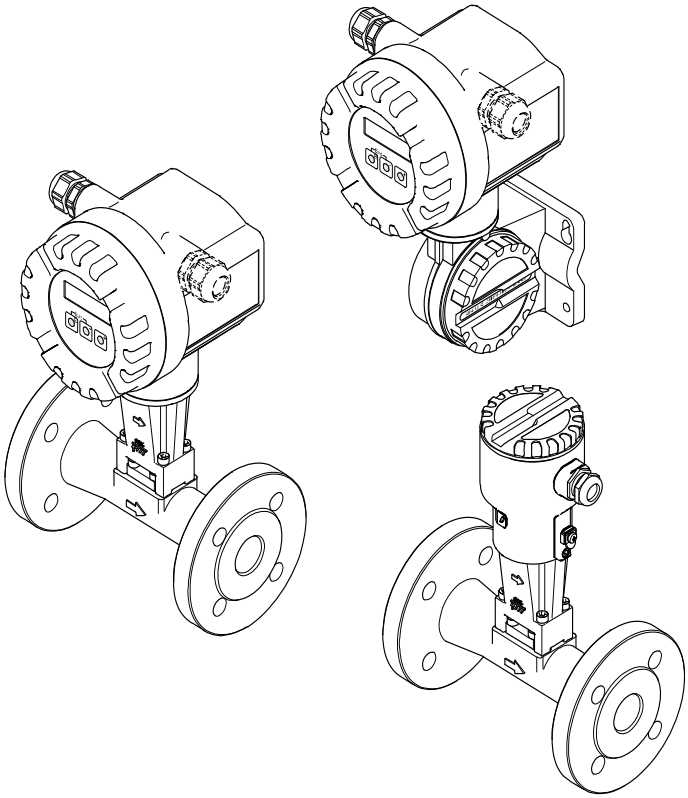
ISO 9001/ ISO 14001

TLV CO., LTD.
Kakogawa, Japan
is approved by LRQA LTD. to ISO 9001/14001

Instruction Manual



Vortex Flowmeter
EF73

Copyright © 2009 by TLV CO., LTD.
All rights reserved
Rev 2-2009

Contents

1 Safety Instructions

1.1 Correct Usage

- EF73 measuring system is used to measure the flow of saturated steam, superheated steam, air and water. Do not use to measure the flow of toxic, flammable or otherwise hazardous fluids. Use this system only as intended.
- The primarily measured variables are volume flow and temperature. From these values, the device can use stored data on density and enthalpy to calculate and output information such as mass flow and heat flow.
- The manufacturer assumes no liability for damage or other accidents caused by incorrect use of the instrument.

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 a condition in which they are safe to operate. The devices comply with the applicable standards and regulations in accordance with EN 61010 “Protection Measures for Electrical Equipment for Measurement, Control, Regulation and Laboratory Procedures”. They can, however, be a source of danger if used incorrectly or for anything other than the designated use. Consequently, always pay particular attention to the safety instructions indicated in these Operating Instructions by the following symbols:


Warning!

Warning!
“Warning” indicates an action or procedure that, if not performed correctly, can result in injury or a safety hazard. Comply strictly with the instructions and proceed with care.


Caution!

Caution!
“Caution” indicates an action or procedure that, if not performed correctly, can result in incorrect operation or destruction of the device. Comply strictly with the instructions.


Note!

Note!
“Note” indicates an action or procedure that, if not performed correctly, can have an indirect effect on operation or trigger an unexpected response on the part of the device.

1.3 Operational Safety

- The EF73 measuring system complies with the general safety requirements in accordance with EN 61010 and the EMC requirements of EN 61326/A1 and NAMUR recommendations NE 21 and NE 43.
- Housing ingress protection IP 67 to EN 60529.
- A comprehensive self-monitoring feature of the measuring system ensures high operational safety. In cases of error, the current output assumes a predefined response, the signal of the pulse output is set to the fall-back value of 0 Hz. The appropriate error messages are shown on the LCD.
- On power failure, the configuration data of the measuring system remain in the EEPROM (without batteries). The totalizer remains on the value last shown.

1.4 Installation, Commissioning and Operation

- Mounting, electrical installation, commissioning and maintenance of the device must be carried out by trained, qualified specialists authorized to perform such work by the operator of the facility. The specialist must have read and understand this manual before carrying out its instructions.
- The device may only be operated by personnel who are authorized and trained by the operator of the facility. Strict compliance with the instructions in these Operating Instructions is mandatory.
- In the case of special fluids (incl. fluids for cleaning), TLV will be happy to assist in clarifying the material resistance properties of wetted parts. However, the user is responsible for the choice of wetted materials as regards their in-process resistance to corrosion; the manufacturer refuses to accept liability..
- The installer must ensure that the measuring system is correctly wired in accordance with the wiring diagrams.

There is no longer any contact protection once the housing cover is removed.

Warning!

- Observe all local regulations governing the opening and repair of electrical devices.

1.5 Repairs, Dangerous Chemicals

The following procedures must be carried out before an EF73 is sent to TLV for repair:
Note: References to use with hazardous fluids are for customers having special permission and a signed contract with TLV for hazardous use.

- A note must be enclosed with the instrument, containing a description of the fault, the application and the chemical and physical properties of the fluid being measured.
- Remove all fluid residues that 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. flammable, toxic, caustic, carcinogenic, etc.
- No instrument should be returned to TLV without all dangerous material being removed first.

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

1.6 Technical Improvements

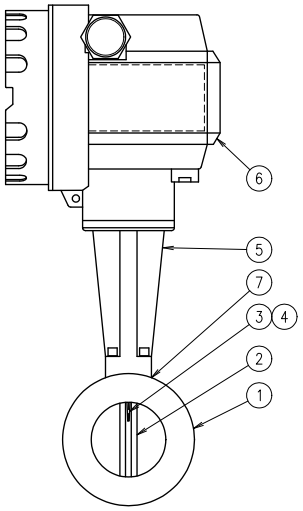
The manufacturer reserves the right to modify technical data without prior notice. Your local TLV Distributor or Sales Office will supply you with all current information and any updates to this manual.

2 System Description

The EF73 vortex flowmeter measures the temperature and volumetric flow of steam, gases and liquids with temperatures in the range of -200 – +400 °C (-330 – +750 °F) and at nominal pressures of up to 4.96 MPaG (49.6 barg, 719 psig). If the process pressure is constant, EF73 can be programmed to supply the flow rate in mass, energy or corrected volume units.

No.	Description
①	Meter Body
②	Bluff Body
③	Sensor (wetted parts)
④	Sensor (non-wetted parts)
⑤	Pipe Stand
⑥	Transmitter Housing
⑦	Gasket*
	Mounting Kit**
	Remote Transmitter Mount***
	Connection Cable (30 m, 98 ft)***

* Other materials available, see 6.1.6
** Flangeless model only, see 3.4
*** Remote version only, see 4.3



2.1 EF73 Measuring System

A measuring system consists of:
- EF73 *remote* or *compact* versions
- EF73 flangeless or flanged connection body

In the *compact version*, the transmitter and sensor form a single mechanical unit; in the *remote version*, they are mounted separate from each other. When the sensor body must be installed in a high or otherwise difficult to reach location, the *remote version* allows more accessible transmitter installation.

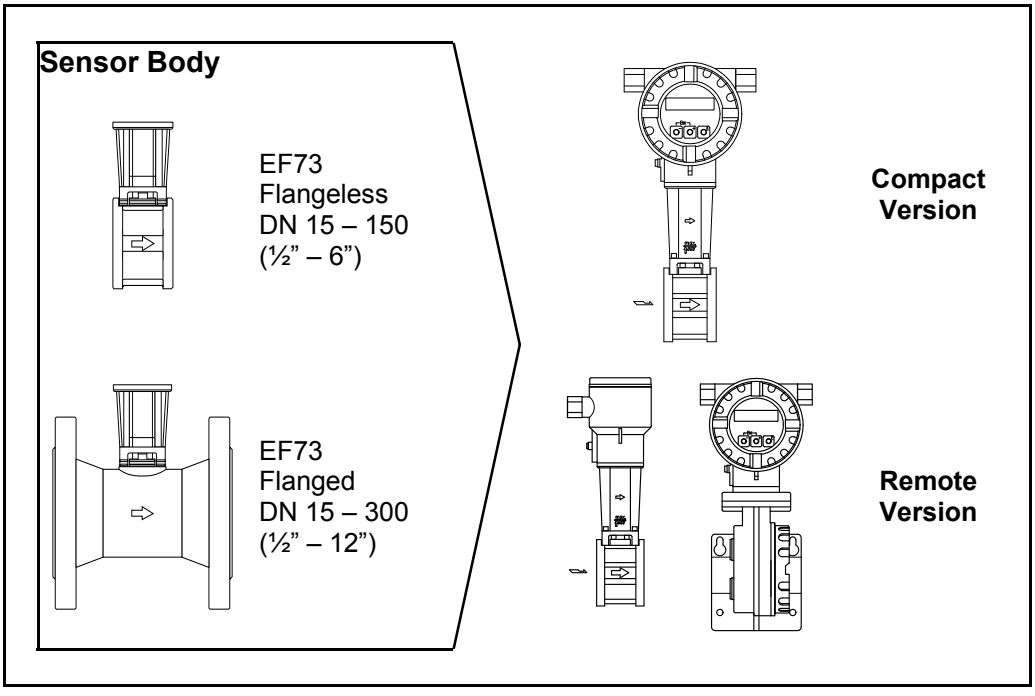


Figure 1
EF73 measuring system

3 Mounting and Installation

3.1 Transport

- The devices must be transported in the container supplied.
- Devices with nominal diameter 40 – 300 mm (DN 40 – 300, 1½" – 12") must not be lifted at the transmitter housing (*compact version*) or at the connection housing (*remote version*) when transporting (see Fig. 2). Use carrier slings when transporting and put the slings around both process connections. Avoid chains as these could damage the housing.

Warning!
The center of gravity of the entire measuring device might be higher than the points around which the slings are slung. Therefore, when transporting, make sure that the device does not unintentionally turn or slip.

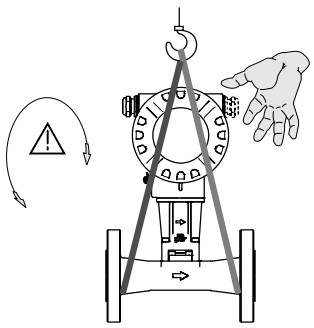

Warning!

Figure 2
Instructions for transporting sensors

3.2 Degree of Protection

The devices fulfill all the requirements for IP 67 / NEMA 4X. Compliance with the following points is mandatory following installation in the field or servicing in order to ensure that IP 67 protection is maintained:

- 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 screw caps must be firmly tightened.
- The cables used for connection must be of the specified outside diameters
- Firmly tighten the cable entry (see Fig. 3).
- The cables must loop down before they enter the cable entries ("water trap", Fig. 3). This arrangement prevents moisture penetrating the entry. Always install the measuring device in such a way that the cable entries do not point up.
- Replace all unused cable entries with dummy plugs.
- Do not remove the grommet from the cable entry.

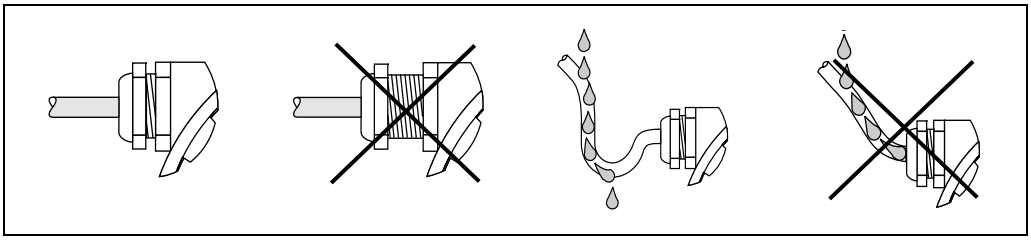


Figure 3
Protection IP 67 / NEMA 4X

Temperature Ranges
The maximum approved ambient and process temperatures must be observed (see 6.1.6).

3.3 Installation Conditions

A vortex flowmeter requires a fully developed flow profile as a prerequisite for measuring volume accurately. The following points must therefore be noted when mounting the EF73 in the pipeline.

Pipe Inner Diameter
When ordering, ensure that the nominal diameter and pipe schedule (DIN/ANSI/JIS) are correct, since calibration of the flowmeter and therefore the achievable accuracy of the measuring point are dependent on these specifications.

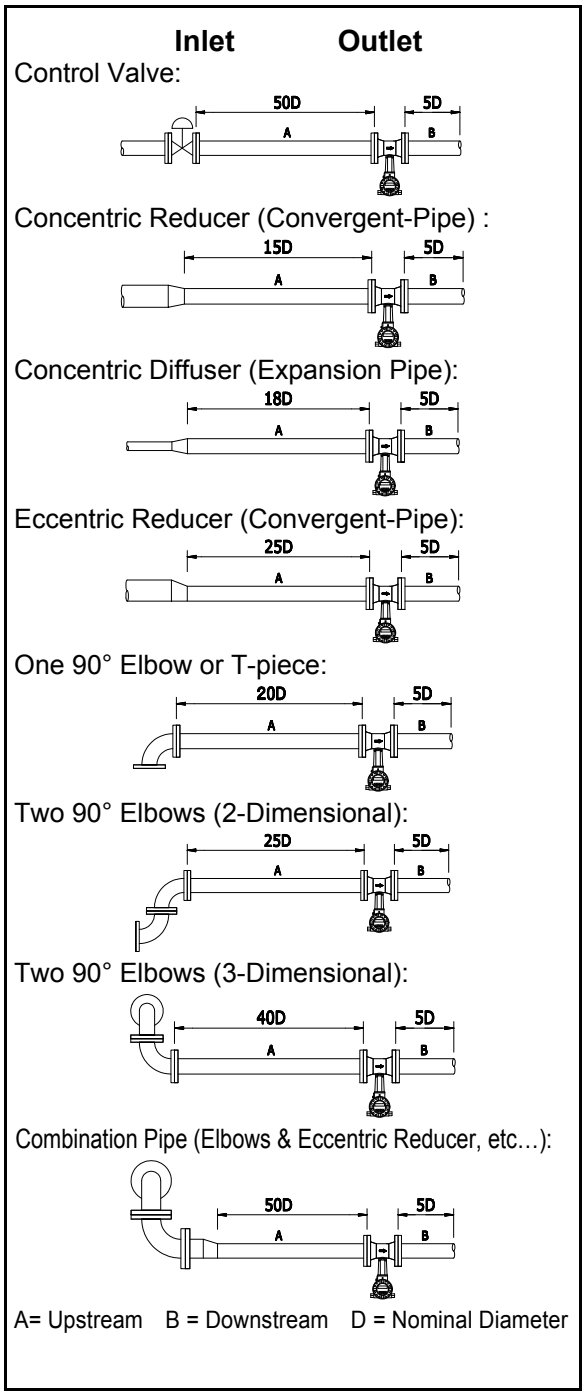


Figure 4-1
Inlet and outlet piping requirements

3.3.1 Inlet and Outlet Sections

To ensure an undisturbed flow profile, the vortex flowmeter should be mounted upstream of any flow disturbances such as pipe elbows, reducers or valves, otherwise the longest possible section of piping should be between the disturbance and the flowmeter. The figures on the left show the *minimum section of straight piping* downstream of the disturbance as multiples of the nominal diameter of the pipe (D, see Fig. 4-1). If two or more flow disturbances are located upstream, the minimum section of straight piping downstream is equal to the sum of each individual disturbance's requirements up to a maximum of 50D.

There must also be a straight outlet section of sufficient length downstream from the flowmeter to ensure that the vortices are properly developed.

Flow Conditioner (Rectifier)
With limited space and large pipes, it is not always possible to use the inlet sections shown in Fig. 4-1. In such cases the specially developed perforated plate flow conditioner (see 6.5) can be fitted as shown on the right (see Fig. 4-2). The flow conditioner is held between two piping flanges and centered with the flange bolts. It reduces the length of the inlet section downstream from flow disturbances to 8D while maintaining full measurement accuracy. The total length of straight piping downstream becomes 10D to 13D.

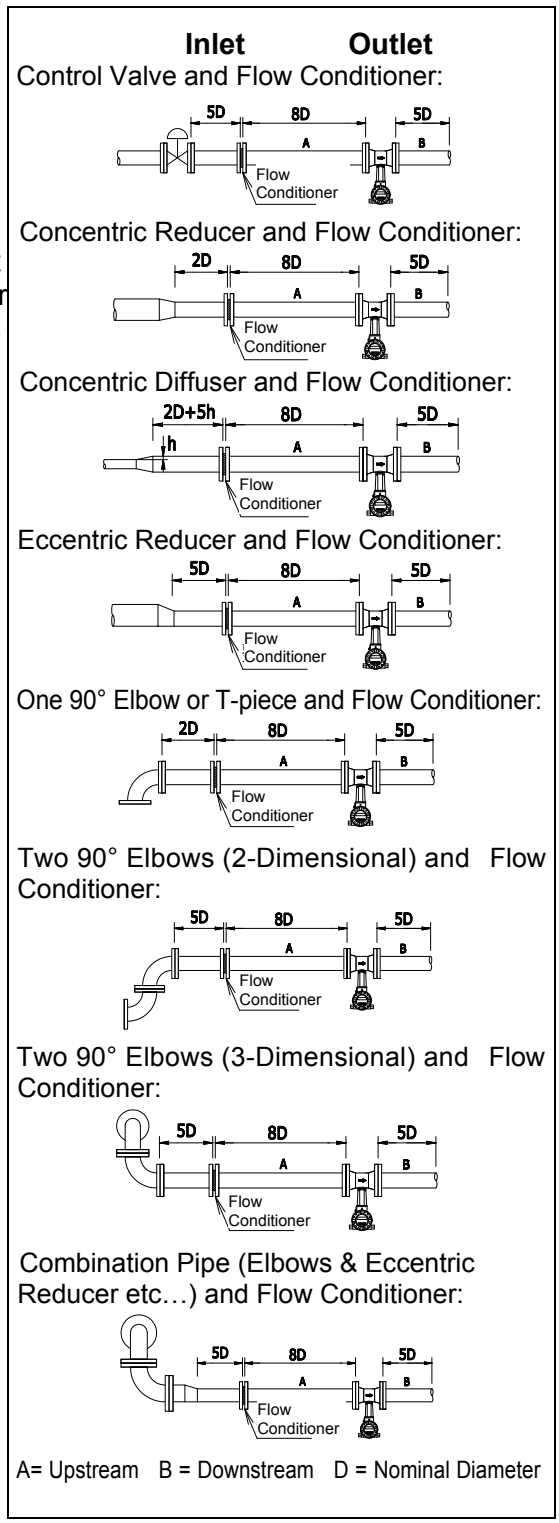


Figure 4-2
Inlet and outlet piping requirements

Pressure Measurement Points
If a pressure measuring point is installed after the device, ensure that there is a large enough distance between the device and the measuring point so that there are no negative effects on vortex formation in the sensor.

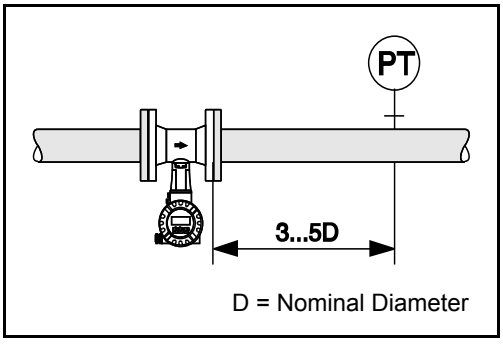


Figure 5
Mounting pressure sensors

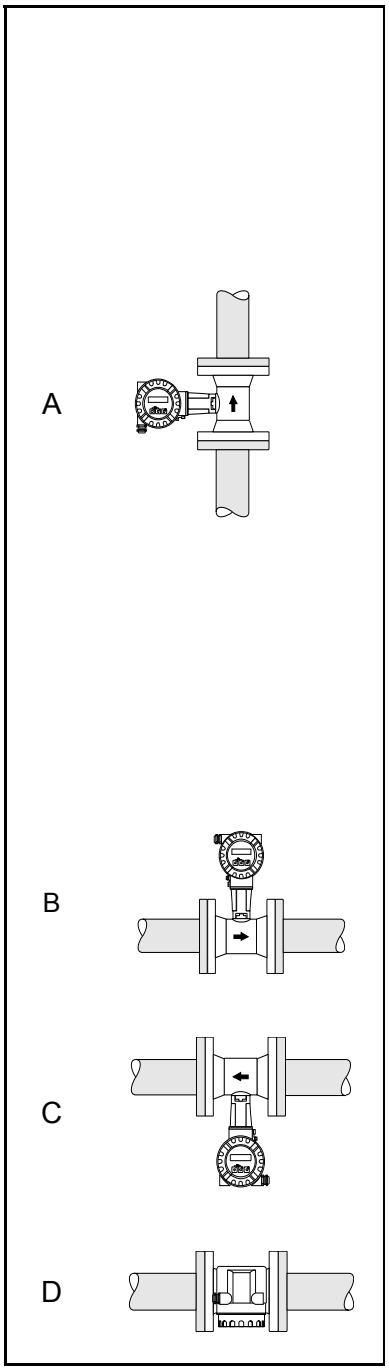


Figure 6
Orientation

3.3.2 Installation Orientation

The EF73 can be mounted in any position in the piping. An arrow on the meter body shows the direction of flow.

For measuring liquids in vertical pipes, the meter should be installed with an upwards flow direction, position A, to make sure pipes are completely flooded, avoiding partial filling (see Fig. 6).

For horizontal pipelines, positions B, C and D are possible (see Fig. 6). With hot piping (e.g. steam), position C or D must be selected in order to respect the maximum permissible ambient temperature at the electronics. Likewise, positions B and D are recommended for extremely cold fluids.

For ambient temperature restrictions, see the Technical Data (6.1.6).

3.3.3 Pipeline Heat Insulation

Caution!
When insulating, please ensure that a sufficiently large area of the housing support is exposed. The uncovered part serves as a radiator and protects the electronics from overheating (or undercooling).

Caution!

The maximum insulation height permitted is illustrated in the diagrams. These apply to both the compact version and the sensor in the remote version, as well as all installation orientations.

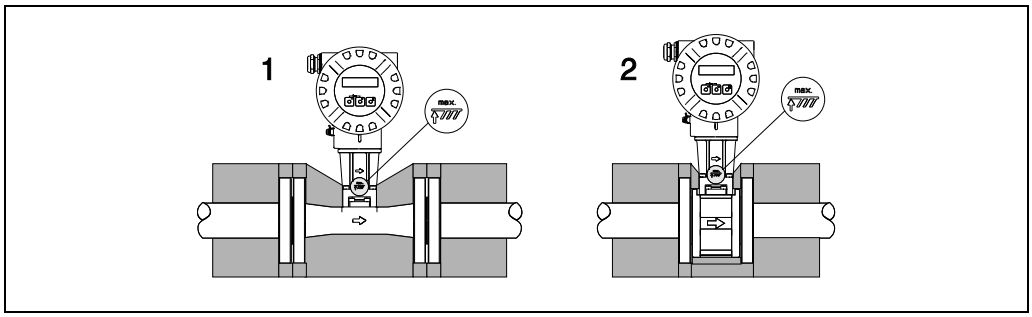


Figure 7
Pipeline insulation flangeless/flanged version

3.3.4 Minimum Maintenance Space

When servicing, it is necessary to remove the transmitter housing from the housing support.
When installing in the piping, be sure to secure the following cable lengths and minimum maintenance space:
Minimum maintenance space in all directions: A = 100 mm (4”)
Cable length required: L + 150 mm (L + 6”)

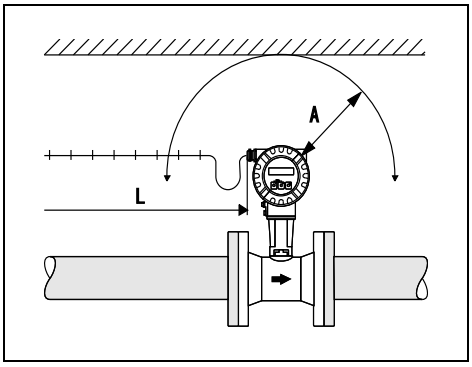


Figure 8
Minimum spacing for mounting and removing the transmitter housing

Caution!
Removing the transmitter from the pipe stand is to be carried out by qualified TLV appointed service personnel only!

Caution!

3.3.5 Other Considerations

Vibrations
The correct operation of the measuring system is not influenced by plant vibrations up to 1 g, 10 – 500 Hz. Consequently, the sensors require no special measures for attachment. If higher levels of vibration are expected, be sure to secure piping before and after the flow meter.

Preventing Excessive Flow
To ensure long service life for the flowmeter, excessive instantaneous/ periodical flow rates should be held below the flow meter's maximum flow rate. Failing to do so might result in damage to the sensor. Special care is necessary for steam at startup when the pressure is low, or when a valve is opened rapidly, such as by a solenoid valve, as excessive instantaneous flow rates often occur.

Pulsating Influences
Performance in air systems may be adversely affected if there are large variations or pulsating pressure from compressors and/or soot blowers. Use the procedures below to minimize pulsating pressures:

- Move the source of the pulsations to the downstream side of the flowmeter. Alternatively, put as much distance as possible between the source and the flowmeter.
- Install a pulsation dampening device, such as a chamber.
- Close the valves before and after the flowmeter when there is no flow. (This is to prevent false non-zero readings under zero-flow conditions.)

Prevent Mixed Phase Flow
This flowmeter is designed to measure both gases and liquids. However, accurate measurement cannot be guaranteed when gases and liquids are mixed together (i.e. gas-liquid mixed phase flow).

Bypass Lines

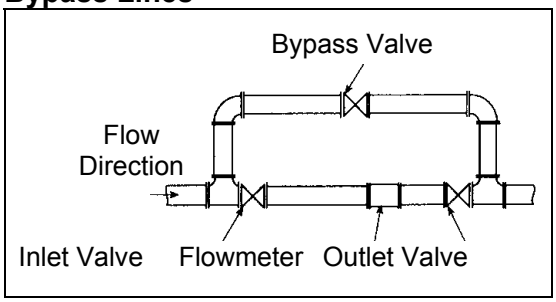


Figure 9
Installing a bypass line

The installation of bypass lines can facilitate maintenance and inspections. When installing a bypass line, use upstream and downstream valves of a type that does not disturb the flow profile, and secure sufficient length of straight pipe.

3.4 Mounting the Flowmeter


Caution!

Caution!
Note the following points before installing the flowmeter:
- Remove all packaging used for transport and protective coverings from the flowmeter before installing the flowmeter in the pipeline.
- Ensure that the inner diameters of the gaskets are identical to or larger than those of the meter body and process piping. Gaskets that protrude into the flow affect vortex formation behind the bluff body and lead to inaccurate measurement. Therefore, the gaskets delivered by TLV come with a slightly larger inner diameter than the measuring pipe.
- Ensure that the direction of the arrow on the sensor body matches the flow direction (direction of medium flow in the piping).
- Face-to-face lengths:
  – EF73 flangeless version: 65 mm (2 9⁄16")
  – EF73 flanged version: see 6.4

Mounting EF73 Flangeless Version
Mounting the flangeless body (see Fig. 10) is carried out using a mounting set consisting of:
- Bolts (tie rod)
- Centering rings (supplied with device)
- Nuts
- Washers
- Gaskets

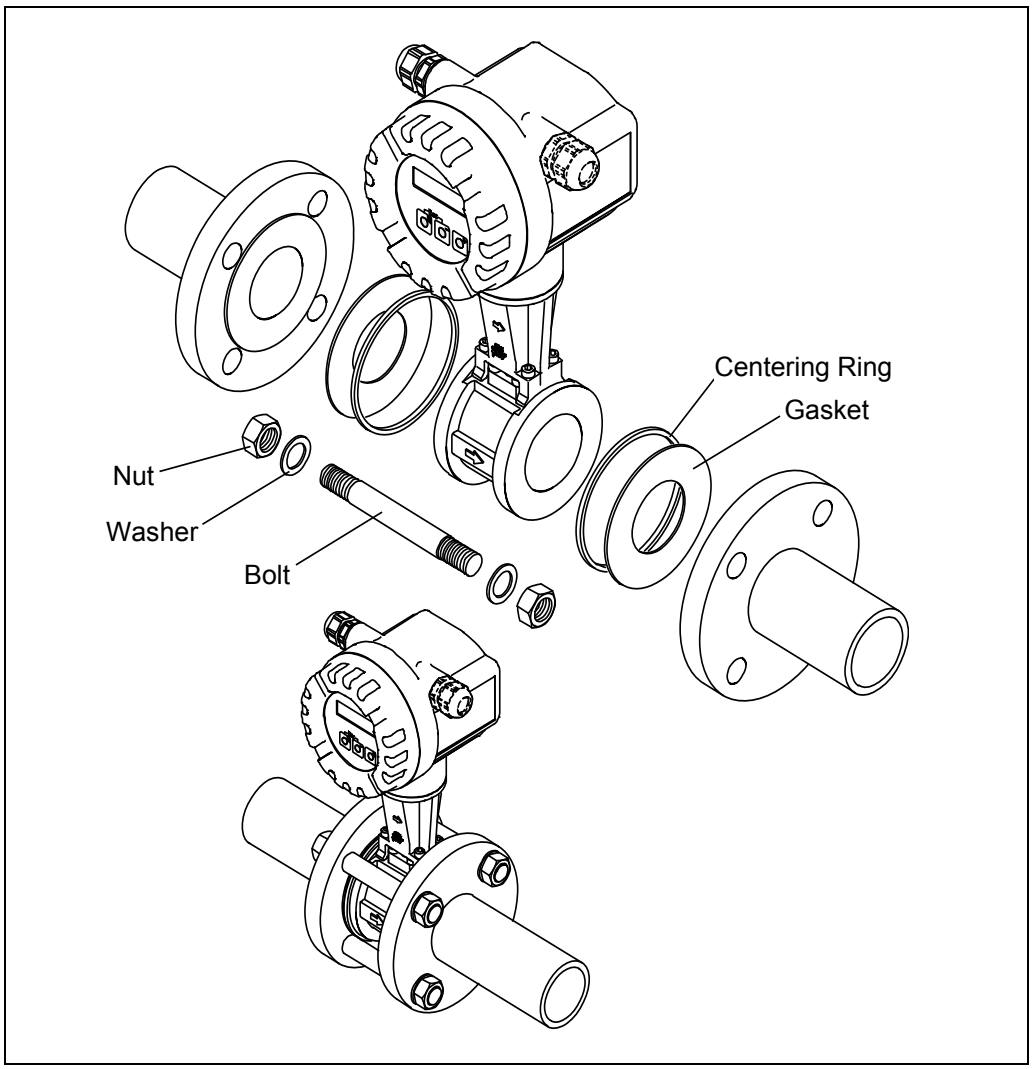


Figure 10
Mounting the EF73 flangeless version

3.5 Mounting the Transmitter (Remote Version)

The transmitter can be mounted in the following ways:
- Wall mounting (Fig. 11.A)
- Pipe mounting (with optional pipe mounting kit) (Fig. 11.B)

The transmitter and the sensor must be mounted separate in the following circumstances:
- Poor accessibility
- Lack of space
- Extreme ambient temperatures

Caution!

Caution!
If the device is mounted to warm piping, make certain that the housing temperature does not exceed the maximum permissible value of +80 °C (176 °F)

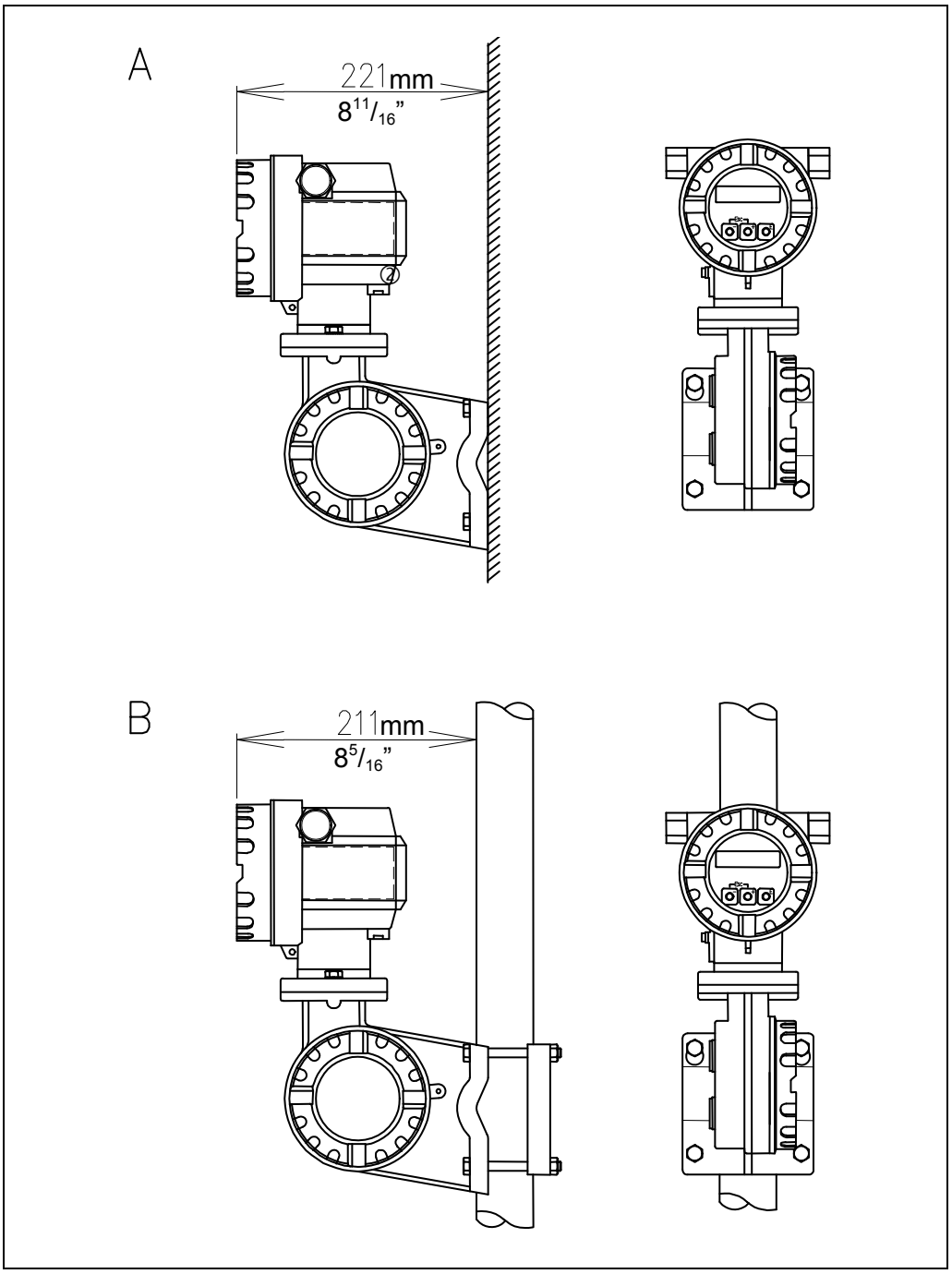


Figure 11
Mounting the transmitter (remote version)

3.6 Electronics Housing / Display (Mounting/Rotating)

Rotating the Transmitter Housing

The electronics housing of EF73 can be rotated on the pipe stand to put the optional local display in the best position to be read. It can rotate up to 180° clockwise or counterclockwise in 90° steps.

This is carried out as follows (see Fig 12):

① Loosen the safety screw (minimum one turn).
② Turn the transmitter housing to the desired position (90° steps, max. 180°).
③ Fasten the securing screw.

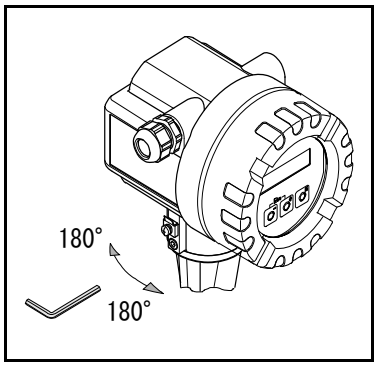


Figure 12
Rotating the electronics housing

Rotating the Display

① Unscrew the cover of the electronics compartment from the transmitter housing.
② Remove the display module from the transmitter retaining rails.
③ Turn the display to the desired position (max. 4 x 45° in each direction) and reset it.
④ Screw the cover of the electronics compartment firmly back onto the transmitter housing.

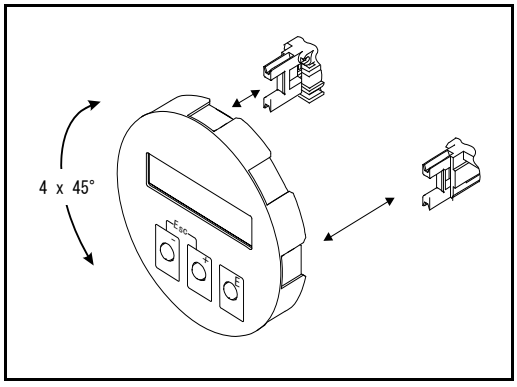


Figure 13
Rotating the local display

Protect the Transmitter Against Direct Sunlight

Install the transmitter in a location out of direct sunlight if possible. If the transmitter is subjected to direct sunlight, even when ambient temperature is within operational range (70 °C (158 °F) for compact version, 80 °C (176 °F) for remote version), the temperature of the transmitter may become higher. Additionally, sunlight may promote deterioration of the finish and appearance of the unit.

If installation outdoors in an uncovered location in unavoidable, installing the optional sunshade is recommended. (This is not required when installing compact version with the transmitter oriented downwards.)

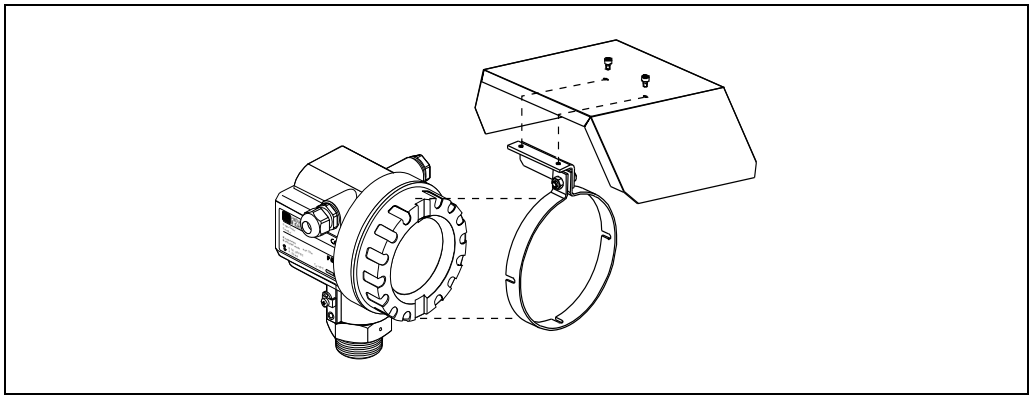


Figure 14
Installing the optional sunshade

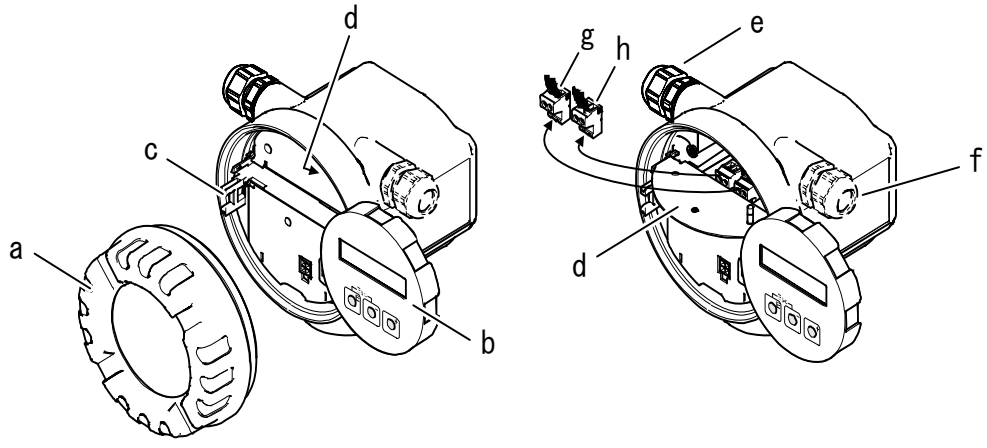
4 Electrical Connection

4.1 Connecting the Transmitter


Caution!

Caution!
- All relevant national installation regulations must be observed.
- The power supply is max. 30 V DC.

Procedure
1. Unscrew the cover (a) of the electronics compartment from the transmitter housing.
2. Remove the display module (b) from the retaining rails (c) and refit onto right retaining rail with the left side (this secures the display module).
3. Loosen screw (d) of the cover of the connection compartment and fold down the cover.
4. Push the cable for the power supply/current output through the cable gland (e). *Optional: push the cable for the frequency output through the cable gland (f).*
5. Tighten the cable glands (e / f) (see 3.2).
6. Pull the terminal connector (g) out of the transmitter housing and connect the cable for the power supply/current output. *Optional: Pull terminal connector (h) out of the transmitter housing and connect the cable for the frequency output.*
7. Plug the terminal connectors (g / h) into the transmitter housing.
8. Secure the ground cable to the ground terminal (only necessary for the *remote version*).
9. Fold up the cover of the connection compartment and tighten the screws (d).
10. Remove the display module (b) and return to original position on the on the retaining rails (c).
11. Screw the cover of the electronics compartment (a) onto the transmitter housing.



a) Cover of electronics compartment
b) Retaining rail for display module
c) Display module
d) Connection compartment cover threaded connection
e) Cable gland for power supply/current output cable
f) Cable gland for frequency output cable (optional output)
g) Terminal connector for power supply/current output
h) Terminal connection for frequency output (optional output)

Figure 15
Procedure for connecting the transmitter

4.2 Wiring Diagrams

EF73 Alone, Connecting Power Supply

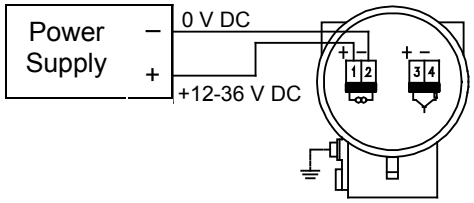
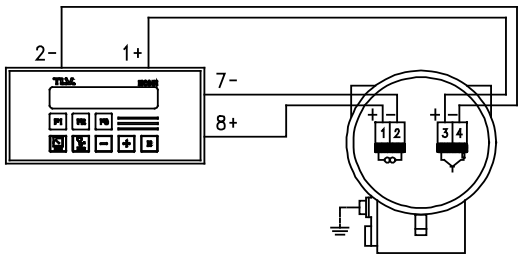


Figure 16
Power Supply

Connecting to TLV EC351 Flow Computer



Select “VORTEX FREQUENCY” for EF73 frequency output.
Select “TEMPERATURE” for EF73 analog output.
Power is supplied by the EC351 flow computer.

Figure 17
Frequency and temperature output to TLV flow computer EC351

Frequency (Pulse) Output for an Electronic Counter or PLC

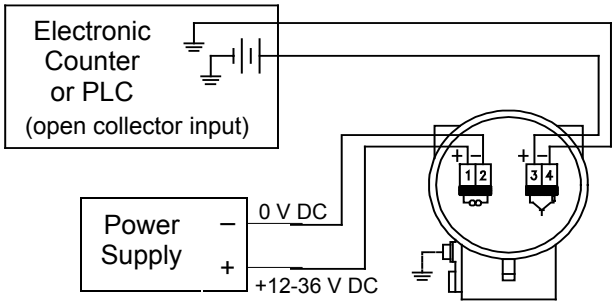


Figure 18
Pulse output to electronic counter or PLC

Current Output for an Analog Data Receiver

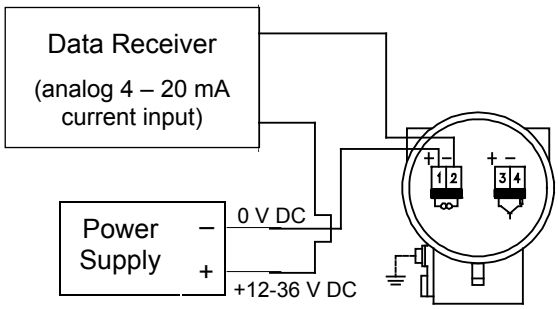


Figure 19
Analog current output connection

4.3 Connecting the Remote Version

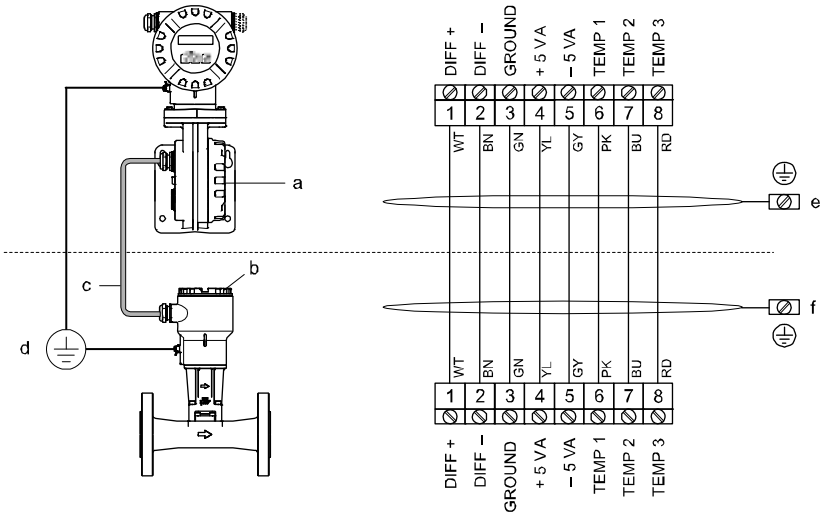
Caution!

Caution!
- The remote version must be grounded. In doing so, the sensor and transmitter must be connected to the same potential matching.
- When using the remote version, always make sure that you connect the sensor only to the transmitter with the same serial number. If this is not observed when connecting the devices, compatibility issues (e.g. the wrong K-factor is used) can arise.

Procedure
1. Remove the cover of the connection compartment of the transmitter (a).
2. Remove the cover of the connection compartment of the sensor (b).
3. Feed the connection cable (c) through the appropriate cable entries.
4. Wire the connection cable between the sensor and transmitter in accordance with the electrical connection diagram (see Fig. 20)
5. Tighten the glands of the cable entries on the sensor housing and transmitter housing.
6. Screw the cover of the connection compartment (a/b) back onto the sensor housing or transmitter housing.

Caution!

Caution!
When cutting the connection cable delivered with the product, be sure to enter the new length in the CABLE LENGTH function (see 8.2.16).



a) Cover of the connection compartment (transmitter)
b) Cover of the connection compartment (sensor)
c) Connection cable (signal cable)
d) Identical potential matching for sensor and transmitter
e) Connect shield to the ground terminal in the transmitter housing and keep as short as possible
f) Connect shield to the ground terminal in the connection housing

Figure 20
Connecting the remote version

Connection Cable Specifications
The specifications of the cable connecting the transmitter and the sensor of the remote version are as follows:
- 4 x 2 x 0.5 mm^2 PVC cable with common shield (4 pairs, pair-stranded).
- Cable length: max. 30 m (98 ft.)
- Conductor resistance to DIN VDE 0295 Class 5 or IEC 60228 Class 5

5 Operation

The EF73 has a number of functions that the user can individually set according to process conditions. The display consists of two lines; this is where measured values and/or status variables are displayed. You can change the assignment of the display lines to different variables to suit your needs and preferences (see USER INTERFACE function group, 8.2.5).

Note!
Due to current use restrictions, the EF73 LCD does not employ a backlight.


Note!

5.1 Display and Operating Elements

The transmitter is operated locally by using three pushbuttons (keys) and the local display (see Fig. 21). This enables individual functions to be selected and parameters or values to be entered.

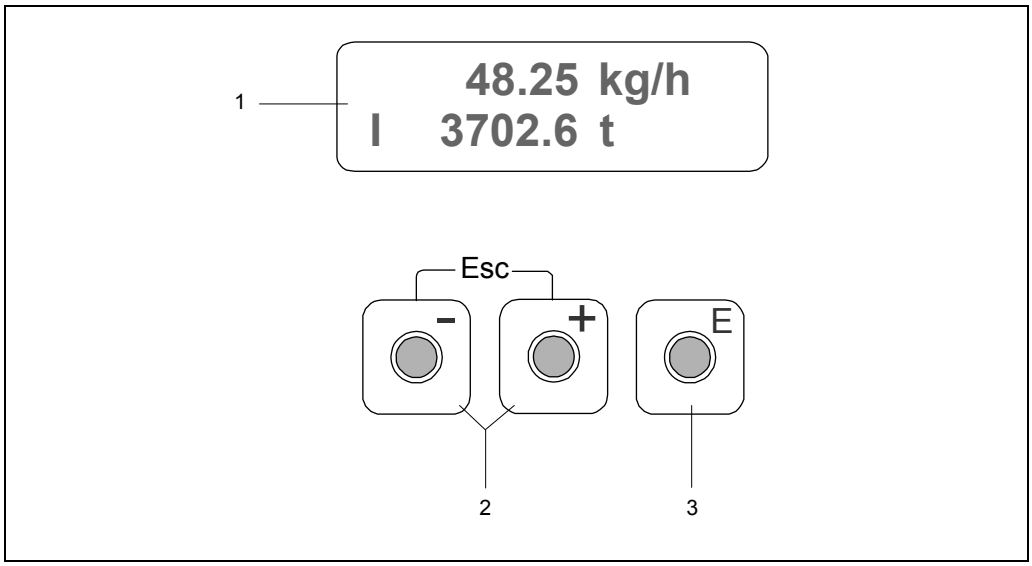


Figure 21
Display and operating elements of the EF73

Liquid Crystal Display (1)
The two-line liquid-crystal display shows measured values, dialog texts, fault messages and notice messages. The display as it appears during standard measuring mode is known as the HOME position (operating mode).
- Top line: shows main measured values, e.g. mass flow in [kg/h] or in [%].
- Bottom line: shows additional measured variables and status variables, e.g. totalizer reading in [t], bar graph, tag name.

Plus/Minus Keys (2)
- Enter numerical values, select parameters
- Select different function groups within the function matrix

Press the +/− keys simultaneously to trigger the following functions:
- Exit the function matrix step by step → HOME position
- Press and hold down +/− keys for longer than 3 seconds → return directly to the HOME position
- Cancel data entry

Enter Key (3)
- HOME position → enter the function matrix
- Save the numerical values you input or settings you changed

5.2 Select Functions and Change Parameters


Note!

Note!
When changing settings for the first time, you will be required to enter the ACCESS CODE. The initial factory setting is “73”. (See “Enabling the Programming Mode” below).

The function matrix is a two-level construct: the function groups form one level and the groups’ functions the other. The groups are the highest-level grouping of the control options for the measuring device. A number of functions is assigned to each group. You select a group in order to access the individual functions for operating and configuring the measuring device.

1. From the HOME position, press E to enter the function matrix.
2. Cycle through the function groups by pressing + or −, then press E to select.
3. Cycle through the functions by pressing E.
4. Press + / − to modify setting for the present function. Press E to save the new setting and proceed to the next function.
5. To change function settings in a different function group, press the Esc key (+ + −), then repeat from step 2.
6. To exit the function matrix (return to HOME position):
   – Press and hold down the Esc key (+ + −) for longer than 3 seconds to return directly
   – Repeatedly press Esc key (+ + −) to return step by step


Note!

Note!
- Certain functions prompt you to confirm your data entries. Press + / − to select “SURE [YES]” and press E to confirm. This saves your setting or starts a function, as applicable.
- Return to the HOME position is automatic if no key is pressed for 5 minutes.
- Programming mode is automatically disabled if you do not press a key within 60 seconds following return to the HOME position.

Enabling the Programming Mode
The function matrix can be disabled. Disabling the function matrix rules out the possibility of inadvertent changes to device functions, numerical values or factory settings. A numerical code (factory setting = 73) must be entered before settings can be changed. If you use a code number of your choice, you exclude the possibility of unauthorized persons accessing data (see ACCESS CODE function, 8.2.4).

6 Technical Data

6.1 Technical Data at a Glance

6.1.1 Application

The measuring system is used to measure the flow of saturated steam, superheated steam, gases and liquids. The measured variables volume flow and temperature are measured primarily. From these values, the device can used stored data on the density and enthalpy to calculate and output the mass flow and heat flow for example.

6.1.2 Function and System Design

Vortex flow measurement on the principle of the Karman vortex street.	Measuring Principle
The measuring system consists of a transmitter and a sensor. Two versions are available: • Compact version: Transmitter and sensor form a single mechanical unit. • Remote version: Sensor is mounted separate from the transmitter.	Measuring System

6.1.3 Input

• Volumetric flow (volume flow) → is proportional to the frequency of vortex shedding after the bluff body. • Temperature → can be output directly and is used to calculate the mass flow for example. The measured process variables volume flow, temperature or the calculated process variables mass flow, heat flow or corrected volume flow can be output as output variables.	Measured Variable
The measuring range depends on the fluid and the pipe diameter.	Measuring Range

Start of Measuring Range:
Depends on the density and the Reynolds number (Re_{min} = 4 000, Re_{linear} = 20 000). The Reynolds number is dimensionless and indicates the ratio of a fluid's inertial forces to its viscous forces. It is used to characterize the flow. The Reynolds number is calculated as follows:

$$Re = \frac{d \cdot V}{\nu}$$

Re = Reynolds number
d = pipe diameter
V = velocity
ν = viscosity

Full Scale Value:
• Gas, steam: v_{max} = 75 m/s (246 ft/s) (DN 15: v_{max} = 46 m/s (151 ft/s))
• Liquids: v_{max} = 9 m/s (30 ft/s)

K-factor Range

The table is used for orientation purposes. The range in which the K-factor can be is indicated for individual nominal diameters and designs.

Size		K-factor Range [pulse/dm³]	
(mm)	(in)	EF73 – Flangeless	EF73 – Flanged
15	½"	245 – 280	390 – 450
25	1"	48 – 55	70 – 85
40	1½"	14 – 17	18 – 22
50	2"	6 – 8	8 – 11
80	3"	1.9 – 2.4	2.5 – 3.2
100	4"	0.9 – 1.1	1.1 – 1.4
150	6"	0.27 – 0.32	0.3 – 0.4
200	8"	—	0.1266 – 0.1400
250	10"	—	0.0677 – 0.0748
300	12"	—	0.0364 – 0.0402

6.1.4 Output

Outputs, General

The following measured variables can generally be output via the outputs:

	Current Output	Frequency Output	Pulse Output	Status Output
Volume Flow (oper. vol.)	X	X	X	Limit value (flow or totalizer)
Temperature	X	X	—	Limit value
Mass Flow	If present	If present	If present	If present (flow or totalizer)
Corrected Volume Flow	If present	If present	If present	If present (flow or totalizer)
Heat Flow (power)	If present	If present	If present	If present (flow or totalizer)

In addition, the calculated measured variables density, specific enthalpy, saturationsteam pressure (for saturated steam), Z-Factor and flow velocity can be displayed ifavailable via the local display.

Output Signal

Current Output:

- 4 – 20 mA
- Start value, full scale value and time constant (0 – 100 s) can be set
- Temperature coefficient: typically 0.005% of reading / °C (~0.01% o.r. / °F)

Frequency Output:

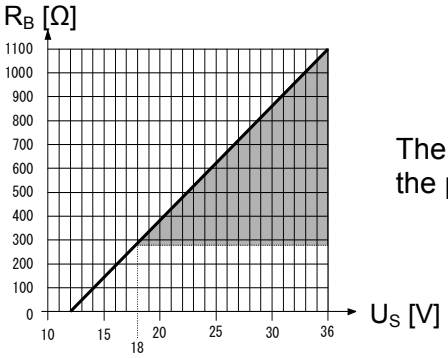
Open collector, passive, galvanically isolated

- U_{max} = 36 V, with 15 mA current limiting, Ri = 500 Ω

The frequency output can be configured as:

- Frequency output: End frequency 0 – 1000 Hz (f_{max} = 1250 Hz)
- Pulse output: Pulse value and polarity can be selected, Pulse width adjustable (0.005 – 2 s); pulse frequency max. 100 Hz
- Status output: Can be configured for error messages or flow and temperature limit values
- Vortex frequency: Unscaled vortex pulses directly output 0.5 – 2850 Hz (impossible to configure pulse width)
- PFM signal (pulse-frequency modulation)

• Current output: failsafe mode can be selected (e.g. in accordance with NAMUR Recommendation NE 43) • Frequency output: failsafe mode can be selected • Status output: “not conductive” during fault	Signal on Alarm



The area marked in gray indicates the permissible load

Load

The load is calculated as follows:

$$R_B = \frac{U_S - U_{KI}}{I_{max} - 10^{-3}} = \frac{U_S - U_{KI}}{0.022}$$

R_B = Load, load resistance
U_S = Supply voltage: 12 – 36 V DC
U_{KI} = Terminal voltage: 12 V DC
I_{max} = Output current (22.6 mA)

Switch points for low flow cut off can be selected as required	Low Flow Cutoff
All electrical connections are galvanically isolated themselves.	Galvanic Isolation

6.1.5 Power Supply

See 4.2.	Electrical Connection
12 – 36 V DC	Supply Voltage
Power supply cable / signal cable (outputs): • Thread for cable entry: ½" NPT, G(PT)½ (not for remote version)	Cable Entry
• Permissible temperature range: -40 °C to ambient temperature +10 °C (-40 °F to ambient temperature +18 °F) • Remote version: see 4.3	Cable Specification
• Totalizer stops at the last value determined (can be configured). • All settings are kept in the EEPROM. • Error messages (incl. value of operated hours counter) are stored.	Power Supply Failure

6.1.6 Performance Characteristics

Error limits following ISO/DIN 11631: • 20 – 30 °C (36 – 54 °F) • 0.2 – 0.4 MPa (2 – 4 bar, 29 – 58 psi) • Calibration rig traced to national standards. • Calibration with the process connection corresponding to the particular standard.	Reference Operating Conditions

Maximum Measured Error	• Volume flow (liquid): ±0.75% o.r. for Re > 20 000 ± 0.75% o.f.s. for Re between 4000 – 20 000 • Volume flow (gas/steam): ±1% o.r. for Re > 20 000 ±1% o.f.s. for Re between 4000 – 20 000 • Temperature: ±1 °C (T > 100 °C, saturated steam); ±2 °F (T > 212 °F, saturated steam); Risetime 50% (agitated under water, following IEC 60751): 8 s • Mass flow (saturated steam): - For flow velocities v 20 – 50 m/s, T > 150 °C (423 K, 302 °F) ±1.7% (2% for remote version) o.r. for Re > 20 000 ±1.7% (2% for remote version) o.f.s. for Re between 4000 – 20 000 - For flow velocities v 10 – 70 m/s, T > 140 °C (413 K, 284 °F) ±2% (2.3% for remote version) o.r. for Re > 20 000 ±2% (2.3% for remote version) o.f.s. for Re between 4000 – 20 000 • Mass flow (other fluids): Depends on the pressure value, specified in the OPERATING PRESSURE function (see 8.2.13). An individual error observation must be carried out. o.r. = of measured value, o.f.s = of full scale value, Re = Reynolds number
Repeatability	±0.25% o.r. (of measured value)
	Environment
Ambient Temperature Range	• Compact Version: -40 – +70 °C (-40 – +158 °F) Display can be read between -20 °C – +70 °C (-4 – +158 °F) • Remote Version – Sensor: -40 – +85 °C (-40 – +185 °F) Remote Version – Transmitter: -40 – +80 °C (-40 – +176 °F) Display can be read between -20 °C – +70 °C (-4 – +158 °F)
 Caution!	Caution! When mounting outside, we recommend you protect from direct sunlight with a sunshade (optional part), especially in warmer climates with high ambient temperatures.
Storage Temperature	-40 – +80 °C (-40 – +176 °F)
Degree of Protection	P 67 (NEMA 4X) in accordance with EN 60529
Vibration Resistance	Acceleration up to 1 g, 10 – 500 Hz, following IEC 60068-2-6
Electromagnetic Compatibility (EMC)	To EN 61326/A1 and NAMUR Recommendation NE 21

Process

Medium Temperature Range

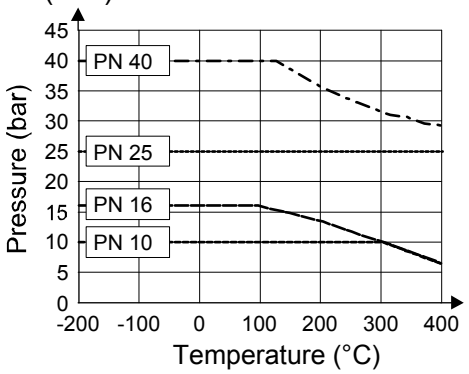
- DSC sensor (digital switched capacitor), capacitive sensor:
  -200 – +400 °C (-330 – +750 °F)
- Gaskets (graphite is standard, other materials are optional)

Graphite:	-200 – +400 °C	(-330 – +750 °F)
Fluorocarbon (FKM):	-15 – +175 °C	(+5 – +345 °F)
Perfluorinated elastomer (FFKM):	-20 – +275 °C	(-4 – +430 °F)
Fluorine resin (PTFE):	-200 – +260 °C	(-330 – +500 °F)

Medium Pressure Range

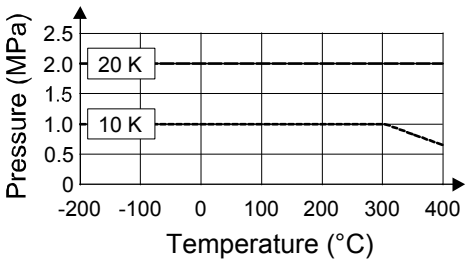
Pressure-Temperature Curve to EN (DIN), Stainless Steel

EN (DIN) PN 10 – 40:



Pressure-Temperature Curve to JIS, Stainless Steel

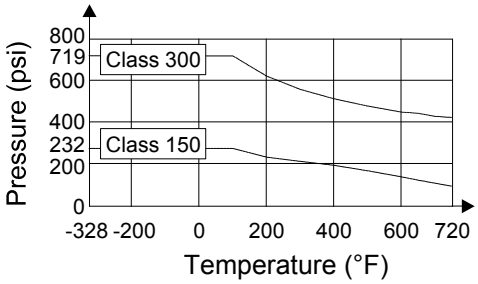
JIS 10, 20 K

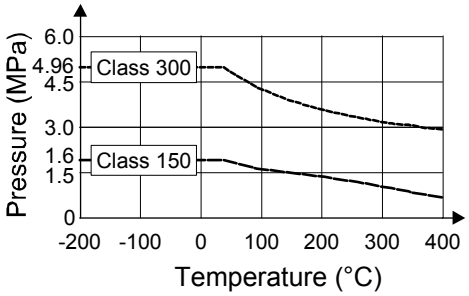


1 MPa = 10 bar

Pressure-Temperature Curve to ASME B16.5, Stainless Steel

ASME Class 150, 300





Limiting Flow

See flow rate data in section 13.

Pressure Loss

TLV will calculate and provide pressure loss data on request

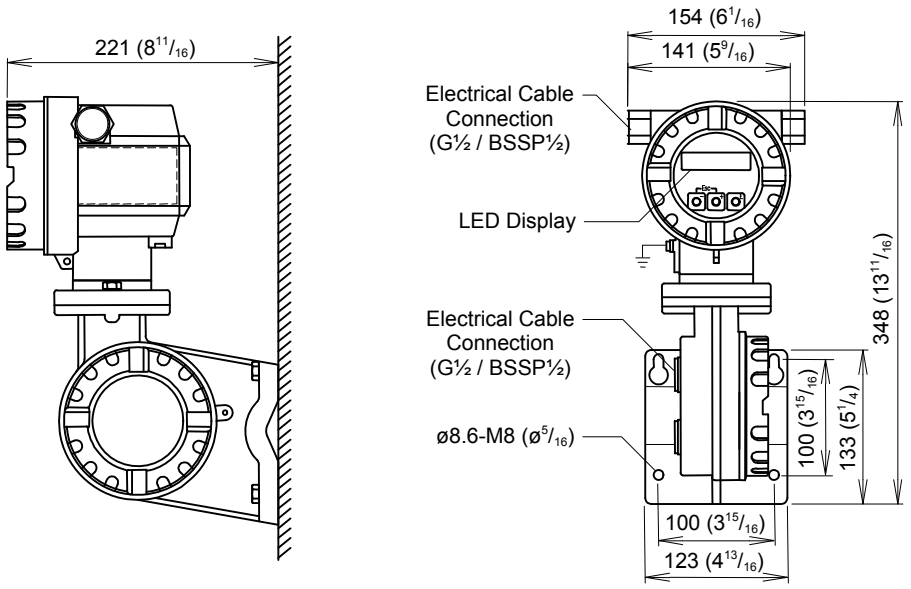
6.1.7 Mechanical Construction

Design, Dimensions, Weight	See 6.2, 6.3 and 6.4.
Material	• Transmitter housing: Powder-coated die-cast aluminum • Sensor: Stainless steel, A351-CF3M (1.4404) • Flanges: Stainless steel, A351-CF3M (1.4404) ASME/JIS, DN 15 – 150, ½" – 6": Stainless steel, weld-on flanges, 316/316L • DSC sensor (differential switched capacitor; capacitive sensor): Wetted parts: Stainless steel 1.4435 (316L) Non-wetted parts: Stainless steel 1.4301 (CF3) • Pipe stand: Stainless steel, 1.4308 (CF8) • Gasket: Graphite (standard; see above)

6.1.8 Human Interface

Display Elements	• Liquid crystal display, two-line, plain text display, 16 characters per line • Display can be configured individually, e.g. for measured variables and status variables, totalizers
Operating Elements	• Local operation with three keys (⊞, ⊟, Ⓔ) • Quick Setup for quick commissioning

6.2 Remote Transmitter Dimensions



Units: mm (in)
Weight: 3.5 kg (7.7 lb)

Figure 22
Dimensions of transmitter, remote version

6.3 EF73 Dimensions – Flangeless Connection

The EF73 flangeless model is compatible with the following flange standards:
- ASME B16.5, class 150, 300
- EN 1092-1 (DIN 2501) PN10, 16, 25, 40
- JIS B2236, 10K/20K

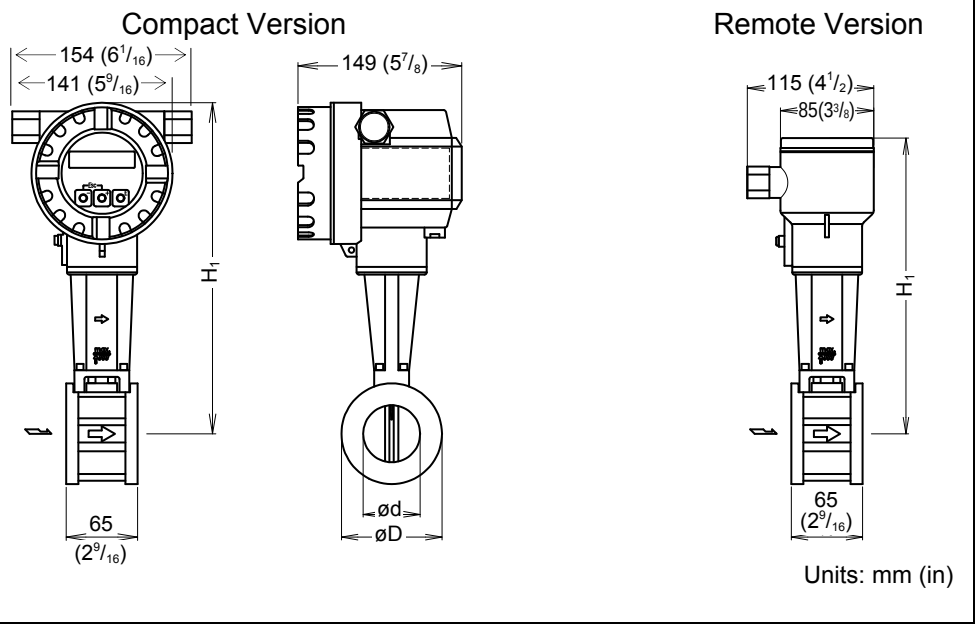


Figure 23
Dimensions of EF73, flangeless model

Size		d		D		H_1 – Compact		H_1 – Remote		Weight	
JIS/DIN	ASME	(mm)	(in)	(mm)	(in)	(mm)	(in)	(mm)	(in)	(kg)	(lb)
15	½”	17	11/16	45	1 3/4	276	10 7/8	246	9 11/16	3.0	6.6
25	1”	28	1 1/8	64	2 1/2	286	11 1/4	256	10 1/16	3.2	7.1
40	1½”	42	1 5/8	82	3 1/4	294	11 9/16	264	10 3/8	3.8	8.4
50	2”	54	2 1/8	92	3 5/8	301	11 7/8	271	10 11/16	4.1	9.0
80	3”	80	3 1/8	127	5	315	12 3/8	285	11 1/4	5.5	12
100	4”	105	4 1/8	157	6 3/16	328	12 15/16	298	11 3/4	6.5	14
150	6”	157	6 3/16	216	8 1/2	354	13 15/16	324	12 3/4	9.0	20

6.4 EF73 Dimensions – Flanged Connection

The EF73 is available with the following flange standards:
- ASME B16.5, class 150, 300
- EN 1092-1 (DIN 2501), PN 10, 16, 25, 40
- JIS B2238, 10K, 20K

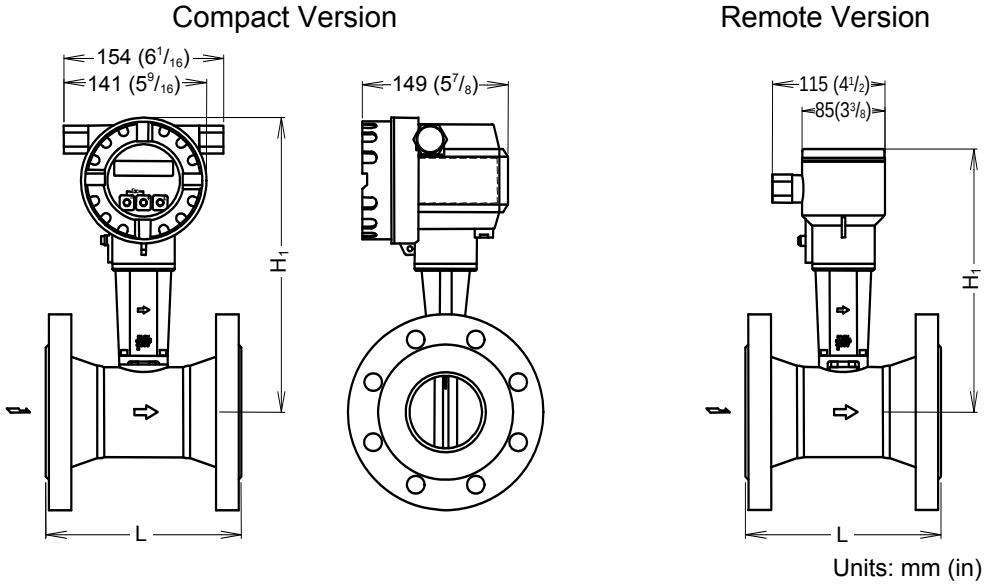


Figure 24 Dimensions of EF73, flanged model

EF73 Flanged – ASME B16.5

Size		ASME Class	L		H_1 - Compact		H_1 – Remote		Weight	
(mm)	(in)		(mm)	(in)	(mm)	(in)	(mm)	(in)	(kg)	(lb)
15	½”	150	200	7 7/8	277	10 7/8	247	9 3/4	5.5	12
		300								
25	1”	150	200	7 7/8	284	11 3/16	254	10	7.5	17
		300								
40	1½”	150	200	7 7/8	292	11 1/2	262	10 5/16	11	23
		300								
50	2”	150	200	7 7/8	299	11 3/4	269	10 9/16	13	28
		300								
80	3”	150	200	7 7/8	312	12 5/16	282	11 1/8	21	46
		300								
100	4”	150	250	9 13/16	324	12 3/4	294	11 9/16	28	61
		300								
150	6”	150	300	11 13/16	348	13 11/16	318	12 1/2	52	114
		300								
200	8”	150	300	11 13/16	377	14 13/16	347	13 11/16	65	142
		300							77	169
250	10”	150	380	14	404	15 7/8	374	14 3/4	93	204
		300							110	241
300	12”	150	450	17 11/16	427	16 13/16	397	15 5/8	144	316
		300							163	358

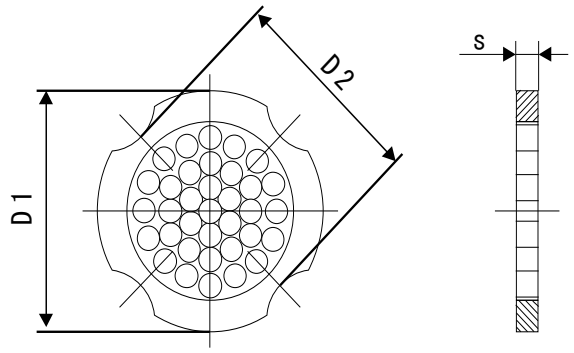
EF73 Flanged – EN 1092-1 (DIN 2501)

Size		PN Rating	L		H_1 - Compact		H_1 – Remote		Weight	
(DN)	(in)		(mm)	(in)	(mm)	(in)	(mm)	(in)	(kg)	(lb)
15	½"	PN25/40	200	$7^{7}/_{8}$	277	$10^{7}/_{8}$	247	$9^{3}/_{4}$	5.5	12
25	1"	PN25/40	200	$7^{7}/_{8}$	284	$11^{3}/_{16}$	254	10	7.5	17
40	1½"	PN25/40	200	$7^{7}/_{8}$	292	$11^{1}/_{2}$	262	$10^{5}/_{16}$	11	23
50	2"	PN25/40	200	$7^{7}/_{8}$	299	$11^{3}/_{4}$	269	$10^{9}/_{16}$	13	28
80	3"	PN25/40	200	$7^{7}/_{8}$	312	$12^{5}/_{16}$	282	$11^{1}/_{8}$	21	46
100	4"	PN16 PN25/40	250	$9^{13}/_{16}$	324	$12^{3}/_{4}$	294	$11^{9}/_{16}$	28	61
150	6"	PN16 PN25/40	300	$11^{13}/_{16}$	348	$13^{11}/_{16}$	318	$12^{1}/_{2}$	52	114
200	8"	PN10	300	$11^{13}/_{16}$	377	$14^{13}/_{16}$	347	$13^{11}/_{16}$	64	140
		PN16							63	138
		PN25							69	151
		PN40							73	160
250	10"	PN10	380	14	404	$15^{7}/_{8}$	374	$14^{3}/_{4}$	89	195
		PN16							93	204
		PN25							101	222
		PN40							112	246
300	12"	PN10	450	$17^{11}/_{16}$	427	$16^{13}/_{16}$	397	$15^{5}/_{8}$	122	268
		PN16							130	285
		PN25							141	310
		PN40							159	349

EF73 Flanged – JIS B2238

Size		Press. Rating	L		H_1 - Compact		H_1 – Remote		Weight	
(mm)	(in)		(mm)	(in)	(mm)	(in)	(mm)	(in)	(kg)	(lb)
15	½"	10/20K	200	$7^{7}/_{8}$	277	$10^{7}/_{8}$	247	$9^{3}/_{4}$	5.5	12
25	1"	10/20K	200	$7^{7}/_{8}$	284	$11^{3}/_{16}$	254	10	7.5	17
40	1½"	10/20K	200	$7^{7}/_{8}$	292	$11^{1}/_{2}$	262	$10^{5}/_{16}$	11	23
50	2"	10/20K	200	$7^{7}/_{8}$	299	$11^{3}/_{4}$	269	$10^{9}/_{16}$	13	28
80	3"	10K 20K	200	$7^{7}/_{8}$	312	$12^{5}/_{16}$	282	$11^{1}/_{8}$	21	46
100	4"	10K 20K	250	$9^{13}/_{16}$	324	$12^{3}/_{4}$	294	$11^{9}/_{16}$	28	61
150	6"	10K 20K	300	$11^{13}/_{16}$	348	$13^{11}/_{16}$	318	$12^{1}/_{2}$	52	114
200	8"	10K	300	$11^{13}/_{16}$	377	$14^{13}/_{16}$	347	$13^{11}/_{16}$	59	129
		20K							65	142
250	10"	10K	380	14	404	$15^{7}/_{8}$	374	$14^{3}/_{4}$	91	200
		20K							105	230
300	12"	10K	450	$17^{11}/_{16}$	427	$16^{13}/_{16}$	397	$15^{5}/_{8}$	120	263
		20K							135	297

6.5 Dimensions of Flow Conditioner (optional)



D1 = The flow conditioner is fitted at the outer diameter between the bolts.
D2 = The flow conditioner is fitted at the indentations between the bolts.

Figure 25 Dimensions of flow conditioner

Flow Conditioner Dimensions to ASME

Size		ASME Class	Centering Ø		D1 / D2	s		Weight	
(mm)	(in)		(mm)	(in)		(mm)	(in)	(kg)	(lb)
15	½”	150	51.1	2	D1	2.0	3/32	0.03	0.07
		300	56.5	2 7/32	D1			0.04	0.09
25	1”	150	69.2	2 23/32	D2	3.5	1/8	0.12	0.26
		300	74.3	2 15/16	D1				
40	1½”	150	88.2	3 15/16	D2	5.3	7/32	0.3	0.7
		300	97.7	3 27/32	D2				
50	2”	150	106.6	4 3/16	D2	6.8	9/32	0.5	1.1
		300	113.0	4 7/16	D1				
80	3”	150	138.4	5 7/16	D1	10.1	13/32	1.2	2.6
		300	151.3	5 31/32	D1			1.4	3.1
100	4”	150	176.5	6 15/16	D2	13.3	17/32	2.7	6.0
		300	182.6	7 13/16	D1				
150	6”	150	223.6	8 13/16	D1	20.0	25/32	6.3	14
		300	252.0	9 29/32	D1			7.8	17
200	8”	150	274.0	10 25/32	D2	26.3	1 1/32	12	27
		300	309.0	12 5/32	D1			16	35
250	10”	150	340.0	13 3/8	D1	33.0	1 5/16	26	57
		300	363.0	14 9/32	D1			28	61
300	12”	150	404.0	15 29/32	D1	39.6	1 9/16	36	80
		300	420.0	16 17/16	D1			45	98

Flow Conditioner Dimensions to EN (DIN)

Size		PN Rating	Centering Ø		D1 / D2	s		Weight	
(DN)	(in)		(mm)	(in)		(mm)	(in)	(kg)	(lb)
15	½"	PN10-40	54.3	$2^{1}/_{8}$	D2	2.0	$^{3}/_{32}$	0.04	0.09
25	1"	PN10-40	74.3	$2^{15}/_{16}$	D1	3.5	$^{1}/_{8}$	0.12	0.26
40	1½"	PN10-40	95.3	$3^{3}/_{4}$	D1	5.3	$^{7}/_{32}$	0.3	0.7
50	2"	PN10-40	110.0	$4^{11}/_{32}$	D2	6.8	$^{9}/_{32}$	0.5	1.1
80	3"	PN10-40	145.3	$5^{25}/_{32}$	D2	10.1	$^{13}/_{32}$	1.4	3.1
100	4"	PN10/16	165.3	$6^{1}/_{2}$	D2	13.3	$^{17}/_{32}$	2.4	5.3
		PN25/40	171.3	$6^{3}/_{4}$	D1				
150	6"	PN10/16	221.0	$8^{11}/_{16}$	D2	20.0	$^{25}/_{32}$	6.3	14
		PN25/40	227.0	$8^{15}/_{16}$	D2			7.8	17
200	8"	PN10	274.0	$10^{25}/_{32}$	D1	26.3	$1^{1}/_{32}$	12	25
		PN16	274.0	$10^{25}/_{32}$	D2			12	27
		PN25	280.0	11	D1			12	27
		PN40	294.0	$11^{9}/_{16}$	D2			16	35
250	10"	PN10/16	330.0	13	D2	33.0	$1^{5}/_{16}$	26	57
		PN25	340.0	$13^{3}/_{8}$	D1			26	57
		PN40	355.0	14	D2			28	61
300	12"	PN10/16	380.0	$14^{31}/_{32}$	D2	39.6	$1^{9}/_{16}$	37	80
		PN25	404.0	$15^{29}/_{32}$	D1			37	80
		PN40	420.0	$16^{17}/_{16}$	D1			45	99

Flow Conditioner Dimensions to JIS

Size		Press. Rating	Centering Ø		D1 / D2	s		Weight	
(mm)	(in)		(mm)	(in)		(mm)	(in)	(kg)	(lb)
15	½"	10/20K	60.3	$2^{3}/_{8}$	D2	2.0	$^{3}/_{32}$	0.06	0.13
25	1"	10/20K	76.3	3	D2	3.5	$^{1}/_{8}$	0.14	0.30
		30K	81.3	$3^{3}/_{16}$	D1				
40	1½"	10/20K	91.3	$3^{19}/_{32}$	D2	5.3	$^{7}/_{32}$	0.31	0.68
50	2"	10/20K	106.6	$4^{3}/_{16}$	D2	6.8	$^{9}/_{32}$	0.47	1.0
80	3"	10K	136.3	$5^{3}/_{8}$	D2	10.1	$^{13}/_{32}$	1.1	2.4
		20K	142.3	$5^{19}/_{32}$	D1				
100	4"	10K	161.3	$6^{11}/_{32}$	D2	13.3	$^{17}/_{32}$	1.8	4.0
		20K	167.3	$6^{19}/_{32}$	D1				
150	6"	10K	221.0	$8^{11}/_{16}$	D2	20.0	$^{25}/_{32}$	4.5	9.9
		20K	240.0	$9^{7}/_{16}$	D1			5.5	12
200	8"	10K	271.0	$10^{21}/_{32}$	D2	26.3	$1^{1}/_{32}$	9.2	20
		20K	284.0	$11^{3}/_{16}$	D1				
250	10"	10K	330.0	13	D2	33.0	$1^{5}/_{16}$	16	35
		20K	355.0	14	D2			19	42
300	12"	10K	380.0	$14^{31}/_{32}$	D2	39.6	$1^{9}/_{16}$	27	58
		20K	404.0	$15^{29}/_{32}$	D1				

7 Commissioning

7.1 Function Check

Make sure that all final checks regarding installation and wiring have been completed before you commission your measuring point.

7.2 Commissioning

7.2.1 Switching on the Measuring Device

Once the function checks have been successfully completed, it is time to switch on the supply voltage. After approximately 5 seconds, the device is ready for operation. The measuring device performs a number of internal test functions after power-up. As this procedure progresses, the following message appears on the local display:

PROWIRL 73 V X.XX.XX	Start-up message. Displays the current software (example).

Normal measuring mode commences as soon as start-up completes. Various measured values and/or status variables appear on the display (HOME position).


Note!

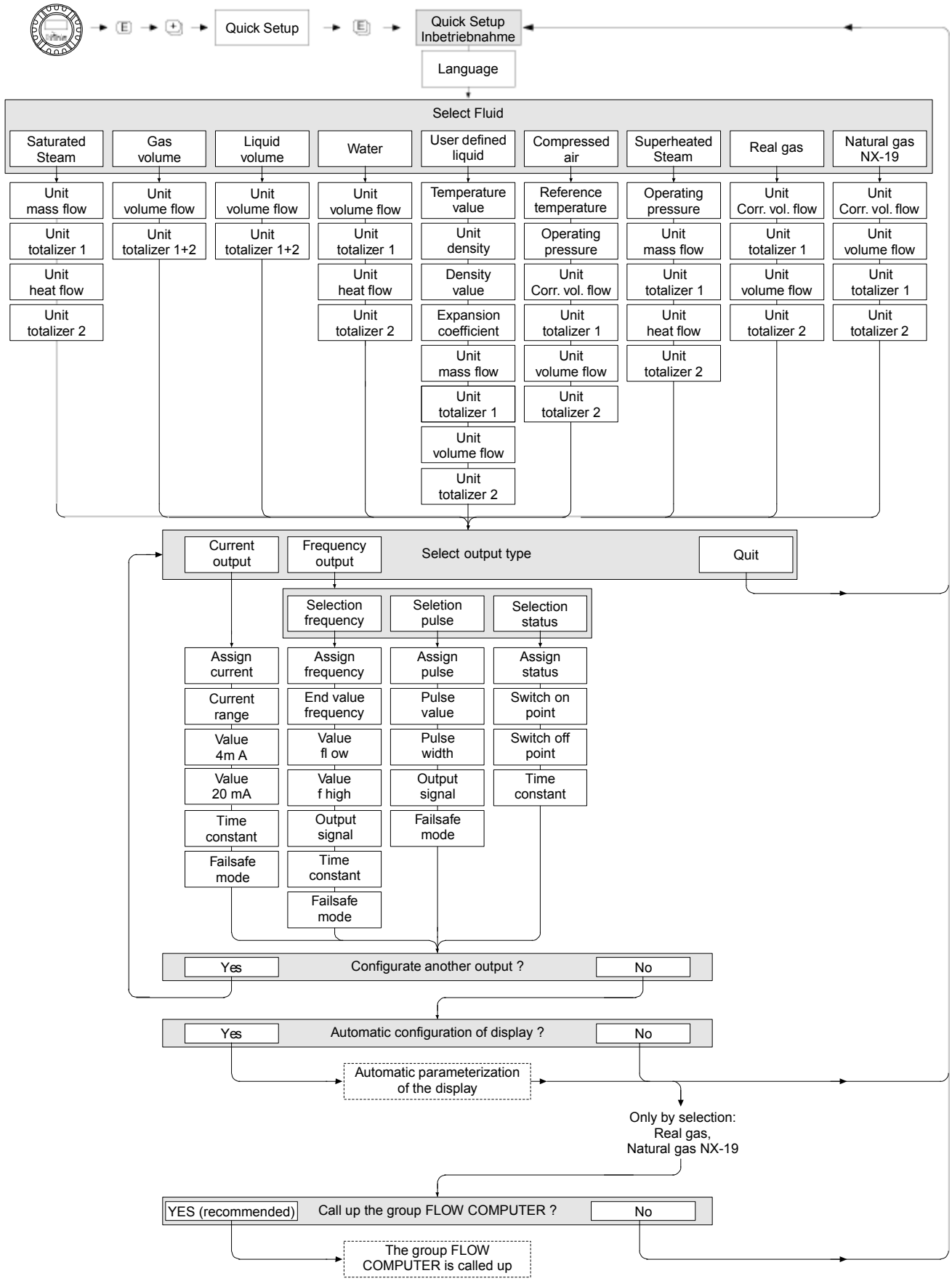
Note!
If start-up fails, an appropriate error message is displayed, depending on the cause.

7.2.2 “Commissioning” Quick Setup

The “Commissioning” Quick Setup guides you systematically through all the major functions of the device that have to be configured for standard measuring operation.

A flowchart of the “Commissioning” Quick Setup is provided on the next page.

Flowchart of “Commissioning” Quick Setup




Note!

Note!
The QUICK SETUP COMMISSIONING function is described in 8.2.3.

The display returns to the QUICK SETUP COMMISSIONING cell if you press the ESC key combination (⊞ + ⊟) during interrogation.

① If the fluid selected is changed, the following parameters are reset to their factory settings:

Function Group	Parameter
Sytem Units	→ all parameters
Display	→ 100% Value Line 1, 100% Value Line 2
Current Output	→ all parameters
Frequency Output	→ all parameters
Process Parameter	→ all parameters
System Parameter	→ all parameters

② Only the output (current output or frequency output) not yet configured in the current Quick Setup is offered for selection after the first cycle.

③ The “YES” option appears as long as a free output is still available. “NO” is the only option displayed when no further outputs are available.

④ When “YES” is selected, the volume flow is assigned to line 1 of the local display and the temperature to line 2.

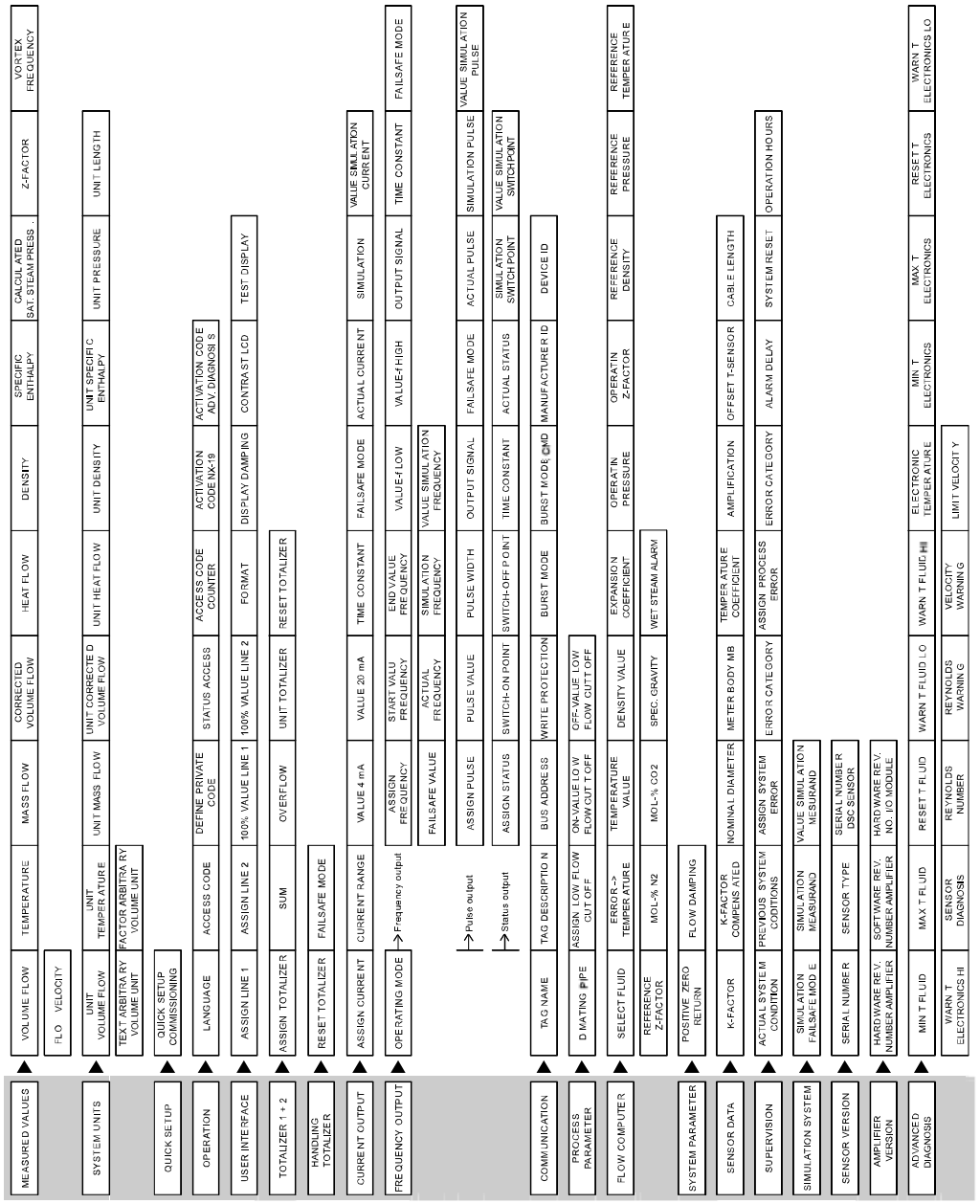
⑤ The SELECT FLUID function is called up. Confirm the fluid selected in this function and configure all the subsequent functions of the FLOW COMPUTER group. Configuration is complete if group selection is displayed. You can get back to the Home position by means of the ESC key combination (⊞ + ⊟).

• Totalizer assignment depends on the fluid selected:

Selected Fluid	Totalizer 1 Assignment	Totalizer 2 Assignment
Saturated steam	→ Mass flow	→ Heat flow
Superheated steam	→ Mass flow	→ Heat flow
Water	→ Volume flow	→ Heat flow
Customer-spec. liquid	→ Mass flow	→ Volume flow
Compressed air	→ Corrected volume flow	→ Volume flow
Natural Gas NX-19	→ Corrected volume flow	→ Volume flow
Gas volume	→ Volume flow	→ Volume flow
Liquid volume	→ Volume flow	→ Volume flow

8 Device Functions

8.1 Function Matrix



8.2 Descriptions of Functions

8.2.1 Group MEASURED VALUES

8.2.1 Function Description MEASURED VALUES

VOLUME FLOW

The volume flow currently measured appears on the display.

Display:
5-digit floating-point number, with unit
(e.g. 5.5445 dm^3/min; 1.4359 m^3/h; etc.)

Note!
The appropriate unit is taken from the UNIT VOLUME FLOW function (8.2.2).

TEMPERATURE

The temperature currently measured appears on the display.

Display:
Max. 4-digit fixed-point number, with unit and sign
(e.g. -23.4 °C, 160.0 °F, 295.4 K, etc.)

Note!
The appropriate unit is taken from the UNIT TEMPERATURE function (8.2.2).

MASS FLOW

Note!
This value is not available unless the SATURATED STEAM, SUPERHEATED STEAM, WATER, COMPRESSED AIR, REAL GAS, NATURAL GAS NX-19 or USER-DEFINED LIQUID option was selected in the SELECT FLUID function (8.2.13). "– – – –" appears on the display if another option was selected.

The calculated mass flow appears on the display.

Display:
5-digit floating-point number, with unit
(e.g. 462.87 kg/h; 731.63 lb/min; etc.)

Note!
- The mass flow is calculated using the measured volume flow and the measured temperature.
- The appropriate unit is taken from the UNIT MASS FLOW function (8.2.2).

CORRECTED VOLUME FLOW

Note!
This value is not available unless the WATER, USER-DEFINED LIQUID, COMPRESSED AIR, REAL GAS or NATURAL GAS NX-19 option was selected in the SELECT FLUID function (8.2.13). "– – – –" appears on the display if another option was selected.

The calculated corrected volume flow appears on the display.

Display:
5-digit floating-point number, with unit
(e.g. 5.5445 Nm^3/min; 1.4359 Sm^3/h; etc.)

Note!
- The corrected volume flow is calculated using the measured volume flow and the measured temperature.
- The appropriate unit is taken from the UNIT CORRECTED VOLUME FLOW function (8.2.2).

8.2.1 Function Description MEASURED VALUES

HEAT FLOW

Note!
This value is not available unless the SATURATED STEAM, SUPERHEATED STEAM or WATER option was selected in the SELECT FLUID function (8.2.13). "– – – –" appears on the display if another option was selected.

The heat flow determined appears on the display.

Display:
5-digit floating-point number, with unit,
corresponds to 0.1000 – 6.000 MJ/h,
(e.g. 1.2345 MJ/h, 993.5 MW, etc.)

Note!
- The heat flow is determined using the fluid selected in the SELECT FLUID function (8.2.13) and the measured temperature.
- The appropriate unit is taken from the UNIT HEAT FLOW function (8.2.2).

DENSITY

Note!
This function is not available unless the GAS VOLUME or LIQUID VOLUME option was selected in the SELECT FLUID function (8.2.13).

The density determined appears on the display.

Display:
5-digit floating-point number, with unit,
corresponds to 0.100000 – 6.00000 kg/dm^3,
(e.g. 1.2345 kg/dm^3, 1.0015 SG 20 °C, etc.)

Note!
- The density is determined using the fluid selected in the SELECT FLUID function (8.2.13) and the measured temperature.
- The appropriate unit is taken from the UNIT DENSITY function (8.2.2).

SPECIFIC ENTHALPY

Note!
This function is not available unless the SATURATED STEAM, WATER or SUPERHEATED STEAM option was selected in the SELECT FLUID function (8.2.13).

The specific enthalpy determined appears on the display.

Display:
5-digit floating-point number, with unit,
(e.g. 5.1467 kJ/kg, etc.)

Note!
- The enthalpy is determined using the fluid selected in the SELECT FLUID function (8.2.13) and the measured temperature.
- The appropriate unit is taken from the UNIT SPECIFIC ENTHALPY function (8.2.2).
- The enthalpy output by the device refers to the specific enthalpy of the boiling liquid at the triple point as per IAPWS-IF97. This means that the specific internal enthalpy and the specific entropy of the boiling liquid are set to zero at the triple point. It results that the specific enthalpy is 0.611783 J/g^{-1} at that point.

8.2.1 Function Description MEASURED VALUES

CALCULATED SATURATED STEAM PRESSURE

Note!
This function is not available unless the SATURATED STEAM option was selected in the SELECT FLUID function (8.2.13).

The calculated steam pressure (of the saturated steam) appears on the display.

Display:
5-digit floating-point number, with unit
(e.g. 5.1467 bara, etc.)

Note!
- The steam pressure of the saturated steam is determined using the fluid selected in the SELECT FLUID function (8.2.13) and the measured temperature.
- The appropriate unit is taken from the UNIT SPECIFIC ENTHALPY function (8.2.2).

Z-FACTOR

Note!
This function is not available unless the NATURAL GAS NX-19 or COMPRESSED AIR option was selected in the SELECT FLUID function (8.2.13).

- If the COMPRESSED AIR option was selected, the calculated real gas constant Z appears on the display.
- If the NATIRAL GAS NX-19 option was selected, the “Supercompressibility Factor” appears on the display.

Display:
5-digit floating-point number,
(e.g. 0.9467)

Note!
The real gas constant Z indicates how far a real gas differs from an ideal gas that exactly fulfills the general gas law (p x V / T = constant, Z = 1). The real gas constant approaches the value 1 the further the real gas is from its liquefaction point.

VORTEX FREQUENCY

The vortex frequency currently measured appears on the display.

Display:
5-digit floating point number, with the unit Hz,
(e.g. 120.23 Hz)

Note!
This function is only used for a plausibility check.

VELOCITY

The flow velocity through the device appears on the display. This is calculated from the current flow through the device and the cross-sectional area flowed through.

Display:
3-digit floating-point number, with unit

Note!
The unit displayed in this function depends on the option selected in the UNIT LENGTH function (8.2.2):
→ “m/s” if UNIT LENGTH = “mm”; “ft/s” if UNIT LENGTH = “inch”

8.2.2 Group SYSTEM UNITS

8.2.2 Function Description SYSTEM UNITS

UNIT VOLUME FLOW

For selecting the unit required and displayed for the volume flow.

The unit you select here is also valid for:
- Flow display
- Current output (value 20 mA)
- Frequency output (pulse value; value-f low, value-f high; on-value/off-value)
- On-value low flow cut off
- Simulation measurand

Note!
The following units of time can be selected:
s = second, m = minute, h = hour, d = day

Options:
Metric:
Cubic centimeter → cm^3/time unit
Cubic decimeter → dm^3/time unit
Cubic meter → m^3/time unit
Milliliter → ml/time unit
Liter → l/time unit
Hectoliter → hl/time unit
Megaliter → Ml/time unit MEGA

US:
Cubic centimeter → cc/time unit
Acre foot → af/time unit
Cubic foot → ft^3/time unit
Fluid ounce → ozf/time unit
Gallon → US gal/time unit
Million gallon → US Mgal/time unit
Barrel (normal fluids: 31.5 gal/bbl) → US bbl/time unit NORM.
Barrel (beer: 31.0 gal/bbl) → US bbl/time unit BEER
Barrel (petrochemicals: 42.0 gal/bbl) → US bbl/time unit PETR.
Barrel (filling tanks: 55.0 gal/bbl) → US bbl/time unit TANK

Imperial:
Gallon → imp. gal/time unit
Mega gallon → imp. Mgal/time unit
Barrel (beer: 36.0 gal/bbl) → imp. bbl/time unit BEER
Barrel (petrochemicals: 34.97 gal/bbl) → imp. bbl/time unit PETR.

Arbitrary Volume Unit:
This option does not appear unless a volume unit was defined via the TEXTARBITRARY VOLUME UNIT function (8.2.2).

Note!
The units for the totalizers are independent of the option selected here; they are selected in the UNIT TOTALIZER function (8.2.6).

UNIT TEMPERATURE

For selecting the unit required and displayed for the temperature.

Options:
°C (Celsius)
K (Kelvin)
°F (Fahrenheit)
R (Rankine)

Factory Setting:
Depends on country (see section 12).

8.2.2 Function Description SYSTEM UNITS

UNIT MASS FLOW

For selecting the unit required and displayed for the calculated mass flow.

The unit you select here is also valid for:
- Flow display
- Current output (value 20 mA)
- Frequency output (pulse value; value-f low, value-f high; on-value/off-value)
- On-value low flow cut off
- Simulation measurand

Note!
The following units of time can be selected:
s = second, m = minute, h = hour, d = day

Options:

Metric:	*US:*
Gram → g/time unit	Ounce → oz/time unit
Kilogram → kg/time unit	Pound → lb/time unit
Metric ton → t/time unit	Ton → ton/time unit

UNIT CORRECTED VOLUME FLOW

For selecting the unit required and displayed for the corrected volume flow.

The unit you select here is also valid for:
- Flow display
- Current output (value 20 mA)
- Frequency output (pulse value; value-f low, value-f high; on-value/off-value)
- On-value low flow cut off
- Simulation measurand

Note!
The following units of time can be selected:
s = second, m = minute, h = hour, d = day

Options:

Metric:
Norm liter → Nl/time unit
Norm cubic meter → Nm^3/time unit

US:
Standard cubic meter → Sm^3/time unit
Standard cubic feet → Scf/time unit

UNIT HEAT FLOW

For selecting the unit required and displayed for the heat flow.

Note!
The following units of time can be selected:
s = second, m = minute, h = hour, d = day

Options:

Metric:		*US:*
kW	GJ/time unit	tons
MW	kcal/time unit	kBtu/time unit
kJ/time unit	Mcal/time unit	MBtu/time unit
MJ/time unit	Gcal/time unit	GBtu/time

8.2.2 Function Description SYSTEM UNITS

UNIT DENSITY

For selecting the unit required and displayed for the density.

Options:

Metric:		*US:*
g/cm^3		lb/ft^3
g/cc		lb/US gal
kg/dm^3		lb/US bbl NORM (normal fluids)
kg/l		lb/US bbl BEER (beer)
kg/m^3		lb/US bbl PETR. (petrochemicals)
SD 4 °C	(SD = Specific Density*)	lb/US bbl TANK (filling tanks)
SD 15 °C		
SD 20 °C		*Imperial:*
SG 4 °C	(SG = Specific Gravity)	lb/imp. Gal
SG 15 °C		lb/imp. bbl BEER (beer)
SG 20 °C		lb/imp. bbl PETR. (petrochemicals)

Factory Setting:
Depends on country (see section 12).

* The specific density is the ratio of fluid density to water density (at water temperature = 4, 15, 20 °C).

UNIT SPECIFIC ENTHALPY

For selecting the unit required and displayed for the specific enthalpy of saturated steam, superheated steam or water.

Options:

Metric:		*US:*
kWh/kg	MJ/kg	Btu/lb
kJ/kg	kcal/kg	

Factory Setting:
Depends on country (see section 12).

UNIT PRESSURE

For selecting the unit required and displayed for the pressure.

Options:
bara (bar absolute)
psia (pounds per square inch absolute)

Factory Setting:
bara

UNIT LENGTH

Use this function to select the unit displayed for the length of the nominal diameter in the NOMINAL DIAMETER function (8.2.16).

The unit you select here is also valid for:
- The unit in which the cable length is entered (8.2.16)
- The unit of velocity on the local display (8.2.1)

Options:
MILLIMETER
INCH

Factory Setting:
Depends on country (see section 12).

8.2.2 Function Description SYSTEM UNITS

TEXT ARBITRARY VOLUME UNIT

Use this function to enter a text for a selectable volume flow unit. You define only the text, the associated unit of time is selected in the UNIT VOLUME FLOW function.

User Input:
xxxx (max. 4 characters)
Valid characters are A-Z, 0-9, +, -, decimal point, white space or underscore

Factory Setting:
"– – – –" (no text)

Example: see FACTOR ARBITRARY VOLUME UNIT function.

Note!
The volume unit defined in this function is offered as a possible option (arbitrary volume unit) in the UNIT VOLUME FLOW function.

FACTOR ARBITRARY VOLUME UNIT

Note!
This function is not available unless a text was entered in the TEXT ARBITRARY VOLUME UNIT function.

Use this function to define a quantity factor (without time) for the selectable volume flow unit. The volume unit on which this factor is based is one liter.

User Input:
5-digit floating-point number

Factory Setting:
1

Unit:
Text arbitrary volume unit / litre

8.2.3 Group QUICK SETUP

8.2.3 Function Description QUICK SETUP

QUICK SETUP COMMISSIONING

Use this function to start the Quick Setup for commissioning.

Options:
NO
YES

Factory Setting:
NO

Note!
Please refer to the a detailed description of the "Commissioning" Quick Setup menu (7.2.2).

8.2.4 Group OPERATION

8.2.4 Function Description OPERATION

LANGUAGE

Use this function to select the language for all texts, parameters and messages shown on the local display.

Options:

ENGLISH	ITALIANO	SUOMI
DEUTSCH	NEDERLANDS	PORTUGUES
FRANCAIS	NORSK	POLSKI
ESPANOL	SVENSKA	CESKI

Factory Setting:
Depends on country (see section 12).

Note!
If you press the ESC key (⎋) at startup, the language defaults to “ENGLISH”.

ACCESS CODE

All data of the measuring system are protected against inadvertent change. Programming is disabled and the settings cannot be changed until a code is entered in this function. If you press the ⎋ keys in any function, the measuring system automatically goes to this function and the prompt to enter the code appears on the display (when programming is disabled).

You can enable programming by entering the private code (**factory setting = 73**, see DEFINE PRIVATE CODE function).

User Input:
Max. 4-digit number: 0 – 9999

Note!
- The programming levels are disabled if you do not press a key within 60 seconds following a return to the HOME position.
- You can also disable programming in this function by entering any number (other than the private code).
- TLV can be of assistance if you mislay your private code.

DEFINE PRIVATE CODE

Use this function to specify the private code for enabling programming.

User Input:
Max. 4-digit number: 0 – 9999

Factory Setting:
73

Note!
- Programming is always enabled if the code defined = 0.
- Programming has to be enabled before this code can be changed. When programming is disabled this function cannot be edited, thus preventing others from accessing your personal code.

STATUS ACCESS

The access status for the function matrix appears on the display.

Display:
ACCESS CUSTOMER (parameters can be modified)
LOCKED (parameters cannot be modified)

8.2.4 Function Description OPERATION

ACCESS CODE COUNTER

The number of times the private and service code was entered to access the device appears on the display.

Display:
7-digit number: 0 – 9999999 (delivery status: 0)

ACTIVATION CODE NX-19

Use this function to enter the activation code of the software option “Natural gas NX-19” (only relevant if the amplifier board was exchanged).

User Input:
8-digit number: 0 – 99999999

Note!
If you have ordered the measuring device with this software option, the activation code for this option is also printed on the service nameplate in the cover of electronics compartment.

ACTIVATION CODE ADVANCED DIAGNOSIS

Use this function to enter the activation code of the software option “Advanced Diagnostics” (only relevant if the amplifier board was exchanged).

User Input:
8-digit number: 0 – 99999999

Note!
If you have ordered the measuring device with this software option, the activation code for this option is also printed on the service nameplate in the cover of electronics compartment.

8.2.5 Group USER INTERFACE

8.2.5 Function Description USER INTERFACE

ASSIGN LINE 1

For selecting the display value for the main line (top line of the local display) that should be displayed during normal operation.

Options:

OFF	CORRECTED VOLUME FLOW
VOLUME FLOW	CORRECTED VOLUME FLOW IN %
VOLUME FLOW IN %	HEAT FLOW
TEMPERATURE	HEAT FLOW IN %
MASS FLOW	TOTALIZER 1
MASS FLOW IN %	TOTALIZER 2

Factory Setting:
VOLUME FLOW (if no data specified or LIQUID VOLUME or GAS VOLUME specified as fluid when ordering), otherwise MASS FLOW

Note!
- The appropriate unit is selected in the Group SYSTEM UNITS (8.2.2)
- On the local display, totalizer 1 is displayed with “I” and totalizer 2 with “II”.

8.2.5 Function Description USER INTERFACE

ASSIGN LINE 2

For selecting the display value for the additional line (bottom line of the local display) that should be displayed during normal operation.

Options:
OFF
VOLUME FLOW
VOLUME FLOW IN %
BARGRAPH VOLUME FLOW IN %
TEMPERATURE
TOTALIZER 1
TOTALIZER 2
TAG NAME
OPERATING/SYSTEM CONDITIONS
MASS FLOW
MASS FLOW IN %
BARGRAPH MASS FLOW IN %
CORRECTED VOLUME FLOW
CORRECTED VOLUME FLOW IN %
BARGRAPH CORRECTED VOLUME FLOW IN %
HEAT FLOW
HEAT FLOW IN %
BARGRAPH HEAT FLOW IN %

Factory Setting:
TEMPERATURE

Note!
- The appropriate unit is selected in the Group SYSTEM UNITS (8.2.2)
- On the local display, totalizer 1 is displayed with "I" and totalizer 2 with "II".

100% VALUE LINE 1

Note!
This function is not available unless one of the following was selected in the ASSIGN LINE 1 function.
- VOLUME FLOW IN %
- MASS FLOW IN %
- CORRECTED VOLUME FLOW IN %
- HEAT FLOW IN %

Use this function to enter the flow value that should be shown on the display as the 100% value.

User Input:
5-digit floating-point number

Factory Setting:
10 l/s (with volume flow; converted to the selected UNIT VOLUME FLOW)
10 kg/h (with mass flow; converted to the selected UNIT MASS FLOW)
10 Nm³/h (with corrected volume flow; converted to the selected UNIT CORRECTED VOLUME FLOW)
10 kW (with heat flow; converted to the selected UNIT HEAT FLOW)

Note!
The appropriate unit is taken from the Group SYSTEM UNITS (8.2.2).

8.2.5 Function Description USER INTERFACE

100% VALUE LINE 2

Note!
This function is not available unless one of the following was selected in the ASSIGN LINE 1 function.
- VOLUME FLOW IN %
- MASS FLOW IN %
- CORRECTED VOLUME FLOW IN %
- HEAT FLOW IN %
- BARGRAPH VOLUME FLOW IN %
- BARGRAPH MASS FLOW IN %
- BARGRAPH CORRECTED VOLUME FLOW IN %
- BARGRAPH HEAT FLOW IN %

Use this function to enter the flow value that should be shown on the display as the 100% value.

User Input:
5-digit floating-point number

Factory Setting:
10 l/s (with volume flow; converted to the selected UNIT VOLUME FLOW)
10 kg/h (with mass flow; converted to the selected UNIT MASS FLOW)
10 Nm³/h (with corrected volume flow; converted to the selected UNIT CORRECTED VOLUME FLOW)
10 kW (with heat flow; converted to the selected UNIT HEAT FLOW)

Note!
The appropriate unit is taken from the Group SYSTEM UNITS (8.2.2).

FORMAT

Use this function to define the maximum number of places after the decimal point for the value displayed in the main line.

Options:
XXXXX. – XXXX.X – XXX.XX – XX.XXX – X.XXXX

Display:
XX.XXX

Note!
- Note that this setting only affects the reading as it appears on the display; it has no influence on the accuracy of the system's calculations.
- The places after the decimal point as computed by the measuring device cannot always be displayed, depending on this setting and the engineering unit. In these instances an arrow appears on the display between the measured value and the engineering unit (e.g. 1.2 → kg/h), indicating that the measuring system is computing with more decimal places than can be shown on the display.

8.2.5 Function Description USER INTERFACE

DISPLAY DAMPING

Use this function to enter a time constant defining how the display reacts to severely fluctuating flow variables, either very quickly (enter a low time constant) or with damping (enter a high time constant).

User Input:
0 – 100 s

Factory Setting:
5 s

Note!
- The setting 0 seconds switches off damping.
- The reaction time of the function depends on the time specified in the FLOW DAMPING function (8.2.15).

CONTRAST LCD

Use this function to optimize the display contrast to suit local operating conditions.

User Input:
10 – 100%

Factory Setting:
50%

Note!
If you press the keys simultaneously at startup, the language defaults to "ENGLISH" and the contrast is reset to the factory setting (50%).

TEST DISPLAY

Use this function to test the operability of the local display and its pixels.

Options:
OFF
ON

Factory Setting:
OFF

Test Sequence:
1. Start the test by selecting ON.
2. All pixels of the main line and additional line are darkened for minimum 0.75 seconds.
3. The main line and additional line show an "8" in each field for minimum 0.75 seconds.
4. The main line and additional line show a "0" in each field for minimum 0.75 seconds.
5. The main line and additional line show nothing (blank display) for minimum 0.75 seconds.
6. When the test is completed, the local display returns to its initial state and the displays the option OFF.

8.2.6 Group TOTALIZERS 1 and 2

8.2.6 Function Description TOTALIZER

ASSIGN TOTALIZER

Use this function to assign a measured variable to the totalizer.

Options (totalizer 1 and 2):
OFF
VOLUME FLOW
MASS FLOW
CORRECTED VOLUME FLOW
HEAT FLOW

Factory Setting (totalizer 1):
VOLUME FLOW (if no data specified or LIQUID VOLUME or GAS VOLUME specified as fluid when ordering), otherwise MASS FLOW

Factory Setting (totalizer 2):
VOLUME FLOW

Note!
- If the option selected is changed, the totalizer is reset to the value “0”.
- If the option selected is changed, the related unit must be adjusted to suit the option in the UNIT TOTALIZER function!
- If you select OFF, only the ASSIGN TOTALIZER function is displayed in the Group Totalizer 1 or 2.

SUM TOTALIZER

The total for the totalizer's measured variable aggregated since measuring commenced appears on the display.

Display:
Max. 7-digit floating-point number, with unit
(e.g.15467.4 m^3)

Note!
- The totalizers' response to errors is defined in the FAILSAFE MODE function (8.2.7)
- On the local display, totalizer 1 is displayed with “I” and totalizer 2 with “II”.

OVERFLOW TOTALIZER

The total for the totalizer's overflow aggregated since measuring commenced appears on the display.

Total flow is represented by a floating-point number consisting of max. 7 digits. You can use this function to view higher numerical values (>9,999,999) as overflows. The effective quantity is thus the total of the SUM TOTALIZER function plus the value displayed in the OVERFLOW TOTALIZER function.

Example:
Reading after 2 overflows: 2 E7 kg (= 20,000,000 kg)
The value displayed in the SUM function = 196,845.7 kg
Effective total quantity = 20,196,845.7 kg

Display:
Integer with exponent, including unit
(e.g. 2 E7 kg)

8.2.6 Function Description TOTALIZER

UNIT TOTALIZER

Use this function to define the unit for the totalizer. Depending on what is selected in the ASSIGN TOTALIZER function, only the associated units are offered for selection here.

Option Selected (ASSIGN TOTALIZER = VOLUME FLOW):

Metric:
0 – 100 s
Cubic centimetre → cm^3
Cubic decimetre → dm^3
Cubic metre → m^3
Millilitre → ml
Litre → l
Hectolitre → hl
Megalitre → Ml

US:
Cubic centimeter → cc
Acre foot → af
Cubic foot → ft^3
Fluid ounce → ozf
Gallon → gal
Million gallon → Mgal
Barrel → bbl (normal fluids)
Barrel → bbl (beer)
Barrel → bbl (petrochemicals)
Barrel → bbl (filling tanks)

Imperial:
Gallon → imp. gal/...
Mega gallon → imp. Mgal/...
Barrel (beer: 36.0 gal/bbl) → imp. bbl/... BEER
Barrel (petrochemicals: 34.97 gal/bbl) → imp. bbl/... PETR.

Arbitrary volume unit:
This option does not appear unless a volume unit was defined via the TEXT ARBITRARY VOLUME UNIT function (8.2.2).

Factory Setting:
Depends on country (see section 12).

Option Selected (ASSIGN TOTALIZER = MASS FLOW):

Metric: g kg t
US: oz lb ton

Factory Setting:
Depends on country (see section 12).

Option Selected (ASSIGN TOTALIZER = CORRECTED VOLUME FLOW):

Metric: Nl Nm^3
US: Sm^3 Scf

Factory Setting:
Depends on country (see section 12).

Option Selected (ASSIGN TOTALIZER = HEAT FLOW):

Metric:
kWh kcal
MWh Mcal
MJ Gcal
GJ

US:
kBtu
Mbtu
tonh

Factory Setting:
Depends on country (see section 12).

RESET TOTALIZER

Use this function to reset the sum and the overflow of the totalizer to 0 (= RESET).

Options:
NO
YES

Factory Setting:
NO

8.2.7 Group HANDLING TOTALIZERS

8.2.7 Function Description HANDLING TOTALIZER

RESET ALL TOTALIZERS

Use this function to reset the sum and the overflow of both totalizers to 0 (= RESET).

Options:
NO
YES

Factory Setting:
NO

FAILSAFE MODE

Use this function to define the response of both totalizers to an alarm condition.

Options:
STOP
The totalizer does not continue to count the flow if a fault is present. The totalizer stops at the last value before the alarm condition occurred.

ACTUAL VALUE
The totalizer continues to count the flow on the basis of the current flow data. The fault is ignored.

HOLD VALUE
The totalizer continues to count the flow on the basis of the last valid flow data (before the fault occurred).

Factory Setting:
STOP

8.2.8 Group CURRENT OUTPUT

8.2.8 Function Description CURRENT OUTPUT

ASSIGN CURRENT

Use this function to assign a measured variable to the current output.

Options:
VOLUME FLOW
TEMPERATURE
MASS FLOW
CORRECTED VOLUME FLOW
HEAT FLOW

CURRENT RANGE

Use this function to define the current range. You can configure the current output either in accordance with the NAMUR recommendation or for the values common in the United States.

Options:
4 – 20 mA HART NAMUR
4 – 20 mA HART US

8.2.8 Function Description CURRENT OUTPUT

VALUE 4 mA

Use this function to assign the 4 mA current a value. The value must be smaller than the value entered in the VALUE 20 mA function.

User Input:
5-digit floating-point number

VALUE 20 mA

Use this function to assign the 20 mA current a value. The value must be greater than the value entered in the VALUE 4 mA function.

User Input:
5-digit floating-point number

TIME CONSTANT

Use this function to select a time constant defining how the current output signal reacts to severely fluctuating measured variables, either very quickly (low time constant) or with damping (high time constant).

User Input:
Fixed-point number: 0 – 100 s

Factory Setting:
5 s

Note!
The reaction time of the function also depends on the time specified in the FLOW DAMPING function (8.2.15).

FAILSAFE MODE

The dictates of safety render it advisable to ensure that the current output assumes a predefined state in the event of a fault. Use this function to define the response of the current output to fault. The setting you select here affects only the current output. It has no effect on other outputs or the display (e.g. totalizers).

Options:
MIN. CURRENT
Depends on the option selected in the CURRENT RANGE function. If the current range is:
4 – 20 mA HART NAMUR → output current = 3.6 mA
4 – 20 mA HART US → output current = 3.75 mA

MAX. CURRENT
22.6 mA

HOLD VALUE
Measured value output is based on the last measured value saved before the error occurred.

ACTUAL VALUE
Measured value output is based on the current flow measurement. The fault is ignored.

Factory Setting:
MAX. CURRENT

8.2.8 Function Description CURRENT OUTPUT

ACTUAL CURRENT

The current computed actual value of the output current appears on the display.

Display:
3.60 – 22.60 mA

SIMULATION CURRENT

Use this function to activate simulation of the current output.

Options:
OFF
ON

Factory Setting:
OFF

Note!
- The notice message #611 “SIMULATION CURRENT OUTPUT” indicates that simulation is active.
- The value which should be output at the current output is defined in the VALUE SIMULATION CURRENT function.
- The measuring device continues to measure while simulation is in progress, i.e. the current measured values are output correctly via the other outputs and the display.

Caution!
The setting is not saved if the power supply fails.

VALUE SIMULATION CURRENT

Note!
This function is not available unless the ON option was selected in the SIMULATION CURRENT function.

Use this function to define a selectable value (e.g. 12 mA) to be output at the current output. This value is used to test downstream devices and the measuring device itself.

User Input:
Floating-point number: 3.60 – 22.60 mA

Factory Setting:
3.6 mA

Caution!
The setting is not saved if the power supply fails.

Note!
Simulation is started by confirming the simulation value with the [E] key. If the [E] key is pressed again afterwards, the prompt “End simulation” (NO/YES) appears.
If you choose “NO”, simulation remains active and the group selection is called up. The simulation can be switched off again via the SIMULATION CURRENT function (set to “OFF”).
If you choose “YES”, you end the simulation and the group selection is called up.

8.2.9 Group FREQUENCY (PULSE) OUTPUT

Note!
The frequency output can also be operated as a pulse or status output.


Note!

8.2.9 Function Description FREQUENCY OUTPUT

OPERATING MODE

Use this function to specify whether the output functions as a frequency output, pulse output or status output. The functions available in this function group vary, depending on which option you select here.

Options:
FREQUENCY
PULSE
STATUS
VORTEX FREQUENCY (unscaled pulses, together with flow computer, see 4.2)
PFM

Factory Setting:
PULSE


Note!

- If PFM is selected, the Current Output Group (see 8.2.8) is no longer available. Current simulation is automatically activated with a simulation value of 4 mA. If the transmitter was wired for pulse-frequency modulation, the HART protocol is not available.
- If VORTEX FREQUENCY and PFM are selected, the vortex pulses are passed on directly. The low flow cut off is also taken into account.

ASSIGN FREQUENCY


Note!
This function is not available unless the FREQUENCY option was selected in the OPERATING MODE function.

Use this function to assign a measured variable to the frequency output.

Options:
VOLUME FLOW
TEMPERATURE
MASS FLOW
CORRECTED VOLUME FLOW
HEAT FLOW

Factory Setting:
VOLUME FLOW


Note!
If FREQUENCY is selected in the OPERATING MODE function and OFF is selected in this function, only the OPERATING MODE and ASSIGN FREQUENCY functions continue to be displayed in this function group.

8.2.9 Function Description FREQUENCY OUTPUT

START VALUE FREQUENCY

Note!
This function is not available unless the FREQUENCY option was selected in the OPERATING MODE function.

Use this function to define a start (minimum) frequency for the frequency output. You specify the associated measured value of the measuring range in the VALUE-f LOW function.

User Input:
4-digit fixed-point number: 0 – 1000 Hz

Factory Setting:
0 Hz

Example:
- START FREQUENCY = 0 Hz, VALUE-f LOW = 0 kg/h: i.e. a frequency of 0 Hz is output with a flow of 0 kg/h.
- START FREQUENCY = 10 Hz, VALUE-f LOW = 1 kg/h: i.e. a frequency of 10 Hz is output with a flow of 1 kg/h.

END VALUE FREQUENCY

Note!
This function is not available unless the FREQUENCY option was selected in the OPERATING MODE function.

Use this function to define an end (maximum) frequency for the frequency output. You specify the associated measured value of the measuring range in the VALUE-f HIGH function.

User Input:
5-digit fixed-point number: 2 – 1000 Hz

Factory Setting:
1000 Hz

Example:
- END FREQUENCY = 1000 Hz, VALUE-f HIGH = 1000 kg/h: i.e. a frequency of 1000 Hz is output with a flow of 1000 kg/h.
- END FREQUENCY = 1000 Hz, VALUE-f HIGH = 3600 kg/h: i.e. a frequency of 1000 Hz is output with a flow of 3600 kg/h.

Note!
In the FREQUENCY operating mode the output signal is symmetrical (on/off ratio = 1:1).

8.2.9 Function Description FREQUENCY OUTPUT

VALUE-f LOW

Note!
This function is not available unless the FREQUENCY option was selected in the OPERATING MODE function.

Use this function to assign a value to the start frequency. The value entered here must be smaller than the value assigned to the VALUE-f HIGH. A negative value is only permitted when TEMPERATURE is selected in the ASSIGN FREQUENCY function. You define the desired span by specifying the VALUE-f LOW and VALUE-f HIGH.

User Input:
5-digit floating-point number

Factory Setting:
Depends on the option selected in the ASSIGN FREQUENCY function:
– 0 UNIT VOLUME FLOW
– 0 °C (converted to the selected UNIT TEMPERATURE)
– 0 UNIT MASS FLOW
– 0 UNIT CORRECTED VOLUME FLOW
– 0 UNIT HEAT FLOW

Note!
The appropriate unit is taken from the Group SYSTEM UNITS (8.2.2).

VALUE-f HIGH

Note!
This function is not available unless the FREQUENCY option was selected in the OPERATING MODE function.

Use this function to assign a value to the end frequency. The value entered here must be greater than the value assigned to the VALUE-f LOW. A negative value is only permitted when TEMPERATURE is selected in the ASSIGN FREQUENCY function. You define the desired span by specifying the VALUE-f LOW and VALUE-f HIGH.

User Input:
5-digit floating-point number

Factory Setting:
Depends on the option selected in the ASSIGN FREQUENCY function:
– 10 l/s (converted to the selected UNIT VOLUME FLOW)
– 200 °C (converted to the selected UNIT TEMPERATURE)
– 10 kg/h (converted to the selected UNIT MASS FLOW)
– 10 Nm^3/h (converted to the selected UNIT CORRECTED VOLUME FLOW)
– 10 kW (converted to the selected UNIT HEAT FLOW)

Note!
The appropriate unit is taken from the Group SYSTEM UNITS (8.2.2).

8.2.9 Function Description FREQUENCY OUTPUT

OUTPUT SIGNAL

Note!
This function is not available unless the FREQUENCY option was selected in the OPERATING MODE function.

Use this function to select the polarity of the frequency.

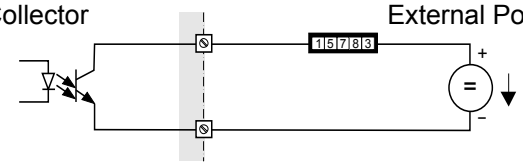
Options:
PASSIVE – POSITIVE
PASSIVE – NEGATIVE

Factory Setting:
PASSIVE – POSITIVE

PASSIVE:

Open Collector

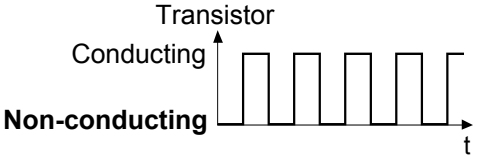
U_{max} = 30 V DC
External Power Supply



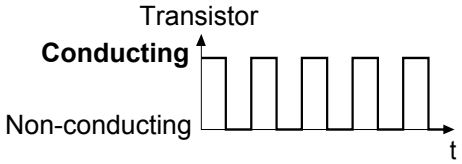
See 4.2 for wiring diagram

Note!
For continuous currents up to 15 mA

PASSIVE – NEGATIVE



PASSIVE – POSITIVE



TIME CONSTANT

Note!
This function is not available unless the FREQUENCY option was selected in the OPERATING MODE function.

Use this function to enter a time constant defining how the frequency output signal reacts to severely fluctuating measured variables, either very quickly (enter a low time constant) or with damping (enter a high time constant).

User Input:
Floating-point number 0 – 100 s

Factory Setting:
5 s

Note!
The reaction time of the function also depends on the time specified in the FLOW DAMPING function (8.2.15).

8.2.9 Function Description FREQUENCY OUTPUT

FAILSAFE MODE

Note!
This function is not available unless the FREQUENCY option was selected in the OPERATING MODE function.

The dictates of safety render it advisable to ensure that the frequency output assumes a predefined state in the event of a fault. Use this function to define this state. The setting you select here affects only the frequency output. It has no effect on other outputs or the display (e.g. totalizers).

Options:
FALLBACK VALUE
0 Hz is output.

FAILSAFE VALUE
The frequency specified in the FAILSAFE VALUE function is output.

HOLD VALUE
Measured value output is based on the last measured value saved before the error occurred.

ACTUAL VALUE
Measured value output is based on the current flow measurement. The fault is ignored.

Factory Setting:
FALLBACK VALUE

FAILSAFE VALUE

Note!
This function is not available unless the FREQUENCY option was selected in the OPERATING MODE function and FAILSAFE VALUE was selected in the FAILSAFE MODE function.

Use this function to define the frequency that the measuring device outputs in the event of an error.

User Input:
Max. 4-digit number: 0 – 1250 Hz

Factory Setting:
1250 Hz

ACTUAL FREQUENCY

Note!
This function is not available unless the FREQUENCY option was selected in the OPERATING MODE function.

The computed actual value of the output frequency appears on the display.

Display:
0 – 1250 Hz

8.2.9 Function Description FREQUENCY OUTPUT

SIMULATION FREQUENCY

Note!
This function is not available unless the FREQUENCY option was selected in the OPERATING MODE function.

Use this function to activate simulation of the frequency output.

Options:
OFF
ON

Factory Setting:
OFF

Note!
- The notice message #621 “SIM. FREQ. OUT.” indicates that simulation is active.
- The measuring device continues to measure while simulation is in progress, i.e. the current measured values are output correctly via the other outputs.

Caution!
The setting is not saved if the power supply fails.

VALUE SIMULATION FREQUENCY

Note!
This function is not available unless the FREQUENCY option was selected in the OPERATING MODE function and ON was selected in the SIMULATION FREQUENCY function.

Use this function to define a selectable frequency value (e.g. 500 Hz) to be output at the frequency output. This value is used to test downstream devices and the measuring device itself.
Simulation is started once the specified value is confirmed with the [E] key.

User Input:
0 – 1250 Hz

Factory Setting:
0 Hz

Note!
Simulation is started by confirming the simulation value with the [E] key. If the [E] key is pressed again afterwards, the prompt “End simulation” (NO/YES) appears.
If you choose “NO”, simulation remains active and the group selection is called up. The simulation can be switched off again via the SIMULATION FREQUENCY function.
If you choose “YES”, you end the simulation and the group selection is called up.

Caution!
The setting is not saved if the power supply fails.

8.2.9 Function Description PULSE OUTPUT

ASSIGN PULSE

Note!
This function is not available unless the PULSE option was selected in the OPERATING MODE function.

Use this function to assign a measured variable to the pulse output.

Options:
VOLUME FLOW
MASS FLOW
CORRECTED VOLUME FLOW
HEAT FLOW

PULSE VALUE

Note!
This function is not available unless the PULSE option was selected in the OPERATING MODE function.

Use this function to define the flow at which a pulse should be output. These pulses can be totaled by an external totalizer and in this way the total flow since measuring commenced can be registered.

Note!
Select the pulse value in such a way that the pulse frequency does not exceed a value of 100 Hz with maximum flow.

User Input:
5-digit floating-point number

Note!
The appropriate unit is taken from the Group SYSTEM UNITS (8.2.2).

PULSE WIDTH

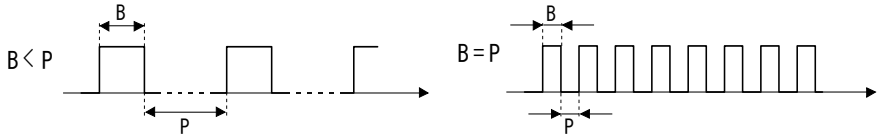
Note!
This function is not available unless the PULSE option was selected in the OPERATING MODE function.

Use this function to enter the maximum pulse width of the output pulses.

User Input:
5 – 2000 ms

Factory Setting:
20 ms

Pulse output is always with the pulse width (B) entered in this function. The intervals (P) between the individual pulses are automatically configured. However, they must at least correspond to the pulse width (B = P).



B = Pulse width entered (the illustration applies to positive pulses)
P = Intervals between the individual pulses

Note!
When entering the pulse width, select a value that can still be processed by a connected totalizer (e.g. mechanical totalizer, PLC, etc.).

Caution!
If the pulse number or frequency resulting from the pulse value entered (see PULSE VALUE function) and the current flow is too large to maintain the pulse width selected (the interval P is smaller than the pulse width B entered), a system error message (#359, PULSE RANGE, see 11.2) is generated after buffering/balancing has occurred.

8.2.9 Function Description PULSE OUTPUT

OUTPUT SIGNAL

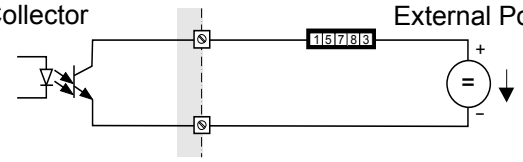
Note!
This function is not available unless the PULSE option was selected in the OPERATING MODE function.

Use this function to configure the pulse output in such a way that it can be operated with an external totalizer, for example. Depending on the application, you can select the direction of the pulses here.

Options:
PASSIVE – POSITIVE
PASSIVE – NEGATIVE

PASSIVE:
Open Collector

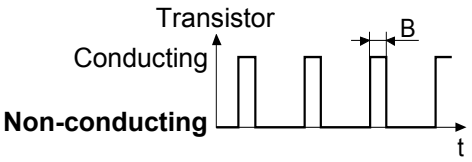
U_{max} = 30 V DC
External Power Supply



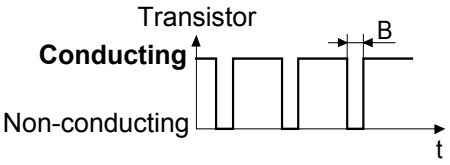
See 4.2 for wiring diagram

Note!
For continuous currents up to 15 mA

PASSIVE – NEGATIVE
Pulse (B= pulse width)



PASSIVE – POSITIVE
Pulse (B = pulse width)



FAILSAFE MODE

Note!
This function is not available unless the PULSE option was selected in the OPERATING MODE function.

The dictates of safety render it advisable to ensure that the pulse output assumes a predefined state in the event of a fault. Use this function to define this state. The setting you select here affects only the pulse output. It has no effect on other outputs or the display (e.g. totalizers).

Options:
FALLBACK VALUE
Output is 0 pulse.

HOLD VALUE
Measured value output is based on the last measured value saved before the error occurred.

ACTUAL VALUE
Measured value output is based on the current flow measurement. The fault is ignored.

Factory Setting:
FALLBACK VALUE

8.2.9 Function Description PULSE OUTPUT

ACTUAL PULSE

Note!
This function is not available unless the PULSE option was selected in the OPERATING MODE function.

The computed actual value of the output frequency appears on the display.

Display:
0 – 100 pulse/second

SIMULATION PULSE

Note!
This function is not available unless the PULSE option was selected in the OPERATING MODE function.

Use this function to activate simulation of the pulse output.

Options:
OFF

COUNTDOWN
The pulses specified in the VALUE SIMULATION PULSE function are output.

CONTINUOUSLY
Pulses are continuously output with the pulse width specified in the PULSE WIDTH function. Simulation is started once the CONTINUOUSLY option is confirmed with the [E] key.

Note!
Simulation is started by confirming the CONTINUOUSLY option with the [E] key. If the [E] key is pressed again afterwards, the prompt “End simulation” (NO/YES) appears.
If you choose “NO”, simulation remains active and the group selection is called up. The simulation can be switched off again via the SIMULATION PULSE function.
If you choose “YES”, you end the simulation and the group selection is called up.

Factory Setting:
OFF

Note!
- The notice message #631 “SIM. PULSE” indicates that simulation is active.
- The on/off ratio is 1:1 for both types of simulation.
- The measuring device continues to measure while simulation is in progress, i.e. the current measured values are output correctly via the other outputs.

Caution!
The setting is not saved if the power supply fails.

8.2.9 Function Description PULSE OUTPUT

VALUE SIMULATION PULSE

Note!
This function is not available unless the COUNTDOWN option was selected in the SIMULATION PULSE function.

Use this function to specify the number of pulses (e.g. 50) that are output during the simulation. This value is used to test downstream devices and the measuring device itself. The pulses are output with the pulse width specified in the PULSE WIDTH function. The on/off ratio is 1:1.

Simulation is started once the specified value is confirmed with the [E] key. The display remains at 0 if the specified pulses have been output.

User Input:
0 – 10,000

Factory Setting:
0

Note!
Simulation is started by confirming the simulation value with the [E] key. If the [E] key is pressed again afterwards, the prompt “End simulation” (NO/YES) appears.
If you choose “NO”, simulation remains active and the group selection is called up. The simulation can be switched off again via the SIMULATION PULSE function.
If you choose “YES”, you end the simulation and the group selection is called up.

Caution!
The setting is not saved if the power supply fails.

8.2.9 Function Description STATUS OUTPUT

ASSIGN STATUS

Note!
This function is not available unless the STATUS option was selected in the OPERATING MODE function.

Use this function to assign a switching function to the status output.

Options:
OFF
ON (operation)
FAULT MESSAGE
NOTICE MESSAGE
FAULT MESSAGE or NOTICE MESSAGE
VOLUME FLOW LIMIT VALUE
TEMPERATURE LIMIT VALUE
MASS FLOW LIMIT VALUE
CORRECTED VOLUME FLOW LIMIT VALUE
HEAT FLOW LIMIT VALUE
TOTALIZER 1 LIMIT VALUE
TOTALIZER 2 LIMIT VALUE

Factory Setting:
FAULT MESSAGE

Note!
- The status output displays quiescent current behavior, in other words the output is closed (transistor conductive) when normal, error-free operation is in progress.
- Please pay particular attention to the illustrations and detailed information on the switching behavior of the status output (8.2.10).
- If you select OFF, the only function shown in this function group is this function (ASSIGN STATUS).

SWITCH-ON POINT

Note!
This function is not available unless a limit value was selected in the ASSIGN STATUS function.

Use this function to assign a value to the switch-on point (status output pulls up). The value can be greater or less than the switch-off point. Only positive values are permissible (exception TEMPERATURE LIMIT VALUE).

User Input:
5-digit floating-point number, with unit

Factory Setting:
Depends on the option selected in the ASSIGN STATUS function:
– If VOLUME FLOW LIMIT VALUE was selected: see 12.1 and 12.2
– If TEMPERATURE LIMIT VALUE was selected: 180 °C
(converted to the selected UNIT TEMPERATURE)
– If MASS FLOW LIMIT VALUE was selected: 10 kg/h
(converted to the selected UNIT MASS FLOW)
– If CORRECTED VOLUME FLOW LIMIT VALUE was selected: 10 Nm^3/h
(converted to the selected UNIT CORRECTED VOLUME FLOW)
– If HEAT FLOW LIMIT VALUE was selected: 10 kW
(converted to the selected UNIT HEAT FLOW)
– If TOTALIZER 1 LIMIT VALUE was selected: 0
(converted to the selected UNIT TOTALIZER 1)
– If TOTALIZER 2 LIMIT VALUE was selected: 0
(converted to the selected UNIT TOTALIZER 2)

Note!
The appropriate unit is taken from the Group SYSTEM UNITS (8.2.2)

8.2.9 Function Description STATUS OUTPUT

SWITCH-OFF POINT

Note!
This function is not available unless a limit value was selected in the ASSIGN STATUS function.

Use this function to assign a value to the switch-off point (status output drops out). The value can be greater or less than the switch-on point. Only positive values are permissible (exception TEMPERATURE LIMIT VALUE).

User Input:
5-digit floating-point number, with unit

Factory Setting:
Depends on the option selected in the ASSIGN STATUS function:
– If VOLUME FLOW LIMIT VALUE was selected: see 12.1 and 12.2
– If TEMPERATURE LIMIT VALUE was selected: 170 °C
(converted to the selected UNIT TEMPERATURE)
– If MASS FLOW LIMIT VALUE was selected: 9 kg/h
(converted to the selected UNIT MASS FLOW)
– If CORRECTED VOLUME FLOW LIMIT VALUE was selected: 9 Nm^3/h
(converted to the selected UNIT CORRECTED VOLUME FLOW)
– If HEAT FLOW LIMIT VALUE was selected: 9 kW
(converted to the selected UNIT HEAT FLOW)
– If TOTALIZER 1 LIMIT VALUE was selected: 0
(converted to the selected UNIT TOTALIZER 1)
– If TOTALIZER 2 LIMIT VALUE was selected: 0
(converted to the selected UNIT TOTALIZER 2)

Note!
The appropriate unit is taken from the Group SYSTEM UNITS (8.2.2)

TIME CONSTANT

Note!
This function is not available unless a limit value (except TOTALIZER 1 or 2 LIMIT VALUE) was selected in the ASSIGN STATUS function.

Use this function to select a time constant defining how the measuring signal reacts to severely fluctuating measured variables, either very quickly (low time constant) or with damping (high time constant).
The purpose of damping, therefore, is to prevent the status output changing state continuously in response to fluctuations in flow.

User Input:
Floating-point number: 0 – 100 s

Factory Setting:
0 s

Note!
The reaction time of the function also depends on the time specified in the FLOW DAMPING (8.2.15) function.

ACTUAL STATUS OUTPUT

Note!
This function is not available unless the STATUS option was selected in the OPERATING MODE function.

The current status of the status output appears on the display.

User Input:
NOT CONDUCTIVE
CONDUCTIVE

8.2.9 Function Description STATUS OUTPUT

SIMULATION SWITCH POINT

Note!
This function is not available unless the STATUS option was selected in the OPERATING MODE function.

Use this function to activate simulation of the status output.

User Input:
OFF
ON

Factory Setting:
OFF

Note!
- The notice message #641 “SIM. STAT. OUT.” indicates that simulation is active.
- The measuring device continues to measure while simulation is in progress, i.e. the current measured values are output correctly via the other outputs.

Caution!
The setting is not saved if the power supply fails.

VALUE SIMULATION SWITCH POINT

Note!
This function is not available unless the ON option was selected in the SIMULATION SWITCH POINT function.

Use this function to define the switching behavior of the status output during the simulation. This value is used to test downstream devices and the measuring device itself.

User Input:
NOT CONDUCTIVE
CONDUCTIVE

Factory Setting:
NOT CONDUCTIVE

Note!
You can change the switching behavior of the status output during the simulation. The prompt “CONDUCTIVE” or “NOT CONDUCTIVE” appears if the ⊞ or ⊟ key is pressed. Select the desired switching behavior and start the simulation with the Ⓔ key.
If the Ⓔ key is pressed again afterwards, the prompt “End simulation” (NO/YES) appears. If you choose “NO”, simulation remains active and the group selection is called up. The simulation can be switched off again via the SIMULATION SWITCH POINT function.
If you choose “YES”, you end the simulation and the group selection is called up.

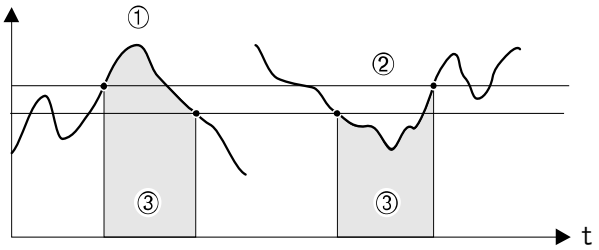
Caution!
The setting is not saved if the power supply fails.

8.2.10 Information on the Response of the Status Output

General Information
f you have configured the status output for “LIMIT VALUE”, you can specify the required switch points in the SWITCH-ON POINT and SWITCH-OFF POINT functions. When the measured variable in question reaches these predefined values, the status output switches as shown in the illustrations below.

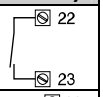
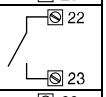
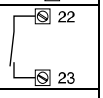
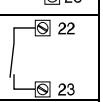
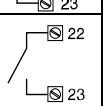
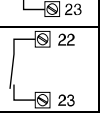
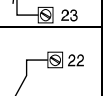
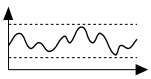
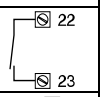
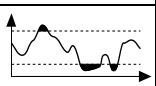
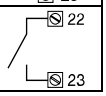
Status Output Configured for Limit Value
The status output switches as soon as the current measured variable undershoots or overshoots a defined switch point.
Application: monitoring flow or process-related boundary conditions.

Measured Variable



① = ON ≤ SWITCH-OFF POINT (maximum safety)
② = ON > SWITCH-OFF POINT (minimum safety)
③ = Status output switched off (not conductive)

Switching Behavior of the Status Output

Function	Status		Open Collector Behavior (transistor)
ON (operation)	System in operation	O	Conductive 
	System not in operation (power supply failure)	X	Not conductive 
Fault Message	System OK	O	Conductive 
	(System or process error) Fault → failsafe mode outputs/inputs and totalizers	X	Not conductive 
Notice Message	System OK	O	Conductive 
	(System or process error) Fault → continuation of operation	X	Not conductive 
Fault Message or Notice Message	System OK	O	Conductive 
	(System or process error) Fault → failsafe mode or Notice → continuation of operation	X	Not conductive 
Limit Value • Volume flow • Totalizer	Limit value not overshot or undershot		Conductive 
	Limit value overshot or undershot		Not conductive 

8.2.11 Group HANDLING COMMUNICATION

8.2.11 Function Description COMMUNICATION

TAG NAME

Use this function to enter a tag name for the measuring device. You can edit and read this tag name via the local display or the HART protocol.

User Input:
Max. 8-character text
Permitted characters are: A-Z, 0-9, +,–, punctuation marks

Factory Setting:
"– – – – – – – –" (no text)

TAG DESCRIPTION

Use this function to enter a tag description for the measuring device. You can edit and read this tag name via the local display or the HART protocol.

User Input:
Max. 16-character text
Permitted characters are: A-Z, 0-9, +,–, punctuation marks

Factory Setting:
"– – – – – – – – – – – – – – – – –" (no text)

BUS ADDRESS

Use this function to define the address for the exchange of data with the HART protocol.

User Input:
0 – 15

Factory Setting:
0

Note!
A constant 4 mA current is applied with addresses 1 – 15.

WRITE PROTECTION

Use this function to check whether the measuring device can be write-accessed.

Display:
OFF (execution status) = Data exchange possible
ON = Data exchange disabled

Note!
Write protection is activated and deactivated by means of a DIP switch on the amplifier board.

BURST MODE

Use this function to activate cyclic data exchange of the process variables selected in the BURST MODE CMD function to achieve faster communication.

Options:
OFF
ON

Factory Setting:
OFF

8.2.11 Function Description COMMUNICATION

BURST MODE CMD

Use this function to activate simulation of the status output.

Options:
CMD 1
Read primary measured variable (e.g. volume flow).

CMD 2
Read current and percentage of the measuring range.

CMD 3
Read current and four (previously defined) measured variables.

Factory Setting:
CMD 1

MANUFACTURER ID

The manufacturer number in decimal numerical format appears on the display.

Display:
17 = (11 hex) for TLV

DEVICE ID

The instrument number in hexadecimal numerical format appears on the display.

Display:
57 = (87 dec) for EF73

8.2.12 Group PROCESS PARAMETER

8.2.12 Function Description PROCESS PARAMETER

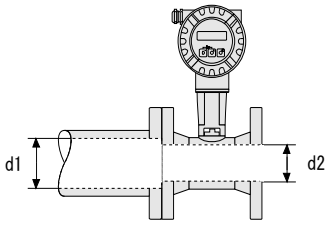
D MATING PIPE

The device has diameter step correction. This can be activated by entering the actual value of the mating pipe (see d1, figure below) in this parameter.

If the mating pipe (d1) and the measuring pipe (d2) have different diameters, this alters the flow profile.

A diameter step can occur if:
- The mating pipe has a different pressure rating to that of the measuring device.
- The mating pipe has another schedule to that of the measuring pipe (e.g. 80 instead of 40), for ASME.

To correct any resulting shift in the calibration factor, enter the actual value of the mating pipe (d1) in this parameter.



d1 > d2
d1 = Mating pipe diameter
d2 = Measuring pipe diameter

User Input:
5-digit floating-point number

Factory Setting:
0

Note!
- Inlet correction is switched off if 0 is entered.
- The appropriate unit is taken from the UNIT LENGTH function (8.2.2).
- Only diameter steps within the same nominal diameter class (e.g. DN 50 / ½“) can be corrected.
- If the standard internal diameter of the process connection ordered for the device and the internal diameter of the mating pipe differ, you must reckon with an additional uncertainty of measurement of typ. 0.1% o.r. (of reading) for every 1 mm diameter deviation.

ASSIGN LOW FLOW CUTOFF

For selecting the process variable on which low flow cut off should act.

Options:
OFF
VOLUME FLOW
MASS FLOW
CORRECTED VOLUME FLOW
HEAT FLOW
REYNOLDS NUMBER*

Factory Setting:
VOLUME FLOW

* This option is not available unless the SATURATED STEAM, WATER, COMPRESSED AIR, SUPERHEATED STEAM or NATURAL GAS NX-19 option was selected in the SELECT FLUID function.

Note!
If you choose a selection that can‘t be calculated for your selected media (e.g. corrected volume for saturated steam), low flow cut off is not taken into account.

8.2.12 Function Description PROCESS PARAMETER

ON-VALUE LOW FLOW CUTOFF

Note!
This function is not available if the OFF option was selected in the ASSIGN LOW FLOW CUT OFF function.

Use this function to enter the on-value for low flow cut off.

If VOLUME FLOW, MASS FLOW, CORRECTED VOLUME FLOW or HEAT FLOW is selected in the ASSIGN LOW FLOW CUTOFF function (8.2.12):
Low flow cut off is switched on if the value entered is not equal to 0. An inverted plus sign is shown on the local display of the flow value as soon as the low flow cut off is active.

User Input:
5-digit floating-point number

Factory Setting:
Below the standard measuring range

Note!
The appropriate unit is taken from the Group SYSTEM UNITS (8.2.2).

If REYNOLDS NUMBER is selected in the ASSIGN LOW FLOW CUTOFF function (8.2.12):
If the Reynolds number entered here is undershot, low flow cutoff becomes active. An inverted plus sign is shown on the local display of the flow value when the low flow cutoff is active.

User Input:
4,000 – 99,999

Factory Setting:
20,000

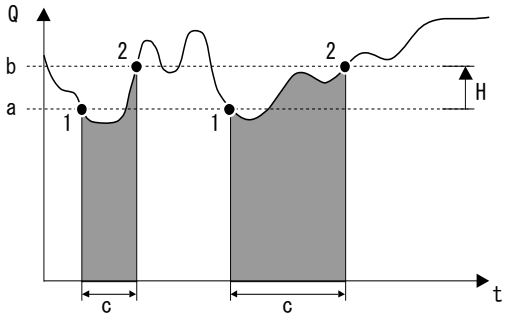
OFF-VALUE LOW FLOW CUTOFF

Use this function to enter the off-value for low flow cutoff.
Enter the off-value as a positive hysteresis from the on-value.

User Input:
Integer 0 – 100%

Factory Setting:
50%

Example:



Q = Flow [volume/time]
t = Time
a = ON-VALUE LOW FLOW CUTOFF = 20 m^3/h
b = OFF-VALUE LOW FLOW CUTOFF = 10%
c = Low flow cutoff active
1 = Low flow cutoff is switched on at 20 m^3/h
2 = Low flow cutoff is switched off at 22 m^3/h
H = Hysteresis

8.2.13 Group FLOW COMPUTER

8.2.13 Function Description FLOW COMPUTER

SELECT FLUID

Note!
We recommend you only change the fluid selected by means of the Commissioning Quick Setup (7.2.2). In the Commissioning Quick Setup, you can adjust all the relevant parameters to suit the newly selected fluid

Options:
SATURATED STEAM
GAS VOLUME (only volume and temperature measurement possible)
LIQUID VOLUME (only volume and temperature measurement possible)
WATER
USER-DEFINED LIQUID
COMPRESSED AIR
SUPERHEATED STEAM
REAL GAS (for all gases not listed here)
NATURAL GAS NX-19 (only available as an option)

Information On Fluids That Can Be Selected

Selected Fluid → SATURATED STEAM:
Applications:
Calculation of mass flow and the enthalpy it contains at the output of a steam generator or an individual consumer.

Calculated Variables:
The mass flow, heat flow, density and the specific enthalpy are calculated from the measured volume flow and the measured temperature, with the aid of the saturated steam curve to the international standard IAPWS-IF97 (ASME steam data) (stored in the device).

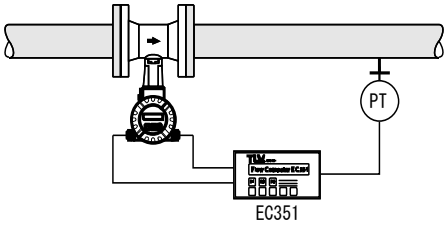
Formula for Calculation:
- Mass Flow → $m = q \cdot \rho(T)$
- Heat Flow → $E = q \cdot \rho(T) \cdot h_D(T)$

m = Mass flow
E = Heat flow
q = Volume flow (measured)
h_D = Specific enthalpy
T = Operating temperature (measured)
ρ = Density (from saturated steam curve in accordance with IAPWS-IF97 (ASME), for the measured temperature)

Selected Fluid → GAS VOLUME or LIQUID VOLUME:
Applications:
The measured volume flow and measured temperature are made available to an external flow computer. The flow can be calculated at a non-constant pressure in conjunction with an external pressure transmitter (PT).

Calculated Variables:
None in this device; calculation takes place in an external flow computer.

Example of Application:



SELECT FLUID continued on next page.

8.2.13 Function Description FLOW COMPUTER

SELECT FLUID (continued)

Selected Fluid → SUPERHEATED STEAM:
Applications:
Calculation of mass flow and the enthalpy it contains at the output of a steam generator or an individual consumer.

Note!
The average operating pressure (p) in the steam line is needed for calculating the process variables and the measuring range limit values. The average operating pressure is not available as an input signal, but must be entered in the OPERATING PRESSURE function, i.e. exact calculation can only take place at a constant operating pressure.

Calculated Variables:
The mass flow, heat flow, density and the specific enthalpy are calculated from the measured volume flow, the measured temperature and the specified operating pressure, with the aid of the saturated steam curve to the international standard IAPWS-IF97 (ASME steam data) (stored in the device).

Formula for Calculation:
- Mass Flow → $m = q \cdot \rho(T,p)$
- Heat Flow → $E = q \cdot \rho(T,p) \cdot h_D(T,p)$

m = Mass flow
E = Heat flow
q = Volume flow (measured)
h_D = Specific enthalpy
T = Operating temperature (measured)
p = Operating pressure (from OPERATING PRESSURE function)
ρ = Density (from saturated steam curve in accordance with IAPWS-IF97 (ASME), for the measured temperature and specified pressure)

Selected Fluid → WATER:
Applications:
Calculation of the enthalpy in a flow of water, e.g. to determine the residual heat in a heat exchanger.

Note!
The average operating pressure (p) in the water line is needed for calculating the process variable. The average operating pressure is not available as an input signal, but must be entered in the OPERATING PRESSURE function, i.e. exact calculation can only take place at a constant operating pressure.

Calculated Variables:
The mass flow, heat flow, density and the specific enthalpy are calculated from the measured volume flow, the measured temperature and the specified operating pressure, with the aid of the water data to the international standard IAPWS-IF97 (ASME water data) (stored in the device).

Formula for Calculation:
- Mass Flow → $m = q \cdot \rho(T,p)$
- Heat Flow → $E = q \cdot \rho(T,p) \cdot h(T,p)$
- Corrected Volume Flow → $q_{ref} = q \cdot (\rho(T,p) \div \rho_{ref})$

m = Mass flow
E = Heat flow
q = Volume flow (measured)
q_{ref} = Corrected volume flow
h = Specific enthalpy of water
T = Operating temperature (measured)
p = Operating pressure (from OPERATING PRESSURE function)
ρ = Density (from water data in accordance with IAPWS-IF97 (ASME), for the measured temperature and specified pressure)
ρ_{ref} = Reference density (from REFERENCE DENSITY function)

SELECT FLUID continued on next page.

8.2.13 Function Description FLOW COMPUTER

SELECT FLUID (continued)

Selected Fluid → USER-DEFINED LIQUID:

Applications:

Calculation of mass flow of a user-defined liquid, e.g. a thermal oil.

Calculated Variables:

The mass flow, density and the corrected volume flow are calculated from the measured volume flow and the measured temperature.

Formula for Calculation:

- Mass Flow → $m = q \cdot \rho(T)$
- Density → $\rho = \rho_1(T_1) \div (1 + \beta_p \cdot [T - T_1])$
- Corrected Volume Flow → $q_{ref} = q \cdot (\rho(T) \div \rho_{ref})$

m = Mass flow
q = Volume flow (measured)
q_{ref} = Corrected volume flow
T = Operating temperature (measured)
T_1 = Temperature at which ρ_1 applies (from TEMPERATURE VALUE function)*
ρ = Density
ρ_{ref} = Reference density (from REFERENCE DENSITY function)
ρ_1 = Density at which the value for T_1 applies (from DENSITY VALUE function)*
β_p = Liquid expansion coefficient at T_1 (from EXPANSION COEFFICIENT function)*
* For some possible combinations of these values, refer to the table in 8.2.14.

Selected Fluid → REAL GAS (nitrogen, carbon dioxide, etc.), COMPRESSED AIR or NATURAL GAS NX-19 (option):

Applications:

Calculation of mass flow and the corrected volume flow of gasses.

Note!
The average operating pressure (p) in the gas line is needed for calculating the process variables and the measuring range limit values. The average operating pressure is not available as an input signal, but must be entered in the OPERATING PRESSURE function, i.e. exact calculation can only take place at a constant operating pressure.

Calculated Variables:

The mass flow, density and the corrected volume flow are calculated from the measured volume flow, the measured temperature and the specified operating pressure using data stored in the device.

Note!
The NX-19 equation is suitable for natural gas with a specific density between 0.554 and 0.75. The specific density describes the ratio of the reference density of the natural gas to the reference density of air (see SPECIFIC DENSITY function)

Formula for Calculation:

- Mass Flow → $m = q \cdot \rho(T,p)$
- Density (natural gas) → $\rho(T,p) = \rho_{ref} \cdot (p \div \rho_{ref}) \cdot (T_{ref} \div T) \cdot (Z_{ref} \div Z)$
- Corrected Volume Flow → $q_{ref} = q \cdot (\rho(T,p) \div \rho_{ref})$

m = Mass flow
q = Volume flow (measured)
q_{ref} = Corrected volume flow
T = Operating temperature (measured)
T_{ref} = Reference temperature (from REFERENCE TEMPERATURE function)
p = Operating pressure (from OPERATING PRESSURE function)
p_{ref} = Reference pressure (from REFERENCE PRESSURE function)
ρ = Density*
ρ_{ref} = Reference density (from REFERENCE DENSITY function)*
Z = Operating Z-factor (from OPERATING Z-FACTOR function)*
Z_{ref} = Reference Z-factor (from REFERENCE Z-FACTOR function)*
* The values from the functions are only used for real gas. For compressed air and natural gas NX-19, the necessary data are taken from tables stored in the device.

8.2.13 Function Description FLOW COMPUTER

ERROR -> TEMPERATURE

Use this function to enter a temperature value for temperature measurement failure. If temperature measurement fails, the device continues to work with the temperature value entered here.

User Input:
5-digit floating-point number; with unit

Factory Setting:
20 °C (converted to the selected UNIT TEMPERATURE)

Note!
The appropriate unit is taken from the UNIT TEMPERATURE function (8.2.2).

TEMPERATURE VALUE

Note!
This function is not available unless the USER-DEFINED LIQUID option was selected in the SELECT FLUID function.

Use this function to enter the fluid temperature for the density specified in the DENSITY VALUE function for calculating the operating density of user-defined liquids (formula for calculation, see SELECT FLUID function).

User Input:
5-digit floating-point number

Factory Setting:
20 °C (converted to the selected UNIT TEMPERATURE)

Note!
- The appropriate unit is taken from the UNIT TEMPERATURE function (8.2.2).
- If the value in this function is changed, we recommend you reset the totalizers.
- A table with sample values (for the TEMPERATURE VALUE, DENSITY VALUE and EXPANSION COEFFICIENT functions) for various fluids can be found in 8.2.14.

Caution!
This setting does not change the permitted temperature range of the measuring system. Please pay particular attention to the temperature application limits specified in the product specification.

DENSITY VALUE

Note!
This function is not available unless the USER-DEFINED LIQUID option was selected in the SELECT FLUID function.

Use this function to enter the density at the fluid temperature specified in the TEMPERATURE VALUE function, for calculating the operating density of user-defined liquids (formula for calculation, see SELECT FLUID function)

User Input:
5-digit floating-point number

Factory Setting:
1.0000 kg/dm^3 (converted to the selected UNIT DENSITY)

Note!
- The appropriate unit is taken from the UNIT DENSITY function (8.2.2).
- If the value in this parameter is changed, we recommend you reset the totalizer.
- A table with sample values (for the TEMPERATURE VALUE, DENSITY VALUE and EXPANSION COEFFICIENT functions) for various fluids can be found in 8.2.14.

8.2.13 Function Description FLOW COMPUTER

EXPANSION COEFFICIENT

Note!
This function is not available unless the USER-DEFINED LIQUID option was selected in the SELECT FLUID function.

Use this function to enter the expansion coefficient for calculating the operating density of user-defined liquids (formula for calculation, see SELECT FLUID function).

User Input:
5-digit floating-point number, with unit (10^{-4} · 1/unit temperature)

Factory Setting:
2.0700 [10^{-4} · 1/K] (expansion coefficient for water at 20 °C)
(converted to the selected UNIT TEMPERATURE)

Note!
- If the value in this function is changed, we recommend you reset the totalizers.
- If two value pairs are known for temperature and density (density ρ_1 at temperature T_1 and density ρ_2 at temperature T_2), the expansion coefficient can be calculated as follows:

$$\beta_p = \frac{\frac{\rho_1}{\rho_2} - 1}{T_1 - T_2}$$

- A table with sample values (for the TEMPERATURE VALUE, DENSITY VALUE and EXPANSION COEFFICIENT functions) for various fluids can be found in 8.2.14.

Note!
The appropriate unit for temperature is taken from the UNIT TEMPERATURE function (8.2.2).

OPERATING PRESSURE

Note!
This function is not available unless the WATER, COMPRESSED AIR, SUPERHEATED STEAM, REAL GAS or NATURAL GAS NX-19 option was selected in the SELECT FLUID function.

Use this function to enter the medium pressure to calculate the operating density (formula for calculation, see SELECT FLUID function).

User Input:
5-digit floating-point number; with unit

OPERATING Z-FACTOR

Note!
This function is not available unless the REAL GAS option was selected in the SELECT FLUID function.

Use this function to enter the Z-factor for gas under operating conditions, i.e. for the average temperature to be expected (formula for calculation, see SELECT FLUID function)

The real gas constant Z indicates how far a real gas differs from an ideal gas that exactly fulfills the general gas law (p x V / T = constant, Z = 1). The real gas constant approaches the value 1 the further the real gas is from its liquefaction point.

User Input:
5-digit floating-point number (Entry value must be > 0)

Factory Setting:
1.0000

8.2.13 Function Description FLOW COMPUTER

REFERENCE DENSITY

Note!
This function is not available unless the REAL GAS or USER-DEFINED LIQUID option was selected in the SELECT FLUID function.

Use this function to enter the reference density of the fluid to calculate the standard volume and the density of real gas (formula for calculation, see SELECT FLUID function), as well as the standard volume of a user-defined liquid.

User Input:
5-digit floating-point number (Entry value must be > 0)

Factory Setting:
As per order, otherwise 1

Note!
- The appropriate unit is taken from the UNIT DENSITY function (8.2.2).
- If the value in this function is changed, we recommend you reset the totalizers.

REFERENCE PRESSURE

Note!
This function is not available unless the REAL GAS, COMPRESSED AIR or NATURAL GAS NX-19 option was selected in the SELECT FLUID function.

Use this function to enter the reference pressure of the fluid for calculating the operating density of real gas and natural gas NX-19 (formula for calculation, see SELECT FLUID function), as well as for the standard volume calculation of compressed air and natural gas NX-19.

User Input:
5-digit floating-point number (Entry value must be > 0)

Factory Setting:
1.0000

Note!
The appropriate unit is taken from the UNIT PRESSURE function (8.2.2).

REFERENCE TEMPERATURE

Note!
This function is not available unless the WATER, REAL GAS, COMPRESSED AIR or NATURAL GAS NX-19 option was selected in the SELECT FLUID function.

Use this function to enter the reference temperature of the fluid for calculating the operating density of real gas and natural gas NX-19 (formula for calculation, see SELECT FLUID function), as well as for the standard volume calculation of compressed air and natural gas NX-19.

User Input:
5-digit floating-point number

Factory Setting:
0 °C (converted to the selected UNIT TEMPERATURE)

Note!
The appropriate unit is taken from the UNIT TEMPERATURE function (8.2.2).

Caution!
This setting does not change the permitted temperature range of the measuring system. Please pay particular attention to the temperature application limits specified in the product specification.

8.2.13 Function Description FLOW COMPUTER

REFERENCE Z-FACTOR

Note!
This function is not available unless the REAL GAS option was selected in the SELECT FLUID function.

Use this function to enter the Z-factor for gas under reference conditions. The values defined in the REFERENCE PRESSURE and REFERENCE TEMPERATURE functions apply as the reference conditions (formula for calculation, see SELECT FLUID function)

The real gas constant Z indicates how far a real gas differs from an ideal gas that exactly fulfills the general gas law (p x V / T = constant, Z = 1). The real gas constant approaches the value 1 the further the real gas is from its liquefaction point.

User Input:
5-digit floating-point number (Entry value must be > 0)

Factory Setting:
1.0000

SPECIFIC DENSITY

Note!
This function is not available unless the NATURAL GAS NX-19 option was selected in the SELECT FLUID function.

Use this function to enter the specific density of natural gas (ratio of density of natural gas at reference conditions to density of air at reference conditions).

User Input:
5-digit floating-point number

Factory Setting:
0.6640

Note!
The values entered in the SPECIFIC DENSITY, MOL-% N2 and MOL-% CO2 functions are interdependent. For this reason, if the value is changed in one of these functions, the values in the other functions should be adjusted accordingly.

MOL-% N2

Note!
This function is not available unless the NATURAL GAS NX-19 option was selected in the SELECT FLUID function.

Use this function to enter the mol-% nitrogen in the expected natural gas mixture.

User Input:
5-digit floating-point number

Factory Setting:
0.0000%

Note!
The values entered in the SPECIFIC DENSITY, MOL-% N2 and MOL-% CO2 functions are interdependent. For this reason, if the value is changed in one of these functions, the values in the other functions should be adjusted accordingly.

8.2.13 Function Description FLOW COMPUTER

MOL-% CO2

Note!
This function is not available unless the NATURAL GAS NX-19 option was selected in the SELECT FLUID function.

Use this function to enter the mol-% carbon dioxide in the expected natural gas mixture.

User Input:
5-digit floating-point number

Factory Setting:
0.6640

Note!
The values entered in the SPECIFIC DENSITY, MOL-% N2 and MOL-% CO2 functions are interdependent. For this reason, if the value is changed in one of these functions, the values in the other functions should be adjusted accordingly.

8.2.14 Sample values for the functions: TEMPERATURE VALUE, DENSITY VALUE and EXPANSION COEFFICIENT

The calculation of the density for customer-defined liquids is better the nearer the operating temperature is to the particular value in the temperature value column. If the operating temperature deviates a lot from the value in the temperature value column, the expansion coefficient should be calculated as per the formula in 8.2.13.

Fluid (liquid)	**Temperature Value** (K)	**Density Value** (kg/m^3)	**Expansion Coefficient** (10^{-4} 1/K)
Air	123.15	594	18.76
Ammonia	298.15	602	25
Argon	133.15	1028	111.3
n-butane	298.15	573	20.7
Carbon Dioxide	298.15	713	106.6
Chlorine	298.15	1398	21.9
Cyclohexane	298.15	773	11.6
n-decane	298.15	728	10.2
Ethane	298.15	315	175.3
Ethylene	298.15	386	87.7
n-heptane	298.15	351	12.4
n-hexane	298.15	656	13.8
Hydrogen Chloride	298.15	796	70.9
i-butane	298.15	552	22.5
Methane	163.15	331	73.5
Nitrogen	93.15	729	75.3
n-octane	298.15	699	11.1
Oxygen	133.15	876	95.4
n-pentane	298.15	621	16.2
Propane	298.15	493	32.1
Vinyl Chloride	298.15	903	19.3

Table values from Carl L. Yaws (2001): Matheson Gas Data Book, 7th edition

For Conversion into US Imperial units:

Temperature value: $°F = 1.8 \times K - 459.67$
Density value: $lb/ft^3 = 0.06243 \times kg/m^3$
Expansion coefficient: $1/°F = 1/K \div 1.8$

8.2.15 Group SYSTEM PARAMETER

8.2.15 Function Description SYSTEM PARAMETER

POSITIVE ZERO RETURN

Use this function to interrupt evaluation of measured variables. This is necessary when a pipe is being cleaned, for example. The setting acts on all functions and outputs of the measuring device. If positive zero return is active, the notice message #601 “POS. ZERO-RET.” is displayed (11.2).

Options:
OFF
ON (signal output is set to the value for zero flow)

Factory Setting:
OFF

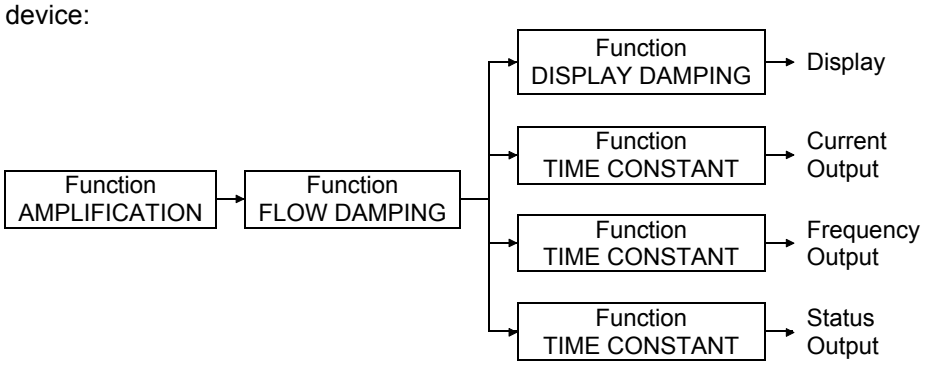
FLOW DAMPING

For setting the filter depth. This reduces the sensitivity of the measuring signal to interference peaks (e.g. in the event of high solids content, gas bubbles in the fluid, etc.). The measuring system reaction time increases with the filter setting.

Options:
0 – 100 s

Factory Setting:
1 s

Note!
The flow damping acts on the following functions and outputs of the measuring device:



8.2.16 Group SENSOR DATA

8.2.16 Function Description SENSOR DATA

All sensor data such as the calibration factor, nominal diameter etc. are set at the factory.


Caution!

Caution!
Under normal circumstances these settings may not be changed because changes affect numerous functions of the entire measuring system, and the accuracy of the measuring system in particular.

Please contact your TLV representative if you have any questions on these functions.

K-FACTOR

The current calibration factor of the sensor appears on the display.

Display:
e.g. 100 P/l (pulse per litre)


Note!
The K-factor is also given on the nameplate, the sensor and the calibration protocol under “K-fct.”.

K-FACTOR COMPENSATED

The current compensated calibration factor of the sensor appears on the display.

The following are compensated:
- The temperature-dependent expansion of the sensor (TEMPERATURE COEFFICIENT function).
- Diameter steps in the inlet of the device (D MATING PIPE function 8.2.12).

Display:
e.g. 102 P/l (pulse per litre)

NOMINAL DIAMETER

The nominal diameter of the sensor appears on the display.

Display:
e.g. DN 25

METER BODY TYPE MB

The type of meter body (MB) of the sensor appears on the display.

Display:
e.g. 71


Note!
Use this function to specify the nominal diameter and the sensor type.

TEMPERATURE COEFFICIENT

The temperature effect on the calibration factor appears on the display. Due to changes in temperature, the meter body expands differently, depending on the material. The expansion has an effect on the K-factor

Display:
4.8800×10^{-5} / K (stainless steel)

8.2.16 Function Description SENSOR DATA

AMPLIFICATION

Devices are always optimally configured for the process conditions you specified. Under certain process conditions, however, interference signals (e.g. strong vibrations) can be suppressed or the measuring range extended by adjusting the amplification.

The amplification is configured as follows:
- A larger value can be entered for the amplification if the fluid is slow-flowing, the density is low and there are minor disturbance influences (e.g. plant vibrations).
- A smaller value can be entered for the amplification if the fluid is fast-flowing, the density is high and there are strong disturbance influences (e.g. plant vibrations).

Caution!
Incorrectly configured amplification can have the following effects:
- The measuring range is limited in such a way that small flows cannot be recorded or displayed. In this instance, the value for the amplification must be increased.
- Undesired interference signals are registered by the device, which means that a flow is recorded and displayed even if the fluid is at a standstill. In this instance, the value for the amplification must be reduced.

Options:
1 – 5 (1 = smallest amplification, 5 = largest amplification)

Factory Setting:
3

OFFSET T-SENSOR

Use this function to enter the zero offset value for the temperature sensor. The value entered in this function is added to the measured temperature value.

User Input:
-10 to 10 °C (-18 to 18 °F; converted to the selected UNIT TEMPERATURE)

Display:
0.00 °C

CABLE LENGTH

Use this function to enter the cable length for the remote version.

Note!
- A cable length of 0 m is specified for the compact version.
- If the cable supplied for connecting the device is shortened, the new cable length must be entered here in this function. The cable length can be rounded up or off since the value entered is in steps of a meter (example: new cable length = 7.81 m → value entered = 8 m).

User Input:
0 – 30 m or 0 – 98 ft

Unit:
The unit depends on the option selected in the UNIT LENGTH function (8.2.2).
→ “m” if UNIT LENGTH = “mm”; “ft” if UNIT LENGTH = “inch”

Factory Setting:
- Compact Version: 0 m/0 ft
- Remote Version: 10 m/30 ft or 30 m/98 ft (depends on specification code)

8.2.17 Group SUPERVISION

8.2.17 Function Description SUPERVISION

ACTUAL SYSTEM CONDITION

The current system status appears on the display.

Display:
"SYSTEM OK" or the fault/notice message with the highest priority

PREVIOUS SYSTEM CONDITIONS

The last 16 fault and notice messages appear on the display.

ASSIGN SYSTEM ERROR

All system errors appear on the display. If you select a single system error you can change its error category.

Display:
List of system errors

Note!
- Each individual message can be selected using the ⊞ and ⊟ key.
- If the E key is pressed twice, the ERROR CATEGORY function is called up.
- Use the ⊞+E key combination or select "CANCEL" (in the system error list) to exit the function.

ERROR CATEGORY (from ASSIGN SYSTEM ERROR)

Use this function to define whether a system error triggers a notice message or a fault message. If you select "FAULT MESSAGES", all outputs respond to an error in accordance with their defined failsafe mode.

Options:
NOTICE MESSAGE (display only)
FAULT MESSAGE (outputs and display)

Note!
- If the E key is pressed twice, the ASSIGN SYSTEM ERROR function is called up.
- Use the ⊞+E key combination to exit the function.

ASSIGN PROCESS ERROR

All process errors appear on the display. If you select a single process error you can change its error category.

Display:
List of system errors

Note!
- Each individual message can be selected using the ⊞ and ⊟ key.
- If the E key is pressed twice, the ERROR CATEGORY function is called up.
- Use the ⊞+E key combination or select "CANCEL" (in the system error list) to exit the function.

8.2.17 Function Description SUPERVISION

ERROR CATEGORY (from ASSIGN PROCESS ERROR)

Use this function to define whether a system error triggers a notice message or a fault message. If you select “FAULT MESSAGES”, all outputs respond to an error in accordance with their defined failsafe mode.

Options:
NOTICE MESSAGE (display only)
FAULT MESSAGE (outputs and display)

Note!
- If the E key is pressed twice, the ASSIGN PROCESS ERROR function is called up.
- Use the key combination to exit the function.

ALARM DELAY

Use this function to define a time span for which the criteria for an error have to be satisfied without interruption before a fault or notice message is generated. Depending on the setting and the type of error, this suppression acts on the display, the current output and the frequency output.

User Input:
0 – 100 s (in steps of one second)

Factory Setting:
0 s

Caution!
If this function is used, fault and notice messages are delayed by the time corresponding to the setting before being forwarded to the higher-level controller (PCS, etc.). It is therefore imperative to check in advance whether a delay of this nature could affect the safety requirements of the process. If fault and notice messages may not be suppressed, a value of 0 seconds must be entered here.

SYSTEM RESET

Use this function to reset the measuring system.

Options:
NO
RESTART SYSTEM → Restart without disconnecting main power.
RESET DELIVERY → Restart without disconnecting main power, the saved settings of the delivery status (factory settings) are applied.

Factory Setting:
NO

OPERATION HOURS

The hours of operation of the device appear on the display.

Display:
Depends on the number of hours of operation elapsed:
– If hours of operation < 10 hours → display format = 0:00:00 (hr:min:sec)
– If hours of operation 10 – 10,000 hours → display format = 0000:00 (hr:min)
– If hours of operation < 10,000 hours → display format = 000000 (hr)

8.2.18 Group SIMULATION

8.2.18 Function Description SIMULATION

SIMULATION FAILSAFE MODE

Use this function to set all inputs, outputs and the totalizer to their error-response modes, in order to check whether they respond correctly. During this time, the message #691 “SIM. FAILSAFE” appears on the display.

Options:
OFF
ON

Factory Setting:
OFF

Caution!
The setting is not saved if the power supply fails.

SIMULATION MEASURAND

Use this function to set all inputs, outputs and the totalizer to their defined flow-response modes, in order to check whether they respond correctly. During this time, the message “#692 SIM. MEASURAND” appears on the display.

Options:
OFF
VOLUME FLOW
TEMPERATURE
MASS FLOW
CORRECTED VOLUME FLOW
HEAT FLOW

Factory Setting:
OFF

Caution!
- The measuring device can only be used for measuring to a certain extent while the simulation is in progress.
- The setting is not saved if the power supply fails.

VALUE SIMULATION MEASURAND

Note!
This function is not available unless the SIMULATION MEASURAND function is active.

Use this function to specify a selectable value (e.g. 12 dm³/s). This value is used to test downstream devices and the measuring device itself.

User Input:
5-digit floating-point number

Factory Setting:
0

Note!
The unit depends on the option selected in the SIMULATION MEASURAND function and is taken from the related function (8.2.2).

Caution!
The setting is not saved if the power supply fails.

8.2.19 Group SENSOR VERSION

8.2.19 Function Description SENSOR VERSION

SERIAL NUMBER

The serial number of the sensor appears on the display.

SENSOR TYPE

The sensor type appears on the display.

SERIAL NUMBER DSC SENSOR

The serial number of the DSC sensor appears on the display.

8.2.20 Group AMPLIFIER VERSION

8.2.20 Function Description AMPLIFIER VERSION

HARDWARE REVISION NUMBER AMPLIFIER

The hardware revision number of the amplifier appears on the display.

SOFTWARE REVISION NUMBER AMPLIFIER

The software revision number of the amplifier appears on the display.

Note!
You can also read off the software revision number of the amplifier from the service plate in the electronics compartment cover.

HARDWARE REVISION NUMBER I/O MODULE

The hardware revision number of the I/O module appears on the display.

8.2.21 Group ADVANCED DIAGNOSIS (optional)

8.2.21 Function Description ADVANCED DIAGNOSIS

MIN T FLUID

Smallest fluid temperature measured since the last reset (RESET T FLUID function).

Display:
5-digit floating-point number, with unit and sign
(e.g. 95.3 °C)

MAX T FLUID

Largest fluid temperature measured since the last reset (RESET T FLUID function).

Display:
5-digit floating-point number, with unit and sign
(e.g. 218.1°C)

8.2.21 Function Description ADVANCED DIAGNOSIS

RESET T FLUID

Resets the values in the MIN T FLUID and MAX T FLUID functions.

Options:
NO
YES

Factory Setting:
NO

WARN T FLUID LO

Use this function to enter the lower limit value for monitoring the fluid temperature. This limit value is used to generate a fault message that should indicate a change in the temperature of the fluid in the direction of the specification limits of the device in order to prevent device failure or prevent the process undercooling.

User Input:
5-digit floating-point number, including sign

Factory Setting:
-202 °C (converted to the selected UNIT TEMPERATURE)

Note!
The appropriate unit is taken from the UNIT TEMPERATURE function (8.2.2).

WARN T FLUID HI

Use this function to enter the upper limit value for monitoring the fluid temperature. This limit value is used to generate a fault message that should indicate a change in the temperature of the fluid in the direction of the specification limits of the device in order to prevent device failure or prevent the process overheating.

User Input:
5-digit floating-point number, including sign

Factory Setting:
402 °C (converted to the selected UNIT TEMPERATURE)

Note!
The appropriate unit is taken from the UNIT TEMPERATURE function (8.2.2).

ELECTRONICS TEMPERATURE

The temperature on the electronics board currently measured appears on the display.

Display:
4-digit floating-point number, with unit and sign
(e.g. -23.5 °C)

MIN T ELECTRONICS

Smallest electronics board temperature measured since the last reset (RESET T ELECTRONICS function).

Display:
5-digit floating-point number, including unit and sign.
(e.g. 20.2 °C)

8.2.21 Function Description ADVANCED DIAGNOSIS

MAX T ELECTRONICS

Largest electronics board temperature measured since the last reset (RESET T ELECTRONICS function).

Display:
5-digit floating-point number, including unit and sign
(e.g. 65.3 °C)

RESET T ELECTRONICS

Resets the values in the MIN T ELECTRONICS and MAX T ELECTRONICS functions.

Options:
NO
YES

Factory Setting:
NO

WARN T ELECTRONICS LO

Use this function to enter the lower limit value for monitoring the temperature on the electronics board. This limit value is used to generate a fault message that should indicate a change in the temperature in the direction of the specification limits of the device in order to prevent device failure.

User Input:
5-digit floating-point number, including sign

Factory Setting:
-41 °C (converted to the selected UNIT TEMPERATURE)

Note!
The appropriate unit is taken from the UNIT TEMPERATURE function (8.2.2).

WARN T ELECTRONICS HI

Use this function to enter the upper limit value for monitoring the temperature on the electronics board. This limit value is used to generate a fault message that should indicate a change in the temperature in the direction of the specification limits of the device in order to prevent device failure.

User Input:
5-digit floating-point number, including sign

Factory Setting:
86 °C (converted to the selected UNIT TEMPERATURE)

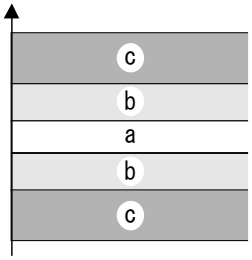
Note!
The appropriate unit is taken from the UNIT TEMPERATURE function (8.2.2).

8.2.21 Function Description ADVANCED DIAGNOSIS

SENSOR DIAGNOSIS

Monitoring of the capacitive signal of the DSC sensor. The system checks in which area the capacitive signal of the DSC sensor is located (see graphic):

a = Signal correct
b = Warning prior to meas. failure → error mess. #395 DSC SENS LIMIT
c = Measurement failure → error message #394 DSC SENS DEFCT



Options:
OFF (error message #395 DSC SENS LIMIT is switched off)
STANDARD

Factory Setting:
STANDARD

REYNOLDS NUMBER

Note!
This function is not available unless the SATURATED STEAM, SUPERHEATED STEAM, NATURAL GAS NX-19, WATER or COMPRESSED AIR option was selected in the SELECT FLUID function.

The Reynolds number appears on the display. The Reynolds number is determined using the selected fluid and the measured temperature.

Display:
8-digit fixed-point number
(e.g. 25800)

REYNOLDS WARNING

Note!
This function is not available unless the SATURATED STEAM, SUPERHEATED STEAM, NATURAL GAS NX-19, WATER or COMPRESSED AIR option was selected in the SELECT FLUID function.

Use this function to activate monitoring of the Reynolds number. If a Reynolds number of < 20,000 is determined during active monitoring, a notice message #494 RE < 20000 is displayed (11.3).

Note!
- With a Reynolds number of < 20,000, reduced accuracy of the device must be reckoned with.
- There is no fault message at zero flow.
- The notice message does not appear if the REYNOLDS NUMBER option was selected in the ASSIGN LOW FLOW CUT OFF function.

Options:
OFF (function switched off)
ON

Factory Setting:
OFF

8.2.21 Function Description ADVANCED DIAGNOSIS

VELOCITY WARNING

Use this function to activate monitoring of the fluid velocity. If, during active monitoring, the fluid velocity exceeds the value for the limit velocity, a notice message is displayed.

Options:
OFF (function switched off)
ON

Factory Setting:
OFF

LIMIT VELOCITY

Use this function to specify the maximum fluid velocity. If the specified maximum fluid velocity is overshot, the fault message #421 FLOW RANGE (11.3) is output.

User Input:
5-digit floating-point number

Factory Setting:
75 m/s (converted to the selected UNIT LENGTH)

Note!
The unit depends on the option selected in the UNIT LENGTH function (8.2.2).
→ “m/s” if UNIT LENGTH = “mm”; “ft/s” if UNIT LENGTH = “inch”

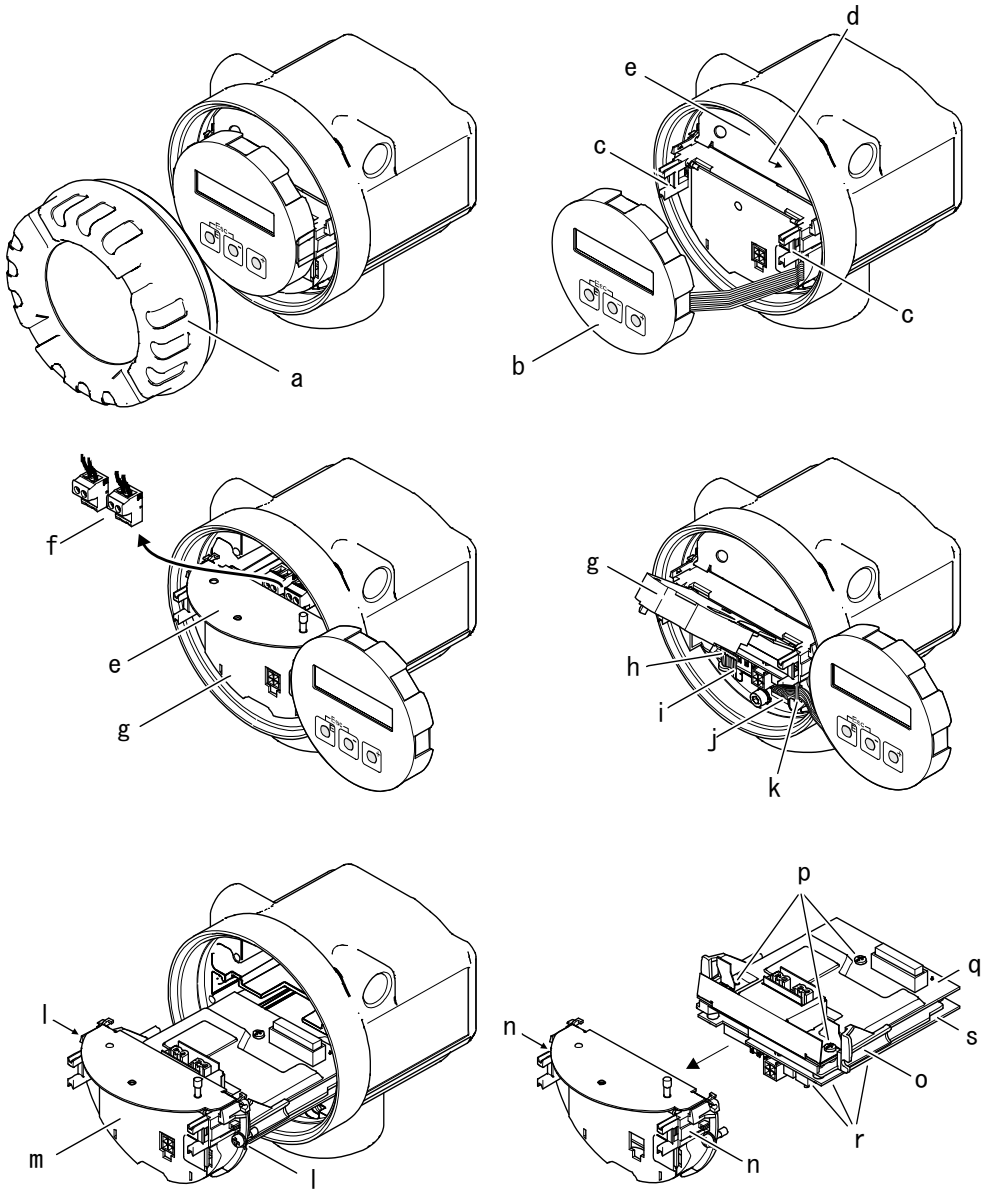
9 Installing and Removing Electronics Boards


Caution!

Caution!
- Risk of damaging electronic components (ESD protection). Static electricity can damage electronic components or impair their operability. Use a workplace with a grounded working surface, purpose-built for electrostatically sensitive devices!
- Use only TLV supplied parts.

Procedure when installing/removing electronics boards (see Fig. 26)

1. Unscrew the cover (a) of the electronics compartment from the transmitter housing.
2. Remove the local display module (b) from the retaining rails (c).
3. Fit the local display module (b) with the left side onto the right retaining rail (c) (this secures the local display module).
4. Loosen the fixing screw (d) of the cover of the connection compartment (e) and fold down the cover.
5. Pull terminal connector (f) out of the I/O board (COM module) (q).
6. Fold up the plastic cover (g).
7. Remove the signal cable connector (h) from the ampifier board (s) and release from the cable holder (i).
8. Remove the ribbon cable connector (j) from the amplifier board (s) and release from the cable holder (k).
9. Remove the local display module (b) from the right retaining rail (c).
10. Fold down the plastic cover (g) again.
11. Release both screws (l) of the board holder (m).
12. Pull the board holder (m) out completely.
13. Press the side latches (n) of the board holder and separate the board holder (m) from the board body (o).
14. Replace the I/O board (COM module) (q):
    – Loosen the three fixing screws (p) of the I/O board (COM module).
    – Remove the I/O board (COM module) (q) from the board body (o).
    – Set a new I/O board (COM module) on the board body.
15. Replace the amplifier board (s):
    – Loosen fixing screws (r) of the amplifier board.
    – Remove the amplifier board (s) from the board body (o).
    – Set a new amplifier board on the board body.
16. Installation is the reverse of the removal procedure.



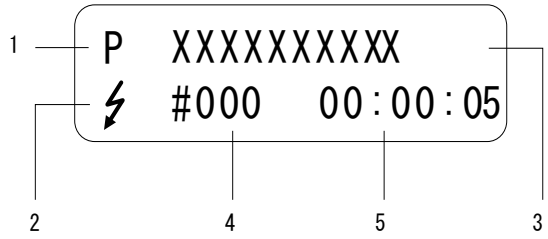
a) Cover of electronics compartment
b) Local display module
c) Retaining rails of local display module
d) Fixing screws for cover of connection compartment
e) Connection compartment cover
f) Terminal connector
g) Plastic cover
h) Signal cable connector
i) Retainer for signal cable connector
j) Display module ribbon-cable connector
k) Retainer for ribbon-cable connector
l) Board holder threaded connection
m) Board holder
n) Board holder latches
o) Board body
p) I/O board (COM module) threaded connection
q) I/O board (COM module)
r) Amplifier board threaded connection
s) Amplifier board

Figure 26
Installing and removing electronics boards

10 Error Message Display

Type of Error
Errors which occur during commissioning or measuring operation are displayed immediately. If two or more system or process errors occur, the error with the highest priority is always the one shown on the display. The measuring system distinguishes between two types of error:

- *System error:* this group includes all device errors, for example communication errors, hardware errors, etc. (11.2)
- *Process error:* this group includes all application errors, for example “DSC SENSOR LIMIT” , etc. (11.2)



1) Type of error: P = Process error, S = System error
2) Error message type: ϟ = Fault message, ! = Notice message (definition: see below)
3) Error designation: e.g. DSC SENS LIMIT = Device being operated near application limits
4) Error number: e.g. #395
5) Duration of last error occurrence (in hours, minutes and seconds) , display format - see OPERATION HOURS function (8.2.17)

Figure 27
Error messages on the display (example)

Type of Error Message
Users have the option of weighting system and process errors differently by defining them as Fault messages or Notice messages. This is specified via the function matrix (see SUPERVISION function group, 8.2.17)

Serious system errors, e.g. electronic module defects, are always categorised and displayed as “Fault messages” by the measuring device.

Notice message (!)
- Displayed as → exclamation mark (!), error group (S: system error, P: process error)
- The error in question has no effect on the inputs or outputs of the measuring device.

Fault message (ϟ)
- Displayed as → lightning flash (ϟ), error group (S: system error, P: process error)
- The error in question has a direct effect on the inputs or outputs. The response of the inputs/outputs (failsafe mode) can be defined by means of functions in the function matrix (8.2.9).


Note!

Note!
Error messages can be output via the current output in accordance with NAMUR NE 43.

11 Troubleshooting

11.1 Troubleshooting Instructions

Always start trouble-shooting with the checklists below if faults occur after start-up or during operation. This takes you directly (via various queries) to the cause of the problem and the appropriate remedial measures.

Check the Display	
No display visible and no output signals present	1. Check supply voltage → Terminal 1, 2 2. Display module defective → contact TLV
No display visible but output signals are present	1. Check whether the ribbon-cable connector of the display module is correctly plugged into the amplifier board → see section 9 2. Display module defective → contact TLV 3. Electronics defective → contact TLV
Display texts are in a foreign language.	Switch off power supply. Press and hold down both the +/– keys and switch on the measuring device again. The display text will appear in English and is displayed at 50% contrast.
Measured value indicated, but no signal output at the current or pulse output	Electronics board defective → contact TLV

▼

Error Messages on Display	
Errors which occur during commissioning or operation are displayed immediately or once the set delay time has elapsed (see ALARM DELAY function, 8.2.17). Error messages consist of a variety of icons. The meanings of these icons are as follows (example): – Type of error: **S** = System error, **P** = Process error – Error message type: ϟ = Fault message, **!** = Notice message – **DSC SENS LIMIT** = Error designation (device being operated near application limits) – **03:00:05** = Duration of most recent error occurrence (in hours, minutes and seconds), display format (see OPERATION HOURS function, 8.2.17). – **#395** = Error number Caution! • Please refer also to the information in section 10. • The measuring system interprets simulations and positive zero return as system errors, but displays them as notice messages only.	
Error number: 001 – 400 601 – 699	System error (device error) has occurred (see 11.2)
Error number: 500 – 600 700 – 750	Process error (application error) has occurred (see 11.2)

▼

Other Errors (without error message)	
Some other error has occurred.	Diagnosis and remedial measures (see 11.4)

11.2 System Error Messages


Caution!

Caution!
In the event of a serious fault, a flowmeter might have to be returned to the manufacturer for repair. In such cases, the proper procedures (1.4) must be carried out before you return the measuring device to TLV.

Type	Error Message/No.	Cause	Remedy
Serious system errors are always recognized by the device as “fault messages” and are indicated with a lightning flash (ϟ) on the display! Fault messages have a direct effect on the inputs and outputs. Simulations and positive zero return, on the other hand, are only classed and displayed as “notice messages”. Please pay attention to the information in sections 10 and 11.5 S = System error ϟ = Fault message (with an effect on the inputs and outputs), ! = Notice message (without an effect on the inputs and outputs)			
S ϟ	CRITICAL FAIL. # 001	Serious device error	Replace the amplifier board.
S ϟ	AMP HW EEPROM # 011	Amplifier: Faulty EEPROM	Replace the amplifier board.
S ϟ	AMP SW EEPROM # 012	Amplifier: Error when accessing EEPROM data.	Contact TLV
S ϟ	COM HW EEPROM # 021	COM module: Faulty EEPROM	Replace COM module.
S ϟ	COM SW EEPROM # 022	COM module: Error when accessing EEPROM data.	Contact TLV.
S ϟ	CHECKSUM TOT. # 111	Totalizer checksum error.	Replace the amplifier board.
S !	PT DSC BROKEN # 310	The temperature sensor is faulty. Temperature measurement becomes inaccurate and total failure of the temperature sensor (#316) must be reckoned with.	Contact TLV.
S !	SHORT C. PT DSC # 311		
S !	PT DSC BROKEN # 312		
S !	SHORT C. PT DSC # 313		
S !	PT ELECT BROKEN # 314	The temperature sensor is defective and temperature measurement is no longer possible. The device uses the value specified in the ERROR -> TEMPERATURE function (8.2.13).	Replace the amplifier board.
S !	SHORT C. PT EL # 315		
S ϟ	NO T SENSOR # 316	The temperature sensor has failed and no temperature sensor is present. The device uses the value specified in the ERROR -> TEMPERATURE function (8.2.13).	Contact TLV.
S ϟ	CHECK T SENSOR # 317	The self-monitoring function of the device has detected an error in the DSC sensor that can have an effect on the temperature measurement. ✎ Note! The mass flow is calculated with the value entered for the temperature in the ERROR -> TEMPERATURE function (8.2.13).	Contact TLV.

Type	Error Message/No.	Cause	Remedy
S ↯	CHECK SENSOR # 318	The self-monitoring function of the device has detected an error in the DSC sensor that can have an effect on the flow and temperature measurements. ✎ Note! The mass flow is calculated with the value entered for the temperature in the ERROR -> TEMPERATURE function (8.2.13).	Contact TLV. ✎ Note! In the ASSIGN SYSTEM ERROR function (8.2.17), the error status can be changed from a fault message to a notice message. Please note that although this means a measured value is output again, the error must still be eliminated.
S ↯	CURRENT RANGE # 351	Current output: The current flow is outside the set range.	1. Change full-scale value entered. 2. Reduce flow.
S ↯	FREQ. RANGE # 355	Frequency output: The current flow is outside the set range.	1. Change full-scale value entered. 2. Reduce flow.
S !	PULSE RANGE # 359	Pulse output: The pulse output frequency is outside the set range.	1. Increase pulse value. 2. When entering the pulse width, select a value that can still be processed by a connected totalizer (e.g. mechanical totalizer, PLC, etc.). Determine pulse width: – Method 1: enter the minimum time for which a pulse has to be present at a connected totalizer in order to be recorded. – Method 2: enter the maximum (pulse) frequency as a half “reciprocal value” for which a pulse has to be present at a connected totalizer in order to be recorded. Example: the maximum input frequency of the connected totalizer is 10 Hz. The pulse width to be entered is: (1 / (2·10 Hz)) = 50 ms. 3. Reduce flow.
S ↯	RESONANCE DSC # 379	The device is being operated in the resonance frequency. ☝ Caution! If the device is operated in the resonance frequency, this can result in damage that can lead to complete device failure.	Reduce the flow.
S ↯	FLUIDTEMP. MIN # 381	The limit value for the minimum permissible fluid temperature is undershot	Increase the fluid temperature.
S ↯	FLUIDTEMP. MAX # 382	The limit value for the maximum permissible fluid temperature is overshot.	Reduce the fluid temperature.
S ↯	DSC SENS DEFCT # 394	The DSC sensor is defective, measurement no longer takes place.	Contact TLV.
S !	DSC SENS LIMIT # 395	The DSC sensor is being operated near application limits, device failure is probable soon.	If this message is permanently displayed, contact TLV.

Type	Error Message/No.	Cause	Remedy
S ↯	SIGNAL>LOW PASS # 396	The device finds the signal outside the set filter range. Possible causes: • The flow is outside the measuring range. • The signal is caused by a strong vibration that is intentionally not measured and is outside the measuring range.	• Check whether the device was installed in the flow direction. • Check whether the right option was selected in the SELECT FLUID function (8.2.13). • Check whether the operating conditions are within the specifications of the measuring device (e.g. flow is above measuring range which means that the flow may have to be reduced). If the checks do not solve the problem, contact TLV.
S ↯	T ELECTR. MIN. # 397	The limit value for the minimum permissible ambient temperature is undershot.	• Check whether the device has been correctly insulated (3.3.3). • Check whether the transmitter is pointing upwards or to the side (3.3.2). • Increase the ambient temperature.
S ↯	T ELECTR. MAX. # 398	The limit value for the maximum permissible ambient temperature is overshot	• Check whether the device has been correctly insulated (3.3.3). • Check whether the transmitter is pointing downwards or to the side (3.3.2). • Reduce the ambient temperature.
S ↯	PREAMP. DISCONN. # 399	Pre-amplifier disconnected.	Check whether the connection between the preamplifier and amplifier board is established and correct and establish connection if necessary.
S !	SW. UPDATE ACT. # 501	Loading a new amplifier software version or data into the device. No other commands possible at this point.	Wait until the procedure is complete and then restart the device.
S !	UP./DOWNLOAD ACT. # 502	Uploading the device data. No other commands possible at this point.	Wait until the procedure is complete.
S !	NO DATA—↯ ->CURRENT # 511	The current output is not receiving any valid data	• Run the “Commissioning” Quick Setup (7.2.2). • Check the option selected in the ASSIGN CURRENT function (8.2.8).
S !	NO DATA—↯ ->FREQ. # 512	The frequency output is not receiving any valid data.	• Run the “Commissioning” Quick Setup (7.2.2). • Check the option selected in the ASSIGN FREQUENCY function (8.2.9).
S !	NO DATA—↯ ->PULSE # 513	The pulse output is not receiving any valid data.	• Run the “Commissioning” Quick Setup (7.2.2). • Check the option selected in the ASSIGN PULSE function (8.2.9).
S !	NO DATA—↯ ->STAT. # 514	The status output is not receiving any valid data.	• Run the “Commissioning” Quick Setup (7.2.2). • Check the option selected in the ASSIGN STATUS function (8.2.9).

Type	Error Message/No.	Cause	Remedy
S !	NO DATA—ϟ ->DISP. # 515	The display is not receiving any valid data.	• Run the “Commissioning” Quick Setup (7.2.2). • Check the option selected in the ASSIGN LINE 1 and ASSIGN LINE 2 functions (8.2.5).
S !	NO DATA—ϟ —>TOT.1 # 516	Totalizer 1is not receiving any valid data.	• Run the “Commissioning” Quick Setup (7.2.2). • Check the option selected in the ASSIGN TOTALIZER 1 function (8.2.6).
S !	NO DATA—ϟ —>TOT.2 # 517	Totalizer 2is not receiving any valid data.	• Run the “Commissioning” Quick Setup (7.2.2). • Check the option selected in the ASSIGN TOTALIZER 2 function (8.2.6).
S !	POS. ZERO-RET. # 601	Positive zero return is active. ☝ Caution! This message has the highest display priority.	Switch off positive zero return.
S !	SIM. CURR. OUT. # 611	Current output simulation is active.	Switch off simulation.
S !	SIM. FREQ. OUT. # 621	Simulation frequency output is active.	Switch off simulation.
S !	SIM. PULSE # 631	Pulse output simulation is active.	Switch off simulation.
S !	SIM. STAT. OUT. # 641	Status output simulation is active.	Switch off simulation.
S !	SIM. FAILSAFE # 691	Simulation of failsafe mode (outputs) is active.	Switch off simulation.
S !	SIM. MEASURAND # 692	Simulation of a measured variable is active.	Switch off simulation.
S !	DEV. TEST ACT. # 698	The measuring device is being checked onsite via the test and simulation device.	—
S !	CURR. ADJUST # 699	Current adjustment is active.	Quite current adjustment.

11.3 Process Error Messages

Process errors can be defined as either “Fault” or “Notice” messages and can thereby be weighted differently. Determination of this is done via the function matrix (see 8.2 Description of Functions).


Note!

Note!
- The listed error message types below correspond to the factory setting.
- Also observe the information in sections 10 and 11.5.

Type	Error Message/No.	Cause	Remedy
P = Process error ↯ = Fault message (with an effect on the inputs and outputs), ! = Notice message (without an effect on the inputs and outputs)			
P !	P, T—>DATA—↯ # 412	No data are stored in the device for the combination of current values for medium pressure and fluid temperature.	• Check the option selected in the SELECT FLUID function (8.2.13). • Check whether the correct pressure was entered in the OPERATING PRESSURE function (8.2.13).
P !	FLOW RANGE # 421	The current flow velocity overshoots the limit value specified in the MAXIMUM VELOCITY function (8.2.12).	Reduce the flow.
P !	Reynolds<20000 # 494	The Reynolds number of 20 000 is undershot. If the Reynolds number is < 20 000, the accuracy is reduced.	Increase the flow.

11.4 Process Errors Without Messages

Symptoms	Remedy
Note! You may have to change or correct settings in certain functions of the function matrix in order to rectify faults. The functions outlined below, such as AMPLIFICATION etc. are described in detail in the section 8.2 Description of Functions.	
No flow signal	• For liquids: Check whether the piping is completely filled. The piping must always be completely filled for accurate and reliable flow measurement. • Check whether all the packaging material, including the meter body protective covers, was completely removed before mounting the device. • Check whether the desired electrical output signal was connected correctly. • Flow rate is below measurable range.
Flow signal even though there is no flow Flow displayed is unstable or correct flow is not displayed.	Check whether the device is exposed to particularly strong vibrations. If so, a flow can be displayed even if the fluid is at a standstill or incorrect flow is displayed, depending on the frequency and direction of the vibration. Remedial measures at the device: • Turn the sensor 90° (please observe the installation conditions when doing so, see 3.3.2). The measuring system is most sensitive to vibrations that follow in the direction of the sensor. Vibrations have less of an effect on the device in the other axes. • The amplification can be altered using the AMPLIFICATION function (8.2.16). Remedy through constructive measures during installation: • If the source of the vibration (e.g. pump or a valve) has been identified, the vibrations can be reduced by decoupling or supporting the source. • Support the piping near the device.

Symptoms	Remedy
Faulty or highly-fluctuating flow signal	• The fluid is not sufficiently single-phase or homogeneous. The piping must always be completely filled and the fluid must be single-phase and homogeneous for accurate and reliable flow measurement. • In many instances, the following measures can be taken to improve the measurement result even under non-ideal conditions: – For liquids with a low gas content in horizontal pipework, it helps to install the device with the head pointing downwards or to the side. This improves the measuring signal since the sensor is not in the area where gas accumulates when this type of installation is used. – For liquids with a low solids content, avoid installing the device with the electronics housing pointing downwards. – For steam or gases with a low liquid content, avoid installing the device with the electronics housing pointing downwards. • The inlet and outlet runs must be present as per the installation instructions (3.3.1). • Suitable seals with an internal diameter not smaller than the pipe internal diameter must be installed and correctly centered. • The static pressure must be large enough to rule out cavitation in the area of the sensor. • Check whether the correct fluid was selected in the SELECT FLUID function (8.2.13). The setting in this function determines the filter settings and can thus have an effect on the measuring range. • Check whether the data for the K-factor on the nameplate match the data in the K-FACTOR function (8.2.16). • Check whether the device is correctly installed in the flow direction. • Check whether the nominal diameter of the mating pipe and the device match (8.2.12). • The flow must be in the measuring range of the device (6.1.3, 13.1). The start of measuring range depends on the density and the viscosity of the fluid. Density and viscosity depend on temperature. Density also depends on the process pressure in the case of gases. • Check whether the operating pressure is affected by pressure pulsations (e.g. from piston pumps). The pulsations can affect vortex shedding if they have a frequency similar to the vortex frequency. • Check whether the correct engineering unit was selected for the flow or totalizer. • Check whether the current output or pulse value was correctly set. • Configure the setting of the filter.
The fault cannot be rectified or some other fault not described above has occurred. (Contact TLV)	The following options are available for tackling problems of this nature: **Request the services of a TLV service technician** If you contact our service organisation to have a service technician sent out, please be ready with the following information: – A brief description of the error with information on the application. – Nameplate specifications: order code and serial number **Return devices to TLV** The proper procedures (1.5) must be carried out before you return a measuring device requiring repair or calibration to TLV.
The display shows “– – – –”	If an unassignable option is selected in the ASSIGN LINE 1 or ASSIGN LINE 2 function for the fluid selected (e.g. corrected volume flow option for saturated steam), “– – – –“ appears on the display. Select an option to suit the fluid in the ASSIGN LINE 1 or ASSIGN LINE 2 function (8.2.5).

11.5 Response of Outputs to Errors


Note!

Note!
The failsafe mode of the totalizers and the current, pulse and frequency outputs can be configured by means of various functions in the function matrix.

Positive zero return and error response:
You can use positive zero return to set the signals of the current, pulse and frequency outputs to their fallback value, for example when operation has to be interrupted while a pipe is being cleaned. This function has priority over all other device functions; simulations are suppressed, for example.

Response of Outputs and Totalizers to Errors		
	Process/system error present	Positive zero return activated
Caution! System or process errors defined as “notice messages” have no effect whatsoever on the inputs and outputs. Please refer also to the information in section 10.		
Current Output	*MIN. CURRENT:* Depends on the setting selected in the CURRENT RANGE function. If the current range is: 4-20 mA HART NAMUR → output current = 3.6 mA 4-20 mA HART US → output current = 3.75 mA *MAX. CURRENT:* 22.6 mA *HOLD VALUE:* Measured value output is based on the last measured value saved before the error occurred. *ACTUAL VALUE:* Measured value output is based on the current flow measurement. The fault is ignored.	Output signal corresponds to Zero flow
Frequency Output	*FALLBACK VALUE:* 0 Hz is output. *FAILSAFE VALUE:* The frequency specified in the FAILSAFE VALUE function is output. *HOLD VALUE:* Measured value output is based on the last measured value saved before the error occurred. *ACTUAL VALUE:* Measured value output is based on the current flow measurement. The fault is ignored.	Output signal corresponds to Zero flow
Pulse Output	*FALLBACK VALUE:* Signal output → output 0 pulse *HOLD VALUE:* Measured value output is based on the last valid flow data before the error occurred. *ACTUAL VALUE:* Measured value output is based on the current flow measurement. The fault is ignored.	Output signal corresponds to Zero flow
Status Output	In the event of a fault or power supply failure: Status output → not conductive	No effect on the status output
Totalizers 1 & 2	*STOP:* The totalizers stop at the last value before the alarm condition occurred. *HOLD VALUE:* The totalizers continue to count the flow on the basis of the last valid flow data (before the fault occurred). *ACTUAL VALUE:* The totalizers continue to count the flow on the basis of the current flow data. The fault is ignored.	The totalizers stop.

12 Factory Settings

System Units (see 8.2.2)

System Unit	Metric	US (North America)
Temperature	°C	°F
Density	kg/m^3	lb/ft^3
Specific Enthalpy	kWh/kg	Btu/lb
Length	mm	Inch

Language (see 8.2.4)

Country	Language	Country	Language
Australia	English	Malaysia	English
Austria	Deutsch	The Netherlands	Nederlands
Belgium	English	Norway	Norsk
Canada	English	Poland	Polski
China	English	Portugal	Portugues
Czech Republic	Ceski	Sweden	Svenska
Denmark	English	Switzerland	Deutsch
Finland	Suomi	Singapore	English
France	Francais	Spain	Espanol
Germany	Deutsch	South Africa	English
Hungary	English	Thailand	English
India	English	United Kingdom	English
Italy	Italiano	USA	English
Luxemburg	Francais	Other Countries	English

Unit for Totalizers 1 + 2 (see 8.2.6)

Totalizer Assignment	Metric	US (North America)
Volume Flow	m^3	US gal
Calculated Mass Flow	kg	lb
Corrected Volume Flow	Nm^3	scf
Heat Flow	kWh	KBtu

Switch-on point and Switch-off Point (see 8.2.9)
The factory settings in the table are given in the unit dm^3/s and US gal/min. If another unit is selected in the UNIT VOLUME FLOW function (8.2.2), the corresponding value is converted and displayed in the selected unit.

Nominal Diameter		Gas				Liquid			
		Switch-on Point		Switch-off Point		Switch-on Point		Switch-off Point	
(mm)	(in)	(dm^3/s)	(US gal/min)	(dm^3/s)	(US gal/min)	(dm^3/s)	(US gal/min)	(dm^3/s)	(US gal/min)
15	½	7.7	120	6.3	100	1.5	24	1.2	19
25	1	38	610	31	500	4.6	73	3.8	60
40	1½	94	1,500	77	1,200	11	180	9.2	150
50	2	160	2,500	130	2,000	19	300	15	240
80	3	350	5,600	290	4,600	42	6,700	35	550
100	4	610	9,700	500	7,900	73	1,200	60	950
150	6	1400	22,000	1100	18,000	170	2,600	140	2,200
200	8	2700	42,000	2200	35,000	320	5,100	260	4,100
250	10	4200	67,000	3400	54,000	500	8,000	410	6,500
300	12	6000	95,000	4900	78,000	720	11,000	590	9,400

13 Flow Rate Data

13.1 Flow Rate for Saturated Steam

Metric Tables (kg/h)

1 MPa = 10 bar

EF73 - Flangeless															
Size	15		25		40		50		80		100		150		Temp (°C)
Press. (MPaG)	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	
0.05	4.4	30	13	140	33	325	53	527	119	1187	203	2023	454	4531	111.6
0.1	5.0	40	14	183	38	424	61	689	136	1551	232	2643	519	5919	120.4
0.2	6.0	58	17	267	45	620	73	1006	165	2263	280	3856	627	8636	133.7
0.3	6.9	76	20	350	52	811	84	1316	188	2962	320	5047	717	11303	143.7
0.4	7.6	94	22	432	58	1000	93	1623	209	3652	356	6223	796	13936	151.9
0.5	8.3	112	24	512	63	1187	101	1927	228	4336	387	7388	867	16545	158.9
0.6	8.9	130	25	593	67	1373	109	2229	245	5015	417	8545	932	19136	165.0
0.7	9.5	147	27	673	72	1558	116	2529	261	5691	444	9697	993	21714	170.5
0.8	10	165	28	752	76	1743	123	2828	276	6364	469	10843	1050	24282	175.4
0.9	11	182	30	832	80	1927	129	3127	290	7035	493	11987	1104	26843	179.9
1.0	11	199	31	911	83	2110	135	3424	303	7705	516	13128	1156	29398	184.1
1.1	12	217	33	990	87	2293	141	3721	316	8374	538	14268	1205	31950	188.0
1.2	12	234	34	1069	90	2476	146	4018	328	9042	559	15406	1252	34499	191.6
1.3	13	251	35	1148	94	2659	152	4315	340	9710	580	16544	1297	37047	195.1
1.4	13	269	36	1227	97	2842	157	4612	352	10378	599	17682	1341	39595	198.3
1.5	14	286	37	1306	100	3025	162	4909	363	11046	618	18820	1384	42143	201.4
1.6	14	303	38	1385	103	3208	166	5206	374	11714	637	19959	1425	44693	204.3
1.7	14	321	39	1464	106	3391	171	5503	384	12383	654	21098	1464	47245	207.1
1.8	15	338	40	1543	108	3575	176	5801	395	13052	672	22239	1504	49799	209.8
1.9	15	355	41	1623	111	3758	180	6099	405	13723	689	23381	1542	52357	212.4
2.0	15	373	42	1702	114	3942	184	6397	414	14394	706	24525	1579	54918	214.9
2.1	16	390	43	1782	116	4126	189	6696	424	15066	722	25570	1626	57483	217.3
2.2	16	408	44	1861	119	4311	193	6995	433	15740	738	26818	1651	60052	219.6
2.3	17	425	45	1941	122	4496	197	7295	442	16414	753	27967	1686	62627	221.8
2.4	17	443	46	2021	124	4681	201	7596	451	17091	769	29119	1721	65206	224.0
2.5	17	460	47	2101	126	4866	205	7897	460	17768	784	30274	1755	67791	226.1
3.0	19	549	51	2505	137	5801	224	9413	502	21180	856	36087	1916	80810	235.7

EF73 - Flanged																					
Size	15		25		40		50		80		100		150		200		250		300		Temp (°C)
Press. (MPaG)	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	
0.05	3.1	21	9.4	108	27	267	45	446	101	1001	174	1735	396	3947	759	7577	1196	11945	1715	17133	111.6
0.1	3.5	28	11	142	31	349	52	583	115	1308	199	2266	452	5156	867	9897	1367	15603	1960	22380	120.4
0.2	4.3	41	13	207	37	510	62	850	139	1909	240	3307	546	7523	1047	14442	1651	22767	2368	32655	133.7
0.3	4.9	54	15	271	43	667	71	1113	159	2498	275	4328	624	9846	1198	18901	1889	29796	2709	42738	143.7
0.4	5.4	66	17	334	47	823	79	1372	176	3080	305	5336	693	12140	1330	23304	2097	36737	3008	52694	151.9
0.5	5.9	79	18	397	52	977	86	1629	192	3657	332	6335	755	14412	1450	27667	2285	43614	3277	62558	158.9
0.6	6.3	91	20	459	56	1130	92	1885	207	4230	357	7328	812	16669	1559	32000	2457	50445	3524	72356	165.0
0.7	6.7	103	21	521	59	1282	98	2139	220	4800	381	8315	865	18915	1661	36311	2618	57241	3754	82103	170.5
0.8	7.1	116	22	583	63	1434	104	2392	233	5368	403	9298	915	21152	1756	40605	2768	64010	3970	91813	175.4
0.9	7.5	128	23	645	66	1585	109	2644	245	5934	423	10279	962	23383	1846	44887	2910	70761	4174	101496	179.9
1.0	7.8	140	24	706	69	1736	114	2896	256	6499	443	11257	1007	25609	1932	49160	3046	77497	4368	111158	184.1
1.1	8.2	152	25	767	72	1887	119	3147	267	7063	462	12235	1050	27832	2014	53427	3175	84224	4554	120806	188.0
1.2	8.5	164	26	829	74	2038	124	3398	277	7626	480	13211	1091	30053	2093	57690	3299	90944	4732	130446	191.6
1.3	8.8	177	27	890	77	2188	128	3649	287	8189	497	14187	1130	32272	2169	61951	3419	97661	4904	140080	195.1
1.4	9.1	189	28	951	80	2339	133	3900	297	8753	514	15162	1168	34492	2242	66212	3534	104377	5069	149713	198.3
1.5	9.4	201	29	1012	82	2489	137	4151	306	9316	530	16138	1205	36712	2313	70473	3646	111095	5230	159349	201.4
1.6	9.6	213	30	1074	85	2640	141	4403	315	9880	546	17114	1241	38933	2382	74737	3755	117816	5386	168990	204.3
1.7	9.9	225	31	1135	87	2791	145	4654	324	10444	561	18092	1276	41155	2449	79004	3861	124543	5537	178638	207.1
1.8	11	237	31	1196	89	2942	149	4906	333	11009	576	19070	1310	43381	2515	83275	3964	131276	5685	188296	209.8
1.9	11	250	32	1258	92	3093	152	5158	341	11574	591	20049	1343	45608	2578	87552	4064	138018	5829	197966	212.4
2.0	11	262	33	1319	94	3244	156	5410	350	12140	605	21030	1376	47839	2641	91835	4162	144769	5970	207649	214.9
2.1	11	274	34	1381	96	3396	160	5663	358	12707	619	22012	1408	50074	2702	96124	4258	151531	6108	217348	217.3
2.2	12	286	34	1443	98	3547	163	5916	365	13275	633	22996	1439	52312	2761	100421	4353	158305	6243	227064	219.6
2.3	12	299	35	1505	100	3699	167	6169	373	13844	646	23982	1469	54555	2820	104726	4445	165091	6375	236798	221.8
2.4	12	311	36	1567	102	3852	170	6424	381	14414	659	24970	1499	56802	2877	109040	4536	171891	6505	246551	224.0
2.5	12	323	37	1629	104	4005	173	6678	388	14986	672	25960	1529	59054	2934	113363	4625	178705	6633	256326	226.1
3.0	13	386	40	1942	114	4774	189	7961	424	17864	734	30945	1669	70394	3203	135132	5049	213023	7242	305549	235.7

US Tables (lb/h)

EF73 - Flangeless															
Size (in)	½"		1"		1½"		2"		3"		4"		6"		Temp. (°F)
Pressure (psig)	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
10	10.1	54.5	28.1	321	75.9	760	124	1252	277	2756	472	4753	1057	10785	239
20	11.8	74.9	32.9	442	88.9	1045	145	1721	325	3789	554	6535	1239	14828	259
30	13.3	95.0	37.1	560	101	1324	163	2182	366	4805	623	8286	1395	18802	274
40	14.6	114	40.8	677	111	1601	179	2638	402	5807	685	10015	1534	22726	287
50	15.8	134	44.2	793	120	1875	194	3089	435	6801	742	11728	1660	26612	298
60	16.9	153	47.2	907	128	2146	207	3537	466	7786	794	13428	1776	30470	307
80	18.9	192	52.8	1136	143	2685	232	4424	521	9741	888	16799	1987	38119	324
100	20.7	230	57.8	1362	157	3220	254	5305	571	11680	972	20143	2175	45706	338
150	24.6	326	68.7	1923	186	4545	302	7489	678	16489	1155	28436	2585	64524	366
200	27.9	420	78.1	2481	211	5865	342	9664	770	21276	1311	36692	2936	83258	388
250	30.9	515	86.4	3039	234	7186	379	11839	852	26067	1451	44954	3249	102004	406
300	33.6	610	94.0	3600	254	8511	412	14023	927	30875	1580	53246	3536	120820	422
350	36.2	706	101	4164	274	9844	443	16220	9977	35712	1699	61587	3803	139746	436
400	39.0	1115	108	5091	292	11789	473	19129	1063	43041	1811	73333	4054	164214	448

EF73 - Flanged																					
Size	½"		1"		1½"		2"		3"		4"		6"		8"		10"		12"		Temp (°F)
Press. (psig)	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
10	7.2	53.3	21.8	268	62.5	659	105	1099	234	2466	405	4271	921	9717	1767	18654	2786	29404	3995	41903	239
20	8.4	73.2	25.6	368	73.2	906	123	1510	274	3390	475	5872	1080	13359	2072	25645	3266	40428	4683	57635	259
30	9.5	92.9	28.8	467	82.5	1148	138	1915	309	4298	535	7446	1216	16939	2333	32517	3678	51260	5275	73135	274
40	10.4	112	31.6	564	90.7	1388	152	2315	340	5195	588	9000	1336	20474	2565	39304	4043	61959	5799	88400	287
50	11.2	131	34.2	661	98.1	1626	164	2711	367	6084	636	10540	1446	23976	2776	46026	4375	72556	6274	103450	298
60	12.0	150	36.6	757	105	1861	175	3104	393	6966	681	12067	1547	27452	2970	52698	4682	83074	6715	118508	307
80	13.4	188	41.0	947	118	2329	196	3884	440	8715	761	15097	1731	34344	3322	65929	5236	103932	7511	148117	324
100	14.7	225	44.9	1136	129	2792	215	4657	481	10450	833	18103	1895	41181	3638	79053	5734	124621	8224	177643	338
150	17.5	318	53.3	1603	153	3942	255	6574	572	14753	990	25556	2252	58136	4322	111601	6813	175928	9772	250844	366
200	19.8	411	60.5	2069	174	5087	290	8483	649	19036	1125	32975	2558	75011	4909	143996	7738	226995	11099	323588	388
250	21.9	504	67.0	2535	192	6232	321	10392	719	23320	1245	40396	2831	91894	5433	176404	8565	278085	12285	396732	406
300	23.9	597	72.9	3002	209	7381	349	12309	782	27620	1355	47845	3081	108838	5913	208930	9321	329359	13370	469782	422
350	25.7	690	78.4	3472	225	8537	375	14236	841	31945	1457	55336	3313	125880	6359	241645	10024	380930	14378	538924	436
400	28.0	784	84.0	3946	240	9701	400	16178	897	36302	1553	62883	3532	143049	6779	274601	10686	432883	15327	620905	448

13.2 Flow Rate for Air or Water

Size		EF77 - Flangeless								EF77 - Flanged							
		Air (0 °C / 32 °F, Atmospheric Pressure)				**Water** (20 °C, 68 °F)				**Air** (0 °C / 32 °F, Atmospheric Pressure)				**Water** (20 °C, 68 °F)			
(mm)	(in)	Minimum		Maximum		Minimum		Maximum		Minimum		Maximum		Minimum		Maximum	
		(m^3/h)	(scfm)	(m^3/h)	(scfm)	(m^3/h)	(Gal/m)	(m^3/h)	(Gal/m)	(m^3/h)	(scfm)	(m^3/h)	(scfm)	(m^3/h)	(Gal/m)	(m^3/h)	(Gal/m)
15	½"	4.1	2.5	35	20.6	0.19	0.9	6.9	30.3	2.9	1.8	24	14.1	0.16	0.7	4.9	21.5
25	1"	12	7.1	161	94.7	0.41	1.9	19	83.6	8.9	5.3	125	73.5	0.32	1.4	15	66.0
40	1½"	31	18.3	374	220	1.11	4.9	44	193	26	15.3	307	180	0.91	4.1	36	158
50	2"	50	29.5	606	356	1.80	7.9	72	317	43	25.4	513	301	1.52	6.7	61	268
80	3"	113	66.6	1365	803	4.04	17.8	163	717	95	56.0	1151	677	3.41	15.0	138	607
100	4"	191	113	2326	1368	6.88	30.3	279	1228	164	96.6	1995	1174	5.90	26.0	239	1052
150	6"	428	252	5210	3066	15.40	67.8	625	2752	373	220	4538	2670	13.5	59.5	544	2395
200	8"	—				—				715	421	8712	5127	25.8	114	1045	4601
250	10"	—				—				1127	664	13735	8083	40.6	179	1648	7256
300	12"	—				—				1617	952	19700	11593	58.3	257	2364	10409

14 Product Warranty

1. Warranty Period
   One year following product delivery.

2. Warranty Coverage
   TLV CO., LTD. warrants this product to the original purchaser to be free from defective materials and workmanship. Under this warranty, the product will be repaired or replaced at our option, without charge for parts or labor.

3. This product warranty will not apply to cosmetic defects, nor to any product whose exterior has been damaged or defaced; nor does it apply in the following cases:
   1) Malfunctions due to improper installation, use, handling, etc., by other than TLV CO., LTD. authorized service representatives.
   2) Malfunctions due to dirt, scale, rust, etc.
   3) Malfunctions due to improper disassembly and reassembly, or inadequate inspection and maintenance by other than TLV CO., LTD. authorized service representatives.
   4) Malfunctions due to disasters or forces of nature.
   5) Accidents or malfunctions due to any other cause beyond the control of TLV CO., LTD.

4. Under no circumstances will TLV CO., LTD. be liable for consequential economic loss damage or consequential damage to property.

15 Service

For Service or Technical Assistance:
Contact your TLV representative or your TLV office.

In North America:

TLV CORPORATION
13901 South Lakes Drive, Charlotte, NC 28273-6790 **U.S.A.**
Tel: [1]-704-597-9070 Fax: [1]-704-583-1610

In Mexico:

TLV ENGINEERING S. A. DE C. V.
San Andrés Atoto No. 12, Col. San Andrés Atoto 53500,
Naucalpan, Edo. de México, **Mexico**
Tel: [52]-55-5359-7949 Fax: [52]-55-5359-7585

In Argentina:

TLV ENGINEERING S.A.
Av. Mitre 775, B1603CQH Villa Martelli, Pcia. Buenos Aires, **Argentina**
Tel: [54]-(0)11-4760-8401 Fax: [54]-(0)11-4761-6793

In Europe:

TLV EURO ENGINEERING GmbH
Daimler Benz-Straße 16-18, 74915 Waibstadt, **Germany**
Tel: [49]-(0)7263-9150-0 Fax: [49]-(0)7263-9150-50

TLV EURO ENGINEERING UK LTD.
Star Lodge, Montpellier Drive, Cheltenham, Gloucestershire GL50 1TY **U.K.**
Tel: [44]-(0)1242-227223 Fax: [44]-(0)1242-223077

TLV EURO ENGINEERING FRANCE SARL
Parc d'Ariane 2, bât. C, 290 rue Ferdinand Perrier, 69800 Saint Priest, **FRANCE**
Tel: [33]-(0)4-72482222 Fax: [33]-(0)4-72482220

In Oceania:

TLV PTY LIMITED
Unit 22, 137-145 Rooks Road, Nunawanding, Victoria 3131 **Australia**
Tel: [61]-(0)3-9873 5610 Fax: [61]-(0) 3-9873 5010

In East Asia:

TLV PTE LTD
66 Tannery Lane, #03-10B Sindo Building, **Singapore** 347805
Tel: [65]-6747 4600 Fax: [65]-6742 0345

TLV PTE LTD
Room 1306, No. 103 Cao Bao Road, Shanghai, **China** 200233
Tel: [86]-21-6482-8622 Fax: [86]-21-6482-8623

TLV ENGINEERING SDN. BHD.
8 & 8A, Jalan BP 6/6, Bandar Bukit Puchong, 47120 Puchong, Selangor,
Malaysia
Tel: [60]-3-8065-2928 Fax: [60]-3-8065-2923

TLV INC.
#302-1 Bundang Technopark B
Yatap, Budang, Seongnam, Gyeonggi, 463-760 **Korea**
Tel: [82]-(0)31-726-2105 Fax: [82]-(0)31-726-2195

Or:

TLV INTERNATIONAL, INC.
881 Nagasuna, Noguchi, Kakogawa, Hyogo 675-8511 **Japan**
Tel: [81]-(0)79-427-1818 Fax: [81]-(0)79-425-1167

Head Office:

TLV CO., LTD.
881 Nagasuna, Noguchi
Kakogawa, Hyogo 675-8511 **Japan**
Tel: [81]-(0)79-422-1122 Fax: [81]-(0)79-422-0112