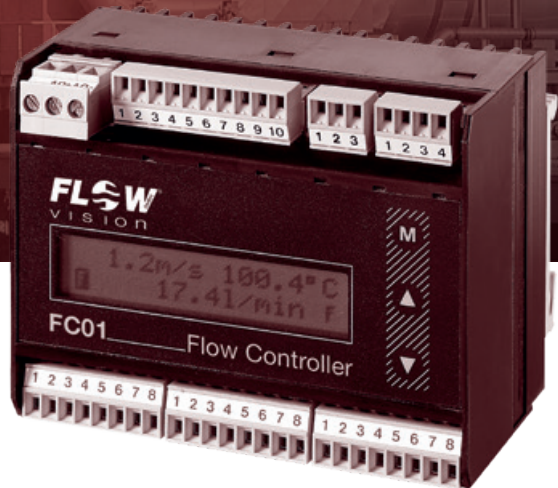


Flow Meter | **FC 01**  
USER HANDBOOK



Please follow these instructions carefully. Failure to comply, or misuse of this equipment, could result in serious damage both to the equipment itself and to the installation. FlowVision is unable to accept responsibility for customer or third party liability, warranty claims or damage caused by incorrect installation or improper handling resulting from non-observance of these instructions.

The instructions cover software version 1.71.



Equipment installation, connection and adjustment by qualified personnel only!

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## 1 Description

The Flow Controller FC01 is designed to detect flow speed, flow volume and, if using a calorimetric type of monitoring head (type CS<sub>x</sub>), medium temperature.

These quantities are made available to the user as analogue electrical signals, physically isolated, as **current** or **voltage output** and may be monitored by means of a **limit monitor**.

As **relay outputs** or **transistor outputs** the digital signals enable the user to integrate the FC01 into a control and monitoring system.

The transistor outputs enable the user to additionally process **fault, status** and **volume pulse indications** in the control system.

The Flow Controller FC01 may be used with two different kinds of measuring sensors:

- calorimetric monitoring heads CS<sub>x</sub> (CST, CSF)
- or
- turbine-type sensors TST

## 1.1 Measuring procedures

### 1.1.1 Calorimetric measuring procedure

The calorimetric measuring procedure is based on the physics of heat dissipation, i.e. a body with a temperature higher than its surroundings supplies a medium flowing past that body with energy in the form of heat. The amount energy supplied is a function of temperature difference  $\Delta\vartheta$  and mass flow.

Flow Controller FC01 operates on the CTD (Constant-Temperature-Difference) method:

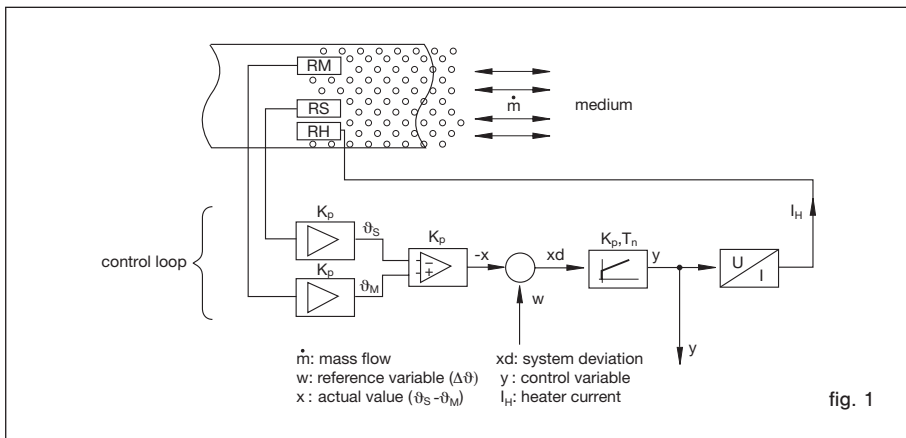
The temperature difference  $\Delta\vartheta$  between the two sensors is kept constant and the mass flow is determined by measuring the calorific power.

Fig. 1 is a schematic diagram of a CTD method based sensor. Two temperature-sensitive resistors (sensor elements RS and RM) are immersed in the medium. Sensor RM assumes the temperature of the medium  $\vartheta_M$  whilst heater resistor RH heats element RS to temperature  $\vartheta_S$ . As a function of the medium, the temperature differential  $\Delta\vartheta = \vartheta_S - \vartheta_M$  is preselected as a reference variable by the CTD control and is kept constant. The required calorific power is a function of mass flow so that the control variable  $y$  of the control can be used for evaluation.

Major benefits of this method are:

- Fast response, particularly to sudden flow standstill.
- Medium temperature measurement, providing optimum temperature compensation.
- Increased safety because the sensor cannot be overheated during flow standstill.

The flow rate is determined by mass flow.





### **1.1.2 Mechanical procedure**

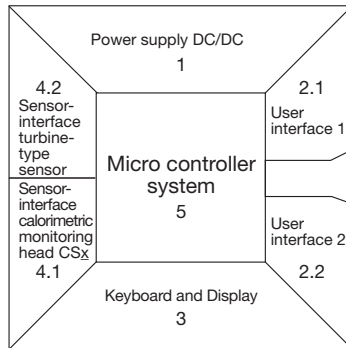
Model FC01 may be equipped with turbine-type sensors to provide true flow measurement.

The measuring principle of turbine-type sensors is based on the conversion of rotational speed into electrical signals. The flow stream will cause the turbine to rotate, converting the rotation inductively into an electrical signal in the form of pulses. The frequency of this signal is evaluated in the FC01 and indicated as flow rate.

## 1.2 System description

The system comprises the following hardware functional modules:

- 1 Input voltage: DC supply (terminal XV)
- 2 User interfaces: 2.1 signal outputs 2-way or 4-way signal outputs (terminal XAH)  
2.2 analogue output 1 and 2 (terminal XAO)
- 3 Keyboard and display: keypads  
liquid crystal display
- 4 Sensor interfaces: 4.1 calorimetric monitoring head type CS<sub>x</sub> (terminal XSK)  
4.2 turbine-type sensor TST (terminal XSF)
- 5 Micro controller system: signal processing and monitoring



- 1 Input voltage: DC 19 ... 32 V
- 2.1 User interface 1 relay outputs: 2 limit values  
transistor outputs: 2 limit values + 1 error indication + 1 busy signal or frequency output (software selected)
- 2.2 User interface 2 analogue outputs  
current or voltage
- 3 Keyboard/Display: keypads  
LC display  
2 x 16 digits
- 4.1 Sensor interfaces calorimetric monitoring head type CS<sub>x</sub>
- 4.2 Sensor interfaces turbine-type sensor TST
- 5 Controller system: signal processing  
I/O - controlling  
monitoring  
parameter memory

fig. 2

**The power supply is physically isolated between power supply input and system power supply output. This also applies to the analogue outputs which are physically isolated from each other as well as from the other electronics and the signal outputs. The signal output channels are also separate and electrically isolated from the central electronic unit.**

There is no electrical isolation between monitoring head and central electronic unit.

Connection of the monitoring heads is by means of precut cable links.

Cables and user interface connections are shown in para. 2.3.2 and circuit diagram 2.3.2.1/ 2.3.2.2.

System configuration and parameter setting are by means of the keyboard if **default values** need to be changed. (paras. 5 and 6)

This mainly applies to monitoring head selection, signal outputs (switch point setting) and analogue outputs (zero point setting and scaling).

### 1.2.1 User interfaces

#### Signal outputs:

(optional)

1. **R2** - Relais outputs (2 limit values)

#### **Two-channel physical isolation**

Contact Form: Single pole double throw (SPDT)

The channels may be assigned in menu "CONFIGURATION", either individually or in pairs, to the physical quantities of temperature or flow. The switch on and off values can be set as desired in menu "PARAMETERS" (yet within the measuring range) for each contact.

Please see para. 8.4.1 for electrical connection.

2. **T4** - Transistor outputs (2 setpoints + 2 status outputs or 2 setpoints + 1 status output + 1 frequency output)

**Four-channel physical isolation**, transistor output - collector/emitter freely connectable

Channel 1: common error signal

Channel 2: busy signal or frequency output

Channels 3 and 4: Both channels may be assigned individually or in pairs to the physical quantities of temperature or flow. The switch on or off values of each transistor output can be set as desired.

Please see para. 8.4.2 for electrical connection.

#### Analogue outputs:

(optional)

**Two-channel physical isolation**, current or voltage output

Please see the ordering number to find out whether it is a current or voltage output.

Output quantities: 0/1 - 5 V FS (option V1)

0/2 - 10 V FS (option V2)

0/4 - 20 mA FS (option C1)

These FS (full scale) output quantities apply to both channels as standard.

20% zero elevation and FS value can be programmed. (See para. 5.11)

Shield connections are ungrounded.

**The shields of the signal cables should be applied on one side only.**



**Power supply:**

DC 24 V supply possible

Internal switch mode power supply with physical isolation of the primary and secondary side.



**Noise emission on the connection cable is limited by circuit design and filter.**

A PTC resistor provides protection from overcurrent. The element automatically resets upon removal of the disturbance or after disconnection of the supply voltage of the FC01 for approx. 1 s (e.g. remove terminal XV).

Please see para. 8.2.1 for technical characteristics.

## 2 Installation

### 2.1 Installation of calorimetric monitoring heads

These are general directions for the application of calorimetric measuring heads which from application to application should be reviewed by the user in accordance with individual requirements.

#### 2.1.1 Selection of material

##### **Stainless steel 1.4571/AISI 316 Ti**

The standard monitoring head material is stainless steel 1.4571/AISI 316 Ti, an austenitic, acid-resisting stainless steel that is commonly used throughout industry. Manufacturers claim it also withstands oxidizing organic and anorganic acids, and partly even reductive media.

The resistance of this stainless steel should however be verified by the user, particularly when it is used in medium mixtures that may from time to time be exchanged with cleansing agents. Its chemical resistance also depends on temperature, flow rate and concentration of the medium.

Stainless steels owe their resistance to rust mainly to their alloy combination with chromium, the formation of chromic oxide on the steel surface resulting in a passive state. Contamination, deposits on the surface, or foreign rust may however neutralize the passivity. Therefore care should be taken to keep the surfaces clean.

Stainless steel heads must not get in contact with steel parts other than stainless steel or with chemically dissimilar metals, as this would cause electrolytic corrosion.

##### **Nickel-based alloy (Hastelloy 2.4610)**

Hastelloy 2.6410 is a material with a chemical resistance generally exceeding that of stainless steel and copper-based alloys. They are particularly suitable for alkaline media (pH > 7). They should however be examined for suitability for each specific application using resistance tables and pragmatical values.

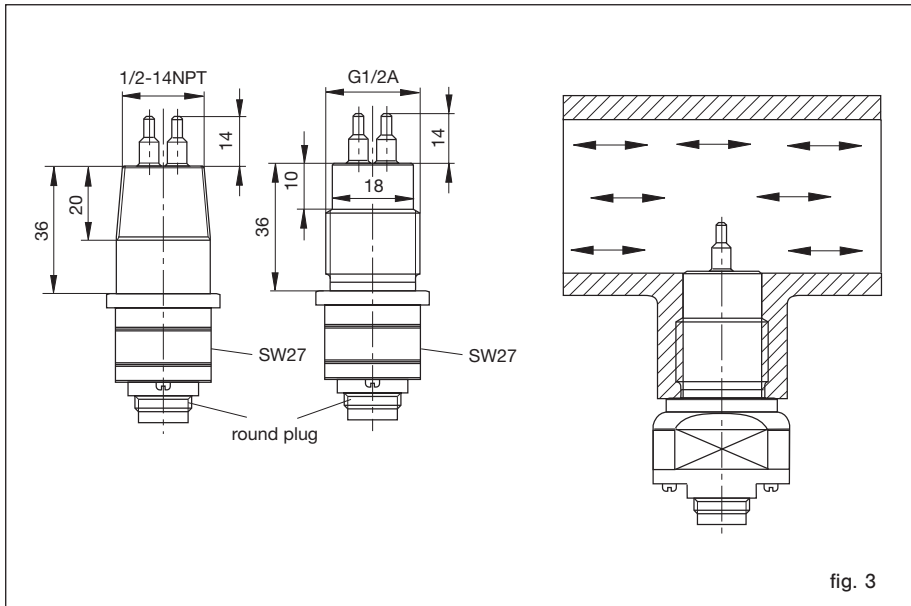
**2.1.2 Mechanical installation**

**2.1.2.1 Thread-mounted monitoring head CST-01**

- Application:** general industry  
**Medium:** gases and liquids  
**Styles:** G1/2A or 1/2"-14NPT

**Materials of the area exposed to medium:** stainless steel 1.4571 /AISI 316 Ti (standard)  
 nickel based alloy (Hastelloy C4 2.4610)

If installed in fittings or T pieces with appropriate internal thread the max. length of the connection piece should be 36 mm from the inner pipe wall.



**2.1.2.2 Monitoring head CSF-01 with adjustable immersion depth**

**Application:** heating and air-conditioning systems

**Medium:** air, inert gases, liquids

**Style:** smooth shank, 18 mm dia., immersion depth adjustable within the PG16 cable gland (accessory) or mounting in the stainless steel cutting ring gland

**Materials of the area exposed to medium:**

- M1 sensor and shank stainless steel 1.4571 /AISI 316 Ti
- M7 sensor stainless steel 1.4571 /AISI 316 Ti, shank aluminium

**Accessories:**

- cable gland PG16 nickel-plated brass (see fig. 9)
- threaded installation bush stainless steel 316 (cutting ring) (see fig. 9)

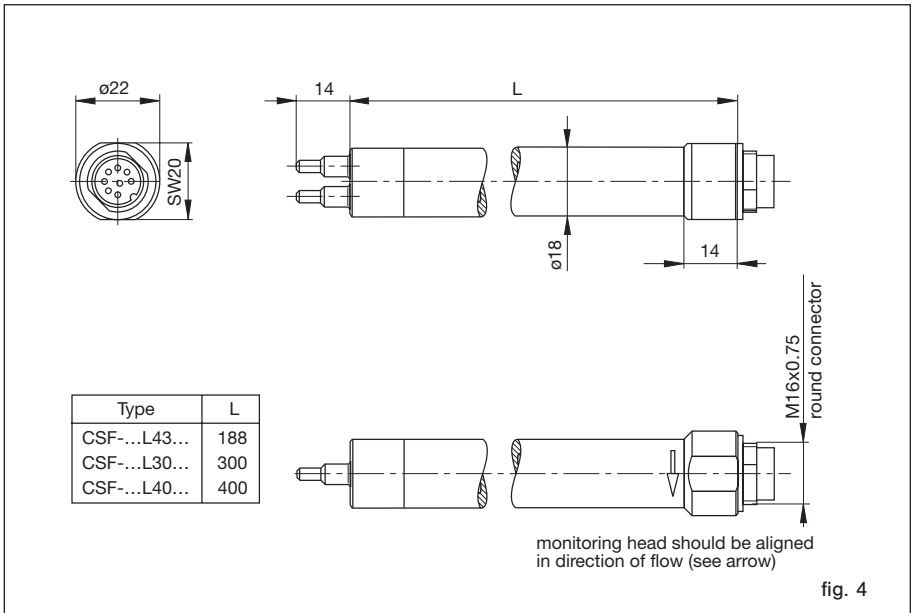
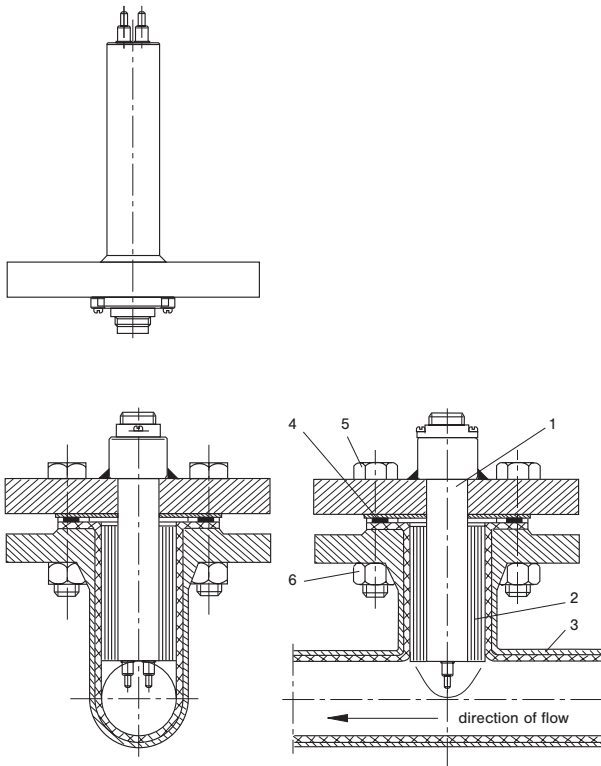


fig. 4

**2.1.2.3 Flange-mounted monitoring head CSF-02**

**Application:** chemical plants  
**Style:** flange dimension to DIN 2500

**Materials of the area exposed to medium:** stainless steel 1.4571 /AISI 316 Ti or nickel based alloy (Hastelloy C4 2.4610)



- |   |                            |
|---|----------------------------|
| 1 - flange-mounted monitoring head (FlowVision) | 4 - flat gasket (customer) |
| 2 - deflector (customer)                        | 5 - screw (customer)       |
| 3 - flange T piece (customer)                   | 6 - nut (customer)         |

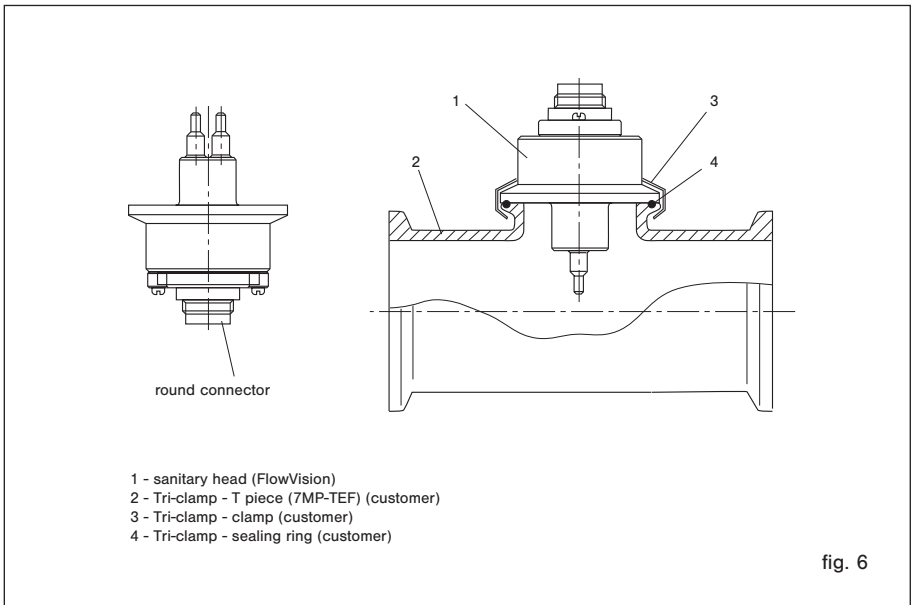
fig. 5



**2.1.2.4 Sanitary head CSF-03 (Tri-clamp)**

**Application:** food industry  
**Medium:** liquids or gases  
**Style:** Tri-clamp flange to DIN 32676 Tri-clamp for internal pipe diameter DN 1"

**Materials of the area exposed to medium:** stainless steel 1.4571 /AISI 316 Ti electro-polished



### 2.1.3 Mounting instructions for monitoring head CST

**Caution!**

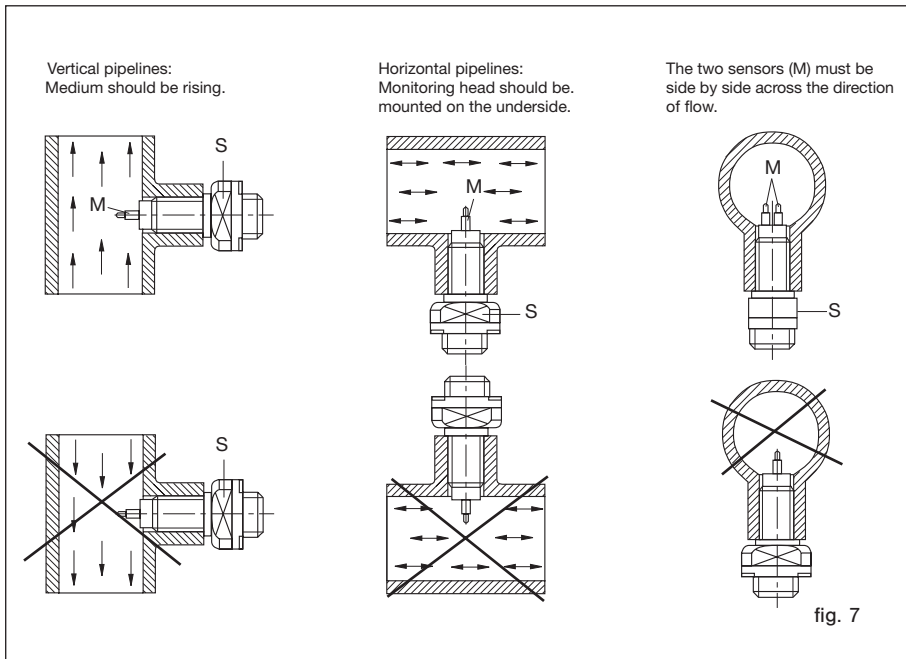


The two sensors (M) should be screwed into the pipeline far enough to ensure that they are aligned side by side directly across the direction of flow. The sensors are correctly positioned when the wrench flats (S) are aligned parallel with the pipeline. The sensors must be positioned fully in the flow stream.

**The surface of the shaft end must not be recessed below the inner pipe wall. Preferably the shaft surface of the monitoring head should project approx. 1-2 mm towards the pipe centre.**

#### 2.1.3.1 Liquid media

- In the case of vertical pipelines the monitoring head should be installed where the flow is rising, if possible.
- For horizontal pipelines the monitoring head should be mounted on the underside of the line (suspended).



- The monitoring head should be installed only in a straight section of piping. There should be a distance of at least 20 pipe diameters before the monitoring head, and 5 pipe diameters after the monitoring head before or after bends and changes in pipe diameter, to avoid any effects of turbulence (fig. 8).
- When installing the monitoring head, please observe that the arrow corresponds to the flow direction.

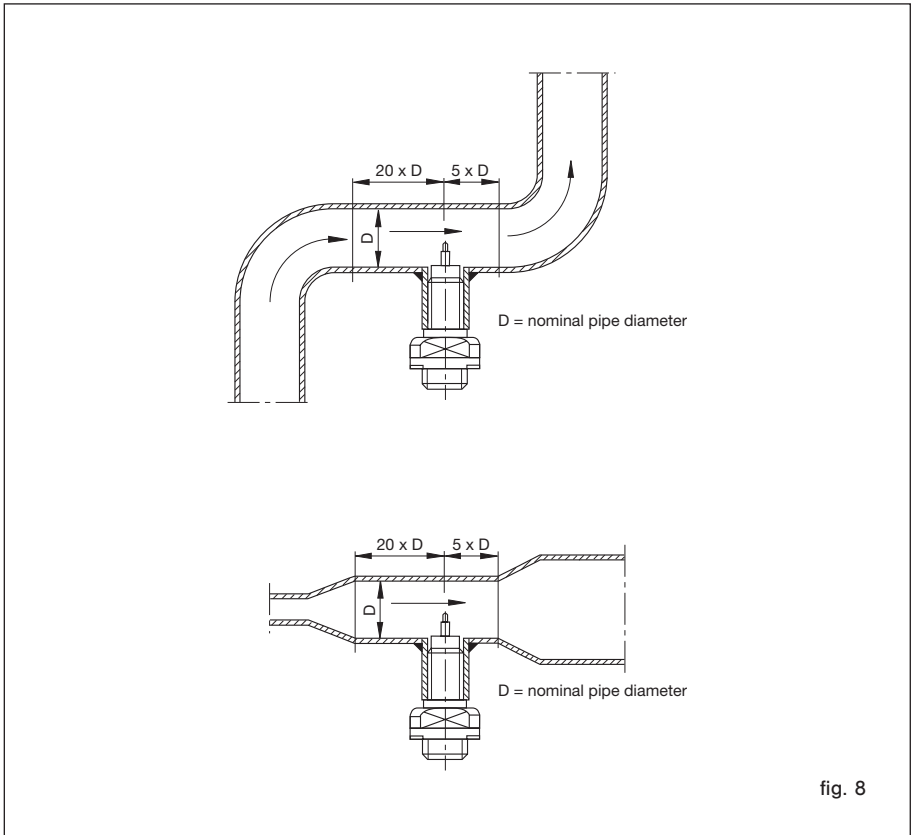


fig. 8

### 2.1.3.2 Gases

If gases are to be monitored, the mounting attitude of the monitoring head is unimportant in either vertical or horizontal pipelines. There should be a distance of at least 20 pipe diameters before the monitoring head, and 5 pipe diameters after the monitoring head before or after bends and changes in pipe diameter, to avoid any effects of turbulence.

### 2.1.3.3 Sealing

Use suitable thread sealing, e.g. hemp, teflon band, sealing glue  
Put pipe system under pressure and check for leakages.

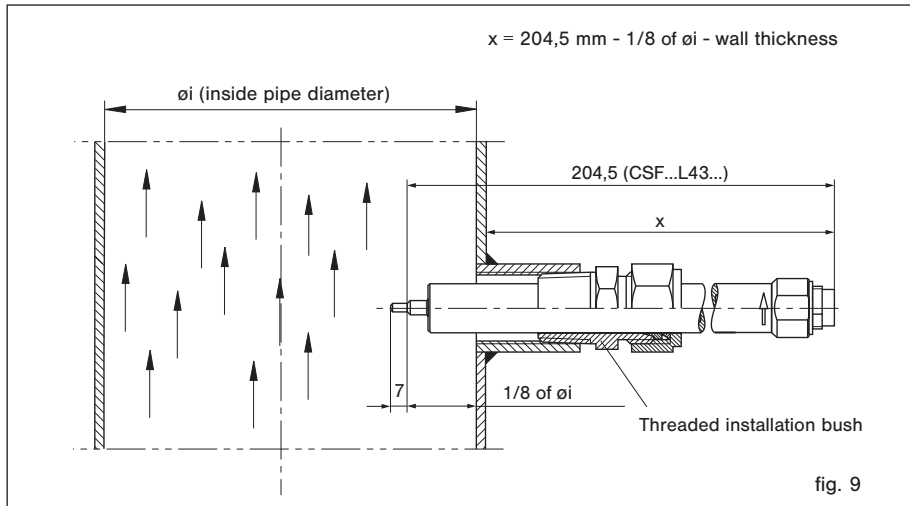
### 2.1.4 Mounting instructions for monitoring head CSF-01

#### Caution!

**!** The two sensors (M) (fig. 7) should be screwed into the pipeline far enough to ensure that they are aligned side by side directly across the direction of flow. The sensors are correctly positioned when the wrench flats (S) are aligned parallel with the pipeline.

The arrow on the housing must point in direction of flow.

**The shoulder of the sensor (7 mm from the tip) must be at the position  $1/8$  from dia. i.**



**2.1.4.1 Point of installation and steadying zones** (see 2.1.3.1 and 2.1.3.2)

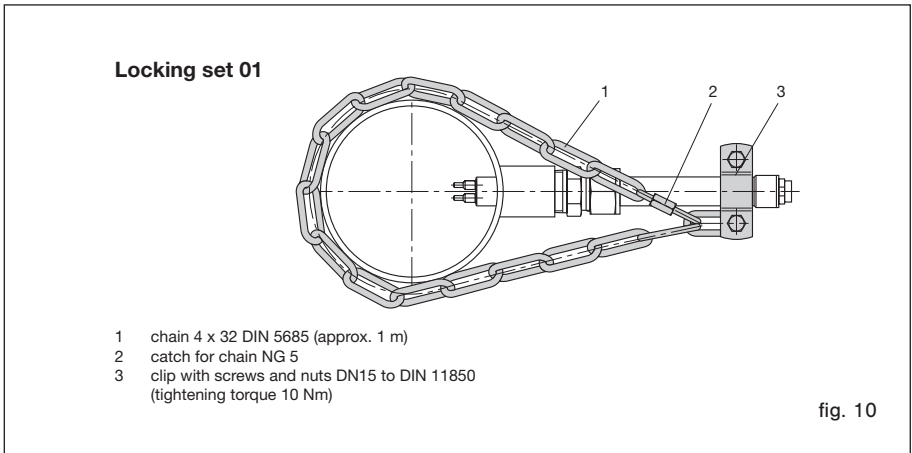
- Fit monitoring head with locking set as follows (fig. 10):
- Fix first link of chain (1) into the clip (3) (tightening torque 10 Nm).
- Put chain catch (2) into link and fasten with the tight chain.

**Caution!**



**Check locking system with regard to strength!**

**The locking chain must be mounted as tightly as possible..**



**2.1.5 Electrical connection**

**Cable Do + Ka type xx**

(depends on FC01 version and sensor type used - see figs. 21 and 22)

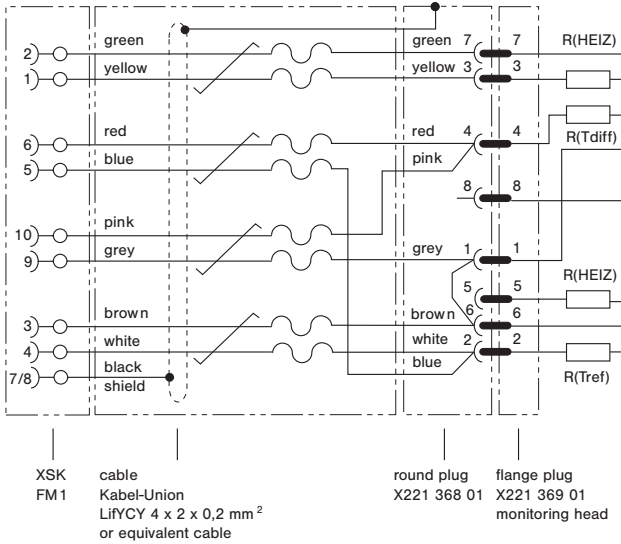


fig. 11

## 2.2 Installation of turbine-type sensor

### 2.2.1 Mechanical installation

#### 2.2.1.1 Monitoring head TST..AM1/WM1

**Application:** clean media, whenever fast response is required

**Style:** G1/2A

**Material of the area exposed to medium:**

- housing PSU: TK-PSU, polysulfon, Udel
- sensor: aluminium
- bearing: bearing: Berivac (beryllium alloy)
- tips: Nivadur

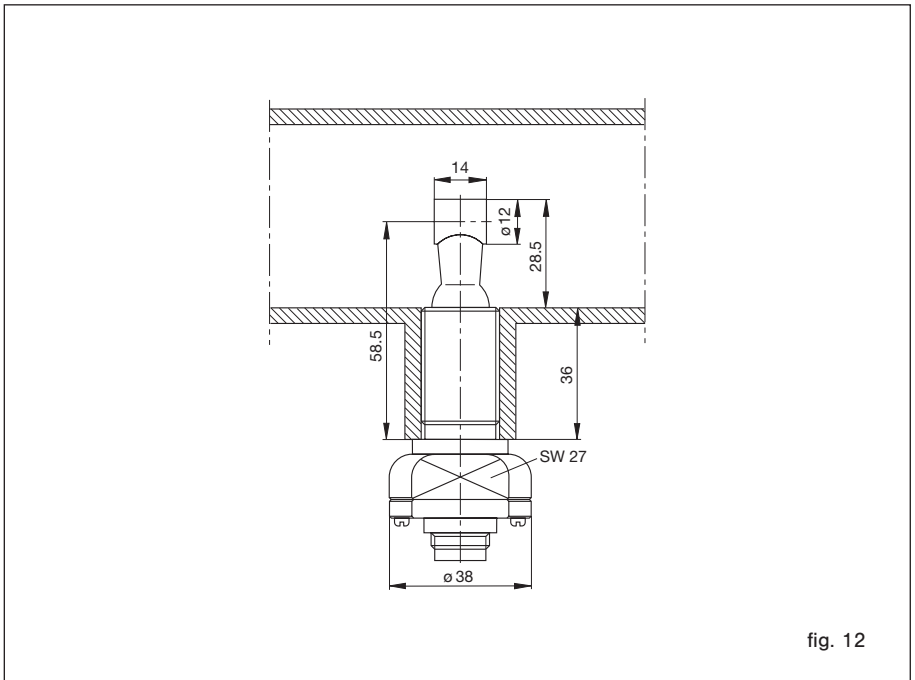


fig. 12

**2.2.1.2 Monitoring head TST..HM2**

**Application:** clean media, in high temperature areas

**Style:** G1/2A

**Material of the area exposed to medium:**

- housing and sensor: chrome-nickel, molybdene VUA
- bearing: bearing: saphir
- tips: Nivadur

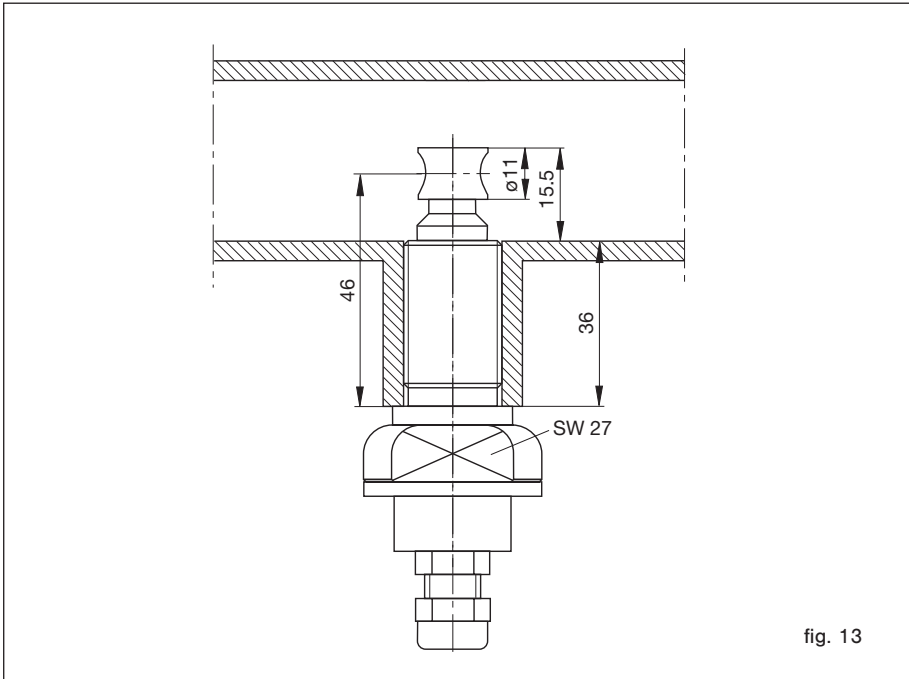


fig. 13

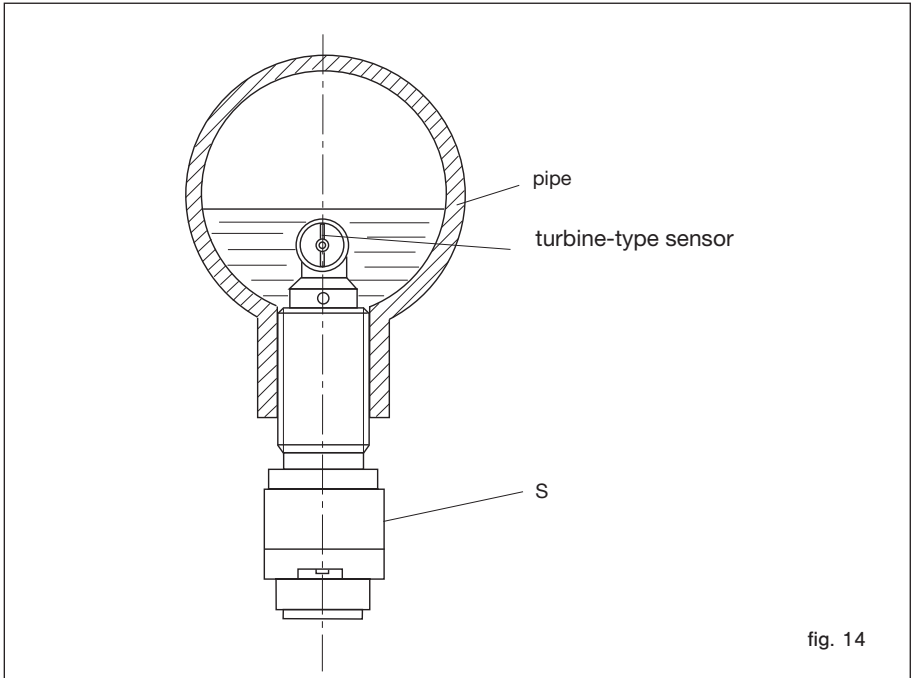


## 2.2.2 Mounting instructions

The turbine-type sensor can be mounted in any radial attitude and also allows oblique streaming (max.  $\pm 25^\circ$ ).

### 2.2.2.1 Mounting in the pipeline

- The sensor should be installed only in a straight section of piping. There should be a distance of at least 1 metre before or after bends and changes in pipe diameter.
- The sensor must be aligned in the range where it is intensive to oblique streaming (fig. 15). It is correctly positioned when the wrench flats (S) are aligned parallel with the pipeline (in direction of flow).



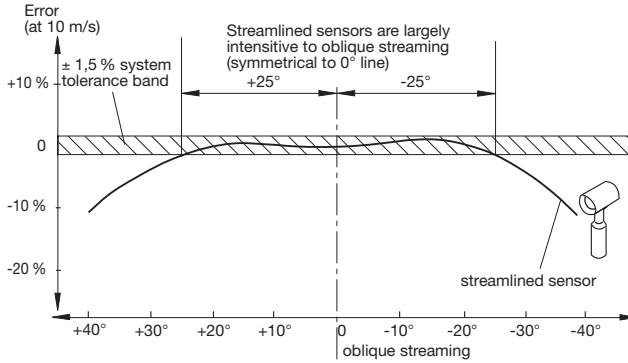


fig. 15

### 2.2.3 Electrical connection

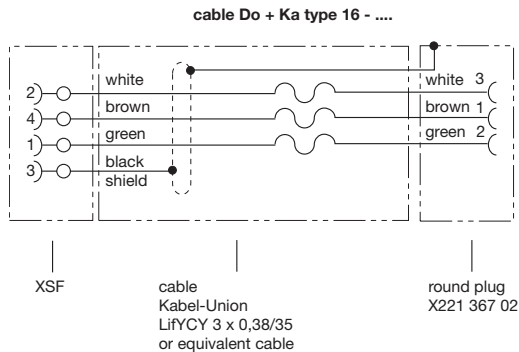


fig. 16

## 2.3 Installation of electronic control unit FC01

### 2.3.1 Mechanical installation

#### 2.3.1.1 Rail-mounted version FC01-U1...

- The electronic housing is mounted on a symmetric rail to EN 50022.
- For thermal reasons, the modules should be spaced by at least 10 mm.
- Removal is by releasing the spring catch.

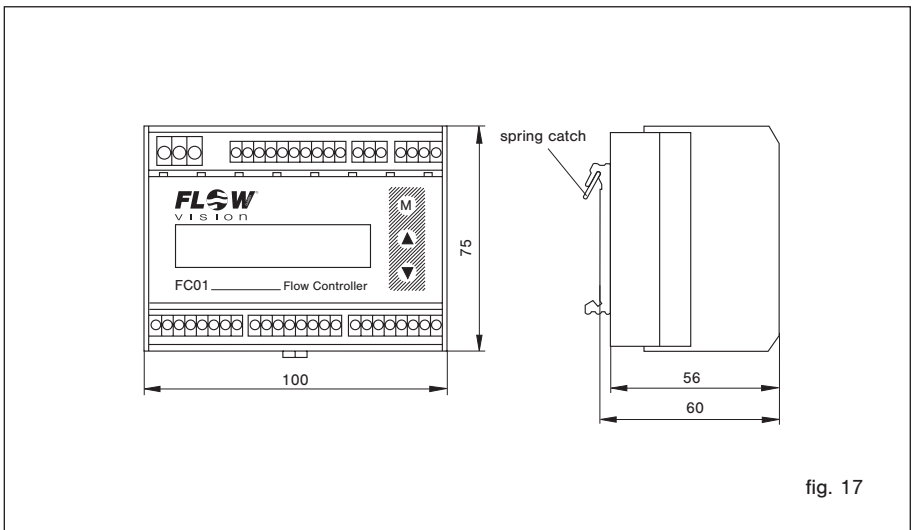


fig. 17

**2.3.1.2 Surface mounted version FC01-FH-U1...**

- Remove the cover of the housing.
- Install the housing in place using the 4 screws M4 (see fig. 18).
- Replace the cover and tighten the retaining screws.

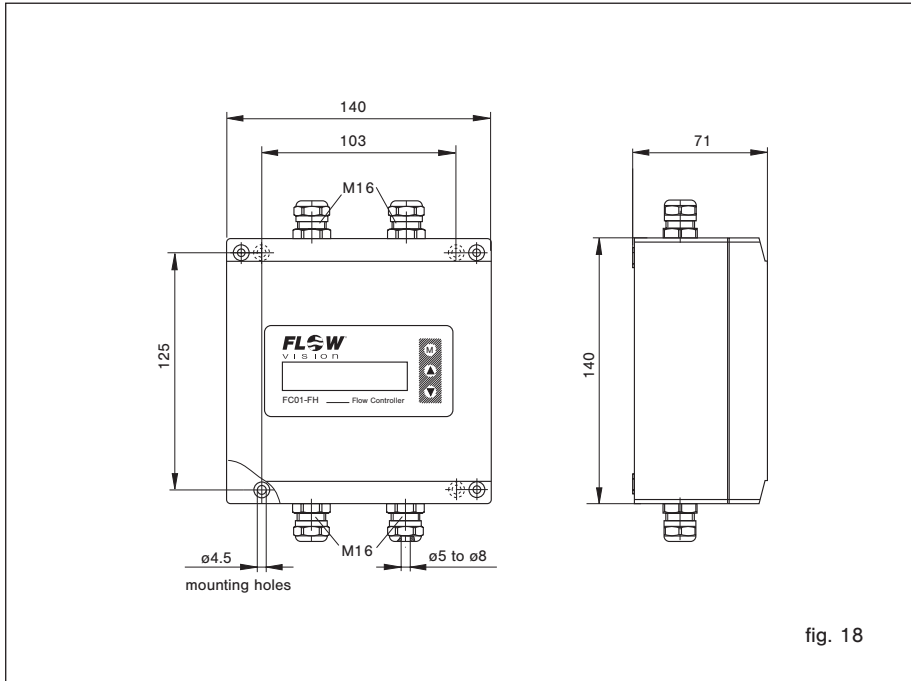
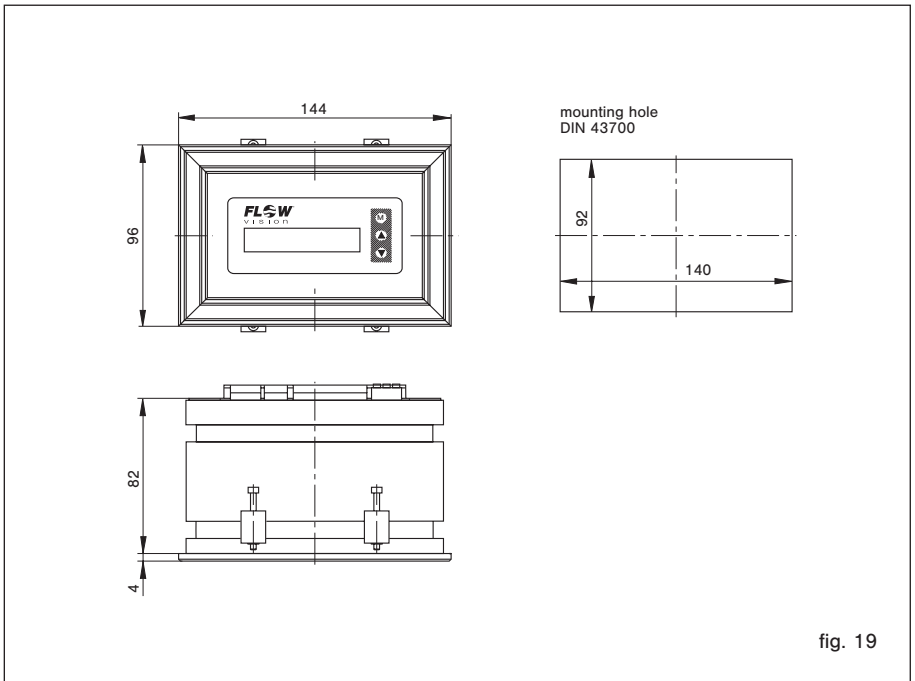


fig. 18

**2.3.1.3 Front panel mounted housing FC01-ST-U1...**

- Insert housing into front of mounting hole and fix with 4 screws (see fig. 19) from the rear.



**2.3.2 Electrical connection**

Valid for all plug-in screw terminal strips:

- Cable size: 0.14 mm<sup>2</sup> to 1.5 mm<sup>2</sup>, single or stranded conductor
- Stripping length: 6.5 mm
- Clamping screw: M2 (nickel-plated brass)
- Contact material: pre-tinned tin bronze

**XV - Power supply**

Connection by 3 pole connector; max. 1.5 mm<sup>2</sup>; 3 x 0.75 mm<sup>2</sup> cable recommended

Pin No.	Signal name	Function
1	SGND	general reference ground/shield ground
2	+U <sub>V</sub>	positive pole of supply voltage
3	-U <sub>V</sub>	negative pole of supply voltage

**XTF - Keyboard release**

Connection by 3 pole connector; factory-wired

Jumper 2-3 inserted = keyboard blocked

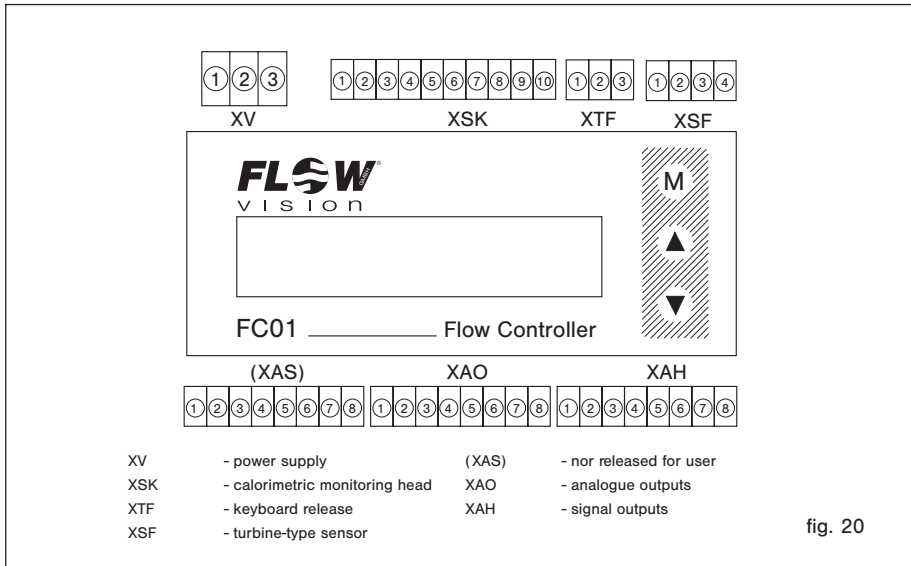


fig. 20

**XAO - Analogue outputs**

Connection by 8 pole connector; max. 1.5 mm<sup>2</sup>; LiYCY 2 x 0.25 mm<sup>2</sup> cable recommended for each analogue output

**Pin selection for analogue outputs** (option: V1, V2, C1)

Pin No.	Signal name	Function		
1	nc	none		
2 ]	[ ANAO1	analogue output 1 - flow		
3 ]			ANA1GND	reference potential for analogue output 1
4 ]			SGNDA1	shield ground for analogue output 1 (ungrounded) *
5 ]	[ SGNDA2	shield ground for analogue output 2 (ungrounded) *		
6 ]			ANA02	analogue output 2 - temperature
7 ]			ANA2GND	reference potential for analogue output 2
8	nc	none		

\* Apply shield on one side only.

**XAH - Limit switch signal outputs - relay outputs - single pole double throw**

Connection by 8 pole connector; max. 1.5 mm<sup>2</sup>; LiYCY 3 x 0.38 mm<sup>2</sup> cable recommended for each signal output

Pin No.	Signal name	Function		
1 ]	[ SGNDL1	shield ground 1		
2 ]			LIM1	non-inverted signal output 1 (N.O.)
3 ]			LIM1COM	common 1 (SPDT)
4 ]			/LIM1	inverted signal output 1 (N.C.)
5 ]	[ SGNDL2	shield ground 2		
6 ]			LIM2	non-inverted signal output 2 (N.O.)
7 ]			LIM2COM	common 2 (SPDT)
8 ]			/LIM2	inverted signal output 2 (N.C.)

**XAH - Limit switch signal outputs - transistor outputs NPN, freely connectable as emitter (-) and collector (+) have been brought out separately.**

Connection by 8 pole connector; max. 1.5 mm<sup>2</sup>; LiFYCY 4 x 2 x 0.2 mm<sup>2</sup> cable recommended

Pin No.	Signal name	Function
1 ]	[ /ERROR E	summarized error indication - emitter terminal
2 ]		
3 ]	[ /BUSY/PULSE E	availability signal or frequency output - emitter terminal
4 ]		
5 ]	[ LIM2 E	limit value 2 - emitter terminal
6 ]		
7 ]	[ LIM1 E	limit value 1 - emitter terminal
8 ]		

**XSK - Connection of calorimetric monitoring heads type CS<sub>x</sub>**

Pre-sized connecting cable Do+Ka type 15 or Do+Ka type 18 with plug-in screw terminal strip (see 2.1.5)

**XSF - Connection of turbine-type sensors type TST**

Pre-sized connecting cable Do+Ka type 16 with plug-in screw terminal strip (see 2.2.3)

**(XAS - secondary current supply)**

Only for connection of cable shield (not released for user)

Pin No.	Signal name	Function
3	SGND	shield ground



**2.3.2.1 Circuit diagram FC01 (relay outputs)**

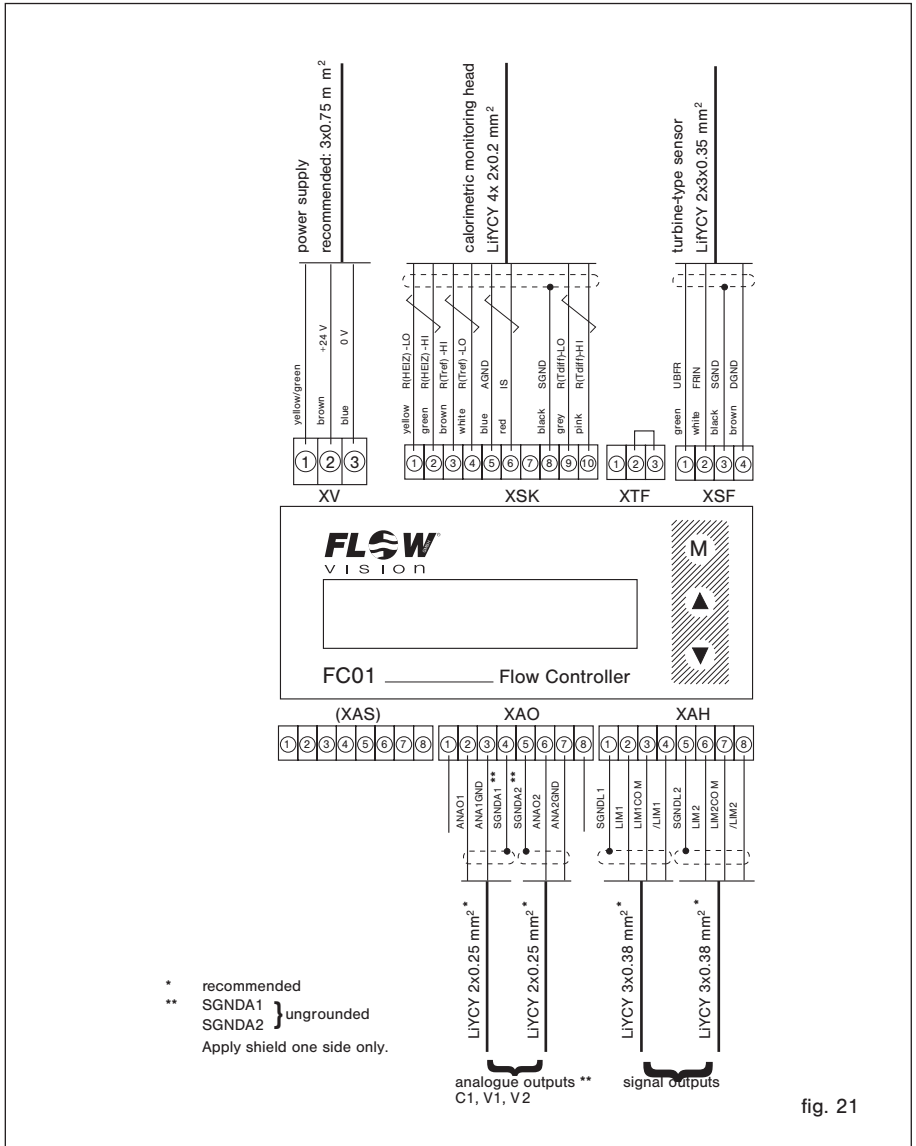


fig. 21

2.3.2.2 Circuit diagram FC01 (transistor outputs (NPN))

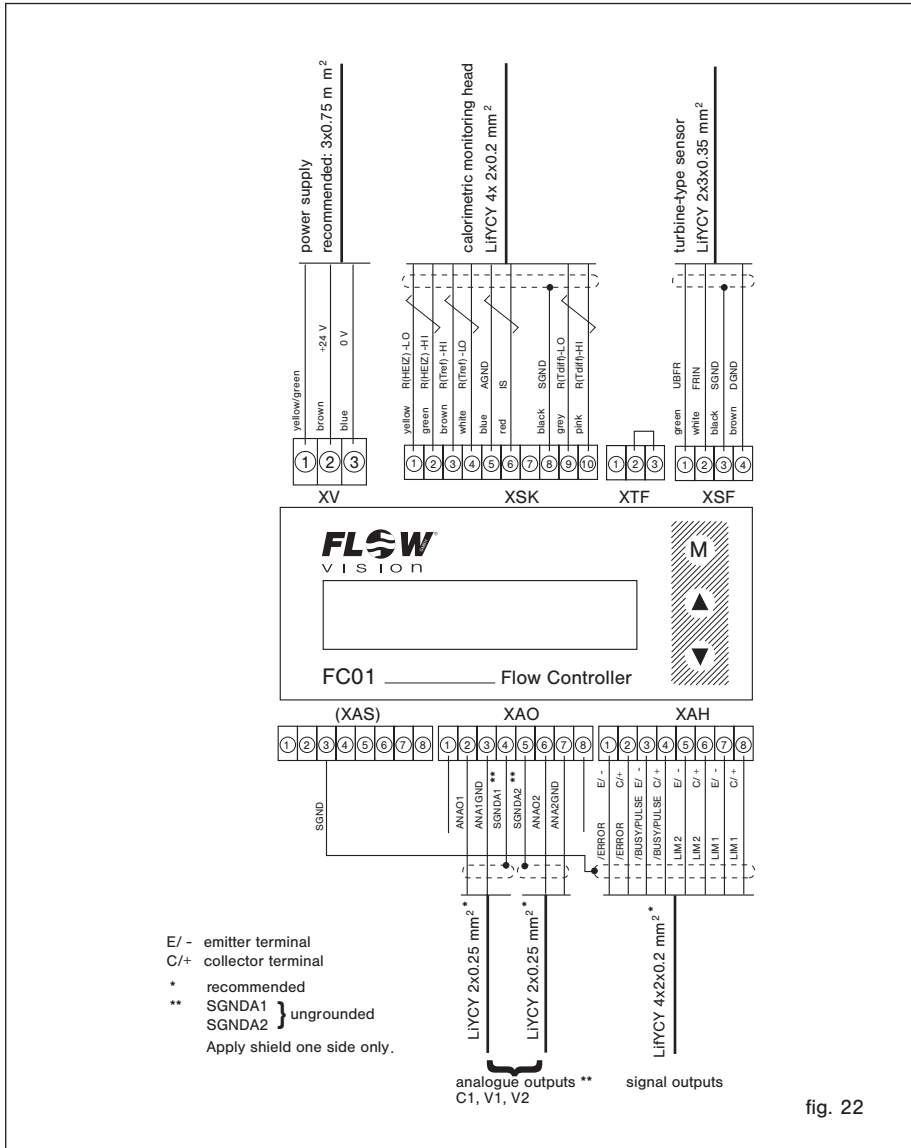


fig. 22

**2.3.2.3 Electrical connection - frequency output (version FC01-U1T4)**

The quantity-dependent pulse may be selected in the menu item "DISPLAY SELECT". A square pulse signal is available for driving a counter of a primary control at the plug **XAH** /BUSY E-/ and /BUSY C/+ (pins 3 and 4) (see fig. 22 - circuit diagram FC01 - transistor outputs).

Signal ground shall be connected to pin 3 (BUSY E/-) and the driving load to pin 4 (BUSY C/+).

The pulse length is 50 ms ( $\pm 1\%$ ) continuously.

Select cable size  $\leq 1.5 \text{ mm}^2$  to make the connections.

The shield cables can be connected to connector **XAS**, pin 3.

**Electronic signal processing (fig. 23)**

If the frequency output of the FC01 is connected to an electronic counter, computer or PLC, the load current should not exceed 10 mA so as to ensure low level is 0.8 V.

**Typical circuit (example 1)**

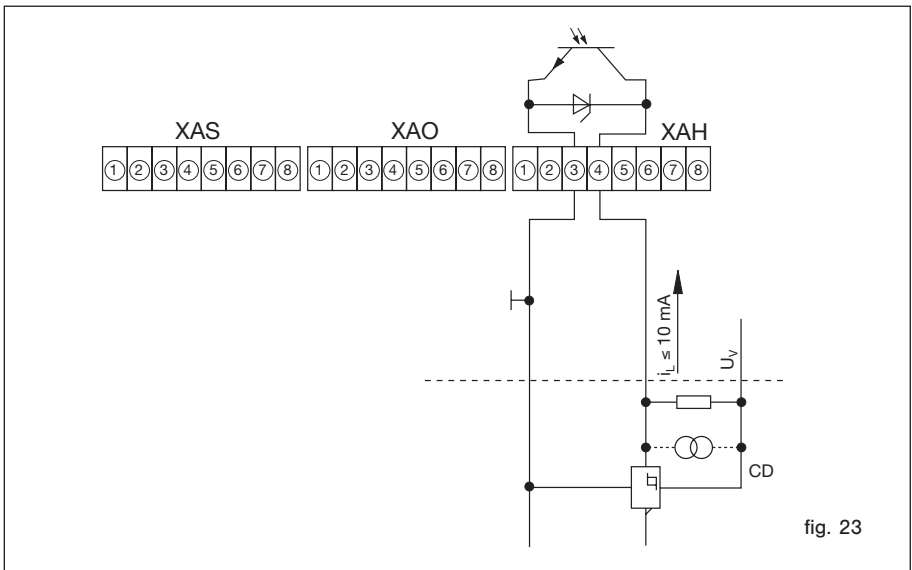


fig. 23

**Electromechanical pulse counter (fig. 24)**

The FC01 driver output comprises an integral safety circuit which when releasing the counter operating coil will limit overvoltages caused by inductance and convert the energy stored.

The counter should be able of processing a counting frequency of  $\geq 10$  Hz as the pulse length is 50 ms ( $\pm 1\%$ ) continuously.

It should therefore be ensured that the counter can be increased by one during the time available.

If a separate release network is preferred to the integral network, care should be taken when processing the max. frequency of 10 Hz to ensure the energy stored in the operating coil has dissipated by the time the counter output is switched on again. The time to do this should be below 40 ms, making due consideration to switching times and pulse variations.

**Typical circuit (example 2)**

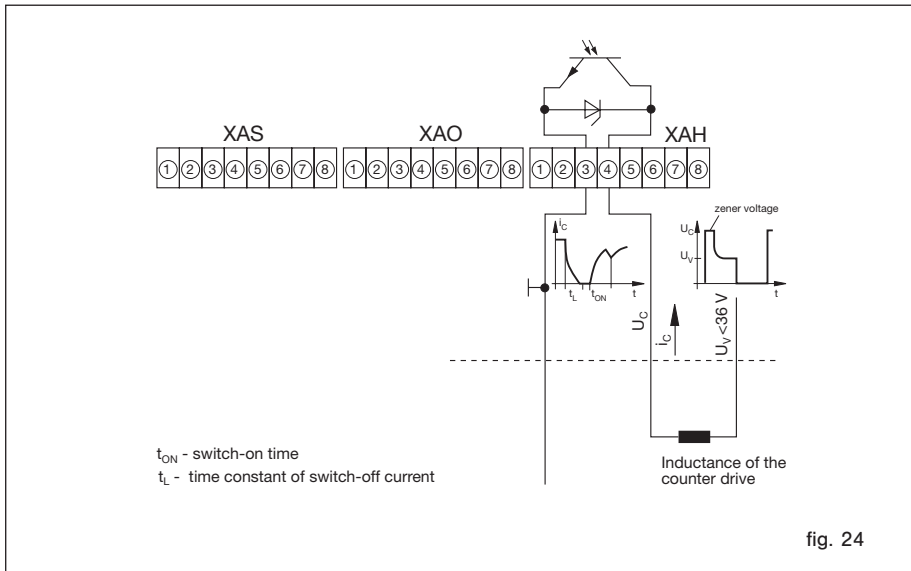


fig. 24

**Note:**

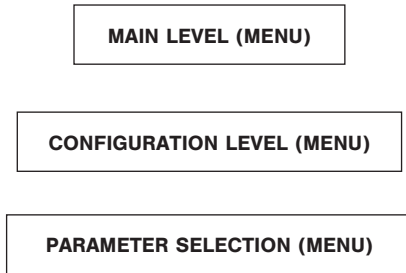
- As there will be a reset pulse available at the output in the moment the supply voltage of the FC01 is applied, make sure that the counter is switched on delayed or set to zero after it has been switched on.

### 3 Operating system

Clear menu-driven control, via keyboard and display, enables easy definition of parameters and configuration. This provides high system flexibility, making the FC01 the optimum solution for a wide variety of measuring, monitoring and display tasks.

When programming the FC01 the user is guided by plaintext in the display through menus in which he may enter or select the required functions.

All functions are distributed on the three following menu levels:




See Appendix 2 listing all functions available.

**Keypads** (M) MODE, (▲) UP and (▼) DOWN

Setting and configuration is by means of three front keypads (M) MODE, (▲) UP and (▼) DOWN. It is also required for setting the unit to simultaneously press (▲) UP and (▼) DOWN = (▲ + ▼).

**Caution!**

 The FC01 can only be set or operated when connector XTF (keyboard release) is removed!

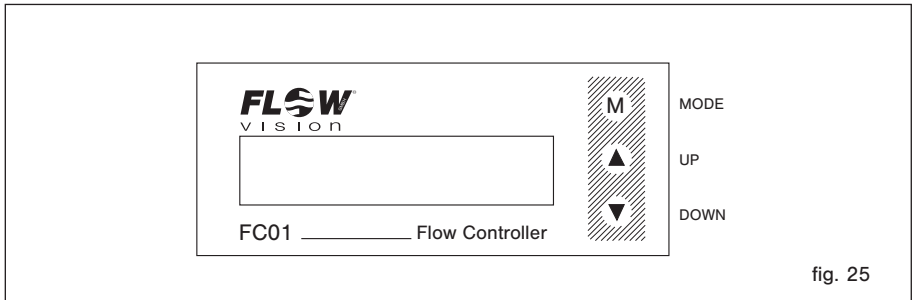


fig. 25

### Menu paging

The next menu option is selected by pressing **(M)** MODE (forward paging).

Pressing **(M)** MODE after the last menu option will cause skipping to the first option of the menu.

### Calling a menu option

Simultaneously pressing **(▲)** UP and **(▼)** DOWN = **(▲+▼)** calls the selected menu option, or causes skipping to the selected submenu.

### Entry of numerals

Some menu options require numerical values to be entered. After selecting the appropriate menu option, the value indicated can be changed by pressing **(▲)** UP or **(▼)** DOWN.

Each time **(▲)** UP or **(▼)** DOWN are pressed, the value indicated will be increased and reduced respectively, by one numeral skip.

The longer **(▲)** UP or **(▼)** DOWN are pressed, the faster the increase or reduction.

### Transfer of entries

Pressing **(M)** MODE transfers the set value or the selected menu option to a volatile memory.

A permanent transfer of settings and values is only effected when quitting the menu, after a plausibility check of all entries.

Afterwards the data are still available even after repeatedly switching the FC01 ON/OFF.

### Deleting data

Selected data such as MIN or MAX values can be deleted or reset by simultaneously pressing **(▲)** UP and **(▼)** DOWN = **(▲+▼)**.

### Caution!

**!** After configuration and parameter selection re-connect plug **XTF** (keyboard release) to protect the system against unauthorised access!

## 4 Operation and main menu

### 4.1 Switch-on performance

Upon power application **POWER ON TEST** will be shown on the display for approx. 2 sec., with the **software version number** being indicated in the second line.

During this period, the integral controller will conduct test routines (see para. 7.1, Test and diagnosis).

If during the test no error was found, the display will indicate either **HEATING UP** (if a calorimetric sensor has been selected) or - - - - (if a turbine-type sensor has been selected).

If a calorimetric monitoring head has been selected, the FC01 will then be in the heating up period required for the measuring procedure.

### 4.2 Measuring cycle

Upon completion of the heating up period (only applicable to calorimetric sensors) and availability of the first measured value, the display will change to measuring cycle, and the user interfaces such as analogue outputs or limit switches will be up-dated.

**Note:**

- It is not possible to configure or select parameters of the system during the measuring operations!

All options of the main menu may be addressed without affecting the measuring and monitoring function.

Menu option values

PEAK VALUE MIN

PEAK VALUE MAX

LAST ERROR

TOTALIZER

may be deleted simultaneously operating the  UP and  DOWN =  switches without affecting the measuring operations.

#### Over limits of the measuring range

Theoretically established measuring values will be used when the measuring range of calorimetric monitoring heads is exceeded (0.1 ... 20 m/s for air, 0.05 ... 3 m/s for water). The FC01 can thus be operated beyond the measuring values defined, i.e. up to 100 m/s for air, and up to 4 m/s for water.

This feature will not affect the accuracy specified for the measuring ranges defined whilst no accuracy information can be given for conditions where the measuring ranges are exceeded.

Analogue output, limit switches etc. can be set beyond the measuring range. When per cent display is selected, the defined measuring range will correspond to 0 ... 100 % (>100 % when the defined range is exceeded).

The following operating data may be retrieved in the main menu during the measuring cycle: (see para. 4.2.1)

## 4.2.1 Operating data

### 4.2.1.1 Measured value(s)

Flow rate and medium temperature (not with turbine-type sensor) are indicated by the units selected in the upper line of the LC display.

The lower line of the display will optionally show the switching condition of the limit switches and an analogue bar with a 10-segment resolution, or the flow volume/time unit pertinent to the indicated flow rate or the totalized flow volume (totalizer function).

The analogue bar has different meanings, depending on its configuration (see para. 5.8 - menu option BARGRAPH).

The limit switches are identified according to their physical assignment, i.e. by **F** for flow rate and **T** for medium temperature, at the first or last place of the second line on the display.

If **F** and **T** are shown reversed, the limit switch is in the switch-on condition.

Limit switches lying within the analogue bar range are also represented at the appropriate place of the analogue bar (see para. 5.8).

The following figures show the display variants under menu option "Measured value(s)" (para. 5.7 - menu option DISPLAY SELECT and 5.10 - menu option FREQUENCY OUTPUT).

**Note:**

- The limit switch for medium temperature is not available if a turbine-type sensor has been selected!



4.2.1.1.1 Calorimetric monitoring head CSx

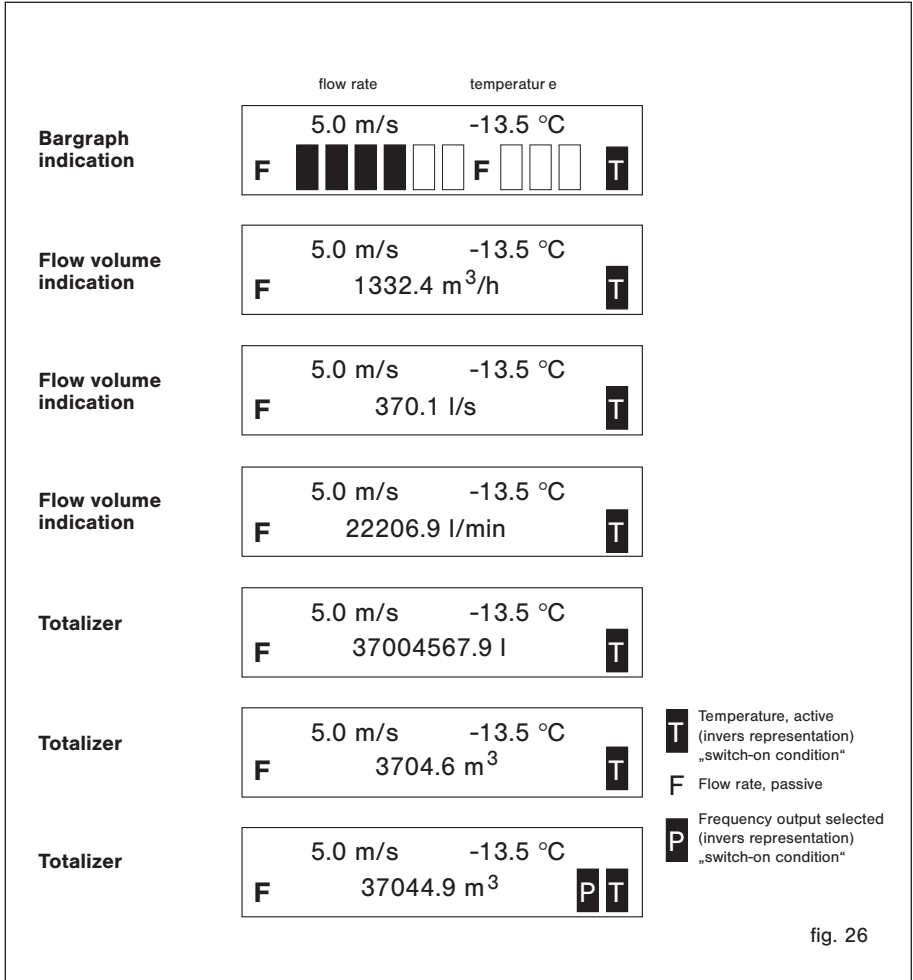


fig. 26

4.2.1.1.2 Turbine-type sensor TST

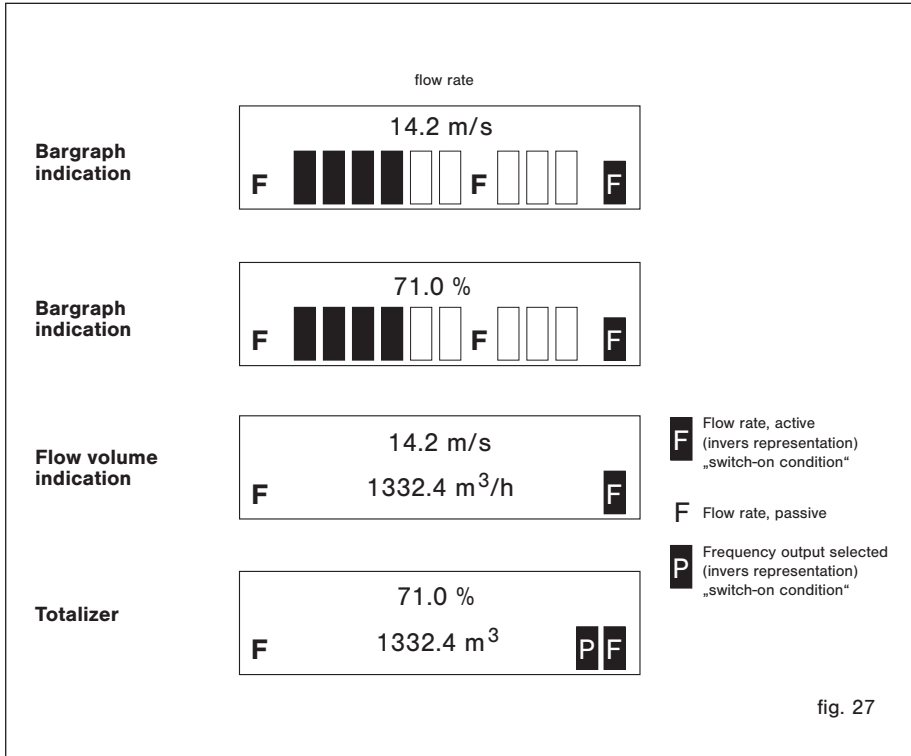


fig. 27

**4.2.1.2 Peak values** (menu option: **PEAK VALUE MIN / PEAK VALUE MAX**)

The FC01 comprises four specific measured-values memories.

They store the lowest and highest value of flow rate and medium temperature.

After switch-on or NOT-BUSY indication, the minimum and maximum values are deleted and will be continuously updated (non-return pointer principle).

The peak values may be retrieved in the main menu and are deleted by simultaneously pressing

▲ UP and ▼ DOWN = ▲ + ▼.

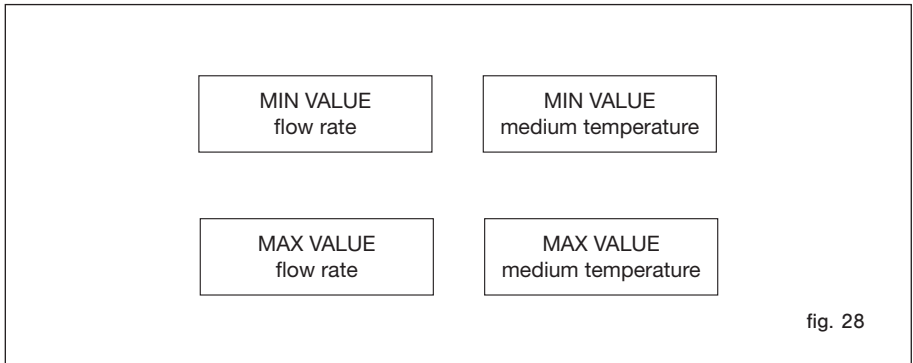
**Caution!**



Power failure or disconnection of the power supply will delete the contents of the four measured-values memories.

**Note:**

- The measured-value memories for medium temperature are not available if a turbine-type sensor has been selected.



**4.2.1.3 Last error** (menu option: **LAST ERROR**)

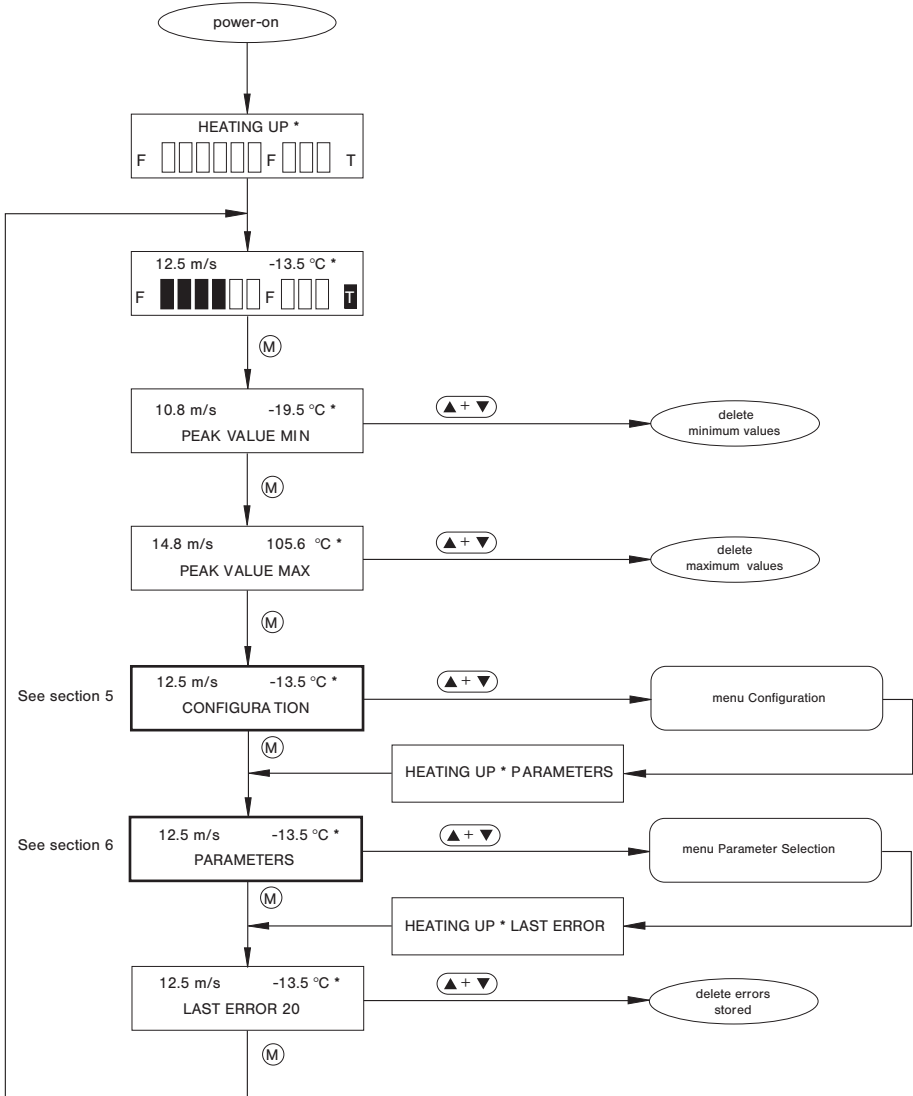
The last main menu option to be called is the error memory.

This error memory comprises the number of the last error (see section 7). It may be very helpful when commissioning the FC01.

Other than the peak value memories described above, the contents of this memory will be retained even upon power failure.

The user may purposely delete the error memory in the condition selected by simultaneously pressing ▲ UP and ▼ DOWN = ▲ + ▼.

**4.2.1.4 Main menu**



\* not available with turbine-type sensor

## 5 Configuration (menu option: CONFIGURATION)

The CONFIGURATION menu serves to adjust the FC01 to the application within the entire system. During system configuration, measuring operations are not possible (see Appendix 1).

Configuration possibilities are:

### 5.1 Selection of monitoring head (menu option: SENSOR SELECT)

This menu option comprises all monitoring heads that can be used with the FC01.

The appropriate sensor can be selected from the following menu (for type designation see type label or FlowVision catalogue).

- TYPE CST01AM1 (calorimetric monitoring head for air)
- TYPE CST01AM2 (calorimetric monitoring head for air)
- TYPE CST01WM1 (calorimetric monitoring head for water)
- TYPE CST02AM1 (calorimetric monitoring head for air)
- TYPE CST02WM1 (calorimetric monitoring head for water)
- TYPE CST03AM1 (calorimetric monitoring head for air)
- TYPE CST03WM1 (calorimetric monitoring head for water)
- TYPE CST04AM1 (calorimetric monitoring head for air)
- TYPE CST04WM1 (calorimetric monitoring head for water)
- TYPE CSF01AM1 (calorimetric monitoring head for air)
- TYPE CSF01AM7 (calorimetric monitoring head for air)
- TYPE CSF01WM1 (calorimetric monitoring head for water)
- TYPE CSF02AM1 (calorimetric monitoring head for air)
- TYPE CSF02WM1 (calorimetric monitoring head for water)
- TYPE CSF03WM1 (calorimetric monitoring head for water)
- TYPE TST01HM2 (turbine-type sensor for air and water)
- TYPE TST01AM1 (turbine-type sensor for air)
- TYPE TST01WM1 (turbine-type sensor for water)
- TYPE TST02HM2 (turbine-type sensor for air and water)
- TYPE TST02AM1 (turbine-type sensor for air)
- TYPE TST02WM1 (turbine-type sensor for water)
- TYPE S-No. xxx (custom designed monitoring head for special media)

#### Note:

- If a turbine-type sensor is selected, the functions relating to medium temperature are not accessible.

Monitoring head S-No. xxx is only available where a custom designed option has been ordered and integrated.

The monitoring head programme is continuously extended - please enquire.

#### Caution!



Menu option SENSOR SELECT may influence data in the parameter selection menu (see para. 5.13, Quitting the configuration menu).

## 5.2 Monitoring head data (menu option: **SENSOR CODE**)

To operate the FC01 with a calorimetric sensor, it is necessary to set sensor-specific characteristics.

These characteristics are specified by the sensor code which together with the monitoring head type number is marked on the monitoring head housing.

Setting is menu driven in two steps:

1. Setting of the C                      characteristics range: **700 ... 1300**
2. Setting of the T                      characteristics range: **01 ... 99**

### Caution!



Take care to repeat these settings after replacing the monitoring head or electronic module (FC01), as the accuracy of measurements is determined by the sensor code.

### Note:

- This submenu is not available if a turbine-type sensor has been selected, in which case the sensor code has no influence on the measuring accuracy.

### 5.3 Limit switch combinations (menu option: **LIMIT SWITCHES**)

The FC01 comprises two limit switches (LS1 and LS2) which are assigned to the physical quantity/quantities to be monitored in submenu LIMIT SWITCHES.

The following combinations are available:

- LS1 → F and LS2 → F
  - limit switch 1 → flow rate
  - limit switch 2 → flow rate
- LS1 → T and LS2 → T
  - limit switch 1 → medium temperature
  - limit switch 2 → medium temperature
- LS1 → F and LS2 → T
  - limit switch 1 → flow rate
  - limit switch 2 → medium temperature
- LS1 → T and LS2 → F
  - limit switch 1 → medium temperature
  - limit switch 2 → flow rate

Mode of operation, limit value and hysteresis of the limit switches are set in menu "PARAMETER SELECTION".

**Note:**

- This submenu is not available if a turbine-type sensor has been selected, in which case the two limit switches are assigned to the flow rate.

**Caution!**



Menu option "LIMIT SWITCHES" may influence data in the parameter selection menu (see para. 5.13, Quitting the configuration menu).

### 5.4 Flow rate unit (menu option: **FLOW UNIT**)

At this point (1<sup>st</sup> line top left with calorimetric monitoring head and 1<sup>st</sup> line with turbine-type sensors) the requested unit for the flow velocity will be set.

This menu option is used to set the desired flow rate unit:

- METRE/SEC [m/s]
- FEET/SEC [FPS]
- PERCENT [%]
- BLANK [no unit]

Any further entries relating to flow rate (e.g. limit value, analogue output etc.) refer to that unit.

Standard percent is displayed when BLANK (no unit) is selected.

When the flow rate unit is changed, all configuration and parameter data relating flow rate will automatically be converted!

### 5.5 Medium temperature unit (menu option: **TEMP. UNIT**)

This submenu is used to select the medium temperature unit (1<sup>st</sup> line top right with calorimetric monitoring head).

Options are:

- GRAD CELSIUS [°C]
- GRAD FAHRENHEIT [°F]
- KELVIN [K]

All other entries relating to the medium temperature (limit value, analogue output, etc.) refer to the unit selected there. When the temperature unit is changed, all configuration and parameter data relating to medium temperature will automatically be converted.

**Note:**

- This submenu is not available if a turbine-type sensor has been selected!

### 5.6 Display (menu option: **DISPLAY SELECT**)

The FC01 enables the user to define the 2nd line of the display in certain points.

When the first line of the LC display in the main menu indicates the flow rate in the unit selected as well as the medium temperature in °C, °F or K (if a calorimetric monitoring head is used), it is possible to select the second line from the following menu options (see para. 5.15).


- |  |  |
|--|--|
| <ul style="list-style-type: none"> <li>• BARGRAPH</li> <li>• LITRE/SECOND [l/s]</li> <li>• LITRE/MINUTE [l/min]</li> <li>• METRE<sup>3</sup> / HOUR [m<sup>3</sup>/h]</li> <li>• GALLONS/MINUTE</li> </ul> | <p><b>Totalizer:</b></p> <ul style="list-style-type: none"> <li>• LITRE [l]</li> <li>• METRE<sup>3</sup> [m<sup>3</sup>]</li> <li>• GALLONS = US-GALLONS]</li> </ul> |
|--|--|

Where totalizer function has been selected, the totalizer will start at zero counting in the unit selected (litre, m<sup>3</sup> or gallons).

When the display changes from m<sup>3</sup> to litre or gallons, or from litre or gallons to m<sup>3</sup>, the value already counted will be converted.

The content of the totalizer is deleted by simultaneously pressing ▲ UP and ▼ DOWN = ▲ + ▼ or when the max. display value (99999999.9 l, m<sup>3</sup> or gallons) is reached. In both cases, the totalizer will restart from zero.

**Caution!**

 The content of the totalizer is deleted in the event of power failure or disconnection of the power supply!

Skipping to the submenu BARGRAPH or PIPE SIZE is effected depending on the selected menu option.



### 5.7 Bargraph (menu option: **BARGRAPH**)

This menu option allows the user to set the bargraph as desired. The following settings should be made:

- FLOW / TEMP = (bargraph assignment: flow rate/medium temperature)
- ZERO = (initial value of the bargraph)
- FS = (final value of the bargraph)

Independent of its assignment, the bargraph has a constant resolution of 10 segments.

When entering the initial or final value, the user should observe reasonable resolution!

The bargraph also comprises the representation of the limit switch(es) as far as they can be indicated in the bar range selected.

The representation of the limit switches in the bargraph depends on the switch-on value of the limit switch.

For representation details see para. 4.2.1 (Operating data).

**Note:**

- This submenu is available only in part if a turbine-type sensor is used. The option "Analogue Bargraph Assignment" is not applicable.

**Example:**

Limit switch assignment: LS1 → F and LS2 → T

Switch-on value LS2: 23 °C

Switch-off value LS2: 29 °C

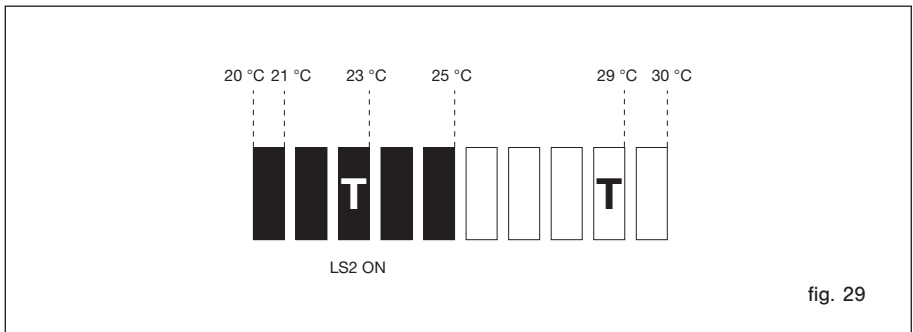
Analogue bargraph assignment: medium temperature

Initial value - analogue bargraph: 20 °C

Final value - analogue bargraph: 30 °C

Instantaneous temperature value: 25 °C

→ resulting in the analogue bargraph display shown below:



### 5.8 Pipe diameter (menu option: PIPE SIZE)

If flow volume/time unit display has been selected, it is necessary to indicate the pipe diameter to calculate mass flow.

This is provided by selecting the pipe diameter in menu option PIPE SIZE comprising pipe diameters from **10.0 ... 999.9** mm.

### 5.9 Frequency output (menu option: FREQUENCY OUTPUT)

The totalizer function of the FC01 has been expanded by the output of **proportional quantity pulses**. The function can only be displayed by version **FC01-U1T4** (transistor outputs).

The proportional quantity pulses have been determined as follow:

**1 pulse / quantity (totalizer unit selected)**

Example:

1 pulse / 10.0 [litre]

The frequency output will supply 1 pulse per 10 litres (totalized quantity).

When the quantity-proportional pulses are assigned, the frequency of the frequency output must not exceed 10 Hz. The limits that can be displayed are determined by the flow velocity range and the pipe diameter.

Potential setting range of the frequency output: 1 pulse per 0.1 ... 999.9 [litre], [m<sup>3</sup>], [gallons]

#### **Behaviour of the frequency output when the max. frequency is exceeded**

The max. frequency being exceeded will not cause the measurement to stop but will rather cause the error output to signal error 60 on the display. This error is included in priority group III.




If a combination of priority III errors occurs simultaneously, they are indicated or stored in the error memory observing the following sequence:

Error No. 20, 30, 60, 40, 41.

#### **Behaviour of the frequency output when the measurement is stopped**

When the measurement is stopped (as caused by priority II error and calling the configuration or parameter selection menus), the pulses for the quantity already counted will be available. Thereafter the output of pulses will be stopped, with the frequency output becoming high-resistive until the measurement is restarted.

#### **Behaviour of the frequency output when the content of the totalizer is deleted**

The content of the totalizer may be deleted by simultaneously pressing  UP and  DOWN =  in the main menu.

As the frequency output refers to the content of the totalizer, although its operation is not dependent on the content of the totalizer, a totalized quantity that is smaller than that set per pulse will not be lost.

This means that only the content of the totalizer is deleted.

### 5.10 Analogue output - flow rate (menu option: ANA OUT FLOW)

This menu option allows adjustment of the flow rate analogue output specifically to the requirements of the entire system.

Options are:

- OFFSET = 0 %/20 % FS (0/4 ... 20 mA, 0/1 ... 5 V, 0/2 ... 10 V)
- ZERO = (initial value 0(20) % corresponds to a flow rate of \_ [m/s] [%] [FPS])
- FS = (final value 100 % corresponds to a flow rate of \_ [m/s] [%] [FPS])

When entering the initial or final value, the user should observe a reasonable resolution!

With a flow volume/time unit selected in menu DISPLAY SELECT and when setting the initial and end values, the pertinent flow volumes will also be indicated.

### 5.11 Analogue output - medium temperature (menu option: ANA OUT TEMP.)

In conformance with the configuration "Flow rate analogue output" it is possible to adjust the medium temperature analogue output to the requirements of the entire system.

Options are:

- OFFSET = 0 %/20 % von FS (0/4 ... 20 mA, 0/1 ... 5 V, 0/2 ... 10 V)
- ZERO = (initial value 0(20) % corresponds to a medium temperature of ... [°C] [°F] [K])
- FS = (final value 100 % corresponds to a medium temperature of ... [°C] [°F] [K])

When entering the initial or final value, the user should observe a reasonable resolution!

**Note:**

- This submenu is not available if a turbine-type sensor has been selected!

### 5.12 Quitting the configuration menu

Upon configuration of the analogue outputs, the menu may be quitted or re-set to the start (SENSOR SELECT).

To quit the configuration menu, the controller will check the data entered for plausibility.



"CONFIG. OK!" is indicated when the data are found to be correct. The menu may than be quitted by pressing MODE.

Errors found during the plausibility check are indicated in the following sequence of priority.

Priority of entry errors in the CONFIGURATION menu:

- ERR. A-OUT FLOW OUT OF RANGE  
(flow analogue output outside measuring range)
- ERR. A-OUT FLOW ZERO ≥ FS  
(initial value ≥ final value with flow analogue output)
- ERR. A-OUT TEMP. OUT OF RANGE  
(temperature analogue output outside measuring range)
- ERR. A-OUT TEMP. ZERO ≥ FS  
(initial value ≥ final value with temperature analogue output)

- ERR. BARGRAPH           OUT OF RANGE  
(bar value outside measuring range)
- ERR. BARGRAPH           ZERO ≥ FS  
(bar initial value ≥ bar final value)

The menu can only be quitted after correction of the error(s). To do this, return to the beginning of the configuration menu by pressing  UP or  DOWN and select the menu option with the incorrect entry for correction.

**Caution!**



If during the configuration data are affected which are accessible in the parameter selection menu, (which may be the case for the options Sensor Selection, Medium Selection and limit Switch Assignment), the option “PARAMETERS” in the main menu will be flashing.

In this event it is imperative to branch into parameter selection menu to set the data in conformance with the desired application.

**Example 1:**           Changing the limit switch assignment from **LS1 → F / LS2 → T** to  
**LS1 → F / LS2 → F**

Effects on parameter data:   **LS2 ON** = 0.00  
**LS2 OFF** = end of measuring range (depending on the medium selected)

Reason:                Changing the physical assignment of limit switch 2 will adjust its switch-on and switch-off values to the new assignment (flow rate).

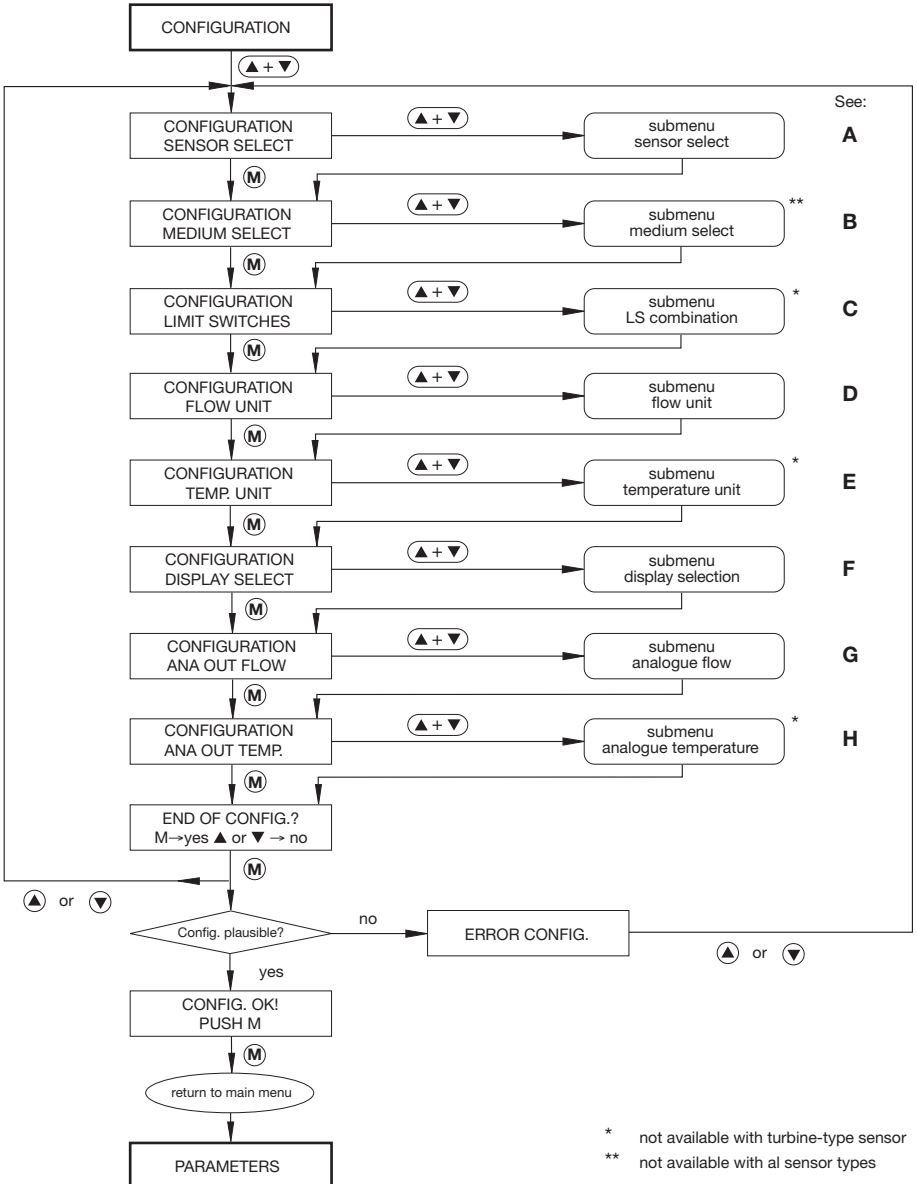
**Example 2:**           Changing sensor type from **CST01AM1** (calorimetric monitoring head) to type **TST01HM2** (turbine-type sensor), with limit switches assigned to medium temperature **LS1 → T / LS2 → T**

Effects on parameter data:   **LS1 ON** = 0.00  
**LS1 OFF** = end of measuring range (depending on the medium selected)  
**LS2 ON** = 0.00  
**LS2 OFF** = end of measuring range (depending on the medium selected)

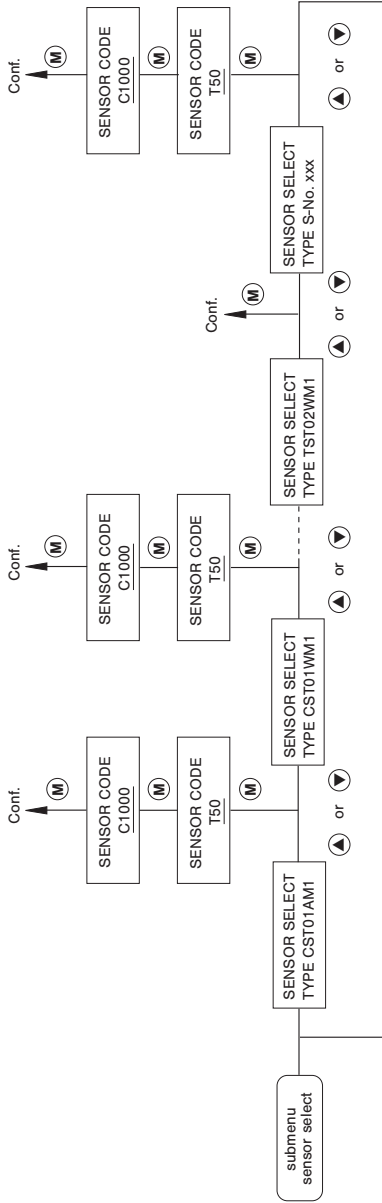
Reason:                As with a turbine-type sensor both limit switches are permanently assigned to flow rate, the switch-on and switch-off values of both limit switches will be affected.

An overview of the configuration menu and a summary of the measuring ranges and menus available for the sensor type selected are shown on the following pages.

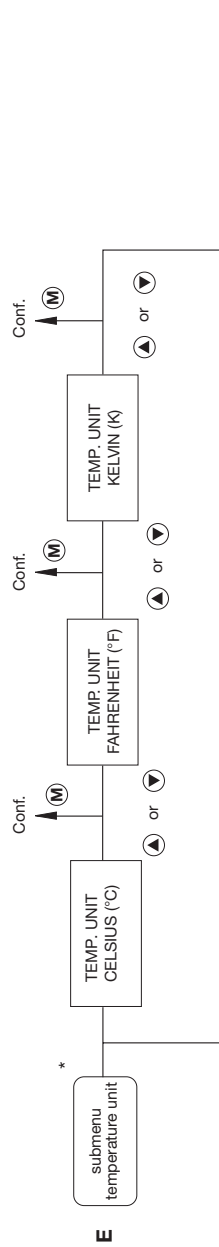
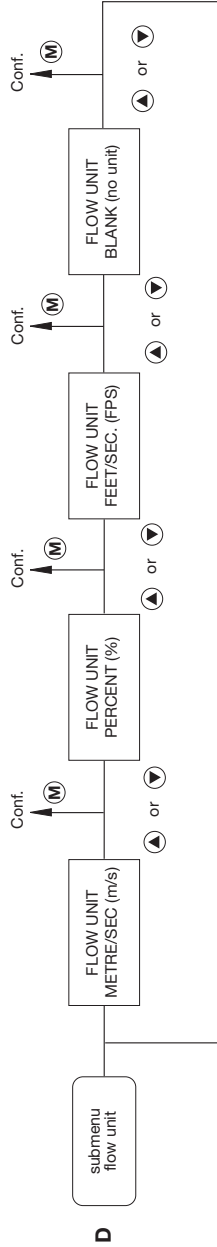
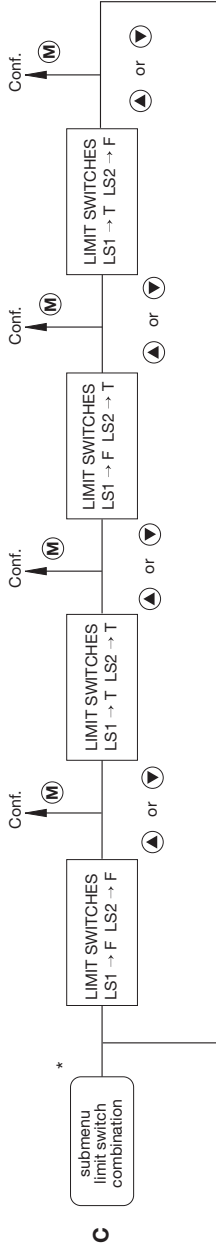
### 5.13 Configuration menu



**5.14 Configuration submenus**

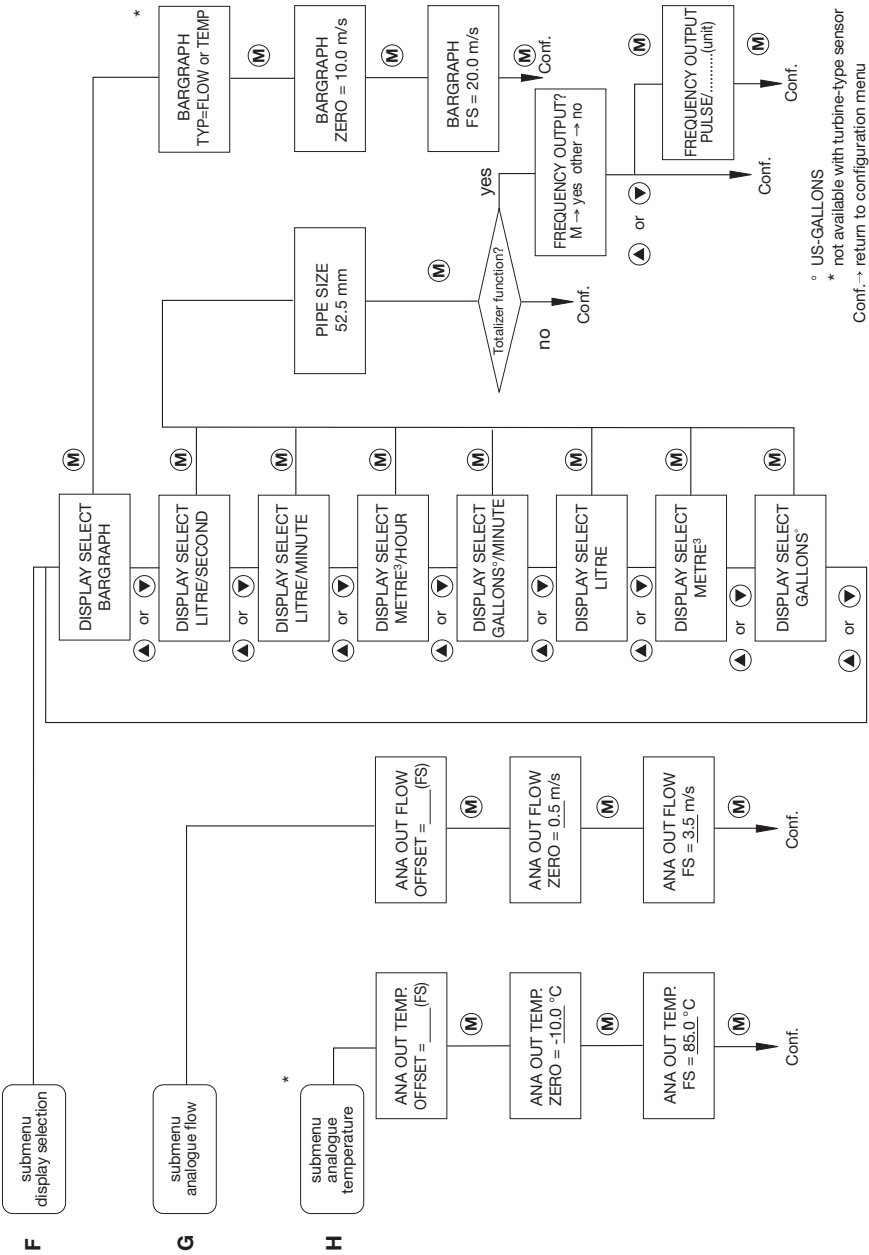


**Configuration submenus (cont' d)**



\*\* not available with turbine-type sensor  
conf. → return to configuration menu

**Configuration submenus (cont' d)**



° US-GALLONS  
\* not available with turbine-type sensor  
Conf.-> return to configuration menu



**5.15 Measuring ranges and menu availability as a function of the sensor selected**

Sensor	Measuring range	Sensor code	Medium	Limit switch	Flow unit	Temp. unit	select Display	Ana-out Flow	Ana-out Temp.
CST01AM1	20 m/s	yes	no	yes	yes	yes	yes	yes	yes
CST01AM2	20 m/s	yes	no	yes	yes	yes	yes	yes	yes
CST01WM1	3 m/s	yes	no	yes	yes	yes	yes	yes	yes
CST02AM1	20 m/s	yes	no	yes	yes	yes	yes	yes	yes
CST02WM1	3 m/s	yes	no	yes	yes	yes	yes	yes	yes
CST03AM1	20 m/s	yes	no	yes	yes	yes	yes	yes	yes
CST03WM1	3 m/s	yes	no	yes	yes	yes	yes	yes	yes
CST04AM1	20 m/s	yes	no	yes	yes	yes	yes	yes	yes
CST04WM1	3 m/s	yes	no	yes	yes	yes	yes	yes	yes
CSF01AM1	20 m/s	yes	no	yes	yes	yes	yes	yes	yes
CSF01AM7	20 m/s	yes	no	yes	yes	yes	yes	yes	yes
CSF01WM1	3 m/s	yes	no	yes	yes	yes	yes	yes	yes
CSF02AM1	20 m/s	yes	no	yes	yes	yes	yes	yes	yes
CSF02WM1	3 m/s	yes	no	yes	yes	yes	yes	yes	yes
CSF03WM1	3 m/s	yes	no	yes	yes	yes	yes	yes	yes
TST01HM2	5 m/s, 20 m/s	no	yes	no	yes	no	yes	yes	no
TST01AM1	20 m/s	no	no	no	yes	no	yes	yes	no
TST01WM1	5 m/s	no	no	no	yes	no	yes	yes	no
TST02HM2	5 m/s, 20 m/s	no	yes	no	yes	no	yes	yes	no
TST02AM1	20 m/s	no	no	no	yes	no	yes	yes	no
TST02WM1	5 m/s	no	no	no	yes	no	yes	yes	no
S-No. xxx	—	—	—	—	—	—	—	—	—

## 6 Parameter selection (menu option: **PARAMETERS**)

After configuration of the FC01 in conformance with its application (configuration menu), it is possible to set parameters (e.g. limit values).

During parameter setting, measuring operations are not possible (see Appendix 1).

The following parameters may be set in the Parameter selection menu:

### 6.1 Measuring time (menu option: **MEAS. TIME**)

The measuring time may be set between 1 and 30 sec., referring both to flow rate and medium temperature.

The effect of the measuring time may be compared to that of a filter; it is used to determine the average of the last measured values after each measurement.

The set measuring time does not influence the measuring rate and display up-date.

### 6.2 Limit switch 1 - switch-on value (menu option: **LS1 ON = .....**)

#### **Limit switch 1 - switch-off value (menu option: **LS1 OFF = .....**)**

Depending on the configuration (see configuration menu) limit value 1 may be set either for flow rate or medium temperature.

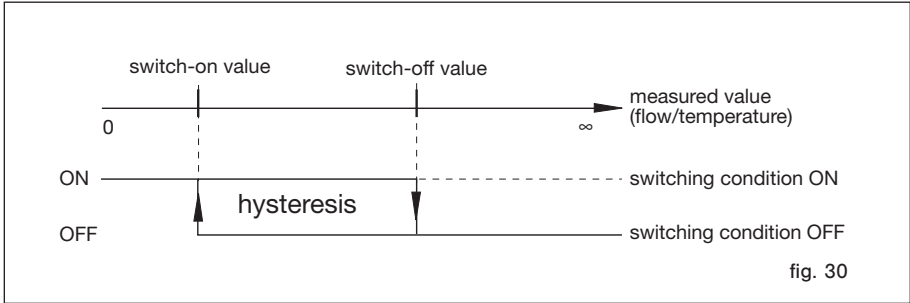
The limit value may be set over the entire measuring range and is always related to the display value.

Limit switch up-date is by measuring rate, independent of the set measuring time.

The hysteresis is determined by entering different switch-on and switch-off values. Its magnitude should be reasonably adjusted to current operating conditions.

A specific definition of the operation (closed-current or open-circuit principle) may be dropped by separately entering the switch-on and switch-off value of the limit switch, because the definition is deducted from the switch-on and switch-off value.

**Example 1: Switch-on value lower than switch-off value**



**Example for ON:**

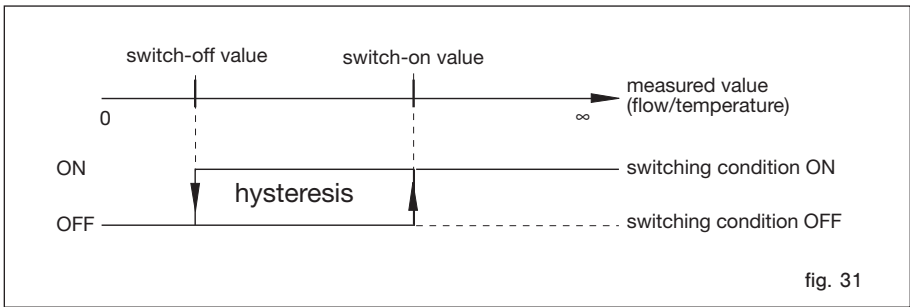
FC01 with relay outputs (option R2):

- LIM1 - LIM1COM = closed  
/LIM1 - LIM1COM = open

FC01 with transistor outputs (option T4):

- LIM1E - LIM1C = switched

**Example 2: Switch-on value higher than switch-off value**



**Example for ON:** as described in example 1 (fig. 30)

With limit switch 1 set for flow rate and a flow volume/time unit selected in menu DISPLAY SELECT, and when setting the switch-on and switch-off value, the pertinent flow volumes will also be indicated.

**6.3 Limit switch 2 - switch-on value (menu option: LS2 ON = .....)**

**Limit switch 2 - switch-off value (menu option: LS2 OFF = .....)**

See limit switch 1!

## 6.4 Scaling factor (menu option: FLOWSCALE)

The scaling factor influences flow rate indication.

The factor, which may be set between 0.01 and 9.99, allows flow rate indication changes (increasing or reducing the measured value in the display).

For example, the scaling factor may be used to indicate the average flow rate in the pipeline rather than that available at the sensor.

## 6.5 Quitting the parameter selection menu



Before the parameter selection menu can be quitted, the controller will conduct a plausibility check of the data entered.

“PARAMETERS OK!” is indicated when the data are found to be correct. The menu may then be quitted by pressing MODE.

Errors found during the plausibility check are indicated in the following sequence of priority.

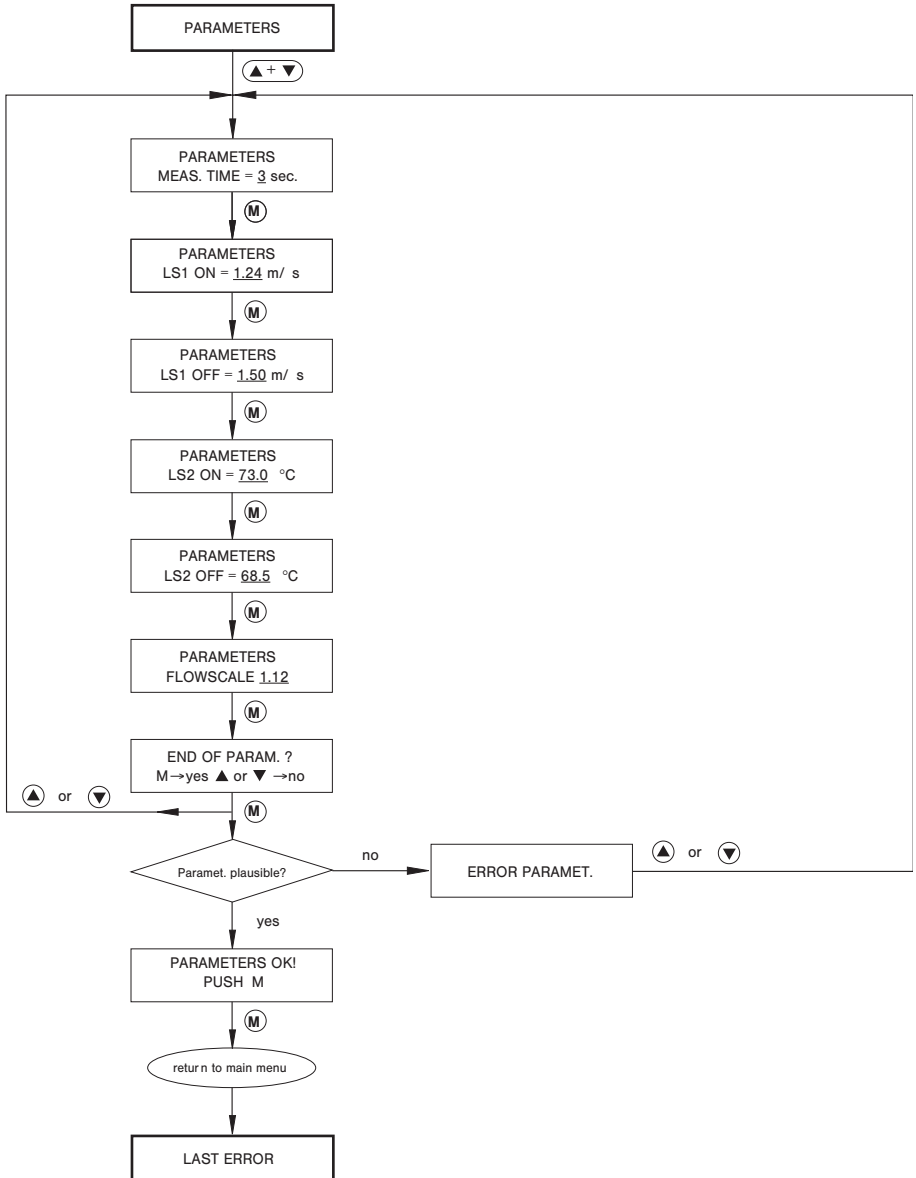
Priority of entry errors in the PARAMETER SELECTION menu:

- ERROR LS1                      OUT OF RANGE  
switch-on and/or switch-off value for limit switch 1 outside measuring range
- ERROR LS2                      OUT OF RANGE  
switch-on and/or switch-off value for limit switch 2 outside measuring range
- ERROR LS1                      ON = OFF  
switch-on value for limit switch 1 equals switch-off value for limit switch 1
- ERROR LS2                      ON = OFF  
switch-on value for limit switch 2 equals switch-off value for limit switch 2

The menu can only be quitted after correction of the error(s). To do this, return to the beginning of the parameter selection menu by pressing  UP or  DOWN and select the menu option with the incorrect entry for correction.

An overview of the parameter selection menu is shown on the following page.

### 6.6 Parameter selection menu



## 7 Errors

### 7.1 Test and diagnosis

The FC01 is provided with extensive test and diagnosis functions.

All faults found will be shown in the display with the corresponding error number (e.g. ERROR 10). If the FC01 is fitted with a T4 option (4 transistor outputs), the output ERROR will additionally be activated.

The functions may be classified in three priority groups.

#### 7.1.1 Priority group I

Priority group I comprises the switch-on test routines (FC01 self-test) which are carried out when the system is switched on.

Their implementation is indicated.

Errors No. 1 to 5 do not allow system operation.

The test routines may be repeated by pressing any of the switches.

If even after several trials the switch-on test cannot be conducted without error indication, the system should be returned to the supplier for rectification, indicating the error number.

Priority I errors cannot be rectified by the user!

#### 7.1.2 Priority group II

These test functions are continuously carried out during operation. The occurrence of errors No. 10 and 21 will cause measurements to stop, indicating the error and monitoring the source of the error. Upon rectification of the error, the system will automatically return to measuring operation.

#### 7.1.3 Priority group III

These test routines are also continuously carried out during operation.

Other than the above priority groups, errors No. 20, 30, 60, 40 and 41 will not cause measurements to stop; the error output will indicate and the number of the error will be shown on the display.

## 7.2 Potential errors

Independent of the priority group, all errors found are indicated with their relevant number.

In order to facilitate operation, the last error is stored in a non-volatile memory. The stored error may be retrieved and deleted in the main menu.

If a combination of errors occurs simultaneously, they are indicated or stored in the error memory observing the following sequence.

### Priority group I

Error	Cause	Rectification
No. 1	No system parameter available	Return to supplier.
No. 2	Incorrect test sum of parameter memory	Return to supplier.
No. 3	Incorrect test sum of program memory	Return to supplier.
No. 4	Incorrect test sum of data memory	Return to supplier.
No. 5	Internal controller error	Return to supplier.

### Priority group II

Error	Cause	Rectification
No. 10	Sensor not connected; or cable between FC01 and sensor defective; or defective sensor	Check cable or replace sensor.
No. 21	Sensor selected (configuration) differs from sensor connected Medium temperature too high	Correct sensor selection in configuration menu

**Priority group III**

Error	Cause	Rectification
No. 20	Medium temperature too low	
No. 30	Over limits of flow rate	
No. 60	Assignment of quantity per pulse too low *	
No. 40	Controller error (oscillator-watchdog) Admissible EMC levels may have been exceeded	
No. 41	Controller error (watchdog timer) Admissible EMC levels may have been exceeded	

\* Error No. 60 can only occur with version FC01-U1T4.



## 8 Technical data

### 8.1 Ambient conditions

	rail-mounted	surface mounted	front panel mounted
Storage temperature:	-20 ... +70 °C	-20 ... +70 °C	-20 ... +70 °C
Ambient temperature: *	+10 ... +50 °C **	+10 ... +50 °C	+10 ... +50 °C
Degree of protection:	IP20	IP65	IP65

\* Only if the modules are spaced by at least 10 mm.

\*\* The max. ambient temperature of +40 °C applies to all systems fitted with current output C1.

### 8.2 Electrical characteristics

#### 8.2.1 Power supply

##### DC supply

Pin selection:	Signal name	Pin XV
	shield	1
	+U <sub>V</sub>	2
	-U <sub>V</sub>	3

##### 8.2.1.1 DC voltage supply

Supply voltage:	U <sub>VN</sub> = DC 24 V *
Input voltage range: (ripple incl.)	U <sub>V</sub> = DC 19 V to DC 32 V
Admissible ripple:	max. 20 % U <sub>V</sub>
Rated current consumption:	I <sub>Vnk</sub> = 170 mA (calorimetric monitoring head) with zero flow
	I <sub>Vnk</sub> = 200 mA (calorimetric monitoring head) with max. flow (end of measuring range)
	I <sub>Vnfr</sub> = 110 mA (turbine-type sensor)

Power consumption may be up to 300 mA ± 10 % when analogue output C1 is fitted.

\* DC 12 V possible if the FC01 is used **without** option C1 (analogue outputs).

Inrush current: I<sub>p</sub> = typ. 3 A (20 μs)

Switch-off current: I<sub>kipp</sub> = typ. 0.75 A

Rated power consumption:	P <sub>n</sub> = 4.1 W (calorimetric monitoring head) with zero flow, voltage outputs
	P <sub>n</sub> = 4.8 W (calorimetric monitoring head) with max. flow (end of measuring range), voltage outputs
	P <sub>n</sub> = 2.6 W (turbine-type sensor) voltage outputs
Insulation voltage:	supply input - central electronic unit ≥ DC 500 V

### 8.3 Analogue outputs

The analogue outputs are physically isolated from each other as well as from the electronic control unit FC01.

#### Pin selection for analogue outputs V1, V2 and C1

Signal name	Pin XAO
NC	1
analogue output 1 - flow rate	2
reference ground 1	3
shield 1 *	4
shield 2 *	5
analogue output 2 - temperature	6
reference ground 2	7
NC	8
NC - not used	

Analogue output 1 - ANA OUT FLOW (flow output)

Analogue output 2 - ANA OUT TEMP. (temperature output)

**\* Shield ungrounded - apply on one side only.**

The output is reverse polarity protected.

Insulation voltage: analogue output - analogue output DC 500 V  
analogue output - central electronic unit DC 500 V

### 8.3.1 Voltage output V1 - 5 V FS

Signal voltage range:	$U_s = 0 \text{ V (1 V) to } 5 \text{ V } \pm 2 \% \text{ FS}$
Max. signal ripple:	$dU_s = 5 \% \text{ FS}$
Min. admissible load resistance:	$R_l = 1 \text{ k}\Omega$
Max. admissible load capacity:	$C_l = 1 \text{ nF}$
Max. admissible load inductance:	$L_l = 100 \text{ nH}$
Short circuit proof:	yes (XAO - between all terminals)

### 8.3.2 Voltage output V2 - 10 V FS

Signal voltage range:	$U_s = 0 \text{ V (2 V) to } 10 \text{ V } \pm 2 \% \text{ FS}$
Max. signal ripple:	$dU_s = 5 \% \text{ FS}$
Min. admissible load resistance:	$R_l = 2 \text{ k}\Omega$
Max. admissible load capacity:	$C_l = 1 \text{ nF}$
Max. admissible load inductance:	$L_l = 100 \text{ nH}$
Short circuit proof:	yes (XAO - between all terminals)

### 8.3.3 Current output C1 - 20 mA FS

Signal current range:	$I_s = 0 \text{ mA (4 mA) to } 20 \text{ mA } \pm 2 \% \text{ FS}$
Max. signal ripple:	$dI_s = 5 \% \text{ FS}$
Min. admissible load resistance:	$R_l = 0 \Omega$
Max. admissible load resistance:	$R_l = 250 \Omega$

## 8.4 Signal outputs

The signal outputs are physically isolated from each other as well as from the electronic control unit FC01.

### 8.4.1 Relay outputs R2 (SPDT)

Pin selection:	Signal name	Pin XAH
	Limit Switch 1 / shield	1
	Limit Switch 1 / N.O.	2
	Limit Switch 1 / common	3
	Limit Switch 1 / N.C.	4
	Limit Switch 2 / shield	5
	Limit Switch 2 / N.O.	6
	Limit Switch 2 / common	7
	Limit Switch 2 / N.C.	8

#### Resistive load

Max. admissible switching capacity:	50 W
Max. admissible switching current:	1 A
Max. admissible continuous current:	1 A
Max. admissible switching voltage:	50 V
Contact life at 1 A:	$3 \times 10^5$ cycles

#### Inductive load - with safety circuit - AC voltage

Max. admissible switching capacity:	125 VA
Max. admissible switching current:	1.25 A
Max. admissible continuous current:	1.25 A
Max. admissible switching voltage:	100 V
Contact life $\cos \varphi = 0.5$ :	$2.4 \times 10^5$ cycles
Insulation voltage:	signal contact - central electronic unit DC 500 V signal contact - signal contact DC 500 V

### 8.4.2 Transistor outputs (DC)

Pin selection:	Signal name	Pin XAH	Polarity
	/ ERROR emitter	1	-
	/ ERROR collector	2	+
	/ BUSY / PULSE emitter	3	-
	/ BUSY / PULSE collector	4	+
	Limit Switch 2 emitter	5	-
	Limit Switch 2 collector	6	+
	Limit Switch 1 emitter	7	-
	Limit Switch 1 collector	8	+

#### Voltage level

Low level - active:	$U_{ce} < 0.8 \text{ V}$ at $I_C < 10 \text{ mA}$ $U_{ce} < 1 \text{ V}$ at $I_C < 100 \text{ mA}$
High level - passive:	$U_{ce} < 48 \text{ V}$ $U_{ce \text{ max}} = 60 \text{ V}$ max. leakage current $\leq 25 \mu\text{A}$
Reverse polarity protection:	yes
Short circuit protection:	yes

#### Resistive load

Max. admissible switching capacity:	1.5 W
Max. admissible switching current:	150 mA
Max. admissible switching voltage:	36 V

#### Inductive load - L < 100 mH

(DC voltage - without external safety circuit)

Max. admissible switching capacity:	1.5 VA
Max. admissible switching current:	40 mA
Max. admissible switching voltage:	36 V

#### Capacitive load - C < 20 $\mu\text{F}$

Max. admissible switching capacity:	1.5 VA
Max. admissible switching current:	1.5 A
Max. admissible switching voltage:	36 V
Insulation voltage:	signal contact - central electronic unit DC 500 V signal contact - signal contact DC 500 V

## 8.5 Metrological data

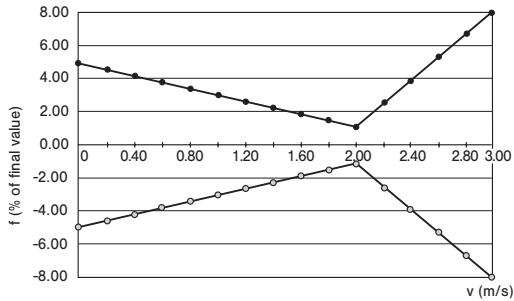
### 8.5.1 FC01 with calorimetric monitoring head

#### Flow rate measurement:

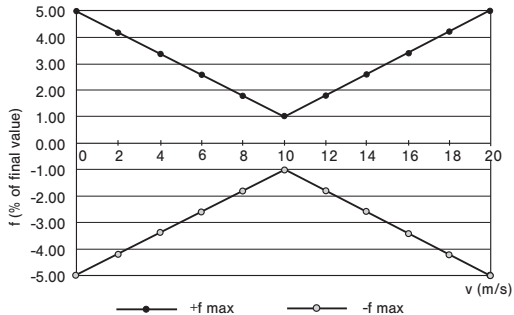
Measuring is possible up to the flow rates indicated in the display range. However, the indicated accuracy is no longer guaranteed. **The repeatability value remains valid.**

Medium:	water	air
Measuring range:	0.05 ... 3 m/s	0.1 ... 20 m/s
Display range:	0 ... 4 m/s	0 ... 100 m/s
Response delay:	2.5 s	3 s
Repeatability: (5 % MBE to 100 % MBE)	1 % MW **	1 % MW **
Accuracy: (see failure diagram)	±1 % MBE * at 2 m/s	±1 % MBE * at 10 m/s

Failure diagram for water



Failure diagram for air



**Temperature measurement:**

Measuring range: -40 ... +130 °C

Accuracy: ±1 % MB \*\*\*

**8.5.2 Calorimetric monitoring heads for FC01/Selector chart**

Monitoring head	CST	CSF01	CSF02	CSF03
Type of head	thread mounted	push-in	flange mounted	flange mounted
Medium:				
air	x	x	x	
water	x		x	x
other media ****	x	x	x	x
Temperature range I (medium)	-40 ... +130 °C	-40 ... +130 °C <sup>1)</sup> -40 ... +80 °C <sup>2)</sup>	-40 ... +130 °C	-40 ... +130 °C
Temperature range II (connector)				
cable type 15	-10 ... +85 °C	+10 ... +85 °C	+10 ... +85 °C	+10 ... +85 °C
cable type 18	-40 ... +85 °C	- 40 ... +85 °C	-40 ... +85 °C	-40 ... +85 °C
Temperature drift	0.05%/K/MB	0.05%/K/MB	0.05%/K/MB	0.05%/K/MB
Pressure range	100 bar	100 bar <sup>1)</sup> 2 bar <sup>2)</sup>	40 bar	40 bar
Degree of protection sensor/connector <sup>3)</sup>	IP67	IP67	IP67	IP67

\* MBE - of final value

\*\* MW - measured value

\*\*\* MB - measuring range

\*\*\*\* Please enquire.

<sup>1)</sup> stainless steel

<sup>2)</sup> aluminium

<sup>3)</sup> with mating connector

**8.5.3 FC01 with turbine-type sensor**

**Flow rate measurement:**

Medium:	air	water
Measuring range:	1 ... 20 m/s	0.1 ... 5 m/s
Accuracy:	$\pm 1\%$ MBE * $\pm 3\%$ MW **	$\pm 1\%$ MBE * $\pm 3\%$ MW **
Repeatability: (5% MBE to 100% MBE)	0.5 % MW **	0.5 % MW **

\* MBE - of final value

\*\* MW - measured value

**8.5.4 Turbine-type sensor for FC01/Selector chart**

Turbine-type sensor	TST-HM2	TST-AM1	TST-WM1
Medium:			
air	x	x	
water	x		x

**8.5.5 Electronic control unit FC01**

Temperature drift: 0.1 %/K/MBE \*

Heating up period until full accuracy is reached: 15 min.



## 8.6 Sensor interface

### 8.6.1 Electrical data of the terminal for calorimetric monitoring heads

Terminal	Mnemonics	Data
XSK1	R(HEIZ)-LO	Function: terminal for negative pole of heater element Drain output of heating current control Max. sink current: $I_{\text{sink}} = 88 \text{ mA}$ Dielectric strength: $-0.5 \text{ V} \dots +20 \text{ V DC}$
XSK2	R(HEIZ)-HI	Function: terminal for positive pole of heater element Hi-potential of heater source Output voltage range (load dependent) $U_a = 21 \text{ V} \dots 24 \text{ V DC}$ Max. current output: $I_{\text{max}} = 100 \text{ mA}$ Not short-circuit proof
XSK3	R(Tref)-HI	Function: terminal for positive RTD * pole for medium temperature measurement Input resistance: $> 1 \text{ G}\Omega$ Dielectric strength: $-17 \text{ V} \dots +30 \text{ V DC}$
XSK4	R(Tref)-LO	Function: terminal for negative RTD * pole for medium temperature measurement Input resistance: $> 1 \text{ G}\Omega$ Dielectric strength: $-17 \text{ V} \dots +30 \text{ V DC}$
XSK5	AGND	Function: analogue ground Reference potential of excitation current source for RTD * operation
XSK6	IS	Function: output of excitation current source for RTD * operation Excitation current: $1 \text{ mA} \pm 1\%$ Admissible load range: $R_{\text{load}} = 0 \dots 2 \text{ k}\Omega$ Dielectric strength: $\pm 15 \text{ V DC}$
XSK7 XSK8	SGND	Function: shield ground Terminals for sensor cable shielding
XSK9	R(Tdiff)-LO	Function: terminal for negative pole of the heated RTD * Input resistance: $> 1 \text{ G}\Omega$ Dielectric strength: $-17 \text{ V} \dots +30 \text{ V DC}$
XSK10	R(Tdiff)-HI	Function: terminal for positive pole of the heated RTD * Input resistance: $> 1 \text{ G}\Omega$ Dielectric strength: $-17 \text{ V} \dots +30 \text{ V DC}$

\* RTD = **R**esistive **T**emperature **D**evice

### 8.6.2 Electrical data of the terminal for turbine-type sensor

Terminal	Mnemonics	Data
XSF1	UBFR	Function: sensor supply voltage with integral amplifier Output voltage: $U_a = 5 \text{ V DC} \pm 4 \%$ Source resistance: $R_{\text{source}} = 1.3 \text{ k}\Omega$ Dielectric strength: $-7.5 \text{ V} \dots +17.5 \text{ V DC}$
XSF2	FRIN	Function: terminal for sensor output signal Max. admissible signal level: $-0.5 \text{ V} \dots +5.5 \text{ V}$ Min. required signal level: $\pm 20 \text{ mV}$ Max. admissible signal frequency: $f_{\text{max}} = 4 \text{ kHz}$ Input resistance: $> 200 \text{ k}\Omega$ Dielectric strength: $-5 \text{ V} \dots +10 \text{ V DC}$
XSF3	SGND	Function: shield-ground Terminal for turbine-type sensor cable shield
XSF4	DGND	Function: digital-ground Reference potential for turbine-type sensor voltage supply and output signal

## 9 Accessories

No.	Accessory	Ordering configuration
1	Surface mounted housing	FC01-FH
2	Front mounted housing	FC01-ST
3	Connecting cable for calorimetric monitoring head cable type LifYCY 4 x 2 x 0.2 mm <sup>2</sup> - type 15 / -10 °C ...+80 °C highly flexible/paired - type 18 / -60 °C ... +200 °C non-halogenous/highly flexible/paired	Do+Ka
4	Connecting cable for turbine-type sensor cable type: LifYCY 3 x 0.35 mm <sup>2</sup>	Do+Ka Typ 16-
5	Calorimetric monitoring heads	CST /CSF
6	Turbine-type sensors	TST
7	Sensor adapter (screw-in or welding type)	TP
8	Ball valve	BV
9	Locking set 01 (for monitoring head CSF-11)	0Z122Z000204

**Appendix 1: Performance of the digital and analogue outputs during the operating and error modes**

Duty-/ Error status	LIMIT SWITCH 1	LIMIT SWITCH 2	NO ERROR	NOT BUSY and FREQUENCY OUTPUT	ANA OUT FLOW	ANA OUT TEMP.
Start-up (reset)	ON	ON	ON	ON	MAX	MAX
Start-up test active	OFF	OFF	OFF	OFF	MIN	MIN
Error No. 1	OFF	OFF	OFF	OFF	MIN	MIN
Error No. 2	OFF	OFF	OFF	OFF	MIN	MIN
Error No. 3	OFF	OFF	OFF	OFF	MIN	MIN
Error No. 4	OFF	OFF	OFF	OFF	MIN	MIN
Error No. 5	OFF	OFF	OFF	OFF	MIN	MIN
Heating period active	OFF	OFF	ON	OFF	MIN	MIN
<b>Normal duty</b>	<b>X</b>	<b>X</b>	<b>ON</b>	<b>ON</b>	<b>X</b>	<b>X</b>
Configuration active	OFF	OFF	ON	OFF	MIN	MIN
Parameter selection active	OFF	OFF	ON	OFF	MIN	MIN
Error No. 10	OFF	OFF	OFF	OFF	MIN	MIN
Error No. 20	X	X	OFF	ON	X	X
Error No. 21	OFF	OFF	OFF	OFF	MIN	MIN
Error No. 30	X	X	OFF	ON	X	X
Error No. 60 *	X	X	OFF	FA	X	X
Error No. 40	X	X	Y	ON	X	X
Error No. 41	X	X	Y	ON	X	X

X = standard performance

Y = OFF pulse

FA = frequency output 10 Hz

\* When frequency output has been selected.

Note: The occurrence of error No. 40/41 will always cause an internal reset.

Status of the outputs prior to the error or status described see start-up (reset)

## 2 Menu structure of the FC01 (operator dialog)

