ISO 9001/ ISO 14001

TLV CO., LTD.
Kakogawa, Japan
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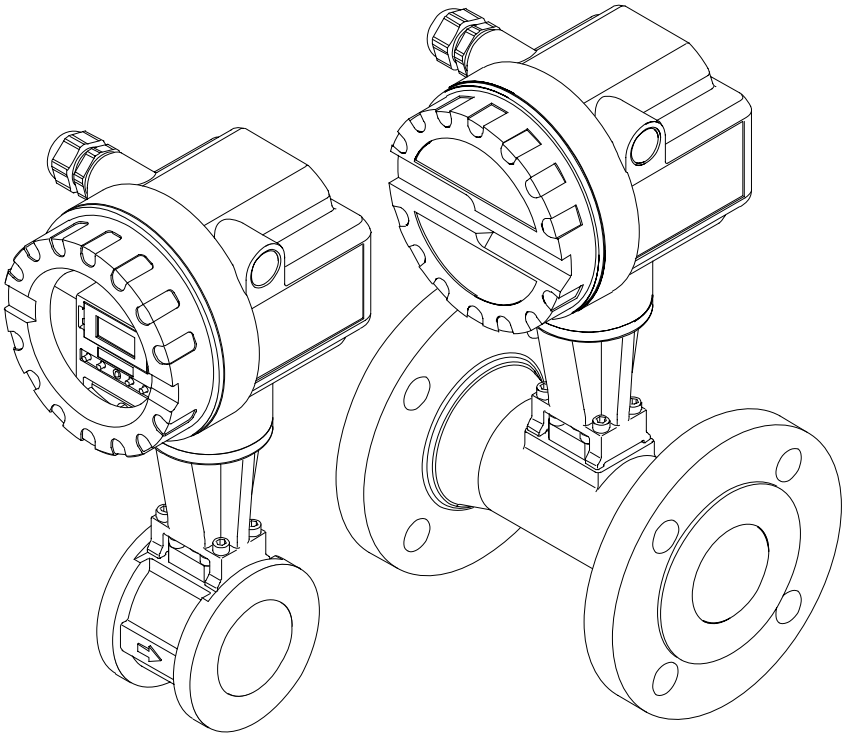
Instruction Manual

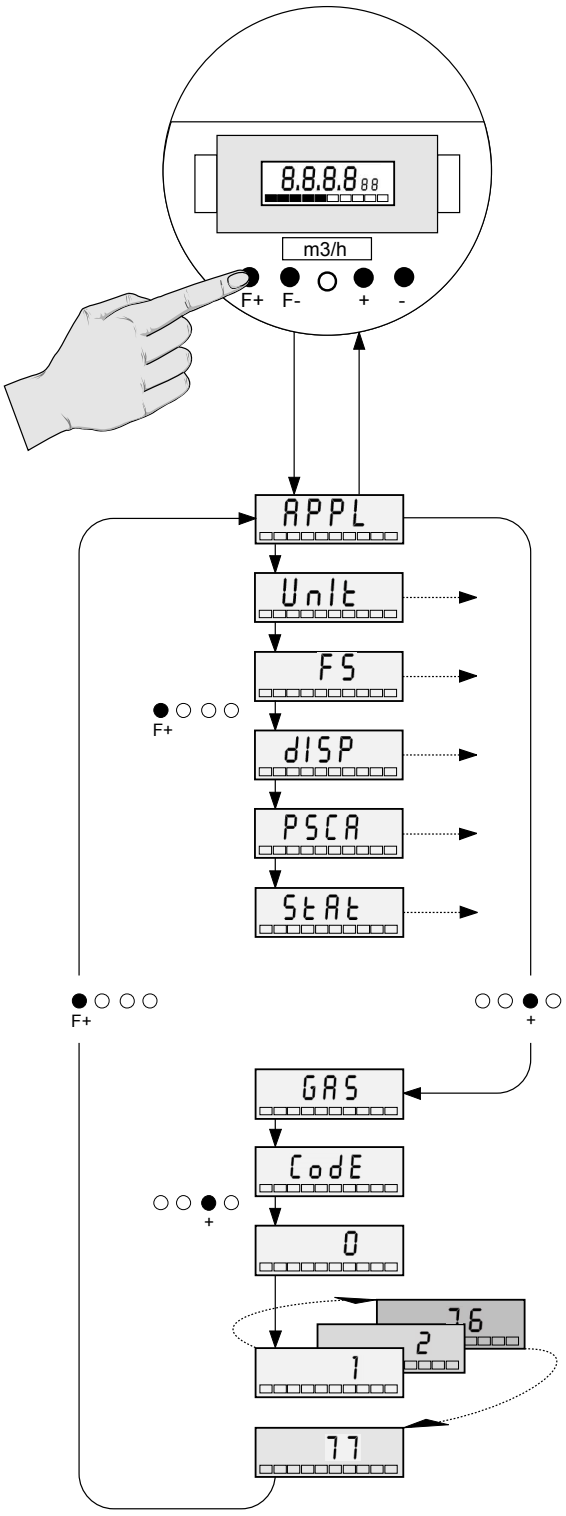


Vortex Flowmeter
EF77

Rev 2-2003

Operating Summary

(For EF77 version with an integrated indicator and local operation.)



Example of operating procedure “Unlocking Programming”

Quick Setup Menu (EF77)		
	Display	Selecting / Entering Values
Application (Fluid)	APPL	LI = Liquid, GAS = Gas / Steam
Flow units	Unit	0 = dm^3/s, 1 = dm^3/min, 2 = dm^3/h, 3 = m^3/s, 4 = m^3/min, 5 = m^3/h, 6 = ACFS, 7 = ACFM, 8 = ACFH, 9 = IGPS, 10 = IGPM, 11 = IGPH, 12 = gps, 13 = gpm, 14 = gph, 15 = USER
Full scale value	FS	Input (Unit)
Display mode	dISP	PErc = Flow in %, rAtE = Flow rate in vol./time, Ltot = Totalizer, Htot = Totalizer overflows
Pulse scaling*	PSCA	Input (Unit)
Diagnosis code*	StAt	E1XX = system error, E2XX = warning message

* Display – dependent on the settings made in other functions

To enter the Quick Setup menu:
→ Press F+ **<3s**

Note!
First jump to the HOME position in order to move from the Quick Setup menu to the Extended menu.

Note!

To enter the Extended menu:
→ Press F+ **>3s**

Return to HOME position from any function → Press Key F+ **>3s**

(HOME position = standard display during normal operation)

Extended menu (EF77)		
	Display	Selecting / Entering Values
Flow rate	Fu00	Display (Flow units)
Vortex frequency	Fu01	Display (Hz)
Totalizer	Fu02	Display (Totalizer units)
Totalizer overflow	Fu03	Display (number of overruns)
Flow units	Unit	0 = dm^3/s, 1 = dm^3/min, 2 = dm^3/h, 3 = m^3/s, 4 = m^3/min, 5 = m^3/h, 6 = ACFS, 7 = ACFM, 8 = ACFH, 9 = IGPS, 10 = IGPM, 11 = IGPH, 12 = gps, 13 = gpm, 14 = gph, 15 = USER
Totalizer units	Full	0 = dm^3,1 = m^3, 2 = ACF, 3 = lgallons, 4 = gallons, 5 = USER = user defined
User-defined units flow rate*	Fu12	Input (Unit)
User-defined units totalizer*	Fu14	Input (Unit)
Output signal	Fu20	4 – 20 (mA), PULS (scaleable Open Collector pulse output), PF (PFM current pulses)
Full scale value	FS	Input (Unit)
Time constant	Fu22	Input (Unit)
Failsafe mode*	Fu23	Lo ≤ 3.6 (mA), Hi = 22 (mA), run = norm. meas. value
Simulation*	Fu24	OFF, 3.6 (mA), 4 (mA), 12 (mA), 20 (mA), 22 (mA)
Nominal current*	Fu25	Display: 4 – 20.5 (mA)
Pulse scaling*	PSCA	Input (Unit)
Pulse width*	Fu31	Input 0.05 – 2.00 (s)
Simulation pulse output*	Fu32	OFF, 1 (Hz), 50 (Hz), 100 (Hz)
Nominal frequency*	Fu33	Display 0.000 – 100.0 (Hz)
Display mode	dISP	PErc = Flow in %, rAtE = Flow rate in vol./time, Ltot = Totalizer, Htot = Totalizer overflows
Totalizer reset	Fu41	ESC = not reset to zero, rESE = set to zero
Private code definition*	Fu50	Input 0 – 9999
Access code entry	CodE	Input 0 – 9999
Meter status*	StAt	E1XX = system error, E2XX = warning message
Software main board	Fu53	Display
Hardware main board	Fu55	Display
Application (Fluid)	APPL	LI = Liquid, GAS = Gas/Steam
Nominal diameter	dn	15 – 300 (mm)
K-factor	CALF	0.010 – 999.9 (pulses/dm^3), as printed on meter
Thermal expansion coef.	Fu63	Display (x 10^{-5}/Kelvin)
Process temperature	Fu64	Input 0 – 999 (Kelvin)
Amplification	Fu65	1 = very low, 2 = low, nor = normal, 3 = high

* Display – dependent on the settings made in other functions

Note!
First jump to the HOME position in order to move from the Extended menu to the Quick Setup menu.

Note!

Contents

1 Safety Instructions

1.1 Correct Usage

- EF77 is only to be used for measuring the volumetric flow rate of saturated steam, superheated steam, gases and liquids. If the process pressure and temperature are constant, then EF77 can also indicate the flow rate in units of mass, energy or corrected volume.
- The manufacturer assumes no liability for damage 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 works in an operationally perfectly safe condition. The devices were developed according to EN 61010 “Protection Measures for Electrical Equipment for Measurement, Control, Regulation and Laboratory Procedures”. A hazardous situation may occur if the flowmeter is not used for the purpose it was designed for or is used incorrectly. Please carefully note the information provided in this Operating Manual indicated by the pictograms:


Warning!

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


Caution!

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


Note!

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

1.3 Operational Safety

- The EF77 measuring system fulfills the general safety regulations according to EN 61010 and the interference immunity regulations (EMC) according to European standard EN 50081 Part 1 and 2 / EN 50082 Part 1 and 2 as well as NAMUR recommendations.
- 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 Personnel for Installation, Start-up and Operation

- Mounting, electrical installation, start-up and maintenance of the instrument may only be carried out by trained personnel authorized by the operator of the facility. Personnel must absolutely and without fail read and understand this manual before carrying out its instructions.
- The instrument may only be operated by personnel who are authorized and trained by the operator of the facility. All instructions in this manual are to be observed without fail.
- In case of corrosive fluids, the compatibility of the material of all wetted parts such as measuring pipe, bluff body, sensor and gaskets is to be verified. This also applies to fluids used to clean the EF77 flowmeter. TLV will be pleased to provide you with any help required.
- The installer has to make sure that the measuring system is correctly wired up according to the wiring diagrams. The measuring system is to be grounded.

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

Warning!

Please observe all provisions valid for your country pertaining to opening and repair of electrical devices.

1.5 Repairs, Dangerous Chemicals

The following procedures must be carried out before an EF77 is sent to TLV for repair:

- 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 residue which may be present. Pay special attention to the gasket grooves and crevices where fluid may be present. This is especially important if the fluid is dangerous to health, e.g. corrosive, poisonous, carcinogenic, radioactive, etc.
- No instrument should be returned to us without all dangerous material being removed first.

Incomplete cleaning of the instrument 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 instrument.

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.

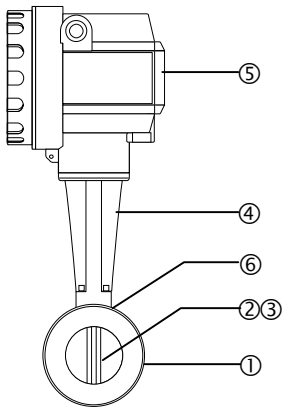
2 System Description

The EF77 vortex flowmeter measures the volumetric flow of steam, gases and liquids for fluid temperatures in the range of -200 – +400 °C (-330 – +750 °F) and at nominal pressures of up to PN 160 / ANSI class 600.

EF77 measures the volumetric flow at operating conditions. If the process pressure and temperature are constant, EF77 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)
	Sensor (non-wetted parts)
④	Pipe Stand
⑤	Transmitter Housing
⑥	Gasket
⑦	Mounting Kit*

* See page 11



2.1 EF77 Measuring System

A measuring system consists of:
- EF77 transmitter in the versions shown below
- EF77 flangeless or flanged connection body

The EF77 transmitter is available in different versions which differ in the type of electrical output signals and digital communication capabilities. The transmitter can be equipped with a local display and local programming capability using pushbuttons. Standard transmitters are equipped with an aluminum cover, versions with a display come with a glass cover (see Fig. 1).

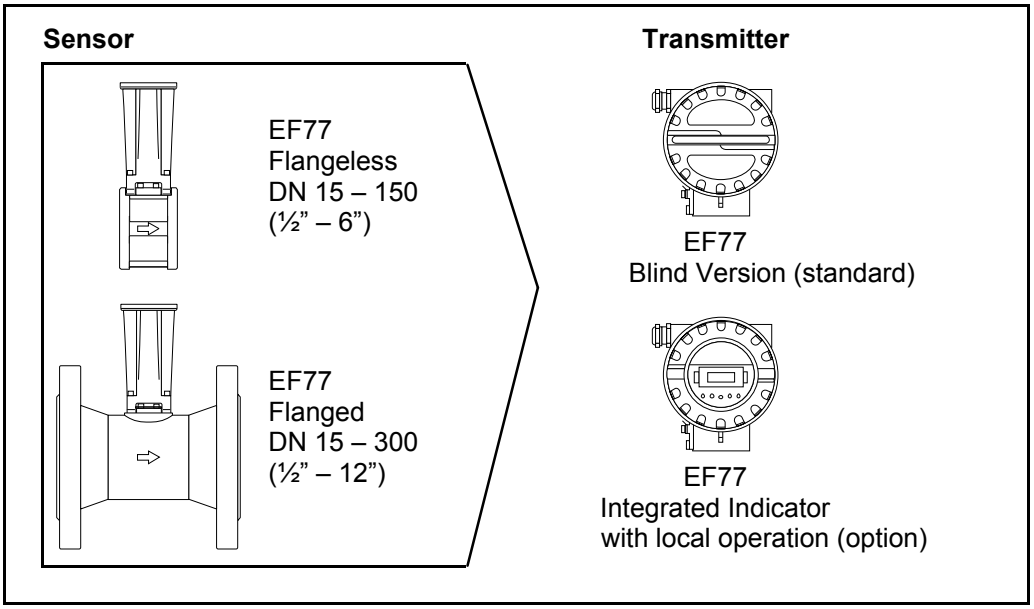


Figure 1
EF77 measuring system

Transmitters with local display and programming can be reconfigured to output either scaleable pulses (open collector or voltage pulses) or two-wire unscaled current pulses (PFM).

3 Mounting and Installation

3.1 General Information

Protection IP 67 (EN 60529)
The instruments fulfill all the requirements for IP 67 / NEMA 4X. The following points must always be observed in order to ensure protection to IP 67 after installation in the field or after servicing:

- Housing gaskets must be clean and undamaged when inserted in the gasket groove. The gaskets may need to be dried, cleaned or replaced.
- All housing screws and the housing cover must be firmly tightened.
- The cables used for connecting must have an outer diameter in the specified range.
- The cable gland must be firmly tightened (see Fig. 2).
- The cable must loop down before entering the cable gland to ensure that no moisture can enter it (see Fig. 2).
- Any unused cable glands are to be replaced with a plug.
- The protective bushing should not be removed from the cable gland.

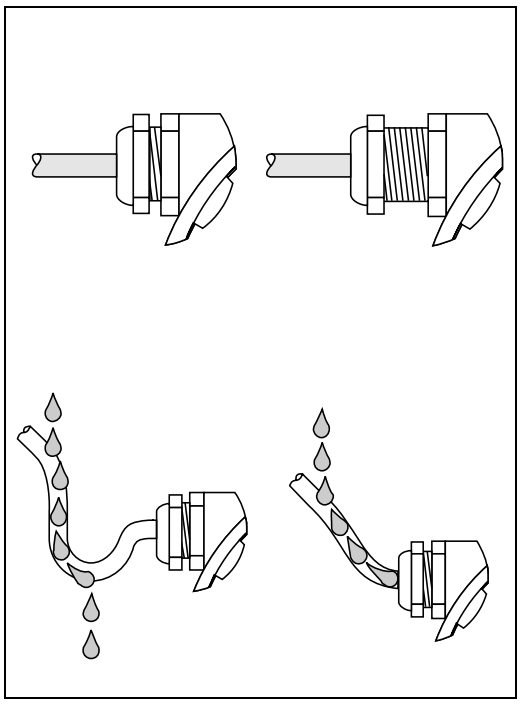


Figure 2
Protection IP 67 / NEMA 4X

Temperature Ranges
- The maximum approved ambient and process temperatures must be observed (see page 43).
- Observe also the instructions on piping insulation and mounting position (see page 9).

3.2 Correct Usage

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 EF77 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.

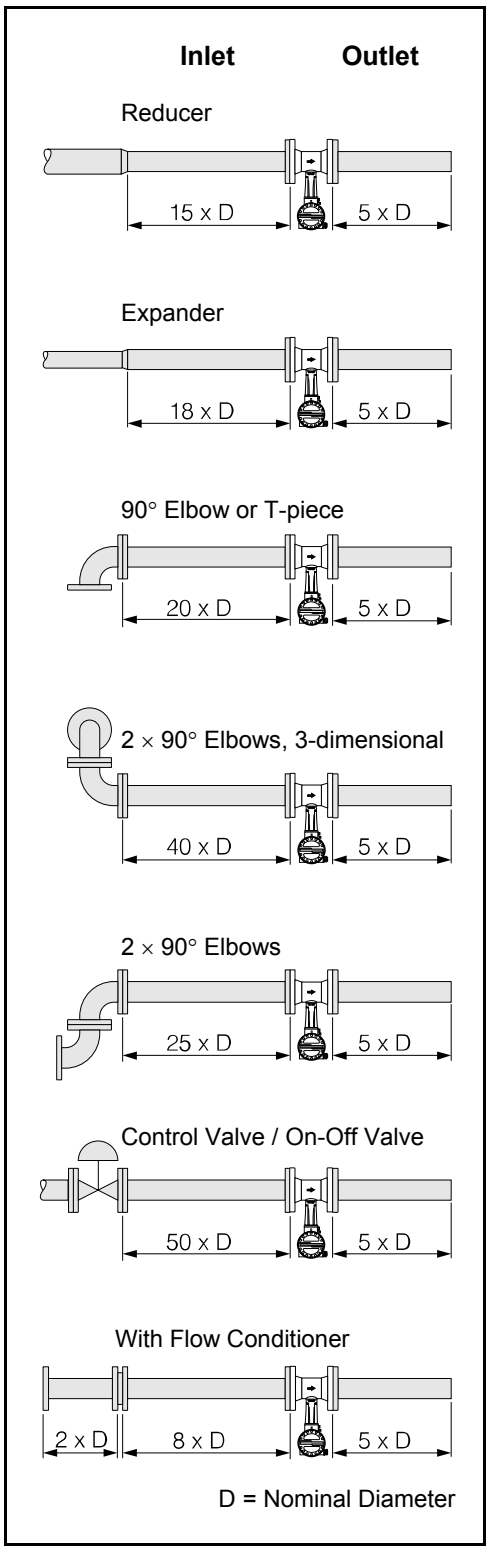


Figure 3
Inlet and outlet piping requirements

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. 3). If two or more flow disturbances are located upstream, then the longest of the inlet sections recommended should be used.

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
With limited space and large pipes, it is not always possible to use the inlet sections given above. In such cases the specially developed perforated plate flow conditioner (see pages 38 and 39) can be fitted as shown on the left (see Fig. 3). 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 10 x D while maintaining full measurement accuracy.

Installation Site
The EF77 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 ensure a full pipe (see Fig. 4).

For horizontal pipelines, positions B, C and D are possible (see Fig. 4). 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.

For ambient temperatures see the Technical Data (see page 41).

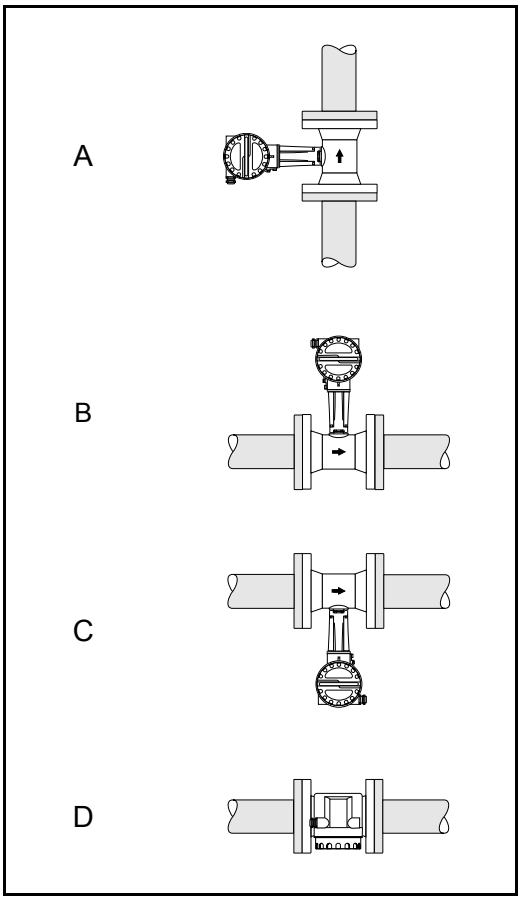


Figure 4
Orientation

Pressure and Temperature Measurement Points
Pressure and temperature measurement points are to be mounted downstream of the EF77 in order to affect vortex formation as little as possible (see Fig. 5).

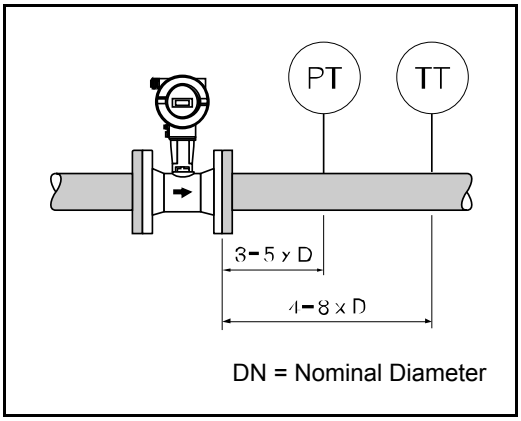


Figure 5
Mounting pressure and temperature sensors

Pipeline Insulation Flangeless/Flanged Version
Pipeline insulation is often used to prevent energy loss in hot processes.

Caution!
When insulating, ensure that sufficient pipe stand surface area is exposed (see Fig. 6). The exposed area serves as a radiator and protects the electronics from overheating.

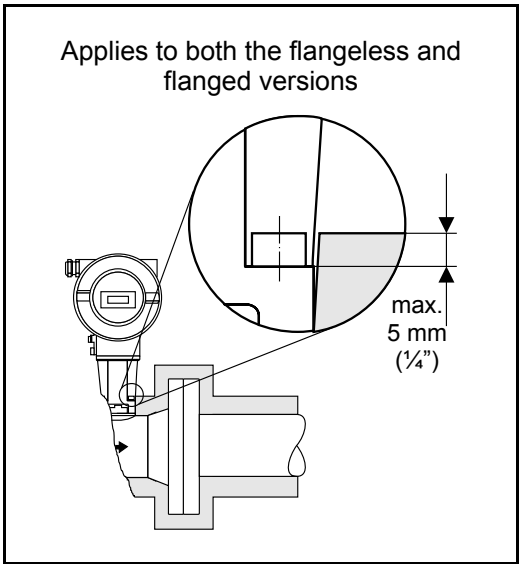


Figure 6
Pipeline insulation flangeless/flanged version

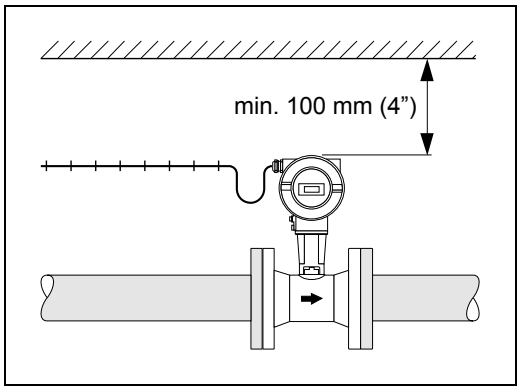


Figure 7
Minimum spacing for mounting and removing the transmitter housing

Minimum spacing
When servicing, it is necessary to remove the transmitter housing from the housing support (see Fig. 7). When installing in the piping, observe the following cable lengths and minimum space:

- Minimum space in all directions 100 mm (4”)
- Cable length required L + 150 mm (L + 6”)


Caution!

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

3.3 Mounting the Flowmeter

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 or larger than those of the meter body and process piping. Gaskets which 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 meter body agrees with the direction of flow in the pipeline.
- Face-to-face lengths:
  – EF77 flangeless version: 65 mm (2 9/16")
  – EF77 flanged version: see pages 36 and 37

Mounting EF77 Flangeless Version
Mounting the flangeless body (see Fig. 8) is carried out using a mounting set consisting of:

- bolts
- centering rings
- nuts
- washers
- gaskets

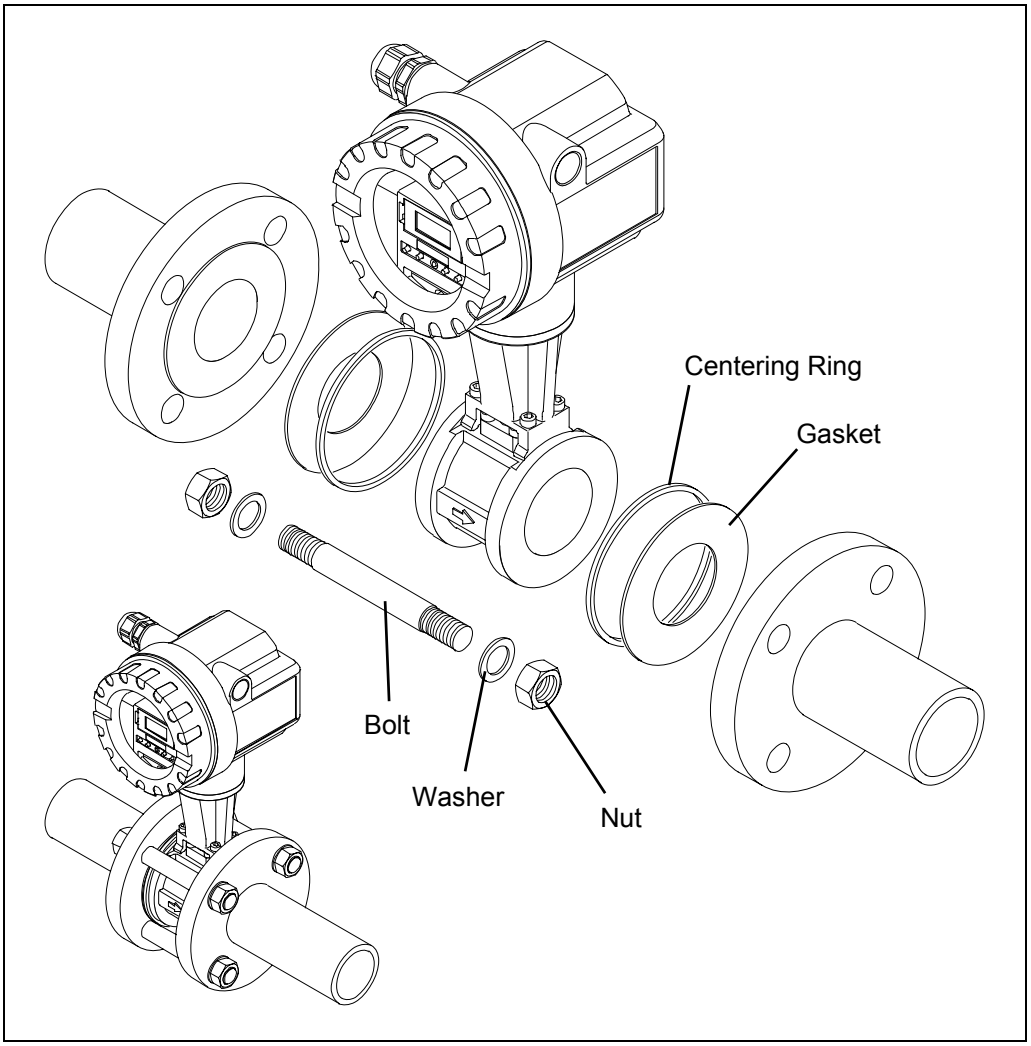


Figure 8
Mounting the EF77 flangeless version

3.4 Electronics Housing / Local Display (Mounting/Rotating)

The electronics housing of EF77 can be rotated in 90° steps on the pipe stand to put the optional local display in the best position to be read.
This is carried out as follows (see Fig 9):

① Remove the securing screw at the pipe stand (minimum one turn).
② Pull out the electronics housing to the mechanical stop and then rotate it to the position required (in 90° steps). Push the housing straight back into the housing support.
③ Fasten the securing screw.


Caution!

Caution!
Push the housing into the housing support carefully to avoid breaking the internal sensor pin!

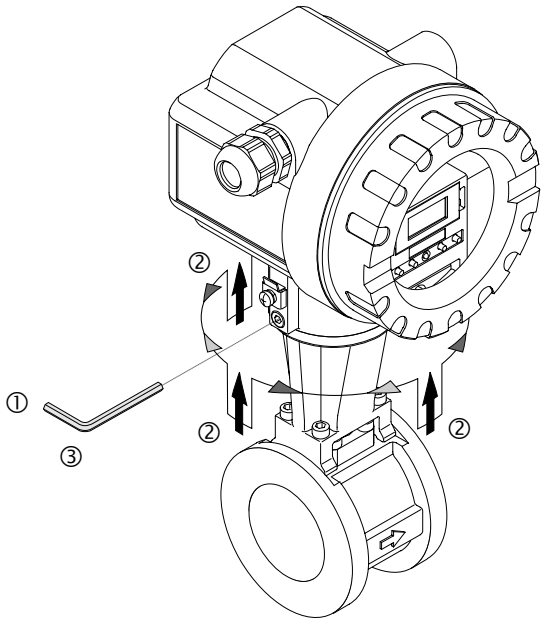


Figure 9
Rotating the electronics housing

The optional indicator's LCD can also be rotated 180° to ensure that the display matches various orientations in a pipeline (see Fig. 10).

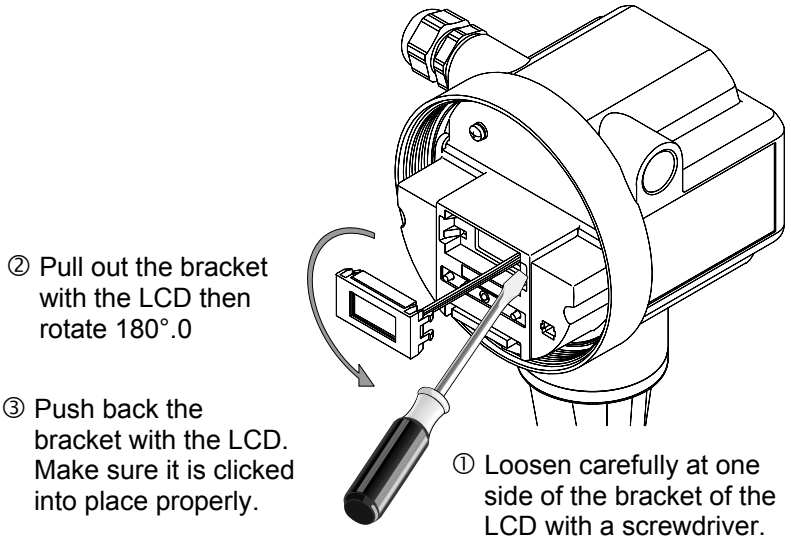


Figure 10
Rotating the local display

4 Electrical Connection

4.1 Connecting the Transmitter

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


Caution!

Procedure
1. Unscrew the front cover.
2. Loosen the two Phillips screws on the upper cover plate and let it swing down.
3. Feed the power and signal cables through the cable gland.
4. Wire up according to the wiring diagrams shown on the following pages.
5. Replace the cover plate and secure.
6. Screw the front cover securely again to the transmitter housing.

4.2 Wiring Diagrams

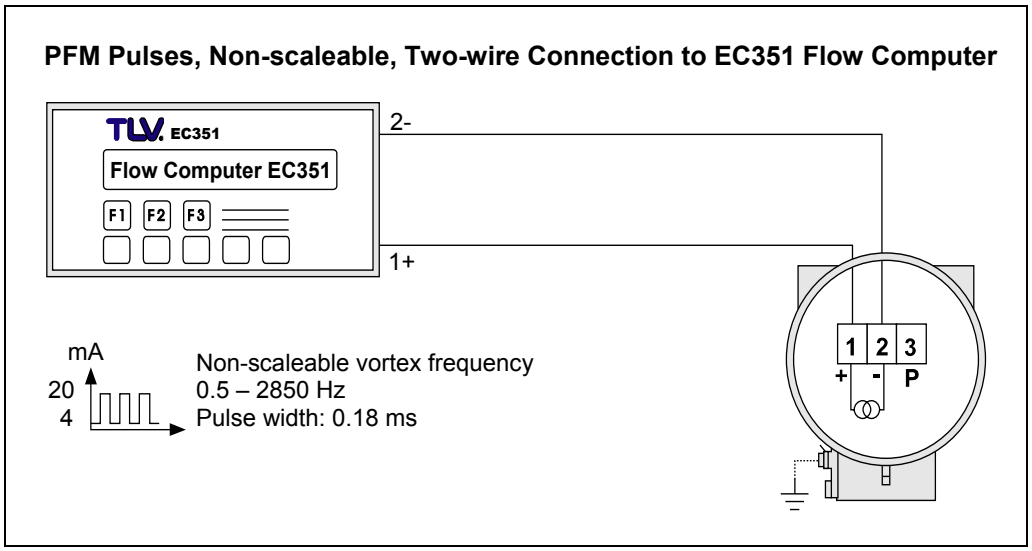


Figure 11
PFM pulses, non-scalable, two-wire connection to TLV flow computer EC351

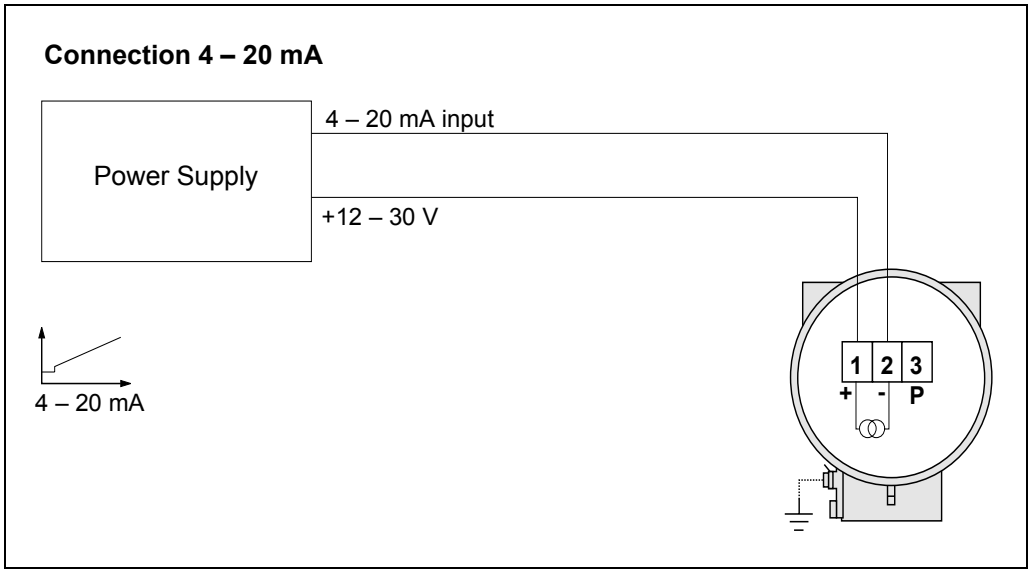


Figure 12
Connection 4 – 20 mA

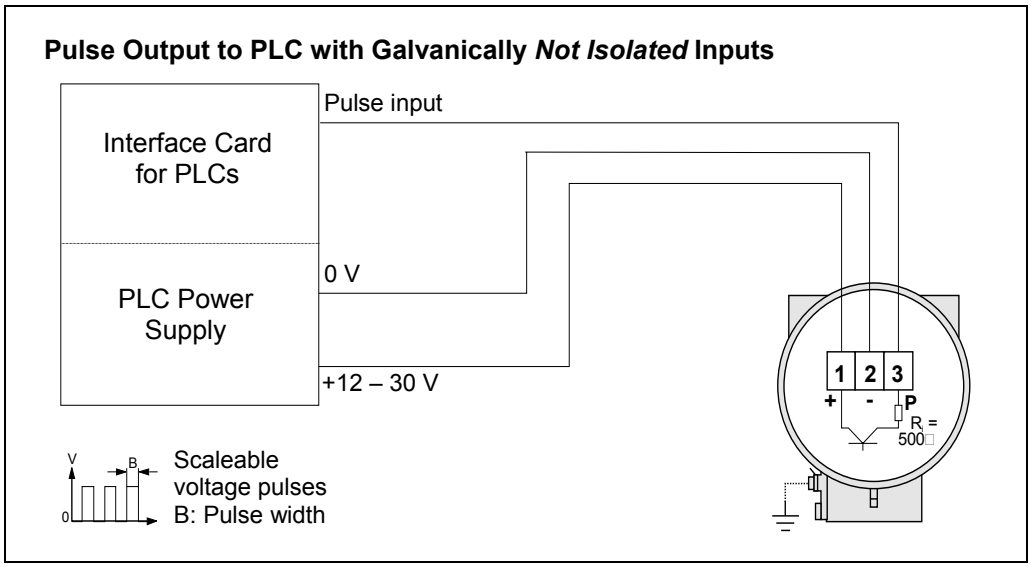


Figure 13
Pulse output to PLC with galvanically not isolated inputs

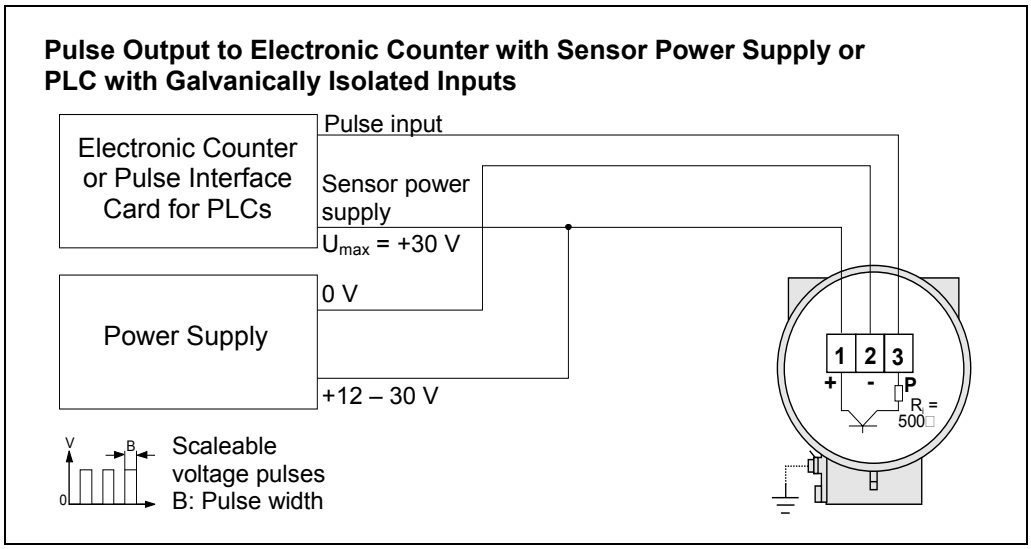


Figure 14
Pulse output to electronic counter with sensor power supply or PLC with galvanically isolated inputs

4.3 Load

$$R_B = \frac{U_S - U_{KI}}{I_{max} \times 10^{-3}} = \frac{U_S - 12}{0.022}$$

R_B = load resistance
U_S = power supply voltage (12 – 30 V DC)
U_{KI} = EF77 terminal voltage (min. 12 V DC)
I_{max} = output current (22 mA)

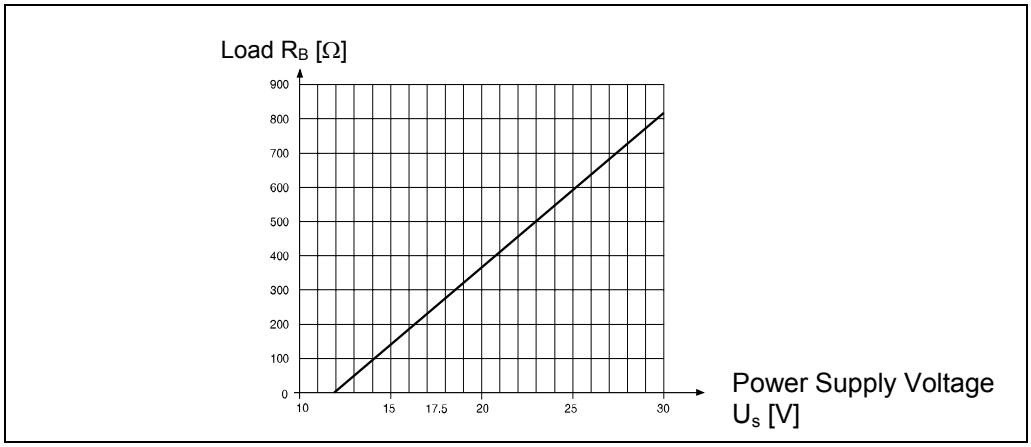


Figure 15
Load and analogue current pulse

5 Operation

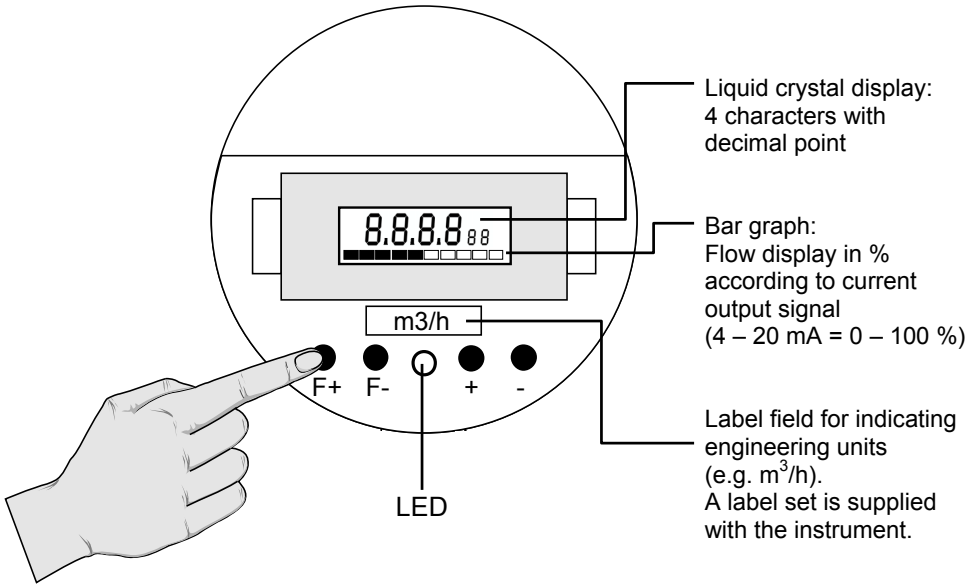
The EF77 version with an integrated indicator and local operation has a number of functions which the user can individually set according to process conditions.

Note!
- Under normal circumstances, reprogramming the functions of EF77 is not required since the flowmeter is already configured in the factory.
- A summary of all factory-set values and selections is given on pages 18 to 31.

Note!

5.1 Display and Operating Elements

The transmitter is operated locally by using four pushbuttons (keys) and the local display (see Fig. 16). This enables individual functions to be selected and parameters or values to be entered.



Use F+ / F- to:

1. Enter programming mode
- Press Key F+ (<3 sec.) → Quick Setup menu is accessed
- Press Key F+ (>3 sec.) → Extended menu is accessed

2. Return to HOME position from any function:
Keep Key F+ pressed (>3 sec.)

HOME position = standard display during measurement

3. Select various functions

Use + / - to:

1. Display actual values or settings in the particular function

2. Change numerical values / settings (keep key depressed: values change at increasing speed)

Figure 16
Display and operating elements of the EF77

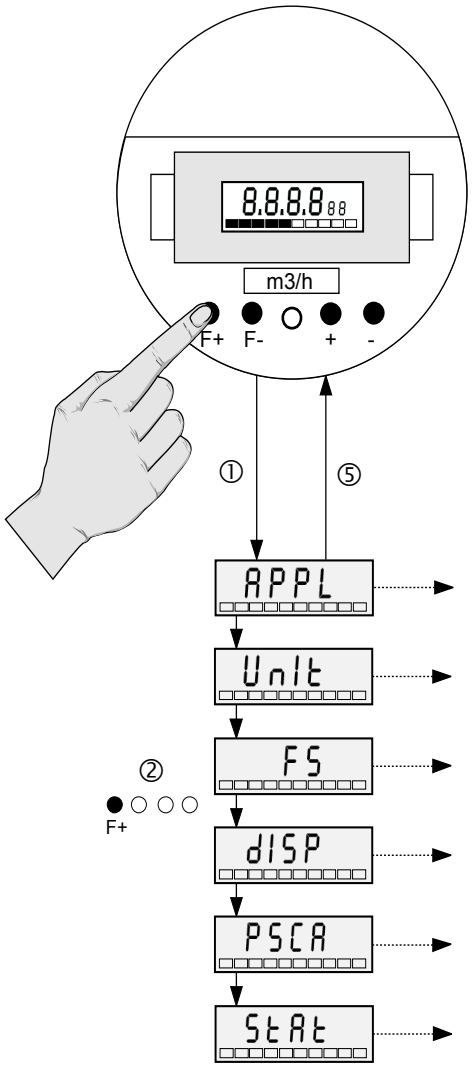
5.2 Select Functions and Change Parameters

Changing numerical values or settings in a function is carried out as follows (see Fig. 17 and 18).

Remove the housing cover
① Enter the programming mode (key F+)
② Select the function (key F+/F-)
③ Enable programming if locked (key +/-, confirm with F+)
④ Change numerical values/settings (key +/-)
⑤ Leave the programming mode; return to the HOME position (key F+, >3s)
(Programming is then locked again if no key is pressed for 60 seconds)
Replace and secure the housing cover

Note!

Note!
See page 2 for a summary of contents in the Quick Setup menu or the Extended menu.



Entering the programming menus

① Press key F+:

<3 s: *Quick Setup menu*
for the most important instrument functions.
A summary is given on page 2.

>3 s: *Extended menu*
this contains all functions of the EF77.
A summary is given on page 2.

Moving between the Quick Setup and Extended menus is only possible by jumping to the HOME position ⑤.

Returning to the HOME position

⑤ Press key F+ (>3 s)
This is automatic if no key is pressed within 3 min. (with locked programming only).

Entering the submenus, see Fig. 18 on following page

Figure 17
Selecting functions

The following functions are explained using the function “APPL” = fluid to be measured as an example:

③ **Enable programming**
Enter code number (factory setting = 77)

Lock programming
- After returning to the HOME position programming is locked again if no key is pressed for 60 seconds.
- Programming can also be locked by entering any number in the Function “CodE” (not customer code).

④ **Changing functions**

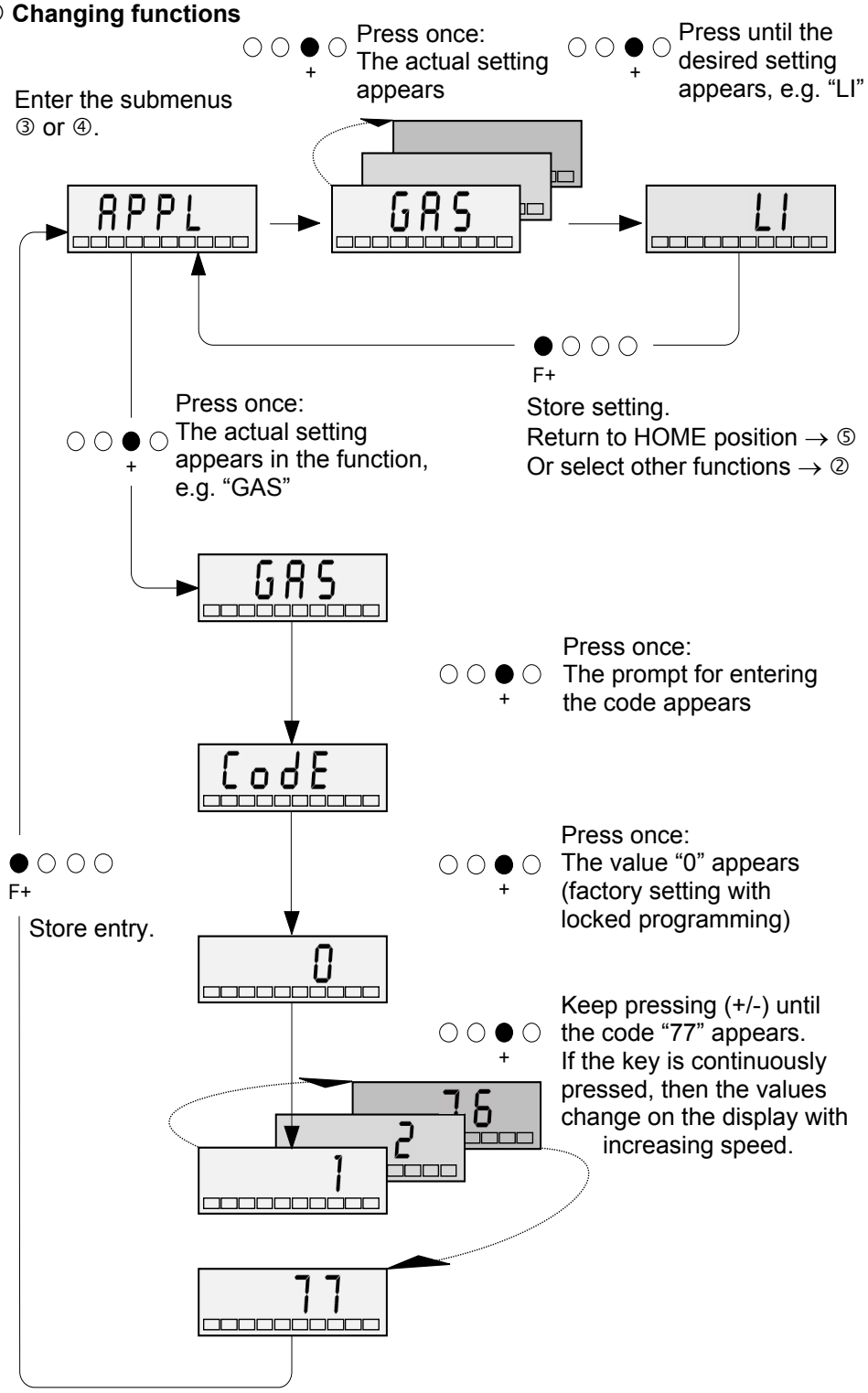


Figure 18
Enable programming, change functions

6 Functions

- The following functions are available on the EF77 version with an integrated indicator and local operation.
- Factory settings are shown in ***bold italics***.

Function Group: ACTUAL MEASURED VALUES	
Flow Rate Fu00	Display of actual measured volumetric flow rate (volume/time). The engineering units used can be defined in the function “Unit” (see page 19). Display: Four-digit number with floating decimal point, e.g. 150.2 (dm^3/s)
Vortex Frequency Fu01	Display of actual measured vortex frequency. *Display*: Four-digit number with floating decimal point, e.g. 300.1 (Hz)
Totalizer Fu02	Display of total flow quantity from when measurement began. The effective amount is calculated from the sum of the value shown in function “Fu02” and the sum of the overruns “Fu03” (see below). Note! In cases of error and after loss of power supply the totalizer remains at the value last shown. *Display*: Four-digit number with floating decimal point, e.g. 123.4 (dm^3)
Totalizer Overflow Fu03	The totalized flow is shown as a maximum 4-digit number with floating decimal point in the function “Fu02” (see above). Larger numbers (>9999) can be read off in this function as overruns. The effective amount is calculated from the sum of the overruns (×10,000) and the value shown in function “Fu02”. A maximum of 9999 overruns is shown. The display then begins to flash. In this case it is recommended that larger engineering units are selected in “Fu11” (see page 19) so that the actual totalizer value can be read off in “Fu02” and “Fu03”. Example: Display of 23 overruns: 23 (= 230,000 dm^3) The value shown in function “Fu02” 129.7 (dm^3) Total amount = 230,129.7 (dm^3) *Display*: Max. four-digit number, e.g. 6453 (overruns)

Note!

Function Group: SYSTEM UNITS

Flow Unit

UnIt

Unit for volumetric flow (volume/time).
These units also define the full scale value of the current output in the function “FS” (see page 24). This function must therefore be set **before** that of the full scale value.

Note!
If the unit is changed, attach an adhesive label showing the selected engineering unit to the field provided on the local display.

Note!

Selection:
0 = dm^3/s, 1 = dm^3/min, 2 = dm^3/h, 3 = m^3/s, 4 = m^3/min, 5 = m^3/h, 6 = ACFS, 7 = ACFM, 8 = ACFH, 9 = IGPS, 10 = IGPM, 11 = IGPH, 12 = gps, 13 = gpm, 14 = gph, 15 = USER = user defined units (see function “Fu12”, page 27)

($1\ dm^3$ = 1 liter)

Factory setting: ***as ordered;*** if not specified by the customer “0” is set.

Totalizer Unit

FuLl

Units for the totalizer also define the pulse value ($m^3 \rightarrow m^3$/pulse).

Note!
If the unit is changed, attach an adhesive label showing the selected engineering unit to the field provided on the local display.

Note!

Selection:
0 = dm^3 , 1 = m^3 , 2 = ACF, 3 = Igallons, 4 = gallons, 5 = USER = user defined units (see function “Fu14”, page 23)

($1\ dm^3$ = 1 liter)

Factory setting: ***corresponding*** to the flow unit.

Function Group: SYSTEM UNITS

User-defined Unit Flow Rate

Fu 12

As well as the engineering units offered (selection “0 – 14” in function “Unit”, see page 19), the flow rate can also be displayed or output in other, user-defined units (selection “15”).
For this purpose, a conversion factor can be entered in this function giving the exact ratio of how many of the desired units correspond to the internally used reference “dm^3/s”.

1 dm^3/s = Factor × [1 user-defined unit]

Example:
1 dm^3/s is equivalent to
- 60 dm^3/min → factor = 60
- 1/100 hectoliter/s → factor = 0.01
- 0.7 kg/s with a fluid density of 700 kg/m^3 → factor = 0.7

Convert this factor into the format: “X,XXX” × $10^{\text{“y”}}$
Shown on the display: e.g. 1.000-1 corresponds to 1.000 × 10^{-1} = 0.1
or 5.678 2 corresponds to 5.678 × 10^2 = 567.8

Caution!

Caution!
EF77 always measures volumetric flow rate at actual operating conditions. The conversion method described here only applies to constant and exactly known process conditions.
Any deviation from the assumed process conditions can lead to significant errors. Generally the use of the TLV EC351 flow computer with pressure and temperature sensors is recommended to continuously calculate the exact corrected volume or mass.

Note!

Note!
- Please observe the detailed instructions and examples on the following pages for calculating the mass and corrected volume flow.
- Attach an adhesive label showing the engineering units on the field provided on the local display (see page 15).
- The user-defined units must be entered **before** setting the full scale value (function “FS”, see page 24).

Input:
Four-digit number with floating decimal point with a single figure exponent:
1.000-9 (corresponds to 1 × 10^{-9}) to 9.999 9 (corresponds to 9.999 × 10^9)

Function Group: SYSTEM UNITS

Instructions for user-defined mass units:

The following instructions explain in more detail pages 20 and 23.

Density at operating conditions in kg/m³ | For desired time base (not for totalizer) | For desired mass unit

$$[\ldots\ldots\ldots\ldots\ldots] = \frac{[\ldots\ldots\ldots\ldots\ldots]}{1000} \times [\ldots\ldots\ldots\ldots\ldots] \times \frac{1}{[\ldots\ldots\ldots\ldots\ldots]}$$

(or lb/ft³ ÷ 62.443)
(Using Specific Volume: 0.01602 ÷ ft³/lb)

.../s → 1
.../min. → 60
.../h → 3600
.../d → 86400

kg/... → 1
t/... → 1000
lbs/... → 0.4536

Factor (Example)	Display
86.4	8.640 1
8.737	8.737
0.1234	1.234-1
0.012	1.200-2
0.00787	7.870-3

Examples:
To display the mass flow of superheated steam at 200 °C (390 °F) and 12 bar (175 psig) in "kg/h".

According to the steam table the density is 5.91 kg/m³ :

$$\text{Factor} = \frac{5.91}{1000} \times 3600 \times \frac{1}{1} = 21.276 \rightarrow \text{“Fu12”} = 2.128\ 1$$

According to the steam table the Specific Volume is 2.46 ft³/lb:

$$\text{Factor} = \frac{0.01602}{2.46} \times 3600 \times \frac{1}{0.4536} = 51.69 \rightarrow \text{“Fu12”} = 5.169\ 1$$

To display the totalizer in "kg" for the same superheated steam application (density 5.91 kg/m³):

$$\text{Factor} = \frac{5.91}{1000} \times \frac{1}{1} = 0.005910 \rightarrow \text{“Fu14”} = 5.910\text{-}3$$

To display the totalizer in "lbs" (Specific Volume = 2.46 ft³/lb):

$$\text{Factor} = \frac{0.01602}{2.46} \times \frac{1}{0.4536} = 0.01436 \rightarrow \text{“Fu14”} = 1.436\text{-}2$$

Function Group: SYSTEM UNITS

Instructions for user-defined corrected volume units:

The following instructions explain in more detail pages 20 and 23.

Fluid density at operating conditions / For desired time base (not for totalizer) / For desired corrected volume unit

$$[\ldots\ldots\ldots\ldots] = \frac{[\ldots\ldots\ldots\ldots]}{[\ldots\ldots\ldots\ldots]} \times [\ldots\ldots\ldots\ldots] \times \frac{1}{[\ldots\ldots\ldots\ldots]}$$

Fluid density at reference conditions (e.g. = 0 °C and 1.013 bar)

.../s → 1
.../min. → 60
.../h → 3600
.../d → 86400

Ndm^3/... → 1
Nm^3/... → 1000
SCF/... → 28.317
Imp.gallon/… → 4.546

Factor (Example)	Display
86.4	8.640 1
8.737	8.737
0.1234	1.234-1
0.012	1.200-2
0.00787	7.870-3

Examples:
To display the *corrected volume flow* of compressed air at 3 bar and 60 °C in "Nm^3/h". The density is 3.14 kg/m^3 for those operating conditions. The density of air at reference conditions (1.013 bar, 0 °C) is 1.2936 kg/m^3 :

$$\text{Factor} = \frac{3.14}{1.2936} \times 3600 \times \frac{1}{1000} = 8.738 \rightarrow \text{“Fu12” = 8.738}$$

To display the *corrected volume total* in "Nm^3" for the same application (compressed air at 3 bar, 60 °C):

$$\text{Factor} = \frac{3.14}{1.2936} \times \frac{1}{1000} = 0.002427 \rightarrow \text{“Fu14” = 2.427-3}$$

For **ideal gases** the following simplified formula can be used to calculate corrected volumes only when reference conditions are at 0 °C and 1.013 bar (abs):
[Reference conditions when using US Imperial units are 60 °F and 14.7 psia]:

For desired time base (not applicable for totalizer) / Process pressure in bar (abs) [psia] / Using US Imperial units → [ ]

$$[\ldots\ldots\ldots\ldots] = \frac{[\ldots\ldots\ldots\ldots] \times [\ldots\ldots\ldots\ldots] \times [520]}{[\ldots\ldots\ldots\ldots] \times 1.013 \times ([\ldots\ldots\ldots\ldots] + 273.15)}$$

$$[14.7] \qquad [460]$$

See above table for conversion to mantissa and exponent

For desired corrected volume
Ndm^3/... → 1
Nm^3/... → 1000
SCF/… → 28.317
Imp.gallon/… → 4.546

Process temperature °C [°F]

Function Group: SYSTEM UNITS

User-defined Unit Totalizer

Fu14

As well as the engineering units offered (selection “0 – 4” in function “Fu11”, see page 19) for the totalizer, other user-defined units (selection “5”) can also be used.
For this purpose, a conversion factor can be entered in this function giving the exact ratio of how many of the desired units correspond to the internally used reference “dm^3/s”.

1 dm^3/s = Factor × [1 user-defined unit]

Example:
1 dm^3/s is equivalent to
- 1000 cm^3 → factor = 1000
- 1/100 hectoliters → factor = 0.01
- 0.7 kg/s with a fluid density of 700 kg/m^3 → factor = 0.7

Convert this factor into the format: “X,XXX” × $10^{\text{“Y”}}$
Shown on the display: e.g. 1.000-1 corresponds to $1.000 \times 10^{-1} = 0.1$
or 5.678 2 corresponds to $5.678 \times 10^{2} = 567.8$


Caution!

Caution!
EF77 always measures volumetric flow rate at actual operating conditions. The conversion method described here only applies to constant and exactly known process conditions.
Any deviation from the assumed process conditions can lead to significant errors. Generally the use of the TLV EC351 flow computer with pressure and temperature sensors is recommended to continuously calculate the exact corrected volume or mass.


Note!

Note!
- Please observe the detailed instructions and examples on the following pages for calculating the mass and corrected volume flow.
- Attach an adhesive label showing the engineering units on the field provided on the local display (see page 15).
- The user-defined units must be entered **before** setting the pulse value (function “PSCA”, see page 26).

Input:
Four-digit number with floating decimal point with a single figure exponent:
1.000-9 (corresponds to 1×10^{-9}) to 9.999 9 (corresponds to 9.999×10^{9})

Function Group: CURRENT OUTPUT

Output Signal

Fu20

Selecting the electrical output signal. The various types of signal are described more fully on page 13 “Electrical Connections”.

Selection:

4-20 [mA]	4 – 20 mA current output signal
PULS	Scaleable Open Collector pulse output
PF	PFM current pulses for direct, non-scaleable output of vortex frequency

Value for 20 mA (Full scale value)

FS

Scaling the full scale value assigns the 20 mA current to a defined flow rate. This value also defines 100% for the bar graph and for selection “Display flow rate in %” (see page 27).
The engineering units for flow rate can be defined in function “Unit” (see page 19). Please first choose the desired measuring unit before entering the full scale value in this function.


Note!

Note!
Zero flow is always defined as the lower range value assigned to 4 mA.

Input:
Four-digit number with floating decimal point, e.g. 126.7 (dm^3/min)
Factory setting: ***as ordered;*** if not specified by the customer, factory setting is ***according to*** the table on page 46.

Time Constant

Fu22

The time constant determines the current output signal and the display responds quickly (small time constant) to rapidly fluctuating flow rates or delayed (long time constant).

The time constant defines the lower limit of the response time of the current output. If the vortex period is larger than the selected time constant, then the response time is increased automatically.

Input:
Three-digit number with fixed decimal point: 0.2 – 100.0 (seconds)
Factory setting: ***5.0*** (seconds)

Fail-safe Mode

Fu23

In cases of fault it is advisable for safety reasons that the current output assumes a previously defined status which can be set in this function. This function is only available if the setting “4-20” is selected in the function “Fu20" (see above).

Selection:

HI	The current signal is set to 22 mA on error
Lo	The current signal is set to 3.6 mA on error
run	Normal measured value given despite error

Function Group: CURRENT OUTPUT

Simulation (Current output)

Fu24

This function enables an output current to simulate 0%, 50% or 100% of the current range. It also enables the error status 3.6 mA and 22 mA to be simulated.

Example:
Checking the wiring or connected instruments is only possible if the appropriate setting is selected in the function “Fu20” (see page 24).

Note!
- The simulation mode affects only the current output, i.e. totalizer and flow display are operating normally.
- During simulation the function “StAt” shows the warning message “E205” (see page 29).

Note!

Selection:
OFF (current output follows actual measured value) -
3.6 [mA] – 4 [mA] – 12 [mA] – 20 [mA] – 22 [mA]

Nominal Current

Fu25

Display of output current which is calculated using the actual flow rate.

This function is only available if the setting “4-20” is selected in function “Fu20” (see page 24).

Display:
4.0 – 20.5 [mA]
(or 3.6 or 22.0 mA on error; see function “Fu23”, page 24)

Function Group: OPEN COLLECTOR OUTPUT

Pulse Value

PSCA

The pulse value indicates the amount of flow corresponding to one pulse. This function is available only if the setting “PULS” is selected in function “Fu20” (see page 24).
The engineering units for pulse value can be selected in function “Fu11” (see page 19).
Select the pulse value so that the pulse frequency for maximum flow does not exceed 100 Hz.

Selection:
Four-digit number with floating decimal point, e.g. 1.000 m^3/pulse
Factory setting: ***dependent*** on nominal diameter and type of fluid (gas, liquid).

Pulse Width

Fu31

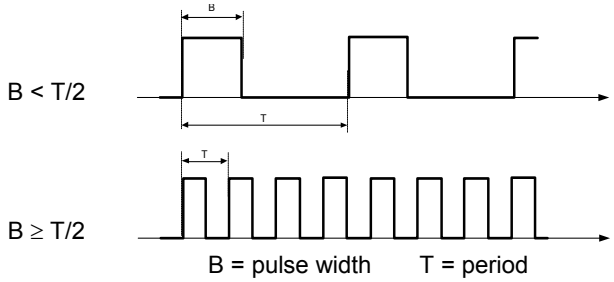
The pulse width can be set in the range 0.05 – 2.00 s.
This function is only available if the setting “PULS” is selected in function “Fu20” (see page 24).

Selection:
Three-digit number with fixed decimal point: 0.05 – 2.00 [s]
Factory setting: ***0.5 [s]***

Note!

Note!
• Standard EF77 (switch position “passive”): 0V = no pulse

If the frequency resulting from the selected pulse value at actual flow is too large (selected pulse width B ≥ T/2), then the pulse width is automatically reduced to half the periodicity (50/50 duty cycle).



B = pulse width T = period

Simulation (Pulse output)

Fu32

With this function predefined frequency signals can be simulated, for example, to check any instruments connected.
This function is only available if the setting “PULS” is selected in function “Fu20” (see page 24).

Note!

Note!
The simulation affects only the simulated three-wire pulse output, i.e. totalizer and flow display are operating normally.
During simulation the function “Stat” shows the warning message “E206” (see page 29).

Selection:
OFF– 1 [Hz] – 50 [Hz] – 100 [Hz]

Nominal Frequency

Fu33

Display of output frequency which is calculated using the actual flow rate.
This function is only available if the setting “PULS ” is selected in function “Fu20” (see page 24).

Display:
Four-digit number with floating decimal point: 0.000 – 100.0 [Hz]

Function Group: DISPLAY

Display Mode

dISP

Selecting the variable to be displayed during normal operation (“HOME position” = standard display).
If you change the factory setting, please attach an adhesive label showing the engineering unit to the field provided on the local display.

Selection:
PErc = Display flow rate in %
rAtE = Display flow rate (volume/time, see page 18)
Ltot = Display totalizer (see page 18)
Htot = Display totalizer overflow (see page 18)

Note!
- For setting “PErc“, the value shown on the display refers to the full scale value set in function “FS” (see page 24)
- Display damping is set with function “Fu22” (see page 24)


Note!

Reset Totalizer

Fu41

This function sets the totalizer (including overruns) to “zero” (reset).

Selection:
ESC = Totalizer will not be reset
rESE = Totalizer is reset to zero

Function Group: SYSTEM PARAMETERS	
Customer Code Fu50	Selecting a personal code number by which programming can be enabled. The following points should be noted: • The code number can only be altered when programming has been enabled. • When programming is locked this function is not available and access to the personal code number by third parties is not possible. • Programming is **always** enabled with customer code “0”. **Input:** Max. four-digit number: 0 – 9999 Factory setting: ***77***
Access Code CodE	All data of the EF77 measuring system are protected against unauthorized changes. Only by entering a code number is programming enabled and the settings of the instrument can then be changed. If in any function the keys “+/-” are pressed, then the measuring system jumps automatically into this function and the display shows the “CodE” prompt to enter the code number (if programming is locked): Enter code number 77 (factory set) or personal code number (see above, function “Fu50”) Lock programming: After jumping to the HOME position, programming is locked again after 60 seconds if no key is pressed during this time. Programming can also be locked by entering any number (not the code number) in this function. Note! If you can no longer find your personal code number, then TLV will be pleased to help you. **Input:** Max. four-figure number: 0 – 9999 Factory setting: ***0***

Note!

Function Group: SYSTEM PARAMETERS

Meter Status

StAt

The appropriate error message is shown in this function if the EF77 measuring system recognizes an error. This function is only available if an error has occurred. Errors which occur during operation are shown by a flashing display.
A list of all system errors and alarm messages is given on page 32.

Note!
- When more than one error is present, the one with the highest priority is displayed.
- When operating in the programming mode, no system or warning messages will be shown (except when in functions “Fu00”, “Fu01”, “Fu02”, “Fu03”, “Fu25” and “Fu33”, i.e. all functions displaying measured values).
- Once the error has been corrected, the normal measured value will again be shown on the display.

Note!

Display and remedial action
See Section “Trouble-shooting” on page 32.

Software Version

Fu53

Display of current software version.
The numbers have the following meaning:

1 . 1 . 02
- Number changes if minor alterations have been made to the new software. This also applies to special versions of the software.
- Number changes if the new software contains additional functions.
- Number changes if basic alterations have been made to the software.

Hardware Version

Fu55

Display of current hardware version.
The numbers have the following meaning:

1 . 1 . 02
- Number changes if minor alterations have been made to the new hardware. This also applies to special versions of the hardware.
- Number changes if the new hardware contains additional functions.
- Number changes if basic alterations have been made to the hardware.

Function Group: MEASURING SYSTEM DATA

Fluid

APPL

Selects whether a fluid or a gas (or steam) is to be measured.
The nominal diameter and the setting selected here define the filter setting of the preamplifier.


Note!

Note!
Changing settings in this function also requires a change in the full scale value (function “FS”, see page 24).

Selection:
LI = flow measurement for liquids
GAS = flow measurement for gas/steam
Factory setting: ***according to order;*** if not specified by the customer, ***“LI”*** is set.

Nominal Diameter

dn

Selecting the nominal diameter of the flowmeter.


Caution!

Caution!
Any alteration to the nominal diameter affects the entire measuring system and is only required when replacing the flowmeter electronics. It is then necessary to enter a new K-factor in function “CALF” (see below).

Selection:
15 – 25 – 40 – 50 – 80 – 100 – 150 – 200 – 250 – 300
Factory setting: ***dependent*** on the flowmeter

K-factor Sensor

CALF

The K-factor describes how many vortices per unit volume (1 dm^3) occur in the sensor. This value is determined in the factory by calibration and then printed on the meter body.


Caution!

Caution!
The K-factor should not be altered under normal circumstances.

In order to provide an exact value of K-factors below 1.000 they are shown on the display in logarithmic form: “X.XXX -Y”

Example:
0.9871 is shown as “9.871 -1”
0.03620 is shown as “3.620 -2”

Input:
Four-digit number with floating decimal point
Min. adjustable value: 1.000 -2 ($pulse/dm^3$) corresponds to
0.010 ($pulse/dm^3$)
Max. adjustable value: 999.9 ($pulse/dm^3$)
Factory setting: ***dependent*** on the flowmeter

Function Group: MEASURING SYSTEM DATA

Sensor Temperature Coefficient

Fu63

The temperature coefficient describes the effects of process temperature on the calibration of the instrument. This coefficient is a function of the meter body and is correctly adjusted in the factory. It must only be altered if a meter body made of another material is mounted at a later date.
A setting in this function affects the internal totalizer and the 4 – 20 mA current output or the scaleable pulse output. It has no effect on the PFM output signal (function "Fu20", see page 24). Any setting in this function affects measurement only if the value of the process temperature "Fu64" is set to a different value than the factory setting 293 K.

Input:
Four-digit fixed decimal point: 1.000 – 9.999 ($\times 10^{-5}$/ Kelvin)
Factory setting: ***4.88*** ($\times 10^{-5}$/ Kelvin) for cast stainless steel A351-CF3M (1.4435)

Process Temperature

Fu64

The flowmeter (measuring pipe and bluff body) expands according to the process temperature and affects the calibration of the instrument. This effect is proportional to the difference from the calibration temperature 293 K (20 °C, 68 °F). By entering the average process temperature, the internal totalizer and the 4 – 20 mA current output or scaleable pulse output are thus corrected.
The PFM output signal, however, cannot be corrected internally. The output signal is selected in function "Fu20" (see page 24).
The various output signals are described in section "Electrical Connections" (see page 13).
Only an external correction can be made with changing operating temperature or if the PFM output signal is set in the function "Fu20", e.g. in the EC351 flow computer. In this case the factory set value 293 K (20 °C, 68 °F) will be used and the temperature coefficient of the sensor 4×10^{-5}/Kelvin for A351-CF3M (1.4404) meter body) will be set in the flow computer (see function "Fu63").

Input:
Number with fixed decimal point 0 – 999 K (Kelvin)
(-273 –726°C, 460 –1339 °F)
Factory setting: ***293 K***; this corresponds to 20 °C (68 °F)

Caution:
The approved operating temperature of the measuring system is not affected by this setting. Note therefore the application limits given in Section 9 "Technical Data" (see page 41).

Caution!

Amplification

Fu65

All EF77 flowmeters are set for optimum operation at process conditions stated by the customer when ordering.
Under certain process conditions the effects of interference signals (e.g. by strong vibration) can be suppressed by adjusting the amplifier.
Adjusting the amplifier can also extend the measuring range:
- For slow flowing liquid with low density and weak interference effects → choose a higher amplification level
- For fast flowing fluid with high density and strong interference effects (plant vibration) or pressure pulses → choose a lower amplification level

An incorrectly set amplifier can have the following consequences:
- The measuring range is limited so that small flow rates are no longer detected or indicated → increase amplification.
- Unwanted interference effects are detected so that flow is still indicated even under no-flow conditions → reduce amplification.

Selection:
1 = very low
2 = low
nor = normal
3 = high

7 Trouble-shooting

The EF77 measuring system operates without the need for maintenance. However, if a fault should occur or incorrect measurements are suspected, then the following instructions will be of help in identifying the cause of and remedying any possible errors.


Warning!

Warning!
All local regulations and all safety instructions in this operating manual are to be strictly observed when making electrical connections.

The EF77 measuring system distinguishes between two kinds of errors:

System error
This error directly affects flow measurement → remedy the error immediately.
- The operating status LED does not light up.
- Response of the current output → see Function “Fu23” (see page 24).
- The scaleable pulse output is not alive and no pulses are present.
- The totalizer remains at the last registered value.
- An error code is displayed in the HOME position and in the function “Stat” of the local display (see page 29).

System Errors		
Codes	Cause	Remedy
E101	Defective sensor	Check and, if necessary, replace the sensor through TLV
E102	EEPROM error (checksum error)	Contact TLV
E103	Communication error with sensor	Power up the measuring system or contact TLV
E106	Download active (i.e. configuration data is being digitally transmitted to the EF77 system)	The sensor will operate normally again once the download is finished
E116	An error has occurred during the download of configuration data	Reload the configuration data

Warnings
These errors do not affect flow measurement directly → The measurement system continues to measure, however the electrical output signal may be incorrect.
- The operating status LED remains lit.
- The actual measured value flashes in the HOME position of the local display.
- An error code is displayed in the function “Stat” of the local display

Warnings		
Codes	Cause	Remedy
E203	The measuring range of the current output is exceeded	Check the application (flow rate too high?) or readjust the full scale value (“FS”, see page 24)
E204	The measuring range of the pulse output is exceeded	Check the application (flow rate too high?) or readjust the pulse value (“PSCA”, see page 26)
E205	Current output in simulation mode	See function “Fu24” page 25
E206	Pulse output in simulation mode	See function “Fu32” page 26
E211	Correct value of totalizer is not guaranteed (checksum error)	Interrupt power supply briefly. In case of repeated warning → reset totalizer (see “Fu41” on page 27)

Note!
When more than one error is present, the one with the highest priority is displayed first. When operating in the programming mode, no system or warning messages will be shown on the local display except when in the functions “Fu00”, “Fu01”, “Fu02”, “Fu03”, “Fu25” and “Fu33” (i.e. all functions displaying measured values).
Once the error has been corrected, the normal measured value will again be shown on the local display.


Note!

The EF77 measuring system is fitted with an LED to indicate its operating status. This can be seen through the glass cover of those instruments which have a local display.
The LED can only be seen on those instruments without a local display once the aluminum cover to the electronics and wiring compartments has been removed.

LED does not light up
- Has the wiring been done according to the wiring diagrams on pages 13 and 14?
- Is the polarity of the power supply correct?
- Is there a voltage between 12 V and 30 V at Terminals 1 and 2 of the EF77? (Check the load on the cabling and any connected devices)
- The self-monitoring system has detected a system error (see page 32).

Local display flashes
- If the normal measured value flashes, then a warning is indicated (see page 32).
- If the figures “9999” flashes on the local display, then the current measured value can no longer be shown in the units selected. In such cases a larger scale of units must be selected in the function “Unit” (or “Fu11” for the totalizer) (see page 19).

No flow signal
- For liquids: Is the pipeline completely filled? The pipeline must always be completely filled to ensure accurate and reliable flow measurement.
- Has all packing material and protective disks been removed from the meter body?
- Is the electrical output signal (“Fu20”) set correctly (see page 24)?

Flow signal under no-flow conditions
Is the flowmeter subject to vibrations greater than 1g?
In such cases flow may be indicated under no-flow conditions due to the frequency and direction of oscillations (see “Technical Data”, page 41).

Remedial procedure on flowmeter:
– Turn the sensor through 90°. The measuring system is most responsive to vibration in the direction of sensor displacement. The vibration has less effect on the measuring system in other axes.
– The amplification can be reduced using the function “Fu65” (see page 31).

Remedial procedure with mechanical layout of the installation:
– If the source of the vibration (e.g. pump or valve) can be identified, then decoupling or supporting the source can reduce vibration.
– Supporting the pipeline near the flowmeter.

Poor or strongly varying flow signal

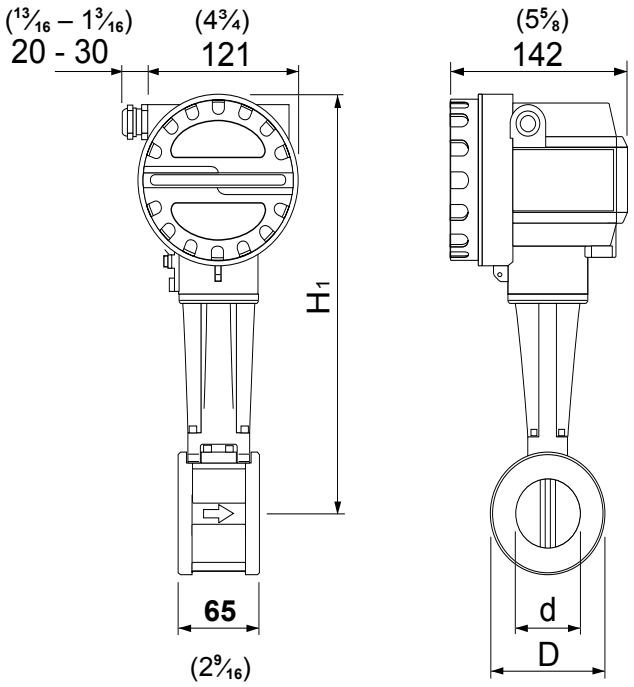
- Is the fluid to be measured single-phase and homogeneous?
  The fluid must be single-phase and homogeneous, and the pipeline always completely filled to ensure accurate and reliable flow measurement. In many cases the measuring result may be improved under poor conditions by taking the following measures:
  – For liquids with low gas content in horizontal pipelines, the flowmeter should be mounted with the head pointing downward or to one side. This improves the measuring signal as the sensor is positioned away from any gas bubbles.
  – For liquids with low solids content, the electronic housing should not be mounted pointing downward.
- Do the inlet and outlet sections correspond to the mounting instructions on page 8?
- Are gaskets of the correct internal diameter (not smaller than the pipeline) and correctly centered?
- Is the static pressure sufficiently large to prevent cavitation at the flowmeter?
- Is the flow within the measuring range of the flowmeter (see “Technical Data” page 41)?
  The start of the measuring range depends on the density and viscosity of the fluid which in turn are functions of temperature. With gases and steam, density is also a function of pressure.
- Are pressure pulsations superimposed on the operating pressure (e.g. due to piston pumps)? These pulsations may affect vortex shedding if they have a similar frequency to that of the vortex shedding itself.
- Have the correct units been selected for flow (“Unit”) or totalizer (“Fu11”) (see page 19)?
- Have the current output (“FS”) (see page 24) or pulse value (“PSCA”) (see page 26) been set correctly?
- Have the fluid (“APPL”) and nominal diameter (“dn”) been set correctly?
  “APPL” must be set to “LI” for liquids, and set to “GAS” for gases and steam. The nominal diameter of the flowmeter must agree with the setting “dn”. The settings in these two functions determine the filter settings and can thus affect the measuring range (see page 30).
- Does the K-factor of the instrument agree with the setting in the function “CALF” (see page 30)?

Maintenance / Calibration

If correctly installed, the meter will operate without maintenance. If installed as a production quality-relevant (ISO 9000) measurement point, the EF77 can be recalibrated by TLV on accredited calibration rigs, traceable according to EN 45001, and supplied with an internationally recognized certificate according to EA (European cooperation for Accreditation of Laboratories).

8 Dimensions and Weights

8.1 Dimensions EF77 – Flangeless Connection



Dimensions:
Blind transmitter is shown. Transmitter with the optional integrated indicator is 7 mm (¼") longer (149 mm, 5 7/8)

Flangeless version compatible with flange standards:

- DIN 2501, PN 10 – 40
- ASTM Class 150/300 RF
- JIS 10/20K

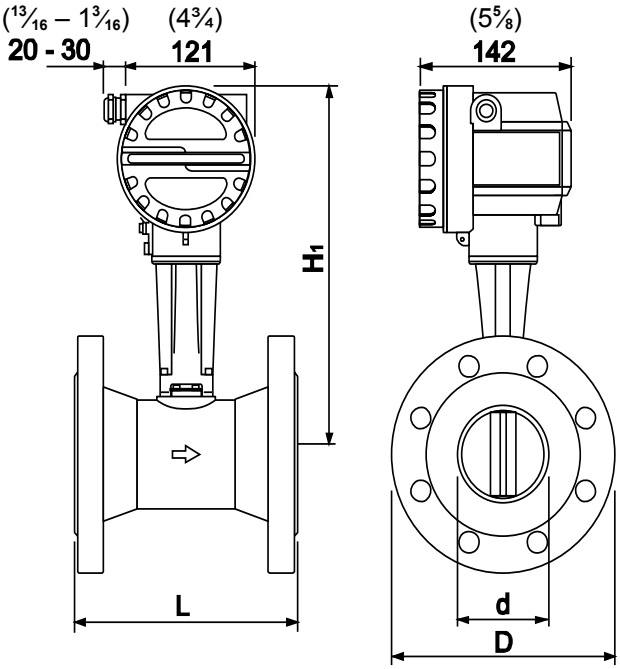
Mounting kits for self centering mounting between flanges can be ordered with the instrument (see p 11).

Units: mm (in)

Figure 19
Dimensions of EF77 with flangeless connection

DN DIN / JIS	Size ASTM	d mm	d (in)	D mm	D (in)	H_1 mm	H_1 (in)	Weight kg	Weight (lb)
15	½"	16.50	(5/8)	45.0	(1¾)	287	(11 5/16)	3.5	(8.1)
25	1"	27.60	(1 1/16)	64.0	(2½)	297	(11¾)	3.7	(8.1)
40	1½"	42.00	(1 5/8)	82.0	(3¼)	305	(12)	4.3	(9.1)
50	2"	53.50	(2 1/8)	92.0	(3 5/8)	312	(12¼)	4.6	(10)
80	3"	80.25	(3 3/16)	127.0	(5)	326	(12 7/8)	6.0	(11)
100	4"	104.75	(4 1/8)	157.2	(6 3/16)	339	(13 3/8)	7.0	(15)
150	6"	156.75	(6 3/16)	215.9	(8½)	365	(14 3/8)	9.5	(21)

8.2 Dimensions EF77 – Flanged Connection



Dimensions:
Blind transmitter is shown.
Transmitter with the optional integrated indicator is 7 mm (¼") longer (149 mm, 5⅞)

Flange standards:
- DIN 2501, PN 10 – 40 RF
- ASTM Class 150/300 RF
- JIS 10/20K

(ISO / DVGW for DN 15 – 150 (½ – 6 in))

Units: mm (in)

Figure 20
Dimensions of EF77 with flanged connection

DN	Size	Standard	Pressure Rating	d mm (in)	D mm (in)	H_1 mm (in)	L mm (in)	Weight kg (lb)
15	½"	DIN	PN 25/40	17.3 (11/16)	95 (3¾)	288 (11 5/16)	200 (7⅞)	5.5 (12)
		ASME	Cl. 150	15.7 (⅝)	89 (3½)			
			Cl. 300		95 (3¾)			
		JIS	20K	16.1 (⅝)				
25	1"	DIN	PN 25/40	28.5 (1⅛)	115 (4½)	295 (11 9/16)		7.5 (16)
		ASME	Cl. 150	26.7 (1 1/16)	108 (4¼)			
			Cl. 300		124 (4⅞)			
		JIS	20K	27.2 (1 1/16)	125 (4 15/16)			
40	1½"	DIN	PN 25/40	43.1(1 11/16)	150 (5 15/16)	303 (12)		10 (23)
		ASME	Cl. 150	40.9 (1⅝)	127 (5)			
			Cl. 300		156 (6⅛)			
		JIS	20K	41.2 (1⅝)	140 (5½)			
50	2"	DIN	PN 25/40	54.5 (2⅛)	165 (6½)	310 (12 3/16)		12 (28)
		ASME	Cl. 150	52.6(2 1/16)	152 (6)			
			Cl. 300		165 (6½)			
		JIS	10K, 20K	52.7(2 1/16)	155 (6⅛)			

Continued next page

DN	Size	Standard	Pressure Rating	d mm (in)	D mm (in)	H_1 mm (in)	L mm (in)	Weight kg (lb)
80	3”	DIN	PN 25/40	82.5 (3 1/4)	200 (7 7/8)	323 (12 3/4)	200 (7 7/8)	20 (45)
		ASME	Cl. 150	78.0 (3 1/16)	191 (7 1/2)			
			Cl. 300		210 (8 1/4)			
		JIS	10K	78.1 (3 1/16)	185 (7 1/4)			
			20K		200 (7 7/8)			
100	4”	DIN	PN 10/16	107 (4 1/4)	220 (8 11/16)	335 (13 3/16)	250 (9 13/16)	27 (61)
			PN 25/40		235 (9 1/4)			
		ASME	Cl. 150	102 (4)	227 (8 15/16)			
			Cl. 300		254 (10)			
		JIS	10K	102 (4)	210 (8 1/4)			
			20K		225 (8 7/8)			
150	6”	DIN	PN 10/16	159 (6 1/4)	285 (11 1/4)	359 (14 1/8)	300 (11 13/16)	51 (113)
			PN 25/40		300 (11 13/16)			
		ASME	Cl. 150	154 (6 1/16)	279 (11)			
			Cl. 300		318 (12 1/2)			
		JIS	10K	151 (6)	280 (11)			
			20K		305 (12)			
200	8”	DIN	PN 10	207 (8 1/8)	340 (13 3/8)	388 (15 1/4)		63 (140)
			PN 16					62 (138)
			PN 25	207 (8 1/8)	360 (14 3/16)			68 (151)
			PN 40		375 (14 3/4)			72 (160)
		ASME	Cl. 150	203 (8)	343 (13 1/2)			64 (142)
			Cl. 300		381 (15)			76 (169)
		JIS	10K		330 (13)			58 (129)
			20K		350 (13 3/4)			64 (142)
250	10”	DIN	PN 10	260 (10 1/4)	395 (15 9/16)	415 (16 5/16)	38 (14 15/16)	88 (195)
			PN 16		405 (15 15/16)			92 (204)
			PN 25	259 (10 3/16)	425 (16 3/4)			100 (222)
			PN 40		450 (17 3/4)			111 (246)
		ASME	Cl. 150	255 (10)	406 (16)			92 (204)
			Cl. 300		445 (17 1/2)			109 (241)
		JIS	10K		400 (15 3/4)			90 (199)
			20K		430 (16 15/16)			104 (230)
300	12”	DIN	PN 10	310 (12 3/16)	445 (17 1/2)	438 (17 1/4)	450 (17 3/4)	121 (268)
			PN 16		460 (18 1/8)			129 (285)
			PN 25	308 (12 1/8)	485 (19 1/16)			140 (310)
			PN 40		515 (20 1/4)			158 (349)
		ASME	Cl. 150	305 (12)	483 (19)			143 (316)
			Cl. 300		521 (20 1/2)			162 (358)
		JIS	10K		445 (17 1/2)			119 (263)
			20K		480 (18 7/8)			139 (357)

8.3 Dimensions Flow Conditioner – DIN

Material: Cast stainless steel A351 Gr. CF3M, DIN 1.4435

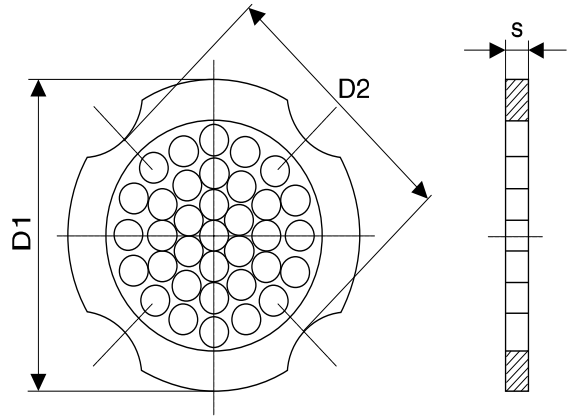


Figure 21
Flow conditioner

D1: The flow conditioner is clamped between bolts at its outer diameter
D2: The flow conditioner is clamped between bolts at the indentures

DN	Pressure Rating	Centering Diameter		D1 / D2	s		Weight	
		mm	(in)		mm	(in)	kg	(lb)
15	PN 10 – 40 PN 64	54.3 64.3	(2 1/8) (2 1/2)	D2 D1	2.0	(5/64)	0.04 0.05	(0.09) (0.11)
25	PN 10 – 40 PN 64	74.3 85.3	(2 15/16) (3 3/8)	D1 D1	3.5	(9/64)	0.12 0.15	(0.26) (0.33)
40	PN 10 – 40 PN 64	95.3 106.3	(3 3/4) (4 3/16)	D1 D1	5.3	(13/64)	0.3 0.4	(0.66) (0.88)
50	PN 10 – 40 PN 64	110.0 116.3	(4 5/16) (4 9/16)	D2 D1	6.8	(17/64)	0.5 0.6	(1.1) (1.3)
80	PN 10 – 40 PN 64	145.3 151.3	(5 3/4) (5 15/16)	D2 D1	10.1	(25/64)	1.4 1.4	(3.1) (3.1)
100	PN 10/16 PN 25/40 PN 64	165.3 171.3 252.0	(6 1/2) (6 3/4) (9 15/16)	D2 D1 D1	13.3	(17/32)	2.4 2.4 2.4	(5.3) (5.3) (5.3)
150	PN 10/16 PN 25/40 PN 64	221.0 227.0 252.0	(8 3/4) (8 15/16) (9 15/16)	D2 D2 D1	20.0	(25/32)	6.3 7.8 7.8	(13.9) (17.2) (17.2)
200	PN 10 PN 16 PN 25 PN 40 PN 64	274.0 274.0 280.0 294.0 309.0	(10 13/16) (10 13/16) (11) (11 9/16) (12 3/16)	D1 D2 D1 D2 D1	26.3	(1 1/32)	11.5 12.3 12.3 15.9 15.9	(25.4) (27.1) (27.1) (35.1) (35.1)
250	PN 10/16 PN 25 PN 40 PN 64	330.0 340.0 355.0 363.0	(25 3/8) (13 3/8) (14) (14 5/16)	D2 D1 D2 D1	33.0	(1 19/64)	25.7 25.7 27.5 27.5	(56.7) (56.7) (60.6) (60.6)
300	PN 10/16 PN 25 PN 40/64	380.0 404.0 420.0	(14 15/16) (15 15/16) (16 9/16)	D2 D1 D1	39.6	(1 9/16)	36.4 36.4 44.7	(80.3) (80.3) (98.6)

8.4 Dimensions Flow Conditioner – ASME

Material: Cast stainless steel A351 Gr. CF3M, DIN 1.4435

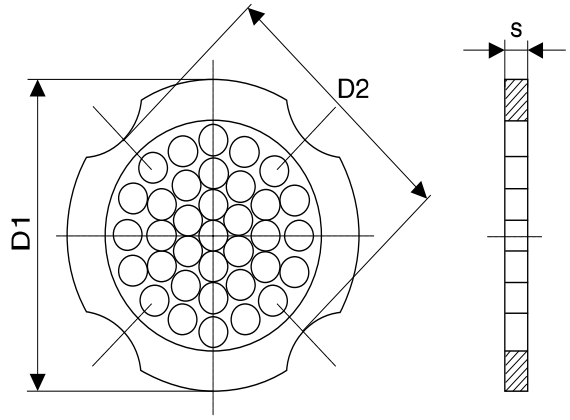


Figure 22
Flow conditioner

D1: The flow conditioner is clamped between bolts at its outer diameter
D2: The flow conditioner is clamped between bolts at the indentures

Size	Pressure Rating	Centering Diameter		D1 / D2	s		Weight	
		mm	(in)		mm	(in)	kg	(lb)
½”	Class 150 Class 300	51.1 56.5	(2) (2¼)	D1 D1	2.0	(5/64)	0.03 0.04	(0.07) (0.09)
1”	Class 150 Class 300	69.2 74.3	(2¾) (2 15/16)	D2 D1	3.5	(9/64)	0.12 0.12	(0.26) (0.26)
1½”	Class 150 Class 300	88.2 97.7	(3½) (3⅞)	D2 D2	5.3	(13/64)	0.3 0.3	(0.66) (0.66)
2”	Class 150 Class 300	106.6 113.0	(4 3/16) (4 7/16)	D2 D1	6.8	(17/64)	0.5 0.5	(1.1) (1.1)
3”	Class 150 Class 300	138.4 151.3	(5 7/16) (5 15/16)	D1 D1	10.1	(25/64)	1.2 1.4	(2.7) (3.1)
4”	Class 150 Class 300	176.5 182.6	(6 15/16) (7 3/16)	D2 D1	13.3	(17/32)	2.7 2.7	(6.0) (6.0)
6”	Class 150 Class 300	223.9 252.0	(8 13/16) (9 15/16)	D1 D1	20.0	(25/32)	6.3 7.8	(13.9) (17.2)
8”	Class 150 Class 300	274.0 309.0	(10 13/16) (12 3/16)	D2 D1	26.3	(1 1/32)	12.3 15.8	(27.1) (34.9)
10”	Class 150 Class 300	340.0 363.0	(13⅜) (14 5/16)	D1 D1	33.0	(1 19/64)	25.7 27.5	(56.7) (60.6)
12”	Class 150 Class 300	404.0 420.0	(15 15/16) (16 9/16)	D1 D1	39.6	(1 9/16)	36.4 44.6	(80.3) (98.3)

8.5 Dimensions Flow Conditioner – JIS

Material: Stainless steel SUS316, DIN 1.4401

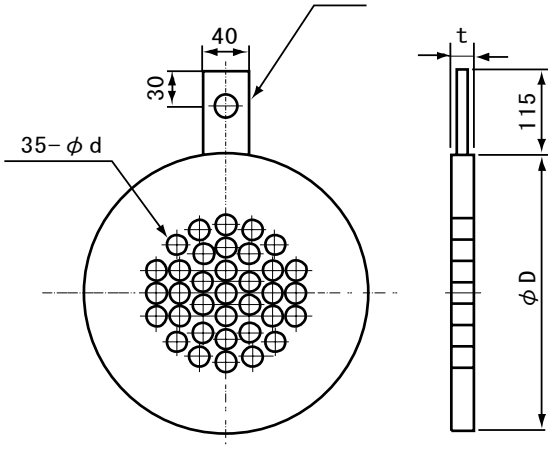


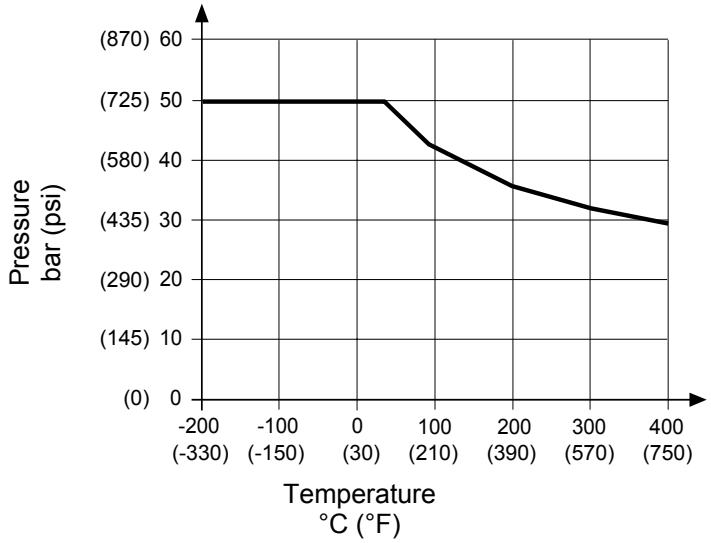
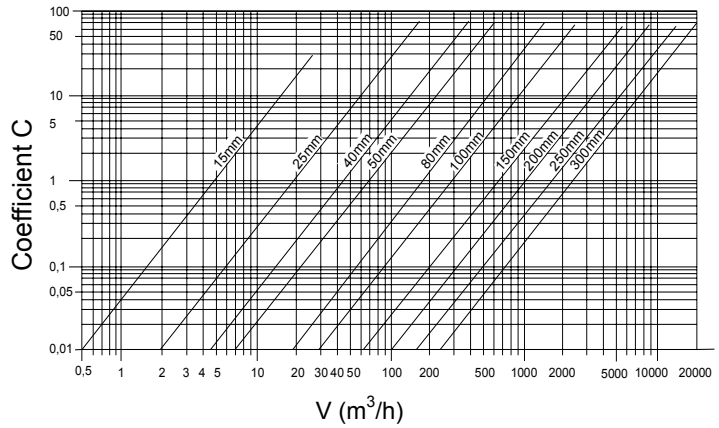
Figure 23
Flow conditioner

Size	Pressure Rating	ØD		t		Ød		Weight	
		mm	(in)	mm	(in)	mm	(in)	kg	(lb)
25	JIS 10K JIS20K	75	(2 15/16)	3.5	(9/64)	3.3	(1/8)	0.2	(0.44)
40	JIS 10K JIS20K	90	(3 9/16)	5.4	(13/64)	5	(13/64)	0.3	(0.66)
50	JIS 10K JIS20K	105	(4 1/8)	6.9	(17/64)	6.4	(1/4)	0.5	(1.1)
80	JIS 10K JIS20K	134 140	(5 1/4) (5 1/2)	10.2	(13/32)	9.6	(3/8)	1.0 1.1	(2.2) (2.4)
100	JIS 10K JIS20K	159 165	(6 1/4) (7 1/2)	13.3	(17/32)	12.6	(1/2)	1.7 1.9	(3.8) (4.2)
150	JIS 10K JIS20K	220 238	(8 11/16) (9 3/8)	19.6	(49/64)	18.6	(47/64)	4.5 5.5	(9.9) (12.1)
200	JIS 10K JIS20K	268 281	(10 9/16) (11 1/16)	26	(1 1/32)	24.8	(31/32)	8.2 9.4	(18.0) (21.7)
250	JIS 10K JIS20K	331 354	(13) (13 15/16)	32.3	(1 17/64)	30.8	(1 7/32)	15.5 18.7	(34.1) (41.1)
300	JIS 10K JIS20K	376 404	(14 13/16) (15 15/16)	38.7	(1 33/64)	36.9	(1 29/64)	22.8 30.9	(49.7) (68.0)

9 Technical Data

Applications	
Designation	Flow measuring system “EF77”
Function	Measurement of volumetric flow rate of saturated steam, superheated steam. gases and liquids. With constant process temperature and pressure, the EF77 can also output flow rates in units of mass, energy and corrected volumes.
Operation and System Design	
Measurement Principle	The EF77 vortex flowmeter operates on the physical principle of Karman vortex shedding.
Measurement System	The “EF77” instrument family consists of: • Transmitter: EF77 – Blind transmitter (standard) EF77 – Integrated indicator with local operation (optional) • Meter body: EF77 – Flangeless version (standard), DN 15 – 150 (½” – 6”) EF77 – Flanged version (optional), DN 15 – 300 (½” – 12”)
Input Variables	
Measured Variables	The average flow velocity and volumetric flow rate are proportional to the frequency of vortex shedding behind the bluff body.
Measuring Ranges	The measuring range is dependent on the fluid and the pipe diameter. • Full scale value: – Liquids: v_{max} = 9 m/s (30 ft/s) – Gas / steam: v_{max} = 75 m/s (248 ft/s) (DN 15 v_{max} = 46 m/s) (½” v_{max} = 152 ft/s) • Lower range value: – Depends on the fluid density and the Reynolds number, Re_{min} = 4000, Re_{linear} = 20,000 DN 15, 25: $v_{min} = 6/\sqrt{\rho}$ m/s with ρ in kg/m^3 ½”, 1”: $v_{min} = 4.92/\sqrt{\rho}$ ft/s with ρ in lb/ft^3 DN 40 – 300: $v_{min} = 7/\sqrt{\rho}$ m/s with ρ in kg/m^3 1½” – 12”: $v_{min} = 5.74/\sqrt{\rho}$ ft/s with ρ in lb/ft^3
Output Variables	
Output Signal	• 4 – 20 mA; full scale value and time constant are adjustable • PFM; two-wire current pulse output unscaled vortex frequency 0.5 – 2850 Hz, pulse width 0.18 ms • Scaleable pulse output (pulse width 0.05 – 2 s) Open collector (passive) or voltage pulses (active) selectable: passive: V_{max} =30 V, I_{max} = 10 mA, Ri = 500 Ω active: V_{out} = 10 – 28 V, I_{max} = 10 mA

Output Variables (continued)	
Signal on Alarm	The following applies for the duration of a fault: • LED: Does not light up • Current output: Programmable (3.6 mA, 22 mA or supplied values despite error) see page 24 • Open collector / pulse output: Not live and no longer supplies pulses • Totalizer: Remains at the last value calculated
Load	See graph on page 14
Galvanic Isolation	The electrical connections are galvanically isolated from the sensor.
Measuring Accuracy	
Reference Conditions	Error limits based on ISO/DIN 11631: • 20 – 30 °C (68 – 86 °F), 2 – 4 bar (29 – 58 psi) • Calibration rig traceable to national standards
Measured Error	• Liquids: < 0.75% o.r. for Re >20,000 < 0.75% o.f.s. for Re 4000 – 20,000 • Gas / steam: < 1% o.r. for Re >20,000 < 1% o.f.s. for Re 4000 – 20,000 Current output temperature coefficient < 0.03% o.f.s./Kelvin
Repeatability	≤ ±0.25% o.r.
Operating Conditions	
Installation Instruction	Any position (vertical, horizontal) For limitations and other recommendations see page 9.
Inlet / Outlet Selections	Inlet section: minimum 10 × D (D = Pipe inner diameter) Outlet section: minimum 5 × D (For detailed information on the relationship between pipe installation and pipe internals see page 9)
Ambient Temperature	-40 – +60 °C (-40 – 140 °F) When mounted outside, it is recommended that it is protected from direct sunlight by a sun shade, especially in warm climates with high process temperatures.
Ingress Protection	IP 67 (NEMA 4X)
Shock and Vibration Resistance	At least 1 g in every axis over the whole frequency range up to 500 Hz
Electromagnetic Compatability (EMC)	To EN 50081 Part 1 and 2 / EN 50082 Part 1 and 2 and NAMUR industrial standard

Process Conditions	
Process Temperature	• Fluid: -200 – +400 °C (-330 – +750 °F) Flangeless type instruments of sizes DN 100 (4") and DN 150 (6") may not be mounted in orientation according to position B (see page 9) for fluid temperatures above 200 °C (400 °F). • Seal: Graphite (Standard) -200 – +400 °C (-330 – +750 °F) Fluorocarbon [FKM] (O) -15 – +175 °C (+5 – +345 °F) Perfluorinated elastomer [FFKM] (O) -20 – +220 °C (-15 – +430 °F) Fluorine resin [PTFE] (O) -200 – +260 °C (-330 – +500 °F) (O) - Option
Process Pressure	DIN: PN 10 – 40 ASME: Class 150 / 300 JIS: 10K / 20K Pressure-temperature curve of the EF77: 
Pressure Loss	Dependent on nominal diameter and fluid: ΔP (mbar) = coefficient C × density ρ (kg/m^3)  1 mbar = 1.45 × 10^{-2} psi 1 kg/m^3 = 6.243 × 10^{-2} lb/ft^3 1 m^3/h = 3.531 ft^3/h

Mechanical Construction	
Construction / Dimensions	See pages 35 to 39.
Weight	See pages 35 to 39.
Materials: *Transmitter Housing* *Sensor* *– Meter Body* *– Sensor* *– Pipe Stand* *Gaskets*	 Powder-coated die-cast aluminum Cast stainless steel A351 Gr. CF3M (1.4435) Wetted parts: – Stainless steel AISI316L (1.4404), complying to NACE MR0175 Non-wetted parts: – Cast stainless steel CF3 (1.4306) Cast stainless steel A351 Gr. CF8 (1.4308) Graphite (standard) Fluorocarbon [FKM] (option) Perfluorinated elastomer [FFKM] (option) Fluorine resin [PTFE] (option)
Cable Entries	Power supply and signal cable (outputs): Cable entry PG 13.5 (5 – 11.5 mm, $^{3}/_{16}$ – $^{7}/_{16}$ in) or Thread for cable entries: M20 × 1.5 (8 – 11.5 mm) ½" NPT G½"
Process Connections	Flangeless: Mounting set (see page 11) for flanges: – DIN 2501, PN 10 – 40 – ANSI B16.5, Class 150/300 – JIS B2238, 10K/20K Flanged: – DIN 2501, PN 10 – 40, raised face acc. to DIN 2526 form C – ANSI B16.5, Class 150/300 – JIS B2238, 10K/20K
User Interface	
Operation Procedure, Display, Communication (for version with integrated indicator and local operation)	• Local operation using 4 keys for programming all functions in the TLV operating matrix (see page 15) • LCD: four-figure with 3 decimal points two-figure with exponent bar graph as flow indicator in % • LED: for status indication
Power Supply	
Power Supply	12 – 30 V DC
Power Consumption	<1 W DC (including sensor)
Power Failure	• LED → off • The totalizer remains at the value last shown. • All programmed data remain in the EEPROM.

9.1 Flow Rate for Saturated Steam

EF77 - 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

EF77 - 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

9.2 Flow Rate for Air or Water

	EF77 - Flangeless				EF77 - Flanged			
DN / Size	**Air** (0 °C, Atmos. Press.)		**Water** (20 °C)		**Air** (0 °C, Atmos. Press.)		**Water** (20 °C)	
DIN / ASME	Min	Max	Min	Max	Min	Max	Min	Max
DN 15 / ½”	4.1	35	0.19	6.9	2.9	24	0.16	4.9
DN 25 / 1”	12	161	0.41	19	8.9	125	0.32	15
DN 40 / 1½”	31	374	1.11	44	26	307	0.91	36
DN 50 / 2”	50	606	1.80	72	43	513	1.52	61
DN 80 / 3”	113	1365	4.04	163	95	1151	3.41	138
DN 100 / 4”	191	2326	6.88	279	164	1995	5.90	239
DN 150 / 6”	428	5210	15.40	625	373	4538	13.5	544
DN 200 / 8”	—	—	—	—	715	8712	25.8	1045
DN 250 / 10”	—	—	—	—	1127	13735	40.6	1648
DN 300 / 12”	—	—	—	—	1617	19700	58.3	2364

9.3 Factory Settings (Transmitter)

EF77 - Flangeless				
DN / Size	End of Measuring Range [dm^3/s] Function “FS” (see page 24)		Pulse Value [dm^3/Imp] Function “PSCA” (see page 26)	
DIN / ASME	Gas	Liquid	Gas	Liquid
DN 15 / ½”	10	2	0.1	0.1
DN 25 / 1”	50	6	1.0	0.1
DN 40 / 1½”	110	13	10.0	1.0
DN 50 / 2”	170	20	10.0	1.0
DN 80 / 3”	400	50	10.0	1.0
DN 100 / 4”	650	80	10.0	1.0
DN 150 / 6”	1500	180	100.0	10.0

EF77 - Flanged				
DN / Size	End of Measuring Range [dm^3/s] Function “FS” (see page 24)		Pulse Value [dm^3/Imp] Function “PSCA” (see page 26)	
DIN / ASME	Gas	Liquid	Gas	Liquid
DN 15 / ½”	10	2	0.1	0.1
DN 25 / 1”	50	6	1.0	0.1
DN 40 / 1½”	110	13	10.0	1.0
DN 50 / 2”	170	20	10.0	1.0
DN 80 / 3”	400	50	10.0	1.0
DN 100 / 4”	650	80	10.0	1.0
DN 150 / 6”	1500	180	100.0	10.0
DN 200 / 8”	2500	300	100.0	10.0
DN 250 / 10”	4000	460	100.0	10.0
DN 300 / 12”	5600	660	100.0	10.0

10 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:
   - Malfunctions due to improper installation, use, handling, etc., by other than TLV CO., LTD. authorized service representatives.
   - Malfunctions due to dirt, scale, rust, etc.
   - Malfunctions due to improper disassembly and reassembly, or inadequate inspection and maintenance by other TLV CO., LTD. authorized service representatives.
   - Malfunctions due to disasters or forces of nature.
   - Accidents or malfunctions due to any other cause (such as water hammer) beyond the control of TLV CO., LTD.

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

11 Service

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