (3.27), without deterioration of its metrological performance

3.17
maximum permissible error
MPE
extreme value of error, with respect to a known reference quantity value, permitted by the specifications given in this document

3.18
measurement transducer
part of the meter that transforms the *flow rate* (3.10) or volume of water to be measured into signals which are passed to the *calculator* (3.6) and includes the *sensor* (3.29)

Note 1 to entry: The measurement transducer may function autonomously or use an external power source and may be based on a mechanical, electrical or electronic principle.

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3.19
metering conditions
conditions of the water, the volume of which is to be measured, at the point of measurement

EXAMPLE Water temperature, water pressure.

3.20
minimum admissible temperature
mAT
minimum water temperatures that a meter can withstand permanently, within its *rated operating conditions* (3.27), without deterioration of its metrological performance

3.21
minimum flow rate
Q_1
lowest *flow rate* (3.10) at which the meter is designed to operate within the *maximum permissible error* (3.17)

3.22
nominal diameter
alphanumeric designation of the size of pipe work components, used for reference purposes, comprising the letters DN followed by a dimensionless round number which is loosely related to the effective dimensions, in millimetres, of the bore or external diameter of the end connections

3.23
operate position time
interval of time between the instant the *reed contact unit* (3.28) 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* (3.5) in a normally open contact or the opening bounce time in a normally closed contact.

3.24
overload flow rate
Q_4
highest *flow rate* (3.10) at which the *water meter* (3.32) is designed to operate for a short period of time within its *maximum permissible error* (3.17), while maintaining its metrological performance when it is subsequently operating within the *rated operating conditions* (3.27)

3.25
permanent flow rate
Q_3
highest *flow rate* (3.10) within the *rated operating conditions* (3.27) at which the meter is designed to operate within the *maximum permissible errors* (3.17)

3.26
pressure loss
difference in pressure due to water flow between two specified points in a system or in part of a system

3.27
rated operating condition
operating conditions requiring fulfilment during measurement in order that a meter performs as designed

[SOURCE: VIM:2012, 4.9]

3.28
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)

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3.29
sensor
element of a meter that is directly affected by a phenomenon, body or substance carrying a quantity to be measured

Note 1 to entry: For a water meter, the sensor may be a disc, piston, wheel or turbine element, the electrodes on an electromagnetic meter, or another element. The element senses the flow rate or volume of water passing through the meter an is referred to as a "flow sensor" or "volume sensor".

3.30
test flow rate
mean *flow rate* (3.10) during a test, calculated from the indications of a calibrated reference device

3.31
transitional flow rate
Q_2
flow rate (3.10) between the *permanent flow rate* (3.25) and the *minimum flow rate* (3.21) that divides the flow rate range into two zones, the upper zone and the lower zone, each characterized by its own *maximum permissible error* (3.17)

3.32
water meter
instrument intended to measure continuously, memorize and display the volume of water passing through the measurement transducer at metering conditions

Note 1 to entry: When a device claiming to be a water meter has the intended use of documenting water flow for payment purposes, then that device must include, 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. Water meters not intended for payment purposes only need to be compatible, in some way, with all the aforementioned three devices.

[SOURCE: OIML R49-1:2006]

3.33
working pressure
average water pressure in the pipe measured upstream and downstream of the meter

3.34
working temperature
T_w
water temperature in the pipe measured upstream of a *water meter* (3.32)

[SOURCE: OIML R49-1:2006]

4 Metrological requirements

4.1 Values of Q_1, Q_2, Q_3 and Q_4

4.1.1 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

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

4.1.2 Measuring range

The measuring range for the flow rate is defined by the ratio (R) 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.

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

The overload flow rate is defined by Formula (1):

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

4.1.4 The ratio Q_2/Q_1 shall be 1,6

The transitional flow rate is defined by Formula (2):

$$Q_2/Q_1 = 1{,}6 \tag{2}$$

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.

4.2 Maximum permissible error (MPE)

4.2.1 Formulation

The error is expressed as a percentage, and is calculated using Formula (3):

$$\varepsilon = \frac{(V_i - V_a)}{V_a} \times 100\ (\%) \tag{3}$$

where

V_i is the indicated volume;

V_a is the actual volume.

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4.2.2 Accuracy class

4.2.2.1 General

A water meter shall be designed and manufactured such that its errors do not exceed the maximum permissible errors (MPE).

A water meter shall be designated as either accuracy class 1 or accuracy class 2, according to the requirements of 4.2.2.2 or 4.2.2.3, respectively.

The meter manufacturer shall specify the accuracy class.

The requirements relating to the MPEs shall be met for all temperature and pressure variations occurring within the rated operating conditions of a water meter.

The two accuracy classes are providing the end users with the option to choose the right meter that best fits their application (flow ranges and measuring accuracy.

4.2.2.2 Accuracy class 1 water meters

The MPE for the upper flow rate zone ($Q_2 \leq Q \leq Q_4$) is ±1 %, for temperatures from 0,1 °C to 30 °C, and 2 % for temperatures greater than 30 °C.

The MPE for the lower flow rate zone ($Q_1 \leq Q < Q_2$) is ±3 % regardless of the temperature range.

4.2.2.3 Accuracy class 2 water meters

The MPE for the upper flow rate zone ($Q_2 \leq Q \leq Q_4$) is ±2 %, for temperatures from 0,1 °C to 30 °C, and 3 % for temperatures greater than 30 °C.

The MPE for the lower flow rate zone ($Q_1 \leq Q < Q_2$) is ±5 % regardless of the temperature range.

4.2.3 Meter temperature classes

The meters form water temperature classes corresponding to the various ranges, chosen by the manufacturer from the values given in Table 1.

The water temperature shall be measured at the inlet of the meter.

Table 1 — Temperature classes

Class	**mAT** (°C)	**MAT** (°C)
T30	0,1	30
T50	0,1	50

4.2.4 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 or not the meter is designed to measure reverse flow.

If the meter is designed to measure reverse flow, the volume passed during reverse flow shall either be subtracted from the indicated volume or the meter shall record it separately. The MPE of 4.2.2.2 or 4.2.2.3 shall be met for both forward and reverse flow. For meters designed to measure reverse flow, the permanent flow rate and the measuring range may be different in each direction.

If the meter is not designed to measure reverse flow, the meter shall either prevent reverse flow or it shall not calculate or report reverse flow if it occurs and any accidental reverse flow shall not change the indicated volume reported by the meter. Additionally, a meter that is not designed to measure

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reverse flow shall not have any deterioration or change in its metrological properties for forward flow if exposed to reverse flows up to the nominal maximum flow rate.

4.2.5 Absence of flow or of water

The water meter totalization shall not change in the absence either flow or of water.

4.2.6 Static pressure

A water meter shall be capable of withstanding the following test pressures without leakage or damage:

a) 1,6 times the maximum admissible pressure applied for 15 min;

b) twice the maximum admissible pressure applied for 1 min.

4.3 Requirements for meters and ancillary devices

The meters with electronic parts and/or ancillary devices shall comply with the requirements establish in ISO 4064-1:2014, 4.3.

5 Water meters equipped with electronic devices

The meters equipped with electronic devices shall comply with the requirements stablish in ISO 4064-1:2014, Clause 5.

6 Technical characteristics

6.1 Materials and construction of water meters

A water meter shall be manufactured from materials of adequate strength and durability for the purpose for which it is to be used.

A water meter shall be manufactured from materials, which shall not be adversely affected by the water temperature variations, within the working temperature range.

All parts of a water meter in contact with the water flowing through it shall be manufactured from materials which are conventionally known to be non-toxic, non-contaminating, and biologically inert.

The complete water meter shall be manufactured from materials which are resistant to internal and external corrosion or which are protected by a suitable surface treatment.

A water meter indicating device shall be protected by a transparent window. A cover of a suitable type may also be provided as additional protection.

Where there is a risk of condensation forming on the underside of the window of a water meter indicating device, the water meter shall incorporate devise for prevention or elimination of condensation.

A water meter shall be of such design, composition, and construction that it does not facilitate the perpetration of fraud.

A water meter shall be fitted with a metrologically controlled display. The display shall be readily accessible to the customer, without requiring the use of a tool.

A water meter shall be of such design, composition, and construction that it does not exploit the MPE or favour any party.

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6.2 Adjustment and correction

A water meter may be fitted with an adjustment device, and/or a correction device. Any adjustment shall be performed in such a way as to adjust the errors of the water meter to values as close as practical to zero so that the meter may not exploit the MPE or systematically favour any party.

If the devices are mounted on the outside of the water meter, provision for sealing shall be made (see 6.8.2).

6.3 Installation conditions

The water meter shall be installed such that it is completely filled with water under normal conditions.

Under specific installation conditions, a strainer or filter, fitted at the inlet of a meter or in the upstream pipeline, may be required.

Provision may be made on a water meter to allow it to be correctly levelled during installation.

If the accuracy of a water meter is affected by disturbance in the upstream or downstream pipeline (e.g. due to the presence of bends, valves or pumps), the water meter shall be provided with a sufficient number of straight pipe lengths, with or without a low straightener, as specified by the manufacturer, so that the indications of the installed water meter meet the requirements of 4.2.2.2 or 4.2.2.3.

A meter manufacturer shall specify the flow profile sensitivity class indicating:

— Sensitivity to irregularity in the upstream velocity profiles:

U**X**, where X is replaced with the manufacturer's nominal diameter requirement, rounded up to the nearest whole number.

When a straightener is required by the manufacturer, the class shall be U**X**S, where X is replaced with the manufacturer's nominal diameter requirement (with the straightener), rounded up to the nearest whole number.

If a straightener is optional, both UX and UXS forms shall be used.

A1 — Water meter manufacturers can specify the flow profile sensitivity class in accordance with Table 2, based on the results of the relevant tests specified in 7.5.

Table 2 — 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
NOTE The values in this table are recommendations, but any other value can be chosen.		

A1

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— Sensitivity to irregularity in the downstream velocity profiles:

D**X**, where X is replaced with the manufacturer's nominal diameter requirement, rounded up to the nearest whole number.

When a straightener is required by the manufacturer, the class shall be D**X**S, where X is replaced with the manufacturer's nominal diameter requirement (with the straightener), rounded up to the nearest whole number.

If a straightener is optional, both UX and DXS forms shall be used.

A1 — Water meter manufacturers can specify the flow profile sensitivity class in accordance with Table 3, based on the results of the relevant tests specified in 7.5.

Table 3 — 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
NOTE The values in this table are recommendations, but any other value can be chosen.		

A1

6.4 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} < 60 °C;

b) pressure (P): 0,03 MPa (0,3 bar) to at least 1 MPa (10 bar), except for meters of DN ≥ 500, where the maximum admissible pressure (MAP) shall be at least 0,6 MPa (6 bar);

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).

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6.5 Pressure loss

The pressure loss through a water meter, including its filter or strainer and/or straightener, where either of these forms an integral part of the water meter, shall not be greater than the maximum value of the pressure loss corresponding to the class declared by the manufacturer, between Q_1 and Q_3.

The pressure loss class is selected by the manufacturer from values taken from A1 Table 4. A1

Table A1 4 A1 — Pressure-loss classes

Class	Maximum pressure-loss	
	(kPa)	(bar)
Δp 100	100	1,00
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.

6.6 Marks and inscriptions

A1 A 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 the meter cover, if it is not detachable. These markings shall be visible without dismantling the water meter after the instrument has been placed on the market or put into use.

a) Unit of measurement.

b) Accuracy class, where it differs from accuracy class 2.

c) Numerical value of Q_3 and the ratio Q_3/Q_1: if the meter measures reverse flow and the values of Q_3 and the ratio Q_3/Q_1 are different in the two directions, both values of Q_3 and Q_3/Q_1 shall be inscribed; the direction of flow to which each pair of values refers shall be clear. The ratio Q_3/Q_1 may be expressed as R, e.g. "R40". If the meter has different values of Q_3/Q_1 in horizontal and vertical positions, both values of Q_3/Q_1 shall be inscribed, and the orientation to which each value refers shall be clear.

d) Name or trademark of the manufacturer.

e) Year of manufacture, the last two digits of the year of manufacture, or the month and year of manufacture.

f) Serial number (as near as possible to the indicating device).

g) Direction of flow, by means of an arrow (shown on both sides of the body or on one side only provided the direction of flow arrow is easily visible under all circumstances).

h) Maximum admissible pressure (MAP) if it exceeds 1 MPa or 0,6 MPa for DN ≥ 500.

Note

1 bar = 100 000 Pa

1 bar = 0,1 MPa

i) Letter V or H, if the meter can only be operated in the vertical or horizontal position.

j) The temperature class as specified in Table 1 where it differs from T30

k) The pressure loss class where it differs from Δp 100.

l) The installation sensitivity class where it differs from U0/D0.

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For a water meter with electronic devices, the following additional inscriptions shall be applied where appropriate.

m) For an external power supply: the voltage and frequency.

n) For a replaceable battery: the latest date by which the battery shall be replaced.

o) For a non-replaceable battery: the latest date by which the meter shall be replaced.

p) Environmental classification.

q) Electromagnetic environmental class.

The environmental classification and electromagnetic environmental class may be given on a separate datasheet, unambiguously related to the meter by a unique identification, and not on the meter itself.

An example of the required marks and inscriptions for a meter without electronic devices follows:

EXAMPLE $Q3$ 63; R 125; H; → 123456; 08; ABC

— Q_3 = 63 m^3/h;

— Q_3/Q_1 = 125;

— horizontal mounting;

— temperature class 30;

— pressure loss class Δp 63;

— maximum admissible pressure: 1 MPa (10 bar);

— flow profile sensitivity class U0/D0;

— serial number: 123456;

— year of manufacture: 2008;

— manufacturer ABC. A1

6.7 Indicating device

6.7.1 General requirements

6.7.1.1 Function

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

6.7.1.2 Unit of measurement

The indicated volume of water shall be expressed preferably, in cubic meters. The other units that can be used are: litres, mega litres, acre-feet, acre-inches, gallons, or thousands of gallons. The manufacturer shall include documentation describing the units, the symbol used to identify the units, and a conversion factor to compute an equivalent value of cubic meters. When a meter's indicating device is capable of displaying different units, the display device must clearly indicate what units are used at any given time.

6.7.1.3 Indicating range

This requirement is set in A1 Table 5. A1

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