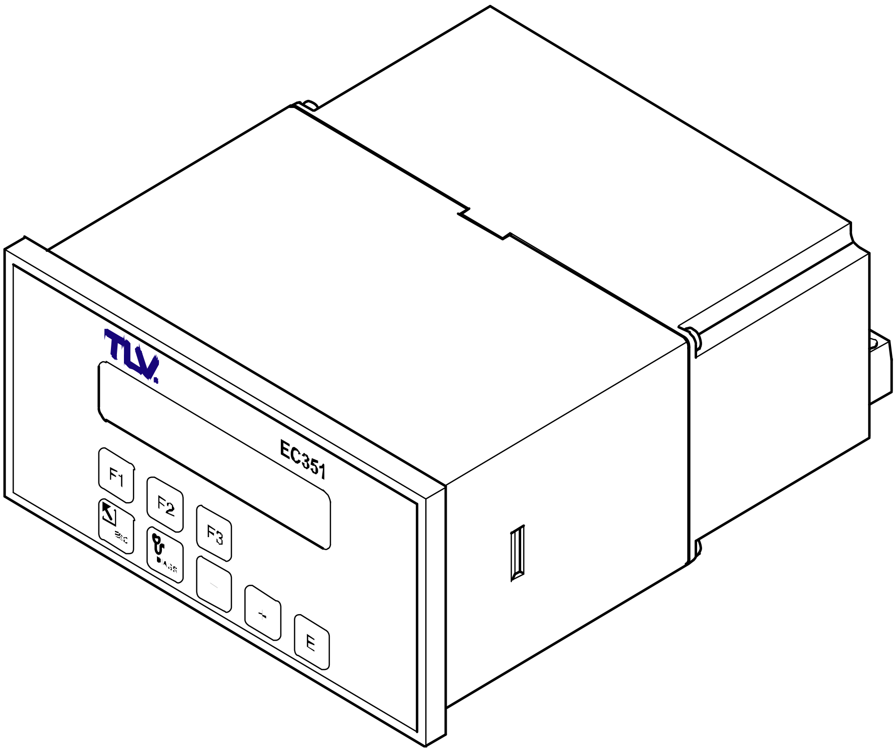
172-65297MA-02 (EC351 Flow Computer)   29 July, 2013

ISO 9001/ ISO 14001

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

Instruction Manual



Flow Computer
EC351

Contents

1 Safety Instructions

1.1 Correct Usage

- The EC351 is a flow computer that combines signals from flowmeters with those from pressure, temperature and density sensors.
- The manufacturer assumes no liability for damage caused by incorrect use of the instrument. Modifications and changes to the instrument may not be carried out.

1.2 Dangers and Notes

The EC351 flow computer is designed and checked according to the regulations in force EN 60950 “Safety of information technology equipment, including electrical business equipment”. A hazardous situation may occur if the flow computer 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, a safety hazard, or destruction of the instrument. Please strictly observe the instructions supplied and proceed carefully.

Caution!

Caution!
A “caution” indicates actions or procedures that, if not performed correctly, may lead to personal injury or faulty operation of the instrument. Please strictly 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 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.
- Ensure that the measuring system is correctly wired up according to the wiring diagrams. Protection against accidental contact is no longer assured when the housing cover is removed (danger from electric shock). The housing may only be opened by trained personnel.

1.4 Repairs

Before an EC351 is sent to TLV for repair, a note must always be enclosed containing a description of the fault and the application.

1.5 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

Function and Fields of Application

The EC351 flow computer combines signals from flowmeters with those from pressure, temperature and density sensors. Using various flow equations, the computer is able to calculate variables for industrial measurement and control:

- Mass, operating volume and standard volumetric flow
- Heat flow
- Delta heat
- Combustion heat

All data required for steam and water such as saturated steam curves, density- and specific heat tables are permanently stored in the flow computer. For various other fluids, such as air, natural gas and other fuels, default data is stored and can be modified by the user according to individual process conditions. This eliminates time-consuming searches in reference manuals. Measured and calculated variables can be displayed in selected engineering units, assigned to various outputs and printed out either automatically at programmed intervals or by pressing a key (see table on page 57).

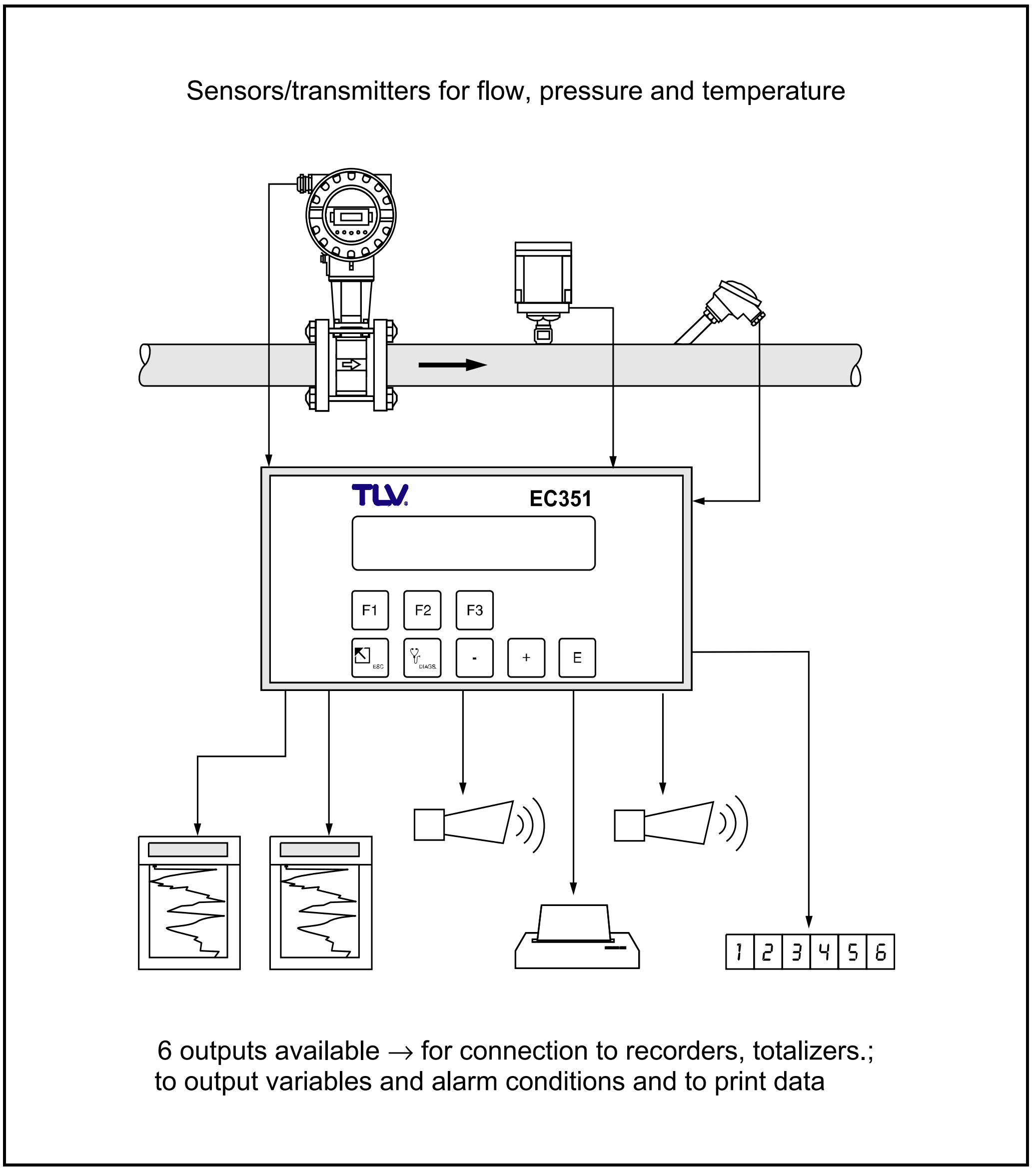


Figure 1
A typical application for the flow computer

Operation

The “Quick Setup” function and the three function keys permit fast commissioning, especially for standard applications. For special applications, the flow computer offers a wide range of functions that the user can individually set, thereby tailoring the unit to the process conditions. All functions can be configured using the TLV programming matrix (see page 73).

Display

The flow computer is equipped with a two-line backlit display. Process data, error messages as well as dialogue text for programming can be displayed in three different languages: English – German – French.

Inputs and Outputs

The flow computer has configurable inputs for flowmeters as well as pressure, temperature and density transmitters. The flow input processes linear signals as well as signals from differential pressure flowmeters (with or without internal square root extraction). The flow signal can also be processed using an internal 16-point linearization table. Measured or calculated variables are available at the outputs as current or pulse signals. In addition, the flow computer has two configurable relays that can be set to indicate limit or alarm conditions, or to supply low-frequency pulses to totalizers or process control systems.

All inputs and outputs can be configured using the TLV programming matrix:
- Input signal type
- Assignment of outputs
- Pulse output signal type
- Range scaling

The serial interface (RS 232) enables a printer to be connected for recording process data and configured parameters in the selected language.

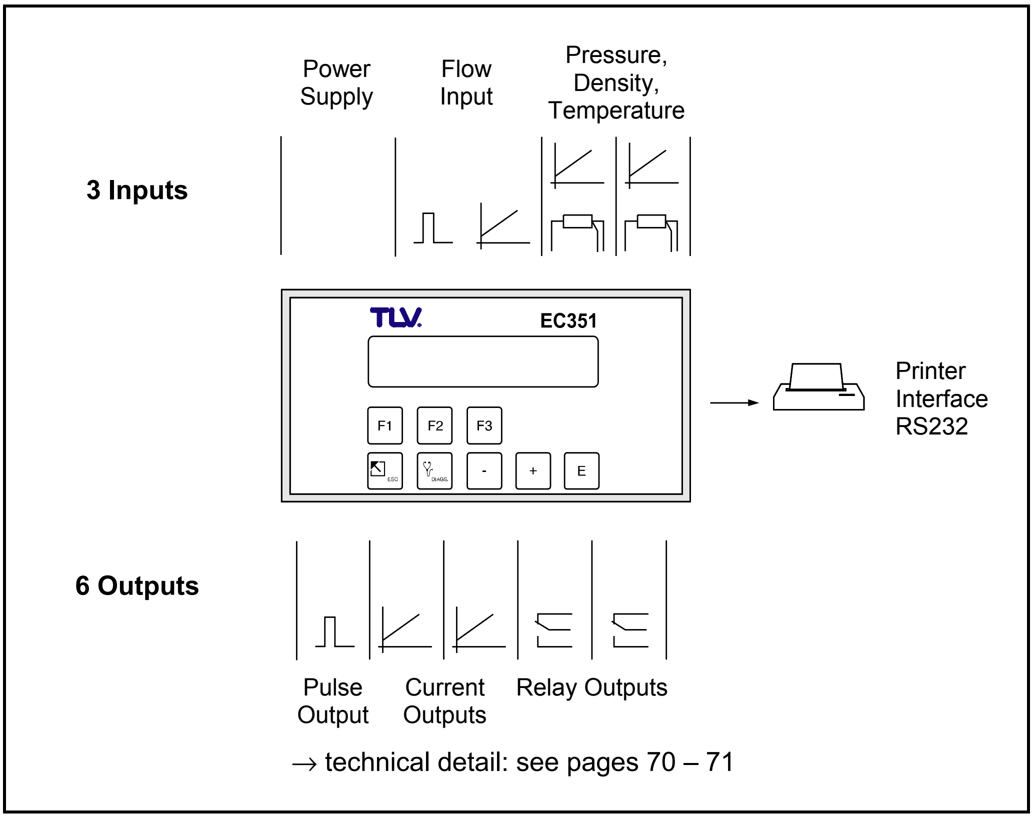


Figure 2
Possible connections: inputs and outputs

3 Mounting and Installation

The EC351 flow computer is available only in a panel mount housing (see Fig. 3).

Caution!
The instructions given in this section are to be observed at all times to ensure correct operation of the measuring system:

- There must be no vibration where the instrument is mounted.
- Observe the permissible ambient temperature (0 – +50 °C, 32 – 122 °F) during operation. Mount the instrument in a shaded area. Direct sunlight can be prevented by fitting a protective cover.
- Install the instrument only in a place that is clean and dry.
- Front panel protection type (panel mount housing):
  To maintain protection type IP65/NEMA 4X, the unit has to be mounted with the bezel adaptor and the gasket (supplied with the mounting kit). The bezel has to be glued to the unit with silicon (see Figure below).

Caution!

Procedure for mounting in a control panel (standard mounting)

① Prepare the opening for the installation in the control panel (see below).

② Slide the housing through the control panel cut out from the front. Depth of instrument = 163 mm ($6\frac{7}{16}$ in). Reserve additional space for wiring!

③ Hold the instrument horizontal and slide the mounting bracket over the housing from behind until the clip snaps into the groove in the housing.

④ Tighten the screws until the housing of the flow computer is attached firmly to the panel control.

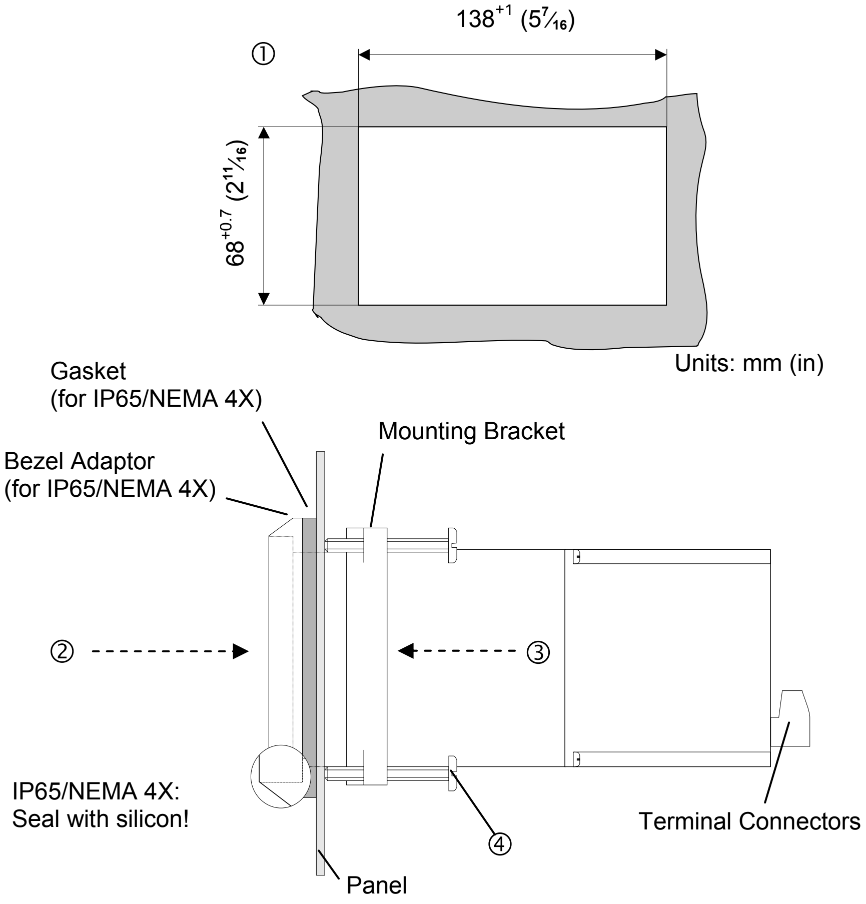
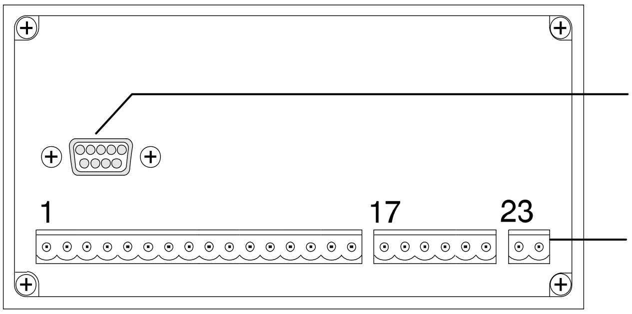


Figure 3
Control panel mounting

4 Electrical Connection

4.1 Terminal Designation



Serial interface RS232 (common ground connection with Terminal 4)

3 separate terminal strip connectors can be easily removed to simplify wiring

(rear view of panel mount housing)

Terminal Designation	**Inputs / Outputs**
1. +24 V DC supply (internally connected with terminal 8)	Flow input
2. Pulse or voltage input (active+, passive-)* or high-range current input for split range DP transmitters	
3. Current input (active+, passive-)* or low-range current input for split range DP transmitters	
4. (-) Ground connection, 24 V DC supply	Active inputs*
5. (+) Pt100	Pt100 or Current input 1
6. (+) Pt100	
7. Pt100 (-) or current input (active+, passive-)*	
8. +24 V DC power (internally connected with terminal 1)	Current inputs
9. (+) Pt100	Pt100 or Current input 2
10. (+) Pt100	
11. Pt100 (-) or current input (active+, passive-)*	
12. (+) active or passive	Pulse output
13. (-) active or passive	
14. (+) Current output 1	Current outputs
15. (+) Current output 2	
16. (-) Ground connection	
17. Function: Normally Open contact (NO)	Relay output 1 (de-energized)
18. Relay 1 wiper	
19. Function: Normally Closed contact (NC)	
20. Function: Normally Closed contact (NC)	Relay output 2 (de-energized)
21. Relay 2 wiper	
22. Function: Normally Open contact (NO)	
23. L1 for AC	Power supply
24. N for AC	

——— Galvanic isolation

The three inputs share a common ground connection. The two current outputs also share a separate ground connection. If complete separation is required between the two current outputs, then external galvanic isolators must be used.

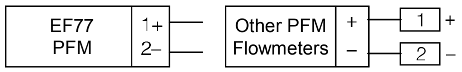
* *active:* Transmitter with own power supply (4-wire)
passive: Transmitter supplied by the flow computer (2-wire)

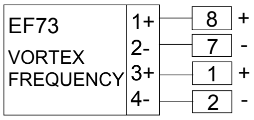
Figure 4
Designation of connecting terminals
(see "Technical Data", p. 71 for output specifications)

4.2 Connecting Other Instruments (Non-hazardous Area)

Input → Flow

Flowmeter with PFM output

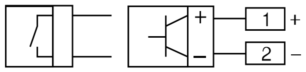




Note!
EF77 must be set to PFM output
(→ Fu20: ON, PF).

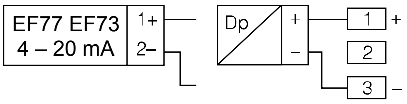
Note!
For EF73 pulse output, select VORTEX FREQUENCY.
For EF73 analog output, select TEMPERATURE.

Flowmeters with Open Collector outputs



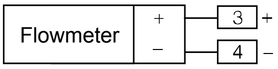
Voltage pulses:
>10 mV, >100 mV, >2.5 V,
V_{max} = 50 V DC, I_{max} = 25 mA
f_{max} = 20 kHz

Flowmeters with Passive Current output (4 – 20 mA)



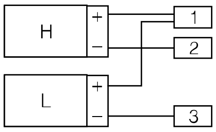
R_{in} = 100 Ω

Flowmeters with Active Current output (0/4 – 20 mA)

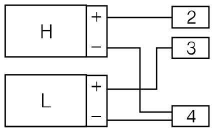


V_{max} = 24 V DC

Split range DP transmitters



Passive current output



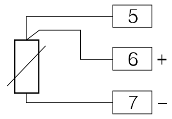
Active current output

H = High-range DP transmitter
L = Low-range DP transmitter

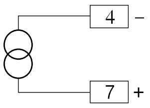
passive: R_{in} = 100 Ω
active: V_{max} = 24 V DC

Compensation Input 1 → Temperature

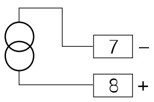
Temperature Signal at input 1 (active/passive)



RTD
Pt100
3-wire*



Current input
active signal



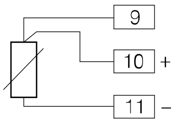
Current input
passive signal

V_{max} = 24 V DC
R_{in} = 100 Ω

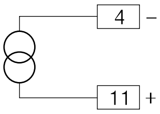
* 2-wire RTD connection is possible but causes an additional inaccuracy.

Compensation Input 2 → Temperature 2, Pressure or Density

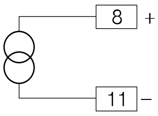
Temperature, Pressure or Density signal at input 2 (active/passive)



RTD
Pt100
3-wire



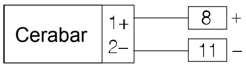
Current input
active signal

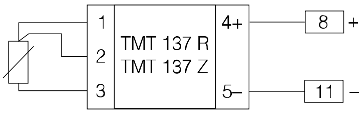


Current input
passive signal

V_{max} = 24 V DC
R_{in} = 100 Ω

Cerabar or Omnigrad at input 2 (passive)





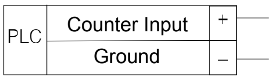
Pt100, 3-wire*

V_{max} = 24 V DC
R_{in} = 100 Ω

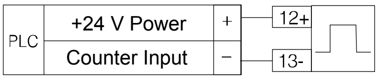
* 2-wire RTD connection is possible but causes an additional inaccuracy.

Outputs

Pulse output



Passive

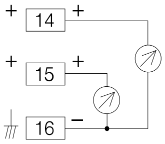


Active

Active:
Internal power supply = +24 V DC
I_{max} = 15 mA, R_{Lmax} = 960 Ω

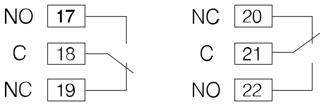
Passive:
External power supply
V_{max} = 30 V, I_{max} = 25 mA

Current output 1 / 2



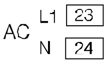
0/4 – 20 mA
Common ground
Load: max. 1 kΩ

Relay output 1 / 2 (de-energized)



Maximum load = 240 V
(1 A × cos φ × 0.7)

Power Supply connection



85 – 250 V AC (50/60 Hz)

4.3 RS232 Interface

The flow computer can be connected either to a personal computer (PC) or to a printer via the serial RS232 interface.

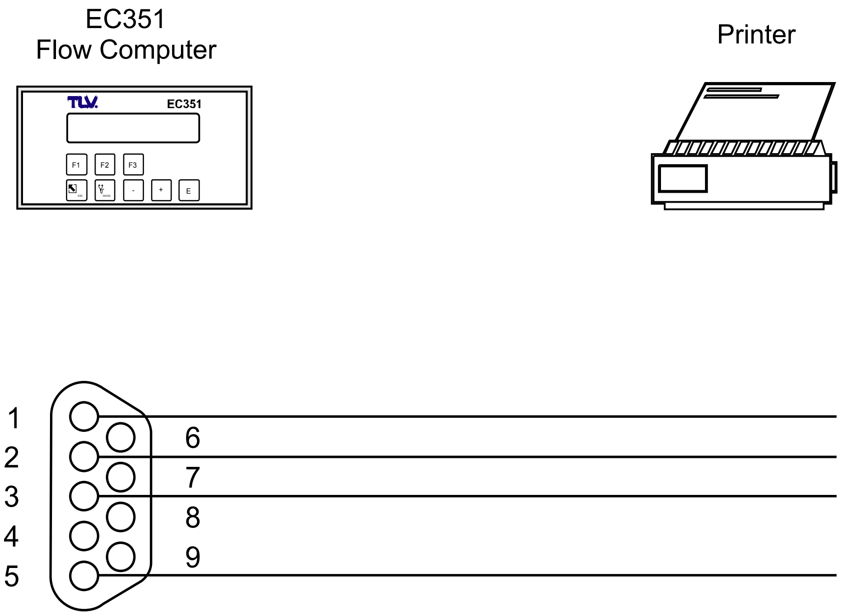


Figure 5
RS232 interface wiring

Contact Assignment

1	DCD	Input:	Handshake	Printer/PC → Flow computer
2	TXD	Output:	Serial data	Flow computer → Printer/PC
3	RXD	Input:	Serial data	Printer/PC → Flow computer
5	GND	Ground:	(internally connected to Terminal 4 of the terminal strip)	

Caution!
- Contacts not assigned must be kept free.
- The RS232 interface has a common ground with inputs of the flow computer (see page 6)

Caution!

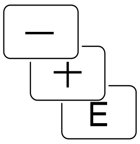
5 Operation

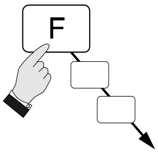
Important Information for Operating the Instrument

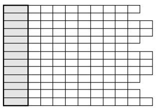
- The flow computer offers a wide range of functions and features. The following sections must be read carefully prior to operation.
- Start configuration using the “Quick Setup” function. This enables the flow computer to be quickly configured for its initial start-up in a short time.
- For further configuration (for example current- and pulse outputs), enter the TLV programming matrix.

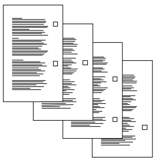
Caution!

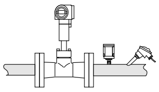
Caution!
Note that the ’Quick Setup’ will change all parameters in other functions of the TLV programming matrix to default values. Values previously programmed by the user will be overwritten or deleted!







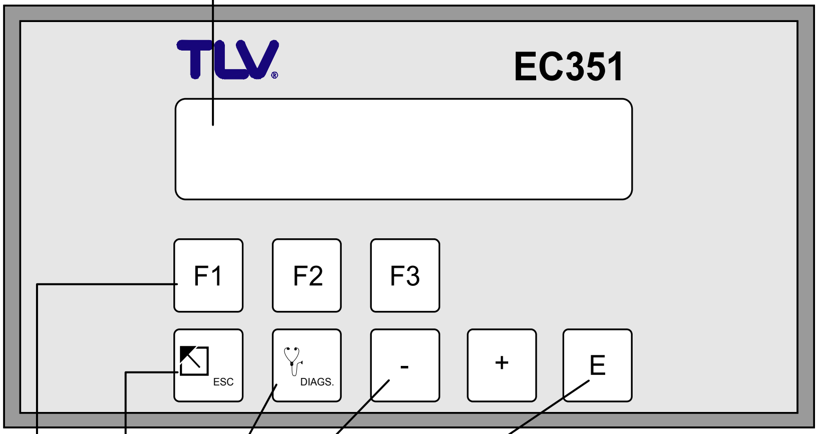




5.1 Display and Operating Elements

LC display

- Shows dialogue text and numerical values as well as error, alarm and status messages.
- HOME position: shows selectable variables during normal operation, e.g. flow + totalizer, temperature + process pressure, etc.



Enter key

- Accesses the programming matrix
- Selects functions within the function group
- Store data (and jump to the next function)

+ / – keys

- Selects function groups in the programming matrix
- Sets parameters and numerical values. Holding down the +/– keys causes the numbers to change at increasing speed.

Diagnostic key

- Help function during programming.

HOME key (Escape)

- Leaves the programming matrix, returns to the HOME position, stores all data
- Flow calculations previously stopped are resumed

Programmable function keys F1, F2, F3

These three keys can be freely assigned to a function (see pages 20 - 22). Pressing the keys accesses their assigned functions. The three keys are assigned in the factory to allow quick initial start-up of the flow computer (see page 12):

Factory settings:
F1 → Function “LANGUAGE” (selects the operating language) or “RATE+TOTAL” (displays the flowrate and the totalizer)
F2 → Function “SYSTEM UNITS” (selects ENGLISH/METRIC system of units) or “TOTAL+GRAND TOTAL” (displays the totalizer and the grand total)
F3 → Function “QUICK SETUP” (starts the quick programming menu) or “TEMP+PRESS” (displays the temperature and the pressure)

Figure 6
Display and key operation

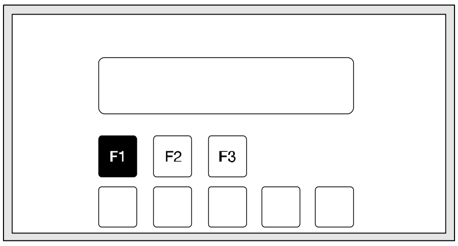
5.2 First Steps in Programming – “Quick Setup”

The EC351 flow computer makes programming easier and quicker using the three functions keys F1, F2, F3.
These three keys can be freely assigned to a function. It is very convenient to assign frequently used functions. (see pages 20 -22).

Caution!

Caution!
All configuration data will be cleared when starting the quick setup function.
Reprogram the function keys F1 – F3 at the end of the “Quick Setup”.

F1 key
Factory setting: “LANGUAGE” or “RATE +TOTAL” (displays the flowrate and the totalizer)

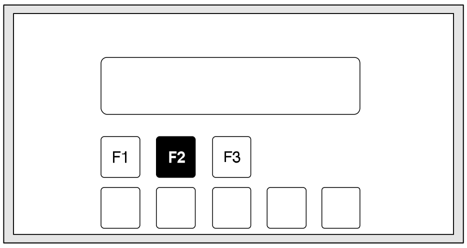


Following is an operation procedure when “LANGUAGE” is selected.

− + Select the required language in which the dialogue text is to appear on the display:ENGLISH
DEUTSCH
FRANCAIS

E Store entry, automatic return to the HOME position

F2 key
Factory setting: “UNITS” or TOTAL + GRAND TOTAL” (displays totalizer and grand total)*



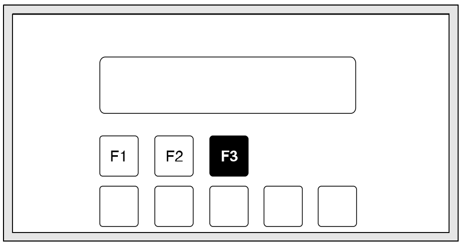
Following is an operation procedure when “UNITS” is selected.

− + Select the required system of units:
ENGLISH
METRIC
(All units are therefore set to defaults of the selected system)

E Store entry, automatic return to the HOME position

* This function can only be called up using the function key and not with the TLV programming matrix).

F3 key
Factory setting: “QUICK SETUP” or “TEMP + PRESS” (displays temperature and pressure)



Following is an operation procedure when “QUICK SETUP” is selected.

The display will show the prompt:
QUICK SETUP? NO
PAUSE COMPUTATIONS*

Warning message *
During ’Quick Setup’, all flow calculations are stopped, the current outputs return to 0 mA, the pulse output stops and both relays de-energize (corresponding to a power failure).

− + Select ’QUICK SETUP? YES’.

E Confirm entry. The display automatically shows the first function: “FLOW EQUATION”.

− + Select the required flow equation, e.g. ’STEAM MASS’.

E Store selection.

Subsequent functions appearing on the display depend on the flow equation selected.

− + Enter numerical values or settings.

E Store entry (automatic return to the HOME position after the last function).

You can also access “QUICK SETUP” from the “SYSTEM PARAMETERS” function group. (See page 20)

Quick Programming Menu “Quick Setup”

(using “STEAM MASS” as an example flow equation and EF73 as an example flowmeter)

Procedure:
Press Function Key F3. The display will show “QUICK SETUP? NO”.
Select ’YES’ by pressing ± and then E to confirm entry. All flow equations are stopped and the configuration parameters reset to default value.

Continue with E :

FLOW EQUATION	The basic functionality of the EC351 flow computer is defined using the flow equation for your particular application. **Note!** • In this example STEAM MASS is selected as flow equation. • For flow equation selections see page 20.	✎ Note!
FLUID TYPE	Select the fluid type: ± SATURATED STEAM – SUPERHEATED STEAM ‘Quick Setup’ configures only one compensation input if “SATURATED STEAM” is selected (Input 2, pressure). The temperature is not measured but calculated using the pressure input and the steam tables (saturated steam curve). **Note!** • In this example ‘SUPERHEATED STEAM’ is selected as fluid. • For more fluid selections see page 29.	✎ Note!
FLOWMETER TYPE	Select the flowmeter for your application. **Note!** • In this example VORTEX FLOWMETER EF73 is selected as flowmeter type. • For meter selections see page 32. • Selections: ORIFICE, NOZZLE and PITOT with 16 point linearization are not available in the Quick Setup. For these selections go to ‘Flowmeter selection’ cell in the matrix (page 32).	✎ Note!
INPUT SIGNAL (Flow)	Enter the type of measuring signal supplied by the flowmeter. **Note!** • PFM signal is used as an example selection. • For signal selections see page 33.	✎ Note!
K-FACTOR	Enter the flowmeter K-Factor. The K-factor describes how many vortices (pulses per dm^3) occur as a function of the flow velocity and nominal diameter. This K-factor definition refers to vortex flowmeters. For other flowmeters see page 34. ± Number with floating decimal point: 0.001 – 999,999; incl. units [P/dm^3] (continued next page)	

Quick Programming Menu "Quick Setup"

(continued)

INPUT SIGNAL (Temperature)	Select the type of signal coming from the temperature sensor. This function is only displayed if a temperature input is used. −/+ 4–20 TEMPERATURE – 0–20 TEMPERATURE – MANUAL TEMPERATURE* – RTD TEMPERATURE * see page 40 for details
LOW SCALE VALUE (Temperature)	Assign the low scale temperature value to the 0/4 mA current signal. This function is displayed only with the following configuration: Function "INPUT SIGNAL" → Setting '4–20 TEMPERATURE' or '0–20 TEMPERATURE'. −/+ Number with fixed decimal point (minimum 20 K or equivalent)
FULL SCALE VALUE (Temperature)	Assign the full-scale temperature value to the 20 mA current signal. This function is displayed only if the setting '4–20 TEMPERATURE' or '0–20 TEMPERATURE' is selected in the function "INPUT SIGNAL". −/+ Number with fixed decimal point (minimum 20 K or equivalent)
INPUT SIGNAL (Pressure)	Select the type of signal coming from the pressure sensor. −/+ 4–20 PRESSURE (G) – 0–20 PRESSURE (G) – MANUAL PRESSURE* – 4–20 PRESSURE (ABS.) – 0–20 PRESSURE (ABS.) * see page 40 for details
FULL SCALE VALUE (Pressure)	Assign the full-scale pressure value to the 20 mA current. This function is not displayed if the setting 'INPUT 2 NOT USED' or 'MANUAL PRESSURE' is selected in the function "INPUT SIGNAL". **Note!** 'Quick Setup' automatically sets the starting pressure value to 0.000. −/+ Number with fixed decimal point: 0 – +10,000 (incl. pressure units)
F1 Key Function	On the front panel are three function keys F1, F2, F3 which can be assigned to various functions as required. Functions often used can be called up immediately without the need to enter the matrix. **Note!** • The assigned functions are not protected by code entry. • Starting the Quick Setup function will overwrite or delete all previously configured data. For this reason, immediately after using Quick Setup, assign another function to the "Quick Setup" function key. • For selections: see page 21
F2 Key Function	
F3 Key Function	

After the entry has been saved in the last function with E, it automatically returns to the HOME position. The 'Quick Setup' programming is completed and the flow computations are resumed.

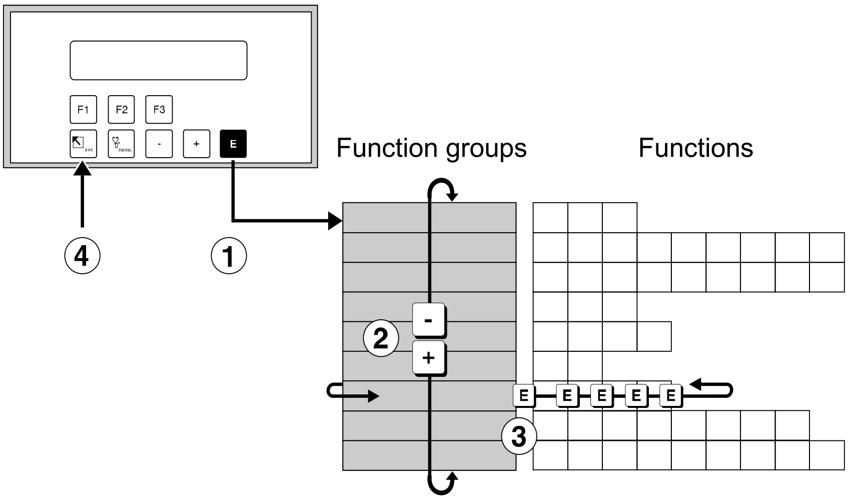
5.3 Programming with the TLV Programming Matrix

The EC351 flow computer offers many functions – beyond the ’Quick Setup’ – that can be individually set up and adapted to specific process conditions. The TLV programming matrix guides the user through the functions.

1. Access to the programming matrix
2. Select function group (>GROUP SELECT<)
3. Select function (Enter/select data with − + and store with E)

Programming matrix → see page 74
Selections / Factory settings → see page 75
Description of functions → see page 16

4. Return to HOME position from any matrix function



Functions of the operating elements

E *Access to the programming matrix* (>GROUP SELECT<)

Select individual functions within the function group

Store the data or settings

ESC *Leave the programming matrix*

Store the data or settings

− + *Select various function groups*

Select parameters and numerical values
(when + or – key is held down, the number on the display will change at increasing speed)

DIAG *Diagnostic function*

Help function
Displays additional information during programming

Enable / Lock programming

- Enable: Enter the code number (Factory setting = ’***351***’)
- Lock: After returning to the HOME position, programming is locked after 60 seconds if no operating element is pressed.

Figure 7
Selecting functions within the TLV programming matrix

6 Functions

- This section lists in detail a description, as well as all information required for the individual functions of the flow computer.
- Factory settings are shown in ***bold italics***.

Note!

Note!
The EC351 may be supplied programmed as ordered with settings different from the factory settings.

Function Groups

Caution!

Caution!
Important when programming

- The selected flow equation affects almost all functions of the flow computer! It is important to select the flow equation before setting other parameters. For this we recommend you use the 'Quick Setup' function. Thoroughly read the appropriate description and instructions given on page 20.
- Depending on previous selections, some functions or options may not appear on the display:

  Example 1:
  The flow equation is set to 'LIQ. CORRECTED VOLUME'. Therefore in the function group "PROCESS VARIABLE" only the following functions appear on the display: COR. VOLUME FLOW, VOLUME FLOW, TEMPERATURE, PROCESS PRESSURE, DATE & TIME.

  Example 2:
  The relay mode is set to 'RELAY PULSE OUTPUT'. Consequently irrelevant functions such as "LIMIT SETPOINT", "HYSTERESIS" and "RESET ALARM" are not shown.

- While programming certain parameters and functions, flow computations are paused. The flow computer changes to 'standby' mode after displaying the following safety prompt:

  "FLOW COMPUTATIONS PAUSED NO" → Select 'YES', and confirm by pressing E → The message "FLOW COMPUTATIONS RESUMED" is then shown.

  All flow calculations are then stopped, the current outputs return to 0 mA, the pulse output stops and both relays de-energize (corresponding to a power failure). Parameters can now be changed and numerical values entered.
  After returning to the HOME position flow computations resume.
  The message "FLOW COMPUTATIONS RESUMED" is displayed.

Function Group: PROCESS VARIABLE

With this group of functions, actual process variables such as flowrate, temperature, pressure or dependent variables can be directly read off the display.

Note!
- A selection of the following functions is available corresponding to the selected flow equation (see page 20), flowmeter (see page 32) and fluid (see page 29).
- The maximum numerical display is 999,999; larger values are displayed as 'INF'.

HEAT FLOW	Display of current calculated energy flow (heat, combustion heat). The heat flow is determined using the stored fluid properties and the actual volumetric flow, including temperature or pressure compensation.
MASS FLOW	Display of current calculated mass flowrate. The mass flowrate is determined using the stored fluid properties and the actual volumetric flow, including temperature or pressure compensation.
COR. VOLUME FLOW	Display of corrected volumetric flowrate of liquids and gases (→ see section "CORRECTED GAS VOLUME", page 62 and "CORRECTED LIQUID VOLUME", page 65) *Corrected volume* = Volume under reference conditions, e.g. at 0 °C and 1.013 bar abs. Reference temperature T_{ref} and reference pressure p_{ref} can be freely selected (see function "STP REFERENCE", page 40).
VOLUME FLOW	Display of actual volumetric (uncorrected) flowrate measured by the sensor under operating conditions. With differential pressure measurement devices the volumetric flowrate is calculated using temperature or pressure compensation. **Note!** This function is always available and is not dependent on the flow equation selected.
TEMPERATURE 1	Display of process temperature used for calculations. **Note!** • Normally the value shown is the measuring signal from the temperature sensor connected to analogue input 1. • With saturated steam the temperature shown is calculated from the saturated steam curve if measurement is *only* carried out using a pressure sensor. • If the flow computer uses fixed temperature values that have been pre-programmed, then these values will be shown here (see function "DEFAULT VALUE", page 40).
TEMPERATURE 2	Display of process temperature from a *second* temperature sensor, e.g. for calculating delta heat. **Note!** • Normally the value shown is the measuring signal from the temperature sensor connected to analogue input 2. • If the flow computer uses fixed temperature values that have been pre-programmed, then these values will be shown here (see function "DEFAULT VALUE", page 40).

Function Group: PROCESS VARIABLE

DELTA TEMPERATURE	Display of the temperature difference between Temperature 1 and Temperature 2. **Note!** This function is only shown with ‘delta heat’ flow equations.
PROCESS PRESSURE	Display of the process pressure used for the calculation. **Note!** • Normally the value shown is the measuring signal from the pressure sensor connected to other input 2. • With saturated steam the pressure shown is calculated from the saturated steam curve if measurement is only carried out using a temperature sensor. • If the flow computer uses fixed pressure values that have been pre-programmed, then these values will be shown here (see function “DEFAULT VALUE”, page 40).
DIFF. PRESSURE	Display of the pressure drop measured by a differential pressure flowmeter. ENGLISH units → units always in [inch H_2O] METRIC units → units always in [mbar]
DENSITY	Display of the fluid density. The density is either directly measured using a density sensor or calculated from measured process pressure and/or temperature values, using stored fluid data.
SPEC. ENTHALPY	Display of the specific enthalpy of steam. The value shown is determined from steam tables using the measured process variables of pressure and temperature. **Note!** This function is only shown with thermal steam flow equations.
DATE & TIME	Display of the actual date and time. The real time clock can be set in the functions “ENTER DATE” and “ENTER TIME” (see pages 20 – 21). **Note!** • After short breaks in the power supply the clock continues to operate normally. • After longer breaks in the power supply (several days) or with initial start-up of the instrument the date and time must be reset.
VISCOSITY	Display of the fluid viscosity in units of centistokes. The viscosity is calculated from measured process temperature using stored fluid data and equations. **Note!** This function is only shown with DP-flowmeters with 16 point linearization table and needed for calculating the Reynolds number.
REYNOLDS NUMBER	Display of the calculated Reynolds number under actual process conditions. **Note!** This function is only shown with DP-flowmeters with 16 point linearization Table.

Function Group: TOTALIZERS

Note!

- A selection of the following functions is available corresponding to the selected flow equation (see function “FLOW EQUATION”, page 20).
- The totalizer contents are saved in the EEPROM on power loss.
- Grand totals cannot be reset.

RESET TOTALIZER	This function resets all resettable totalizers simultaneously to ’zero’. **Note!** Grand totals cannot be reset. − + ***NO*** – YES
HEAT TOTAL	Display of total energy (heat quantity, combustion heat) since the last reset of the totalizer.
HEAT GRAND TOTAL	Display of total energy (heat quantity, combustion heat) since initial start-up.
MASS TOTAL	Display of the total mass since the last reset of the totalizer.
MASS GRAND TOTAL	Display of total mass since initial start-up.
COR. VOLUME TOTAL	Display of the total corrected volume since the last reset of the totalizer.
COR. VOL. GRND TOT.	Display of total corrected volume since initial start-up.
VOLUME TOTAL	Display of the total uncorrected volume under operating conditions since the last reset of the totalizer. **Note!** This function is always accessible independent of the flow equation selected (see page 20).
VOL. GRAND TOTAL	Display of the total uncorrected volume under operating conditions since initial start-up.

Function Group: SYSTEM PARAMETERS

Caution!	**QUICK SETUP**	The 'Quick Setup' function allows fast configuration of all important parameters and process functions. The F3 function key is set at the factory so that the "Quick-Setup" can be directly activated. **Caution!** • A "QUICK-SETUP" automatically sets all parameters except 'language' (F1) and 'unit system' (F2), back to their default values. • To avoid unintentional loss of configuration data the F3 function key should be assigned another function as offered at the end of "Quick-Setup". • For more detailed information on the "Quick Setup" → see page 12 −+ ***QUICK SETUP? NO PAUSE COMPUTATIONS**** QUICK SETUP? YES PAUSE COMPUTATIONS* Option 'YES' → INITIALIZING MEMORY** PLEASE WAIT The various functions are shown one after another. Select option with −+, enter numerical value and store with E. * Warning message "PAUSE COMPUTATIONS": All calculations are then stopped, the current outputs return to 0 mA, the pulse output stops and both relays de-energize (corresponding to a power failure). ** All parameters are reset to their default values.
Note! Caution!	**FLOW EQUATION**	The *Basic functionality* of the EC351 flow computer is defined using the flow equation for your particular application! **Note!** Various functions of the TLV programming matrix (see page 74) are only available depending on the flow equation selected. The flow equation also determines the assignment of flow computer inputs. **Caution!** • Select the flow equation as the first step. You should use 'Quick Setup' to change the flow equation. • Detailed descriptions to the individual flow equations and applications are found on page 57. −+ ***STEAM MASS*** – STEAM HEAT – STEAM NET HEAT – STEAM DELTA HEAT – GAS CORRECTED VOLUME – GAS MASS – GAS COMBUSTION HEAT – LIQ. CORRECTED VOLUME – LIQUID MASS – LIQ. COMBUSTION HEAT – LIQUID SENSIBLE HEAT – LIQUID DELTA HEAT
Note!	**ENTER DATE**	Enter the actual date: *Day – Month – Year* An integrated clock in the flow computer changes the date accordingly. **Note!** After prolonged breaks in the power supply (several days) or with initial start-up of the instrument the date and time must be reset. −+ Flashing positions can be changed. Confirm entries with E.

Function Group: SYSTEM PARAMETERS

ENTER TIME

Entering the actual time: *Hours – Minutes*

Note!
After prolonged breaks in the power supply (several days) or with initial start-up of the instrument, the date and time must be reset.

Note!

− + Flashing positions can be changed.
Confirm entries with E.

F1 KEY FUNCTION

F2 KEY FUNCTION

F3 KEY FUNCTION

On the front panel are three function keys F1, F2 and F3, which can be assigned various functions as required. Functions often used can be called up immediately without the need to enter the programming matrix.

Note!
The function keys are not protected by a code number (see function "ACCESS CODE", page 22), so the functions assigned to them are freely accessible.

Note!

− +

LANGUAGE*	Define language (see page 24) * Available with F1 key only
MEASURING SYSTEM**	Define system units ** Available with F2 key only
QUICK SETUP***	Start quick programming menu (see page 12), *** Available with F3 key only
RATE + TOTAL	Display of flowrate and totalizer
TOTAL + GRAND TOTAL	Display of totalizer and grand total
CLEAR TOTALIZERS	Reset totalizer to zero
PRINT TRANSACTION	Start printout (see page 50)
ACK. + CLEAR ALARMS	Confirm alarm message (see page 46)
CHANGE SETPOINT 1 CHANGE SETPOINT 2	Define switchpoint Relay 1 (see page 45) Define switchpoint Relay 2 (see page 45)
TEMP.1 + DENSITY TEMP.1 + PRESSURE TEMP.1 + TEMP. 2 DELTA TEMP. + VOL.FLOW DIFF.PRES. + VOL.FLOW ENTHALPY + DENSITY VISCOSITY + REYNOLDS	Display of process variables

Function Group: SYSTEM PARAMETERS

PRIVATE CODE

A personal code number can be selected in order to enable programming.

Note!

Note!
- Changing the code number is only possible after programming has been enabled. If the programming is locked then this function is not available and access to the personal code number is denied to other persons.
- Selecting a private code number of ’0’ will always enable programming.
- The functions assigned to keys F1, F2 and F3 are freely accessible.

⊟⊞ max. 4-figure number: 0 – 9999
Factory setting: ***351***

ACCESS CODE

All the data in the flow computer is protected against unauthorized access. Programming is enabled by entering the “Private code number” in this function. The settings of the instrument can then be altered.
If the ⊟⊞ keys are pressed in any function, then this function is automatically called up and the prompt to enter the code number is shown on the display (with locked programming only):

→ Enter code number 351 (Factory setting) or if redefined by user,
→ Enter personal code number (see “PRIVATE CODE”, page 22)

Note!

Note!
- Locking programming: After returning to the HOME position, programming is automatically locked after 60 seconds if no keys are pressed. Programming can also be locked by entering any number (except the code number).
- If you can no longer find your personal code number, then TLV will be pleased to help you.
- The function keys F1, F2 and F3 are freely accessible without entering a code number.

⊟⊞ max. 4-figure number: 0 – 9999
Factory setting: ***0***

TAG NUMBER

A freely selectable tag for your measuring point can be entered (max. 10 characters).

⊟⊞ Alphanumeric character for each of the ten positions:
1 – 9; A – Z; _, <, =, >, ?, etc.

Flashing positions can be changed. Confirm entry with E and with an automatic jump to the next position (altogether 10). Spaces are also considered characters and are to be confirmed by pressing E.

SERIAL-NO. SENSOR

The serial number or tag number of the connected flowmeter can be entered (max. 10 characters).

⊟⊞ Alphanumeric characters for each of the ten positions:
1 – 9; A – Z; _, <, =, >, ?, etc.

Flashing positions can be changed. Confirm entry with E and with an automatic jump to the next position (altogether 10). Spaces are also considered characters and are to be confirmed by pressing E.

Function Group: DISPLAY

DISPLAY LIST

Selecting those variables which are to appear on the display in the 'HOME position' during normal operation. Each option shows two variables simultaneously (→ see following list). If more than one option is selected, then each option appears on the display one after the other for 3 to 4 seconds each.

−+ ***CHANGE? NO***
CHANGE? YES

'YES' → display of measured values tube indicated:

E	−+
Save option → next option	Display?
DATE + TIME?	NO (YES)
MASS FLOW + TOTAL?	NO (YES)
VOL.FLOW + TOTAL?	NO (YES)
TEMP.1 + PRESSURE?	NO (YES)
TEMP.1 + DENSITY?	NO (YES)
HEAT FLOW + TOTAL?	NO (YES)
DENS. + SPEC.ENTH?	NO (YES)
COR.VOL. + TOTAL?	NO (YES)
TEMP.1 + TEMP.2?	NO (YES)
DELTA T + VOL. FLOW?	NO (YES)
VISC. + REYNOLDS NO.?	NO (YES)

'YES' + E → Both variables are shown on the display.
'NO' + E → The variables do **not** appear on the display.

There is an automatic jump to the next function after the last option is selected.

DISPLAY DAMPING

By entering a 'damping constant' the display bounce can be reduced (high constant) or increased (low constant). This ensures that reading off measured values can still be carried out even with quickly changing process conditions (reading off the 'mean value').

−+ max. 2-figure number: 0 – 99
Factory setting: ***1***

Function Group: DISPLAY

Caution!

Note!

LCD CONTRAST	The contrast of the display can be adjusted to local operating conditions e.g. ambient temperature and lighting conditions. **Caution!** Note that the permissible ambient temperature for the flow computer is 0 – +50 °C (32 – 122 °F). The visibility of the LC display may no longer be guaranteed for temperatures below 0 °C (32 °F). −/+ ▌▌▌▌▌▌▌▌▌▌▌▌ . . . . A change in contrast can immediately be seen with the bar display.
MAX. DEC. POINT	Determine the number of decimal places for numerical values. **Note!** • The number of decimal places applies to all displayed variables and totalizers. • The number of decimal places is automatically reduced if there is insufficient space on the display for large numbers. • The value set here does not affect the functions in the TLV programming matrix. −/+ 0 – 1 – ***2*** – 3 (decimal places)
LANGUAGE	The language can be selected in which all text, parameters and operating messages are to be displayed. −/+ ***ENGLISH*** – DEUTSCH – FRANCAIS

Function Group: SYSTEM UNITS

Definitions of common system units:

bbl	1 barrel (Definition → see function “DEFINITION bbl”, page 27)
gal	1 US Gallon (equals 3.7854 liters)
igal	1 Imperial Gallon (equals 4.5609 liters)
l	1 liter
hl	1 hectoliter = 100 liters
dm^3	1 dm^3 = 1 liter
ft^3	1 ft^3 = 28.37 liters
m^3	1 m^3 = 1000 liters
acf	Actual cubic foot (equals ’ft^3 ’ under operating conditions)
scf	Standard cubic foot (equals ’ft^3 ’ under reference conditions)
Nm^3	Standard cubic meter (equals ’m^3 ’ under reference conditions)
Nl	Standard liter (equals one liter under reference conditions)
tons (US)	1 US ton, equals 2000 lbs (= 907.2 kg)
tons (long)	1 long ton, equals 2240 lbs (= 1016 kg)
tons	1 tons, equals 200 Btu/min
tonh	1 tonh, equals 1200 Btu

TIME BASE	*One* unit of time is selected as a reference for all measured or derived and time-dependent process variables and functions such as: • flowrate (volume/time; mass/time), • heat flow (amount of energy/time) etc. ⊟⊞ /s (per second) – /m (per minute) – ***/h (per hour)*** – /d (per day)
HEAT FLOW UNIT	Select the unit for heat flow (amount of energy, combustion heat). The unit selected here also applies to the following: • Full-scale value for current • Relay switchpoints ⊟⊞ kBtu/unit of time – kW – ***MJ/unit of time*** – kcal/unit of time – MW – tons – GJ/unit of time – Mcal/unit of time – Gcal/unit of time – MBtu/unit of time – GBtu/unit of time
HEAT TOTAL UNIT	Select the unit of heat (amount of energy, combustion heat) for the particular totalizer. The unit selected here also applies to the following: • Pulse value (kCal → kCal/p) • Relay switchpoints ⊟⊞ kBtu – kWh – ***MJ*** – kcal – MWh – tonh – GJ – Mcal – Gcal – MBtu – GBtu
MASS FLOW UNIT	Select the unit for mass flowrate (mass/unit of time). The unit selected here also applies to the following: • Full-scale value for current output • Relay switchpoints ⊟⊞ lbs/unit of time – ***kg/unit of time*** – g/unit of time – t/unit of time – tons(US)/unit of time – tons (long)/unit of time

Function Group: SYSTEM UNITS	
MASS TOTAL UNIT	Select the units of mass for the totalizer. The unit selected here also applies to the following: • Pulse value (kg → kg/p) • Relay switchpoints lbs – ***kg*** – g – t – tons (US) – tons (long)
COR. VOL. FLOW UNIT	Select the unit for corrected volumetric flowrate (corrected volume/unit of time). The unit selected here also applies to the following: • Full-scale value for current • Relay switchpoints *Corrected volume* = volume measured under operating conditions converted to volume under reference conditions. (see also pages 62 and 65; flow equations “CORRECTED GAS VOLUME” and “CORRECTED LIQUID VOLUME” respectively). *Reference conditions:* see page 40 Depending on the selected flow equation, not all of the following units are available: bbl/unit of time – gal/unit of time – l/unit of time – hl/unit of time – ***dm^3/unit of time**** – ft^3/unit of time – m^3/unit of time – scf/unit of time – ***Nm^3/unit of time***** –Nl/unit of time – igal/unit of time Factory setting: * for liquids, ** for gas Definitions for the units given above → see page 25 All units listed here apply to corrected volume. Additionally, the unit nomenclature scf, Nm^3 or Nl points this out.
COR. VOL. TOTAL UNIT	Select the unit for the appropriate totalizer. The unit selected here also applies to the following: • Pulse value (bbl → bbl/p) • Relay switchpoints *Corrected volume* = volume measured at operating conditions converted to volume at reference conditions. (see also pages 62 and 65: flow equations “CORRECTED GAS VOLUME” and “CORRECTED LIQUID VOLUME” respectively). Depending on the selected flow equation, not all of the following units are available: bbl – gal – l – hl – ***dm^3**** – ft^3 – ***m^3***** – scf – Nm^3 – Nl – igal Factory setting: * for liquids, ** for gas Definitions for the units given above → see page 25. All units listed here apply to corrected volume. Additionally, the unit nomenclature scf, Nm^3 or Nl points this out.

Function Group: SYSTEM UNITS

VOLUME FLOW UNIT	Select the unit for volumetric flowrate. The unit selected here also applies to the following: • Full-scale value for current • Relay switchpoints Depending on the selected flow equation, not all of the following units are available: bbl/unit of time – gal/unit of time – l/unit of time – hl/unit of time – ***dm^3/unit of time**** – ft^3/unit of time – ***m^3/unit of time***** – acf/unit of time – igal/time Factory setting: * for liquids, ** for gas Definitions for the units given above → see page 25. All units given above refer to the actual volume measured under operating conditions.
VOLUME TOTAL UNIT	Select the unit for uncorrected volumetric flowrate and for the totalizer. The unit selected here also applies to the following: • Pulse value (bbl → bbl/p) • Relay switchpoints Depending on the selected flow equation, not all of the following units are available: bbl – gal – l – hl – ***dm^3**** – ft^3 – ***m^3***** – acf – igal Factory setting: * for liquids, ** for gas Definitions for the units given above → see page 25. All units given above refer to the actual volume measured under operating conditions.
DEFINITION bbl	In certain countries the ratio of barrels (bbl) to gallons (gal) can vary according to the fluid used and the specific industry. Select one of the following definitions: • US or imperial gallons • Ratio gallons/barrel ***US: 31.0 gal/bbl*** for beer (brewing) US: 31.5 gal/bbl for liquids (used in normal cases) US: 42.0 gal/bbl for oil (petrochemicals) US: 55.0 gal/bbl for filling tanks Imp: 36.0 gal/bbl for beer (brewing) Imp: 42.0 gal/bbl for oil (petrochemicals)
TEMPERATURE UNIT	Select the unit for the fluid temperature. The unit selected here also applies to the following: • Zero and full-scale value for current • Relay switchpoints • Reference conditions • Specific heat ***°C (CELSIUS)*** – °F (FAHRENHEIT) – K (KELVIN) – °R (RANKINE)

Function Group: SYSTEM UNITS

PRESSURE UNIT	Select the unit for process pressure. The unit selected here applies to the following: • Zero and full-scale value for current • Relay switchpoints • Reference conditions ⊟ ***bara*** – kPaa – kc2a – psia – barg – psig – kPag – kc2g Definitions: $\left.\begin{array}{ll}\text{bara} & \text{bar}\\ \text{kPaa} & \text{kPa}\\ \text{kc2a} & \text{kg/cm}^2\\ \text{psia} & \text{psi}\end{array}\right\}$ Absolute pressure ('a' for absolute) $\left.\begin{array}{ll}\text{barg} & \text{bar}\\ \text{psig} & \text{psi}\\ \text{kPag} & \text{kPa}\\ \text{kc2g} & \text{kg/cm}^2\end{array}\right\}$ Gauge pressure compared to atmospheric pressure ('g' for gauge) Gauge pressure differs from absolute pressure by the atmospheric pressure, which can be set in the function "BAROMETRIC PRESS." (see page 40).
DENSITY UNIT	Select the unit for density of the fluid. The units selected here also define those for all corresponding functions, e.g. • Zero and full-scale value for current • Relay switchpoints ⊟ ***kg/m^3*** – kg/dm^3 – #/gal – #/ft^3 (# = lbs = 0.4536 kg)
SPEC. ENTHALPY UNIT	Select the unit for the combustion value (= specific enthalpy). The units selected here are also used for the specific thermal capacity (kWh/kg → kWh/kg → °C) ⊟ ***Btu/#**** – kWh/kg – ***MJ/kg***** – kcal/kg (# = lbs = 0.4536 kg) Factory settings: * for english units ** for metric units
LENGTH UNIT	Select the pipe diameter unit. ⊟ ***mm***** – ***in**** Factory setting: * for english unit system ** for metric unit system

Function Group: FLUID DATA

FLUID TYPE	Select the fluid. There are three different types: **1. Steam / Water** All information required for steam and water such as the saturated steam curve, density and thermal capacity are permanently stored in the flow computer. **2. Fluid displayed (see below)** For other fluids, such as air, natural gas and various fuels (see below) are preset values already stored in the flow computer, which can be directly adopted by the user. If these *preset values* are to be changed to fit your specific process conditions, then proceed as follows: Select fluid → press E → Reselect function "FLUID TYPE" → Select 'GENERIC' fluid → Press E. The characteristics of any 'Generic fluid' can now be defined by the user in the following functions. This procedure can also be used to view the default settings of the previously selected fluid. **3. Generic fluid** Select the setting 'GENERIC'. The characteristics of any fluid can now be defined by the user in the following functions. −/+ GENERIC – ***WATER*** – ***SATURATED STEAM*** – SUPERHEATED STEAM – ***AIR*** – NATURAL GAS – AMMONIA – CARBON DIOXIDE – PROPANE – OXYGEN – ARGON – METHANE – NITROGEN – GASOLINE – NO.2 FUEL OIL – KEROSENE – NATURAL GAS (NX-19) Factory setting: ***dependent*** on the flow equation selected. **Note!** • A detailed description of all applications and flow equations are found on page 57. • For Natural Gas (NX-19) selection the gas operating conditions and composition must lie within the following specifications: Temperature -40 – +116 °C (-40 – +241 °F) Pressure < 345 bar (< 5000 psi) Mole % CO_2 0 – 15% Mole % Nitrogen 0 – 15%
REF. DENSITY	Enter the density for a generic fluid at reference temperature and pressure (see also function "STP REFERENCE", page 40). −/+ Number with floating decimal point: 0.0001 – 10,000.0 Factory setting: ***dependent*** on fluid.
COMBUSTION HEAT	Enter the specific combustion heat for generic fuels (gas or liquid). −/+ Number with floating decimal point: 0.000,00 – 100,000 Factory setting: ***dependent*** on fluid.
SPECIFIC HEAT	Enter the specific heat capacity for generic fluids. This value is required for calculating the delta heat of liquids (see flow equation "LIQUID DELTA HEAT.", page 68). −/+ Number with floating decimal point: 0.000,00 – 100,000 Factory setting: ***dependent*** on fluid (units e.g. [MJ/t × °C]).

Note!

Function Group: FLUID DATA

THERM. EXP. COEF.

Enter the thermal expansion coefficient for a generic fluid. This coefficient is required for the temperature compensation of volume with various flow equations, e.g. for ’LIQUID MASS’ or ’CORRECTED LIQUID VOLUME’ (see page 57).

Number with floating decimal point: 0.000 – 100,000 (e–6)
Factory setting: ***dependent*** on fluid [e-6/temperature unit].

Calculate the thermal expansion coefficient as follows:

$$\alpha = \frac{1 - \frac{\sqrt{\rho\ (T_1)}}{\rho\ (T_0)}}{T_1 - T_0} \times 10^6$$

α	Thermal expansion coefficient.
T_0, T_1	Reference temperatures (see below) in units selected for temperature in the “SYSTEM UNITS” function group.
ρ (T_0, T_1)	Density of the liquid at temperature T_0 or T_1.
	For optimum accuracy, chose the reference temperatures as follows: T_0: ca. 10% above minimum process temperature T_1: ca. 10% below maximum process temperature The percentage refers to the span between minimum and maximum process temperatures.
10^6	The value entered is internally multiplied by a factor of 10^{-6} (display: “e–6/temperature unit”) since the value to be entered is very small.

FLOW Z-FACTOR

Enter a Z-factor (compressibility factor) for the gas *at operating conditions*.
The Z-factor indicates how different a ’real’ gas behaves from an ’ideal gas’ which exactly obeys the ’general gas law’ (P × V / T = constant; Z = 1). The further the real gas is from its condensation point, the closer the Z-Factor approaches ’1’.

Note!

Note!
- The Z-factor is used for all gas flow equations.
- Enter the Z-factor for the average process conditions (pressure and temperature).

Number with fixed decimal point: 0.1000 – 10.0000
Factory setting: ***dependent*** on fluid.

REF. Z-FACTOR

Enter a Z-factor (compressibility factor) for gases *at reference conditions*.
The Z-factor is an indication of how different a ’real’ gas differs from an ’ideal gas’ which exactly obeys the ’general gas law’ (P × V / T = const.; Z = 1). The further the real gas is from its condensation point, the closer the Z-Factor approaches ’1’.

Note!

Note!
- The Z-factor is used for all gas flow equations.
- Define the standard conditions in the function “STP REFERENCE” (see page 40).

Number with fixed decimal point: 0.1000 – 10.0000
Factory setting: ***1.0000***

Function Group: FLUID DATA

ISENTROPIC EXPONENT	Enter the isentropic exponent of the fluid. The isentropic exponent describes the behavior of the fluid when measuring the flow using a differential pressure flowmeter. The isentropic exponent is a fluid property dependent on operating conditions. Number with fixed decimal point: 0.1000 – 10.0000 Factory setting: ***1.4000***
MOLE % NITROGEN	Enter the MOLE % Nitrogen in the expected natural gas mixture. This information is needed by the NX-19 computation. Number with fixed decimal point: 00.000 – 15.000 Factory setting: ***00.000***
MOLE % CO_2	Enter the MOLE % CO_2 in the expected natural gas mixture. This information is needed by the NX-19 computation. Number with fixed decimal point: 00.000 – 15.000 Factory setting: ***00.000***
VISCOSITY COEF. A **VISCOSITY COEF. B**	For the fluid type “GENERIC” this information is needed for the calculation of the Reynolds number and to calculate the viscosity of the fluid. These coefficients can be derived from two known temperature/viscosity pairs. This information can be obtained from tables for the specific fluid. **Note!** • Always use centipoise (cP) as unit for the viscosity. • Metric unit system → “Kelvin” must be used as unit for T_1 and T_2. English system → “Rankine” must be used as unit for T_1 and T_2. The viscosity coefficient A and B can then be computed by using the following equations based on the fluid state: **Liquids:** $B = \frac{(T_1 + 273.15) \times (T_2 + 273.15) \times \ln[\eta_1/\eta_2]}{(T_2 + 273.15) - (T_1 + 273.15)}$ $A = \frac{\eta_1}{\exp[B/(T_1 + 273.15)]}$ **Gas:** $B = \frac{\ln[\eta_2/\eta_1]}{\ln[(T_2 + 273.15)/ (T_1 + 273.15)]}$ $A = \frac{\eta_1}{(T_1 + 273.15)^B}$ T_1 Temperature of pair 1 (Kelvin or Rankin, see Note!) T_2 Temperature of pair 2 (Kelvin or Rankin, see Note!) η_1 Viscosity of pair 1 (centipoise) η_2 Viscosity of pair 2 (centipoise) Number with fixed decimal point: 000.000 – 100,000 Factory setting: ***1.000***

Note!

Function Group: FLOW INPUT

The settings selected in both functions “FLOWMETER TYPE” and “INPUT SIGNAL” determine the functions and selections available in this group.

FLOWMETER TYPE

Select the flowmeter. The flow equation (see page 20) and the flowmeter selected here determine the basic operation of the flow computer.

Note!

Note!
For differential pressure applications the “BASIC SQUARE LAW” option is the simplest equation. For applications with changing process conditions (further away from sizing sheet conditions) the equations ORIFICE / NOZZLE / PITOT can be used for higher accuracies, but they also require more process data to be entered.

VORTEX FLOWMETER EF77	Vortex flowmeter with linear pulse or analogue output, e.g. TLV EF77 EF73 vortex flowmeter. (This parameter should be selected even when using EF73.)
PROMAG	Electromagnetic flowmeter with linear pulse or analogue output.
LINEAR	Volumetric flowmeter with linear pulse or analogue output.
LINEAR 16 PT*	Volumetric flowmeter with linear pulse or analogue output; with 16-point linearization table.
BASIC SQUARE LAW	Generic differential pressure device without integrated square root extraction.
BASIC SQUARE W/SQRT	Generic differential pressure device with integrated square root extraction.
ORIFICE	Orifice plate flowmeter without integrated square root extraction and with analogue output.
ORIFICE W/SQRT	Orifice plate flowmeter with integrated square root extraction and with analog output.
ORIFICE 16 PT*	Orifice plate flowmeter without integrated square root extraction, with analog output and 16 point linearization table.
ORIFICE 16 PT* W/SQRT	Orifice plate flowmeter with integrated square root extraction, with analog output and 16 point linearization table.
NOZZLE	Nozzle, venturi and other contoured flowmeters without integrated square root extraction and with analog output.
NOZZLE W/SQRT	Nozzle, venturi and other contoured flowmeters with integrated square root extraction and with analog output.
NOZZLE 16 PT*	Nozzle, venturi and other contoured flowmeters without integrated square root extraction, with analog output and 16 point linearization table.
NOZZLE 16 PT* W/SQRT	Nozzle, venturi and other contoured flowmeters with integrated square root extraction, analog output and 16 point linearization table.

Note!

Note! *
For selections with 16 PT, a linearization table must be constructed → see function “LINEARIZATION”, page 37.

(Continued next page)

Function Group: FLOW INPUT

FLOWMETER TYPE
(Continued)

PITOT	Pitot tube flowmeter without integrated square root extraction and with analog output.
PITOT W/SQRT	Pitot tube flowmeter with integrated square root extraction and analog output.
PITOT 16 PT*	Pitot tube flowmeter without integrated square root extraction, with analog output and 16 point linearization table.
PITOT 16 PT* W/SQRT	Pitot tube flowmeter with square root extraction, analog output and 16 point linearization table.

Note! *
For selections with 16 PT, a linearization table must be constructed → see function “LINEARIZATION”, page 37.

Note!

INPUT SIGNAL

Enter the type of measuring signal supplied by the flowmeter.

PFM	PFM → Pulse output signal of TLV’s EF77 EF73 flowmeter (current pulse, trigger threshold ca. 10 mA)
DIGITAL, 10 mV level	Voltage pulses, trigger threshold 10 mV
DIGITAL, 100 mV level	Voltage pulses, trigger threshold 100 mV
DIGITAL, 2.5 V level	Voltage pulses, trigger threshold 2.5 V
4–20 mA SPLIT 0–20 mA SPLIT	Analog current signal for split range DP transmitters.
4–20 mA 0–20 mA	Analog current signal
0–5 V 1–5 V 0–10 V	Analog voltage signal

FULL SCALE

Set the full-scale value for the analog input signal.
The value entered here must be identical to the value set in the flowmeter.

Note!
- For flowmeters with analog/linear output the flow computer uses the selected system units for volumetric flowrate.
- Differential pressure flowmeters → The units for differential pressure are dependent on the unit system selected:
  - Imperial units → [inches H_2O]
  - Metric units → [mbar]
- For use of split range (stacking) the full scale value of the lower range analogue signal should be entered here.

Note!

Number with floating decimal point: 0.000 – +999,999
Factory setting: ***dependent*** on the selected unit and flow equation.

FULL SCALE – HI RANGE

For use of split range (stacking) the full scale value of the higher range analogue signal should be entered here.
The value entered here must be equal to the value set in the flowmeter.

Number with floating decimal point: 0.000 – +999,999
Factory setting: ***dependent*** on the selected unit and flow equation.

Function Group: FLOW INPUT	
LOW FLOW CUTOFF	Enter the switchpoint for creep suppression. The creep suppression setting can be used to prevent low flows from being registered. Number with floating decimal point: 0.000 – 999,999 Factory setting: ***0.000*** [units]
CALIBRATION DENSITY	Enter the calibration density for the generic square law flowmeter (density on sizing sheet). Number with floating decimal point: 0.0001 – 10000 Factory setting: ***1.0000*** [units]
K-FACTOR	The K-factor is defined as number of pulses per dm^3 flow. If an EF77 EF73 with PFM output is used as flowmeter, the value shown on the meter body has to be entered as the K-factor. If an Open Collector output is used, then – independent of the flowmeter type – the inverse of the pulse value (pulse scaling) has to be entered. **Note!** The flow computer always uses [pulses/liter] as units for the K-factor. A conversion must be carried out for instruments using different units. Number with floating decimal point: 0.001 – 999,999 Factory setting: ***1.000*** [P/dm^3]
PIPE INNER DIAMETER	Enter the inlet bore of the pipeline. **Note!** This value is required to calculate the Reynolds number, when a 16 point linearization is selected. Number with floating decimal point: 0.0001 – 1000.00 Factory setting: ***1.0000*** [units]
ENTER BETA	Enter the opening ratio (d/D) of the DP-flowmeter being used. This value is given by the manufacturer of the orifice plate. **Note!** • ’Beta’ is only required for measuring gas or steam with DP-flowmeters. • ‘Beta’ is used to calculate the expansion factor. It is not required when “generic DP-meter” is selected. Number with fixed decimal point: 0.0000 – 1.0000 Factory setting: ***0.0001***

Function Group: FLOW INPUT

METER EXP. COEF.

The flowmeter pipe expands depending on the temperature of the fluid, which affects the calibration of the flowmeter.
In this function an appropriate correction factor is entered which is given by the manufacturer of the flowmeter. This factor converts the changes in the measuring signal per degree variation from the calibration temperature. This calibration temperature is permanently set in the flow computer to 70 °F / 21 °C.

Some manufacturers use a graph or a formula to show the influence of temperature on the calibration of the flowmeter. In this case use the following equation to calculate the meter expansion coefficient:

$$K_{ME} = \frac{1 - \frac{Q\,(T)}{Q\,(T_{cal})}}{T - T_{cal}} \times 10^6$$

K_{ME}	Meter expansion coefficient
Q (T)	Volumetric flow at temperature T resp. T_{cal}
T	Average process temperature
T_{cal}	Calibration temperature 294 K (21 °C or 70 °F)

Note!

- Note that this correction should be set either in the flowmeter or in the flow computer.
- Entering the value ’0.000’ switches this function off.
- The temperature T and T_{cal} should be entered in the units selected in the “SYSTEM UNITS” function group.

Note!

Number with fixed decimal point: 0.000 – 999.900 (e–6/°X)
Factory setting: ***dependent*** on the selected temperature unit and flowmeter.

DP-FACTOR

This factor gives the relationship between the flowrate and the measured differential pressure. The volume flowrate is computed according to one of the following equations. Additionally, one of the flow equations on pages 58 to 69 is used to compute values of mass, heat or corrected volume.

Steam (or gas) volume flow: $$Q = \frac{K_{DP} \times \varepsilon_1}{(1 - K_{ME} \times (T - T_{cal}))} \times \sqrt{\frac{2 \times \Delta p}{\rho}}$$

Liquid volume flow: $$Q = \frac{K_{DP}}{(1 - K_{ME} \times (T - T_{cal}))} \times \sqrt{\frac{2 \times \Delta p}{\rho}}$$

Q	Volumetric flow
K_{DP}	DP-Factor
ε_1	Gas expansion factor
T	Operating temperature
T_{cal}	Calibration temperature 294 K (21 °C or 70 °F)
Δp	Differential pressure
ρ	Density
K_{ME}	Meter expansion coefficient

The DP-Factor KDP can be entered manually or the flow computer can calculate it for you with the help of the function “COMPUTE DP FACTOR”. The information necessary for this calculation can be found on the sizing sheet from a DP-meter sizing program.

(Continued next page)

Function Group: FLOW INPUT

Note!

DP FACTOR
(Continued)

Note!
The following data must be entered in the corresponding matrix functions before computing the DP-Factor:

1. Flow equation	see group “SYSTEM PARAMETER”
2. Fluid data	see group “FLUID DATA”
3. Beta (diameter ratio: d/D)*	see group “FLOW INPUT”
4. Meter expansion coefficient	see group “FLOW INPUT”
5. STP Reference temperature**	see group “COMPENSATION INPUT” (Input selection → 1)
6. STP Reference pressure**	see group “COMPENSATION INPUT” (Input selection → 2)

* Only for orifice or nozzle
** Only for “GAS….” flow equations

CHANGE FACTOR? NO
CHANGE FACTOR? YES

If ’YES’ → the flow computer will prompt you further:

COMPUTE FACTOR? NO
COMPUTE FACTOR? YES

If ’NO’ → enter DP FACTOR
If ’YES’ → the flow computer will prompt you for the following:

ENTER DELTA P
ENTER FLOWRATE
ENTER DENSITY
ENTER TEMPERATURE
ENTER INLET PRESSURE
ENTER ISENTROPIC EXP

The flow computer first computes the gas expansion factor ε_1 using one of the following equations:

Orifice plate

$$\varepsilon_1 = 1 - (0.41 + 0.35\,\beta^4) \times \frac{\Delta p}{\kappa \times p1}$$

Flow nozzle or Venturi

$$\varepsilon_1 = \sqrt{\frac{(1 - \beta^4) \times \frac{\kappa}{\kappa - 1} \times R^{2/\kappa} \times (1 - R^{(\kappa - 1)/\kappa})}{[(1 - (\beta^4 - R^{2/\kappa})) \times (1 - R)]}}\text{, with } R = 1 - \frac{\Delta p}{p_1}$$

Pitot tube

$\varepsilon_1 = 1.0$

ε_1	Gas expansion factor
β	BETA (orifice plate opening ratio)
Δp	Differential pressure
κ	Isentropic Exponent
p_1	Inlet pressure

(Continued next page)

Function Group: FLOW INPUT

DP FACTOR
(Continued)

The DP-Factor KDP is then computed according to one of the three following equations, depending on the selected flow equation:

Steam: $$K_{DP} = \frac{M \times (1 - K_{ME} \times (T - T_{cal}))}{\varepsilon_1 \times \sqrt{2 \times \Delta p \times \rho}}$$

Liquid: $$K_{DP} = \frac{Q\ (1 - K_{ME} \times (T - T_{cal}))}{\sqrt{\frac{2 \times \Delta p}{\rho}}}$$

Gas: $$K_{DP} = \frac{Q_{ref} \times \rho_{ref} \times (1 - K_{ME} \times (T - T_{cal}))}{\varepsilon_1 \times \sqrt{2 \times \Delta p \times \rho}}$$

K_{DP}	DP-Factor
M	Mass flow
Q	Volumetric flow
Q_{ref}	Corrected volume flow
ε_1	Gas expansion coefficient
K_{ME}	Meter expansion coefficient
T	Operating temperature
T_{cal}	Calibration temperature 294 K (21 °C or 70 °F)
Δp	Differential pressure
ρ	Density
ρ_{ref}	Reference density

Note!
The computation accuracy can be enhanced by entering up to 16 values for Reynolds number and DP-factor in a linearization table (see function “LINEARIZATION” below). Every single DP-factor can then be calculated using the above procedure. For every calculation a sizing sheet is required. The results have to be entered in the linearization table afterwards.

Note!

LOW PASS FILTER

Enter the maximum possible frequency of a flowmeter with PFM or digit signal type (see function “INPUT SIGNAL”, page 33). Using the value entered here, the flow computer selects a suitable limiting frequency for the low-pass filter in order to suppress any higher frequency interference signals.

max. 5-figure number: 10 – 40,000 [Hz]
Factory setting ***40,000 Hz***

LINEARIZATION

With flowmeters the relationship between the flowrate and the output signal may deviate from an ideal curve – linear or squared. The flow computer is able to compensate for this deviation with an additional linearization.
The appearance of the linearization table used for this is dependent on the particular flowmeter selected (see following sections):

Linear flowmeters with pulse output
The linearization table enables up to 16 pairs of values to be entered (frequency/K-factor). The frequency [Hz] and the corresponding K-factor [pulse/dm^3] are prompted for each pair of values.

(Continued next page)

Function Group: FLOW INPUT

LINEARIZATION (Continued)	**Linear flowmeters with analogue output** The linearization table enables up to 16 pairs of values to be entered (current/flowrate). The flowrate and the corresponding current signal are prompted for each pair of values. **Linear/squared differential pressure transmitters with analogue output** The linearization table enables up to 16 pairs of values to be entered (Reynolds number/differential pressure factor). The Reynolds number and the corresponding differential pressure factor is prompted for each pair of values in ascending order of the first variable. **Application hint:** For the 16PT linearization table (Reynolds number/DP-factor), set the meter type to orifice/nozzle/pitot (without 16PT linearization). Then go into the DP factor cell and calculate it for all table points (max. 16 times), or calculate it by hand using the formula for DP factor, described on page 37. The information needed will be given on the sizing sheet (from the manufacturer of the DP-device) for the calculated process. Having done this set the flowmeter to Orifice/Nozzle or Pitot with 16PT linearization, and enter the calculated points into the linearization table. ***CHANGE TABLE? NO*** CHANGE TABLE? YES 'YES' → Correction factors can be entered for up to 16 different input values. *Example (for linear flowmeters with analogue output):* Entry of current value: INPUT mA 5.00 POINT 0 Entry of corresponding flowrate: RATE m^3/h 0.25 POINT 0 Note! **Note!** If the number '0' is entered as the first value for a pair of values, then all pairs of values entered so far are adopted and no more prompts are given.
FLOWMETER LOCATION	Select the location of the flowmeter in a 'delta heat' application. HOT – ***COLD***
VIEW INPUT SIGNAL	Display of actual flow input signal. Depending on input signal this cell displays a frequency, current or a voltage.
VIEW HI FLOW SIGNAL	Display of actual flow input signal of the hi-range input signal of split range DP transmitter.

Function Group: COMPENSATION INPUT	
SELECT INPUT	In addition to the flow input, the flow computer provides two further inputs for temperature, density and/or pressure signals. In this function select the particular input that is to be configured in the following functions. ***1*** (Input 1: Temperature) 2 (Input 2: Pressure, Temperature 2, Density)
INPUT SIGNAL	Determine the type of measuring signal coming from the temperature, density or pressure sensor. **Note!** In case saturated steam is measured with only a pressure sensor, “INPUT 1 NOT USED” must be selected. If only a temperature sensor is used, “INPUT 2 NOT USED” must be selected. *Input 1 (Temperature):* INPUT 1 NOT USED – RTD TEMPERATURE – 4–20 TEMPERATURE – 0–20 TEMPERATURE – MANUAL TEMPERATURE* *Input 2 (Process pressure, Temperature 2, Density):* INPUT 2 NOT USED – 4–20 PRESSURE (G) – 0–20 PRESSURE (G) – MANUAL PRESSURE* – 4–20 PRESSURE (ABS.) – 0–20 PRESSURE (ABS.) – RTD TEMPERATURE 2 – 4–20 TEMPERATURE 2 – 0–20 TEMPERATURE 2 – MANUAL TEMPERATURE 2* – 4–20 DENSITY – 0–20 DENSITY – MANUAL DENSITY* * Select this setting if a self-defined fixed value for the corresponding measuring variable is required (see function “DEFAULT VALUE”; page 40). Factory setting: ***dependent*** on flow equation and input selected (1 or 2).
LOW SCALE VALUE	Set the low scale value of the analogue current input signal (value for 0 or 4 mA input current). The value entered here must be identical with the one set in the pressure, temperature or density transmitter. Number with fixed decimal point: -9999.99 – +9999.99 Factory setting: ***dependent*** on flow equation and input selected (1 or 2).
FULL SCALE VALUE	Set the full-scale value of the analogue current input signal (value for 20 mA input current). The value entered here must be identical with the one set in the pressure, temperature or density transmitter. Number with fixed decimal point: -9999.99 – +9999.99 Factory setting: ***dependent*** on flow equation and input selected (1 or 2).

Note!

Function Group: COMPENSATION INPUT

DEFAULT VALUE	A fixed value can be defined for the assigned variable (pressure, temperature or density) in the function "INPUT SIGNAL". The flow computer requires this value in the following cases: • In cases of error, e.g. defective sensors, the flow computer continues to operate with the fixed value entered here, and indicates an error. • If in the function "INPUT SIGNAL" (see page 39) the setting 'MANUAL TEMPERATURE', 'MANUAL PRESSURE' or 'MANUAL DENSITY' has been selected. Number with fixed decimal point: -9999.99 – +9999.99 Factory settings: Temperature → ***21 °C*** Pressure → ***1.013 bara*** Density → ***998.9 kg/m***^{3}
STP REFERENCE	Define the STP reference conditions (standard temperature and pressure) for the variable assigned to the input. Standard conditions are at present defined differently according to the country and the application. Number with fixed decimal point: -9999.99 – +9999.99 Factory settings: Pressure → ***1.013 bara*** Temperature → ***dependent*** on unit system and fluid selected: • Metric unit system: – Gas → 0 °C – Liquid → 20 °C • English unit system: – Gas/Liquids → 70 °F (21 °C)
BAROMETRIC PRESS.	Enter the actual atmospheric pressure. When using gauge pressure transmitters for determining gas pressure, the reduced atmospheric pressure above sea level is then taken into account. Number with floating decimal point: 0.0000 – 10,000.0 Factory setting: ***1.013 bara***
LOW DELTA T CUTOFF	Enter the minimum value of temperature difference (DT), below which the energy flow is assumed to be zero and energy totalizing stops. Number with fixed decimal point: 0.0 – 99.9 Factory setting: ***0.0*** [temperature unit]
VIEW INPUT SIGNAL	Display of actual input signal. Depending on input signal, this cell displays a current or a resistance.

Function Group: PULSE OUTPUT

ASSIGN PULSE OUTPUT

A measured or calculated value can be assigned to the pulse output.

HEAT TOTAL – MASS TOTAL – CORRECTED VOL. TOTAL – ACTUAL VOLUME TOTAL

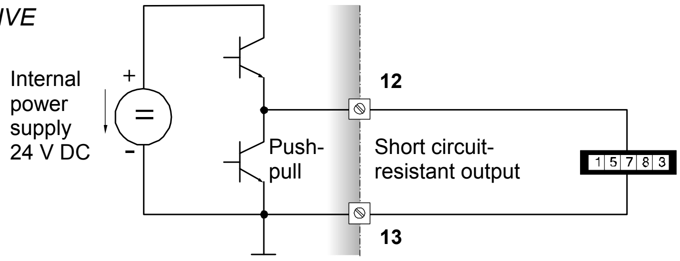
Factory setting/options:
dependent on the flow equation selected.

PULSE TYPE

The pulse output of the flow computer can be configured as required for external instrument, such as totalizers, etc.

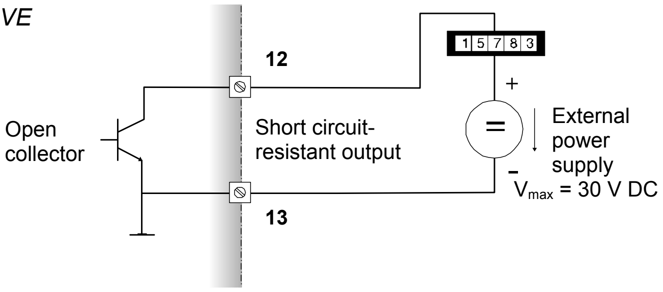
ACTIVE:	Internal power supply used (+24 V)
PASSIVE:	External power supply required
POSITIVE:	Fall-back value at 0 V (“active high”)
NEGATIVE:	Fall-back value at 24 V (“active low”) or external power supply

ACTIVE



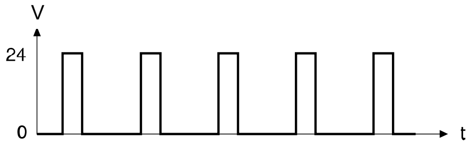
For continuous currents up to 15 mA

PASSIVE

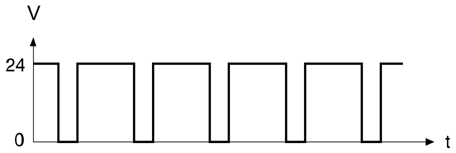


For continuous currents up to 25 mA

POSITIVE pulses



NEGATIVE pulses



PASSIVE-NEGATIVE
PASSIVE-POSITIVE
ACTIVE-NEGATIVE
ACTIVE-POSITIVE

Function Group: PULSE OUTPUT

PULSE VALUE

Define the flow quantity per output pulse. By means of an external counter the sum of these pulses can be totalized and the total quantity determined since the start of measurement.

Note!

Note!
Ensure that the max. flowrate (full-scale value) and the pulse value selected here agree with one another. The maximum possible output frequency is 50 Hz. The appropriate pulse value can be determined as follows:

$$\text{Pulse value} > \frac{\text{estimated max. flowrate per second}}{\text{max. output frequency (max. 50Hz)}}$$

Number with floating decimal point: 0.001 – 1000.0

Factory setting: ***1.000*** [units/pulse]

PULSE WIDTH

Set the pulse width required for external counters. The pulse width limits the maximum possible output frequency of the pulse output. For a certain output frequency, the maximum permissible pulse width can be calculated as follows:

$$\text{Pulse width} < \frac{1}{2 \times \text{max. output frequency [Hz]}}$$

Number with floating decimal point: 0.01 – 10.00 s (seconds)

Factory setting: ***0.01 s***

SIMULATION FREQ.

Frequency signals can be simulated in order to check any instruments that may be connected. The simulated signals are always symmetrical (pulse/pause ratio = 1:1).

Note!

Note!
- The simulation mode selected affects only the frequency output. The flow computer is fully operational during simulation, i.e. totalizer, flow display, etc. continue operating normally.
- Simulation mode is ended immediately after leaving this function.

OFF – 0.0 Hz – 0.1 Hz – 1.0 Hz – 10 Hz – 50 Hz

Function Group: CURRENT OUTPUT

SELECT OUTPUT	Select the current output to be configured. *Two* current outputs are available. ⊟⊞ ***1*** (Current output 1) 2 (Current output 2)
ASSIGN CURRENT OUT.	Assign a variable to the current output. ⊟⊞ HEAT FLOW – MASS FLOW – COR. VOLUME FLOW – VOLUME FLOW – TEMPERATURE 1 – TEMPERATURE 2 – DELTA TEMPERATURE – PRESSURE – DENSITY – VISCOSITY – REYNOLDS NUMBER Factory setting/options: ***dependent*** on the flow equation.
CURRENT RANGE	Define the 0/4-mA initial current value. The current for the scaled full-scale value is always 20 mA. ⊟⊞ 0–20 mA – ***4–20 mA*** – NOT USED
LOW SCALE VALUE	Assign the low scale value to the 0/4 mA current signal for the variable assigned to the current output. ⊟⊞ Number with floating decimal point: -999,999 – +999,999 Factory setting*:* ***0.000*** [units]
FULL SCALE VALUE	Assign the full-scale value to the 20 mA current signal for the variable assigned to the current output. ⊟⊞ Number with floating decimal point: -999,999 – +999,999 Factory setting: ***50,000*** [units]
TIME CONSTANT	Select the time constant to determine whether the current output signal reacts quickly (small time constant) or slowly (large time constant) to rapidly changing variables, e.g. flowrate. The time constant does not affect the behavior of the display. ⊟⊞ max. 2-figure number: 0 – 99 Factory setting: ***1***
CURRENT OUTPUT VALUE	Display the actual value of the output current. **Display:** Actual current value in [mA]
SIMULATION CURRENT	Various output currents can be simulated in order to check any instruments that may be connected. **Note!** • The simulation mode selected affects only the current output. The flow computer is fully operational during simulation, i.e. totalizer, flow display, etc. continue operating normally. • Simulation mode is ended immediately after leaving this function. ⊟⊞ ***OFF*** – 0 mA – 2 mA – 4 mA – 12 mA – 20 mA – 25 mA

Note!

Function Group: RELAYS

SELECT RELAY	Select the relay output to be configured. *Two* relay outputs are available. − + **1** (Relay 1) 2 (Relay 2)
RELAY FUNCTION	Both relays (1 and 2) can be assigned various functions as required: • **Limit functions** Exceeding limit switch points (see pages 45 - 47). Freely assignable to measured or calculated variables or totalizers. • **Malfunction** For indication of instrument failure, power loss, etc. the relay de-energizes. • **Wet steam alarm** The flow computer can monitor pressure and temperature in superheated steam applications continuously and compare them to the saturated steam curve. When the degree of superheat (distance to the saturated steam curve) drops below 2 °C (3.6 °F), the relay switches and the message “WET STEAM ALARM” is displayed. • **Pulse output** The relays can be defined as additional pulse outputs (see function “RELAY MODE”, page 45) for totalized values such as heat, mass, volume or corrected volume. Depending on the flow equation (see page 20) and type of transmitter different options are available: − + HEAT TOTAL – MASS TOTAL – CORRECTED VOL. TOTAL – ACTUAL VOLUME TOTAL – HEAT FLOW – MASS FLOW – COR. VOL. FLOW – VOLUME FLOW – TEMPERATURE 1 – TEMPERATURE 2 – DELTA TEMPERATURE – PRESSURE – DENSITY – WET STEAM ALARM – MALFUNCTION – VISCOSITY – REYNOLDS NUMBER Factory setting/options: ***dependent*** on the flow equation.

Function Group: RELAYS

RELAY MODE

Sets when and how the relays are switched ’on’ or ’off’.
This defines both the alarm conditions and the time response of the alarm status (see page 47).

Caution!
See page 47 for relay behavior for limit switches, malfunction or wet steam alarm.

Caution!

HI ALARM, FOLLOW
LO ALARM, FOLLOW
HI ALARM LATCH
LO ALARM LATCH
RELAY PULSE OUTPUT

Note!

- For relay functions “MALFUNCTION” and “WET STEAM ALARM” there is no difference between the modes “HI …” and “LO …”:
  → HI ALARM FOLLOW = LO ALARM FOLLOW
  → HI ALARM LATCH = LO ALARM LATCH
- Relay mode “RELAY PULSE OUTPUT” defines the relay as additional pulse output:
  Set pulse value → see below
  Set pulse width → see page 46

Note!

LIMIT SETPOINT

After configuring a relay for ’Alarm indication’ (limit value), the required switchpoint can be set in this function. If the variable reaches the set value, then the relay switches and the corresponding message is displayed.
With the function “HYSTERESIS” (see page 46) continuous switching near the switchpoint can be prevented.

Note!

- Initially select the units (see page 25), before entering the switchpoint in this function.
- Normally open or normally closed contacts are determined by the type of wiring (see page 6).

Note!

Number with floating decimal point -999,999 – +999,999
Factory setting: ***50,000*** [units] for variables

PULSE VALUE

Define the flow quantity per output pulse if the relay is configured to ’RELAY PULSE OUTPUT’.

Note!
Ensure that the max. flowrate and the pulse value selected here agree with one another. The maximum possible output frequency is 5 Hz.
The appropriate pulse value can be determined as follows:

Note!

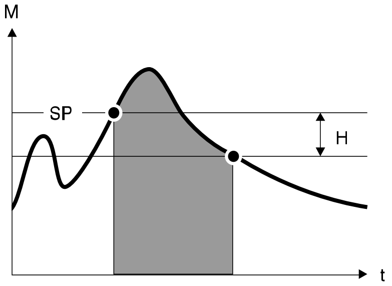
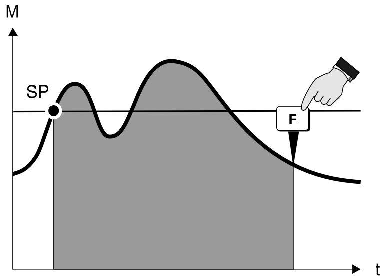
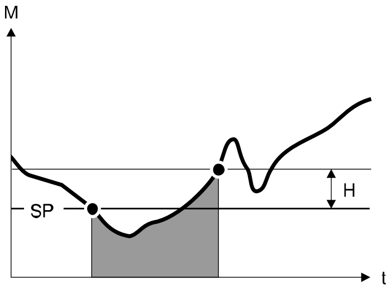
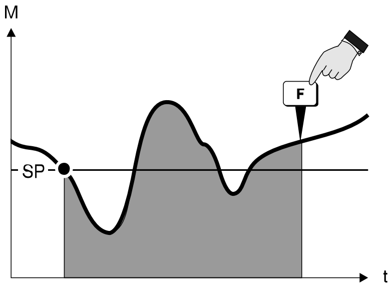
$$\text{Pulse value} > \frac{\text{estimated max. flowrate (full-scale value)}}{\text{required max. output frequency}}$$

Number with floating decimal point: 0.001 – +100,000,000
Factory setting: ***1000*** [units/pulse]

Function Group: RELAYS	
PULSE WIDTH	Enter the pulse width. Two cases are possible: **Case A: Relay → Setting 'MALFUNCTION' or limit value** The response of the relay during alarm status is determined by selecting the pulse width. • *Pulse width = 0.0 s (Normal case):* Alarm response as described on page 47. • *Pulse width = 0.1 – 9.9 s (Special case):* Relay remains de-energized for the selected duration (0.1 – 9.9 seconds) independent of the cause of the alarm. This setting is only used in special cases, e.g. for activating signal horns. **Case B: Relay → Setting 'RELAY PULSE OUTPUT'** Set the pulse width required for the external totalizer. The pulse width entered here can be made to agree with the actual flow amount and pulse value (see above) by using the following equation: $\text{Pulse width} < \frac{1}{2 \times \text{max. output frequency [Hz]}}$ 2-figure number with fixed decimal point: 0.1 – 9.9 s ('RELAY PULSE OUTPUT') or 0.0 – 9.9 s (all other relay configurations) Factory setting: ***0.0 s*** (0.1 s with 'RELAY PULSE OUTPUT')
HYSTERESIS	Enter a hysteresis value to ensure that the 'on' and 'off' switchpoints have different values and therefore prevent continual and undesired switching near the limit value (see page 45). **Note!** The arithmetic sign for the hysteresis value is determined by the following settings in the function "RELAY MODE": 'HI ALARM, FOLLOW' → negative hysteresis 'LO ALARM, FOLLOW' → positive hysteresis Number with floating decimal point: 0.000 – 999999 Factory setting: ***0.000*** [units]
RELAY SIMULATION	This cell may be used to simulate a relay status for test purposes. ***NO*** – Relay ON – Relay OFF
RESET ALARM	The alarm status for the particular relay can be cancelled here if for safety reasons the setting '…, LATCH' has been selected in the function "RELAY MODE". This ensures that the user is actively aware of the alarm message. **Note!** • If this function is used often, then one of the three function keys F1-F3 should be assigned to "ACK. + CLEAR ALARMS" (see page 21). • The alarm status can only be permanently cancelled if the cause of the alarm is removed. ***RESET ALARM? NO*** RESET ALARM? YES

Note!

Note!

<table>
<tr><th colspan="2">RELAY 1 / 2
Alarm response on “Limit Value” (pulse width: 0.0 s)</th></tr>
<tr><td>
 </td><td>HI ALARM, FOLLOW
When the measured value exceeds the limit switchpoint, the relay de-energizes and the corresponding message is displayed. This status remains only as long as the following condition is met:
Measured value M > (SP - H)
HI ALARM LATCH
When the measured value exceeds the limit switchpoint, the relay de-energizes and the corresponding message is displayed until the alarm is acknowledged and reset by the operator:
→ see function “ALARM RESET” (page 46)
→ see function keys F1 – F3 (page 21)
If the measured value still exceeds the limit switchpoint (M > SP), the relay de-energizes again immediately and the message reappears on the display. An alarm can only be reset permanently when its cause is rectified (M < SP).</td></tr>
<tr><td>
 </td><td>LO ALARM, FOLLOW
When the measured value drops below the limit switchpoint, the relay de-energizes and the corresponding message is displayed. This status remains only as long as the following condition is met:
Measured value M < (SP + H)
LO ALARM LATCH
When the measured value drops below the limit switchpoint, the relay de-energizes and the corresponding message is displayed until the alarm is acknowledged and reset by the operator:
→ see function “ALARM RESET” (page 46)
→ see function keys F1-F3 (page 21)
If the measured value remains below the limit switchpoint (M < SP), the relay de-energizes again immediately and the message reappears on the display.
An alarm can only be reset permanently when its cause is rectified (M > SP).</td></tr>
<tr><td>▨ Relay de-energized
Alarm message on the display

SP = Limit set point
H = Hysteresis (only with “… FOLLOW”)
M = Measured value
t = Time</td><td>Note!
• The above table is only valid for pulse width = 0.0 seconds. For pulse widths 0.1 – 9.9 s → see page 46
• The above table also applies to relay functions “MALFUNCTION” and “WET STEAM ALARM” (see page 44), but then reactions are the same for “HI …” and “LO …”.</td></tr>
</table>

Note!

Function Group: COMMUNICATION

RS232 USAGE	The flow computer can be connected over a serial RS232 interface to a personal computer or printer. −+ COMPUTER – ***PRINTER***
DEVICE ID	Enter the instrument number for unique tagging of the flow computer if a number of flow computers are connected to the same interface. −+ max. 2-figure number: 0 – 99 Factory setting: ***1***
BAUD RATE	In this function the ’baud rate’ is entered for serial communication between the flow computer and personal computer or printer. −+ ***9600*** – 2400 – 1200 – 300
PARITY	Parity check can be switched on and off. The setting selected here must agree with that of the printer or personal computer. −+ ***NONE*** – ODD – EVEN
HANDSHAKE	The control of data flow can be defined. The setting required is determined by the personal computer or printer connected. −+ ***NONE*** – HARDWARE

Function Group: COMMUNICATION

PRINT LIST

Select the variables or parameters which are to be printed via the RS232 interface.

−+ ***CHANGE? NO***
CHANGE? YES

If 'YES' → The variables which can be printed are displayed one after the other. Depending on the selected flow equation (see page 20) only some of the following options are available:

E Storing option → next option	−+ Print?	E Storing option → next option	−+ Print?
PRINT HEADER?	NO (YES)	COR.VOL.GRAND TOTAL?	NO (YES)
INSTRUMENT TAG?	NO (YES)	VOLUME FLOW?	NO (YES)
FLUID TYPE?	NO (YES)	VOLUME TOTAL?	NO (YES)
TIME?	NO (YES)	VOL. GRAND TOTAL?	NO (YES)
DATE?	NO (YES)	TEMPERATURE1?	NO (YES)
TRANSACTION NO.?	NO (YES)	TEMPERATURE 2?	NO (YES)
HEAT FLOW?	NO (YES)	DELTA TEMPERATURE?	NO (YES)
HEAT TOTAL?	NO (YES)	PROCESS PRESSURE?	NO (YES)
HEAT GRAND TOTAL?	NO (YES)	DENSITY?	NO (YES)
MASS FLOW?	NO (YES)	SPEC. ENTHALPY?	NO (YES)
MASS TOTAL?	NO (YES)	VISCOSITY?	NO (YES)
MASS GRAND TOTAL?	NO (YES)	REYNOLDS NUMBER?	NO (YES)
COR. VOLUME FLOW?	NO (YES)	ERRORS?	NO (YES)
COR. VOLUME TOTAL?	NO (YES)	ALARMS?	NO (YES)

'YES' + E → Parameter is added to the printer list.
'NO' + E → Parameter is **not** printed.

After the last option there is an automatic jump to the next function.

PRINT INITIATE

Printing variables and parameters over the serial RS232 interface can either be at regular intervals (INTERVAL) or daily at a fixed time (TIME OF DAY).

Note!
Printing can always be initiated if assigned to the function keys (F1 – 3) independent of the selection made here.

Note!

−+ ***NONE*** – TIME OF DAY – INTERVAL

PRINT INTERVAL

Define a time interval after which variables and parameters are to be periodically printed. The setting '00:00' deactivates this function.

−+ Flashing positions can be changed.
Confirm entries with E.

Factory setting: ***00:00*** (HH:MM)

PRINT TIME

Define the time at which variables and parameters are to be printed out daily.

−+ Flashing positions can be changed.
Confirm entries with E.

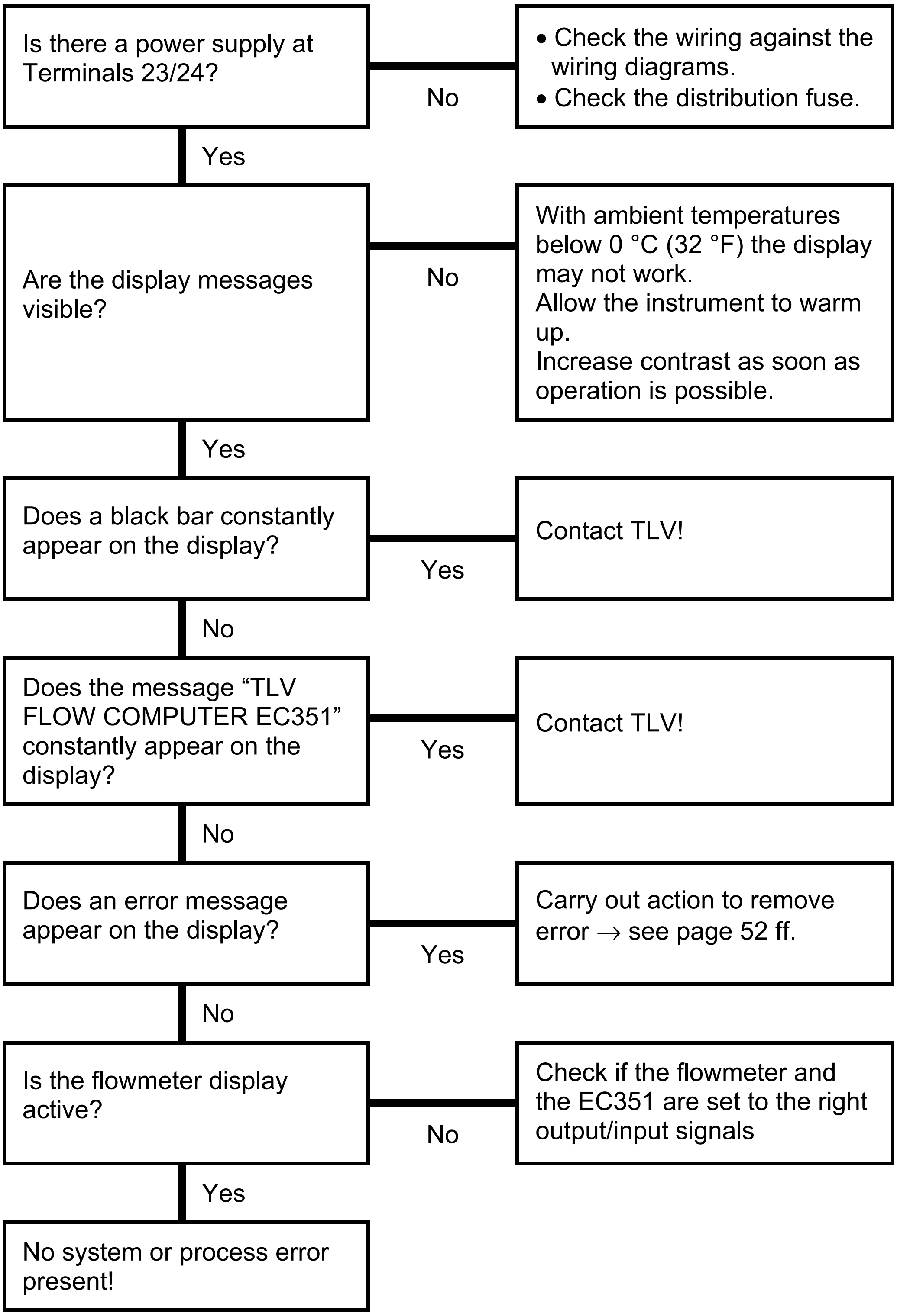
Factory setting: ***00:00*** (HH:MM)

Function Group: SERVICE & ANALYSIS	
EXAMINE AUDIT TRAIL	Changes in important calibration and configuration data are registered and displayed (“electronic stamping”). Those displays cannot be reset, so that unauthorized changes can be identified. *Example:* CAL 185 CFG 969
ERROR LOG	Display of logged system error message. *Example:* POWER FAILURE
SOFTWARE VERSION	Display of the software version being used. *Example:* 02.00.00
PRINT SYSTEM SETUP	This function allows the actual set parameters (set-up) to be printed on a connected printer. − + ***NO*** – YES
SELF CHECK	This function starts the self-test of the flow computer. − + ***RUN? NO*** RUN? YES

7 Troubleshooting and Remedies

7.1 Instructions for Troubleshooting

During manufacture, all units undergo quality control at numerous stages.
To help you locate faults, some of their possible causes are given here.



Is there a power supply at Terminals 23/24?

No:

- Check the wiring against the wiring diagrams.
- Check the distribution fuse.

Yes:

Are the display messages visible?

No: With ambient temperatures below 0 °C (32 °F) the display may not work. Allow the instrument to warm up. Increase contrast as soon as operation is possible.

Yes:

Does a black bar constantly appear on the display?

Yes: Contact TLV!

No:

Does the message “TLV FLOW COMPUTER EC351” constantly appear on the display?

Yes: Contact TLV!

No:

Does an error message appear on the display?

Yes: Carry out action to remove error → see page 52 ff.

No:

Is the flowmeter display active?

No: Check if the flowmeter and the EC351 are set to the right output/input signals

Yes:

No system or process error present!

7.2 Error Messages

Error messages that occur during operation are shown on the display (HOME position) alternately with the measured variable.

SYSTEM ERROR MESSAGES
EC351

DISPLAY	CAUSE	REMEDY
COMMUNICATION ERROR	• Faulty wiring between flow computer and connected PC/printer • Incorrect use of connected PC or printer	• Check wiring (see page 6) • Check settings in function group "COMMUNICATION" • Check settings on the printer/PC
CALIBRATION ERROR	Faulty programming or loss of calibration data	Repeat programming, check settings. Contact TLV if the fault cannot be removed.
PRINT BUFFER FULL	• Printer buffer of the connected printer is full (loss of data between flow computer and printer possible)	• Check connection to printer • Check paper supply of printer
TOTALIZER ERROR	Totalizer contents are lost.	Reset totalizer. Contact TLV if the fault cannot be removed.

PROCESS ERROR MESSAGES EC351		
DISPLAY	**CAUSE**	**REMEDY**
WET STEAM ALARM	The steam condition (temperature and pressure) is close to the saturated steam curve.	Check the application. Ensure that all transmitters and sensors that are connected are working correctly. Change the relay function, if the “WET STEAM ALARM” is not required (see page 44).
OFF FLUID TABLE	Temperature and/or pressure input signals are *outside* the range of steam table values stored in the flow computer.	Check application and settings. Ensure that all transmitters and sensors that are connected are working correctly.
FLOW IN OVERRANGE	Current input signal of the flowmeter input exceeds 21.5 mA: • Incorrectly set full-scale value for the flowmeter • Function error in the flowmeter or faulty wiring	• Check whether the programmed full-scale value of the connected flowmeter agrees with process conditions (see page 33) • Check the application conditions • Check wiring
INPUT 1 OVERRANGE	Current input signal of compensation input 1 exceeds 21.5 mA: • Incorrectly set full-scale value for transmitter • Function error in transmitter or faulty wiring	• Check whether the programmed full-scale value of the connected transmitter agrees with process conditions (see page 39) • Check the application conditions • Check wiring
INPUT 2 OVERRANGE	Current input signal of compensation input 2 exceeds 21.5 mA: • Incorrectly set full-scale value for transmitter • Function error in transmitter or faulty wiring	• Check whether the programmed full-scale value of the connected transmitter agrees with process conditions (see page 39) • Check the application conditions • Check wiring
FLOW LOOP BROKEN	Input current at flow input smaller than 3.6 mA: • Faulty wiring • Flowmeter not set to ’4 – 20 mA’ • Function error in flowmeter	• Check wiring • Check calibration of flowmeter • Check function of flowmeter

PROCESS ERROR MESSAGES
EC351

DISPLAY	CAUSE	REMEDY
LOOP 1 BROKEN	Input current at current input 1 smaller than 3.6 mA: • Faulty wiring • Transmitter not set to '4 – 20 mA' • Function error in transmitter	• Check wiring • Check calibration of transmitter • Check function of transmitter
LOOP 2 BROKEN	Input current at current input 2 smaller than 3.6 mA: • Faulty wiring • Transmitter not set to '4 – 20 mA' • Function error in transmitter	• Check wiring • Check calibration of transmitter • Check function of transmitter
RTD 1 OPEN	Input current at Pt100 Input 1 too low: • Faulty wiring • Pt100 sensor defective	• Check wiring • Check function of Pt100 sensor
RTD 1 SHORT	Resistance at Pt100 Input 1 too low: • Faulty wiring • Pt100 sensor defective	• Check wiring • Check function of Pt100 sensor
RTD 2 OPEN	Input current at Pt100 Input 2 too low: • Faulty wiring • PTt00 sensor defective	• Check wiring • Check function of Pt100 sensor
RTD 2 SHORT	Resistance at Pt100 Input 2 too low: • Faulty wiring • Pt100 sensor defective	• Check wiring • Check function of Pt100 sensor
PULSE OUT OVERRUN	Calculated pulse frequency too large: • Pulse value too low • Pulse width too large • Assigned measured variable too large	• Adjust pulse value • Adjust pulse width • Check process conditions

PROCESS ERROR MESSAGES
EC351

DISPLAY	CAUSE	REMEDY
Iout 1 OUT OF RANGE	Calculated current for current output 1 larger than 21.5 mA: • Full-scale value too low • Assigned measured variable too large	• Adjust full scale value • Check process conditions
Iout 2 OUT OF RANGE	Calculated current for current output 2 larger than 21.5 mA: • Full-scale value too low • Assigned measured variable too large	• Adjust full scale value • Check process conditions
RELAY 1 HI ALARM RELAY 1 LO ALARM	Limit value exceeded (see also pages 45 and 47)	• The alarm indication must be confirmed in the function “RESET ALARM” if the function “RELAY MODE” has been set to ’…, LATCH.’ (see page 46) • Check the application if necessary • Adjust the limit value if necessary
RELAY 2 HI ALARM RELAY 2 LO ALARM	Limit value exceeded (see also pages 45 and 47).	• The alarm indication must be confirmed in the function “RESET ALARM” if the function “RELAY MODE” has been set to ’…, LATCH.’ (see page 46) • Check application if necessary • Adjust the limit value if required

PROCESS ERROR MESSAGES
EC351

DISPLAY	CAUSE	REMEDY
A/D MALFUNCTION	Fault in analogue/digital converter has occurred.	Contact TLV.
PROGRAM ERROR	Fault in program EPROM has occurred.	Contact TLV.
SETUP DATA LOST	Stored data in EEPROM is destroyed or overwritten.	• Enter settings and numerical values again • Contact TLV if this fault indication occurs again
TIME CLOCK LOST	The correct time is no longer shown, e.g. after a long break in the power supply.	Re-enter data and time (see pages 20 and 21).
DISPLAY MALFUNCTION	Fault in display module has occurred.	Contact TLV.
RAM MALFUNCTION	A part or all the data stored in the RAM has been destroyed.	Switch off the instrument and then switch on again. If this occurs often then contact TLV.

8 Flow Equations / Applications

- The **basic operation** is determined by the flow equation selected. Every flow equation requires certain measured variables such as pressure, temperature and density in order to be able to calculate and/or show other parameters (see following table).
- The following pages give detailed descriptions and instructions on the applications for every flow equation used. The figures show typical applications with vortex flowmeters.
- For use with differential pressure flowmeters the pressure sensor must be installed in front of the flowmeter. Detailed installation guidelines can be found in the flow-meter documentation.

Measured variable / **Calculated variable** / **Flow equation**	HEAT FLOW	MASS FLOW	CORRECTED VOLUME FLOW	VOLUME FLOW	TEMPERATURE	TEMPERATURE 2	DELTA TEMPERATURE	PROCESS PRESSURE	DIFFERENTIAL PRESSURE	DENSITY	SPECIFIC ENTHALPY	DATE & TIME	VISCOSITY*	REYNOLDS NUMBER*
STEAM MASS		▨		▨	▨			▨	■	▨		▨	■	■
STEAM HEAT	▨	▨		▨	▨			▨	■	▨	▨	▨	■	■
STEAM NET HEAT	▨	▨		▨	▨			▨	■	▨	▨	▨	■	■
STEAM DELTA HEAT	▨	▨		▨	▨			▨	■	▨	▨	▨	■	■
CORRECTED GAS VOLUME			▨	▨	▨			▨	■			▨	■	■
GAS MASS		▨		▨	▨			▨	■	▨		▨	■	■
GAS COMBUSTION HEAT	▨	▨		▨	▨			▨	■	▨		▨	■	■
CORRECTED LIQUID VOLUME			▨	▨	▨			▨	■			▨	■	■
LIQUID MASS		▨		▨	▨			▨	■	▨		▨	■	■
LIQUID COMBUSTION HEAT	▨	▨		▨	▨			▨	■	▨		▨	■	■
LIQUID SENSIBLE HEAT	▨	▨		▨	▨			▨	■	▨		▨	■	■
LIQUID DELTA HEAT	▨	▨		▨	▨	▨	▨		■	▨		▨	■	■

▨ Measured value available

■ Measured value available with differential pressure flow measurement

* Only with 16 point linearization

STEAM MASS

Measured variables
Measures uncorrected volumetric flow, temperature and pressure in a steam line.

Calculated variables

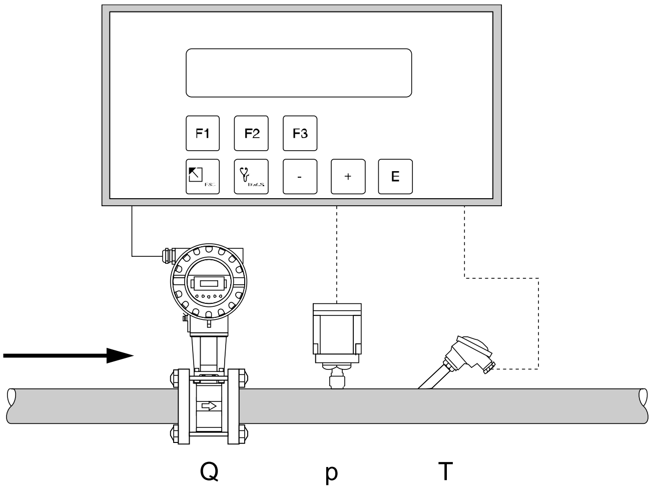
- Calculates density and mass flow using the steam tables stored in the flow computer.
- With DP-measurement the uncorrected volume is also calculated from the differential pressure taking into account temperature and pressure compensation.
- Saturated steam requires either a pressure or temperature measurement with the other variable calculated using the steam table.

Input variables
Superheated steam: Flow, temperature and pressure
Saturated steam: Flow, temperature or pressure

Output variables

- Mass flow, uncorrected volumetric flow, temperature, pressure and density
- Totalizer for mass and uncorrected volume
- If a relay is configured for “WET STEAM ALARM” (see page 44) and the superheated steam approaches the saturated steam curve, then this relay switches and an alarm is displayed (see Fig. page 47).

Applications
Calculate the mass flow in a steam line at the output of a steam generator or at individual consumers.



$m = Q \times \rho\ (T, p)$

m	Mass
Q	Uncorrected volume
ρ	Density
T	Temperature
p	Pressure

STEAM HEAT

Measured variables
Measures uncorrected volumetric flow, temperature and pressure in a steam line.

Calculated variables

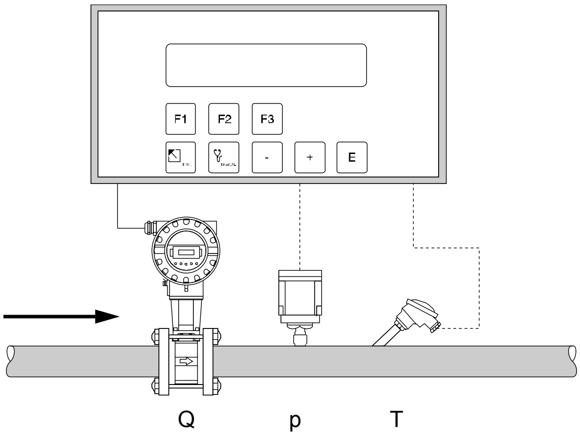
- Calculates density, mass flow and heat flow using steam tables stored in the flow computer. The heat is defined as the enthalpy of steam under actual conditions with reference to the enthalpy of water at T = 0 °C.
- With DP-measurement the uncorrected volume is also calculated from the differential pressure taking into account temperature and pressure compensation.
- Saturated steam requires either a pressure or temperature measurement with the other variable calculated using the saturated steam curve.

Input variables
Superheated steam: Flow, temperature and pressure
Saturated steam: Flow, temperature or pressure

Output variables

- Heat flow, mass flow, uncorrected volumetric flow, temperature, pressure, density and specific enthalpy
- Totalizer for heat, mass and uncorrected volume
- If a relay is configured for “WET STEAM ALARM” (see page 44) and the superheated steam approaches the saturated steam curve, then this relay switches and an alarm is displayed (see Fig. page 47).

Applications
Calculates the mass flow and the thermal energy at the output of a steam generator or at individual consumers.



$$H = Q \times \rho\ (T, p) \times E_D\ (T, p)$$

H	Heat
Q	Uncorrected volume
ρ	Density
T	Temperature
p	Pressure
E_D	Specific Enthalpy of steam

STEAM NET HEAT

Measured variables

Measures the uncorrected volumetric flow, temperature and pressure in a steam line upstream of a heat exchange.

Calculated variables

- Calculates density, mass flow and net heat flow using steam tables stored in the flow computer. The net heat is defined as the difference between the heat of the steam and the heat of the condensate. For simplification it is assumed that the condensate (water) has a temperature which corresponds to the temperature of saturated steam at the pressure measured upstream of the heat exchanger.
- With DP-measurement the uncorrected volume is also calculated from the differential pressure taking into account temperature and pressure compensation.
- Saturated steam requires either a pressure or temperature measurement with the other variable calculated using the saturated steam curve.

Input variables

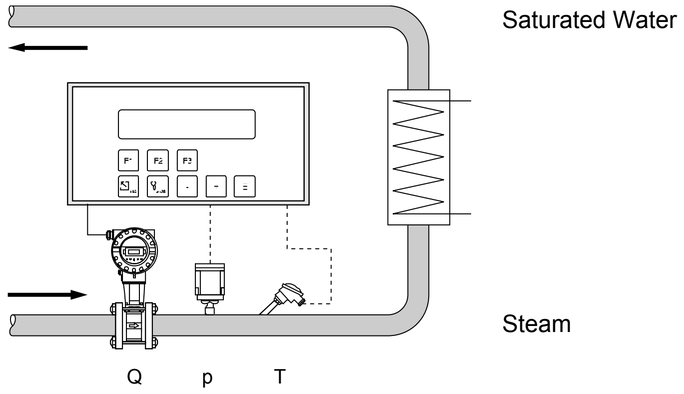
Superheated steam: Flow, temperature and pressure
Saturated steam: Flow, temperature or pressure

Output variables

- Heat flow, mass flow, uncorrected volumetric flow, temperature, pressure, density and specific enthalpy
- Totalizer for heat, mass and uncorrected volume
- If a relay is configured for "WET STEAM ALARM" (see page 44) and the superheated steam approaches the saturated steam curve, then this relay switches and an alarm is displayed (see figure on page 47).

Applications

Calculate the mass flow and the thermal energy which can be extracted by a heat exchanger taking into account the thermal energy remaining in the returned condensate. For simplification it is assumed that the condensate (water) has a temperature which corresponds to the temperature of saturated steam at the pressure measured upstream of the heat exchanger.



$$H = Q \times \rho\ (T, p) \times [\ E_D\ (T, p) - E_W\ (T_{S\ (p)})\ ]$$

H	Heat
Q	Uncorrected volume
ρ	Density
T	Temperature
p	Pressure
E_D	Specific enthalpy of steam
E_W	Specific enthalpy of water
$T_{S\ (p)}$	Calculated condensation temperature (= saturated steam temperature for the supply pressure)

STEAM DELTA HEAT

Measured variables
Measures uncorrected volumetric flow and pressure of the saturated steam in the supply piping as well as the temperature of the condensate in the downstream piping of a heat exchanger.

Calculated variables

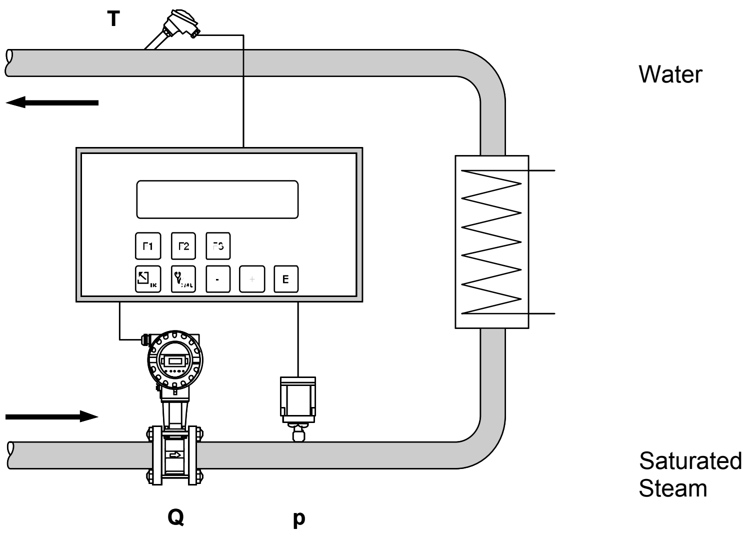
- Calculates the density and mass flow as well as the delta heat between the saturated steam (supply) and condensation (return) using physical characteristic tables of steam and water stored in the flow computer.
- With DP-measurement the uncorrected volume is also calculated from the differential pressure taking into account temperature and pressure compensation.
- The saturated steam temperature in the supply piping is calculated from the pressure measured there.

Input variables
Supply: Flow and pressure (saturated steam)
Return: Temperature (condensation)

Output variables

- Heat flow, mass flow, uncorrected volumetric flow, temperature, pressure, density and specific enthalpy
- Totalizer for heat, mass and uncorrected volume

Applications
Calculate the saturated steam mass flow and the heat extracted by a heat exchanger taking into account the thermal energy remaining in the condensate.



$$H = Q \times \rho (p_1) \times [E_D (p_1) - E_W (T_2)]$$

H	Heat
Q	Uncorrected volume
ρ	Density
T_2	Return temperature
p_1	Supply pressure
E_D	Specific enthalpy of steam
E_W	Specific enthalpy of water

CORRECTED GAS VOLUME

Measured variables
Measures uncorrected volumetric flow, temperature and pressure in a gas line.

Calculated variables

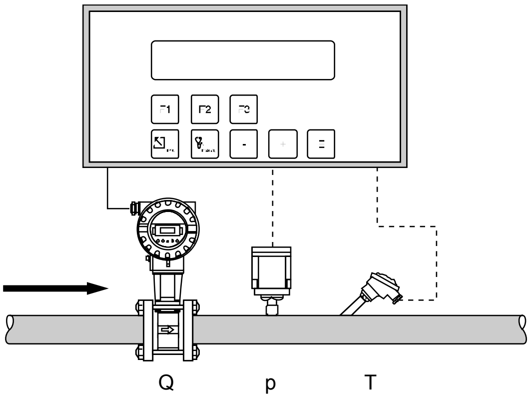
- Calculates the corrected volumetric gas flow using the gas characteristics stored in the flow computer (see function “FLUID DATA”, page 29). The reference conditions for temperature and pressure can be defined in the function “STP REFERENCE” (see page 40).
- With DP-measurement the uncorrected volume is also calculated from the differential pressure taking into account temperature and pressure compensation.

Input variables
Flow, temperature and pressure

Output variables

- Corrected volumetric flow, uncorrected volumetric flow, temperature and pressure
- Totalizer for corrected volume and uncorrected volume

Applications
Calculate the corrected volumetric flow of any gas such as compressed air, gaseous fuels, CO_2, etc.



$$Q_{ref} = Q \times \frac{p}{p_{ref}} \times \frac{T_{ref}}{T} \times \frac{Z_{ref}}{Z}$$

In this equation, T_{ref} and T are absolute values in K (Kelvin); p and p_{ref} are also absolute values, e.g. ’bara’ or ’psia’.

Q_{ref}	Corrected volume
Q	Uncorrected volume
p_{ref}	Reference pressure (see function, page 40)
p	Actual pressure
T_{ref}	Reference temperature (see function, page 40)
T	Actual temperature
Z_{ref}	Reference Z-factor (see function, page 30)
Z	Actual Z-factor (see function, page 30)

Note!

Note!
For natural gas (NX-19) selection, the ratio $\frac{Z_{ref}}{Z}$ is calculated by the NX-19 equation of state.

GAS MASS

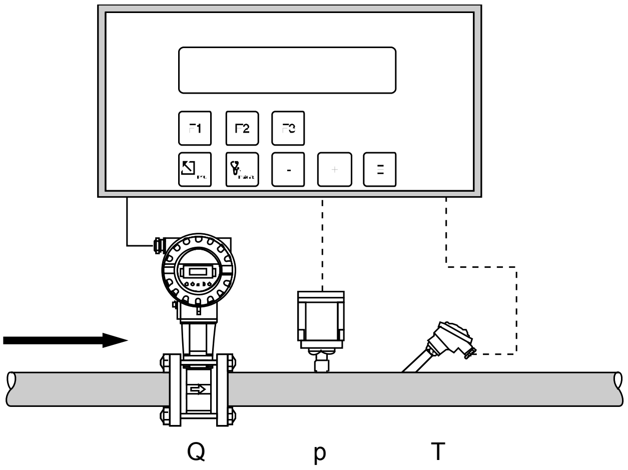
Measured variables
Measures the uncorrected volumetric flow, temperature and pressure in a gas line.

Calculated variables
- Calculates the density and mass flow using gas characteristics stored in the flow computer (see function “FLUID TYPE”, page 29).
- With DP-measurement the uncorrected volume is also calculated from the differential pressure taking into account temperature and pressure compensation.

Input variables
Flow, temperature and pressure

Output variables
- Mass flow, uncorrected volumetric flow, temperature, pressure and density
- Totalizer for mass and uncorrected volume

Applications
Calculate mass flow of any gas such as compressed air, gaseous fuels, CO_2, etc.



$$M = \rho_{ref} \times Q \times \frac{p}{p_{ref}} \times \frac{T_{ref}}{T} \times \frac{Z_{ref}}{Z}$$

In this equation, T_{ref} and T are absolute values in K (Kelvin);
p and p_{ref} are also absolute values, e.g. ’bara’ or ’psia’.

M	Mass
ρ_{ref}	Reference density (see function, page 29)
Q	Uncorrected volume
p_{ref}	Reference pressure (see function, page 40)
p	Actual pressure
T_{ref}	Reference temperature (see function, page 40)
T	Actual temperature
Z_{ref}	Reference Z-factor (see function, page 30)
Z	Actual Z-factor (see function, page 30)

Note!

For natural gas (NX-19) selection, the ratio $\frac{Z_{ref}}{Z}$ is calculated by the NX-19 equation of state.

Note!

GAS COMBUSTION HEAT

Measured variables
Measures uncorrected volumetric flow, temperature and pressure in a gas line.

Calculated variables

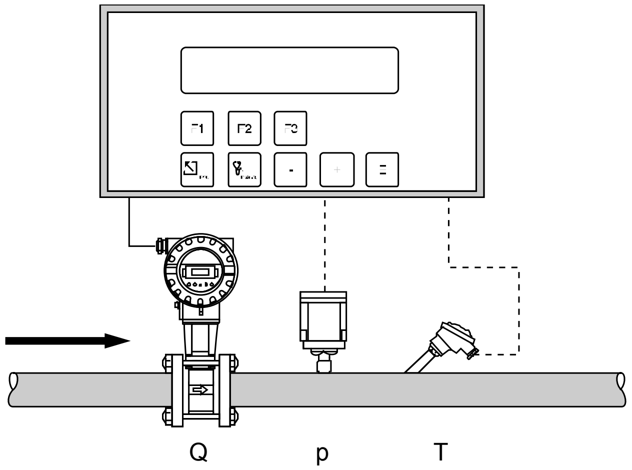
- Calculates density, mass flow and combustion heat of gases using gas characteristics stored in the flow computer (see function “FLUID TYPE”, page 29).
- With DP-measurement the uncorrected volume is also calculated from the differential pressure taking into account temperature and pressure compensation.

Input variables
Flow, temperature and pressure

Output variables

- Combustion heat flow, mass flow, uncorrected volume, temperature, pressure and density
- Totalizer for combustion heat, mass and uncorrected volume

Applications
Calculate the energy released by combustion of gaseous fuels.



$$H = C \times \rho_{ref} \times Q \times \frac{p}{p_{ref}} \times \frac{T_{ref}}{T} \times \frac{Z_{ref}}{Z}$$

In this equation, T_{ref} and T are absolute values in K (Kelvin); p and p_{ref} are also absolute values, e.g. ’bara’ or ’psia’.

H	Heat
C	Specific combustion heat (see function, page 30)
ρ_{ref}	Reference density (see function, page 29)
Q	Uncorrected volume
p_{ref}	Reference pressure (see function, page 40)
p	Actual pressure
T_{ref}	Reference temperature (see function, page 40)
T	Actual temperature
Z_{ref}	Reference Z-factor (see function, page 30)
Z	Actual Z-factor (see function, page 30)

Note!

Note!
For natural gas (NX-19) selection, the ratio $\frac{Z_{ref}}{Z}$ is calculated by the NX-19 equation of state.

CORRECTED LIQUID VOLUME

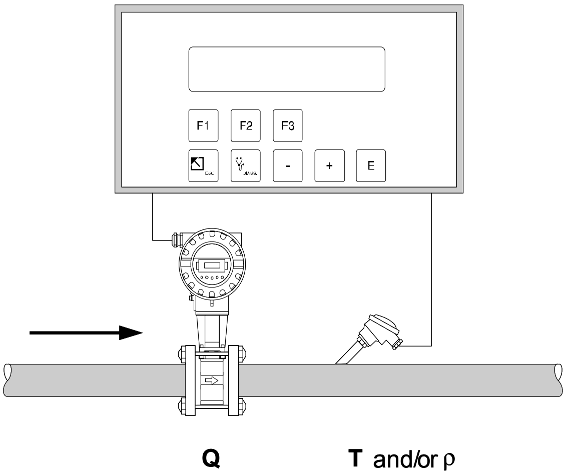
Measured variables
Measures uncorrected volume and temperature in a liquid line. A pressure transmitter can also be installed in order to show or monitor pressure. Pressure measurement does not affect the calculation.

Calculated variables
- Calculates corrected volumetric flow using thermal expansion coefficients stored in the flow-computer (see function group “FLUID TYPE”, page 29). The reference temperature can be defined in the function “STP REFERENCE” (see page 40).
- With DP-measurement the uncorrected volume is also calculated from the differential pressure taking into account temperature compensation.

Input variables
- Flow and temperature or,
- Flow and density (temperature is also used for calculating the meter expansion).

Output variables
- Corrected volumetric flow, uncorrected volumetric flow, temperature and pressure
- Totalizer for corrected volume and uncorrected volume

Applications
Calculate temperature compensated volumetric flow of any liquid if its thermal expansion coefficient is sufficiently constant within the entire temperature range.



$$Q_{ref} = Q \times (1 - \alpha \times (T - T_{ref}))^2$$

Q_{ref}	Corrected volume
Q	Uncorrected volume
α	Thermal expansion coefficient (see function, page 29)
T	Actual temperature
T_{ref}	Reference temperature (see function, page 40)

If density input:

$$Q_{ref} = Q \times \frac{\rho}{\rho_{ref}}$$

ρ	Operating density
ρ_{ref}	Reference density (see function, page 29)

LIQUID MASS

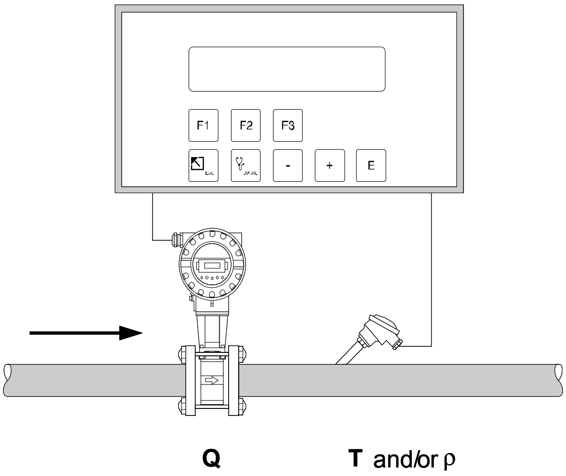
Measured variables
Measures the uncorrected volumetric flow and temperature in a liquid line. A pressure transmitter can also be installed in order to show and monitor the pressure. Pressure measurement does not affect the calculation.

Calculated variables
- Calculates the density and mass flow using the reference density and the thermal expansion coefficient of the liquid (see function group "FLUID TYPE", page 29).
- With DP-measurement the uncorrected volume is also calculated from the differential pressure taking into account the temperature compensation.

Input variables
- Flow and temperature or,
- Flow and density (temperature is also used for calculating the meter expansion).

Output variables
- Mass flow, uncorrected volume, temperature, pressure and density
- Totalizer for mass and uncorrected volume

Applications
Calculate the mass flow of any liquid if its thermal expansion coefficient is sufficiently constant within the entire temperature range.



Water:

$m = Q \times \delta(T)$

Other liquids:

$m = Q \times (1 - \alpha \times (T - T_{ref}))^2 \times \rho_{ref}$

m	Mass
Q	Uncorrected volume
α	Thermal expansion coefficient (see function, page 29)
T	Actual temperature
T_{ref}	Reference temperature (see function, page 40)
ρ_{ref}	Reference density (see function, page 29)
$\delta(T)$	Density of water at temperature T

If density input:

$m = Q \times \rho$

ρ	Operating density

LIQUID COMBUSTION HEAT

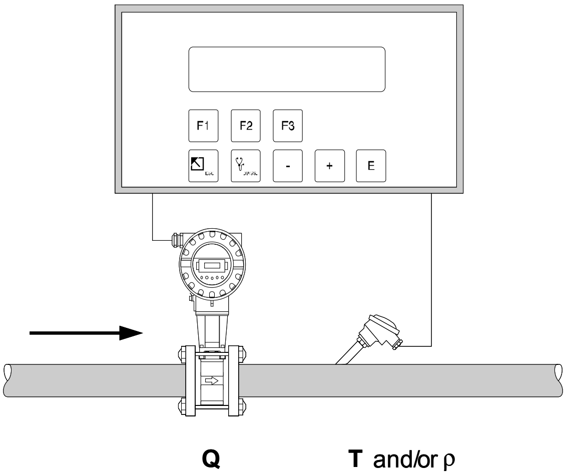
Measured variables
Measures uncorrected volume and temperature in a liquid line. A pressure transmitter can also be installed in order to show or monitor the pressure. Pressure measurement does not affect the calculation.

Calculated variables
- Calculates density, mass flow and combustion heat using liquid characteristics stored in the flow computer (see function group “FLUID TYPE”, page 29).
- With DP-measurement the uncorrected volume is also calculated from the differential pressure taking into account temperature compensation.

Input variables
- Flow and temperature or,
- Flow and density (temperature is also used for calculating the meter expansion).

Output variables
- Combustion heat flow, mass flow, uncorrected volume, temperature, pressure and density
- Totalizer for combustion heat and mass, uncorrected volume

Applications
Calculate the energy released by combustion of liquid fuels.



$$H = C \times Q \times (1 - \alpha \times (T - T_{ref}))^2 \times \rho_{ref}$$

H	Heat
C	Specific combustion heat (see function, page 30)
Q	Uncorrected volume
α	Thermal expansion coefficient (see function, page 29)
T	Actual temperature
T_{ref}	Reference temperature (see function, page 40)
ρ_{ref}	Reference density (see function, page 29)

If density input:

$$H = C \times Q \times \rho$$

ρ Operating density

LIQUID DELTA HEAT

Measured variables
Measures uncorrected volume and temperature of a heat carrying liquid in the supply line and the temperature in the return line of a heat exchanger.

Calculated variables
- Calculates density, mass flow and delta heat using values of the heat carrying liquid stored in the flow computer.
- With DP-measurement the uncorrected volume is also calculated from the differential pressure taking into account temperature compensation.

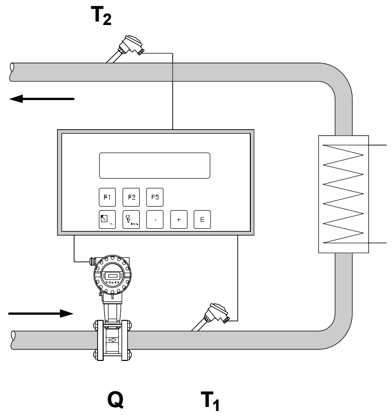
Note!

Note!
An accurate measurement of flow and temperature difference is essential.
The use of paired temperature sensors is recommended.
Temperature sensor 1 should be installed as close as possible to the flowmeter.

Input variables
- Flow and temperature 1
- Temperature 2

Output variables
- Delta heat, mass flow, uncorrected volume, temperature 1, temperature 2, temperature difference and density
- Totalizer for heat, mass and uncorrected volume

Applications
Calculate energy which is extracted by a heat exchanger from heat carrying liquids.



Example:
Cooling application with
cold liquid in the supply line

Water:
$H = Q \times \rho\ (T_1) \times [\ h\ (T_2) - h\ (T_1)\ ]$

Other heat carrying liquids:
$H = c \times Q \times (1 - \alpha \times (T - T_{ref}))^2 \times \rho_{ref} \times (T_2 - T_1)^*$

Note!

Note! *
If the “FLOWMETER LOCATION” function (see page 38) is set to “HOT”, then the last term of the equation is “$T_1 - T_2$” instead of “$T_2 - T_1$”.

H	Heat
c	Specific heat (see function, page 30)
Q	Uncorrected volume
α	Thermal expansion coefficient (see function, page 29)
T_1	Actual temperature (compensation input 1 of the flow computer)
T_2	Actual temperature (compensation input 2 of the flow computer)
T_{ref}	Reference temperature (see function, page 40)
ρ_{ref}	Reference density (see function, page 29)
$\rho\ (T_1)$	Density of water at T_1
$h\ (T_1)$	Specific enthalpy of water at temperature T_1
$h\ (T_2)$	Specific enthalpy of water at temperature T_2

LIQUID SENSIBLE HEAT

Measured variables
Measures uncorrected volume and temperature of water. A pressure transmitter can also be installed in order to show and monitor the pressure. Pressure measurement does not affect the calculation.

Calculated variables
- Calculates density, mass flow and heat flow in a water line using the characteristics of water stored in the flow computer.
- With DP-measurement the uncorrected volume is also calculated from the differential pressure taking into account temperature compensation.

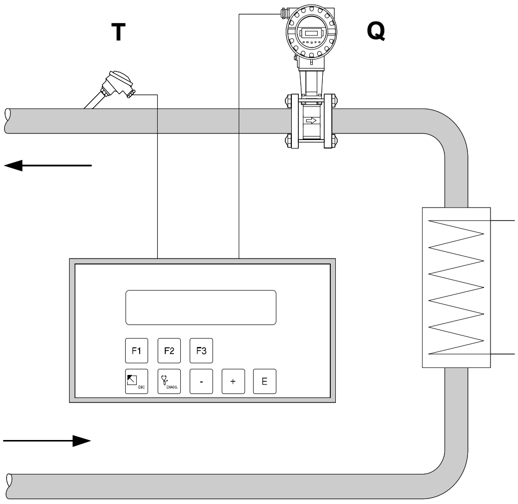
Note!
An accurate measurement of flow and temperature is essential.

Note!

Input variables
Flow and temperature

Output variables
- Heat flow, mass flow, uncorrected volumetric flow, temperature, pressure and density
- Totalizer for heat, mass and uncorrected volume

Applications
Accurate calculation of energy in a flow of water. A typical application is the accurate determination of the residual heat in the return pipe of a heat exchanger.



$$H = Q \times \rho\,(T) \times h\,(T)$$

H Heat
Q Uncorrected volume
T Actual temperature
ρ (T) Density of water at T
h (T) Specific enthalpy of water at temperature T

9 Technical Data

9.1 Technical Data (Flow Computer)

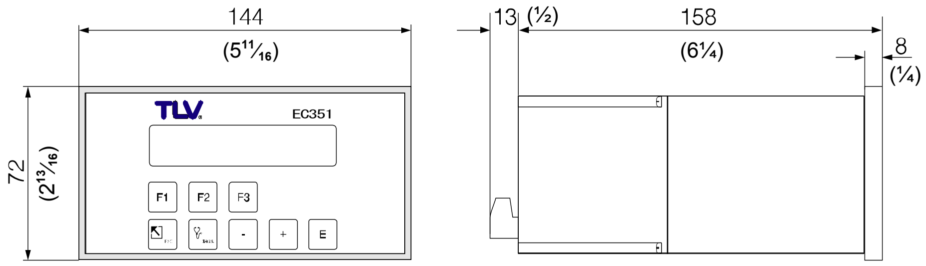
General	
Display	Two-line, backlit, liquid crystal, 20 characters per line
Housing Material	Flameproof plastic
Electromagnetic Compatibility	According to IEC 1000-4
Protection Type	Panel mount: IP 20 (EN 60529), Front: IP 65/NEMA 4X
Ambient Temperature	0 – +50 °C (+32 – +122 °F)
Storage Temperature	-40 – +85 °C (-40 – +185 °F)
Power Supply	85 – 260 V AC (50/60 Hz)
Power Consumption	AC: <10 VA
Flow Input	
Analogue Input	0/4 – 20 mA, 0 – 10 V, 0 – 5 V, 1 – 5 V Resolution: 18 bit, Automatic error recognition: signal overrange, current loop broken V_{max}: 50 V DC, R_{in}: >25 kΩ (voltage input) V_{max}: 24 V DC, R_{in}: 100 Ω (current input)
Pulse Input	• Current pulse: trigger level 12 mA • Voltage pulse: trigger level 10 mV, 100 mV, 2.5 V V_{max}: 50 V DC, I_{max}: 25 mA f_{max}: 20 kHz
Compensation Inputs (Temperature, Pressure or Density)	
Current Input	0/4 – 20 mA Automatic error recognition: signal overrange, current loop broken
Pt100 Input	3-wire connection Temperature resolution: 0.01°C Internal linearization Automatic error recognition: RTD short, RTD open

(Continued next page)

Outputs	
Relay Outputs	2 relays for: flow alarm, temperature alarm, pressure alarm, pulse output (f_{max}: 5 Hz) Contacts: SPDT 240 V, 1 A Galvanically isolated
Current Outputs	2 outputs: 0/4 – 20 mA Resolution: 16 bit Linearity: 0.05% o.f.s. (at 20 °C, 68 °F) Load: max. 1 kΩ Galvanically isolated
Pulse Outputs	Selectable as open collector or as voltage pulses: • Open collector: voltage <30 V DC, current <25 mA, V_{CE} <0.4 V • Voltage pulses voltage 24 V, current <15 mA, internal resistance 100 Ω f_{max}: 50 Hz Galvanically isolated
Printer Port	Serial interface RS 232 9-pin DSUB connector

9.2 Dimensions

EC351 Panel Mounting



Units: mm (in)

Weight: approx. 0.6 kg (1.3 lb)

Figure 8
Dimensions for panel mounting

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:
   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 (such as water hammer) 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.

Programming at a Glance

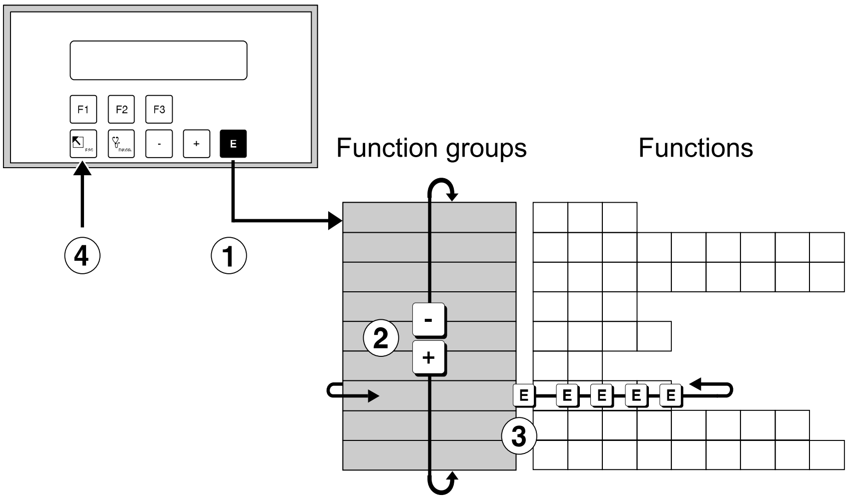
1. Access to the programming matrix

2. Select function group (>GROUP SELECT<)

3. Select function (Enter/select data with −+ and store with E)

Programming matrix → see page 74
Selections / Factory settings → see page 75
Description of functions → see page 16

4. Return to HOME position from any matrix function



Functions of the operating elements

E *Access to the programming matrix* (>GROUP SELECT<)

Select individual functions within the function group

Store the data or settings

Esc *Leave the programming matrix*

Store the data or settings

−+ *Select various function groups*

Select parameters and numerical values
(when + or – key is held down, the number on the display will change at increasing speed)

Diagnostic function

Help function
Displays additional information during programming

Enable / Lock programming
- Enable: Enter the code number (Factory setting = ’***351***’)
- Lock: After returning to the HOME position, programming is locked after 60 seconds if no operating element is pressed.

“Quick Setup” Programming Menu
Using the “QUICK-SETUP” programming menu the most important parameters and process functions can be quickly set for an initial start-up of the flow computer.
Please read the instructions on pages 12 and 20!

Caution!

PROCESS VARIABLE	HEAT FLOW (Display)	MASS FLOW (Display)	COR. VOLUME FLOW (Display)	VOLUME FLOW (Display)	TEMPERATURE 1 (Display)	TEMPERATURE 2 (Display)	DELTA TEMPERATURE (Display)	PROCESS PRESSURE (Display)	DIFF. PRESSURE (Display)	DENSITY (Display)	SPEC. ENTHALPY (Display)	DATE & TIME (Display)	VISCOSITY (Display)	REYNOLDS NUMBER (Display)	
TOTALIZERS	RESET TOTALIZER	HEAT TOTAL (Display)	HEAT GRAND TOTAL (Display)	MASS TOTAL (Display)	MASS GRAND TOTAL (Display)	COR. VOLUME TOTAL (Display)	COR. VOL. GRAND TOTAL (Display)	VOLUME TOTAL (Display)	VOL. GRAND TOTAL (Display)						
SYSTEM PARAMETER	QUICK SETUP	FLOW EQUATION	ENTER DATE	ENTER TIME	F1 KEY FUNCTION	F2 KEY FUNCTION	F3 KEY FUNCTION	PRIVATE CODE	ACCESS CODE	TAG NUMBER	SERIAL-NO. SENSOR				
DISPLAY	DISPLAY LIST	DISPLAY DAMPING	LCD CONTRAST	MAX. DEC. POINT	LANGUAGE										
SYSTEM UNITS	TIME BASE	HEAT FLOW UNIT	HEAT TOTAL UNIT	MASS FLOW UNIT	MASS TOTAL UNIT	COR. VOL. FLOW UNIT	COR. VOL. TOTAL UNIT	VOLUME FLOW UNIT	VOLUME TOTAL UNIT	DEFINITION bbl	TEMPERATURE UNIT	PRESSURE UNIT	DENSITY UNIT	SPEC. ENTHALPY UNIT	LENGTH UNIT
FLUID DATA	FLUID TYPE	REF. DENSITY	THERM. EXP. COEF.	COMBUSTION HEAT	SPECIFIC HEAT	FLOW Z-FACTOR	REF. Z-FACTOR	ISENTROPIC EXP.	MOLE % NITROGEN	MOLE % CO2	VISCOSITY COEF. A	VISCOSITY COEF. B			
FLOW INPUT	FLOWMETER TYPE	INPUT SIGNAL	FULL SCALE	FULL SCALE-HIGH RANGE	LOW FLOW CUTOFF	CALIBRATION DENSITY	K-FACTOR	PIPE INNER DIAMETER	ENTER BETA	METER EXP. COEF	DP-FACTOR	LOW PASS FILTER	LINEARIZATION	FLOW METER LOCATION	VIEW INPUT SIGNAL VIEW HI FLOW SIGNAL
COMPENSATION INPUT	SELECT INPUT 1	INPUT SIGNAL	LOW SCALE VALUE	FULL SCALE VALUE	DEFAULT VALUE	STP REFERENCE	LOW DELTA T CUTOFF	VIEW INPUT SIGNAL							
	SELECT INPUT 2	INPUT SIGNAL	LOW SCALE VALUE	FULL SCALE VALUE	DEFAULT VALUE	STP REFERENCE	BAROMETRIC PRESS	VIEW INPUT SIGNAL							
PULSE OUTPUT	ASSIGN PULSE OUTPUT	PULSE TYPE	PULSE VALUE	PULSE WIDTH	SIMULATION FREQ.										
CURRENT OUTPUT	SELECT OUTPUT 1	ASSIGN CURRENT OUT.	CURRENT RANGE	LOW SCALE VALUE	FULL SCALE VALUE	TIME CONSTANT	CURRENT OUT VALUE (Display)	SIMULATION CURRENT							
	SELECT OUTPUT 2	ASSIGN CURRENT OUT.	CURRENT RANGE	LOW SCALE VALUE	FULL SCALE VALUE	TIME CONSTANT	CURRENT OUT VALUE (Display)	SIMULATION CURRENT							
RELAYS	SELECT RELAY 1	RELAY FUNCTION	RELAY MODE	LIMIT SETPOINT	PULSE VALUE	PULSE WIDTH	HYSTERESIS	RELAY SIMULATION	RESET ALARM						
	SELECT RELAY 2	RELAY FUNCTION	RELAY MODE	LIMIT SETPOINT	PULSE VALUE	PULSE WIDTH	HYSTERESIS	RELAY SIMULATION	RESET ALARM						
COMMUNI-CATION	RS232 USAGE	DEVICE ID	BAUD RATE	PARITY	HANDSHAKE	PRINT LIST	PRINT INITIATE	PRINT INTERVAL	PRINT TIME						
SERVICE & ANALYSIS	EXAMINE AUDIT TRAIL	ERROR LOG	SOFTWARE VERSION (Display)	PRINT SYSTEM SETUP	SELF CHECK										

☐ These functions are displayed only with appropriate settings in other functions.

Note!

Note!
After commissioning and configuring the measuring point, please fill in the adjacent matrix with the values and settings you have selected.

PROCESS VARIABLE	
HEAT FLOW (p. 17)	Display
MASS FLOW (p. 17)	Display
COR. VOLUME FLOW (p. 17)	Display
VOLUME FLOW (p. 17)	Display
TEMPERATURE 1 (p. 17)	Display
TEMPERATURE 2 (p. 17)	Display
DELTA TEMPERATURE (p. 18)	Display
PROCESS PRESSURE (p. 18)	Display
DIFF. PRESSURE (p. 18)	Display
DENSITY (p. 18)	Display
SPEC. ENTHALPY (p. 18)	Display
DATE & TIME (p. 18)	Display
VISCOSITY (p. 18)	Display
REYNOLDS NUMBER (p. 18)	Display
TOTALIZERS	
RESET TOTALIZER (p. 19)	Reset totalizers to ’zero’ ***NO*** – YES
HEAT TOTAL (p. 19)	Display
HEAT GRAND TOTAL (p. 19)	Display (non resettable)
MASS TOTAL (p. 19)	Display
MASS GRAND TOTAL (p. 19)	Display (non resettable)
COR. VOLUME TOTAL (p. 19)	Display
COR. VOL. GRAND TOTAL (p. 19)	Display (non resettable)
VOLUME TOTAL (p. 19)	Display
VOL.GRAND TOTAL (p. 19)	Display (non resettable)
SYSTEM PARAMETERS	
QUICK SETUP (p. 20)	***QUICK SETUP? NO*** QUICK SETUP? YES If ’YES’ → Initializing memory (to factory defaults) → Several functions are shown on the display one after the other. Select options or enter numbers with −+; store with E.
FLOW EQUATION (p. 20)	***STEAM MASS*** STEAM HEAT STEAM NET HEAT STEAM DELTA HEAT GAS CORRECTED VOLUME GAS MASS GAS COMBUSTION HEAT LIQ. CORRECTED VOLUME LIQUID MASS LIQ.COMBUSTION HEAT LIQUID SENSIBLE HEAT LIQUID DELTA HEAT
ENTER DATE (p. 20)	The display flashes. Enter month, day and year with −+; store with E.
ENTER TIME (p. 21)	The display flashes. Enter hours and minutes with −+; store with E.

SYSTEM PARAMETERS (Continued)	
F1 KEY FUNCTION (p. 21)	***LANGUAGE*** RATE + TOTAL TOTAL + GRAND TOTAL CLEAR TOTALIZERS PRINT TRANSACTION ACK. + CLEAR ALARMS CHANGE SETPOINT 1 CHANGE SETPOINT 2 TEMP.1 + DENSITY TEMP.1 + PRESSURE TEMP.1 + TEMP.2 DELTA TEMP.+ VOL.FLOW DIFF.PRES.+ VOL.FLOW ENTHALPY + DENSITY VISCOSITY + REYNOLDS
F2 KEY FUNCTION (p. 21)	***MEASURING SYSTEM*** RATE + TOTAL TOTAL + GRAND TOTAL CLEAR TOTALIZERS PRINT TRANSACTION ACK. + CLEAR ALARMS CHANGE SETPOINT 1 CHANGE SETPOINT 2 TEMP.1 + DENSITY TEMP.1 + PRESSURE TEMP.1 + TEMP.2 DELTA TEMP.+ VOL.FLOW DIFF.PRES.+ VOL.FLOW ENTHALPY + DENSITY VISCOSITY + REYNOLDS
F3 KEY FUNCTION (p. 21)	***QUICK SETUP*** RATE + TOTAL TOTAL + GRAND TOTAL CLEAR TOTALIZERS PRINT TRANSACTION ACK. + CLEAR ALARMS CHANGE SETPOINT 1 CHANGE SETPOINT 2 TEMP.1 + DENSITY TEMP.1 + PRESSURE TEMP.1 + TEMP.2 DELTA TEMP.+ VOL.FLOW DIFF.PRES.+ VOL.FLOW ENTHALPY + DENSITY VISCOSITY + REYNOLDS
PRIVATE CODE (p. 22)	max. 4-figure number: 0 – 9999 ***351***
ACCESS CODE (p. 22)	max. 4-figure number: 0 – 9999 ***0***
TAG NUMBER (p. 22)	Alphanumeric characters for each of the ten positions available: 1 – 9; A – Z; _, <, =, >, ?, etc.
SERIAL-NO. SENSOR (p. 22)	Alphanumeric characters for each of the ten positions: 1 – 9; A – Z; _, <, =, >, ?, etc.
DISPLAY	
DISPLAY LIST (p. 23)	***CHANGE? NO*** CHANGE? YES If ’YES’ → display of measured values to be indicated: E −+ Save options → next option: TIME/DATE? NO (YES) MASS FLOW/TOTAL? NO (YES) VOL.FLOW/TOTAL? NO (YES) TEMP.1/PRESSURE? NO (YES) TEMP.1/DENSITY? NO (YES) HEAT FLOW/TOTAL? NO (YES) DENS./SPEC.ENTH? NO (YES) COR.VOL./TOTAL? NO (YES) TEMP.1/TEMP.2? NO (YES) DELTA T/VOL. FLOW? NO (YES) VISC.+REYNOLDS? NO (YES)
DISPLAY DAMPING (p. 23)	max. 2-figure number: 0 – 99 ***1***
LCD CONTRAST (p. 24)	▮▮▮▮▮▮▮▮▮▮▮▮ . . . . Any change in contrast is immediately seen with the adjustable bar graph.

DISPLAY (Continued)	
MAX.DEC. POINT (p. 24)	0 – 1 – ***2*** – 3 (decimal points)
LANGUAGE (p. 24)	***ENGLISH*** – DEUTSCH – FRANCAIS
SYSTEM UNITS	
TIME BASE (p. 25)	s (per second) – m (per minute) – ***h (per hour)*** – d (per day)
HEAT FLOW UNIT (p. 25)	kBtu/unit of time – kW – ***MJ/unit of time*** – kcal/unit of time – MW – tons – GJ/unit of time – Mcal/unit of time – Gcal/unit of time
HEAT TOTAL UNIT (p. 25)	kBtu – kWh – ***MJ*** – kcal – MWh – tonh – GJ – Mcal – Gcal
MASS FLOW UNIT (p. 25)	lbs/time base – ***kg/time base*** – g/time base – t/time base – tons(US)/time base – tons(long)/time base
MASS TOTAL UNIT (p. 26)	lbs – ***kg*** – g – t – tons (US) – tons (long)
COR. VOL. FLOW UNIT (p. 26)	bbl/time base – gal/time base – l/time base – hl/time base – ***dm3/time base**** – ft3/time base – m3/time base – scf/time base – ***Nm3/time base***** – Nl/time base – igal/time base (* with liquids; ** with gas)
COR. VOL. TOTAL UNIT (p. 26)	bbl – gal – l – hl – ***dm3**** – ft3 – ***m3***** – scf – Nm3 – Nl – igal (* with liquids; ** with gas)
VOLUME FLOW UNIT (p. 27)	bbl/time base – gal/time base – l/time base – hl/time base – ***dm3/time base**** – ft3/time base – ***m3/time base***** – acf/time base – igal/time base (* with liquids; ** with gas)
VOLUME TOTAL UNIT (p. 27)	bbl – gal – l – hl – ***dm3**** – ft3 – ***m3***** – ac – igal (* with liquids; ** with gas)
DEFINITION bbl (p. 27)	***US: 31.0 gal/bbl*** – 31.5 gal/bbl – 42.0 gal/bbl – 55.0 gal/bbl – Imp: 36.0 gal/bbl – 42.0 gal/bbl
TEMPERATURE UNIT (p. 27)	***°C (CELSIUS)*** – K (KELVIN) – °F (FAHRENHEIT) – °R (RANKINE)
PRESSURE UNIT (p. 28)	***bara*** – kPaa – kc2a – psia – barg – psig – kPag – kc2g
DENSITY UNIT (p. 28)	***kg/m3*** – kg/dm3 – #/gal – #/ft3
SPEC. ENTHALPY UNIT (p. 28)	***Btu/#**** – kWh/kg – ***MJ/kg***** – kcal/kg (Unit system: * english; ** metric)
LENGTH UNIT (p. 28)	***mm*****, ***in**** (Unit system: * english; ** metric)
FLUID DATA	
FLUID TYPE (p. 29)	GENERIC – ***WATER*** – ***SATURATED STEAM*** – SUPERHEATED STEAM – ***AIR*** – NATURAL GAS – AMMONIA – CARBON DIOXIDE – PROPANE – OXYGEN – ARGON – METHANE – NITROGEN – GASOLINE – NO.2 FUEL OIL – KEROSINE – NATURAL GAS (NX19); Factory setting: ***dependent*** on the flow equation selected
REF. DENSITY (p. 29)	Number with floating decimal point: 0.0001 – 10,000.0; Factory setting: ***dependent*** on the fluid type
THERM. EXP.COEF. (p. 29)	Number with floating decimal point: 0.000 – 100,000 (e–6); Factory setting: ***dependent*** on the fluid type
COMBUSTION HEAT (p. 30)	Number with floating decimal point: 0.00000 – 100,000; Factory setting: ***dependent*** on the fluid type

FLUID DATA (Continued)	
SPECIFIC HEAT (p. 30)	Number with floating decimal point: 0.00000 – 10.0000; Factory setting: ***dependent*** on the fluid type
FLOW. Z-FACTOR (p. 30)	Number with fixed decimal point: 0.1000 – 10.0000; Factory setting: ***dependent*** on the fluid type
REF. Z-FACTOR (p. 30)	Number with fixed decimal point: 0.1000 – 10.0000; ***1.0000***
ISENTROPIC EXP. (p. 31)	Number with fixed decimal point: 0.1000 – 10.0000; ***1.4000***
MOLE % NITROGEN (p. 31)	Enter the MOLE % Nitrogen in the expected natural gas mixture. Number with fixed decimal point: 000.000 – 15.000; ***00.000***
MOLE % CO$_2$ (p. 31)	Enter the MOLE % CO$_2$ in the expected natural gas mixture. Number with fixed decimal point: 000.000 – 15.000; ***00.000***
VISCOSITY COEF. A (p.31)	Number with fixed decimal point: 0.00000 – 10000; ***1.000***
VISCOSITY COEF. B (p.31)	Number with fixed decimal point: 0.00000 – 10000; ***1.000***
FLOW INPUT	
FLOWMETER TYPE (p. 32)	**VORTEX FLOWMETER EF73** – PROMAG – LINEAR – LINEAR 16PT – BASIC SQUARE LAW – BASIC SQUARE W/SQRT – ORIFICE – ORIFICE W/SQRT – ORIFICE 16 PT – ORIFICE 16 PT W/SQRT – NOZZLE – NOZZLE W/SQRT – NOZZLE 16 PT – NOZZLE 16 PT W/SQRT – PITOT – PITOT W/SQRT – PITOT 16 PT – PITOT 16 PT W/SQRT
INPUT SIGNAL (p. 33)	***PFM*** – DIGITAL, 10 mV LEVEL – DIGITAL, 100 mV LEVEL – DIGITAL, 2.5 V LEVEL – 4–20 mA SPLIT – 0–20 mA SPLIT – 4–20 mA – 0-20 mA – 0–5 Vdc – 1–5 Vdc – 0–10 Vdc
FULL SCALE (p. 33)	Number with floating decimal point: 0.000 – 999,999; ***0.000*** [Unit] Factory setting: ***dependent*** on the selected unit and flow equation
FULL SCALE - HIGH RANGE (p.33)	Number with floating decimal point: 0.000 – +999,999; ***0.000*** [Unit] Factory setting: ***dependent*** on the selected unit and flow equation
LOW FLOW CUTOFF (p. 34)	Number with floating decimal point: 0.000 – 999,999; ***0.000*** [Unit]
CALIBRATION DENSITY (p. 34)	Number with floating decimal point: 0.0001 – 10,000; ***1.0000*** [Unit]
K - FACTOR (p. 34)	Number with floating decimal point: 0.001 – 999,999; ***1.000*** [P/dm3]
PIPE INNER DIAMETER (p. 34)	Number with floating decimal point: 0.0001 – 1000.00; ***1.0000*** [unit]
ENTER BETA (p. 34)	Number with fixed decimal point: 0.0000 – 1.0000; ***0.0001***
METER EXP. COEF. (p. 35)	Number with fixed decimal point: 0.000 – 999.900 (e–6/ °X) ***dependent*** on the selected temperature unit and flowmeter

FLOW INPUT (Continued)	
DP - FACTOR (p. 35 – 37)	***CHANGE FACTOR? NO*** CHANGE FACTOR? YES If ’YES’ → further choice: COMPUTE FACTOR? NO COMPUTE FACTOR? YES If ’NO’ → enter DP FACTOR directly If ’YES’ → display of different parameters which can be entered or changed one after the other: ENTER DELTA PRESSURE ENTER FLOWRATE ENTER DENSITY ENTER TEMPERATURE ENTER INLET PRESSURE ENTER ISENTROPIC EXP
LOW PASS FILTER (p. 37)	max. 5-figure number: 10 – 40000 [Hz]; ***40000 Hz***
LINEARIZATION (p. 37, 38)	***CHANGE TABLE? NO*** CHANGE TABLE? YES ’YES’ → correction factors can be entered for up to 16 different flow rates. Example: *Entry of current value* INPUT mA 5.00 POINT 0 *Entry of corresponding flowrate:* RATE 0.25 m^3/h POINT 0
FLOWMETER LOCATION (p. 38)	Select the location of the flowmeter in a ‘delta heat’ application: HOT – ***COLD***
VIEW INPUT SIGNAL (p.38)	Display of actual flow input signal
VIEW HI FLOW SIGNAL (p. 38)	Display of actual flow input signal of the hi-range input signal of split range DP transmitter
COMPENSATION INPUT	
SELECT INPUT (p. 39)	***1*** – 2 ***Input 1: Temperature 1*** Input 2: Pressure, Temperature 2, Density
INPUT SIGNAL (p. 39)	*Input 1 (Temperature 1):* INPUT 1 NOT USED RTD TEMPERATURE 4–20 TEMPERATURE 0–20 TEMPERATURE MANUAL TEMPERATURE *Input 2 (Pressure, Temperature 2, Density):* INPUT 2 NOT USED 4–20 PRESSURE (G) 0–20 PRESSURE (G) MANUAL PRESSURE 4–20 PRESSURE (ABS.) 0–20 PRESSURE (ABS.) RTD TEMPERATURE 2 4–20 TEMPERATURE 2 0–20 TEMPERATURE 2 MANUAL TEMPERATURE 2 4–20 DENSITY 0–20 DENSITY MANUAL DENSITY Factory setting: ***dependent*** on the flow equation and the input selected (1 or 2)
LOW SCALE VALUE (p. 39)	Number with fixed decimal point: -9999.99 – +9999.99 [unit] Factory setting: ***dependent*** on the flow equation and the input selected (1 or 2)

COMPENSATION INPUT (Continued)	
FULL SCALE VALUE (p. 39)	Number with fixed decimal point: -9999.99 – +9999.99 [unit] Factory setting: ***dependent*** on the flow equation and the input selected (1 or 2)
DEFAULT VALUE (p. 40)	Number with fixed decimal point: -9999.99 – +9999.99 [unit] Temperature → ***21°C*** Pressure → ***0 psig (1.013 bara)*** Density → ***62.358 #/ft3*** ***(998.9 kg/m3)***
STP REFERENCE (p. 40)	Number with fixed decimal point: -9999.99 – +9999.99 [unit] Pressure → ***1.013 bara*** Temperature → ***dependent*** on units: • Metric unit system: Gas → 0 °C; Liquid → 20 °C • English unit system: Gas/Liquid → 70 °F
BAROMETRIC PRESS. (p. 40)	Number with floating decimal point: 0.0000 – 10,000.0 ***14.696 psia (1.013 bara)***
LOW DELTA T CUT-OFF (p.40)	Number with fixed decimal point: 0.00 – 99.9; ***0.0*** [temperature unit]
VIEW INPUT SIGNAL (p. 40)	Display of actual input signal.
PULSE OUTPUT	
ASSIGN PULSE OUTPUT (p. 41)	HEAT TOTAL MASS TOTAL CORRECTED VOL. TOTAL ACTUAL VOLUME TOTAL Factory setting: ***dependent*** on the flow equation selected.
PULSE TYPE (p. 41)	PASSIVE / NEGATIVE ***PASSIVE / POSITIVE*** ACTIVE / NEGATIVE ACTIVE / POSITIVE
PULSE VALUE (p. 42)	Number with floating decimal point: 0.001 – 1000.00; ***1.000*** [Unit/pulse]
PULSE WIDTH (p. 42)	Number with floating decimal point: 0.01 – 10.00 s; ***0.01 s***
SIMULATION FREQ. (p. 42)	***OFF*** – 0.0 Hz – 0.1 Hz – 1.0 Hz – 10 Hz – 50 Hz
CURRENT OUTPUT	
SELECT OUTPUT (p. 43)	***1*** – 2
ASSIGN CURRENT OUT. (p. 43)	HEAT FLOW – MASS FLOW – COR. VOLUME FLOW – VOLUME FLOW – TEMPERATURE 1 – TEMPERATURE 2 – DELTA TEMPERATURE – PRESSURE – DENSITY – VISCOSITY – REYNOLDS NUMBER Factory setting: ***dependent*** on the flow equation selected.
CURRENT RANGE (p. 43)	0-20 mA – ***4-20 mA*** – NOT USED
LOW SCALE VALUE (p. 43)	Number with floating decimal point: -999,999 – +999,999; ***0.000*** [unit]
FULL SCALE VALUE (p. 43)	Number with floating decimal point: -999,999 – +999,999; ***1.000*** [unit]
TIME CONSTANT (p. 43)	max. 2-figure number: 0 – 99 ***1***
CURRENT OUT VALUE (p. 43)	Display of current target value in [mA]
SIMULATION CURRENT (p. 43)	***OFF*** – 0 mA – 2 mA – 4 mA – 12 mA – 20 mA – 25 mA

RELAYS	
SELECT RELAY (p. 44)	***1*** (Relay 1) – 2 (Relay 2)
RELAY FUNCTION (p. 44)	HEAT TOTAL – MASS TOTAL – CORRECTED VOL. TOTAL – ACTUAL VOLUME TOTAL – HEAT FLOW – MASS FLOW – COR. VOL.FLOW – VOLUME FLOW – TEMPERATURE 1 – TEMPERATURE 2 – DELTA TEMPERATURE – PRESSURE – DENSITY – WET STEAM ALARM – MALFUNCTION – VISCOSITY – REYNOLDS NUMBER Factory setting: ***dependent*** on the flow equation selected.
RELAY MODE (p. 45)	***HI ALARM, FOLLOW*** LO ALARM, FOLLOW HI ALARM, LATCH LO ALARM, LATCH RELAY PULSE OUTPUT
LIMIT SETPOINT (p. 45)	Number with floating decimal point: -999,999 – +999,999; ***50000*** [Unit] with process variables
PULSE VALUE (p. 45)	With ’RELAY PULSE OUTPUT’ Number with floating decimal point: 0.001 – 100,000,000; ***1000*** [Unit]
PULSE WIDTH (p. 46)	Number with fixed decimal point: 0.1 – 9.9 s (RELAY PULSE OUTPUT) or 0.0 – 9.9 s (all other configurations) ***0.0 s*** resp. ***0.1 s*** with “RELAY PULSE OUTPUT”
HYSTERESIS (p. 46)	Number with floating decimal point: 0.000 – 999,999; ***0.000*** [Unit]
RELAY SIMULATION (p. 46)	***NO*** – Relay ON – Relay OFF
RESET ALARM (p. 46)	***RESET ALARM? NO*** RESET ALARM? YES

COMMUNICATION	
RS232 USAGE (p. 48)	COMPUTER – ***PRINTER***
DEVICE ID (p. 48)	max. 2-figure number: 0 – 99 ***1***
BAUD RATE (p. 48)	***9600*** – 2400 – 1200 – 300
PARITY (p. 48)	***NONE*** – ODD – EVEN
HANDSHAKE (p. 48)	***NONE*** – HARDWARE

COMMUNICATION (Continued)	
PRINT LIST (p. 49)	***CHANGE? NO*** CHANGE? YES If ’YES’ → display of measured values to be printed: E − + Save option → next option: PRINT HEADER? NO (YES) INSTRUMENT TAG? NO (YES) FLUID TYPE? NO (YES) TIME? NO (YES) DATE? NO (YES) TRANSACTION NO.? NO (YES) HEAT FLOW? NO (YES) HEAT TOTAL? NO (YES) HEAT GRAND TOTAL? NO (YES) MASS FLOW? NO (YES) MASS TOTAL? NO (YES) MASS GRAND TOTAL? NO (YES) COR. VOLUME FLOW? NO (YES) COR. VOL. TOTAL? NO (YES) COR.VOL.GND. TOTL? NO (YES) VOLUME FLOW? NO (YES) VOLUME TOTAL? NO (YES) VOL. GRAND TOTAL? NO (YES) TEMPERATURE 1? NO (YES) TEMPERATURE 2? NO (YES) DELTA NO (YES) TEMPERATURE NO (YES) PROCESS PRESSURE NO (YES) DENSITY SPEC. NO (YES) ENTHALPY NO (YES) VISCOSITY NO (YES) REYNOLDS NUMBER NO (YES) ERRORS ALARMS NO (YES)
PRINT INITIATE (p. 49)	***NONE*** – TIME OF DAY – INTERVAL
PRINT INTERVAL (p. 49)	The display flashes. Enter values for hours and minutes. Store with E. ***00:00***
PRINT TIME (p. 49)	The display flashes. Enter values for hours and minutes. Store with E. ***00:00***

SERVICE & ANALYSIS	
EXAMINE AUDIT TRAIL (p. 50)	Display of changes of important calibration and configuration data (“electronic seal”). *Example:* CAL 185 CFG 969
ERROR LOG (p. 50)	Display of logged system error messages *Example:* POWER FAILURE
SOFTWARE VERSION (p. 50)	Display of actual software version: e.g. 02.00.00
PRINT SYSTEM SETUP (p. 50)	***NO*** – YES ’YES’ → Prints of actual parameter settings on the connected printer.
SELF CHECK (p. 50)	***RUN? NO*** RUN? YES ’YES’ → starts of internal checks

Service

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