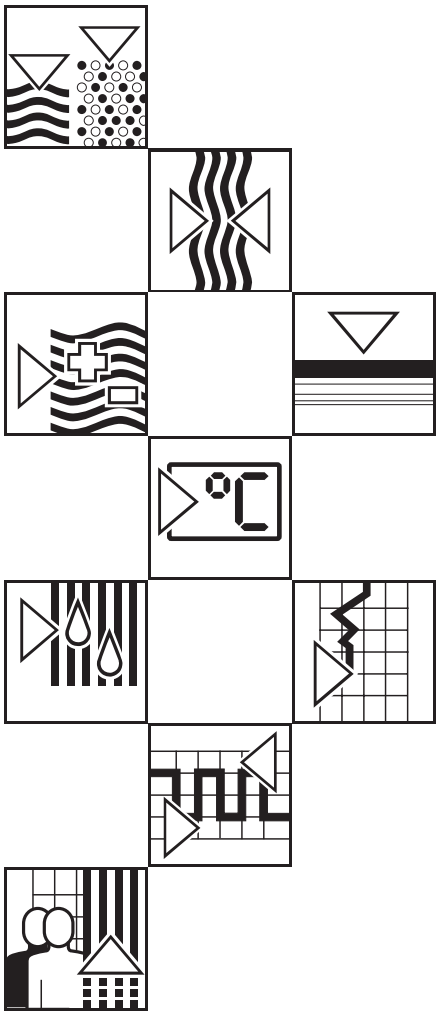
BA 041D/06/en/01.99
No. 50093115
CV 5.0

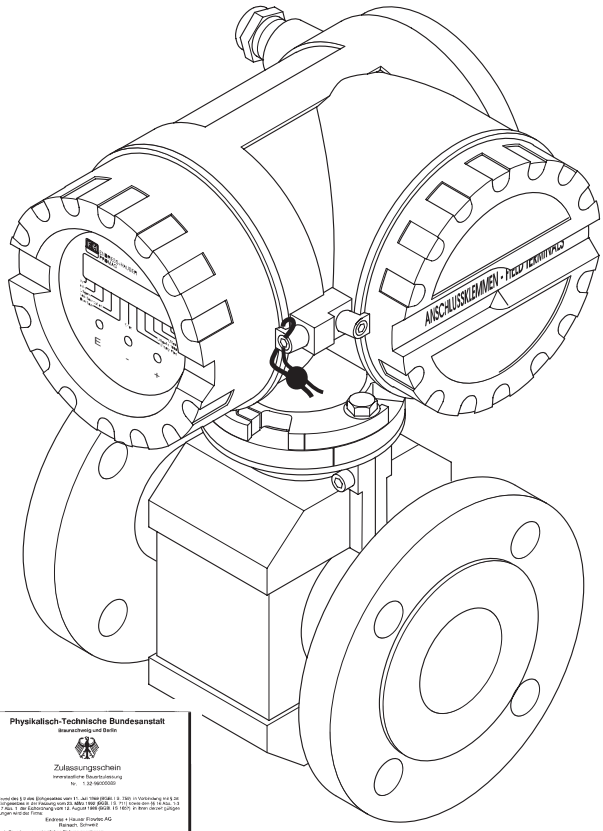
Valid as of software version
V 4.00.XX (amplifier)

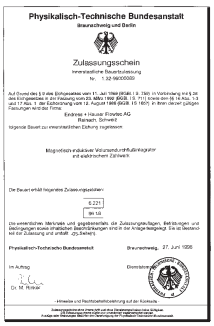
promag 31 F (Model '99) Electromagnetic Flow Measuring System

For custody transfer with cold water (wastewater)

Operating Manual







Physikalisch-Technische Bundesanstalt
Braunschweig und Berlin

Zulassungsschein

Innereuropäische Bauartzulassung
Nr. 1.32-96003000

Auf Grund des § 9 des Eichgesetzes vom 11. Juli 1969 (BGBl. I S. 759) in Verbindung mit § 26 des Eichgesetzes in der Fassung vom 23. März 1992 (BGBl. I S. 711) sowie den §§ 14 Abs. 1 3 und 17 Abs. 1 der Eichordnung vom 12. August 1988 (BGBl. I S. 1657) in ihren derzeit gültigen Fassungen wird das Firma

Endress + Hauser Flowtec AG
Reinach, Schweiz

folgende Bauart zur innereuropäischen Eichung zugelassen

Magnetisch-induktiver Volumendurchflußmengenmesser
mit elektronischem Zählwerk

Die Bauart erhält folgendes Zulassungszeichen:

D 221
99 10

Die einzelnen Merkmale und zugelassenen die Zulassungsgegenstand, Bedingungen und Bedingungen sowie inhaltlichen Beschränkungen sind in der Anlage beigefügt. Sie ist Bestandteil der Zulassung und enthält ... (Zeichen).

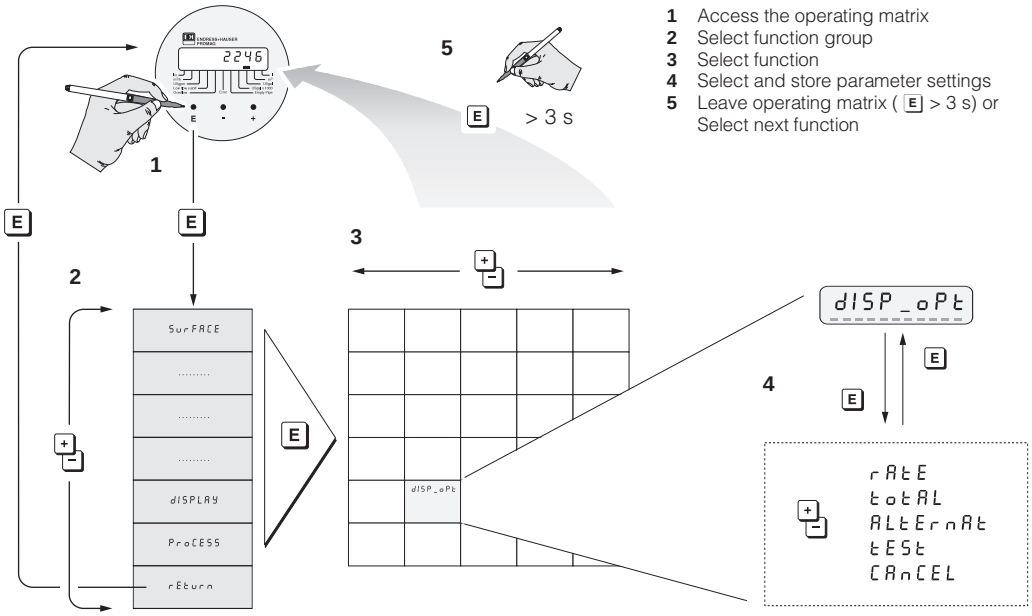
Physikalisch-Technische Bundesanstalt Braunschweig, 27. Juni 1996

Im Auftrag Dienstsiegel
Dr. M. Richter

Endress+Hauser

Nothing beats know-how

Operating summary / Operating matrix

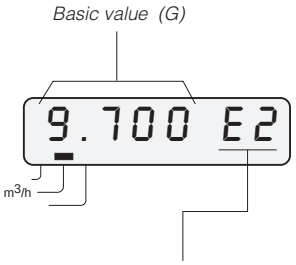


1 Access the operating matrix
2 Select function group
3 Select function
4 Select and store parameter settings
5 Leave operating matrix (E > 3 s) or Select next function

Function group "Gr00 / SurFACE"		
Fu01 / PAGECodE	Function code	ALPHA = Text code nbr = Number code
Fu02 / u_rAtE	Flow rate unit	unit_1 = l/s; unit_2 = m³/h; unit_3 = USgpm
Fu03 / u_totAL	Totalizer unit	unit_4 = USgal x 1000; unit_5 = USgal; unit_6 = m³; unit_7 = l (Litre)
Function group "Gr10 / Curr_out"		
Fu11 / F_SCALE	Full scale current value	Numeric entry: x.xxx E ± x
Fu12 / t_ConSt	Time constant	Numeric entry: xx.x (in steps of 0.5 seconds)
Fu13 / I_rAnGE	Current range	0-20 (mA); 4-20 (mA)
Function group "Gr20 / PuLS_out"		
Fu21 / P_FACtor	Pulse value	Numeric entry: x.xxx E ± x
Function group "Gr30 / StAt_out"		
Fu31 / StAt_FCt	Status output function *	Error = System and process error indication FLo_dir = Flow direction indication
Function group "Gr40 / InPut"		
Fu41 / InP_FCt	Auxiliary input function *	SuPPrESS = Positive zero return rES_tot = Totalizer reset to "0"
Function group "Gr50 / dISPLAY"		
Fu51 / rES_tot	Totalizer reset	CAnCEL rES_YES = Totalizer reset to "0"
Fu52 / dISP_oPt	Display mode	rAtE = Flow rate display; totAL = Totalizer display; ALtErnAt = Alternating display of flow rate and totalizer tESt = Display test function
Fu53 / dISP_dA	Display damping	Numeric entry: xx.x (in steps of 0.5 seconds)
Fu54 / tot_oFL	Totalizer overflows	Display of totalizer overflows
Function group "Gr60 / ProCESS"		
Fu61 / LFC	Creep suppression *	LFC_oFF = Suppression off LFC_on = Suppression on
Fu62 / EPD	Empty Pipe Detection (EPD)	EPD_oFF = off; EPD_on = on; EPD_Ad_E = Empty pipe adjust EPD_Ad_F = Full pipe adjust
Fu63 / ECC	Electrode cleaning (ECC) *, optional	ECC_oFF = off ECC_on = on
rEturn	E → Return to the Function group (or HOME Position)	

* Configurations and selections in ***custody transfer mode*** → see page 33

Display of numerical values



E 5 = 10^{+5} = 100000
E 4 = 10^{+4} = 10000
E 3 = 10^{+3} = 1000
E 2 = 10^{+2} = 100
E 1 = 10^{+1} = 10
E 0 = 10^{0} = 1
E–1 = 10^{-1} = 0.1
E–2 = 10^{-2} = 0.01
E–3 = 10^{-3} = 0.001
E–4 = 10^{-4} = 0.0001
E–5 = 10^{-5} = 0.00001

Actual value = $G \times M$

Example:

9.700 E 2
= **9.700** × 10^{+2} = **970.0** [m³/h]

9.700 E-2
= **9.700** × 10^{-2} = **0.097** [m³/h]

Contents

Registered Trademarks

KALREZ ®, VITON ® and TEFLON ®
Registered trademark of E.I. Du Pont de Nemours & Co., Wilmington, USA

TRI-CLAMP ®, HASTELLOY ®
Registered trademark of Ladish & Co., Inc., Kenosha, USA

1 Safety Instructions

1.1 Correct usage

- The measuring system Promag 31 is PTB certified for custody transfer with cold water (wastewater) and may only be used for measuring the flow of freshwater having a min. conductivity of ≥ 5 µS/cm. The Promag 31 F is operated exclusively with a totalizer display suitable for custody transfer.
  The measuring system operates within a temperature range of 0...30 °C and can be deployed for the following uses in the supply of drinking water:
  – Internal monitoring of delivery pipe network (local water network)
  – Calculation of the bill from the main supply pipe (junctions)
  – Monitoring of the water source. For example, the amount of ground water (tank inlet points, incl. pump stations).
  – Certification for the amount supplied to the delivery network (tank outlet points).
  – Monitoring of the withdrawal and supply of different water works in a supply pipe (Overland supply pipe of a water network).

- The manufacturer assumes no liability for damage caused by incorrect use of the instrument.
- Instruments which are used in the explosion hazardous area are supplied with a separate “Ex documentation”, which is an integral part of this Operating Manual. The instructions and connected loads provided in this supplement must absolutely be observed. An appropriate icon is shown on the front of this document according to the approval given and the test center.

1.2 Dangers and notes

All instruments are designed to meet state-of-the-art safety requirements, have been tested, and have left the factory in an operational perfectly safe condition.
The devices were developed according to EN 61010 “Protection Measures for Electronic Equipment for Measurement, Control, Regulation and Laboratory Procedures”.
A hazardous situation may occur if the flowmeter is not used for the purpose it was designed for or is used incorrectly.
Please carefully note the information provided in this Operating Manual indicated by the following pictograms:

Warning!
A “warning” indicates actions or procedures which, if not performed correctly, may lead to personal injury or a safety hazard.
Please strictly observe the instructions supplied and proceed carefully.


Warning!

Caution!
A “caution” indicates actions or procedures which, if not performed correctly, may lead to faulty operations or the destruction of the instrument.
Please strictly observe the respective instructions.


Caution!

Note!
A “note” indicates actions or procedures which, if not performed correctly, may indirectly affect operations or lead to an unexpected instrument response.


Note!

1.3 Personnel for installation, start-up and operation

- A calibrated Promag 31 measuring system is protected by seals on the transmitter or the sensor connection housing from manipulation of calibration parameters such as pulse weighting (see page 35). As a rule, these seals may only be broken by a representative of the appropriate approval authorities.
- Mounting, electrical installation, start-up and maintenance of the instrument may only be carried out by trained personnel authorized by the operator of the facility. Personnel must absolutely and without fail read and understand this Operating Manual before carrying out its instructions.
- The instrument may only be operated by personnel who are authorized and trained by the operator of the facility. All instructions in this manual are to be observed without fail.
- With special fluids, incl. those used for cleaning, E+H will be pleased to supply information concerning the chemical resistance properties of wetted parts.
- When welding the piping, the welding machinery must not be grounded through the Promag.
- The installer has to make sure that the measuring system is correctly wired up according to the wiring diagrams. The measuring system is to be grounded.
- Please observe all provisions valid for your country and pertaining to the opening and repairing of electrical devices.


Warning!

Danger of electrical shock!

With the housing cover removed, protection against accidental contact is no longer present. Components with high voltages are exposed below the local display. When programming according to section 5.1–5.3, avoid any contact with the electronic components which lie below the local display, and do not use any electrically conductive object to depress the operating keys.

1.4 Repairs and dangerous substances

The following procedures must be carried out before a Promag 31 is sent to Endress+Hauser for repair:

- A note must always be enclosed with the instrument, containing a description of the fault, the application, and the chemical and physical properties of the product being measured.
- Remove all residue which may be present. Pay special attention to the gasket grooves and crevices where fluid may be present. This is especially important if the fluid is dangerous to health, e.g. corrosive, carcinogenic, radioactive, etc.
- No instrument should be returned without all dangerous material being removed first (e.g. in scratches or diffused through plastic).

Incomplete cleaning of the instrument may result in waste disposal or cause harm to personnel (burns, etc). Any costs arising from this will be charged to the owner of the instrument.

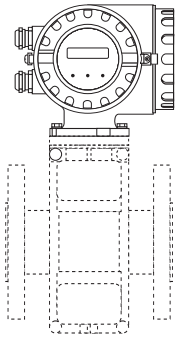
1.5 Technical improvements

The manufacturer reserves the right to modify technical data without prior notice. Your local E+H Sales Office will supply you with all current information and any updates to this Operating Manual.

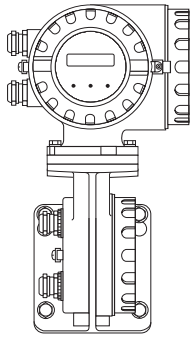
2 Instrument Identification

An overview of the complete Promag 31 measuring system is shown below.
The technical specifications are stamped on the nameplate and contain the following information:

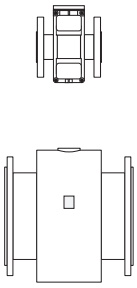
Promag 31 (Model '99) transmitter



Compact version



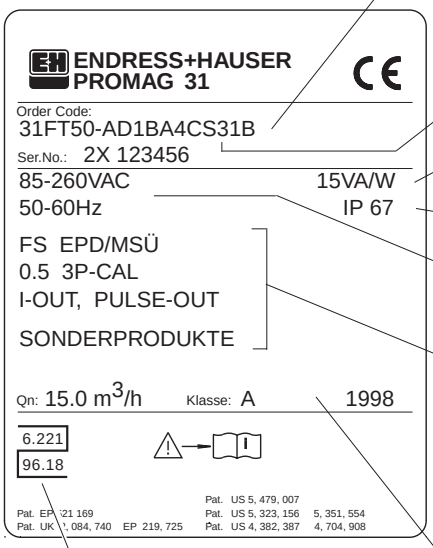
Remote version



Promag F
DN 15...300

Promag F
DN 350...2000

Sensors
(see next page)



Order code / Serial number
Definition code: see specifications on order confirmation

Identification number (“3”) for Promag 31 (Model '99)

Power consumption
15 VA / W

Ingress protection (IP 67)

Power supply / frequency
85...260 V AC (50...60 Hz)

Additional information
- FS: remote version “FS”
- EPD/MSÜ: with Empty Pipe Detection
- 0.5: with 0.5% accuracy
- 3P-CAL: 3-point calibration
- I-OUT: with current output
- PULSE-OUT: with pulse output
- Additional information for special products

Approval markings
for custody transfer instruments

Specifications for custody transfer mode
- Nominal flow rate (Qn) = 15.0 m^3/h
- Metrological Class A
- Year of manufacture 1998

ba041y03

Fig. 1
Promag 31 transmitter
Typical nameplate specifications (example)

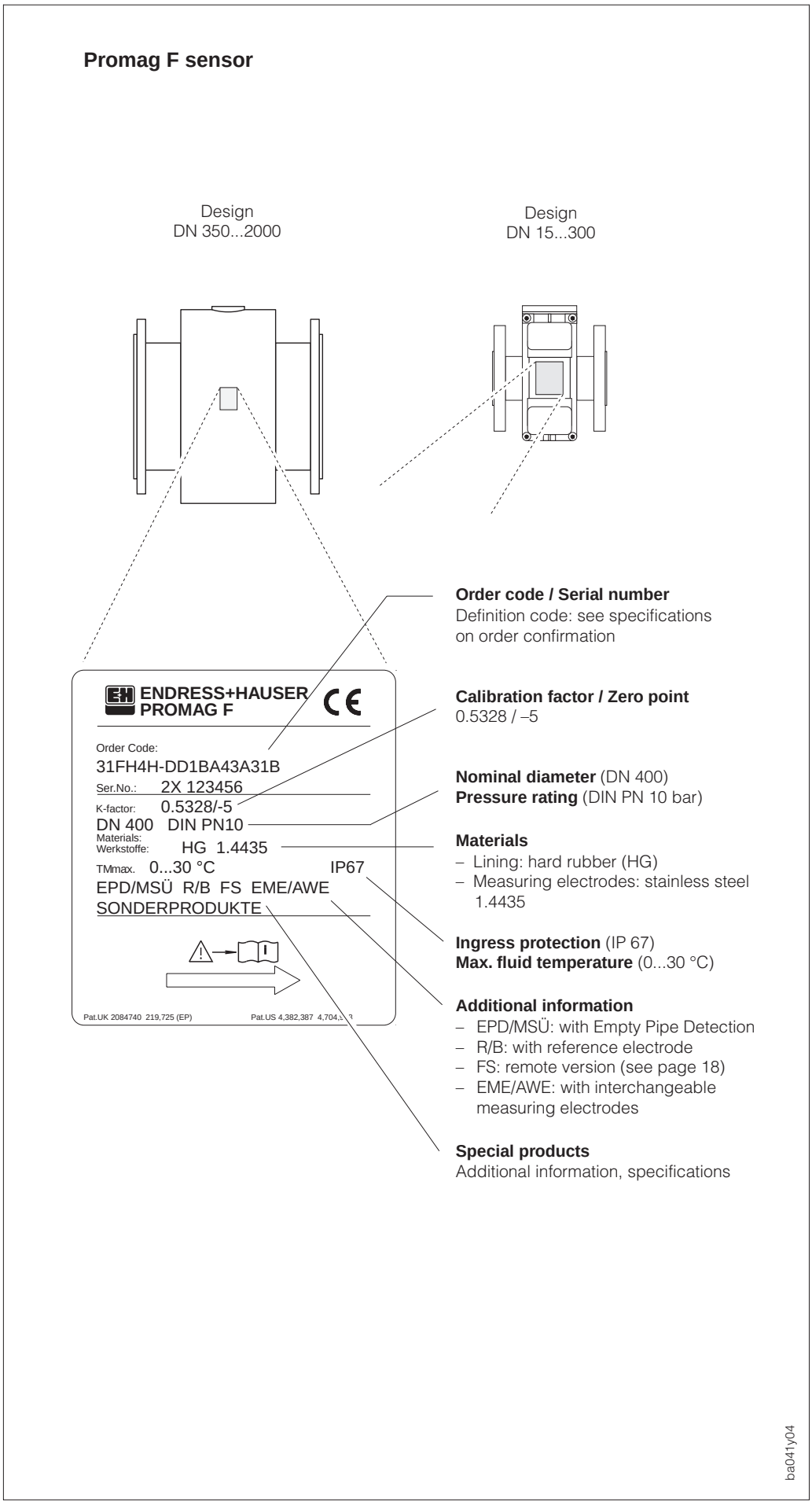


Fig. 2
Promag F sensor
Typical nameplate specifications (example)

3 Mounting and Installation

Warning!
- The instructions given in this section are to be observed at all times in order to ensure safe and reliable operation of the measuring system.
- For explosion protected instruments the mounting regulations and the technical data may differ from those stated here. Please refer to the Ex supplement of this Operating Manual for additional information.

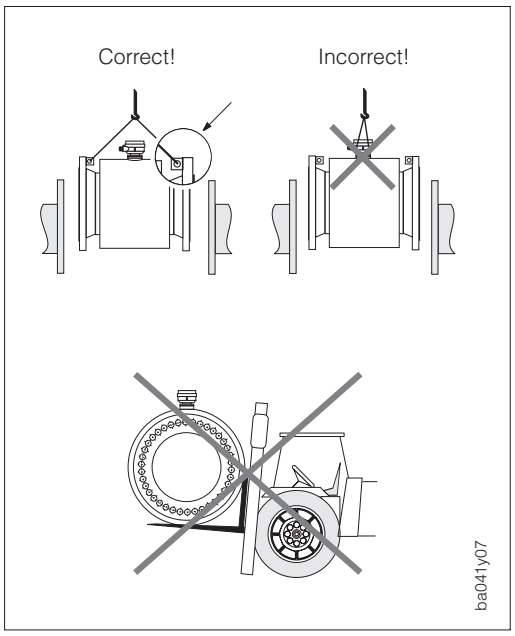
Warning!

3.1 Transport instructions (DN ≥ 350/14")

The pipe lining on the flanges is protected by disks to prevent damage when transporting to the measuring point. These are to be removed when installing. Instruments are to be transported in the containers they are delivered in.

Transporting to the measuring point
- The sensor must not be lifted by the transmitter housing!
- Use only the grips on the flange for lifting out and mounting the sensor in the piping (from DN 350 or 14").

Caution!
The sensor must not be lifted by the metal casing using a fork lift truck! This can buckle the casing and so damage the internal magnetic coils.

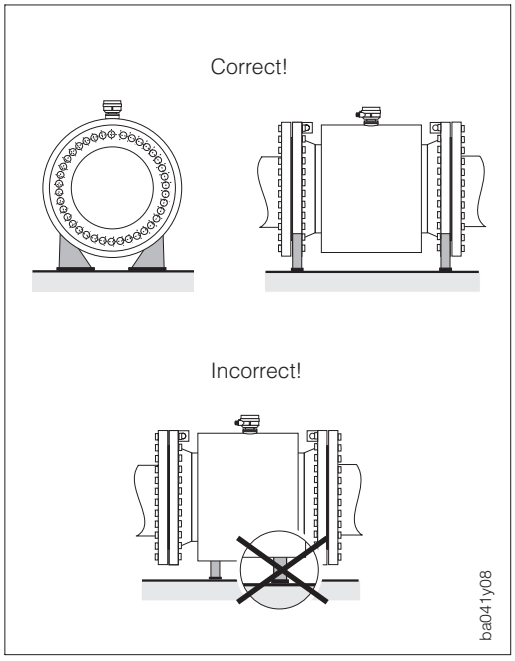


Caution!

Fig. 3
Transport instructions for large diameter sensors (DN ≥ 350)

Base and supports
The sensor is to be mounted on a base which is sufficiently strong enough to withstand its weight.

Caution!
Do not support the sensor by the sheet casing. The casing may be dented and so damage the magnetic coils inside the sensor.



Caution!

Fig. 4
The proper way to support large diameter sensors (DN ≥ 350)

3.2 Mounting location

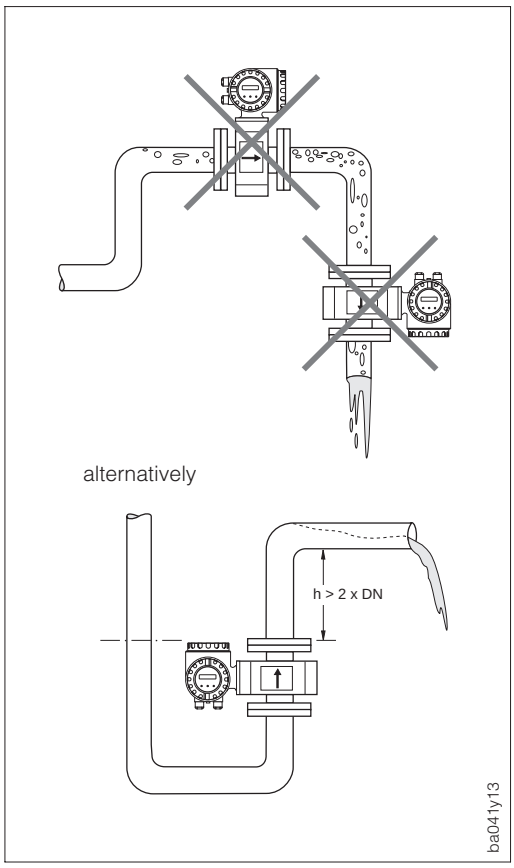
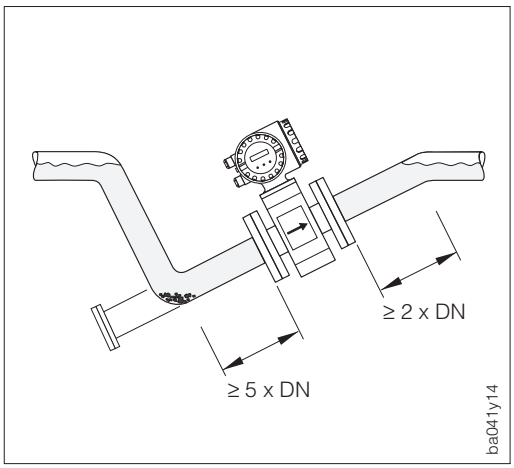


Fig. 5
Mounting location

Correct measurement is only possible when the pipe is full. The following locations should therefore be avoided:

- No installation at the highest point (air accumulation).
- No installation immediately before an open pipe outlet in a downward line.

  The alternative installation, however, permits a correct measurement.



Note!

Fig. 6
Mounting with a partly filled pipe

Partly filled pipes
For inclines a mounting similar to a drain should be adopted.
Added security is offered by Empty Pipe Detection in order to detect empty or partly filled pipes (see page 48).

Note!
Danger of solids accumulation!
Do not mount the sensor at the lowest point of the drain. A cleaning valve should also be installed.

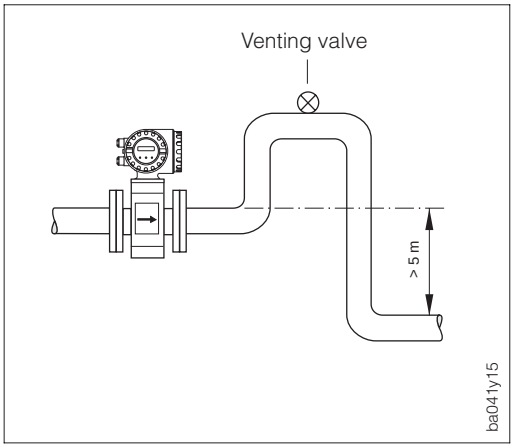


Fig. 7
Installation downward pipe

Downward pipe
With the installation suggested opposite, partial vacuum is avoided even with a downward pipe > 5 m long (siphon, vent valve downstream of the sensor).

Installation of pumps
Do not mount the sensors on the suction side of pumps. This prevents low pressure and therefore possible damage to the lining of the measuring tube.
Information on the resistance to vacuum of the flowmeter lining can be found on page 70.

Pulse dampers should be installed when using reciprocal, diaphragm or peristaltic pumps.

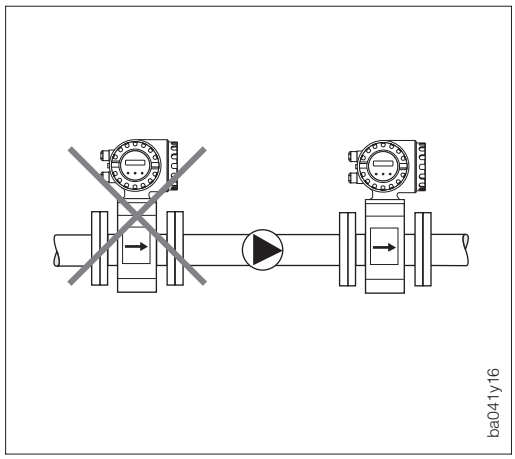
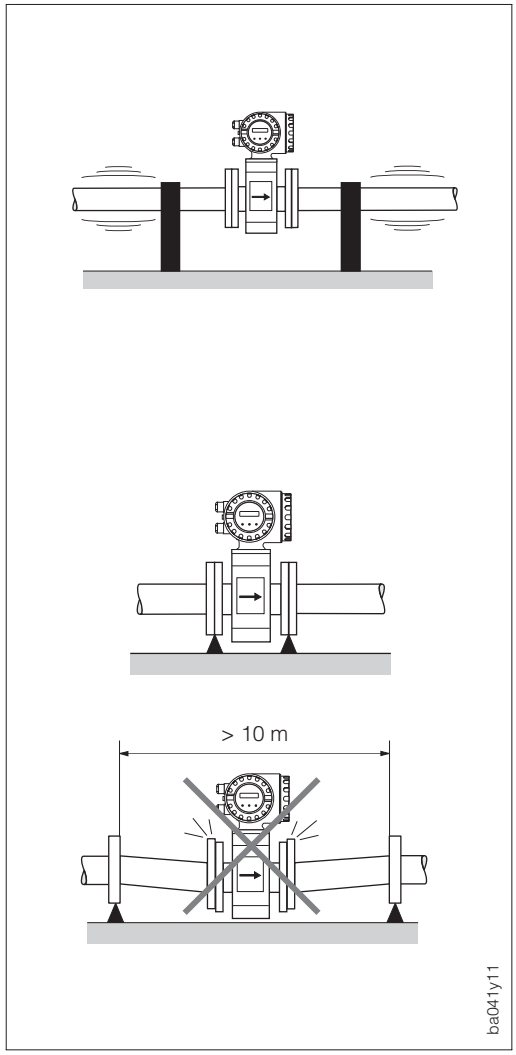


Fig. 8
Installation of pumps

Vibration
The piping before and after the sensor should be securely fastened if there is excessive vibration.
Information on shock and vibration resistance is found on page 63.

Caution!
Excessive vibration necessitates separate mounting of the sensor and transmitter (see pages 18, 63).

Mechanical support of the sensor is recommended for free runs of piping over 10 m long.



Caution!

Fig. 9
Remedies to avoid vibrations

3.3 Mounting position

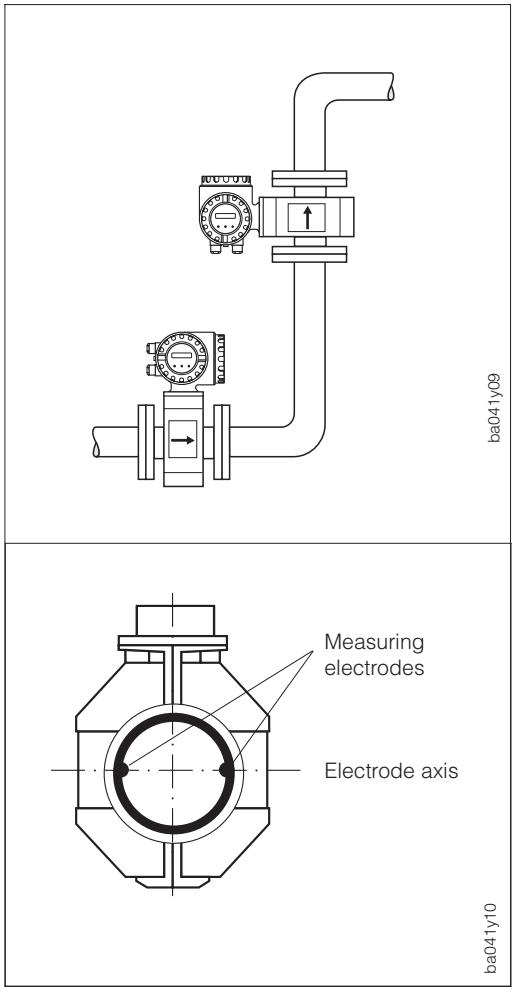


Fig.10
Mounting position (horizontal, vertical)

Vertical mounting:
This is the recommended position with the flow upwards. Entrained solid particles sink and fatty components in the stationary fluid rise away from the measuring electrodes. This is the optimal position in empty pipe system and when using Empty Pipe Detection (see page 48).

Horizontal mounting:
The axis of the electrodes must be horizontal, thus preventing brief insulation of the electrodes by entrained air bubbles.

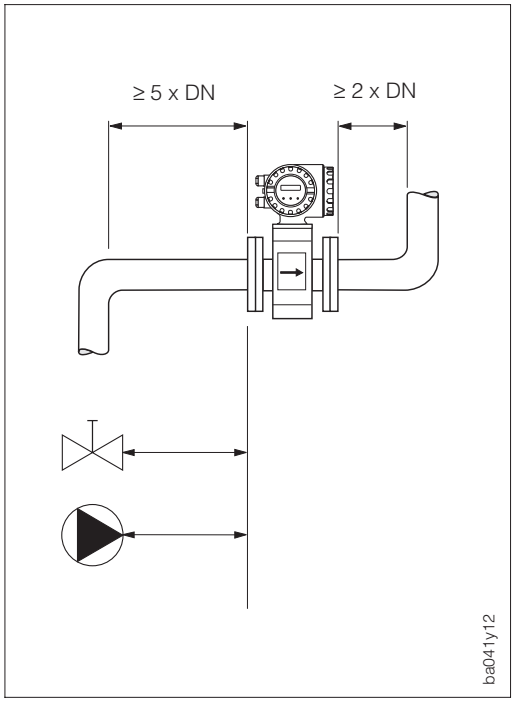


Fig. 11
Inlet and outlet sections

Inlet and outlet sections

The sensor should by mounted away from fittings such as valves, T-pieces, elbows, etc.

Inlet section: ≥ 5 x DN
Outlet section: ≥ 2 x DN

The inlet and outlet sections must be observed in order to maintain accuracy.

3.4 Nominal diameter and flow rate

The diameter of the pipe usually governs the nominal diameter of the sensor. The plant should be designed so that under “normal” operating conditions, the optimum flow rate lies between 2...3 m/s.

If it is necessary to increase the flow velocity, this can be done by reducing the nominal diameter of the sensor (see following chapter).

Nominal flow rate Qn [m^3/h]

Diameter	Metrological class A			Metrological class B		
DN [mm]	Qn (min)		Qn (max)	Qn (min)		Qn (max)
15	0.8	Qmin : Qn = 1 : 25	3.0	1.6	Qmin : Qn = 1 : 50	3.0
25	2.2		8.8	4.4		8.8
32	3.6		14.0	7.2		14.0
40	5.6		22.6	11.3		22.6
50	9.0		35.0	15.0 *	Qmin : Qn = 1 : 33	35.0
65	15.0		60.0	20.0		60.0
80	15.0 *	Qmin : Qn = 1 : 12.5	90.0	30.0		90.0
100	18.0		140.0	46.0		140.0
125	28.0		220.0	73.0		220.0
150	40.0		320.0	105.0		320.0
200	70.0		550.0	190.0		550.0
250	110.0		880.0	290.0		880.0
300	160.0		1250	420.0		1250
350	215.0		1700	570.0		1700
400	280.0		2200	750.0		2200
500	440.0		3500	1170		3500
600	640.0		5000	1700		5000
700...2000	Diameters DN 700...2000 are also approved. However, measuring points with these diameters are not normally subject to inspection requirements (Q_{max} = 2 x Qn > 2000 m^3/h).					

* Limit range Q ≥ 15 m^3/h

Qn (min): lowest nominal flow rate with reference to $Q_{(min)}$, v = 0.05 m/s
Qn (max): highest nominal flow rate with reference to $Q_{(max)}$, v = 5 m/s

Designations → see page 37

3.5 Adapters

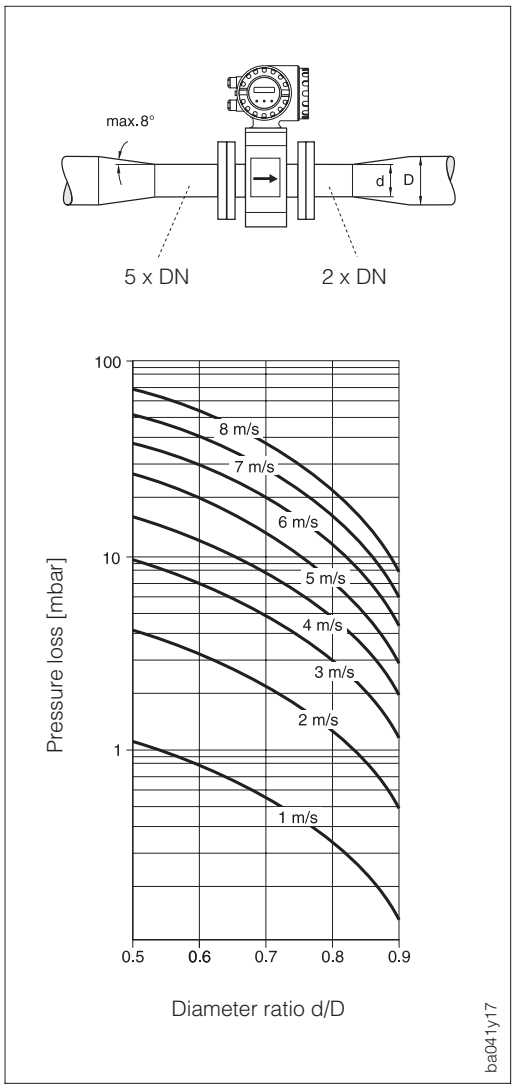


Fig. 12
Pressure loss when using adapters

The sensor can also be mounted in a pipe with a larger nominal diameter when suitable adapters (reducers and expanders) to DIN 28545 are fitted. The resultant increase in the rate of flow increases the accuracy of measurement with slowly moving fluids.

Note!
The inlet section (5 x DN) and the outlet section (2 x DN) must have the same nominal width as the flowmeter!

The adjacent nomogram can be used to determine the pressure loss caused.

Procedure:
1. Determine the ratio of the diameter d/D.
2. From the nomogram read off the pressure loss at the flow velocity and d/D ratio.

Note!
The nomogram applies to fluids with a viscosity similar to that of water.

3.6 Mounting Promag F sensor

The sensor is mounted between the flanges of the piping (Fig. 13). Since the lining of the measuring tube also covers the sensor flange, it also performs as a seal.

Caution!
The Teflon (PTFE) lined Promag F is fitted with protective discs to guard the lining which is turned over the flanges. These discs are to be removed just before mounting the sensor. Ensure that the lining on the flange is not damaged or removed.
These discs must remain in position during storage.

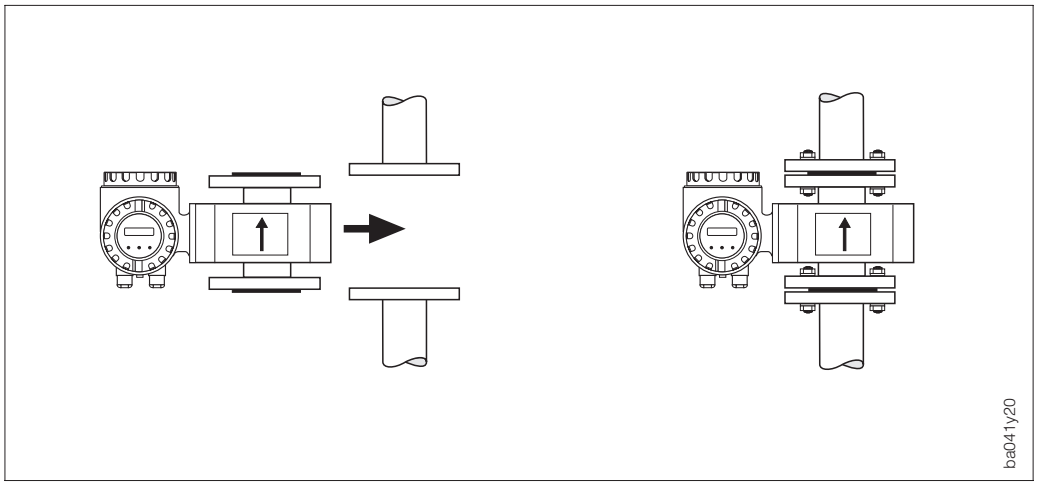


Fig. 13
Mounting Promag 31 F

Seals
- If the measuring tube liner is made of soft rubber or Teflon (PTFE), a flange seal is not required.
- With soft rubber lining the mating flange should have a thin film of non-conductive sealing grease applied.
- Use a seal according to DIN 2690.
- Mounted seals must not protrude into the piping section.

Caution!
Danger of short-circuit! Do not use sealing materials that are electrically conductive, e.g. graphite. This could result in an electrically conductive layer forming on the inside of the measuring tube and therefore short-circuiting the measuring signal.

Screw tightening torques → see following page!

Length and dimensions → see pages 59, 60

Screw tightening torques (Promag F)
The tightening torques listed apply to greased threads.
Screws tightened up too tightly deform the sealing surface. Special attention should be paid to soft rubber linings.

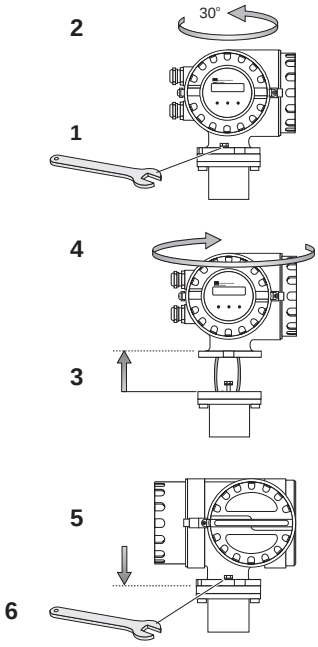

Note!

Note!
The tightening torques given here apply only to those pipes which are not subject to mechanical stress.

Diameter		Pressure ratings				Screws	Max. tightening torques [Nm]		
[mm]	[inch]	DIN [bar]	ANSI [lbs]	AWWA	JIS		Hard rubber	Soft rubber (EPDM)	PTFE (Teflon)
15	1/2"				20K	4 x M 12	–	–	15
25	1"				20K	4 x M 12	25	5	33
32	–	PN 40	Class	–	20K	4 x M 12	40	8	53
40	1 1/2"		150		20K	4 x M 16	50	11	67
50	2"				10K	4 x M 16	64	15	84
65	–				10K	4 x M 16	87	22	114
80	3"				10K	8 x M 16	53	14	70
100	4"	PN 16	Class	–	10K	8 x M 16	65	22	85
125	–		150		10K	8 x M 16	80	30	103
150	6"				10K	8 x M 20	110	48	140
200	8"				10K	8 x M 20	108	53	137
250	10"	PN 10	Class	–	10K	12 x M 20	104	29	139
300	12"		150		10K	12 x M 20	119	39	159
350	14"					16 x M 20	141/193	39/79	188/258
400	16"	PN	Class	–		16 x M 24	191/245	59/111	255/326
500	20"	10/16	150			20 x M 24	197/347	70/152	262/463
600	24"					20 x M 27	261/529	107/236	348/706
700	28"					24 x M 27	312/355	122/235	–
800	30"	PN	–	Class		24 x M 30	417/471	173/330	–
900	32"	10/16		D		28 x M 30	399/451	183/349	–
1000	36"					28 x M 33	513/644	245/470	–
1200	48"					32 x M 36	720	328	–
1400	–					36 x M 39	840	432	–
1600	–	PN 6	–	Class		40 x M 45	1217	592	–
1800	72"			D		44 x M 45	1238	667	–
2000	–					48 x M 45	1347	749	–

3.7 Turning the transmitter housing and local display

The transmitter housing and local display can be rotated in steps of 90°. This enables the unit to be adapted to different mounting positions in the piping and so simplifying reading and operation.



Turning the transmitter housing

1. Loosen the two fixing screws of the transmitter bayonet catch (approx. two turns)
2. Turn the bayonet catch of the transmitter as far as the screw slits (approx. 15 mm).
3. Carefully lift the transmitter housing to the stop.

   Caution!
   Do not damage the cable between the transmitter and sensor!

   Caution!
4. Turn the transmitter housing to the desired position.
5. Lower the housing and engage the bayonet catch.
6. Retighten the two screws.

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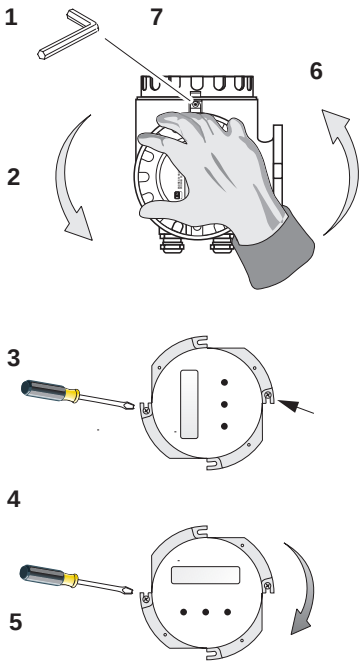
Fig. 14
Turning the transmitter housing



Turning the local display

Warning!
Danger from electric shock! Switch off the power supply before opening the instrument.

Warning!

1. Loosen the Allen screw of the safety grip (3 mm Allen key).
2. Unscrew the cover of the electronics area of the transmitter housing.
3. Unscrew the two Phillips screws of the front panel display.
4. Turn the display module to the required position.
5. Securely tighten the Phillips screws.
6. Replace and screw down securely the cover of the electronics area of the transmitter housing.
7. Securely tighten the Allen screw of the safety grip.

ba041y23

Fig. 15
Turning the local display

3.8 Mounting the transmitter (remote version)

The transmitter has to be mounted remote from the sensor when:
- access is difficult,
- space is restricted,
- extreme process and ambient temperatures prevail (for temperature ranges: see page 63 ff.) or if
- there is severe vibration (> 2 g/2 h per day; 10...100 Hz).

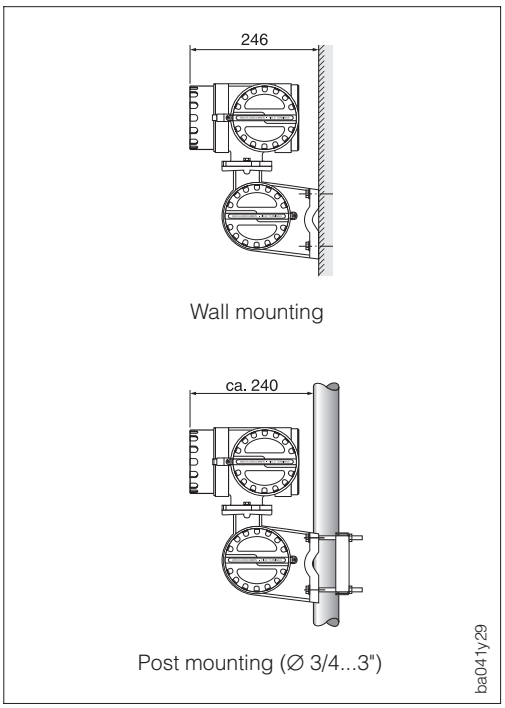


Fig. 16
Wall and post mounting

Wall and post mounting
The remote mounted version is delivered with a wall bracket as standard.
A special mounting set can be supplied for post mounting: Order No. 50076905.

Connecting cable
Two different versions are available for remote versions:

FS version:
- The permissible length of cable L_{max} of more than 10 m is governed by the conductivity of the fluid (see Fig. 17).
- The maximum possible cable length is limited to 10 meter for instruments with Empty Pipe Detection (EPD). This function is only available with the FS version.
- The FS cable is recommended only for distances smaller than 20 m.

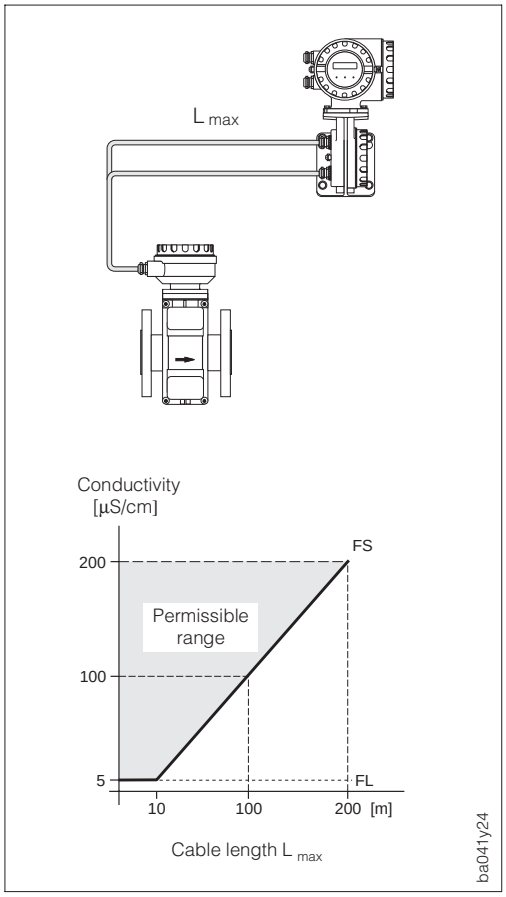


Fig. 17
Fluid conductivity and cable length with the remote version

FL version:
- All fluids with a minimum conductivity of ≥ 5 µS/cm (demineralised water ≥ 20 µS/cm) can be measured. This is not dependent on the distance between transmitter and sensor (see Fig. 17).
- Empty Pipe Detection (EPD) is *not* available with this version.
- The maximum cable length is limited to 200 meters.

Please also note the following for obtaining correct readings:
- Fasten the cable gland or lay it in a conduit. When the fluid conductivity is low, cable movements can cause serious changes in capacitance and thereby falsify the measuring signal.
- Do not run the cable in the vicinity of electrical machines or switching elements.
- Ensure potential equalization between the transmitter and the sensor.

4 Electrical Connection

Warning!
When connecting Ex-approved instruments, please observe all instructions and wiring diagrams given in the Ex supplement to this Operating Manual.
Your E+H representative will be pleased to provide you with more information.

4.1 Degree of protection

The instruments fulfil all the requirements for IP 67. After successful installation in the field or after servicing, the following points must always be observed in order to ensure the degree of protection IP 67:

- Housing gaskets must be clean and undamaged when inserted in the gasket groove. The gaskets may need to be dried, cleaned or replaced.
- All housing screws and the housing cover must be tightened firmly.
- The cables used for connecting must have the correct outer diameter (see page 26).
- The cable gland must be tightened firmly (see Fig. 18).
- The cable must loop down before entering the cable gland to ensure that no moisture can enter it (see Fig. 18).
  Install the sensor so that the cable glands first hang down and do not first go upwards.
- Any cable gland not used must be replaced with a blind plug.
- The protective bushing should not be removed from the cable gland.

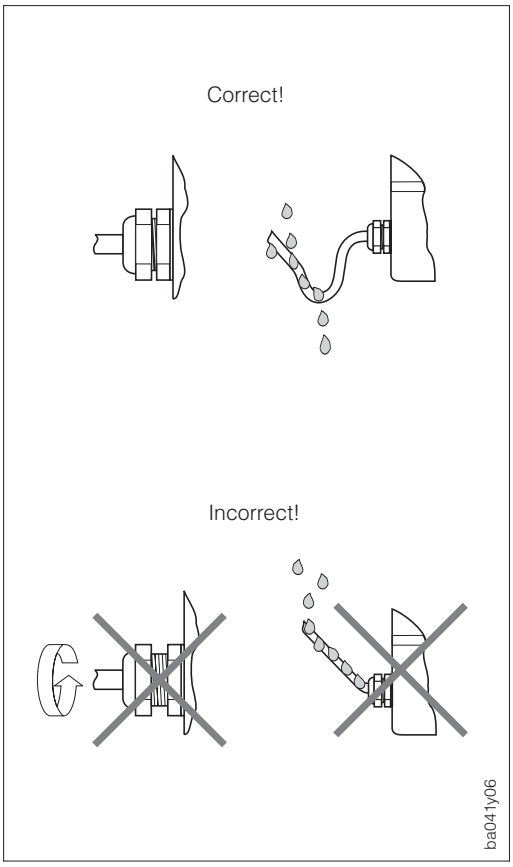


Fig. 18
Mounting cable entries

Caution!
The screws of the Promag sensor housing must not be loosened or the degree of protection guaranteed by E+H is no longer valid.

Note!
The Promag F sensor can optionally be supplied with the IP 68 degree of protection (permanently under water to a depth of 3 m). In this case the transmitter (IP 67) has to be mounted remote from the sensor.

4.2 Connecting the transmitter

Warning!

- Risk of electric shock! Switch off the power supply before opening the instrument. Do not install or wire the unit while connected to the power supply. Failure to comply may also result in damage of electronic components.
- Connect the protective conductor to the ground terminal on the housing before the power supply is switched on.
- Check that local power supply and frequency agree with the information on the nameplate. All relevant national regulations for mounting must also be observed.

Warning!

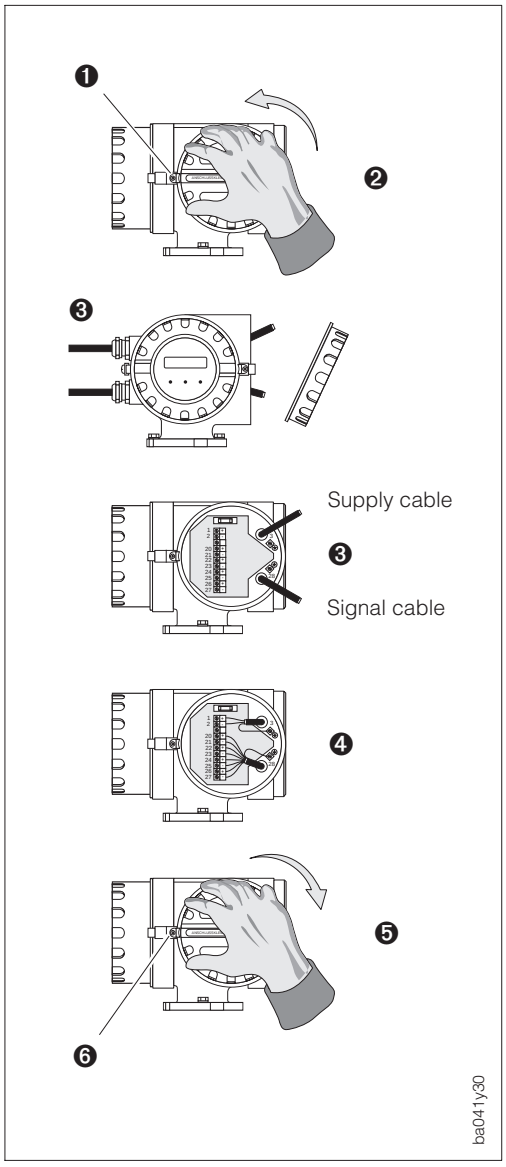
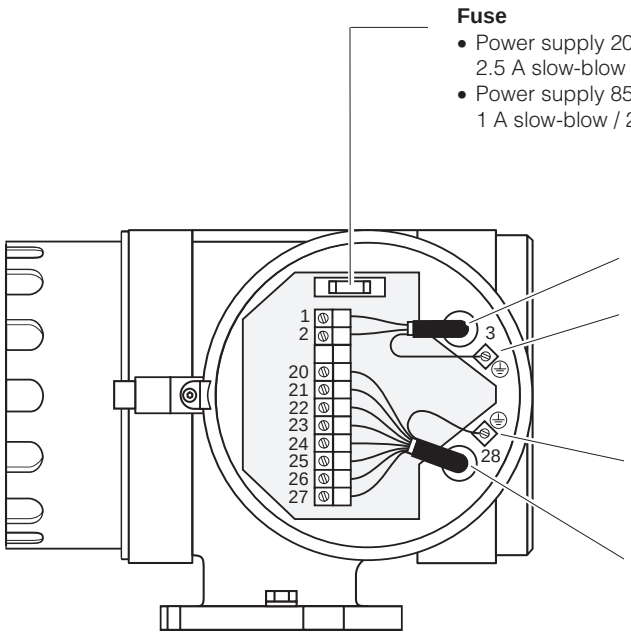
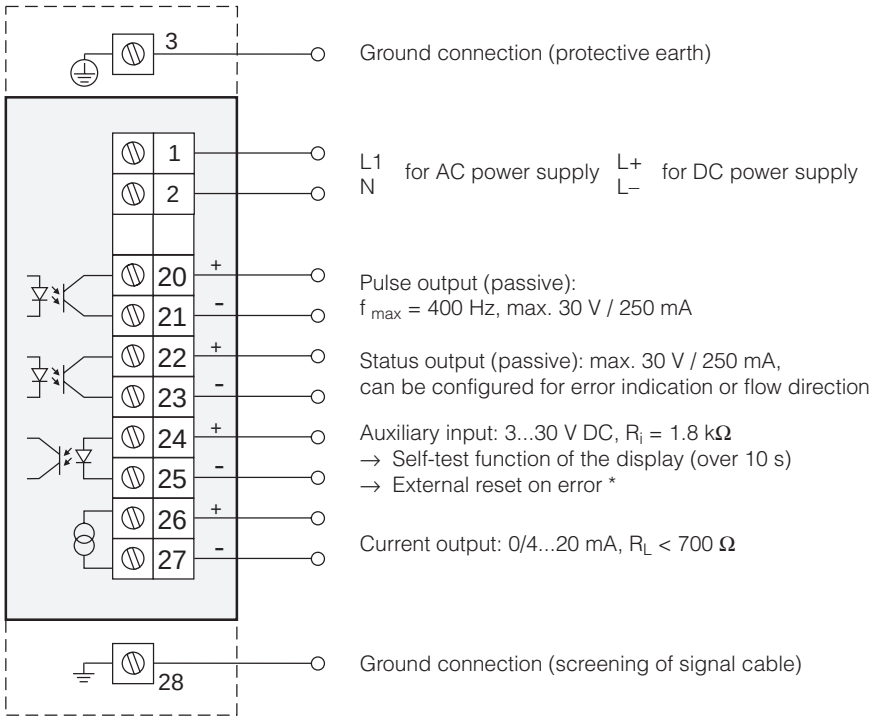


Fig. 19
Connecting the transmitter

1. Loosen the Allen screw of the safety grip using an 3 mm Allen key.
2. Unscrew the wiring compartment cover.
3. Feed the power and signal cables into the appropriate cable glands.
4. Wire up according to the wiring diagrams:
   → see Fig. 20
   → Wiring diagram in the screw cover
   - Power supply is connected to terminal 1 (L1, L+), terminal 2 (N, L–) and the ground terminal (3).
   - Fine-wire leads: max. 4 mm^2; put sleeve on the end of the cores. Single-core lead: max. 6 mm^2.
5. Having made the connection, screw the cover tightly again on the transmitter housing.
6. Tighten the Allen screw of the safety grip securely.

Connection diagram (Promag 31 transmitter)





Note!
- Example connection diagrams for the pulse, current, status output and auxiliary input are given on the following pages.
- The input and outputs for the power supply are galvanically separated from one other.

* The "Error" segment flashes on the display after initial start-up or after a power failure. Resetting such error messages is carried out as described on page 36 or by using an external reset key on the auxiliary input (for connection: see following page).

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Note!

Fig. 20
Terminal compartment
Promag 31

Examples for electrical connections (inputs and outputs)

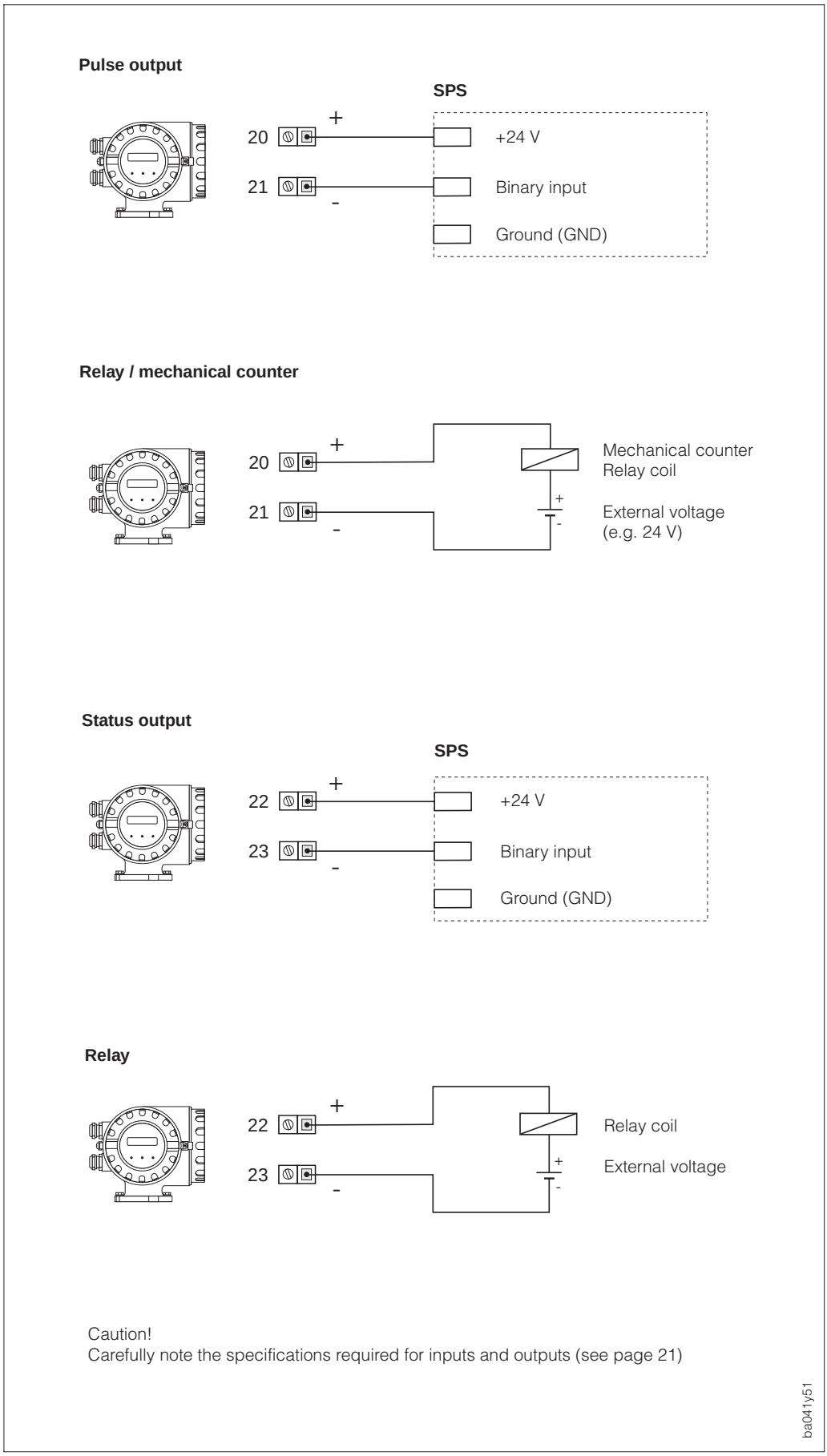
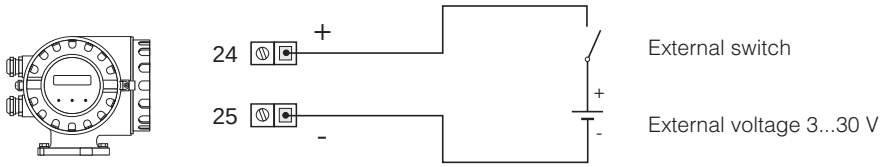


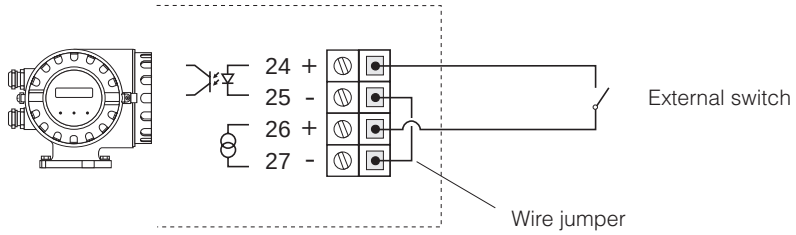
Fig. 21
Examples of electrical connections (Promag 31)

Auxiliary input



Current output as a power supply source

If the current output is not required, then this can be used as a power supply.
Set the current output to 4-20 mA (see page 42).



Caution!
Carefully note the specifications required for inputs and outputs (see page 21).

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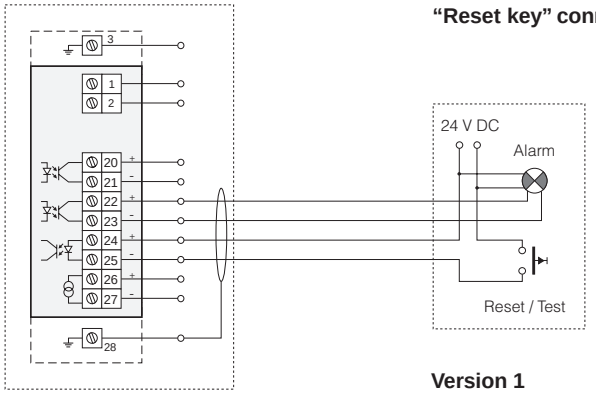
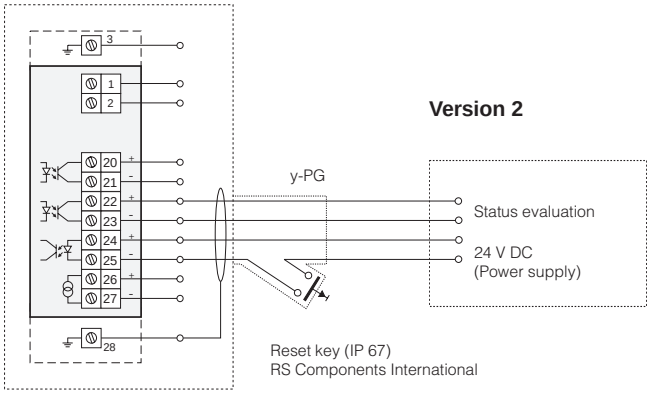
Fig. 22
Examples of electrical connections (Promag 31)

"Reset key" connection



Version 1



Version 2

ba041y77

Fig. 23
Different wiring versions for connecting a "reset" key: (alarms can be reset and the display test activated using this key).

Version 1:
This version should be chosen if there is a 24 V power supply near to the display. The alarm instrument has to be supplied by the customer. The key can be ordered from Endress+Hauser.

Version 2:
This version should be used if the 24 V power supply is ***not*** *in the near of the display. The cable entry for the power supply (y-PG) can be ordered from Endress+Hauser.*

4.3 Connecting the cable of the remote version

Warning!

Warning!
Danger from electric shock! Switch off the power supply before opening the instrument.

1. Loosen the safety grip and remove the cover of the *transmitter housing*.
2. Loosen the safety grip and remove the cover of the *sensor connection housing*.
3. Feed both signal and coil-current cable into the appropriate cable entries of the connection housings.

Caution!

Caution!
Danger of destroying the coil current control! Only connect or disconnect the coil cable once the power supply to the instrument has been switched off.

4. Connect the sensor / transmitter cable according to the wiring diagrams (see Fig. 25).
5. Securely retighten the connection housing covers and the Allen screws of the safety grips.

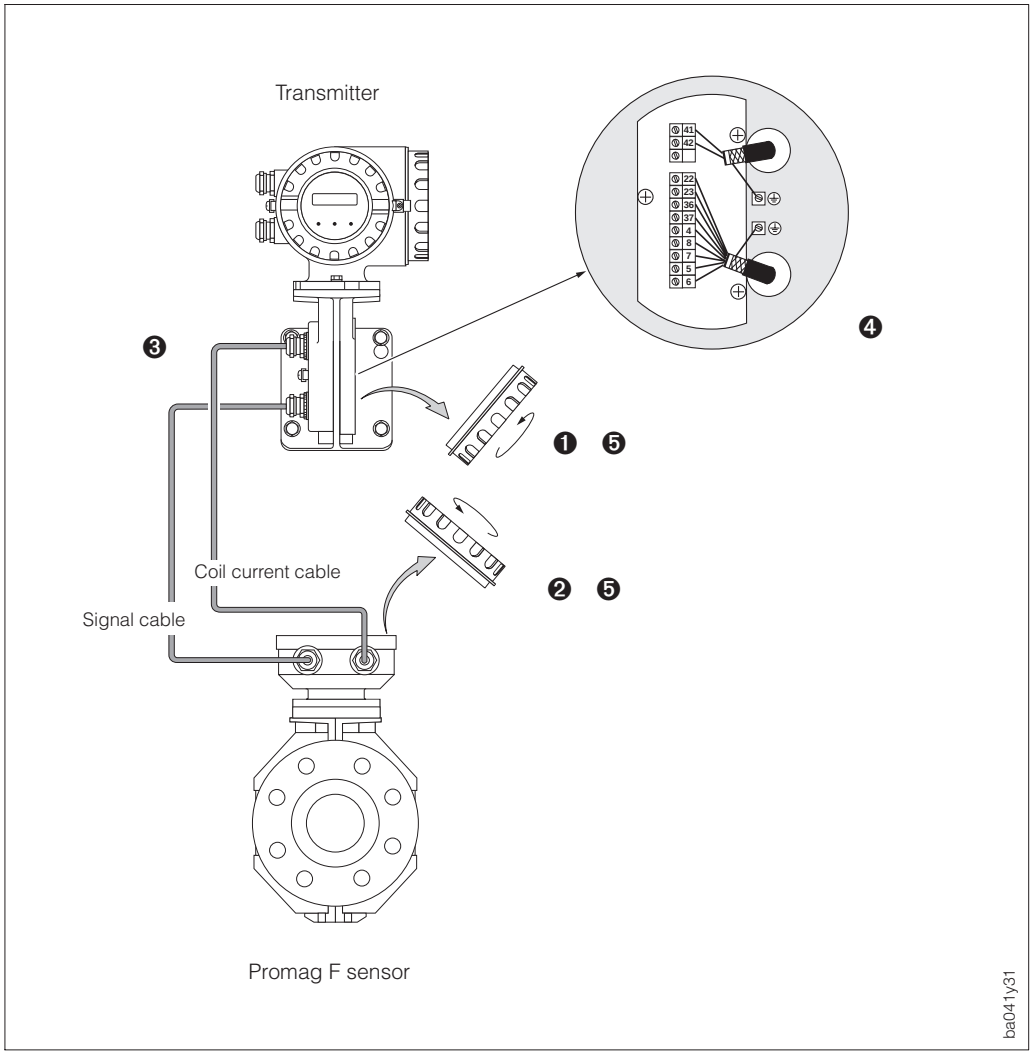
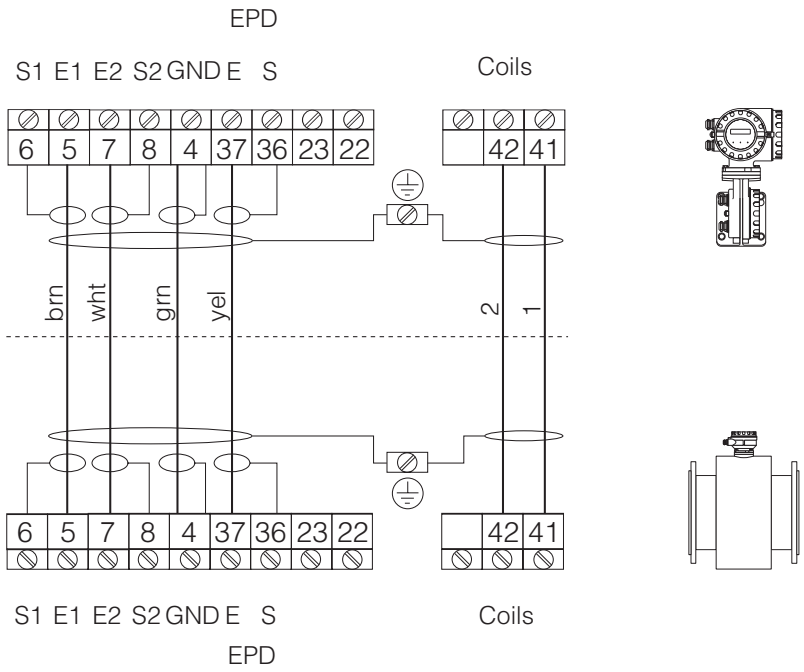


Fig. 24
Connecting the transmitter / sensor cable

Wiring diagrams for the remote version (FS/FL)

Remote version “FS”



Remote version “FL”

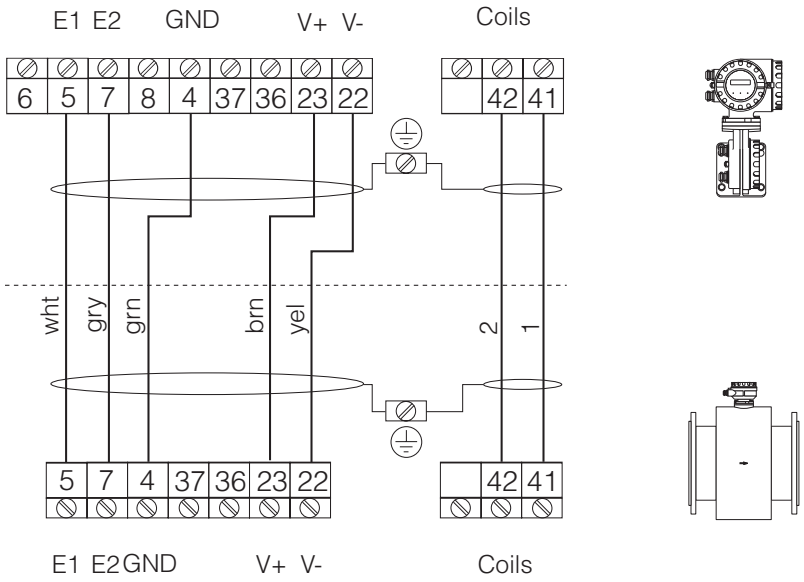


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Fig. 25
Wiring diagrams for the remote version “FS” and “FL”

4.4 Cable specifications

Remote version "FS"

Coil cable:	2 x 0.75 mm^2 PVC cable with common screen *	
	Conductor resistance	≤ 37 Ω/km
	Capacitance: core/core, screen grounded	≤ 120 pF/m
Signal cable:	3 x 0.38 mm^2 PVC cable with common screen * and separately screened cores	
	With EPD (Empty Pipe Detection)	4 x 0.38 mm^2 PVC cable
	Conductor resistance	≤ 50 Ω/km
	Capacitance: core/screen	≤ 420 pF/m

Permanent operation temperature: –20...+70 °C
* braided copper screening: ∅ ~ 7 mm

Remote version "FL"

Coil cable:	2 x 0.75 mm^2 PVC cable with common screen *	
	Conductor resistance	≤ 37 Ω/km
	Capacitance: core/core, screen grounded	≤ 120 pF/m
Signal cable:	5 x 0.5 mm^2 PVC cable with common screen *	
	Conductor resistance	≤ 37 Ω/km
	Capacitance: core/core, screen grounded	≤ 120 pF/m

Permanent operation temperature: –20...+70 °C
* braided copper screening (coil cable ∅ ~ 7 mm; signal cable ∅ ~ 9 mm)

Operation in areas with severe electrical interference
The Promag 31 measuring system fulfils all general safety requirements according to EN 61010 and electromagnetic compatibility (EMC) according to EN 50081 Part 1 and 2 / EN 50082 Part 1 and 2 when installed in accordance with the NAMUR recommendations.


Note!

Note!
To observe the statement of conformity for the remote version, the signal and coil cables should be screened and grounded at both ends.

4.5 Potential equalisation

The sensor and the fluid must have roughly the same electrical potential to ensure that measurement is accurate and no galvanic corrosion takes place at the electrode. Normally the reference electrode in the sensor or the metal pipe ensures that the potentials are equalized.

If the reference electrode is correctly grounded and the fluid flows through metallic, unlined and grounded piping, then it is sufficient to connect the grounding terminal of the Promag 31 transmitter housing to the potential equalisation line in order to prevent corrosion. The connection with the remote-mounted version is made at the ground terminal of the connection housing.

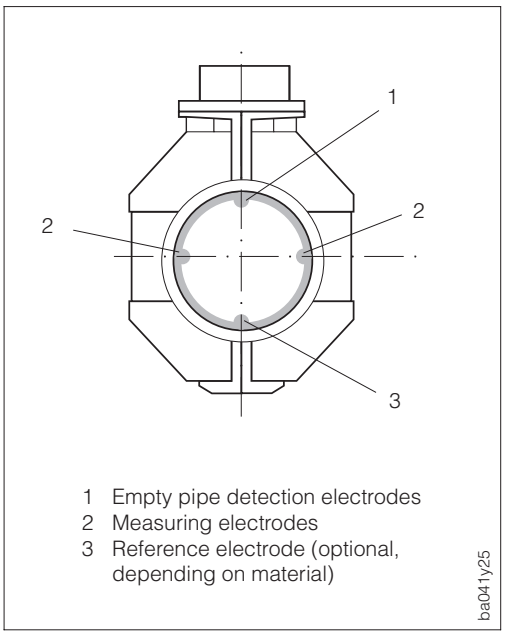


Fig. 26
Position of different electrodes in the measuring tube

Caution!
Danger of permanent damage to the instrument! If the fluid cannot be grounded for operational reasons, ground disks are to be used.

Potential equalisation for some special cases is described below:

Potential equalisation for lined pipes with cathodic protection

When the fluid cannot be earthed for operational reasons, the measuring unit must be installed that it is potential-free (Fig. 27). Ensure that components of the piping are connected to one another (copper wire, 6 mm^2).

All national regulations regarding potential free installation are to be observed (e.g. VDE 0100).
Ensure that the mounting material used does not result in a conductive bond with the measuring unit and that the material can withstand the tightening torque used.

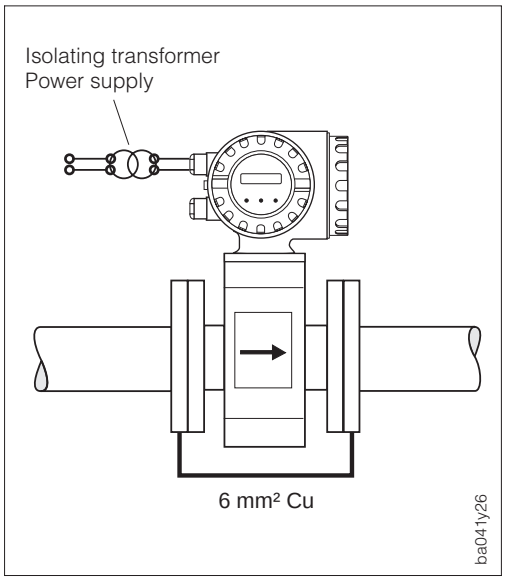


Fig. 27
Potential equalisation for lined pipes with cathodic protection

Plastic or lined piping

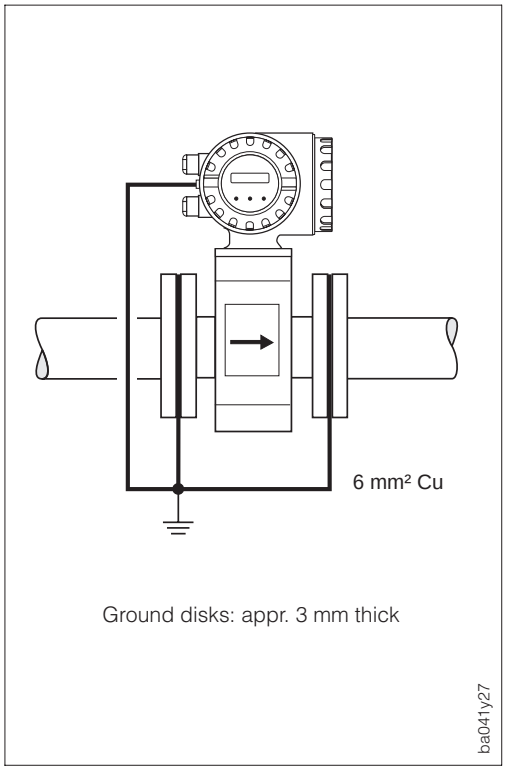


Fig. 28
Potential equalisation with plastic or lined pipings

Ground disks must always be used with non-conductive piping materials if compensation currents flow through the fluid. They can irreparably damage the reference electrode within a short time due to electrochemical corrosion.

Such conditions occur especially if:
- the piping is insulated with electrically non-conductive materials and
- the piping is made of fibreglass or PVC through which flow highly concentrated acids and alkalis.

Caution!
Danger from damage due to electrochemical corrosion!
- Note the corrosion resistance of the ground disks!
- Note the electrochemical potential series in cases where the ground disks and the measuring electrodes are made of different material.

Equalising currents in unearthed metal pipes / Earthing in an area with severe interference

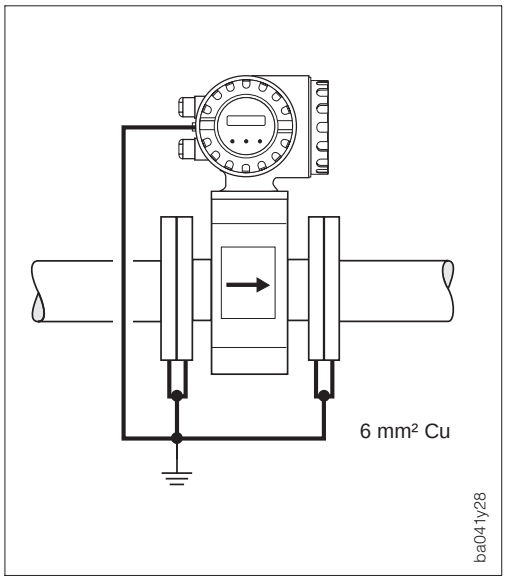


Fig. 29
Potential equalisation with
– equalising currents,
– in areas with severe interference

The fluid may be earthed. In order to make the most of the electromagnetic compatibility (EMC) of the Promag 31, it is advisable to provide two flange-to-flange links and to connect them jointly with the transmitter housing to earth potential.

4.6 Commissioning

Before switching on the measuring system, the following checks should be carried out again:
- Check the electrical connections and terminal assignments.
- Compare the data on the nameplate with the local mains voltage and frequency.
- Does the direction of the arrow on the nameplate (sensor) agree with the actual direction of flow in the piping?

If the results of these checks are satisfactory, switch on the supply voltage.
The unit is now ready for operation.

After switching on, the system performs various self-test routines. During this procedure the following sequence of messages appears on the display:

`Pro-3_'` Promag 31 (Model '99)

The actual set display mode is then shown (3 possibilities):

– `rAtE` Flow rate (not permissible for certified instruments)
– `totAL` Totalizer
– `ALtErnAt` Alternating display of flow rate / totalizer (display changes approx. every 10 seconds)

After successful start-up, normal measurement mode is assumed. Depending on the display mode set, it now shows flow rate and/or totalizer value as well as the actual units (“HOME position”).

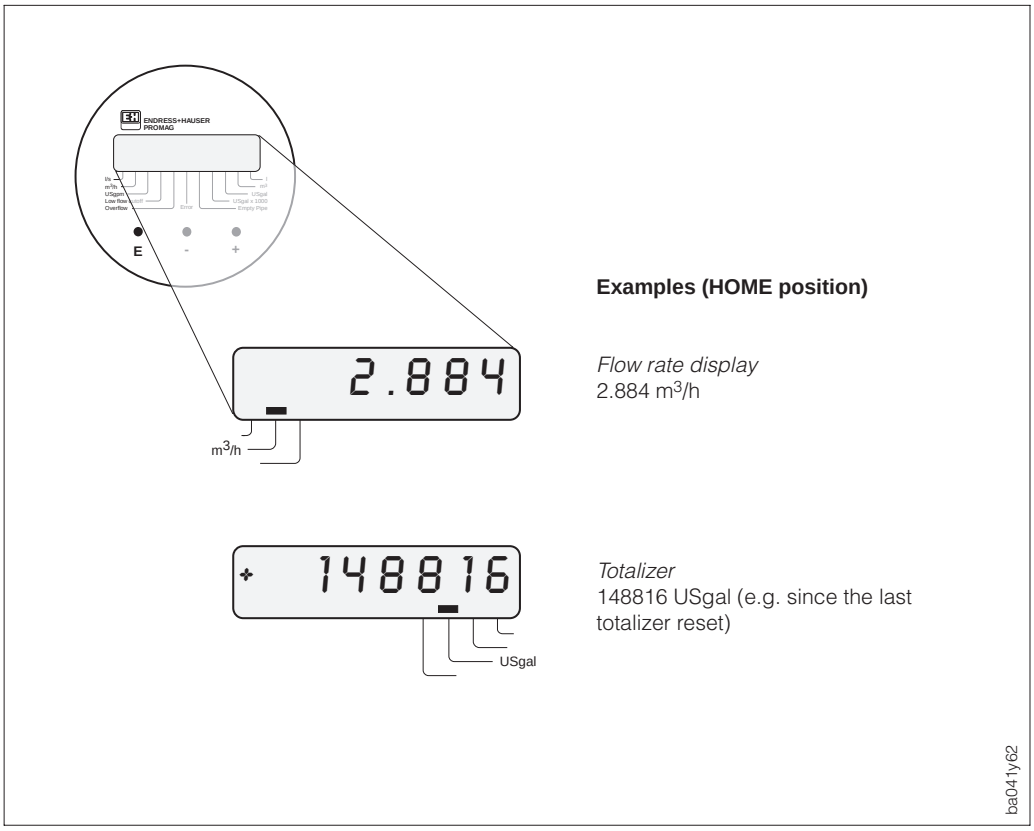


Fig. 30: Examples of the display (HOME position)

5 Display and Operation

5.1 Display and operating elements

With Promag 31 important variables can be directly read off at the measuring point.

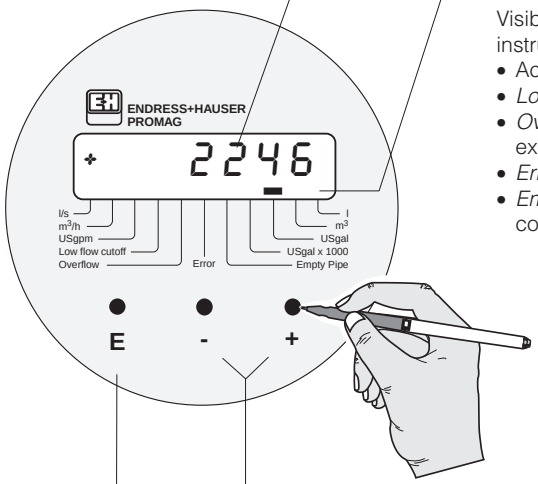
Note!
Promag 31 transmitters can no longer be configured when given a leaded seal.

Note!

Warning!
Danger of electrical shock! With the housing cover removed, protection against accidental contact is no longer present. Components with high voltages are exposed below the local display. When programming avoid any contact with the electronic components which lie below the local display, and do not use any electrically conductive object to depress the operating keys!

1. Loosen the Allen screw (3 mm) of the safety grip.
2. Unscrew the cover of the electronics compartment.
3. The keys may now be operated by pressing with a thin (non-conductive) pin.
   A switching cycle takes about 0.5...0.8 seconds.
4. Firmly screw back the cover of the electronics compartment to the transmitter housing once the settings have been entered. Firmly tighten the Allen screw of the safety grip.

Warning!



LC Display
All measured values, operating and status messages are shown here (HOME position: display during normal operation)

11 display segments
Visible segments enable units, process and instrument status to be easily read:
- Actual measuring units used
- *Low flow cutoff* → creep suppression
- *Overflow* → permissible measuring range exceeded ($v_{max} \geq 12.5$ m/s)
- *Error* → system error
- *Emtpy Pipe* → measuring tube is not completely filled (Empty Pipe Detection)

+/– Keys
– Select function goups (all 11 display segments visible)
– Select functions (all 11 display segments flash)
– Select parameters or entering values

Enter key
- HOME position → access operating matrix
- Leave the operating matrix → HOME position (key is pressed for more than 3 seconds)
- Change operating level: Function group → Function → Input
- Save data or settings

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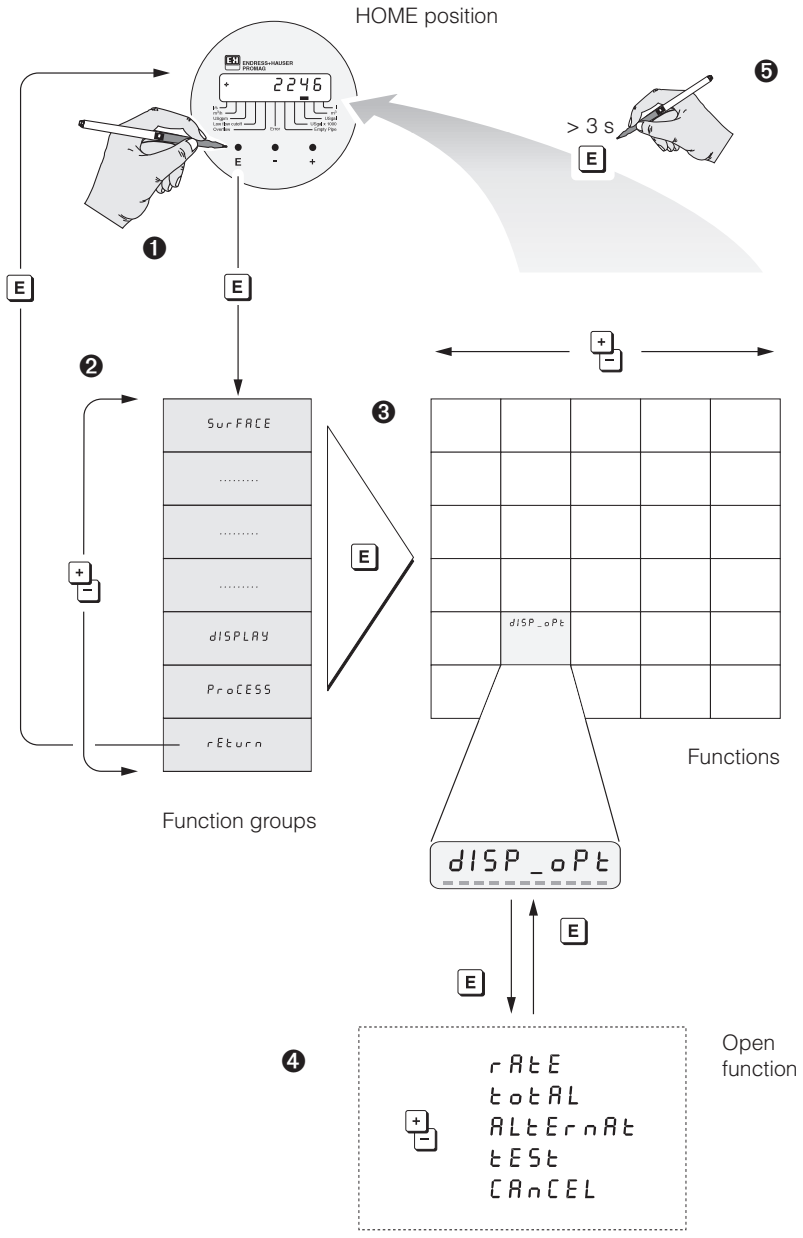
Fig. 31
Display and operating elements

5.2 Operation (operating matrix)

Warning!

Warning!
Danger of electrical shock! With the housing cover removed, protection against accidental contact is no longer present.

1. Access the operating matrix
2. Select function group
3. Select functions
4. Select and store parameters (operating example: see page 34)
5. Leave operating matrix → HOME position (from any matrix position) or Select other functions



Note!

Note!
- An automatic return to the HOME position will be made if the operating keys are not actuated for 60 seconds (although not from an opened function).
- "rEturn" + Enter → Return to the next higher operating level (function group, HOME)
- "CAnCEL" + Enter → Return to the function level *without* storing the changed parameter

Fig. 32
Select functions in the E+H operating matrix

Operating matrix / Summary of functions

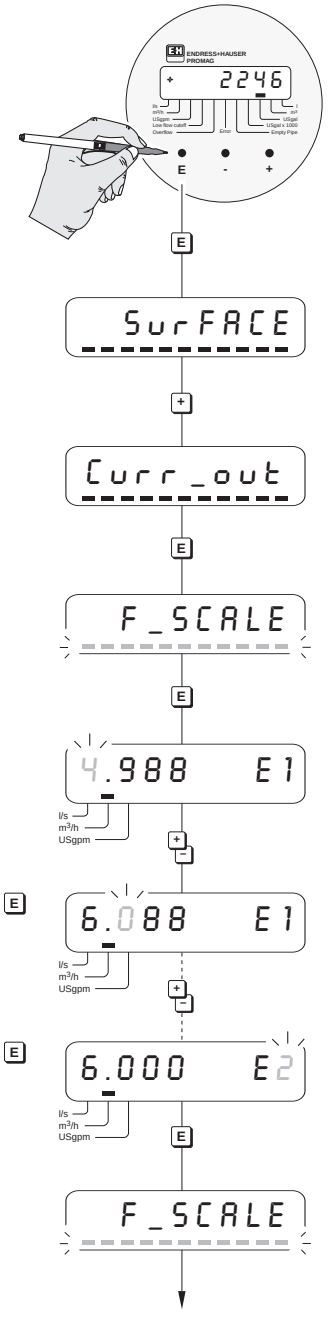
SurFACE Gr00 *Interactive surface* → page 39	PAGECodE / Fu01 *Function code* ALPHA text code * nbr number code CAnCEL	u_rAtE / Fu02 *Flow rate units* unit_1 [l/s] * unit_2 [m^3/h] unit_3 [USgpm] CAnCEL	u_totAL / Fu03 *Totalizer units* unit_4 [USgal × 1000] unit_5 [USgal] unit_6 [m^3] unit_7 [l] * CAnCEL	rEturn	
Curr_out Gr10 *Current output* → page 40	F_SCALE / Fu11 *Full scale value (current output)* Numeric entry: x.xxx E±x Factory setting: page 68	t_ConSt / Fu12 *Time constant* Numeric entry: xx.x (in steps of 0.5 s) Factory setting = 1.0 s	I_rAnGE / Fu13 *Current range* 0-20 (mA) 4-20 (mA) * CAnCEL	rEturn	
PuLS_out Gr20 *Pulse output* → page 42	P_FACtor / Fu21 *Pulse value* Numeric entry: x.xxx E±x Factory setting: page 68	rEturn			
StAt_out Gr30 *Status output* → page 44	StAt_FCt / Fu31 *Status output function* Error System/process error indication * Flo_dir Flow direction indication CAnCEL **Custody transfer mode:** The status output is permanently configured to Error.		rEturn		
InPut Gr40 *Auxiliary input* → page 45	InP_FCt / Fu41 *Auxiliary input function* SuPPrESS Positive zero return rES_tot Reset totalizer * CAnCEL **Custody transfer mode:** The above parameters are not effective! In custody transfer mode the auxiliary input is used exclusive for resetting the error messages.		rEturn		
dISPLAY Gr50 *Display* → page 45	rES_tot / Fu51 *Totalizer reset* CAnCEL rES_YES reset	dISP_oPt / Fu52 *Display mode* rAtE Flow rate * totAL Totalizer ALtErnAt Flow rate & Totalizer tESt Display test function CAnCEL	dISP_dA / Fu53 *Display damping* Numeric entry: xx.x (in steps of 0.5 s) Factory setting = 1.0 s	tot_oFL / Fu54 *Number of totalizer overflows* Display: xxxxxxxx (max. 8 characters)	rEturn
ProCESS Gr60 *Process parameters* → page 46	LFC / Fu61 *Creep suppression* LFC_oFF off LFC_on on * CAnCEL **Custody transfer mode:** Low flow cut-off is always activated in custody transfer mode (LFC_on)!	EPD / Fu62 *Empty Pipe Detection* EPd_oFF off * EPd_on on EPd_Ad_E Empty pipe adjustment EPd_Ad_F Full pipe adjustment CAnCEL	ECC / Fu63 *Electrode cleaning (optional)* ECC_oFF off ECC_on on * CAnCEL **Custody transfer mode:** This function is not available in custody transfer mode!	rEturn	
rEturn	***** Factory setting (can be different for instruments with customer specific parameterisation)				

5.3 Operating example

Warning!

Warning!
Danger of electrical shock! With the housing cover removed, protection against accidental contact is no longer present. Components with high voltages are exposed below the local display. When programming avoid any contact with the electronic components which lie below the local display, and do not use any electrically conductive object to depress the operating keys!

You would like to set the full scale value for the current output to 600.0 m^3/h.
Proceed as follows:



HOME position
(display during normal operation)

Change flashing number with ± and store with E. The next number to be changed will then flash automatically.

Remarks:
- Selecting units → see page 39
- Display of numerical values: → see page 2
- If the value entered is too high or too low, then the message "too_HI" or "too_Lo" is displayed for approx. 2 seconds.
  The maximum or minimum possible full scale value (depending on nominal diameter) will then be shown → see page 41.

Terminate entry

E > 3 sec. → HOME position
± → next function (t_Const)

ba041y70

Fig. 33:
Operating example
(E+H operating matrix)

6 Custody Transfer Measurement

The Promag 31 flowmeter is suitable for custody transfer measurement with cold water (wastewater). The measuring system operates within a temperature range of 0...30 °C and can be used, for example, in drinking water supplies. Examples are given on page 5. The Promag 31 F is operated exclusively with a totalizer display suitable for custody transfer.

6.1 Suitability for custody transfer, custody transfer approval, reapproval

With flowmeters *suitable* for custody transfer, approval by the standards authorities has not yet been carried out. Flowmeters suitable for custody transfer may not be used for custody transfer procedures until approved. However, such flowmeters can either be approved at a later date by a test centre or, with the agreement of the authorities, *calibrated for custody transfer* on site. The leaded seal of the certified instruments confirms this status.

The operator of an approved Promag 31 measuring system is required to apply for *reapproval* and to comply with current regulations set by the standards authorities.

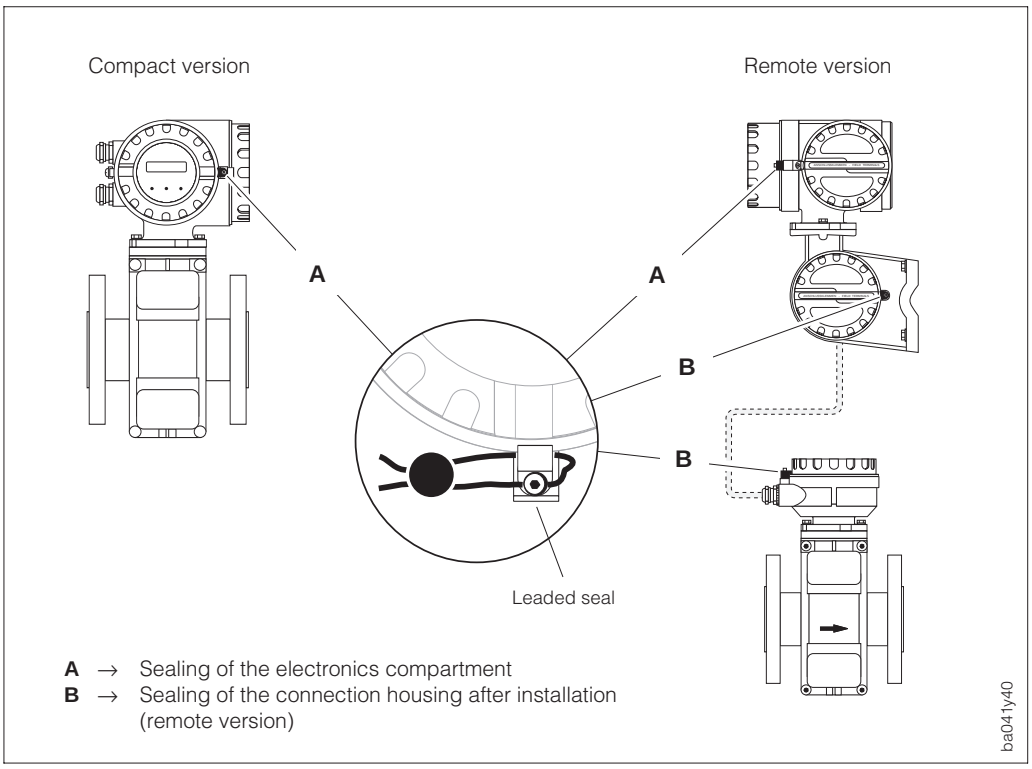


Fig. 34
Sealing of a certified Promag 31 by standards authorities

Note!
- Flowmeters suitable for custody transfer are technically identical to flowmeters approved for “custody transfer”.
- In contrast to mechanical counters, magnetic flowmeters approved by the standards authorities may be in continuous operation at Q_{max} (= 100%).
- Flowmeters with a flow rate of Q > 2000 m^3/h are exempted from custody transfer approval. Such instruments are not approved but however can still be used as suitable for custody transfer measurement.

Note!

Caution!
Only flowmeters approved by the standard authorities may be used for regulatory fiscal metering.

Caution!

6.2 Special features of custody transfer measurement

Approved Promag 31 flowmeters differ from non-approved flowmeters as follows:

- After official approval or leaded sealing, configuration can no longer be carried out using the local display.
- Approved flowmeters totalize bidirectional flow, while the pulse and current outputs only supply values when flow is in a positive (forwards) direction.
- The electrode cleaning circuitry (ECC) is not available during custody transfer measurements.
- The wiring of the status output and auxiliary input must be done by the user of the system.
- Diameters DN 700...2000 are also approved. However, measuring points with these diameters are not normally subject to inspection requirements (Q_{max} = 2 x Qn > 2000 m^3/h).

Function settings:

Certain function settings are to be stated when ordering a Promag 31 flowmeter:
– Nominal flow rate Qn → see page 13 *
– Metrological class → see page 37 *
– Full scale value (current output) → see page 40 **
– Current range: 0/4...20 mA **
– Pulse value → see page 42 **
– Display mode (totAL or ALtErnAt) → see page 45
– Totalizer units: litres [l] or cubic meters [m^3/h]

* These parameters must be stated when ordering!
** Values otherwise specified, the instrument will be delivered with factory settings.

For custody transfer measurement, settings for the functions below are fixed:
– Status output → Error (totalizer measures bidirectional flow; current/pulse output measures unidirectional flow, forwards)
– Low flow cut-off → always activated (LFC_on)
– In contrast to “normal” operation, the auxiliary input is only configured for resetting alarm messages on the display (see below) or else for activating the display test function. Creep suppression or resetting the totalizer via the auxiliary input is not possible in custody transfer mode.

Error messages on the display
System and process errors are signalled via the status output during custody transfer measurement. On the display, both the corresponding segment bars for system error (Error) and/or process errors (Overflow, Empty Pipe) are shown. The following cases differ from one another:

System error
Display segment “Error” is visible.
The error can possibly be corrected by switching off and then switching on the power supply again. If the measuring system does not start-up (or again shows an error display), then please contact the Endress+Hauser Service organisation.

Process error
Display segments for “Error” and “overflow / Empty Pipe” are both visible.
If the error is corrected then the display segment for the process error goes out and the “Error” segment begins to flash. The instrument now assumes normal operation. The flashing “Error” segment still indicates a corrected error but can be reset via the auxiliary input.

Switching on the power supply
Every time the power supply is switched on or on first start-up, the “Error” display segment flashes to indicate a power failure. The instrument still measures normally despite this display, i.e. the status output issues no error.
The flashing “Error” segment can be reset via the auxiliary input.

6.3 Definitions

Cold water (wastewater)
Fluid temperature between 0...30 °C

Flow ranges

Q_{max} Maximum flow without damaging the flowmeter and without exceeding the maximum permissible error.

Q_n Nominal flow rate is half the value of the maximum flow rate Q_{max} and characterises the flowmeter (see page 13, “Nominal diameter and flow rate”).

Q_{min} Minimum flow rate above which the totalizer is within the error limits. It is dependent on the nominal flow rate ($Q_{n)}$ and the metrological class.

Q_t “Transitional flow rate”, which separates the lower from the upper maximum permissible range. Lower or upper range differ from each other by the permitted error limits for custody transfer measurements (see Fig. 35):
- Lower range (Q_{min}...Q_t) → Error limits ± 5%
- Upper range (Q_t...Q_{max}) → Error limits ± 2%

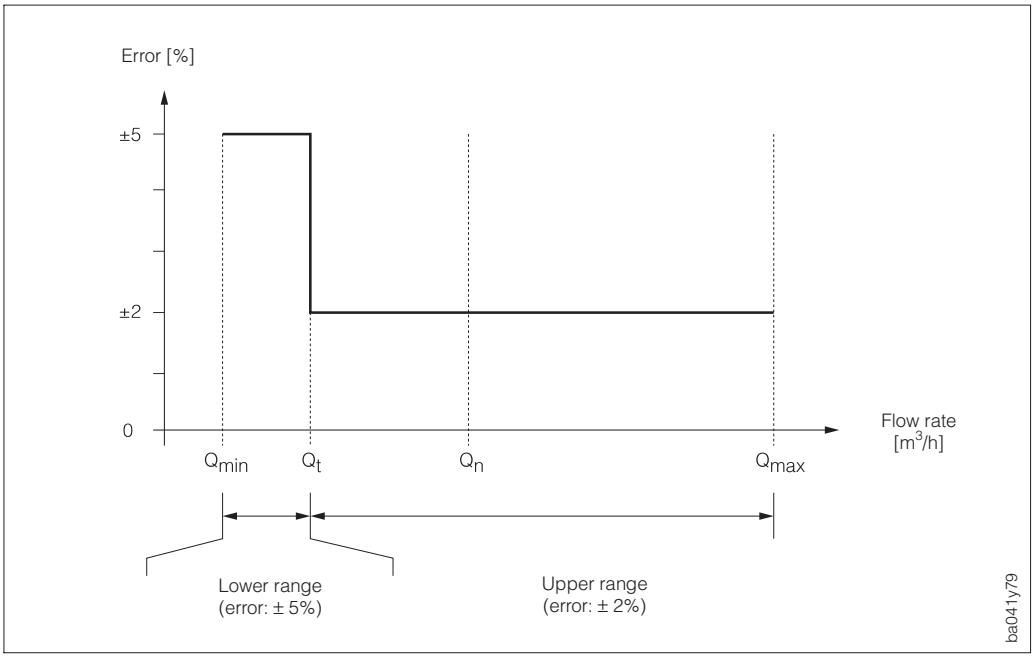


Fig. 35
Flow ranges and error limits in custody transfer mode for cold water

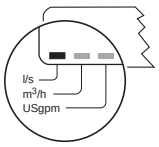
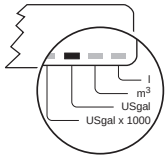
Metrological Classes
Metrological classes A / B indicate the range in which the approved custody transfer flowmeter can measure, from full scale value (Q_{max}) down to Q_{min}. The error limits within this range are set by the standards authorities and must not be exceeded.

	Nominal flow rate (Q_n)	
	< 15 m³/h	> 15 m³/h
Class A	$Q_{min} = Q_n \times 0.04$ $Q_t = Q_n \times 0.10$	$Q_{min} = Q_n \times 0.08$ $Q_t = Q_n \times 0.30$
Class B	$Q_{min} = Q_n \times 0.02$ $Q_t = Q_n \times 0.08$	$Q_{min} = Q_n \times 0.03$ $Q_t = Q_n \times 0.20$

7 Description of Functions

This section describes in detail, along with specifications, the individual functions of the Promag 31. The function designation in the following table shows the two versions available – as well as the text and number codes used (see function "PAGECodE / Fu01").

Function groups

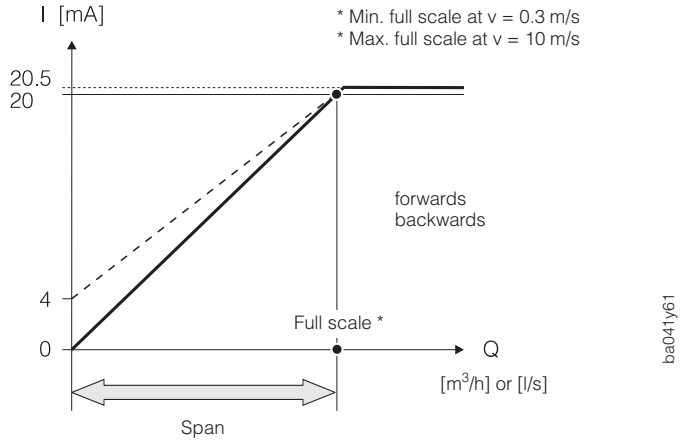
Function group **INTERACTIVE SURFACE – SurFACE / Gr00**	
PAGECodE Fu 01 Function code	All functions of the operating matrix can be shown on the display in two different ways – with a function number or a text code. ALPHA Type of display → text code e.g. F_SCALE for function "full scale value current output" nbr Type of display → number code e.g. Fu 11 for function "full scale value current output" CAnCEL
u_rAtE Fu 02 Flow rate	Select the units required for flow rate (volume/time). The units selected here also define those for: • creepage (see LFC / Fu 61 function) • full scale value (current output) unit_1 Display segment " l/s " unit_2 Display segment " m^3/h " unit_3 Display segment " USgpm" CAnCEL  ba041y71
u_totAL Fu 03 Volume unit	Select the units required for flow volume (totalizer). The units selected here also define those for: • pulse value (volume/pulse) • totalizer (counter) unit_4 Display segment " USgal × 1000 " unit_5 Display segment " USgal " unit_6 Display segment " m^3 " unit_7 Display segment " l " CAnCEL  ba041y72

Function group
CURRENT OUPUT – Curr_out / Gr10

F_SCALE
Fu 11

Full scale value

Enter the desired full scale value for the volume flow (in the appropriate units selected). When exceeding the max. possible full scale value, the current output is limited to a maximum of 20.5 mA.

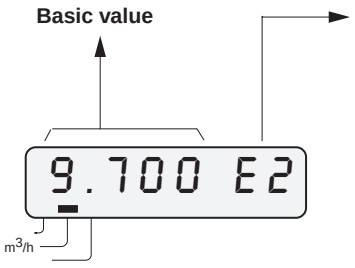


Numeric entry:
Change the flashing number with ± and store with E.
The next number to be changed will then flash automatically.
After the last number has been changed and stored, the instrument returns to the function level (all display segments flash).

Note!

Note!
The minimum or maximum possible full scale value is given for every nominal diameter in the table on page 41. If the value entered is too high or too low then the display reacts as follows:
1. The value entered is *not* stored.
2. The message "too_HI" (value entered is too high) or "too_Lo" (value entered is too low) is shown on the display.
3. The minimum or maximum possible values are then shown on the display which may be entered for the full scale (see table).

Display of numerical values:
Due to the limited size of the display, values are shown in a special way.



E 5	= 10^{+5}	=	100000
E 4	= 10^{+4}	=	10000
E 3	= 10^{+3}	=	1000
E 2	= 10^{+2}	=	100
E 1	= 10^{+1}	=	10
E 0	= 10^{0}	=	1
E–1	= 10^{-1}	=	0.1
E–2	= 10^{-2}	=	0.01
E–3	= 10^{-3}	=	0.001
E–4	= 10^{-4}	=	0.0001
E–5	= 10^{-5}	=	0.00001

Examples:

9.700 E 2 = **9.700 × 10^{+2}** = **970.0** [m³/h]
9.700 E-2 = **9.700 × 10^{-2}** = **0.097** [m³/h]

Display limits / Full scale values (current output)

DN	l/s		m^3/h	
	Min.	Max.	Min.	Max.
2	9.424 E-4	3.141 E-2	3.392 E-3	1.130 E-1
4	3.769 E-3	1.256 E-1	1.357 E-2	4.523 E-1
8	1.507 E-2	5.026 E-1	5.428 E-2	1.809 E 0
15	5.301 E-2	1.767 E 0	1.908 E-1	6.361 E 0
25	1.472 E-1	4.908 E 0	5.301 E-1	1.767 E 1
32	2.412 E-1	8.042 E 0	8.685 E-1	2.895 E 1
40	3.769 E-1	1.256 E 1	1.357 E 0	4.523 E 1
50	5.890 E-1	1.963 E 1	2.120 E 0	7.068 E 1
65	9.954 E-1	3.318 E 1	3.583 E 0	1.194 E 2
80	1.507 E 0	5.026 E 1	5.428 E 0	1.809 E 2
100	2.356 E 0	7.853 E 1	8.482 E 0	2.827 E 2
125	3.681 E 0	1.227 E 2	1.325 E 1	4.417 E 2
150	5.301 E 0	1.767 E 2	1.908 E 1	6.361 E 2
200	9.424 E 0	3.141 E 2	3.392 E 1	1.130 E 3
250	1.473 E 1	4.908 E 2	5.301 E 1	1.767 E 3
300	2.120 E 1	7.068 E 2	7.634 E 1	2.544 E 3
350	2.886 E 1	9.621 E 2	1.039 E 2	3.463 E 3
400	3.769 E 1	1.256 E 3	1.357 E 2	4.523 E 3
500	5.890 E 1	1.963 E 3	2.120 E 2	7.068 E 3
600	8.482 E 1	2.827 E 3	3.053 E 2	1.017 E 4
700	1.154 E 2	3.848 E 3	4.156 E 2	1.385 E 4
800	1.507 E 2	5.026 E 3	5.428 E 2	1.809 E 4
900	1.908 E 2	6.361 E 3	6.870 E 2	2.290 E 4
1000	2.356 E 2	7.853 E 3	8.482 E 2	2.827 E 4
1200	3.392 E 2	1.130 E 4	1.221 E 3	4.071 E 4
1400	4.618 E 2	1.539 E 4	1.662 E 3	5.541 E 4
1600	6.031 E 2	2.010 E 4	2.171 E 3	7.238 E 4
1800	7.634 E 2	2.544 E 4	2.748 E 3	9.160 E 4
2000	9.424 E 2	3.141 E 4	3.392 E 3	1.130 E 5

The last figure of the above values can differ by ±1 from the value shown in the display (error in rounding off)!

Minimum full scale → flow rate = 0.3 m/s
Maximum full scale → flow rate = 10 m/s

Factory settings → see page 68

Function group
CURRENT OUTPUT – Curr_out / Gr10

t_ConSt
Fu 12

Time constant

Selecting the time constant determines whether the current output signal reacts very quickly to rapidly changing flows (small time constant) or slowly (large time constant).

Note!
The time constant does not affect the behaviour of the display!

Numeric entry: 0.5...95 [s] in steps of 0.5 s

I_rAnGE
Fu 13

Current range

Set the current range. The current for the scaled full scale value is always 20 mA (see page 40).

0-20 (mA)
4-20 (mA)

Function group
PULSE OUTPUT – PuLS_out / Gr20

P_FACtor
Fu 21

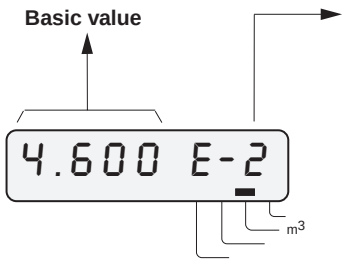
Pulse value

Enter that flow quantity for which an output pulse is supplied (pulse width: max. 1s, pulse/pause ratio up to 0.5 Hz approx. 1:1; with pulse frequencies less than 0.5 Hz the pulse width is limited to 1 s; f_{max} = 400 Hz).
With external totalizers these pulses can be totalized and thus determine the total flow quantity since the start of measurement.

Numeric entry:
Change flashing number with ± and store with E. The next number to be changed will then flash automatically. After the last number has been changed and stored, the instrument returns back to the function level (all display segments flash).

Note!
The minimum or maximum possible full scale value is given for every nominal diameter in the table on page 43. If the value entered is too high or too low then the display reacts as follows:
1. The value entered is *not* stored.
2. The message "too_HI" (value entered is too high) or "too_Lo" (value entered is too low) is shown on the display.
3. The minimum or maximum possible values are then shown on the display which can be entered for the pulse value (see table).

Display of numerical values:
Due to the limited size of the display, values are shown in a special way.



Multiplication factor

E 9 = 10^{+9} = 1000000000
.....
E 3 = 10^{+3} = 1000
E 2 = 10^{+2} = 100
E 1 = 10^{+1} = 10
E 0 = 10^{0} = 1
E–1 = 10^{-1} = 0.1
E–2 = 10^{-2} = 0.01
E–3 = 10^{-3} = 0.001
.....
E–9 = 10^{-9} = 0.000000001

Examples:

4.600 E-2 = **4.600** × 10^{-2} = **0.046** [m^3/pulse]
4.600 E 2 = **4.600** × 10^{+2} = **460.0** [m^3/pulse]

Display limits / Pulse value

DN	Litre		m^3	
	Min.	Max.	Min.	Max.
2	7.853 E-5	9.999 E 9	7.853 E-8	9.999 E 6
4	3.141 E-4	9.999 E 9	3.141 E-7	9.999 E 6
8	1.256 E-3	9.999 E 9	1.256 E-6	9.999 E 6
15	4.417 E-3	9.999 E 9	4.417 E-6	9.999 E 6
25	1.227 E-2	9.999 E 9	1.227 E-5	9.999 E 6
32	2.010 E-2	9.999 E 9	2.010 E-5	9.999 E 6
40	3.141 E-2	9.999 E 9	3.141 E-5	9.999 E 6
50	4.908 E-2	9.999 E 9	4.908 E-5	9.999 E 6
65	8.295 E-2	9.999 E 9	8.295 E-5	9.999 E 6
80	1.256 E-1	9.999 E 9	1.256 E-4	9.999 E 6
100	1.963 E-1	9.999 E 9	1.963 E-4	9.999 E 6
125	3.067 E-1	9.999 E 9	3.067 E-4	9.999 E 6
150	4.417 E-1	9.999 E 9	4.417 E-4	9.999 E 6
200	7.853 E-1	9.999 E 9	7.853 E-4	9.999 E 6
250	1.227 E 0	9.999 E 9	1.227 E-3	9.999 E 6
300	1.767 E 0	9.999 E 9	1.767 E-3	9.999 E 6
350	2.405 E 0	9.999 E 9	2.405 E-3	9.999 E 6
400	3.141 E 0	9.999 E 9	3.141 E-3	9.999 E 6
500	4.908 E 0	9.999 E 9	4.908 E-3	9.999 E 6
600	7.068 E 0	9.999 E 9	7.068 E-3	9.999 E 6
700	9.621 E 0	9.999 E 9	9.621 E-3	9.999 E 6
800	1.256 E 1	9.999 E 9	1.256 E-2	9.999 E 6
900	1.590 E 1	9.999 E 9	1.590 E-2	9.999 E 6
1000	1.963 E 1	9.999 E 9	1.963 E-2	9.999 E 6
1200	2.827 E 1	9.999 E 9	2.827 E-2	9.999 E 6
1400	3.848 E 1	9.999 E 9	3.848 E-2	9.999 E 6
1600	5.026 E 1	9.999 E 9	5.026 E-2	9.999 E 6
1800	6.361 E 1	9.999 E 9	6.361 E-2	9.999 E 6
2000	7.853 E 1	9.999 E 9	7.853 E-2	9.999 E 6

The last figure of the above values can differ by ±1 from the value shown in the display (error in rounding off)!

Min. pulse value at v = 10 m/s and f = 400 Hz
Factory settings → see page 68

Function group
STATUS OUTPUT – StAt_out / Gr 30

StAt_FCt
Fu 31

Status output function

Select or assign the function of the status output.

Error	Indicates system/process errors (for definition: see page 51)
FLo_dIr	Indicates direction of flow
CAnCEL	

Note!

Notes!
- The status output acts as a normally closed contact, i.e. in normal operation, free from fault, the output is closed (transistor conducting, see table).
- The behaviour of the outputs in the event of a fault is described on page 51.
- Process/system errors are *always* shown on the local display, independent of the status output configuration.
- For custody transfer measurement, the status output is configured to Error.
- For custody transfer measurement, the totalizer is configured to bidirectional and the outputs to unidirectional.

Configuration of status output	Status	Response Transistor 
System / process error message (Error)	System OK	closed 
	Fault indication	open 
	Supply failure	open 
Flow direction indication (FLo_dIr)	forward 	open 
	reverse 	closed 
	"closed" → Transistor conductive "open" → Transistor non-conductive	

"Unidirectional" or "bidirectional" operating mode:
Promag 31 measuring system can operate either bidirectionally or in one direction only. Selecting the operating mode is, however, directly coupled with the configuration of the status output.

Status output	*Operating mode*	*Current / pulse output*
"FLo_dIr" (Flow direction)	bidirectional	always active (signal output in both flow directions)
"Error" (Fault indication)	unidirectional	active only with positive flow direction (no signal output with negative flow, reverse)

Negative flows are shown on the display by an negative sign.

Function group
AUXILIARY INPUT – InPut / Gr40

InP_FCt
Fu 41

Auxiliary input function

Select or assign the auxiliary input function. The appropriate function is actuated by applying an external voltage (3...30 V DC) at the auxiliary input.

Note!
The following selection parameters are not available in custody transfer mode (SuPPrESS, res_tot). The auxiliary input is only used in custody transfer mode for resetting the error message (flashing display segment) or for testing the display.

- **SuPPrESS** Measured value suppression (Positive Zero Return): By activating the Positive Zero Return, the measuring mode is interrupted and all output signals are reset to defined values (~zero flow). *Example:* Interruption of measurement to clean the piping.

  Response of display with active suppression:
  "rAtE" → Display with 8 vertical bars.
  "totAL" → Display segment "Low flow cutoff" is shown (if creep suppression is activated).

- **rES_tot** Totalizer is reset to "0". (The totalizer can also be reset by using the function "rES_tot" resp. "Fu51").
- **CAnCEL**

Function group
DISPLAY – dISPLAY / Gr50

rES_tot
Fu 51

Reset totalizer

Reset the totalizer to '0'.

Notes!
- The totalizer and its overruns are set to zero with this function.
- The totalizer can also be reset using the auxiliary input (see function InP_FCt / Fu 41).

- **CAnCEL** Cancel
- **rES_YES** Reset totalizer (press E)

dISP_oPt
Fu 52

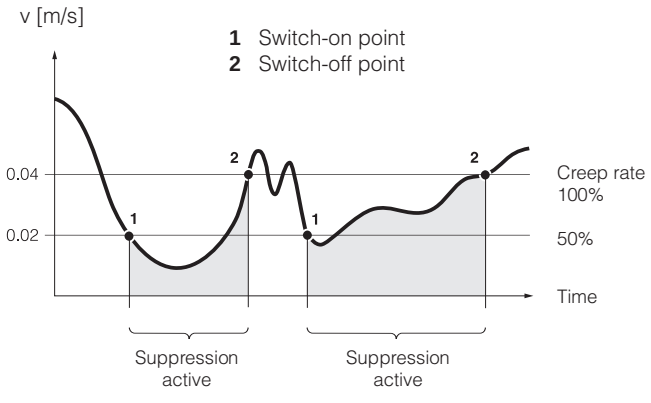
Display mode

Select the display mode (e.g. display of flow rate or display of totalizer, etc.).

Note!
For custody transfer measurement only the parameters ALtErnAt or totAL can be selected.

- **rAtE** Display flow
- **totAL** Display totalizer (counter status)
- **ALtErnAt** Display flow *and* totalizer (alternating)
- **tESt** Display test function *
- **CAnCEL**

* An automatic test of all display elements is carried out with this function (Start with E). The following displays are shown one after the other:
1. +8.8.8.8.8.8.8.8. (all display segments visible)
2. -0 0 0 0 0 0 0 0 (no display segments visible)
3. No display elements visible at all.

Function group **DISPLAY** – dISPLAY / Gr50	
dISP_dA Fu 53 Display damping (Flow rate)	Selecting the time constant determines whether the current output signal reacts very quickly to rapidly changing flows or is dampened: • small time constant → display with quick reaction • large time constant → display with dampened reaction Note! The display damping does not affect the response of the current output. Numeric entry: 0.5...20 [s] in steps of 0.5 s
tot_oFL Fu 54 Totalizer overflows	Display of totalizer overflows (arithmetic sign flashes on the display!) On the display the totalized flow is shown as a max. 8-digit number. Larger numerical values (> 99999999) can be read off in this function as overflows. The effective amount is therefore calculated from the sum of overflows and the actual displayed counter status (display mode → totAL). *Example:* Display of 2 overflows: 2 Actual displayed value for totalized sum: 00004321 [m^3] Total amount: 200004321 [m^3]
Function group **PROCESS PARAMETERS** – ProCESS / Gr60	
LFC Fu 61 Creep suppression	Switching on or off the creep suppression (Low flow cutoff). The creep suppression prevents the flow in the lowest measuring range from being detected e.g. with varying liquid head at standstill. With variations in flow in the lower part of the measuring range, the hysteresis (50% of creepage) prevents continual switching on and off of the creep suppression function. Note! This function is always activated in custody transfer mode (LFC_on) **Switch-on point (1)** When the velocity of the fluid is less than 0.02 m/s creep suppression is then *activated* and all output signals such as pulse and analogue signals, are set to the fall back value (0/4 mA, logical '0'). The segment for "Low flow cutoff" is then immediately visible on the LC display. **Switch-off point (2)** When the velocity of the fluid again exceeds v = 0.04 m/s, then creep suppression is *deactivated*. LFC_oFF Switch off creep suppression LFC_on Switch on creep suppression CAnCEL 

Switch-on and switch-off points (creepage)

Diameter DIN	On [l/s]	Off [l/s]	On [m^3/h]	Off [m^3/h]
2	0.00006	0.0001	0.0002	0.0005
4	0.0003	0.0005	0.0009	0.0018
8	0.001	0.002	0.004	0.007
15	0.003	0.007	0.013	0.025
25	0.010	0.020	0.035	0.071
32	0.016	0.032	0.058	0.116
40	0.025	0.050	0.090	0.181
50	0.039	0.079	0.141	0.283
65	0.066	0.132	0.239	0.478
80	0.101	0.201	0.362	0.724
100	0.157	0.314	0.565	1.131
125	0.245	0.491	0.884	1.767
150	0.353	0.707	1.272	2.545
200	0.628	1.257	2.262	4.524
250	0.982	1.963	3.534	7.069
300	1.413	2.827	5.089	10.179
350	1.924	3.848	6.927	13.854
400	2.513	5.026	9.048	18.096
500	3.926	7.854	14.137	28.274
600	5.654	11.310	20.358	40.715
700	7.696	15.394	27.709	55.418
800	10.053	20.106	36.191	72.382
900	12.723	25.447	45.804	91.609
1000	15.708	31.416	56.549	113.097
1200	22.619	45.239	81.443	162.860
1400	30.788	61.575	110.836	221.672
1600	40.212	80.425	144.764	289.528
1800	50.894	101.788	183.218	366.436
2000	62.832	125.664	226.194	452.388

On and off switch points are fixed values:
Switch-on point → at v = 0.02 m/s
Switch-off point → at v = 0.04 m/s

Function group
PROCESS PARAMETERS – ProCESS / Gr60

EPD
Fu 62

Empty Pipe Detection

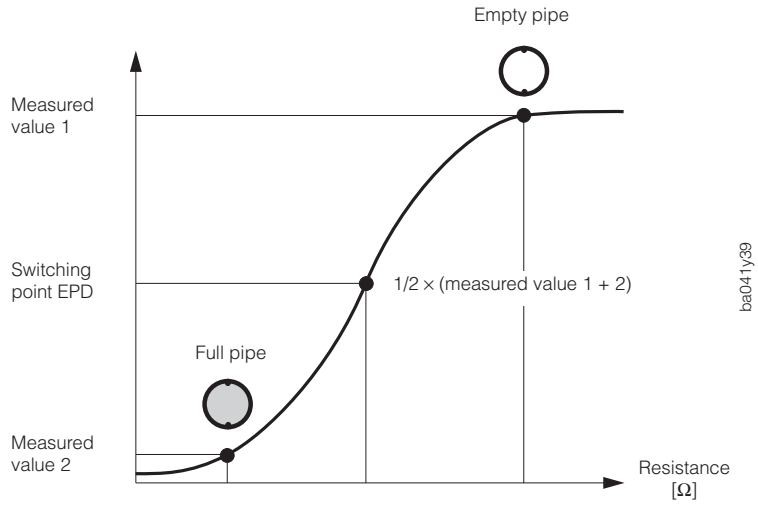
Note!

With this function (EPD = Empty Pipe Detection), two procedures can always be activated:
– Carrying out the empty and full pipe adjustment for Emty Pipe Detection
– Switching on/off Empty Pipe Detection (EPD).

Note!
- This function is available only if the sensor is fitted with an extra EPD electrode (see "Technical Data", page 65).
- The EPD function is not available with the remote "FL" version.
- The connection cable with the remote "FS" version may only be a maximum of 10 m long. Only then can correct functioning of the EPD be guaranteed!
- The EPD function is switched off when the flowmeter is delivered and must be switched on manually when required.

EPd_oFF	EPD switched off
EPd_on	EPD switched on (This selection is only displayed if the EPD adjustment has already been carried out successfully. If the adjustment is incorrect then the message "AdJ_Err" is shown instead)
EPd_Ad_E	Start empty pipe adjustment (confirm with E)
EPd_Ad_F	Start full pipe adjustment (confirm with E)
CAnCEL	

Remarks on Empty Pipe Detection (EPD)
Only a completely full measuring tube enables correct readings to be obtained. This can be continuously checked by Empty Pipe Detection. EPD is based on measuring the resistance between reference and EPD electrode (see Figure).



Response when partially full
If the EPD is active and responds due to a partially filled or empty pipe, the display segment "Empty Pipe" is shown on the display. The outputs respond in such cases as described on page 51.
When the pipe is partially filled and the EPD is not active, then the response may be different for identical plants:
– varying flow display
– zero flow
– excess flow values

(continued next page)

Function group
PROCESS PARAMETERS – ProCESS / Gr60

EPD
Fu 62

Procedure (Empty pipe / full pipe adjustment)

Notes!
- If Promag 31 is fitted with an EPD electrode, then the unit is already calibrated in the factory with drinking water (500 µS/cm). A new empty pipe or full pipe adjustment is to be carried out on site when liquids having different conductivities are used.
- Every (new) adjustment automatically switches off the EPD function.
- The EPD function can only be switched on (again) if empty or full pipe adjustment has been successfully carried out.

Note!

1. Empty the piping. For the emtpy pipe adjustment to be carried out now, the walls of the measuring tube should be wetted with fluid.

2. Start the empty pipe adjustment:
   Select EPd_Ad_E and confirm with E.
   – Display during adjustment: AdJ_buSY
   – Display after adjustment: ADJ_donE

3. Fill the piping with fluid.

4. Start the full pipe adjustment with the fluid stationary:
   Select EPd_Ad_F and confirm with E.
   – Display during adjustment: AdJ_buSY
   – Display after adjustment: ADJ_donE

5. Switch on the Empty Pipe Detection after the adjustment
   → Select EPd_on and confirm with E.

   Note!
   The EPD function can only be switched on (again) if empty or full pipe adjustment has been successfully carried out. If the adjustment is not successful then the message ADJ_Err is shown instead of "EPd_on". In such cases the empty or full pipe adjustment must again be carried out.

Note!

   Possible sources of error:
   – Empty pipe adjustment has been carried out when the pipe was full.
   – Full pipe adjustment was carried out when the pipe was empty or partially filled.

Function group
PROCESS PARAMETERS – ProCESS / Gr60

ECC
Fu 63

Electrode cleaning

Switching on and off the electrode cleaning circuitry (ECC). This function is not available in custody transfer mode!

Note!
- This function is only available if the Promag 31 is fitted with an electrode cleaning function (optional).
- The ECC function is not available with the remote "FL" version.
- The ECC is always switched on when first delivered from the factory.

ECC_oFF ECC switched off
ECC_on ECC switched on
CAnCEL

Remarks on ECC:
Conductive build-up on the electrodes and the measuring tube walls (e.g. magnetite) can cause measurement errors. The Electrode Cleaning Circuitry (ECC) has been developed in order to prevent build-up occurring. The cleaning cycle repeats itself every 30 minutes for approx. 3 seconds. The ECC works in the way described for all electrode materials available except tantalum. If the electrode material is tantalum then the ECC only protects the electrode surface from oxidation.

Note!

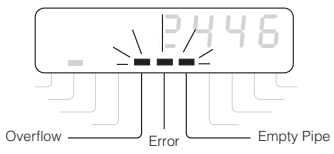
Note!
After the electrode cleaning procedure is completed, the signal outputs may be unsteady for a little while. This is due to electrochemical potentials caused by electrostatic charging of the fluid during the cleaning cycle. The set recovery time of approx. 2 seconds is generally sufficient to stabilise the signal output after the cleaning phase. During the recovery time the last value registered before cleaning is given.

Caution!
If the ECC is switched off for a long period of time in an application where there is a conductive build-up in the measuring tube, then this can lead to errors. If there is a large concentration of build-up at one point, then, under certain circumstances, switching on the ECC may not remove it. In such cases the flowmeter is to be cleaned and the build-up removed.

8 Trouble-shooting, Maintenance and Repairs

8.1 Response of the measuring system on faults or alarm

The Promag 31 distinguishes between two kinds of error:
- System error: instrument failure, power failure (Error)
- Process error: partially filled pipe (Empty Pipe), measuring range exceeded (Overflow)



Errors which occur during normal operation are indicated on the display by appropriate *segment bars* ("Error, Empty Pipe, Overflow").
Special features with custody transfer measurement are given on page 36.
The error response of the outputs is described in the following table.

Positive Zero Return *not* activated					
	Current output		**Pulse output**	**Status output (transistor)**	
	"0-20"	"4-20"		"Error"	"Flo_dir" (not available in custody transfer mode!)
No System / process error present	measurement OK (signal for flow)	measurement OK (signal for flow)	measurement OK (signal for flow)	conductive (closed)	*forward:* non-conductive (open) *reverse:* conductive (closed)
System or process error present	0 mA	2 mA	no signal output (0 Hz) non-conductive (open)	non-conductive (open)	Status kept before error occurred: *forward:* non-conductive (open) *reverse:* conductive (closed)

Positive Zero Return *activated* (not available in custody transfer mode!)					
	Current output		**Pulse output**	**Status output (transistor)**	
	"0-20"	"4-20"		"Error"	"Flo_dir"
No System and process errors present	0 mA	4 mA	no signal output (0 Hz) non-conductive (open)	conductive (closed)	conductive (closed)
System error only present	0 mA	2 mA		non-conductive (open)	
Process error only present	0 mA	4 mA		conductive (closed)	
System and process error present	0 mA	2 mA		non-conductive (open)	

8.2 Trouble-shooting and remedy

All instruments undergo various stages of quality control during production. The last of these stages is the wet calibration carried out on state-of-the-art calibration rigs.
The following summary helps to identify possible causes of error during normal measurement. An LED on the amplifier board is lit as long as the measuring system is operating normally.


Note!

Note!
For approved instruments, errors can only be corrected by breaking the seal. After repair, the appropriate standards authorities are to be informed (for resealing with lead).


Warning!

Warning!
This error diagnosis cannot be carried out with Ex instruments as they must be opened and thus the ignition protection type is no longer present.

Type of error	Remedy (Steps 1 → 2 → 3)
– No display – No output signal – LED on amplifier board is not lit	**1** Check the power supply → terminals 1, 2 **2** Check fuse → see page 21 85...260 V AC: 1 A slow-blow 20...55 V AC and 16...62 V DC: 2.5 slow-blow **3** Replace electronics → see page 56
The display is blank, with outputs still functioning.	**1** Check the ribbon cable connector of the display module → see page 56 (No. 3b) **2** Replace display module → see page 56 **3** Replace electronics → see page 56
No signal (current or pulse output) despite display showing value?	**1** Check the ribbon cable connector to the terminal compartment → see page 56 (No. 8) **2** Replace electronics → see page 56
Is the message "**Overflow**" shown on the display?	**1** Is the measuring tube empty? If yes → fill measuring tube **2** Check ground and potential equalisation → see page 27 **3** Is the flow velocity >12.5 m/s? If yes → reduce flow
Is the message "**Empty Pipe**" shown on the display although the measuring tube is full?	**1** Carry out an empty or full pipe adjustment and then switch on Empty Pipe Detection → see page 48 ff. **2** Check the following connections: • Electronics: EPD cable → see page 56 (No. 5c) • Remote version: EPD cable → see page 25 (terminals 36 and 37) **3** If the measuring tube is always full (pressure line): → Switch off function EPD / FuG2 → see page 48

Continued next page

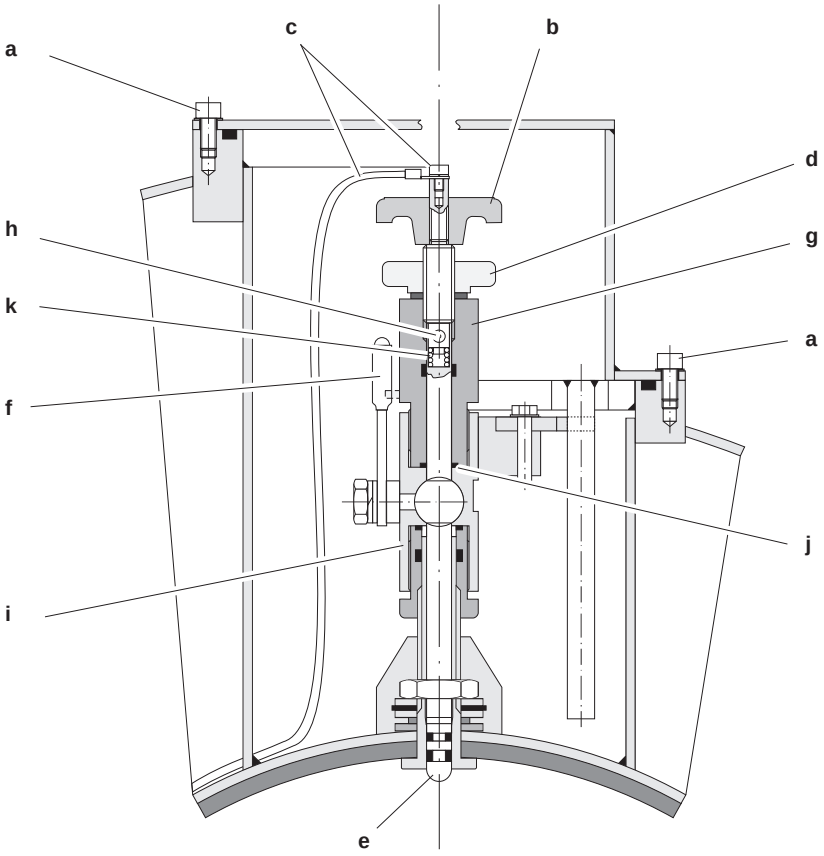
Type of error	Remedy (Steps 1 → 2 → 3)
Is the message "**Error**" shown on the display?	**1** Check the following connections on the amplifier board → see page 56: • Electrode signal cable → No. 5a • DAT module → No. 5b • Coil current cable → No. 7 **2** Replace electronics → see page 56
Does the instrument show negative flow values although the fluid in the piping is flowing forwards?	**1** Remote version → switch off power supply and change round terminals 41 and 42. **2** Set status output (function `StAt_FCt`) to "`Flo_dir`" → see page 44
Is the display unsettled despite continuous flow?	**1** Check ground and potential equalisation → see page 27 **2** Check to see if air bubbles are in the fluid. **3** Increase the time constant for the current output → see page 42 Increase the display damping for flow → see page 46
Is a low flow indicated despite standstill of the fluid and filled measuring tube?	**1** Check ground and potential equalisation → see page 27 **2** Check to see if air bubbles are in the fluid. **3** Activate creep suppression (function `LFC / FuG1`) → see page 46
The error cannot be remedied or else there is another type of error. In such cases please contact your local E+H Service organisation.	The following solutions are possible: **Request an E+H service technician** The following information is required when contacting a customer service technician: – brief description of the error – order code given on the nameplate → see page 7, 8 **Repair** Note the procedures on page 57 "Repairs" before returning the instrument for repair. Please state a brief description of the error on the delivery note.

8.3 Replacing the measuring electrodes

The Promag F (DN 350...2000) is available with replacement electrodes as an option. This version enables the measuring electrodes to be cleaned or replaced under process conditions.

Type DN 1200...2000
left side

Type DN 350...1050
right side



a	Allen screw	g	Holding cylinder
b	Rotary arm	h	Locking pins (rotary arm)
c	Electrode cable	i	Ball valve housing
d	Knurled nut (counter nut)	j	Gasket (holding cylinder)
e	Measuring electrode	k	Coil spring
f	Shut-off valve (ball valve)		

ba041y21

Fig. 36
Replacement unit for changing electrodes

Dismantling the electrode

1. Loosen the Allen screw (a) and remove the cover.
2. Unscrew the electrode cable (c) attached to the rotary arm (b).
3. Undo the knurled nut (d) by hand. This nut is used as a counter nut.
4. Remove the electrode (e) using the rotary arm (b). This can now be taken out from the holder (g) as far as the stop allows.

   Warning!
   Danger of injury! Under process condition (piping under pressure) the electrode can spring back to the stop. Keep pressing against while loosening.

   
   Warning!
5. Close the shut-off valve (f) after the electrode has been taken out as far as the stop.

   Warning!
   Do not attempt to open the shut-off valve. Keeping it shut prevents fluid from escaping.

   
   Warning!
6. Unscrew the entire electrode along with the holding cylinder (g).
7. Remove the rotary arm (b) from the electrode (e), while pressing to remove the locking pin (h). Take care not to lose the coil spring (k).
8. Replace the old electrode with a new electrode.
   A set of replacement electrodes can be ordered from Endress+Hauser.

Assembling the electrode

1. Slide the new electrode (e) into the holding cylinder (g) from below. Ensure that gaskets at the tip of the electrode are clean.
2. Put the rotary arm (b) on the electrode and secure with the locking pin (h).

   Caution!
   Ensure that the coil spring (k) is in place. This ensures close electrical contact and thus reliable measuring signals.

   
   Caution!
3. Pull back the electrode as far as possible so that the tip does not protrude out from the holding cylinder (g).
4. Screw the holding cylinder onto the shut-off unit (i) and thighten by hand. Gasket (j) on the holding cylinder must be in place and clean.

   Note!
   Ensure that the rubber tubes on the holding cylinder (g) and shut-off valve (f) have the same colour (red or blue)

   
   Note!
5. Open the shut-off valve (f) and screw in the electrode using the rotary arm (b) until the stop.
6. Screw the knurled nut (d) onto the holding cylinder. This clamps the electrode tight.
7. Screw the electrode cable (c) to the rotary arm (b) using the Allen screw.

   Caution!
   Ensure that the Allen screw of the electrode cable is tight. This ensures close electrical contact and thus reliable measuring signals.

   
   Caution!
8. Replace the cover and tighten the Allen screw (a).

8.4 Replacing the transmitter electronics

Warning!

Warning!
- Danger from electric shock! Switch off the power supply before opening the transmitter housing.
- When using Ex instruments, they must first cool down for at least 10 minutes before opening.
- The local power supply voltage and frequency must be the same as the technical specifications of the power supply boards.
- Ensure that the new electronics board is the same as the old one before replacing it (power supply, version of amplifier and software).

1. Loosen the Allen screws of the safety grip (3-mm Allen key).
2. Unscrew the cover of the electronics area of the transmitter housing.
3. Remove the local display as follows:
   a. Loosen the mounting screws of the display module.
   b. Unplug the ribbon cable of the display from the amplifier board.
4. Unplug the 2-pole plug of the power supply cable (by pressing down the catch) from the power supply board.
5. Remove the electrode signal cable from the amplifier board:
   a. Remove the cable board.
   b. Remove the blue DAT module.
   c. Loosen the EPD cable from the screw terminals.
6. Loosen the two Phillips screws of the board support plate. Carefully remove the support plate approx. 4...5 cm out of the transmitter housing.
7. Remove the coil current cable plug from the power supply board.
8. Remove the ribbon cable plug (connection cable to the terminal area) from the amplifier board.
9. The entire transmitter electronics, together with the board support plate, can now be completely removed from the housing.
10. Replace the old transmitter electronics with new transmitter electronics.
11. Reassemble in reverse sequence.

Replacing the DAT module (see 5b):
- Procedure for replacing the transmitter electronics → plug the old DAT onto the new amplifier board.
- Procedure for replacing a defective DAT → plug the new DAT onto the old amplifier board.

DAT = Replaceable data memory in which the basic data of the sensor are stored (see page 65).

Note!

Note!
Replacing transmitter electronics on approved flowmeters can only be done by breaking the seal. After replacement, the appropriate standards authorities are to be informed (for resealing with lead).

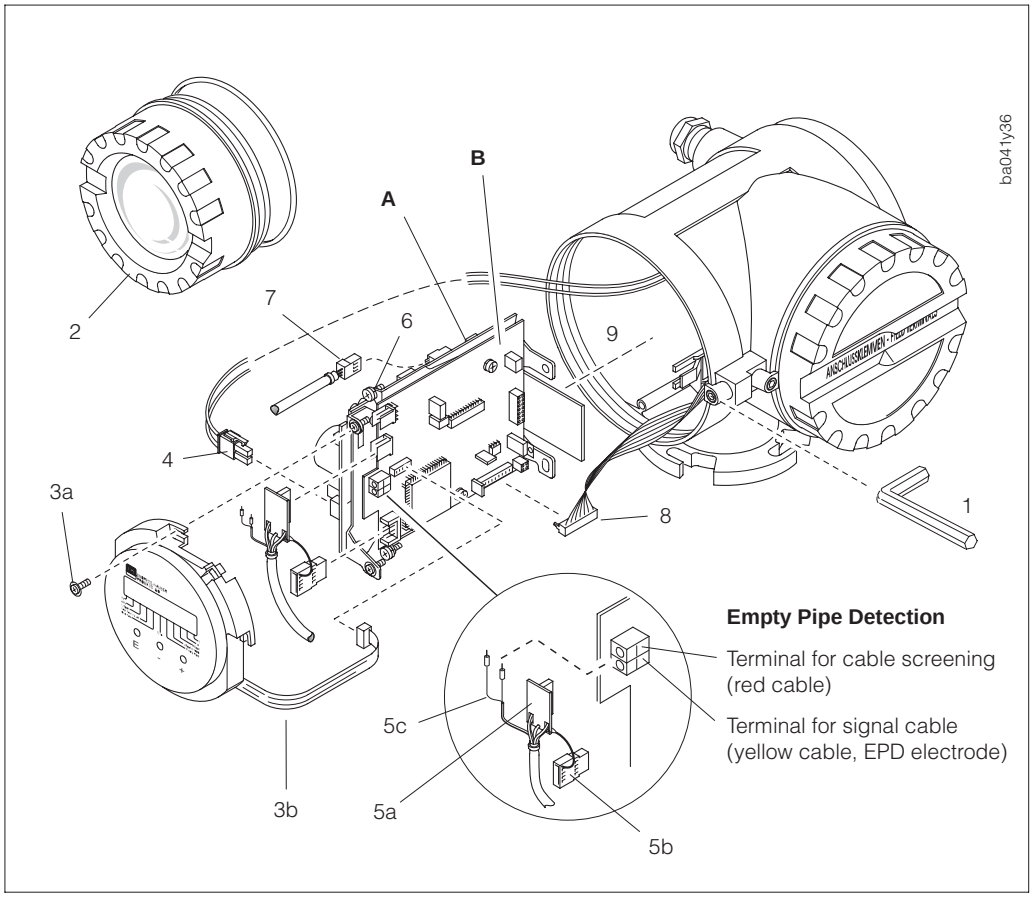


Fig. 37
Replacing the transmitter electronics:

A *Power supply board*
B *Amplifier board*

8.5 Replacing the fuse

Warning!
Danger from electric shock! Switch off the power supply before unscrewing the cover of the terminal compartment from the transmitter housing.

The instrument fuse can be found in the terminal compartment → see page 21

Exclusively use the following types of fuses:
- Power supply 20...55 V AC / 16...62 V DC → 2.5 A slow-blow / 250 V; 5.2 × 20 mm
- Power supply 85...260 V AC → 1 A slow-blow / 250 V; 5.2 × 20 mm

8.6 Repairs

Please carry out the following procedure before returning the Promag 31 for repair to Endress+Hauser:
- A note must always be enclosed with the instrument, giving the following information:
  – Brief description of the error
  – Description of the application
  – Chemical and physical properties of the fluid
- Remove all residue which may be present. Pay special attention to the gasket grooves and crevices where fluid may be present. This is especially important if the fluid is dangerous to health, e.g. corrosive, carcinogenic, radioactive, etc.

Warning!
We must request you not to return a unit if it is not completely certain that harmful substances can be removed e.g. cracks have been penetrated or substances have diffused through plastics.
Incomplete cleaning of the instrument may result in waste disposal or cause harm to personnel (burns, etc.). Any costs arising from this will be charged to the operator of the instrument.

8.7 Spare parts

The electronics plug-in module of the Promag 31 can be ordered separately as a spare part by E+H Service technicians (Replacement → see page 56).

8.8 Maintenance

No special maintenance is necessary for the Promag 31 measuring system.

9 Dimensions

9.1 Dimensions Promag 31 F (DN 15...300)

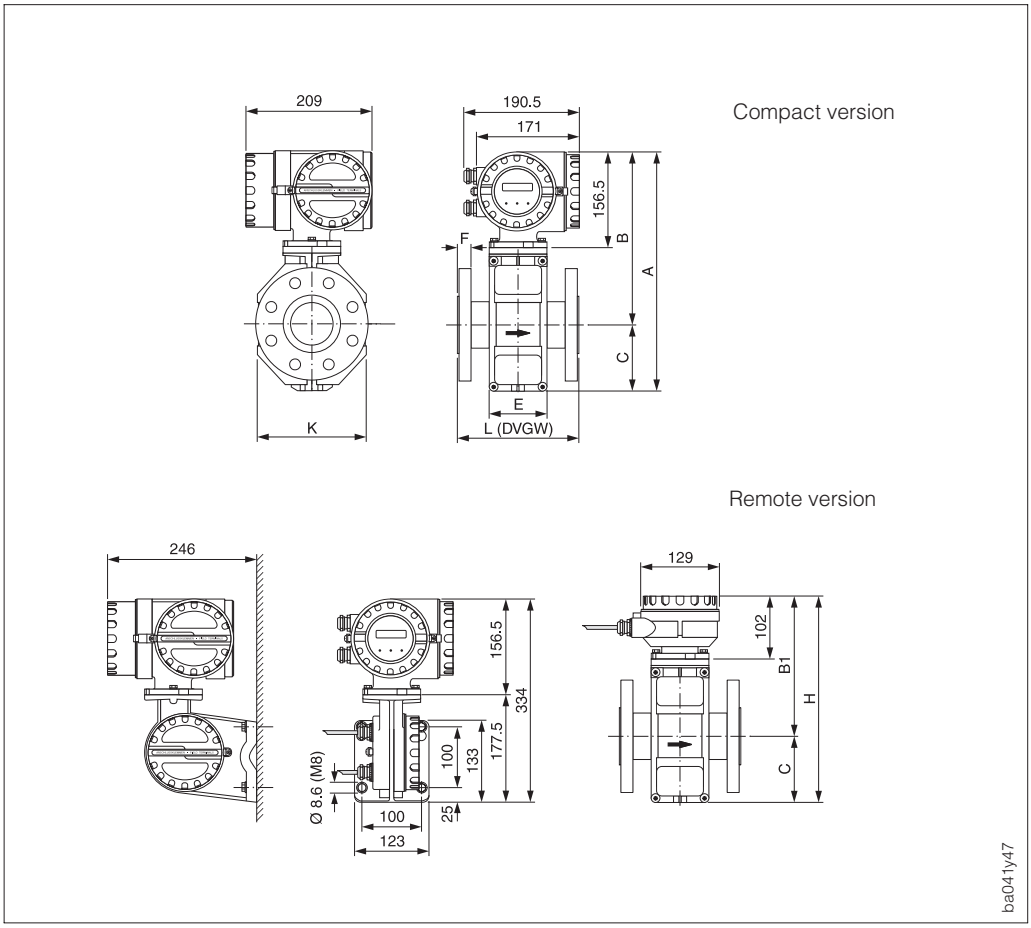


Fig. 38
Dimensions
Promag 31 F (DN 15...300)

DN		PN			L[1]	A	B	C	K	E	F			B1	Weight[2]
[mm]	[inch]	DIN	ANSI Class	JIS	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	DIN [mm]	ANSI [mm]	[mm]	[mm]	[kg]
15	1/2"	40	150	20K	200	340.5	256.5	84	120	94	14	11.2	286	202	6.5
25	1"	40	150	20K	200	340.5	256.5	84	120	94	16	14.2	286	202	7.3
32	–	40	–	20K	200	340.5	256.5	84	120	94	18	–	286	202	8.0
40	1 1/2"	40	150	20K	200	340.5	256.5	84	120	94	18	17.5	286	202	9.4
50	2"	40	150	10K	200	340.5	256.5	84	120	94	20	19.1	286	202	10.6
65	–	16	–	10K	200	390.5	281.5	109	180	94	18	–	336	227	12.0
80	3"	16	150	10K	200	390.5	281.5	109	180	94	20	23.9	336	227	14.0
100	4"	16	150	10K	250	390.5	281.5	109	180	94	22	23.9	336	227	16.0
125	–	16	–	10K	250	471.5	321.5	150	260	140	24	–	417	267	21.5
150	6"	16	150	10K	300	471.5	321.5	150	260	140	24	25.4	417	267	25.5
200	8"	10	150	10K	350	526.5	346.5	180	324	156	26	28.4	472	292	35.3
250	10"	10	150	10K	450	576.5	371.5	205	400	156	28	30.2	522	317	48.5
300	12"	10	150	10K	500	626.5	396.5	230	460	166	28	31.8	572	342	57.5

[1] The length is always identical independently of the chosen pressure rating.

Weight:

Compact version [2]	see table above
Promag 31 transmitter	3 kg (5 kg for wall mounted version)
Sensor connection housing	approx. 1 kg

9.2 Dimensions Promag 31 F (DN 350...2000)

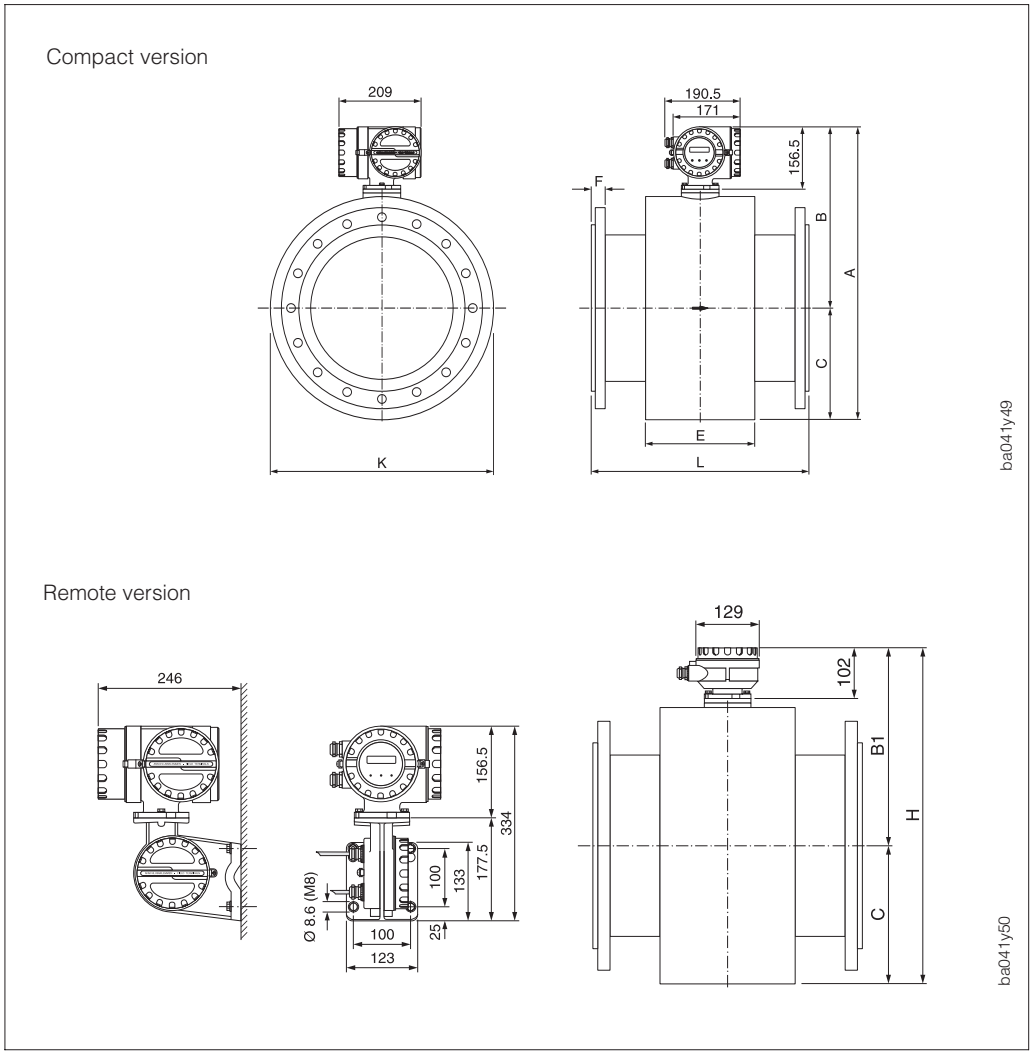


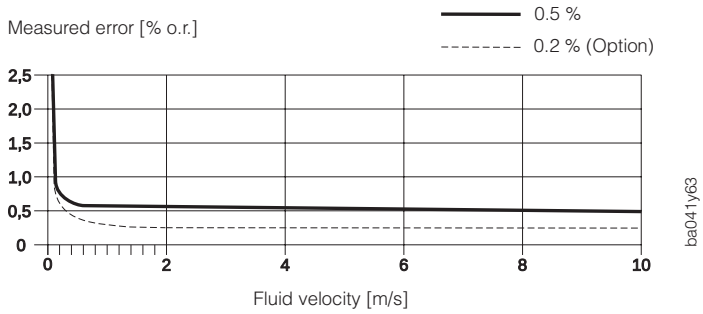
Fig. 39
Dimensions
Promag 31 F (DN 350...2000)

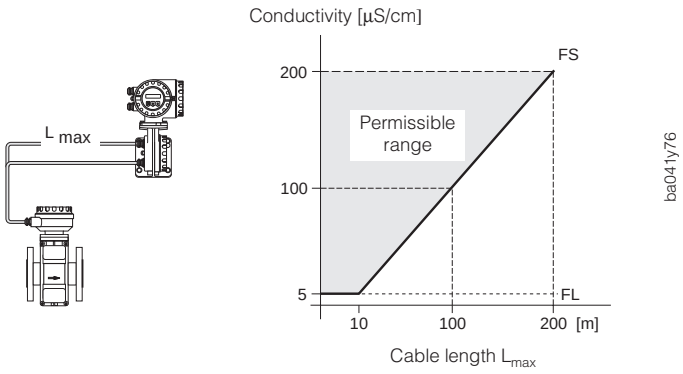
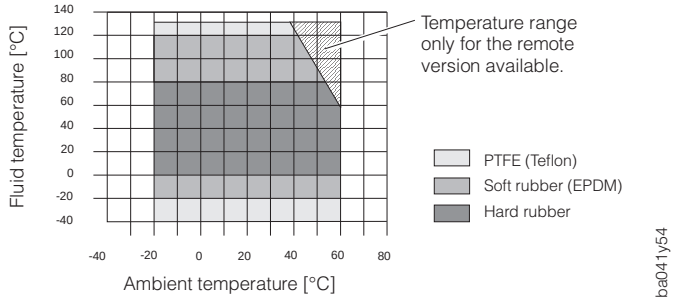
DN		PN			L [1]	A	B	C	K	E	F			H	B1	Weight [2]
[mm]	[inch]	DIN [bar]	ANSI [Class]	AWWA [Class]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	DIN [mm]	ANSI [mm]	AWWA [mm]	[mm]	[mm]	[kg]
350	14"	10	150	–	550	738	456.0	282.0	564	276	26	34.9	–	683.5	401.5	110
400	16"	10	150	–	600	790	482.0	308.0	616	276	26	36.5	–	735.5	427.5	130
450	18"	–	150	–	650	840	507.0	333.0	666	292	–	39.7	–	785.5	452.5	240
500	20"	10	150	–	650	891	532.5	358.5	717	292	28	42.9	–	836.5	478.0	170
600	24"	10	150	–	780	995	584.5	410.5	821	402	28	47.6	–	940.5	530.0	230
700	28"	10	–	D	910	1198	686.0	512.0	1024	589	30	–	33.3	1143.5	631.5	350
750	30"	–	–	D	975	1198	686.0	512.0	1024	626	–	–	34.9	1143.5	631.5	450
800	32"	10	–	D	1040	1241	707.5	533.5	1067	647	32	–	38.1	1186.5	653.0	450
900	36"	10	–	D	1170	1394	784.0	610.0	1220	785	34	–	41.3	1339.5	729.5	600
1000	40"	10	–	D	1300	1546	860.0	686.0	1372	862	34	–	41.3	1491.5	805.5	720
1050	42"	–	–	D	1365	1598	886.0	712.0	1424	912	–	–	44.5	1543.5	831.5	1050
1200	48"	6	–	D	1560	1796	985.0	811.0	1622	992	28	–	44.5	1741.5	930.5	1200
1350	54"	–	–	D	1755	1998	1086.0	912.0	1824	1252	–	–	54.0	1943.5	1031.5	2150
1400	–	6	–	–	1820	2148	1161.0	987.0	1974	1252	32	–	–	2093.5	1106.5	1800
1500	60"	–	–	D	1950	2196	1185.0	1011.0	2022	1392	–	–	57.2	2141.5	1130.5	2600
1600	–	6	–	–	2080	2286	1230.0	1056.0	2112	1482	34	–	–	2231.5	1175.5	2500
1650	66"	–	–	D	2145	2360	1267.0	1093.0	2186	1482	–	–	63.5	2305.5	1212.5	3700
1800	72"	6	–	D	2340	2550	1362.0	1188.0	2376	1632	36	–	66.7	2495.5	1307.5	3300
2000	78"	6	–	D	2600	2650	1412.0	1238.0	2476	1732	38	–	69.9	2595.5	1357.5	4100

[1] Thickness of the flange face includes sealing strip. The length is always identical independently of the chosen pressure rating.
[2] Weights of compact version
Weights for transmitter: see page 59

10 Technical Data

Application	
Instrument name	Flow measuring system “Promag 31 F (Model '99)” for custody transfer measurement.
Instrument function	Flow measurement of liquids for custody transfer with cold water (wastewater) in closed piping. Fields of Applications → see page 5.
Function and system design	
Measuring principle	Electromagnetic flow measurement according to Faraday's law (Generation of a voltage by induction in a magnetic field).
Measuring system	Instrument family “Promag 31 F (Model '99)” consisting of: • Transmitter: Promag 31 • Sensor: Promag F (DN 15...2000) Two versions are available: • Compact version • Remote version (FS or FL version)
Input variables	
Measuring variable	Flow velocity (proportional to induced voltage. Measured by two electrodes in the measuring tube)
Measuring range	Measuring range of electronics within v = 0...12.5 m/s The full scale values for the current output can be selected within the following limits (see also page 41): – Minimum full scale value at v = 0.3 m/s – Maximum full scale value at v = 10 m/s
Operable flow range	Over 1000 : 1 When the flow is pulsating, the amplifier is not overloaded above its set full scale value even with peak velocities of 12.5 m/s. Flow is measured between 0.01...>10 m/s at the stated accuracy.
Auxiliary input	U = 3...30 V DC, R_i = 1.8 kΩ, galvanically isolated Configurable for positive zero return or totalizer reset. With custody transfer measurement, error messages can only be reset and a display test function activated via the auxiliary input!
Output variables	
Output signal	• *Current output:* 0/4...20 mA, galvanically isolated, R_L < 700 Ω, time constant selectable (0.5...95 s), full scale value freely selectable temperature coefficient: typical 0.01% o.r./°C; resolution: 10 µA • *Pulse output (transistor output):* passive, f_{max} = 400 Hz, U_{max} = 30 V, I_{max} = 250 mA, galvanically isolated, pulse value selectable, pulse/pause ratio up to 0.5 Hz approx. 1:1 (the pulse width is limited to 1 s for pulse frequencies < 0.5 Hz) • *Status output (transistor output):* passive, U_{max} = 30 V, I_{max} = 250 mA Can be configured for: – indicating system errors (error), process errors (overflow, Empty Pipe) – flow direction indication

Output variables (continued)	
Signal on alarm	• Current output: The current is set to a defined value (see page 51) • Pulse output: no signal supplied • Status output: on "Error" → not conducting (open) on "Flow direction" → last status held (forward → not conducting; backward → conducting) Error response of the outputs (detailed description) → see page 51 Display response on errors → see page 36
Load	R_L < 700 Ω (current output)
Creep suppression	Switch-on point at v = 0.02 m/s Switch-off point at v = 0.04 m/s Further information → see page 46
Accuracy	
Reference conditions	According to DIN 19200 and VDI/VDE 2641: Fluid temperature +28 °C ± 2 K Ambient temperature +22 °C ± 2 K Warm up period 30 minutes Mounting – Inlet run >10 x DN – Outlet run > 5 x DN – Transmitter and sensor are grounded. – The sensor is build-in centered into the piping.
Measured error	Pulse output: ± 0.5% o.r. ± 0.01% o.f.s. (full scale value = 10 m/s) Current output: additionally ± 10 µA (typical)  *Option:* Promag 31 F: ± 0.2% o.r. ± 0.005% of Q_k Q_k = desired reference flow quantity for calibration (v = 2...10 m/s). Q_k has to be noted for ordering. Deviations in power supply voltage have no influence on the specified ranges.
Repeatability	± 0.1% o.r. ± 0.005% o.f.s. o.r. = of reading o.f.s. = of max. full scale value (see table on page 41)

Operating conditions	
Installation conditions	
Installation instructions	Orientation: vertical or horizontal Restrictions and other recommendations → see page 10 ff.
Inlet and outlet sections	The inlet and outlet sections must have the same nominal width as the flowmeter: Inlet section: ≥ 5 x DN Outlet section: ≥ 2 x DN
Connection cable length for remote version	*FS version:* 0... 10 m → min. conductivity ≥ 5 µS/cm 10...200 m → min. conductivity = f (L_{max}) *FL version:* 0...200 m → min. conductivity ≥ 5 µS/cm *Instrument equiped with empty pipe detection (EPD):* max. cable length = 10 m Minimum conductivity for demineralised water: generally ≥ 20 µS/cm 
Ambient conditions	
Ambient temperature	–20...+60 °C (Transmitter and sensor) • An all-weather cover should be used to protect the housing from direct sunlight when mounting in the open. This is especially important in warmer climates and with high ambient temperatures. • Due to the danger of the transmitter electronics overheating, the transmitter and sensor are to be mounted separately with high ambient and fluid temperatures (see Figure). 
Storage temperature	–10...+50 °C (preferably at +20 °C)
Degree of protection (EN 60529)	IP 67 (NEMA 4X) Option: IP 68 (NEMA 6P) for Promag F sensor
Shock and vibration resistance	Accelleration up to 2 g / 2 h per day; 10...100 Hz
Electromagnetic compatibility (EMC)	According to EN 50081 Part 1 and 2 (interference emission) / EN 50082 Part 1 and 2 (interference immunity) as well as to NAMUR recommendations

Operating conditions (continued)	
Process conditions	
Fluid temperature	*"Custody transfer certifiable" instruments:* Fluid temperature range depends on the sensor lining (see also Figure on page 63): –40...+130 °C PTFE (Teflon), DN 15...600 –20...+120 °C Soft rubber (EPDM), DN 25...2000 0...+ 80 °C Hard rubber, DN 65...2000 *Certified instruments:* 0...30 °C (Cold water)
Nominal pressure	DIN PN 6 (DN 1200...2000) PN 10 (DN 200...1000) PN 16 (DN 65...150) PN 40 (DN 15...50) PN 16/25 (DN 200...300) PN 40 (DN 65...100, optional) ANSI Class 150 ($^1/_2$...24") Class 300 ($^1/_2$...6", optional) The material load curves (p-T-load diagrams) for all process connections can be found in the Technical Information TI 043D/06/en "Promag 30 (Model '99)"
Conductivity	Minimum conductivity: ≥ 5 µS/cm (for liquids in general) ≥ 20 µS/cm (for demineralised water) With the "FS" remote version the conductivity required also depends on the length of the cable → see page 63 *"Connection cable length"*
Pressure loss	• No pressure loss if sensor and piping have the same nominal diameter. • Pressure loss specifications when using adapters e.g. reducers or expanders → see page 14. • Vacuum resistance of measuring tube lining → see page 70
Mechanical construction	
Design / Dimensions	Dimensions → see pages 59–60 Internal diameter of measuring tube → see page 69
Weight	See pages 59–60
Materials	*Process connections (flanges):* DIN: Stainless steel 1.4571, St. 37-2 *Electrodes:* 1.4435; Platinum/Rhodium 80/20; Hastelloy C-22; Tantalum *Seal material:* no seals (Lining = 'seal') *Transmitter housing:* Powder-coated die-cast aluminium *Sensor housing:* DN 15...300: Powder-coated die-cast aluminium DN 350...2000: Coated steel

Mechanical construction (continued)	
Electrodes fitted	Measuring, reference and empty pipe detection electrodes As standard with 1.4435, Hastelloy C-22, Tantalum
CIP cleanable	Yes (observe maximum temperature)
SIP cleanable	No
Process connections	Flange connection (DIN)
Electrical connection	• Wiring diagrams: see page 21 ff. • Cable specifications: see page 26 • Galvanic isolation: All circuits for inputs, outputs, power supply and sensors are galvanically isolated from one another.
Cable entries	*Power supply and signal cable (output):* Cable glands PG 13.5 (5...15 mm) or threads for cable glands M20 x 1.5 (8...15 mm) *Coil current cable and signal cable (remote version)* Cable glands PG 13.5 (5...15 mm) or threads for cable glands M20 x 1.5 (8...15 mm)
User interface	
Operation	On-site operation: All functions of the E+H operating matrix can be selected and changed using three keys (E, –, +).
Display	– Eight character LC display – 11 display segments for indicating units and instrument status. – Damping of flow display can be adjusted: 0.5...20 s
Communication	none
Power supply	
Supply voltage / Frequency	85...260 V AC, 45...65 Hz 20... 55 V AC, 45...65 Hz 16... 62 V DC
Power consumption	AC: < 15 VA (incl. sensor) DC: < 15 W (incl. sensor) Current at make (Promag 31 X / 24 V DC): – max. 13.5 A (< 100 µs) – max. 6 A (< 5 ms)
Power supply failure	Bridges minimum 1 power cycle (22 ms) • EEPROM saves measuring system data on power failure (no batteries required). • DAT = replaceable data memory in which basic data of the sensor are stored: nominal diameter, SAPS (actual values), serial number, calibration factor, zero point, status EPD (yes/no), EPD calibration values.

Certificates and approvals	
Ex approvals	Information on Ex versions (e.g. CENELEC, SEV, FM, CSA) can be supplied by your E+H sales center on request. All explosion protection data are given in separate documentation available on request.
Custody transfer	PTB approval for custody transfer with cold water and wastewater (either for approval or approved for custody transfer).
CE mark	By attaching the CE mark, Endress+Hauser confirms that the Promag 31 measurement system has been successfully tested and fulfils all legal requirements of the relevant CE directives.
Order information	
Accessories	• Post mounting set for transmitter (remote version): Order No. 50076905 • Wall mounting kit for Promag A sensor: Order No. 50064550
Supplementary documentation	System Information Promag (SI 010D/06/en) Technical Information Promag 30 (TI 043D/06/en) * Operating Manual Promag 30 (BA 039D/06/en) * Supplementary Ex documentation: CENELEC, SEV, FM, CSA * Model '99

Other standards and guidelines

EN 60529	Degree of protection by housing (IP code)
EN 61010	Protection Measures for Electronic Equipment for Measurement, Control, Regulation and Laboratory Procedures
EN 50081	Part 1 and 2 (interference emission)
EN 50082	Part 1 and 2 (interference immunity)
NAMUR	Association of Standards for Control and Regulation in the Chemical Industry

Physikalisch-Technische Bundesanstalt

Braunschweig und Berlin

Zulassungsschein

Innerstaatliche Bauartzulassung

Nr. 1.32-96000089

Auf Grund des § 9 des Eichgesetzes vom 11. Juli 1969 (BGBl. I S. 759) in Verbindung mit § 26 des Eichgesetzes in der Fassung vom 23. März 1992 (BGBl. I S. 711) sowie den §§ 16 Abs. 1-3 und 17 Abs. 1 der Eichordnung vom 12. August 1988 (BGBl. I S 1657) in ihren derzeit gültigen Fassungen wird der Firma:

Endress + Hauser Flowtec AG
Reinach, Schweiz

folgende Bauart zur innerstaatlichen Eichung zugelassen:

Magnetisch-induktiver Volumendurchflußintegrator
mit elektrischem Zählwerk

Die Bauart erhält folgendes Zulassungszeichen:

6.221
96.18

Die wesentlichen Merkmale und gegebenenfalls die Zulassungsauflagen, Befristungen und Bedingungen sowie inhaltlichen Beschränkungen sind in der Anlage festgelegt. Sie ist Bestandteil der Zulassung und umfaßt -05-Seite(n).

Physikalisch-Technische Bundesanstalt **Braunschweig,** 27. Juni 1996

Im Auftrag

Dr. M. Rinker

Dienststempel: PHYSIKALISCH-TECHNISCHE BUNDESANSTALT 41

- Hinweise und Rechtsbehelfsbelehrung auf der Rückseite -

Zulassungsscheine ohne Unterschrift und ohne Dienststempel haben keine Gültigkeit.
Die Zulassungsscheine dürfen nur unverändert weiterverbreitet werden.
Auszüge oder Änderungen bedürfen der Genehmigung der Physikalisch-Technischen Bundesanstalt.

Factory settings (full scale value, pulse values)

DN		Factory settings			
		Full scale value (current output) (I = 20 mA; at v ~ 2.5 m/s)		Pulse value (Imp_{out} = 1 Hz; at v ~ 2.5 m/s)	
[mm]	[inch]	[l/s]	[USgpm]	[l/pulse]	[USgal/pulse]
2	1/12"	0.008	0.1	0.008	0.0020
4	5/32"	0.03	0.5	0.03	0.0085
8	5/16"	0.10	2.0	0.10	0.035
15	1/2"	0.45	7.0	0.45	0.10
25	1"	1.0	20.0	1.0	0.30
32	1 1/4"	2.0	30.0	2.0	0.55
40	1 1/2"	3.0	50.0	3.0	0.85
50	2"	5.0	80.0	5.0	1.0
65	2 1/2"	8.0	150.0	8.0	2.0
80	3"	10.0	200.0	10.0	3.5
100	4"	20.0	300.0	20.0	5.0
125	5"	30.0	500.0	30.0	8.0
150	6"	45.0	700.0	45.0	10.0
200	8"	80.0	1000.0	80.0	20.0
250	10"	100.0	2000.0	100.0	30.0
300	12"	150.0	3000.0	150.0	50.0
350	14"	250.0	4000.0	250.0	65.0
400	16"	300.0	5000.0	300.0	85.0
500	20"	500.0	8000.0	500.0	150.0
600	24"	700.0	10000.0	700.0	200.0
700	28"	950.0	15000.0	950.0	250.0
800	32"	1000.0	20000.0	1000.0	350.0
900	36"	1500.0	25000.0	1500.0	400.0
1000	40"	2000.0	30000.0	2000.0	500.0
1200	48"	3000.0	50000.0	3000.0	750.0
1400	56"	4000.0	60000.0	4000.0	1000.0
1600	64"	5000.0	80000.0	5000.0	1500.0
1800	72"	6500.0	100000.0	6500.0	1500.0
2000	78"	8000.0	100000.0	8000.0	2000.0

Internal diameter of the measuring tube

DN		PN			AWWA	Internal diameter		
		DIN	ANSI	JIS		PFA	PTFE (Teflon)	Hard rubber Soft rubber (EPDM)
[mm]	[inch]	[bar]	[lbs]					
15	1/2"	40	Class 150	20K		-	15	-
25	1"	40	Class 150	20K		-	26	-
32	-	40	Class 150	20K		-	35	-
40	1 1/2"	40	Class 150	20K		-	41	-
50	2"	40	Class 150	10K		-	52	-
65	-	16	Class 150	10K		-	68	65
80	3"	16	Class 150	10K		-	80	78
100	4"	16	Class 150	10K		-	105	100
125	-	16	Class 150	10K		-	130	126
150	6"	16	Class 150	10K		-	156	154
200	8"	10	Class 150	10K		-	207	205
250	10"	10	Class 150	10K		-	259	259
300	12"	10	Class 150	10K		-	309	310
350	14"	10	Class 150			-	337	341
400	16"	10	Class 150			-	387	391
500	20"	10	Class 150			-	487	491
600	24"	10	Class 150			-	593	593
700	28"	10			Class D	-	-	692
800	32"	10			Class D	-	-	794
900	36"	10			Class D	-	-	893
1000	40"	10			Class D	-	-	995
1200	48"	6			Class D	-	-	1195
1400	-	6			-	-	-	1401
1600	-	6			Class D	-	-	1599
1800	72"	6			Class D	-	-	1799
2000	-	6			-	-	-	1995

Resistance of the lining to vacuum (standard version)

DN		Measuring tube lining	Limits for vacuum [mbar] at different fluid temperatures				
[mm]	[inch]		25 °C	80 °C	100 °C	120 °C	130 °C
65...2000 25...2000	3...78" 1...78"	Hard rubber Soft rubber (EPDM)	0 0	0 0	0	0	
15...50 65...80 100 125...150 200 250 300 350 400	1/2...2" 3" 4" 6" 8" 10" 12" 14" 16"	PTFE (Teflon)	0 0 0 135 200 330 400 470 540	0 * * * * * * * *	0 40 135 240 290 400 500 600 670	* * * * * * * * *	100 130 170 385 410 530 630 730 800
500...600	20...24"		Vacuum not permitted!				

* No value available

Index

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