FLOW GMBH
vision

Flow Meter | **FC100-LQ**
USER MANUAL

M_FC100-LQ_1121_e

Important:
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. All dimensions are for reference only. In the interest of improved design, performance and cost-effectiveness the right to make changes in these specifications without notice is reserved. Errors and omissions excepted.

The instructions cover firmware version 1.00.

Equipment installation, connection and adjustment by qualified personnel only!

Table of Contents

1 Description

Flow Meter FC100-LQ is designed to detect flow speed, volume flow and 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 FC100-LQ 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.

A RS232 interface enables communication with the FC100-LQ.

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 Meter FC100-LQ 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 ϑ_M whilst heater resistor RH heats element RS to temperature ϑ_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 in the event of a sudden complete flow stoppage.
- Medium temperature measurement, providing optimal temperature compensation.
- Increased safety because the sensor cannot be overheated during flow standstill.

The average flow velocity is determined by mass flow.

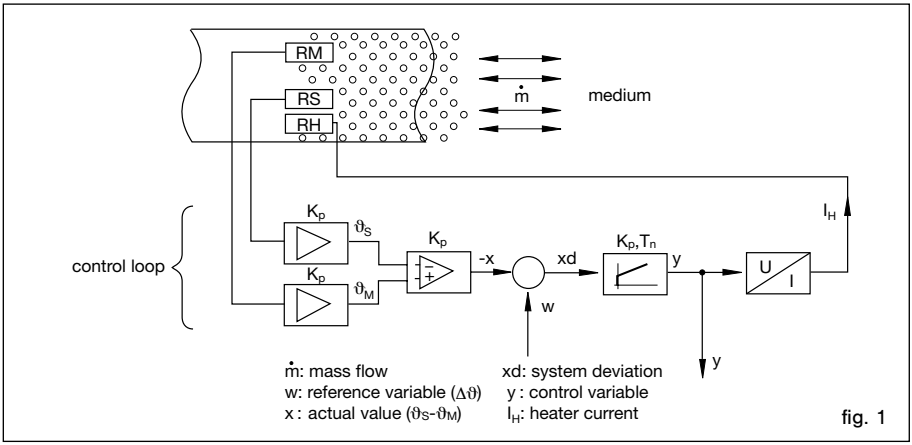


fig. 1

1.2 System description

The system comprises the following hardware functional modules:

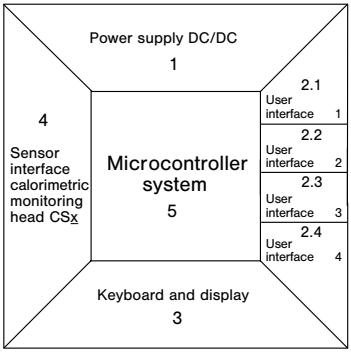
1 Input voltage: DC supply (terminal XV)

2 User interfaces: 2.1 signal outputs, 2-way or 4-way signal outputs (terminal XAH)
2.2 analogue outputs (terminal XAO)
2.3 RS232 interface (terminal XSE)
2.4 external totalizer reset (terminal XRE)

3 Keyboard and display: keypads
LC display

4 Sensor interface: calorimetric monitoring head type CSx (terminal XSK)

5 Microcontroller system: signal processing, communication and monitoring



1	Input voltage:	DC 10 ... 40 V	
2.1	User interface 1:	relay outputs:	2 limit values
		transistor outputs:	2 limit values + 1 error indication + 1 busy signal or pulse output (software selected)
2.2	User interface 2:	analogue outputs:	temperature and flow current or voltage
2.3	User interface 3:	RS232 interface	
2.4	User interface 4:	totalizer reset:	edge controlled potential free, normally open contact or voltage pulse DC10 ... 40 V
3	Keyboard/Display:	keypads LC display 2 x 16 digits backlight (can be switched off)	
4	Sensor interface:	calorimetric monitoring head type CSx	
5	Controller system:	signal processing I/O - controlling monitoring parameter memory communication	

fig. 2

The analogue outputs and the signal outputs are galvanically isolatated from the other electronics.
The two analogue output channels are not galvanically isolated from each other.

There is no electrical isolation between power supply, controller system, sensor interface, monitoring head and RS232 interface.

The monitoring heads are connected by means of precut cables.

Cables and user interface connections are shown in chapters 2.2.2 and circuit diagrams 2.2.2.1/ 2.2.2.2.

System configuration and parameter settings can be modified by means of the keyboard if **default values** need to be changed (see chapter 5).

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** - Relay outputs (2 limit values)
   Two-channel galvanic 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 (yet within the measuring range) for each contact.
   Please see chapter 7.4.1 for electrical connection.

2. **T4** – Transistor outputs (2 limit values + 2 status outputs or 2 limit values + 1 status output + 1 pulse output)
   Four-channel galvanic isolation, transistor output (NPN) – collector/emitter freely connectable
   Channel 1: common error signal
   Channel 2: busy signal or pulse 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 (yet within the measuring range).
   Please see chapter 7.4.2 for electrical connection.

Analogue outputs: **Galvanic 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 chapter 5)
Shield connections are ungrounded.

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

Power supply: DC 10 ... 40 V
Internal switched mode power supply without galvanic isolation of the primary and secondary side. The secondary side is short-circuit proof. There is a fuse on the primary side which can only be replaced by FlowVision.

Noise emission is limited by appropriate circuit design and filters.
Pin XV1 (shield) is internally connected with Pin XV3 ($-U_V$).
The housing is connected to shield potential.

Please see chapter 7.2 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 2.4610 is a material with a chemical resistance generally exceeding that of stainless steel. It is particularly suitable for alkaline media (pH > 7). It should however be examined for suitability for each specific application using resistance tables and empirical values.

2.1.2 Mechanical installation

2.1.2.1 Insertion head CSP for sensor adapter TP-..

Application: general industry and installation

Style: insertion-type for sensor adapter TP-... and ball valve

Installation: sensor adapter TP-.. (fig. 4)
ball valve BV-.. (fig. 5)

Material of the area exposed to medium: stainless steel 1.4571/AISI 316 Ti, electropolished

O ring viton

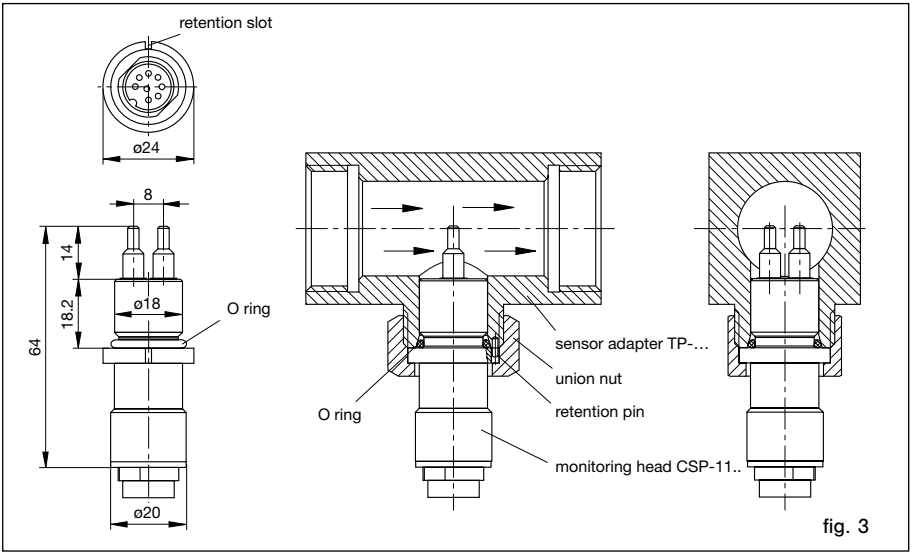


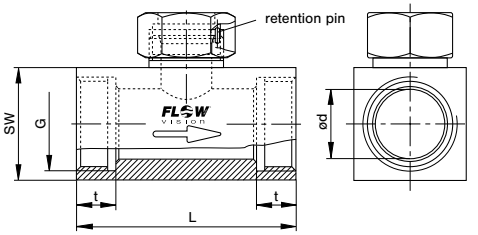
fig. 3

2.1.2.2 Sensor adapter TP-..

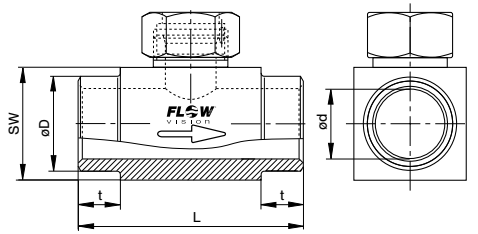
The sensor adapter TP-.. is available in 6 pipe diameters from 1/2“ to 2“.

Material of the area exposed to medium:

- brass or
- stainless steel 1.4571/AISI 316 Ti or
- red brass (only TP03)



Type	DN	ød	G	t	L	SW
TP-01 ...	15	16	1/2"	11	50	27
TP-02 ...	20	20	3/4"	12	64	32
TP-03 ...	25	25	1"	14	78	40
TP-04 ...	32	32	1 1/4"	15	94	50
TP-05 ...	40	40	1 1/2"	15	110	55
TP-06 ...	50	50	2"	19	138	70

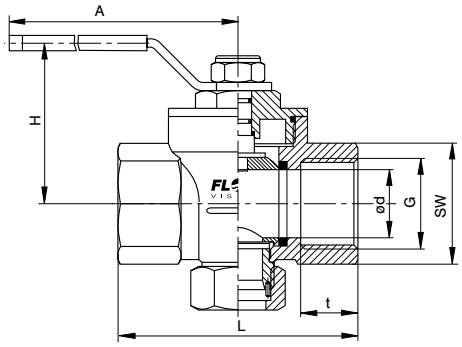


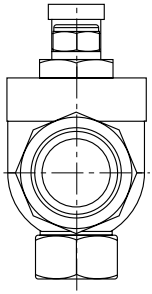
Type	DN	ød	øD	t	L	SW
TP-01M1-S A	15	16	21.3	15	50	27
TP-02M1-S A	20	20	26.9	15	70	32
TP-03M1-S A	25	25	33.7	15	80	40
TP-04M1-S A	32	32	42.4	15	100	50
TP-05M1-S A	40	40	48.3	15	110	55
TP-06M1-S A	50	50	60.3	15	140	70

fig. 4

2.1.2.3 Ball valve

The ball valve is available in 4 nominal diameters from 1“ to 2“.
The ball valve ensures the sensors are fully immersed in the medium.
The monitoring head may also be replaced in pressurised pipe systems on duty.





Typ	DN	ød	G	t	L	SW	H	A
BV-03M 3	25	25	1"	21	88	41	59	115
BV-04M 3	32	32	1 1/4"	24	100	50	65	115
BV-05M 3	40	40	1 1/2"	24	110	54	77	150
BV-06M 3	50	50	2"	28	131	70	85	150

fig. 5

2.1.2.4 Push-in monitoring head CSF-11

Application: pipelines with inside pipe diameter > 50 mm

Medium: water

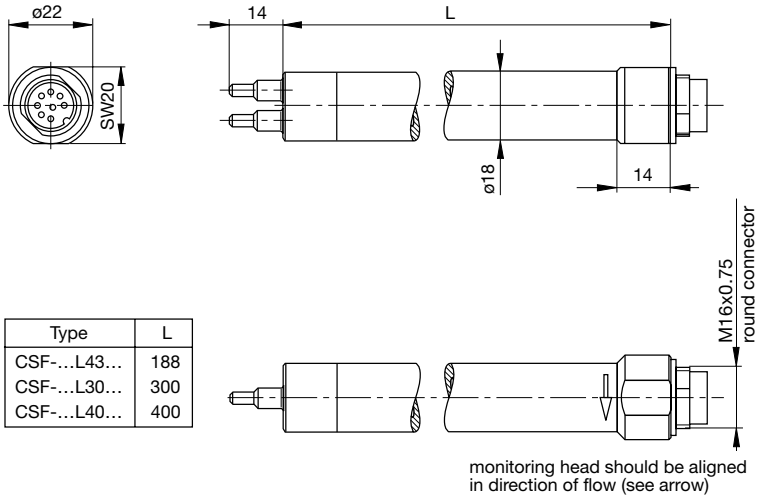
Style: smooth shank, 18 mm dia., immersion depth adjustable within the PG16 cable gland (accessory) or mounting in the stainless steel cutting ring gland

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. 7)
- threaded installation bush stainless steel 316 (cutting ring) (see fig. 7)



Type	L
CSF-…L43…	188
CSF-…L30…	300
CSF-…L40…	400

All dimensions in mm

fig. 6

2.1.3 Mounting instructions for push-in monitoring head CSF-11

Caution!

The two sensors (M) should be 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 shoulder of the sensor (7 mm from the tip) must be at the position 1/8 of the inside pipe diameter Ø i.

- 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 (see fig. 9).
- When installing the monitoring head, please observe that the arrow corresponds to the flow direction.

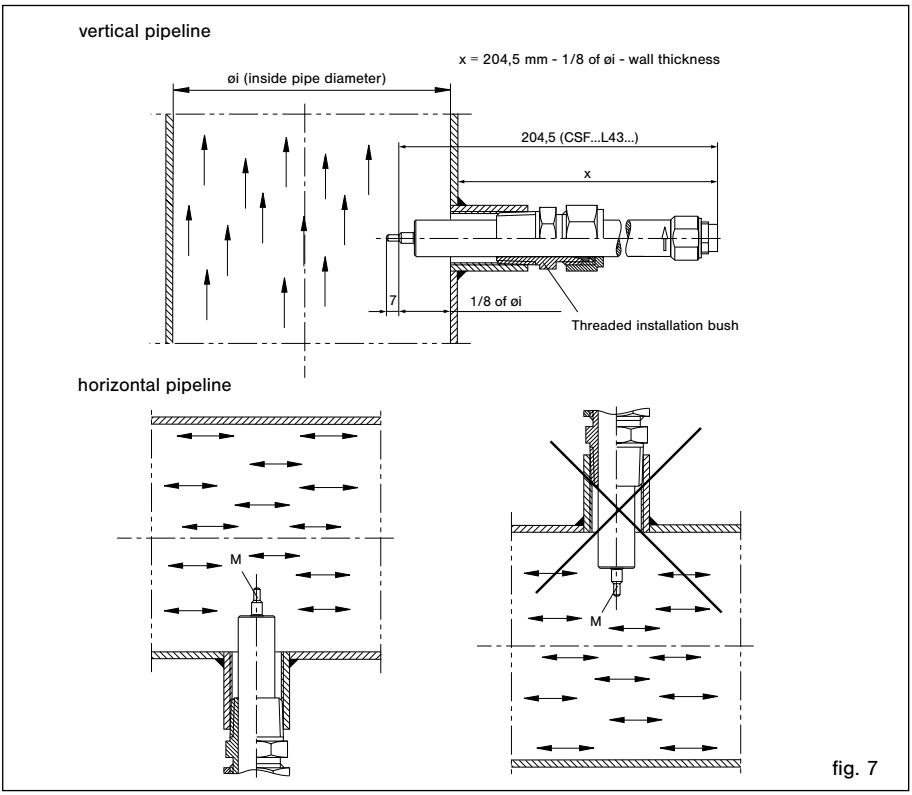


fig. 7

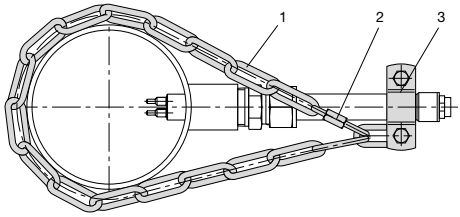
- Fit monitoring head with locking set as follows (fig. 8):
- Fix first link of chain (1) into the clip (3) (tightening torque 10 Nm).
- Put chain catch (2) into link and fasten with the tight chain.

Caution!

Check locking system with regard to strength!

The locking chain must be mounted as tightly as possible…

Locking set 01



1 chain 4 x 32 DIN 5685 (approx. 1 m)
2 catch for chain NG 5
3 clip with screws and nuts DN15 to DIN 11850 (tightening torque 10 Nm)

fig. 8

2.1.4 Minimum distances before and after the monitorung head (VDI 1952)

- minimum distance before the monitoring head — 20 x D (D = nominal pipe diameter)
- minimum distance after the monitoring head — 5 x D

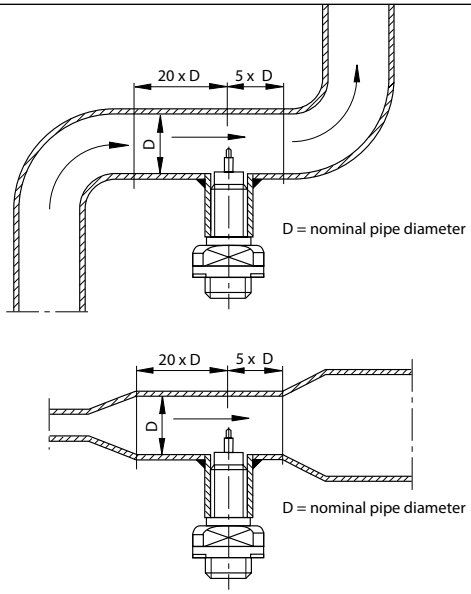
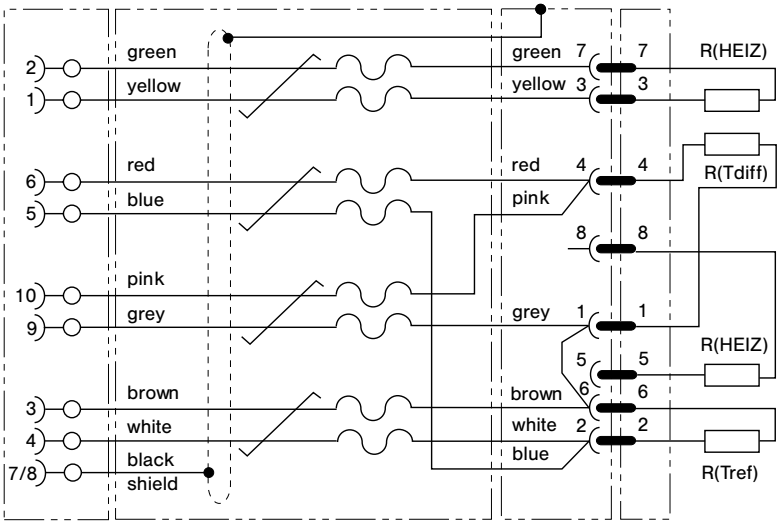


fig. 9

2.1.5 Electrical connection

Cable Do + Ka type 15/18



XSK	cable	circular plug	flange plug
FC100-LQ	Kabel-Union LifYCY 4 x 2 x 0,2 mm² or equivalent cable	X221 368 01	X221 369 01 monitoring head

fig. 10

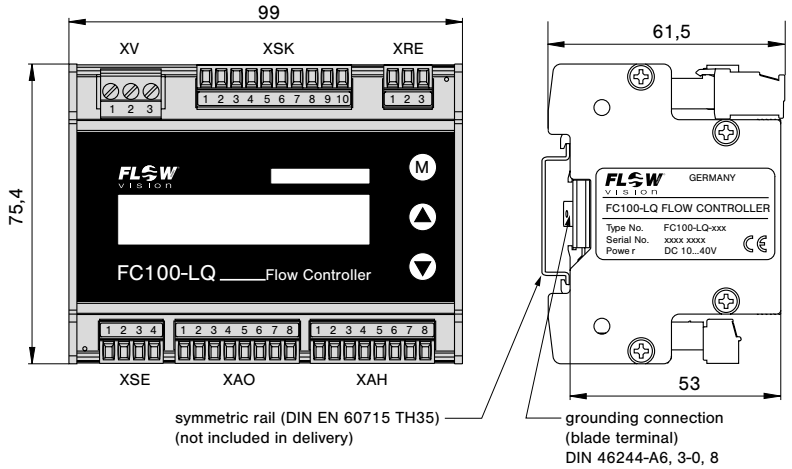
2.2 Installation of electronic control unit FC100-LQ

2.2.1 Mechanical installation

2.2.1.1 Rail-mounted version FC100-LQ-U1...

- The electronic housing is mounted on a symmetric (35mm) rail to DIN EN 60715 TH 35 (formerly EN 50022).
- There is no need for space between several modules.
- Removal is by releasing the spring catch.

FC100-LQ (rail mounted version)



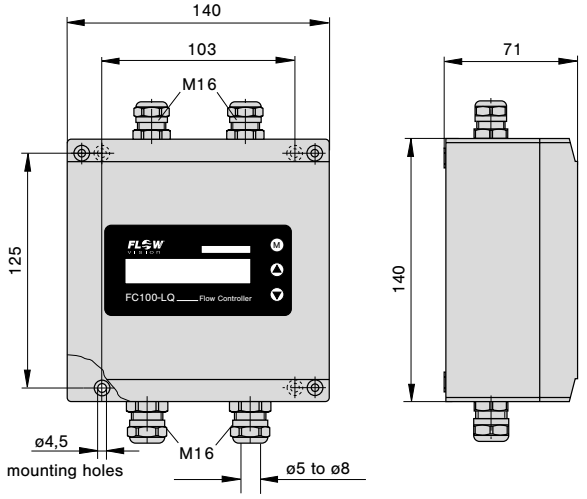
All dimensions in mm

fig. 11

2.2.1.2 Surface mounted version FC100-FH-LQ-U1...

- Remove the cover of the housing.
- Install the housing in place using the 4 screws M4.
- Replace the cover and tighten the retaining screws.

FC100-FH-LQ (surface mounted version)



All dimensions in mm

fig. 12

2.2.2 Electrical connection

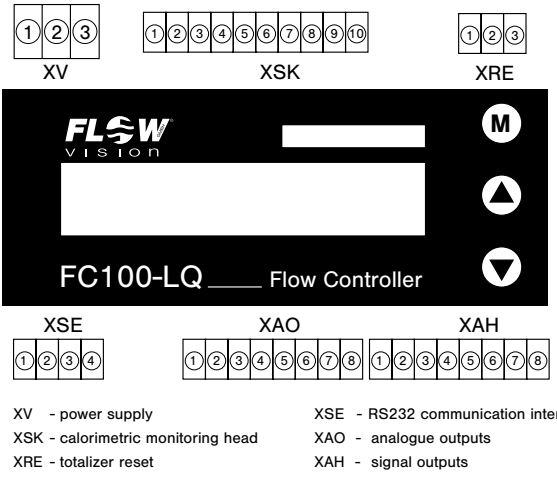
Valid for all plug-in screw terminal strips (XV, XSK, XRE, XSE, XAO, XAH):

Cable size: 0.14 mm^2 to 1.5 mm^2, single or finely stranded conductor

XV – Power supply

Connection: 3 pole plug-in screw terminal strip

Pin No.	Signal name	Function
1	SGND	general reference ground/shield ground
2	$+U_V$	positive pole of supply voltage
3	$-U_V$	negative pole of supply voltage



XV - power supply
XSK - calorimetric monitoring head
XRE - totalizer reset
XSE - RS232 communication interface
XAO - analogue outputs
XAH - signal outputs

fig. 13

XAO - Analogue outputs (option: V1, V2, C1)

Connection: 8 pole plug-in screw terminal strip

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 connection for analogue output 1 (ungrounded) *
5	SGNDA2	shield connection for analogue output 2 (ungrounded) *
6	ANAO2	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: 8 pole plug-in screw terminal strip

Pin No.	Signal name	Function
1	SGNDL1	shield ground 1
2	LIM1	non-inverted signal output 1 (N.O.)
3	LIM1COM	common 1
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
8	/LIM2	inverted signal output 2 (N.C.)

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

Connection: 8 pole plug-in screw terminal strip

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

XSK - Connection of calorimetric monitoring heads type CSx

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

XSE - Communication interface RS232

Connection: 4 pole plug-in screw terminal strip

Pin No.	Signal name	Function
1	TXD	RS232 transmitter
2	RXD	RS232 receiver
3	GND	ground
4	SGND	shield ground

XRE - external totalizer reset

Connection: 3 pole plug-in screw terminal strip

Examples of connection: see fig. 18 and 19

2.2.2.1 Circuit diagram FC100-LQ (relay outputs)

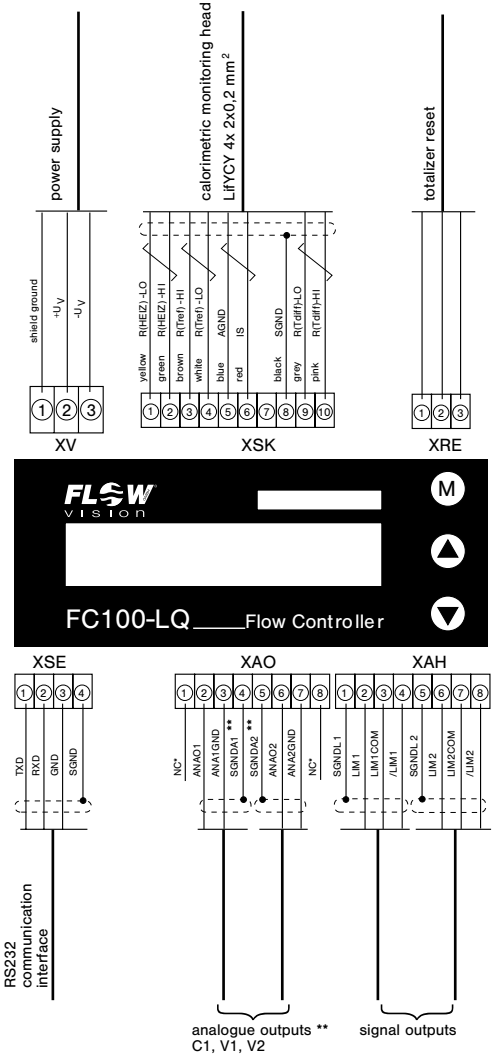


fig. 14

2.2.2.2 Circuit diagram FC100-LQ (transistor outputs (NPN))

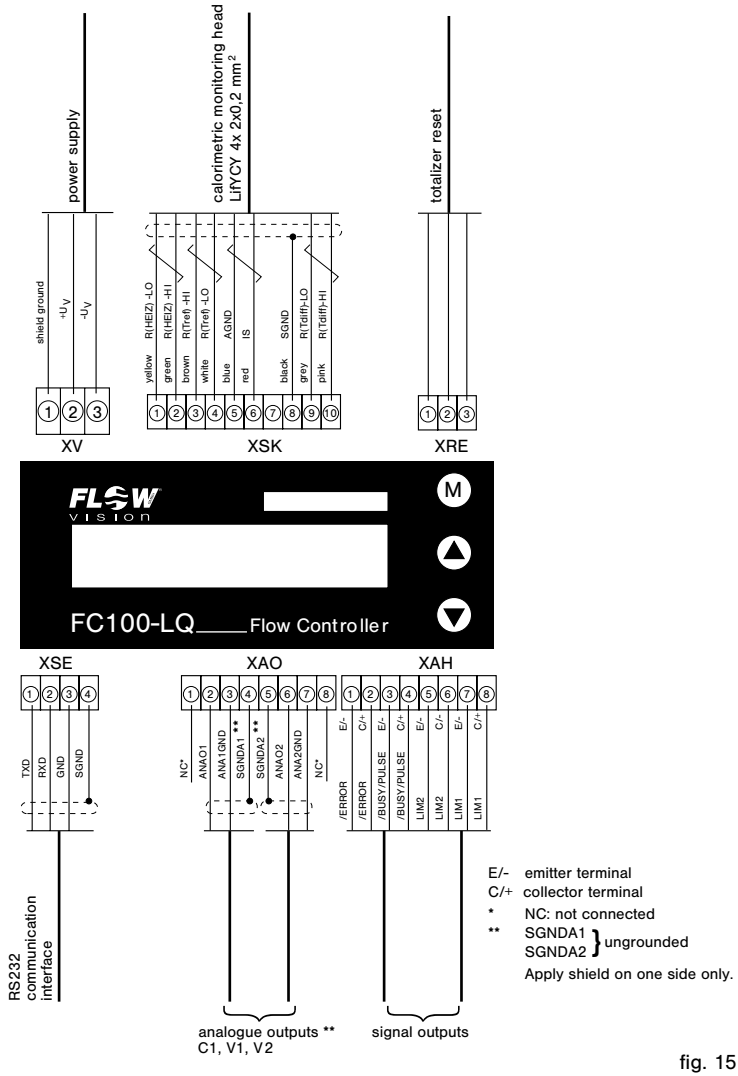


fig. 15

2.2.2.3 Electrical connection - pulse output (version FC100-LQ-…T4…)

The quantity-dependent pulse may be selected in the menu item “USER OUTPUTS” (see chapter 5). 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. 15 - circuit diagram FC100-LQ - 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 (±1%) continuously.

Select cable size ≤1.5 mm^2 to make the connections.

Electronic signal processing (see fig. 16)

If the frequency output of the FC100-LQ is connected to an electronic counter, computer or PLC, the load current should not exceed 10 mA to ensure low level is 0.8 V.

Typical circuit (example 1)

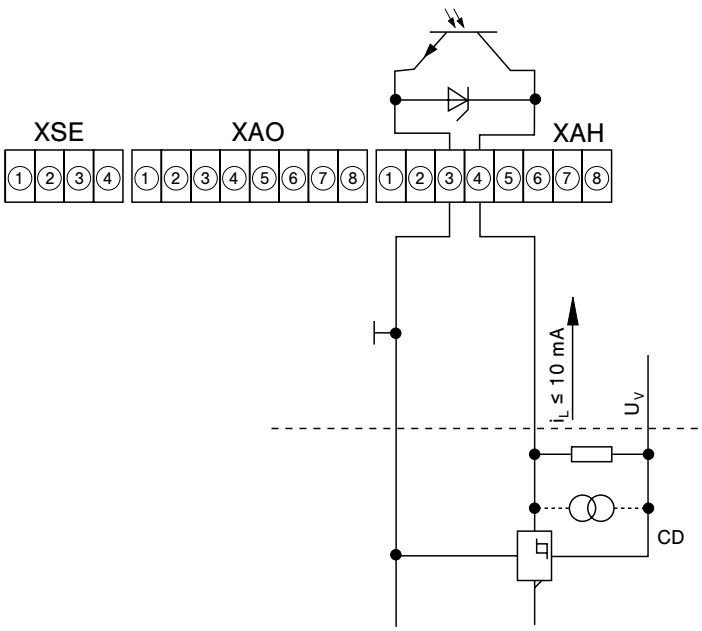


fig. 16

Electromechanical pulse counter (see fig. 17)

The FC100-LQ driver output comprises an integral safety circuit which when isolating the counter operating coil will limit overvoltages caused by inductance.

The counter should be able to process a counting frequency of **≥10 Hz** as the pulse length is 50 ms (±1%) continuously.

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

If a separate relief 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)

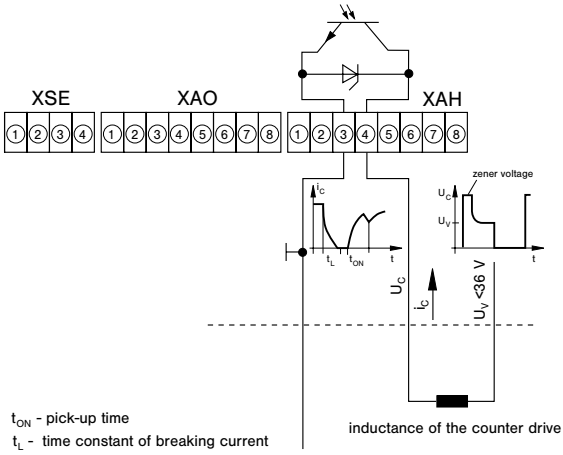


fig. 17

Note:

- As there will be a reset pulse available at the output in the moment the supply voltage of the FC100-LQ is applied, make sure that the counter is switched on delayed or set to zero after the FC100-LQ has been switched on.

2.2.2.4 Electrical connection - totalizer reset

The FC100-LQ has an external totalizer reset. The control signal is connected to plug **XRE**.

The totalizer reset is edge controlled – it is performed when the signal changes from low to high level.

There are two possible operating modes:

Operating mode 1

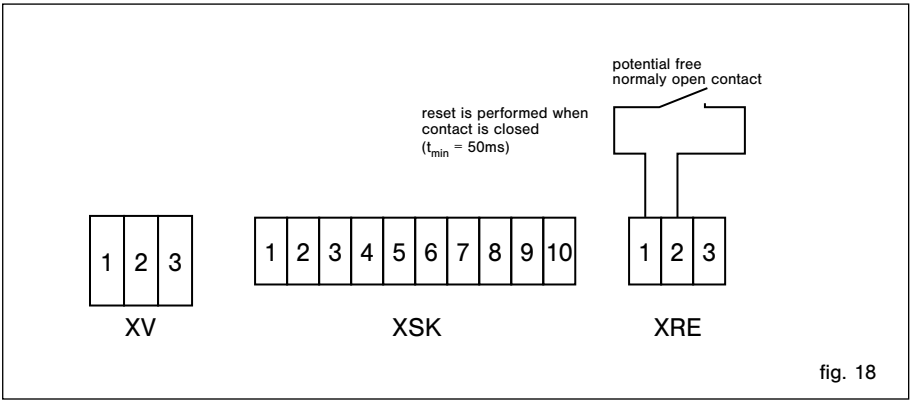


fig. 18

Operating mode 2

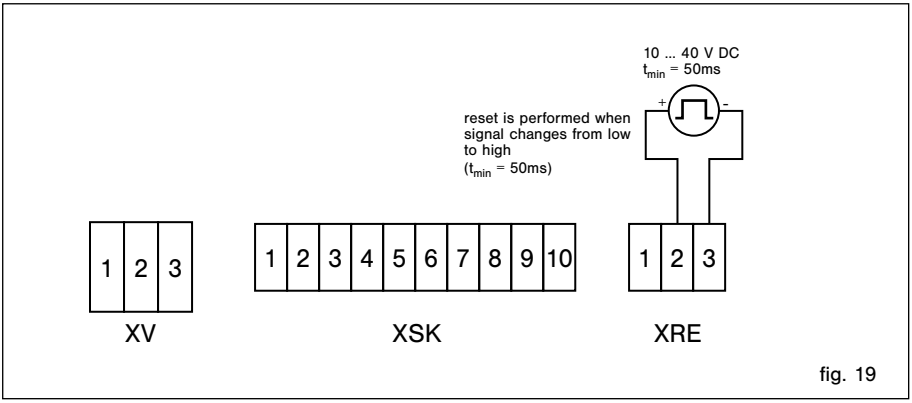


fig. 19

Note:

Pin XRE/1 is connected to pin XV2 (+U_V).

The input resistance of pin XRE/2 is 3kΩ.

Pin XRE/3 is connected to pin XV3 (-U_V).

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 FC100-LQ the optimum solution for a wide variety of measuring, monitoring and display tasks.

When programming the FC100-LQ the user is guided by plaintext in the display through menus in which you may enter or select the required functions.

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

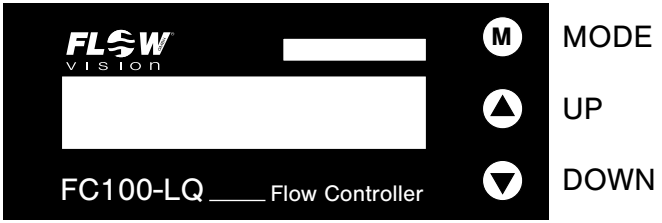


fig. 20

Menu paging

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

Calling a menu option

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

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 is pressed, the value indicated will be increased and reduced respectively, by one numeral skip.

The longer (▲) UP or (▼) DOWN is 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 FC100-LQ ON/OFF.

Deleting data

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

Keyboard lock

The keyboard can be locked by pressing (▼) DOWN for at least 10 seconds. This is possible in the entire main menu and in all submenus. Menu items which allow to set a numerical value by pressing (▲) UP and (▼) DOWN respectively are excluded (e.g. setting of measuring time).

The keyboard can be released by pressing (▲) UP for at least 10 seconds.

The actual state of the keyboard lock is stored power fail-safe.

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 **firmware version number** being indicated in the second line.

During this period, the integral controller will conduct test routines (see chapter 6.1, Test and diagnosis).

If no error was found during the test, the display will indicate **HEATING UP**. In the second line the remaining time will be displayed until the FC100-LQ will start measuring.

4.2 Measuring cycle

Upon completion of the heating up period the display will change to measuring cycle, and the user interfaces such as analogue outputs or limit switches will be updated.

Note:

- It is not possible to configure the system during the measuring operations!

All options of the main menu, the peak-value menu and the information menu may be addressed and all functions of these menus may be used without affecting the measuring and monitoring function.

Over limits of the measuring range

Theoretically established measuring values will be used when the measuring range is exceeded (> 3.0 m/s). The FC100-LQ can thus be operated beyond the measuring range up to 4.0 m/s.

Above 4.0 m/s the error message „ERROR 30“ indicates exceeding of the display range.

This feature will not affect the accuracy specified for the measuring range defined. No accuracy information can be given for conditions where the measuring range is exceeded.

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

If the measuring range is exceeded “^” will be indicated behind the measuring value on the display.

Measured value(s)
Flow velocity, medium temperature, volume flow or totalized flow rate may be shown on the display in the selected unit.

4.3 Main menu

The structure of the main menu is shown below. All menu items and submenus are described on the following pages.

4.3.1 Main menu – overview

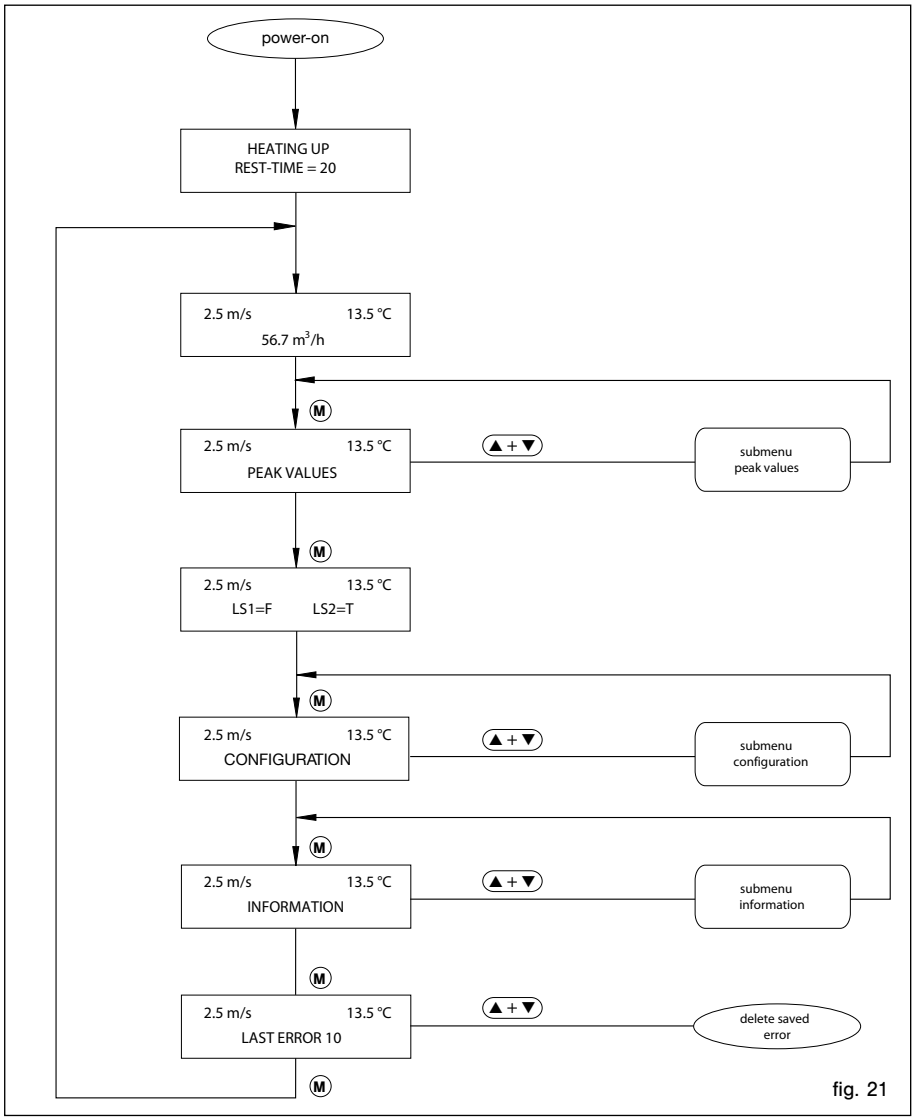


fig. 21

4.3.2 Peak values

The FC100-LQ comprises six specific measured-values memories which may be retrieved in submenu PEAK-VALUES.

They store the lowest and highest value of flow velocity, medium temperature and volume flow.

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 deleted by simultaneously pressing (▲) UP and (▼) DOWN = (▲ + ▼).

Caution!

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

MAX VALUES
flow velocity
medium temperature
volume flow

MIN VALUES
flow velocity
medium temperature
volume flow

fig. 22

4.3.2.1 Submenu PEAK-VALUES

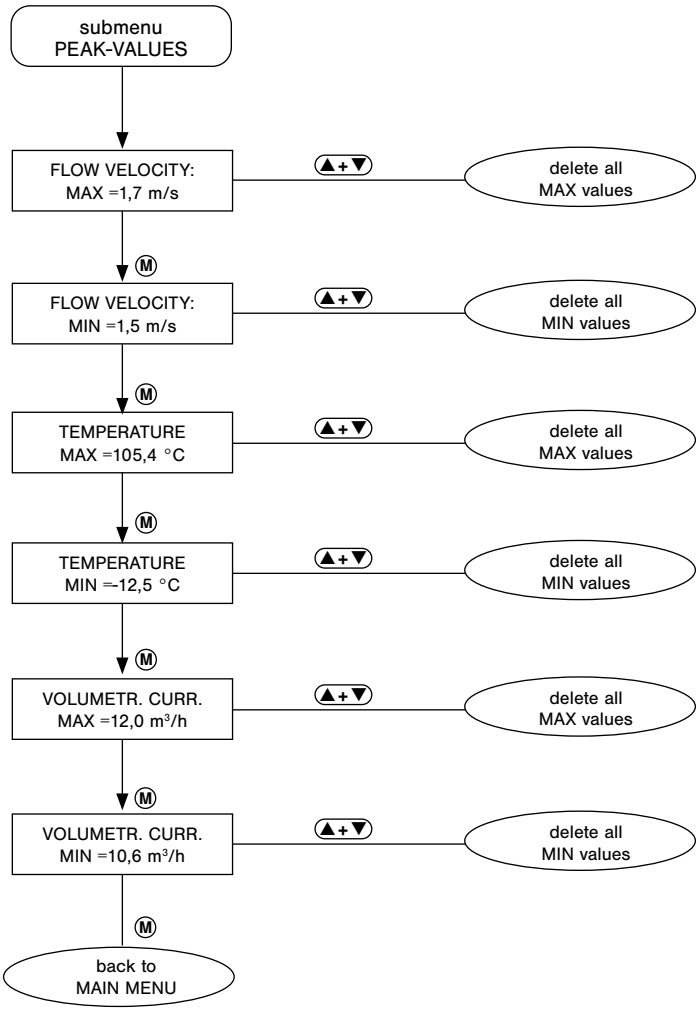


fig. 23

4.3.3 Limit switches

The next menu item shows the limit switches which are assigned to the physical quantity/quantities. **F** means the limit switch (LS) is assigned to flow velocity, **T** means the limit switch is assigned to medium temperature.

An inverse representation of **T** or **F** indicates that the limit switch is in switch-on condition.

4.3.4 Submenu CONFIGURATION

The submenu CONFIGURATION is described in chapter 5.

4.3.5 Submenu INFORMATION

The submenu INFORMATION shows the device type, the version of the firmware and the selected type of the monitoring head.

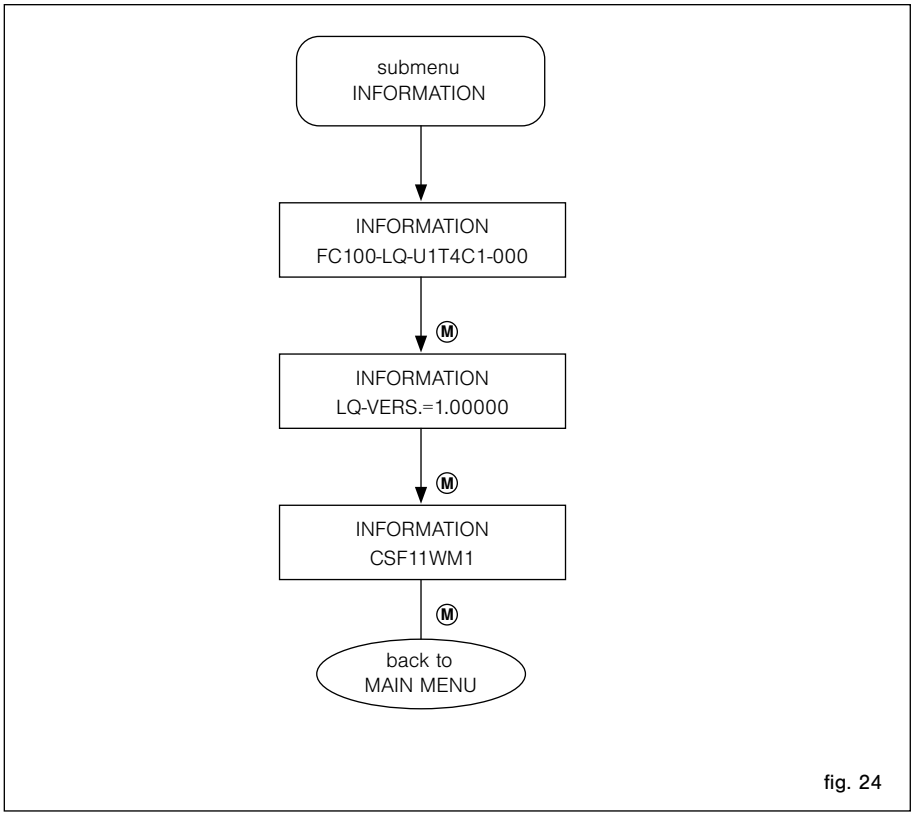


fig. 24

4.3.6 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 chapter 6.2). It may be very helpful when commissioning the FC100-LQ.

Other than the peak value memories 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 = (▲ + ▼).

5 Configuration

The CONFIGURATION submenu serves to adjust the FC100-LQ to its application. During system configuration, measuring operations are not possible (see appendix 1).

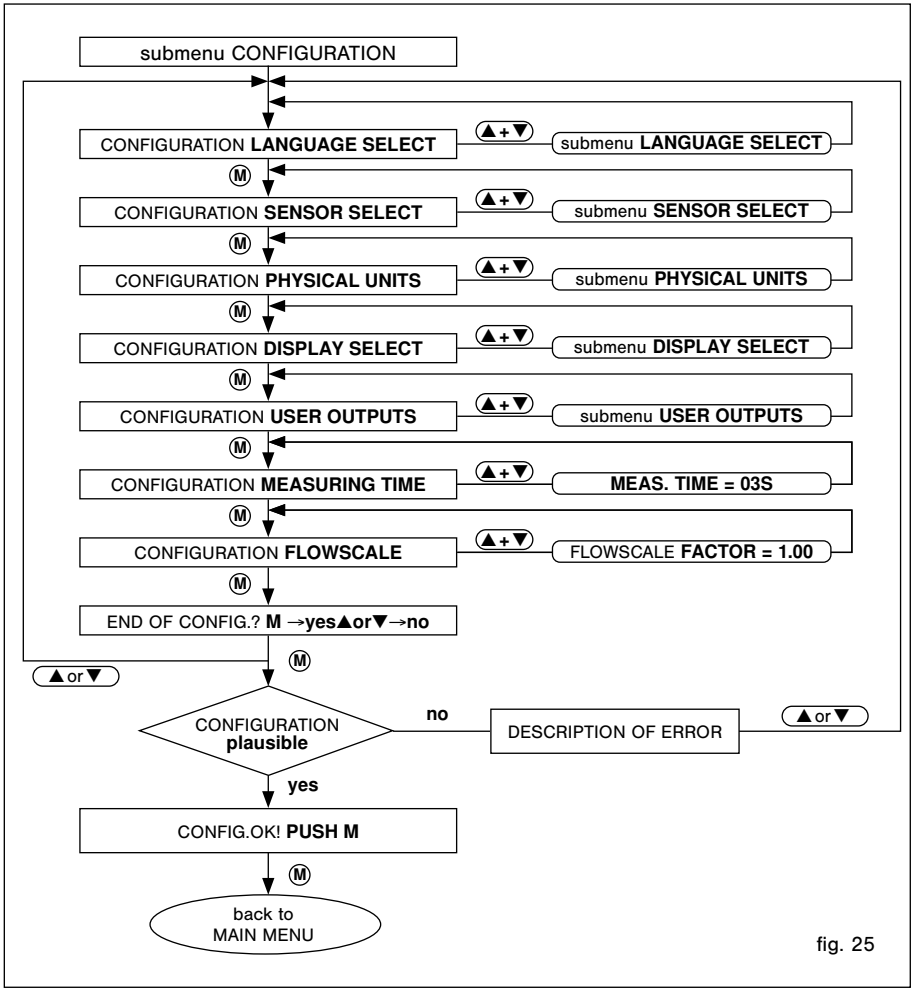


fig. 25

5.1 Language select

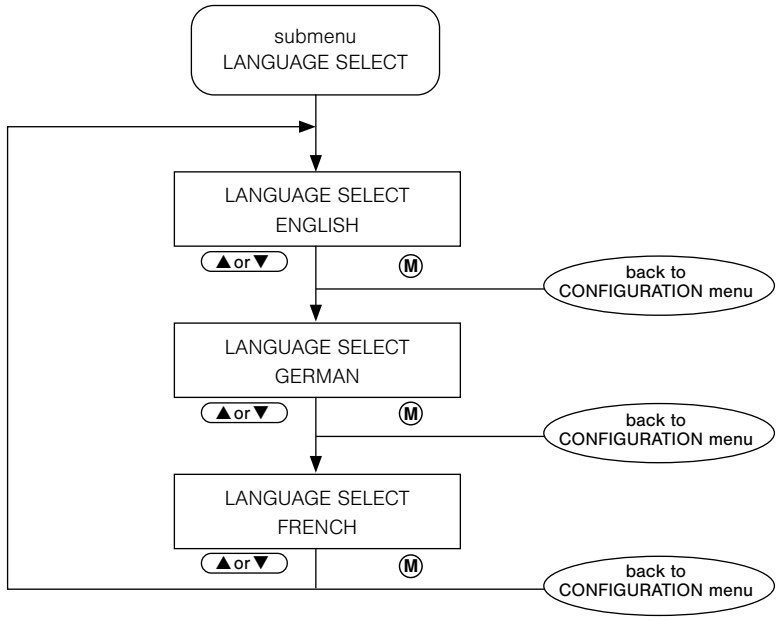


fig. 26

The menu language can be changed in this submenu. It is possible to choose ENGLISH, GERMAN or FRENCH (see fig. 27).

5.2 Sensor select

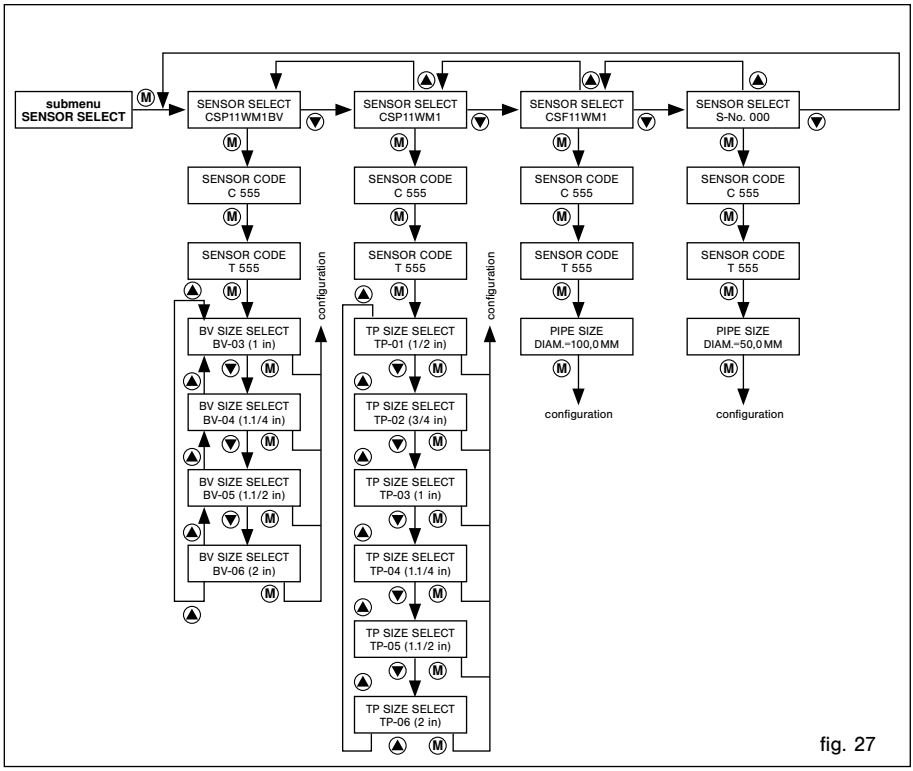


fig. 27

The sensor select menu allows the selection of the monitoring head types that can be used with the FC100-LQ.

- TYPE CSP-11WM1BV insertion head for ball valve
- TYPE CSP-11WM1 insertion head for sensor adapter TP-...
- TYPE CSF-11WM1 push-in monitoring head
- TYPE S-No. xxx custom designed monitoring head

5.2.1 Monitoring head data

To operate the FC100-LQ 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.

Monitoring head CSF: Setting is menu driven in three steps:

1. Setting of the C value — characteristics range: **700 … 1300**
2. Setting of the T value — characteristics range: **01 … 99**
3. Setting of the inside pipe diameter

Monitoring head CSP for ball valve: Setting is menu driven in three steps:

1. Setting of the C value — characteristics range: **700 … 1300**
2. Setting of the T value — characteristics range: **01 … 99**
3. Setting of the installed ball valve
   - DN25 (1 in)
   - DN32 (1 1/4 in)
   - DN40 (1 1/2 in)
   - DN50 (2 in)

Monitoring head CSP for sensor adapter TP: Setting is menu driven in three steps:

1. Setting of the C value — characteristics range: **700 … 1300**
2. Setting of the T value — characteristics range: **01 … 99**
3. Setting of the installed sensor adapter
   - TP01 (1/2 in)
   - TP04 (1 1/4 in)
   - TP02 (3/4 in)
   - TP05 (1 1/2 in)
   - TP03 (1 in)
   - TP06 (2 in)

Caution!

⚠ **Take care to repeat these settings after replacing the monitoring head or electronic module (FC100-LQ), as the accuracy of measurements is determined by the sensor code.**

5.3 Physical units

This submenu is used to select the unit of flow velocity, temperature, volume flow and the totalizer. All quantities will be indicated in the units selected. Figure 28 shows all units which can be selected.

Note:
If the totalizer unit is changed by keypad the value already counted will be converted.

5.3.1 Submenu physical units

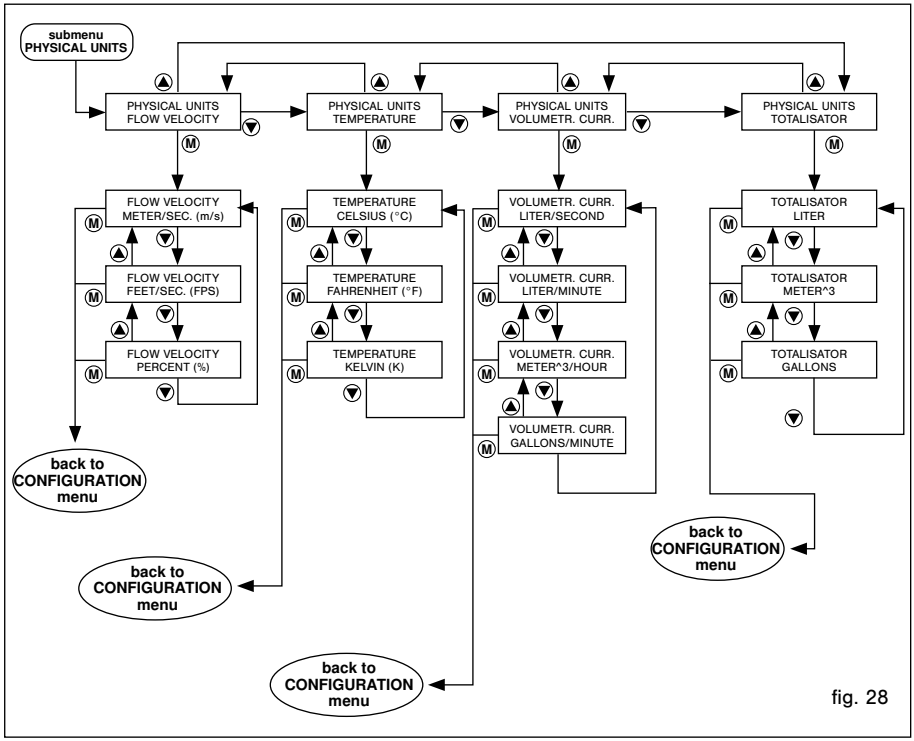


fig. 28

5.4 Display select

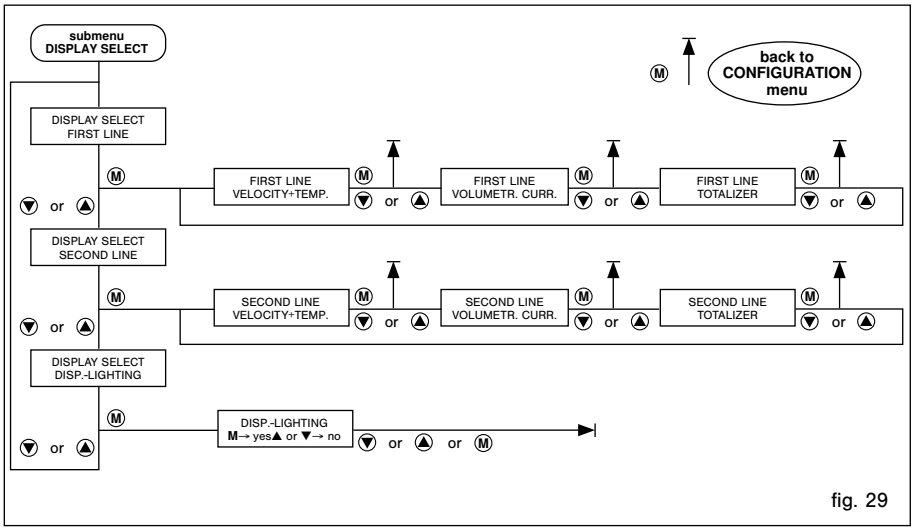


fig. 29

The FC100-LQ enables the user to define both lines of the display in certain points. It is possible to select the quantities indicated on both lines. The unit of the indicated quantities may be selected in submenu PHYSICAL UNITS.

The menu item DISPLAY-LIGHTING enables the user to choose weather the display is permanently lighted or lighting is deactivated 30 seconds after the last keystroke.

The display-lighting will also be activated if an error occures. It will be deactivated 30 seconds after the error was rectified.

5.5 User outputs

The following USER OUTPUTS may be adjusted in this submenu:

- analogue output – flow velocity
- analogue output – medium temperature
- limit switches
- pulse output (only with FC100-LQ...T4...)

5.5.1 Submenu user outputs

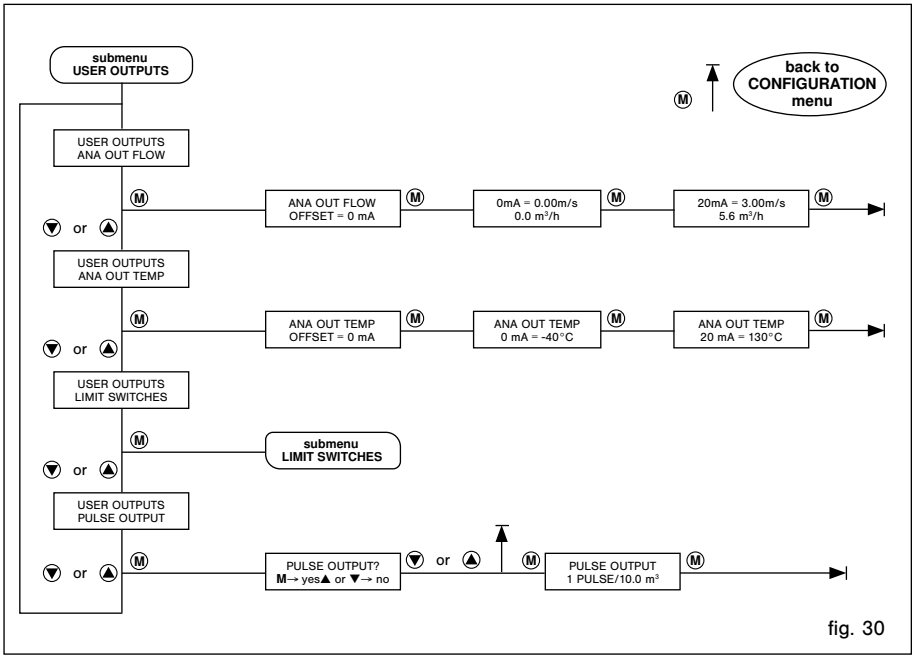


fig. 30

5.5.2 Analogue output – flow velocity

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

Options are:

- OFFSET 0/4 ... 20 mA, 0/1 ... 5 V, 0/2 ... 10 V
- INITIAL VALUE 0/20% corresponds to a flow velocity of ... [m/s] [%] [FPS]
- FINAL VALUE 100% corresponds to a flow velocity of ... [m/s] [%] [FPS]

When entering the initial and final value, the user should observe a reasonable resolution.

With a volume flow unit selected in menu PHYSICAL UNITS and when setting the initial and final values, the pertinent volume flow will also be indicated.

5.5.3 Analogue output – medium temperature

In conformance with the configuration “Analogue output – flow velocity” it is possible to adjust the medium temperature analogue output to the requirements of the entire system.

Options are:

- OFFSET 0/4 ... 20 mA, 0/1 ... 5 V, 0/2 ... 10 V
- INITIAL VALUE 0/20% corresponds to a medium temperature of ... [°C] [°F] [K]
- FINAL VALUE 100 % corresponds to a medium temperature of ... [°C] [°F] [K]

When entering the initial and final value, the user should observe a reasonable resolution.

5.6 Limit switches

The FC100-LQ 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 → T
  limit switch 1 → flow velocity
  limit switch 2 → medium temperature
- LS1 → T and LS2 → T
  limit switch 1 → medium temperature
  limit switch 2 → medium temperature
- LS1 → F and LS2 → F
  limit switch 1 → flow velocity
  limit switch 2 → flow velocity
- LS1 → T and LS2 → F
  limit switch 1 → medium temperature
  limit switch 2 → flow velocity

Mode of operation, limit value and hysteresis of the limit switches are determined by the switch-on and switch-off values of LS1 and LS2 (see chapter 5.6.1).

5.6.1 Limit switches – switch-on/switch-off value

Depending on the configuration limit values 1 and 2 may be set either for flow velocity or medium temperature.

The limit value may be set over the entire display range (-40 °C ... 130 °C | 0 m/s ... 4.0 m/s) 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

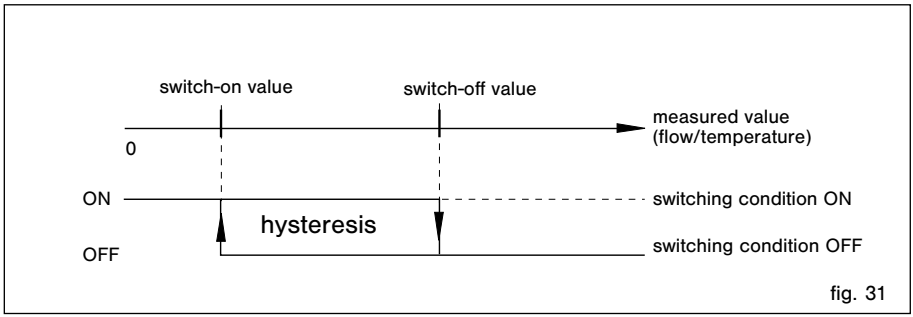


fig. 31

Example for ON:

FC100-LQ with relay outputs (option R2):

- LIM1 - LIM1COM = closed

  /LIM1 - LIM1COM = open

FC100-LQ with transistor outputs (option T4):

- LIM1E - LIM1C = switched

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

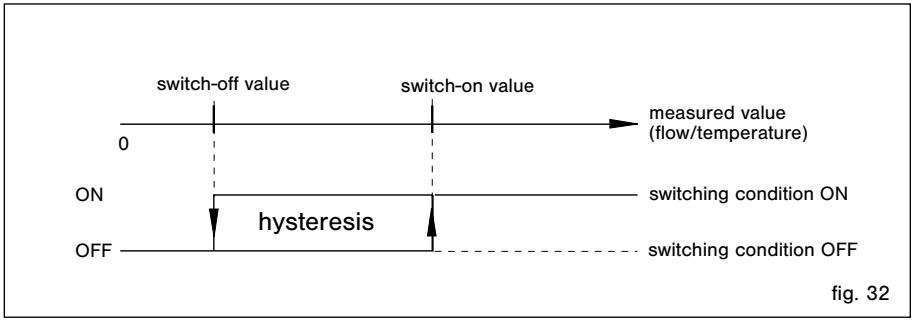


fig. 32

5.6.2 Submenu limit switches

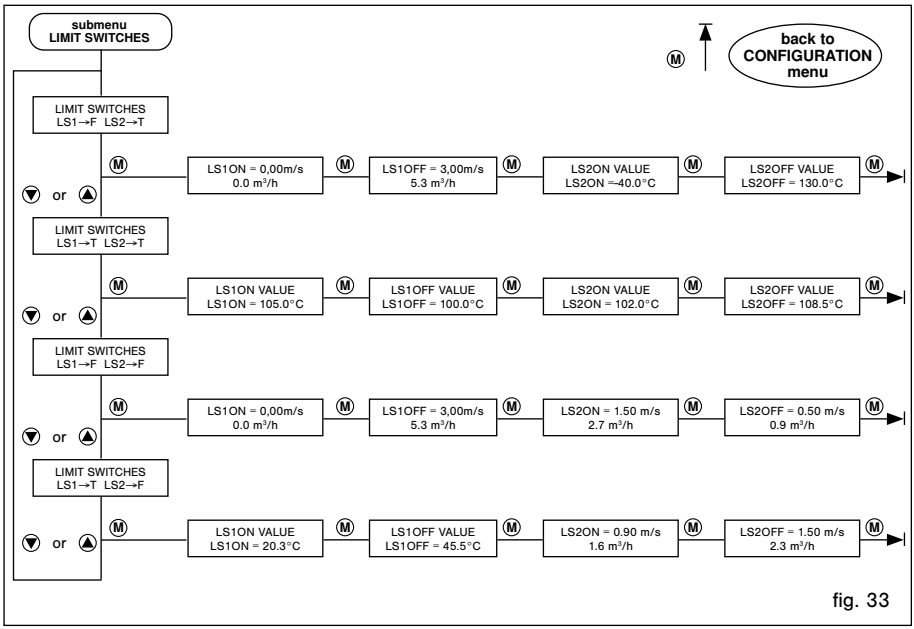


fig. 33

5.7 Pulse output for totalizer

The totalizer function of the FC100-LQ has been expanded by the output of **quantity pulses**.

The proportional quantity pulses have been determined as follow:

1 pulse/quantity (totalizer unit selected)

Example: 1 pulse/10.0 [litre]
The pulse output will supply 1 pulse per 10 litres (totalized quantity).

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

Potential setting range of the pulse output: 1 pulse per 0.1 ... 999.9 [liter], [m^3], [gallons]

Behaviour of the pulse 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 pulse output when the measurement is stopped

When the measurement is stopped (as caused by priority II error and calling the CONFIGURATION menu), the pulses for the quantity already counted will be available. Thereafter the output of pulses will be stopped, with the pulse output becoming high resistive until the measurement is restarted.

Deleting the content of the totalizer

The content of the totalizer may be deleted by simultaneously pressing ▲ UP and ▼ DOWN = (▲ + ▼) in the main menu.

5.8 Measuring time

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

The effect of the measuring time may be compared to that of a low pass 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 update.

5.9 Scaling factor (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).

5.10 Quitting the configuration menu

To quit the configuration menu, the controller will check the data entered for plausibility. "CONFIG. OK!" is indicated when the data are correct. The menu may then be quit by pressing (M) 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	→	analogue output – flow velocity flow analogue output outside measuring range
ERR. A-OUT FLOW ZERO ≥ FS	→	analogue output – flow velocity initial value ≥ final value
ERR. A-OUT TEMP. OUT OF RANGE	→	analogue output – medium temperature temperature analogue output outside measuring range
ERR. A-OUT TEMP. ZERO ≥ FS	→	analogue output – medium temperature initial value ≥ final value
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 configuration menu by pressing (▲) UP or (▼) DOWN and select the menu option with the incorrect entry for correction.

6 Errors

6.1 Test and diagnosis

The FC100-LQ 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-No. = 10).
If the FC100-LQ 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.

6.1.1 Priority group I

Priority group I comprises the switch-on test routines (FC100-LQ 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 key.

If even after several trials the switch-on test cannot be carried out 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!

6.1.2 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.

6.1.3 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 be set and the number of the error will be shown on the display.

6.2 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 checksum of parameter memory	Return to supplier.
No. 3	Incorrect checksum of program memory	Return to supplier.
No. 4	Incorrect checksum 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; cable between FC100-LQ and sensor or sensor defective	Check cable or replace sensor.
	Sensor selected (CONFIGURATION menu) differs from sensor connected	Correct sensor selection in CONFIGURATION menu
No. 21	Medium temperature too high	

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 FC100-LQ...T4 ...

7 Technical data

7.1 Ambient conditions

	rail-mounted version	surface mounted version
Storage temperature:	-20 ... 70 °C	-20 ... 70 °C
Ambient temperature:	5 ... 50 °C	5 ... 50 °C
Degree of protection:	IP20	IP65

7.2 Electrical characteristics

DC supply

Connector pin assignment:	signal name	Pin XV
	shield	1
	$+U_V$	2
	$-U_V$	3

Caution!

⚠ **Pin XV1 (Shield) is internally connected to pin XV3 ($-U_V$).**
The housing is connected to shield potential.

Input voltage range: U_V = DC 10 ... 40V (ripple incl.)

Admissible ripple: max. 20% U_V

Max. current consumption:
I = 650mA at U_V = 10V
I = 500mA at U_V = 12V
I = 240mA at U_V = 24V
I = 150mA at U_V = 40V

7.3 Analogue outputs

The analogue outputs are galvanically isolated from the electronic control unit FC100-LQ.

Connector pin assignment for analogue outputs V1, V2 and C1:

Signal name	Pin XAO
NC	1
analogue output 1 - flow	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 - central electronic unit DC 500 V

7.3.1 Voltage output V1 - 5 V FS

Signal voltage range:	U_S = 0 V (1 V) to 5 V
Accuracy:	± 0,75 % FS
Resolution:	10 Bit (5 mV)
Min. admissible load resistance:	R_l = 1 kΩ
Max. admissible load capacity:	C_l = 1 nF
Max. admissible load inductance:	L_l = 100 nH
Short circuit proof:	yes (XAO - between all terminals)

7.3.2 Voltage output V2 - 10 V FS

Signal voltage range:	U_S = 0 V (2 V) to 10 V
Accuracy:	± 0,75 % FS
Resolution:	10 Bit (10 mV)
Min. admissible load resistance:	R_l = 2 kΩ
Max. admissible load capacity:	C_l = 1 nF
Max. admissible load inductance:	L_l = 100 nH
Short circuit proof:	yes (XAO - between all terminals)

7.3.3 Current output C1 - 20 mA FS

Signal current range:	I_S = 0 mA (4 mA) to 20 mA
Accuracy:	± 0,75 % FS
Resolution:	10 Bit (20 µA)
Min. admissible load resistance:	R_l = 0 Ω
Max. admissible load resistance:	R_l = 300 Ω

7.4 Signal outputs

The signal outputs are galvanically isolated from each other as well as from the electronic control unit FC100-LQ.

7.4.1 Relay outputs R2 (DC or AC)

Connector pin assignment:

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 x 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 φ = 0.5:	2.4 x 10^5 cycles
Insulation voltage:	signal contact - central electronic unit DC 500 V
	signal contact - signal contact DC 500 V

7.4.2 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 V at I_C < 10 mA
	U_{ce} < 1 V at I_C < 100 mA
High level - passive:	U_{ce} < 48 V
	$U_{ce\ max}$ = 60 V
	max. leakage current ≤ 25 µA
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 µF

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

7.5 Metrological data

7.5.1 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.**

7.5.1.1 Monitoring head CSP with sensor adapter TP-…

Measuring ranges:

sensor adapter Typ	measuring range in m^3/h	display range in m^3/h
TP01	0,02 ... 2,2	2,9
TP02	0,04 ... 3,4	4,5
TP03	0,05 ... 5,3	7,1
TP04	0,1 ... 8,7	11,6
TP05	0,14 ... 13,6	18,1
TP06	0,2 ... 21,2	28,3

7.5.1.2 Monitoring head CSF

Measuring ranges:
The measuring range is determined by the inside pipe diameter (see table). It can be calculated with the following equation:

$$\mathbf{Q = V_N \times A_R}$$

Q [m^3/h] - volume flow

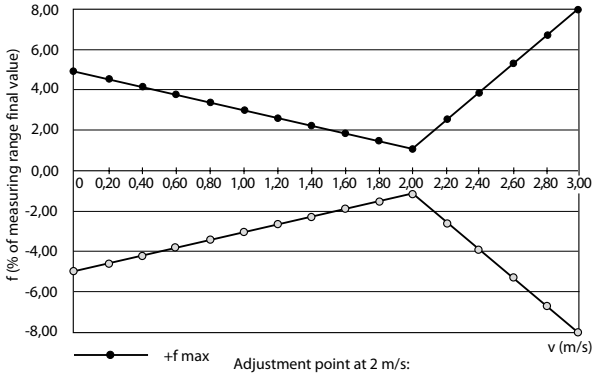
V_N [m/h] - average velocity

A_R [m^2] - inside pipe diameter

inside pipe diameter D in mm	measuring range in m^3/h	display range in m^3/h
50	21	28
80	55	70
100	85	110
150	190	250
200	340	450
250	530	700
350	1040	1380
500	2120	2830

Setting range for inside pipe diameter:	50,0 mm ... 999,9 mm
Measuring range:	0,05 ... 3 m/s
Display range:	0 ... 4 m/s
Response delay:	2,5 s
Repeatability: (5% MBE ... 100% MBE)	1% MW **
Accuracy: (see failure diagram)	±1% MBE * at 2 m/s

7.5.1.3 failure diagram for water



Adjustment point at 2 m/s:
±1% of measuring range final value
Other accuracy values or adjustment points upon request
(see also type FC01-CC).

fig. 34

7.5.2 Temperature measurement

Measuring range:	-40 ... +130 °C
Accuracy:	±1 % MB ***

7.5.3 Electronic control unit FC100-LQ

Temperature drift:	0.01 % of measuring range/°C
Warm up period until full accuracy is reached:	5 minutes

* MBE - of final value
** MW - measured value
*** MB - measuring range

7.6 Maintenance

The sensor is maintenance free for fluids that do not adhere to the sensor tips. If impurities or particles are present in the fluid and adhere to the sensor tips, this can cause incorrect measured values. In this case, the sensor tips must be cleaned at suitable intervals. When cleaning, make sure that the sensor tips are not damaged.

7.7 Sensor interface

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_{sink} = 88 mA Electric strength: -0.5 V ... +20 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 V ... 24 V DC Max. current output: I_{max} = 100 mA Not short-circuit proof
XSK3	R(Tref)-HI	Function: terminal for positive RTD * pole for medium temperature measurement Input resistance: > 1 GΩ Electric strength: -17 V ... +30 V DC
XSK4	R(Tref)-LO	Function: terminal for negative RTD * pole for medium temperature measurement Input resistance: > 1 GΩ Electric strength: -17 V ... +30 V DC
XSK5	AGND	Function: analogue ground Reference potential of current source for RTD * operation
XSK6	IS	Function: output of current source for RTD * operation Output current: 1 mA ± 1 % Admissible load range: R_{load} = 0 ... 2 kΩ Electric strength: ±15 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 GΩ Electric strength: -17 V ... +30 V DC
XSK10	R(Tdiff)-HI	Function: terminal for positive pole of the heated RTD * Input resistance: > 1 GΩ Electric strength: -17 V ... +30 V DC

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

8 Accessories

No.	Accessory	Order reference
1	Surface mounted housing	FC100-FH-LQ
2	Connecting cable for calorimetric monitoring head	
	cable type LifYCY 4 x 2 x 0.2 mm^2 - type 15 / -10 ... +80 °C highly flexible/paired	Do+Ka
	- type 18 / -60 °C ... +180 °C halogen-free/highly flexible/paired	
3	Calorimetric monitoring heads	CSP/CSF
4	Sensor adapter	TP
5	Ball valve	BV
6	Locking set 01 (for monitoring head CSF-...)	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/ PULSE OUTPUT	ANA OUT FLOW	ANA OUT TEMP
Start-up (Reset)	ON	ON	ON	ON	MIN	MIN
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/FREEZE**	MIN/FREEZE**
Normal operation	**X**	**X**	**ON**	**ON**	**X**	**X**
Configuration active	OFF	OFF	ON	OFF	FREEZE	FREEZE
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 = pulse output 10 Hz

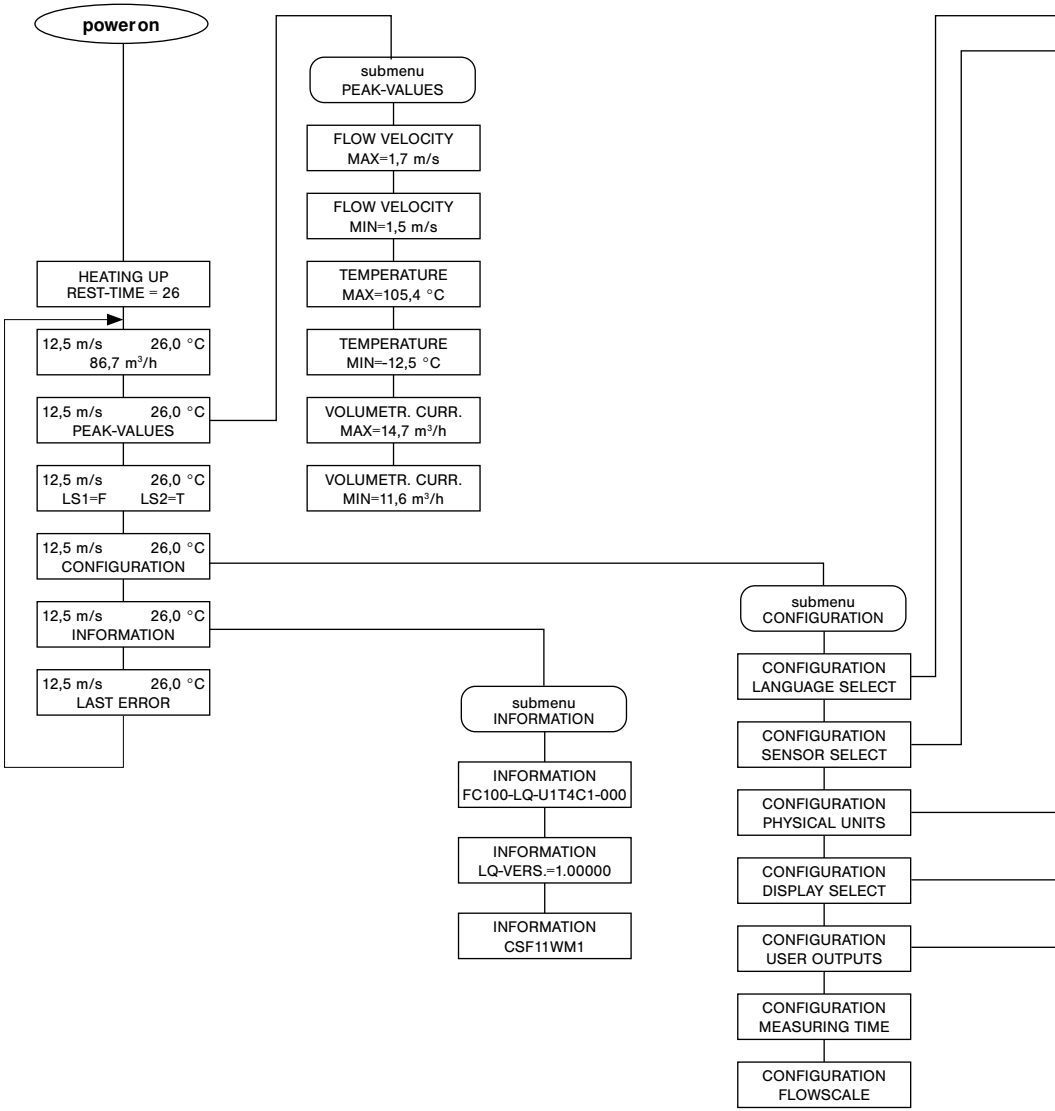
FREEZE = the last output value before error occurred will be retained

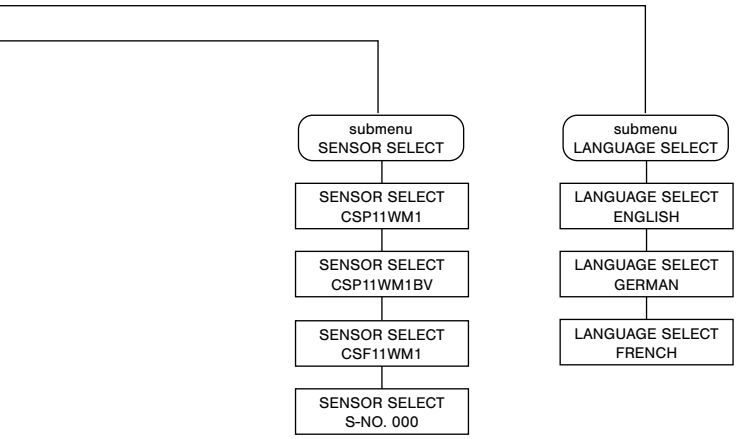
* When pulse output has been selected.

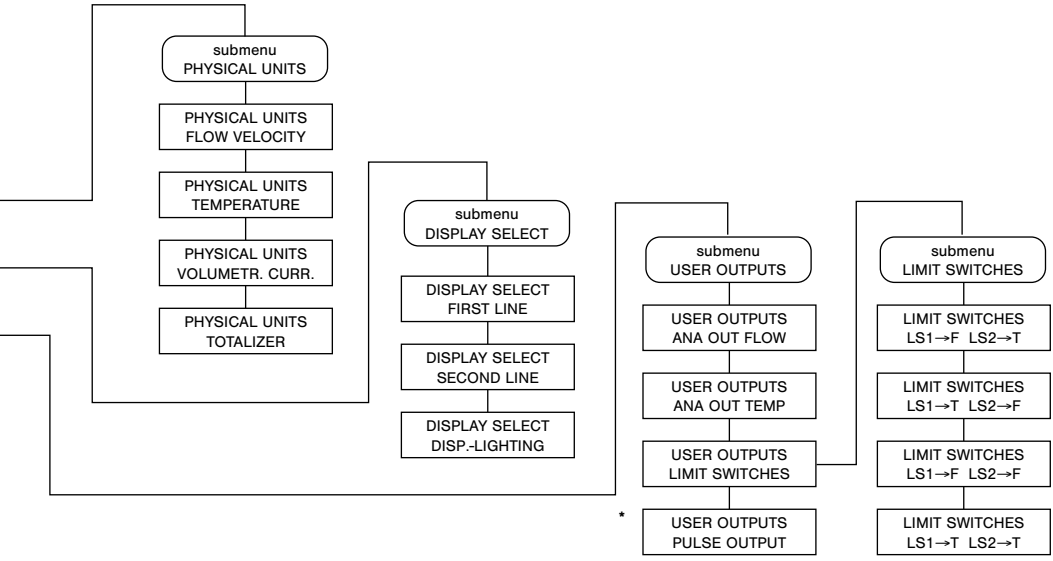
** After power-on: MIN, after quitting the configuration menu: FREEZE

Note: The occurence of error No. 40/41 will always cause an internal reset
Status of the outputs prior to the error status described
→ see start-up (reset)

Appendix 2 - Menu structure of the FC100-LQ







* Only FC100-LQ...T4...

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