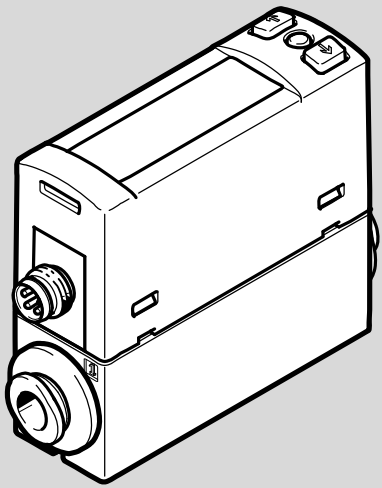
Flow sensor

SFAH



FESTO

en Description

8075046
2017-09
[8075048]

Translation of the original instructions
SFAH

Installation and commissioning must be carried out only by properly qualified personnel in accordance with these operating instructions.

Identification of hazards and instructions on how to prevent them:

Warning
Hazards that can cause death or serious injuries

Note
Dangers that can result in material damage or failure of function.

Other symbols:

Recommendations or references to additional sources of information.

English – Flow sensor SFAH

Table of contents

Note

Installation and commissioning must be carried out only by properly qualified personnel in accordance with these operating instructions.

Note

The product is suitable for use only for industrial purposes.
In residential areas, measures for radio interference suppression may be necessary. It is not suitable for commercial invoicing, such as for measurement of air consumption in public utilities.

1 About this document

This document describes the use of the above-mentioned product. Certain aspects of use are described in other documents and must be observed (➔ 1.1 Further applicable documents).

1.1 Further applicable documents

For all available product documentation ➔ www.festo.com/pk

Device description file (IODD) ➔ www.festo.com/sp

2 Safety

2.1 Intended use

The SFAH is intended for monitoring the flow of gaseous media in piping systems or terminals in the industrial sector ➔ Chapter 13 Technical data.

2.2 General safety information

- Note that if the switching status of the outputs is modified in the Edit mode, the new status will be effective immediately.
- Activate password protection in order to prevent possible severe personal injuries due to unauthorised manipulation of signal statuses ➔ Chapter 8.5 Security code.
- Only use the product in its original condition, without any unauthorised modifications.
- Only use the product if it is in an excellent technical status.
- Take the ambient conditions into consideration at the location of use.
- Do not use the product in combination with inflammable, caustic, vapour-emitting or other hazardous media.
- Check the operating medium to determine compatibility with the materials it contacts.
- Observe the specifications on the product labelling.
- Remove all transport packaging. Recycle packaging material.

Disposal
- Observe the local specifications for environmentally friendly disposal.

3 Service

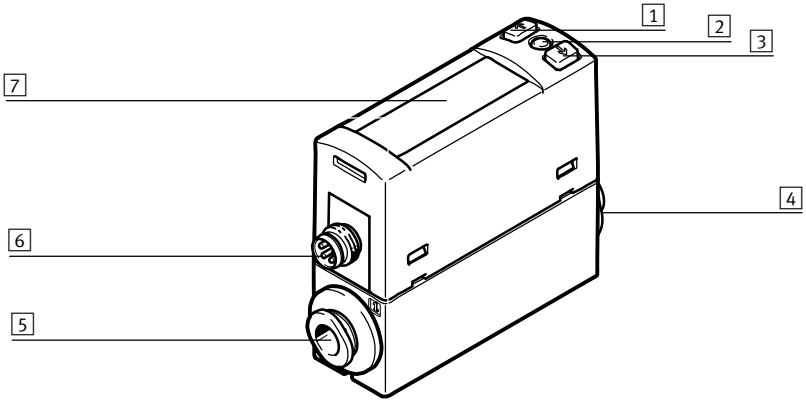
- Consult your regional Festo contact if you have any technical queries ➔ www.festo.com

4 Accessories

Accessories ➔ www.festo.com/catalogue

5 Product overview

5.1 Configuration



1 A-key
2 Edit button
3 B-key
4 Flow connection
➔ Marking on the product
5 Flow connection
➔ Marking on the product
6 Plug for electrical connection
7 Display

Fig. 1

5.2 Product variants and type code

Characteristic	Value	Description
Type	SFAH	Flow sensor
Flow measuring range	-0.1	Max. 0.1 l/min
	-0.5	Max. 0.5 l/min
	-1	Max. 1 l/min
	-5	Max. 5 l/min
	-10	Max. 10 l/min
	-50	Max. 50 l/min
	-100	Max. 100 l/min
	-200	Max. 200 l/min
Flow input	U	Unidirectional
	B	Bidirectional
Pneumatic port	-Q4	Push-in connector 4 mm
	-Q6	Push-in connector 6 mm
	-Q8	Push-in connector 8 mm
	-G18	G1/8
	-G14	G1/4
Thread type		None
	F	Female thread
Outlet orientation	S	Straight
	AR	Angled, alignable
Electrical output 1	-PNLK	PNP or NPN or IO-Link
Electrical output 2	-PNVBA	PNP or NPN or 0 ... 10 V or 1 ... 5 V or 4 ... 20 mA
Electrical connection	-L1	Plug L1
	-M8	Plug M8
Certificate		None
	+T	Test report

Tab. 1

6 Function

The SFAH measures the flow rate (standard flow rate, mass flow rate) with the help of a thermal procedure. Measurements are carried out using a micromechanical sensor element with a downstream electronic evaluation unit.
Connection to higher-level systems is provided by 2 switching outputs, an analogue output and/or an IO-Link interface. The outputs can be configured as appropriate to the application.
The switching outputs can be configured to monitor a threshold value, signal range or signal change. The outputs can be set as PNP or NPN and normally open (NO) or normally closed (NC). Through the IO-Link interface, process values can be read out and parameters changed and transmitted to additional devices. Through integration of the flow rate, a volume/load signal can be calculated and output via a pulse output as well as a cumulated measurement value via IO-Link.

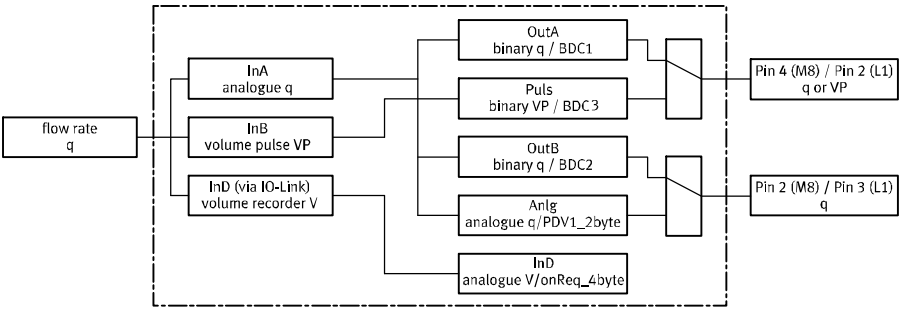


Fig. 2 SFAH signal structure

6.1 Operating statuses

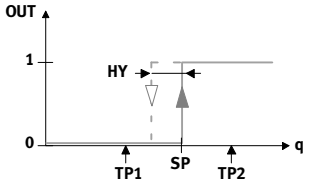
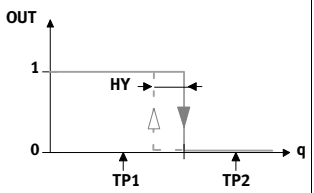
Operating status	Function
RUN mode	– Basic status after the operating voltage is applied – Display of the current measured value – Display of the selected inputs and outputs – Switchover between the measured variables of flow rate and volume/load
SHOW mode	– Display of current settings of the switching outputs and analogue output – Display and resetting of the minimum and maximum values – Display of the average flow rate measurement
EDIT mode	– Setting of parameters
TEACH mode	– Acceptance of the current measured value to determine switching points

Tab. 2 Operating statuses of the SFAH

6.2 Switching outputs

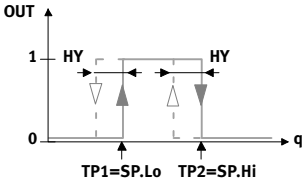
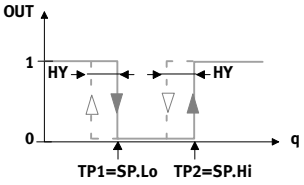
6.2.1 Switching functions

Threshold value comparator in the flow measurement for OutA or OutB _I¯

Function	NO (normally open)	NC (normally closed)
Switching function: – 1 switching point (SP) TEACH mode: – 2 Teach points (TP1, TP2) – SP = ½ (TP1+TP2)		

Tab. 3 Threshold value comparator: setting of switching point [SP] and hysteresis [HY]

Window comparator in the flow measurement for OutA or OutB _⌈⌉_

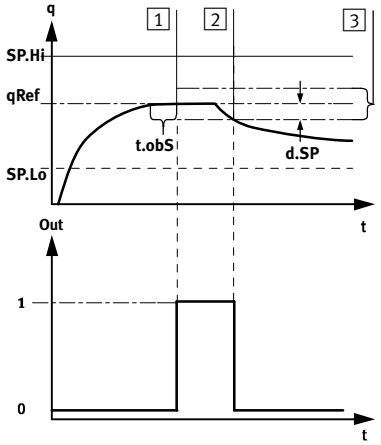
Function	NO (normally open)	NC (normally closed)
Switching function: – 2 switching points (SP.Lo, SP.Hi) TEACH mode[1]: – 2 Teach points (TP1, TP2) – TP1 = SP.Lo, TP2 = SP.Hi		

1) SP.Lo = smaller value, SP.Hi = larger value, independent of the Teach sequence

Tab. 4 Window comparator: setting of switching points [SP.Lo] and [SP.Hi] and hysteresis [HY]

Auto difference monitoring d_I¯I_

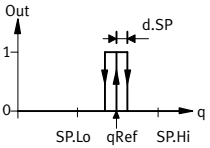
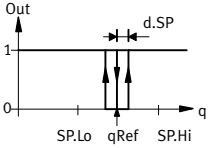
This function permits monitoring of a signal value for constancy. If the applied signal is constant in the range between [SP.Lo] and [SP.Hi], the reference signal qRef is automatically determined. The result is a switching operation at the output and signalises the start of the signal monitoring procedure.
If signal remains in the monitoring range [d.SP] around qRef, the signal is stable. When the monitoring range is left, the output switches back.



1 Reference value qRef is determined
2 Measured value deviates by [d.SP] from the reference value
3 Monitoring range

Tab. 5

The parameters [SP.Lo], [SP.Hi], [t.obS] and [d.SP] can be configured by the user. The greater [t.obS] is set, the more stable the signal must be to establish the reference value qRef.

Function	NO (normally open)	NC (normally closed)
Switching function: – 2 switching points (SP.Lo, SP.Hi) for setting the valid work range – 1 switching point (d.SP) for determination of the monitoring area TEACH mode[1]: – 2 Teach points (TP1, TP2) – TP1 = SP.Lo, TP2 = SP.Hi		

1) SP.Lo = smaller signal value, SP.Hi = larger signal value, independent of the Teach sequence

Tab. 6

6.2.2 Change in colour

A red colour change can be set in the display for OutA and OutB, dependent on the switching status. As a result, the switching status of the sensor can be identified over a large distance.
The colour change reacts both on OutA and on OutB, depending on the setting.

Parameter	Meaning
bLUE	Display is always blue; the colour change function is switched off.
R.On	Display is red if the switching output is set (High =1) or blue if the switching output is not set (Low = 0).
R.OFF	Display is red when the switching output is not set. (Low = 0) or blue when the switching output is set (High =1).

Tab. 7 Colour change on the display

6.2.3 Volume/load pulse

A threshold value SP for the volume or load can be set in the accumulated volume/load measurement. If the configured threshold value is reached, a switching impulse is emitted at the Pulse output (➔ Fig. 2) for an adjustable period of time. With each switching impulse, the volume/load measurement is started again (➔ Fig. 3).

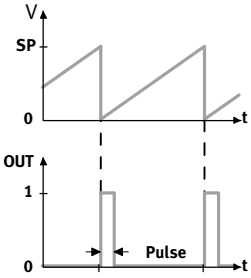
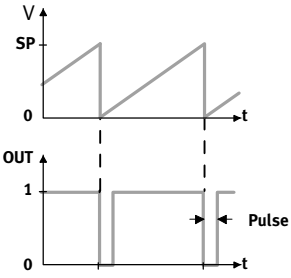
Volume/load pulse with accumulated volume measurement	
Setting NO (normally open)	**Setting NC (normally closed)**
	

Fig. 3

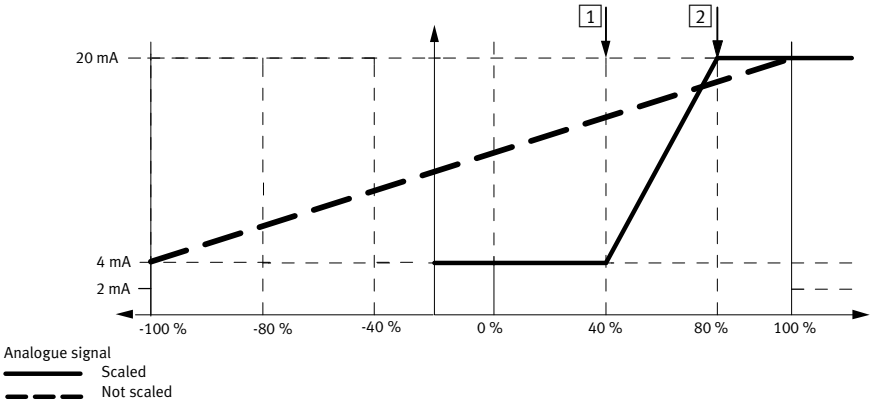
6.3 Analogue output

Analogue signal

The analogue output can be operated either as a voltage output 0...10 V or 1...5 V or as a current output 4 ... 20 mA. The voltage output 0...10 V is set at the factory.

Scaling of the analogue signal

In the bidirectional sensor variants, the analogue output signal 0...10 V, 1...5 V or 4...20 mA is assigned to the complete sensing range (-100 to +100 % FS), in the unidirectional variants to the positive sensing range (0 to +100 % FS). If only part of the sensing range is to be used, the analogue value output can be scaled to this partial range with the help of the parameters [In.Lo], [In.Hi].

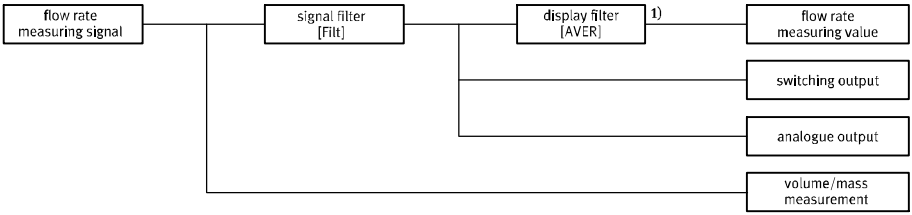


1 Starting point of the scaled sensing range (In.Lo)
2 End point of the scaled sensing range (In.Hi)

Fig. 4 Example: scaling of the analogue signal at the current output

6.4 Filters

With the low-pass filter [Filt], the flow input signal can be smoothed. This also changes the rise and fall time. Filtering affects all outputs as shown in the following diagram. The filter time equals the time constant T of a low-pass filter.
A smoothed average [AVER] of the flow measurement can be displayed in the SHOW mode.



1) The display filter is only active as long as AVER is selected in the SHOW mode

Fig. 5 Example: scaling of the analogue signal at the current output

6.5 Zero point synchronisation

The sensor has the possibility to make an offset synchronisation for the zero point. This synchronisation affects the display and all outputs. The offset synchronisation is possible only for the Zero Adjust = ON setting. As a result, the zero range hiding is no longer active. For bidirectional sensor variants, the function Zero Adjust [Z.Adj] is preset to [ON]. As a result, visible offset errors can be set to zero through a Zero Adjust Teach procedure (offset synchronisation). A requirement for this is that the measured value in the Teach procedure lies in the range ± 3 % FS with reference to the original factory adjustment.

6.6 Switchover of standard condition for volume values – REF / Cond

The represented flow rate units can be related to different standard conditions. It is possible to switch between the following standard conditions. In the menu navigation on the display, the corresponding standard is determined by selecting the reference temperature.

REF / Cond		**Off**	**15 °C**	**20 °C**
Standard		DIN 1343	ISO 2533	ISO 6358
Air pressure (absolute)	[bar] / [kPa]	1.01325 / 101.325	1.01325 / 101.325	1 / 100
Temperature	[°C]	0	15	20
Air humidity	[%]	0	0	65
Status information “Option”		Does not light up	Lights up	Lights up
Correction factor, measurement range limit value		1	1.055	1.087

Fig. 6

Calibration of the SFAH refers back to the physical standard conditions in accordance with DIN 1343.

If a standard other than DIN 1343 is selected, the specified measurement range (±100 % FS) changes in value by the factor specified in Fig. 6. This change is visualised in the display through [Option].

Changing the reference standard only adjusts the display on the sensor. If necessary, the effect on the nominal measurement range of the respective sensor must also be considered when evaluating the analogue output.

6.7 Replicating parameters

With this function, all settings that have been carried out on one sensor (master) can be transferred to other, identical sensors (device). If multiple sensors with similar function are to be installed in a system, the commissioning time can thereby be significantly reduced.
Parameter transmission takes place through the IO-Link function. The already configured sensor (master) is brought into a master mode and so can transfer its parameters to a device with similar design (same device ID).

6.8 Minimum/maximum value

In the SHOW mode, the minimum values and the maximum values for the flow measurement are displayed and reset.

Switching off the operating voltage resets the minimum and maximum values.

7 Installation

Note

Installation and commissioning are to be carried out only by qualified personnel.

7.1 Mechanical installation

Any mounting position is possible but can have an influence on measurement precision (➔ Chapter 13, Nominal conditions).

7.1.1 Plate mounting

- Secure the SFAH to the plate by using screws of suitable length.
  - Tightening torque: 0.5 Nm
  - Hole diameter: max 3.3 mm

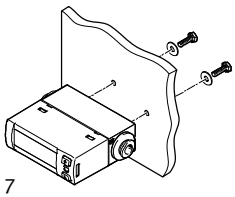


Fig. 7

7.1.2 Lateral plate mounting

1. Mount H-rail mounting on the SFAH.
   - Tightening torque 0.5 Nm
2. Mount H-rail mounting with washers and M4 screws.
   - Tightening torque 0.5 Nm

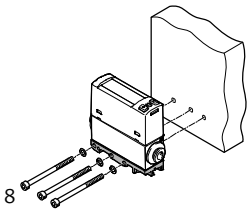


Fig. 8

7.1.3 H-rail mounting

1. Mount H-rail mounting on the SFAH.
   - Tightening torque 0.5 Nm
2. Hang H-rail mounting in the H-rail [1].
3. Press the H-rail mounting in the direction of the arrow until the mounting slide catches [2].

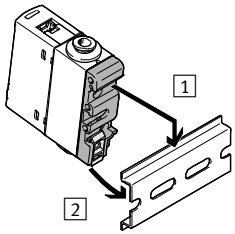


Fig. 9

7.1.4 Wall mounting

1. Screw wall mounting to SFAH.
   – Tightening torque 0.5 Nm
2. Mount wall mounting.

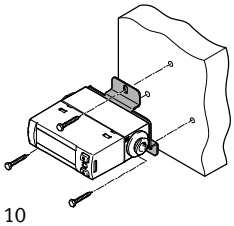


Fig. 10

7.1.5 Front panel mounting kit

1. Mount H-rail mounting on the SFAH.
   – Tightening torque 0.5 Nm
2. Mount accompanying hexagon head screw on the H-rail mounting.
3. Push panel frame through cut-out (62 mm x 24 mm ± 0.1 mm).
   – Front panel thickness 1...3 mm
4. Push sensor through front frame so that all 4 remaining hooks engage.
5. Push clamping element over hexagon head screw.
6. Attach sensor with accompanying knurled nut.
   – Tightening torque 0.3 Nm

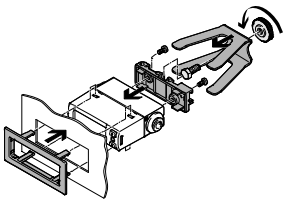


Fig. 11

7.2 Pneumatic installation

For unidirectional sensors SFAH-...U-..., the flow is supplied at connection 1 and withdrawn from connection 2. The direction of flow is indicated on the sensor by an arrow.

Note

Only for unidirectional types: If the tubing connection of the SFAH is incorrect, the measurement values are presented with the negative minus sign and lie outside the specified measurement range.

For the bidirectional sensors SFAH-...B-..., the flow can be supplied at connection 1 or connection 2. To have a sign that correctly represents the flow direction in the display, the flow direction can be set in the Edit menu and also represented in the sub-display.

Connect the sensor as follows:
- Mount the two hoses to connection 1 and connection 2 ➔ Marking on the product.

7.3 Inlet situation

The specified accuracies shown in the technical data of the sensor are achieved when the conditions for the inlet section from ➔ Tab. 8 are complied with on the sensor.

Min. internal diameter of inlet path in mm	**Design of the inlet path**	**Measuring range**							
		-0.1	-0.5	-1	-5	-10	-50	-100	-200
2.9 (e.g. QS4)	Any	Permitted [1]			± 2 %[2]		Not permitted[3]		
4 (e.g. QS6)	Straight	Permitted [1]					± 1 %[2]		
4 (e.g. QS6)	Angle directly on sensor								
4 (e.g. QS6)	Angle at distance of 5-80 cm						± 10 %[2]		
6 (e.g. QS8)	Any	Permitted [1]							

1) Accuracy as specified in the technical data ➔ Chapter 13 Technical data.

2) Deviation from the specified accuracy.

3) Operation possible, but deviations of more than 20 % must be expected.

Tab. 8 Effect of the inlet conditions and connection sizes on the specified accuracy

7.4 Electrical installation

Warning

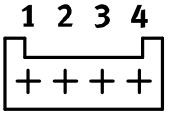
Electric voltage
Injury caused by electric shock, damage to machine and to system
- Only use power sources which guarantee reliable electrical isolation of the operating voltage in accordance with IEC/DIN EN 60204-1.
- Observe the general requirements for PELV circuits in accordance with IEC/DIN EN 60204-1.
- Use switched-mode power supplies, which ensure reliable separation in accordance with EN 60950/VDE 0805.

Note

Long signal lines reduce the resistance to interference.
- Comply with the maximum permissible I/O signal line length of 30 m, 20 m in IO-Link operation

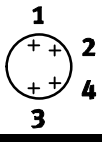
Note

The binary outputs at pin 2 and pin 4 can be wired as PNP or NPN connections as needed.
- Configure binary outputs according to your wiring ➔ Setting special menu [SPEC] section.

Pin	Colour[1)]	Assignment	Plug L1
1	Brown (BN)	Operating voltage +24 V DC	
2	Black (BK)	Switching output OutA, volume/load pulse or IO-Link (C/Q line)	
3	White (WH)	Switching output OutB or analogue output	
4	Blue (BU)	0 V	

1) Colours apply for connecting cables NEBS-L1...

Fig. 12

Pin	Colour[1)]	Assignment	Plug M8 x 1
1	Brown (BN)	Operating voltage +24 V DC	
2	White (WH)	Switching output OutB or analogue output	
3	Blue (BU)	0 V	
4	Black (BK)	Switching output OutA, volume/load pulse or IO-Link (C/Q line)	

1) Colours apply for connecting cables NEBU-...M8...

Fig. 13

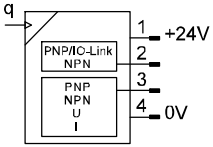
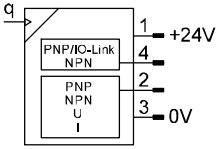
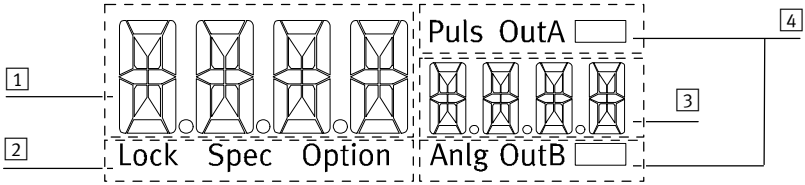
Circuit diagrams	
SFAH-...-L1	**SFAH-...-M8**
	

Fig. 14

8 Commissioning

8.1 LCD display



1 Main display (e.g. measurement value)
2 Status information
3 Lower display (e.g. unit)
4 Output display

Upper output display: In the RUN mode, which signal is allocated to pin 4 (M8) or pin 2 (L1) is displayed.
Lower output display: In the RUN mode, which signal is allocated to pin 2 (M8) or pin 3 (L1) is displayed.

Example for LCD display	Meaning
Output display	
[OutA]	Switching output OutA selected (flashes with active IO-Link)
[OutA] ▬	Switching output OutA set
Output display	
[OutB]	Switching output OutB selected
[OutB] ▬	Switching output OutB set
[Pulse]	Illuminates with reference to the pulse signal at the volume/load-pulse output
[Anlg]	Illuminates with reference to the analogue output (flow rate)
Status information/signal indicator	
[Lock]	Security code activated
[Spec]	Special menu selected
[Option]	Illuminates when parameters having a special influence on the measured value indicator have been changed (compared to the factory setting): reference condition (standard), gas

Tab. 9

Example for LCD display		Meaning
Main display	**Lower display**	
Measured value indicator and unit in the RUN mode		
[– 0.53]	[L.Min]	Measured value indicator (here: negative value) and unit
Menu for the switching outputs (OutA and OutB)		
[Edit]	[bin]	[OutA]/[OutB]: Edit menu for the switching outputs (binary)
_|¯	[Fctn]	Threshold value comparator
_|¯|_	[Fctn]	Window comparator
d_|¯|_	[Fctn]	Auto difference monitoring
[18.0]	[SP]	Switchpoint value
[1.80]	[SP.Lo]	Value of lower switching point
[6.45]	[SP.Hi]	Value of upper switching point
[0.50]	[HY]	Hysteresis value
[18]	[t.obS] / [MSEC]	Time interval for determination of the signal change, which is used to establish the reference value.
[0.25]	[d.SP]	Threshold value for determination of the monitoring area
[NO]	[LOGC]	Switching characteristics: [NO] = normally open contact, [NC] = normally closed contact
[bLUE]	[COLR]	Display colour
Extreme values (only SHOW mode)		
[1.64]	[MIN]	Minimum measured value since switch-on of the supply voltage or the last reset
[8.50]	[MAX]	Maximum measured value since switch-on of the supply voltage or the last reset
[20.8]	[AVER]	Average of the flow measurement, filter time constants
Additional settings (pulse at the output)		
[100]	[PULS]	Duration of the volume or load pulse at the output
Analogue output		
[Edit]	[ANLG]	Edit menu for the analogue output
[0...10]	[Out] / [V]	Output function of the analogue output

Example for LCD display		Meaning
Main display	**Lower display**	
[100]	[In.Hi] / [%]	Scaling of the analogue output to the final value of the flow measuring range in percent of FS
[–100]	[In.Lo] / [%]	Scaling of the analogue output to the start value of the flow measuring range in percent of FS
Menu for device settings (Spec)		
[Edit]	[Menu]	[Spec]: Edit menu for additional settings
[16]	[Filt] / [MSEC]	Value of the filter time constant for the measurement signal
[L.Min]	[FLOW Unit]	Display unit for flow measurement
[0°C]	[REF] / [Cond]	Reference standard for gas volume
[Air]	[GAS]	Selection of the operating medium
[1->2]	[FLOW] / [Path]	Selection of the flow direction from Port 1 to 2 or vice versa (only for bidirectionally calibrated product variant)
[ON]	[Z.Adj]	Offset synchronisation for display, switching and analogue output
[Unit]	[Sub.d]	Settings of the lower display in RUN mode: selected unit or switching point of OutA or bar graph or gas or flow direction
[40]	[Eco] / [SEC]	Economy mode: period after which the display background lighting is switched off
[PNP]	[bin] / [Out]	Shift of the switching outputs (binary) between PNP and NPN
[Flow]	[bin] / [Pin4]	Shift of binary switching output or pulse output. Pin 4 for SFAH-...-M8, pin 2 for SFAH-...-L1
[bin]	[FLOW] / [Pin2]	Shift of binary switching output or analogue output to pin 2 for SFAH-...-M8, pin 3 for SFAH-...-L1
[OFF]	[Code]	Activation and determination of the security code
[OFF]	[MASt]	Activation of the IO-Link master function for replication of parameters

Tab. 10

8.2 Switch on sensor (RUN mode)

- Switch on the operating voltage.
  ➔ Current measured value is displayed. The sensor is in the basic status (RUN mode).

The basic status can be reached from other modes by:
– Pressing Edit button for 3 seconds
– Expiration of a monitoring time (timeout)

8.3 Shift measured value indicator (RUN mode)

- The measured value indicator is shifted by pressing key A to flow rate measurement or key B to volume measurement.

8.4 Displaying parameters (SHOW mode)

Requirement: The sensor is ready for operation (RUN mode).

8.4.1 Switching output OutA or volume pulse output

- Press the A key twice.
  ➔ The first parameter set is displayed. [Fctn] flashing for OutA or [SP] for Pulse.

The following parameters can be displayed by repeatedly pressing the A key (➔ Fig. 15).

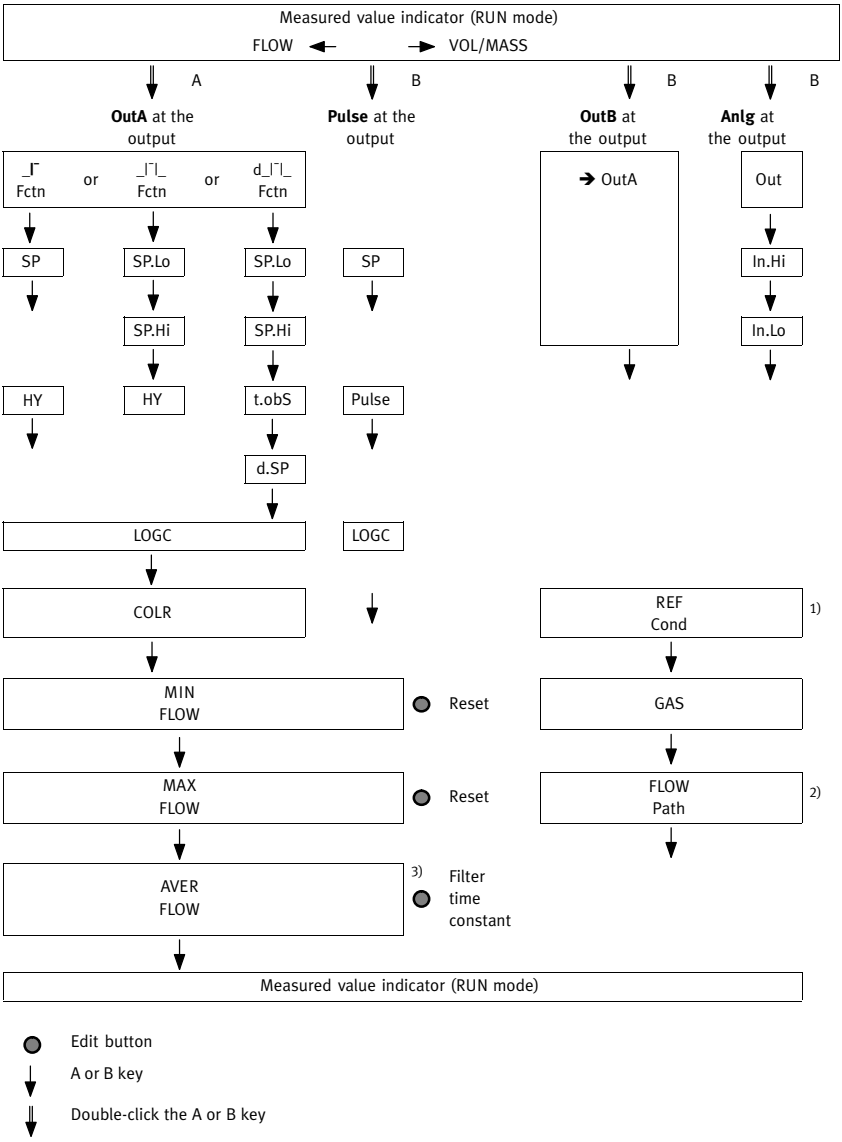
➔ The averaged flow rate value [AVER] is displayed at the end.

8.4.2 Switching output OutB or analogue output Anlg

- Press the B key twice.
  ➔ The first parameter set is displayed. [Fctn] flashes with OutB or [Out] with Anlg (➔ Fig. 15).

The following parameters are displayed by repeatedly pressing the B-key (➔ Fig. 15).

➔ For bidirectional product variant SFAH-...-B, the flow direction [Path] is displayed at the end.



1) Not for flow unit G.Min
2) Only for bidirectional product variant
3) Selectable values: **256**, 512, 1024 ms

Fig. 15

8.5 Enter the security code (EDIT mode)

Note

If [Lock] [IOL] appears on the display, the sensor is blocked through the IO-Link Device Access Lock and can only be parameterised via IO-Link.

Requirement: The sensor is ready for operation (RUN mode).

1. Press the Edit button.
   ➔ The EDIT mode is active. If the security code is activated, the parameter entry option is blocked: [Lock] flashes.
2. Enter security code set with A or B key.
3. Press the Edit button briefly.
   ➔ [OutA] flashes. The parameter entry option is unblocked.

8.6 Configuring switching output (EDIT mode)

Note

The process is the same for configuring the switching outputs for [OutA] and [OutB]. In the following, the process is described using the switching output OutA. Menu structure ➔ Fig. 17.

Requirement: The sensor is ready for operation (RUN mode).

1. Press the Edit button briefly.
   ➔ [Edit] appears. [OutA] flashes.
2. Press the Edit button briefly.
   ➔ [Fctn] flashes.
3. Select switching function _I¯ or _I¯I_ or d_I¯I_ with A or B key.
4. Press the Edit button briefly.
   ➔ The set value is saved.
   ➔ The next adjustable parameter is shown.
5. Set the parameter with A or B key.
6. Repeat points 4 and 5 until all parameters are set.
   – Switching functions ➔ Chapter 3.2

8.7 Change device settings (EDIT mode)

Requirement: The sensor is ready for operation (RUN mode).

1. Press the Edit button briefly.
   ➔ [Edit] appears. [OutA] flashes.
2. With A or B key, select special menu [Spec].
   ➔ [Spec] flashes.
3. Press the Edit button briefly.
   ➔ [Filt] / [MSEC] flashes.

4. Set the parameter with A or B key.
5. Press the Edit button briefly.
   ➔ The set value is saved.
   ➔ The next adjustable parameter is shown.
6. Repeat points 4 and 5 until all parameters are set.

8.8 Set volume pulse output (EDIT mode)

Requirement: The sensor is ready for operation (RUN mode).
1. Press the Edit button briefly.
   ➔ [Edit] appears. [OutA] flashes.
2. Select [Puls] with the A-key or B-key.
3. Press the Edit button briefly.
   ➔ [SP] / [Volume unit] flashes.
4. Set the parameter with A or B key.
5. Press the Edit button briefly.
   ➔ The set value is saved.
   ➔ The next adjustable parameter is shown.
6. Repeat points 4 and 5 until all parameters are set.

8.9 Set analogue output (EDIT mode)

Requirement: The sensor is ready for operation (RUN mode).
1. Press the Edit button briefly.
   ➔ [Edit] appears. [OutA] flashes.
2. Select [Anlg] with the A-key or B-key.
3. Press the Edit button briefly.
   ➔ [Out] / [V] flashes.
4. Set the parameter with A or B key.
5. Press the Edit button briefly.
   ➔ The set value is saved.
   ➔ The next adjustable parameter is shown.
6. Repeat points 4 and 5 until all parameters are set.

8.10 Replicating parameters (EDIT mode)

Requirement:
– The pre-configured sensor (master sensor) is ready for operation (RUN mode).
– Master sensor and device sensor have the same design regarding the parameters (same device ID).
– The master sensor is connected to the device sensor and power supply (➔ Fig. 16).
– Parameterisation of the device sensor must not be blocked via IO-Link.
– The device sensor is in an unswitched status (switching output PNP, display OutA off).

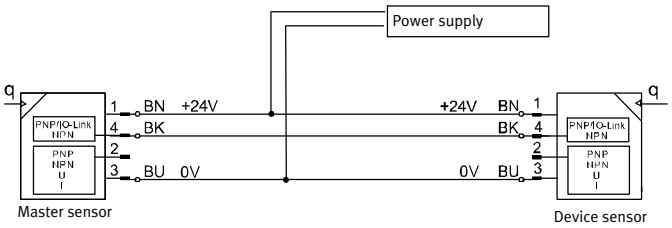


Fig. 16 Example of port assignment SFAH-...M8

1. Select special menu [Spec] at the master sensor via device settings.
2. Press the Edit button briefly until [MASt] appears.
3. With A or B key, select [ON].
4. Press the Edit button.
   ➔ [REPL] / [RedY] appears.
5. Press A- or B-key.
   ➔ [REPL] / [RUN] appears briefly.
   ➔ The parameters are transmitted to the device sensor.
   ➔ [REPL] / [RedY] appears. If an error occurs, an error message appears (➔ Tab. 30).
6. Repeat point 5 if an additional sensor should be parameterised.
7. Press the Edit button.
   ➔ Switch to the RUN mode.

8.11 Configure sensor (EDIT mode)

Fig. 17 shows the complete menu structure. Some menu options or setting values are not applicable, depending on the product variant and the selected switching function.

8.12 Teach switching points (TEACH mode)

➔ **Note**

If [Lock] [IOL] appears on the display, the sensor is blocked through the IO-Link Device Access Lock and can only be parameterised via IO-Link.

➔ **Note**

The process for Teach is the same for configuring the switching outputs for OutA and OutB.
- For teaching-in OutA: A-key + Edit button
- For teaching-in OutB: B-key + Edit button

In the following, the process is described using the switching output OutA.
The Teach function is only available for flow monitoring.

Requirement: The sensor is ready for operation (RUN mode).
If the security code is activated, the parameter entry option is blocked: [Lock] flashes.
1. Enter the security code (➔ Chap. 8.5).
2. Establish switching function in the EDIT mode (➔ Chap. 8.6).
3. Apply signal value 1.
4. Press the A key and Edit button.
   ➔ The current signal value will then be adopted as the first Teach point (TP1).
   ➔ [t-IN] flashes.
5. Apply signal value 2.
6. Press the A key and Edit button.
   ➔ The current signal value will then be adopted as the first Teach point (TP2).
   ➔ Switch to the RUN mode.

There is no timeout in the TEACH mode. The sensor changes to the RUN mode only after the entire teach process is ended.

8.13 Zero point synchronisation (zero adjust)

➔ **Note**

Ensure that operating pressure is applied to the SFAH but there is no flow, so that the offset synchronisation is without error.

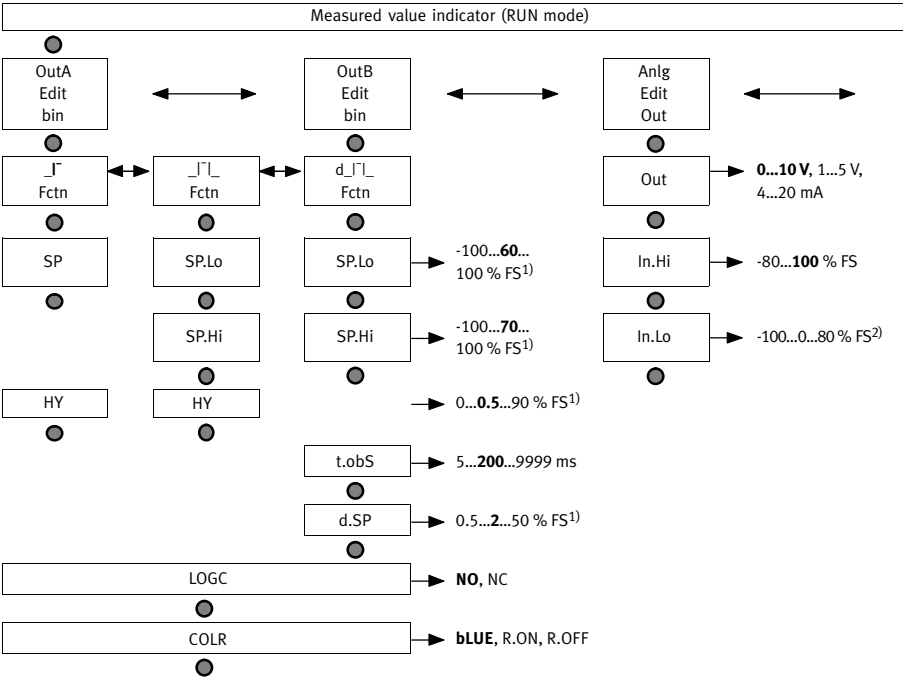
Prerequisite:
– The sensor is ready for operation (RUN mode).
– [Z.AdJ] [ON] is set (➔ Chap. 8.7).
– The measured value lies in the range 0 l/min ± 3 % FS.

- Press the A- and B-key and Edit button simultaneously.
  ➔ [OK] appears. The zero point synchronisation was successful.
  ➔ [FAIL] appears. The zero point synchronisation was not successful. Check requirements.

➔ **Note**

If [Z.AdJ] [OFF] is set for a later time, the device takes over the factory setting calibration values.

8.14 Menu structure (EDIT mode)



Measured value indicator (RUN mode)

= Edit button

= A or B key

Bold = factory setting

1) The values refer to the respective measuring range and selected unit
2) Factory setting **-100** for bidirectional variant; factory setting **0** for unidirectional variant
3) Factory setting **L/h** for measurement ranges 0.1 l/min and 0.5 l/min; factory setting **L/min** for all other measurement ranges
4) Menu option only for bidirectional variant
5) Factory setting **OFF** for unidirectional variant; factory setting **ON** for bidirectional variant
6) For M8 plug: Pin4; for L1 plug: Pin2
7) For M8 plug: Pin2; for L1 plug: Pin3

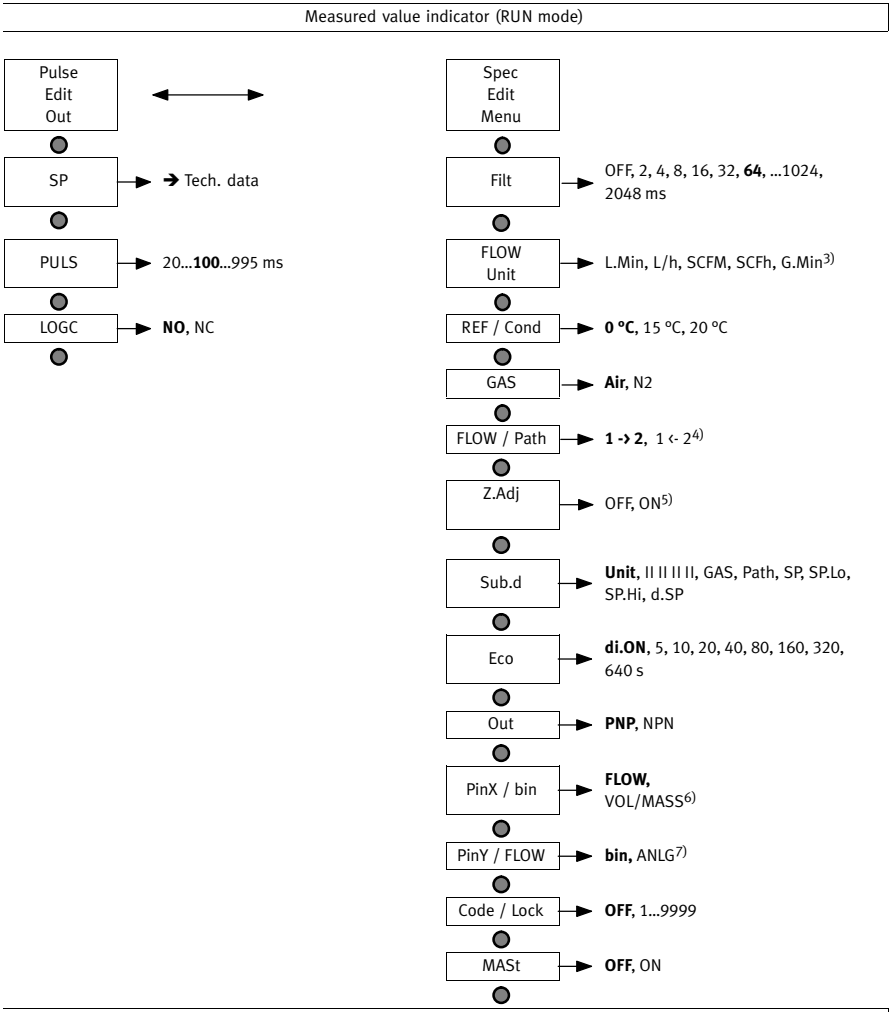

Measured value indicator (RUN mode)
Pulse Edit Out
SP
→ Tech. data
PULS
20...**100**...995 ms
LOGC
NO, NC
Spec Edit Menu
Filt
OFF, 2, 4, 8, 16, 32, **64**, ...1024, 2048 ms
FLOW Unit
L.Min, L/h, SCFM, SCFh, G.Min3)
REF / Cond
0 °C, 15 °C, 20 °C
GAS
Air, N2
FLOW / Path
1 -> 2, 1 <- 24)
Z.Adj
OFF, ON5)
Sub.d
Unit, II II II II, GAS, Path, SP, SP.Lo, SP.Hi, d.SP
Eco
di.ON, 5, 10, 20, 40, 80, 160, 320, 640 s
Out
PNP, NPN
PinX / bin
FLOW, VOL/MASS6)
PinY / FLOW
bin, ANLG7)
Code / Lock
OFF, 1...9999
MASt
OFF, ON
Measured value indicator (RUN mode)

Fig. 17

9 IO-Link interface description

Note

Related device description file (IODD) ➔ www.festo.com/sp
For detailed information on the IO-Link specification and for the Smart Sensor Profil
➔ www.io-link.com

9.1 General IO-Link specification

Characteristic		Specification
Protocol version		Device V1.1
Profile		Smart sensor profile
Function classes		Binary data channel (BDC) Process data variable (PDV) Identification Diagnostics Teach channel
Communication mode		COM2 (38.4 kBaud)
SIO mode support		Yes
Port class		A
Process data content IN	Byte	3
Servicer data content IN	Bit	2 BDC (flow monitoring) 1 BDC (volume monitoring) 14 PDV (measured flow value)
Min. cycle time	Bit	4
Data storage required	ms	0.5

Tab. 11

9.2 Communication functions

- Preoperate: Frame type 1_V, OD-capability 8 bytes
- Operate: Frame type 2_V, OD-capability 2 bytes
- ISDU: supported
- Data storage: supported
- Block parameterisation: supported

9.3 Identification parameters

– Vendor-ID: 333 d / 01 4D h
– Device ID: ➔ Tab. 12

Device ID [dec]	Device ID [hex]	Order code
80	0x000050	SFAH-01U
81	0x000051	SFAH-05U
82	0x000052	SFAH-1U
83	0x000053	SFAH-5U
84	0x000054	SFAH-10U
85	0x000055	SFAH-50U
86	0x000056	SFAH-100U
87	0x000057	SFAH-200U
88	0x000058	SFAH-01B
89	0x000059	SFAH-05B
90	0x00005A	SFAH-1B
91	0x00005B	SFAH-5B
92	0x00005C	SFAH-10B
93	0x00005D	SFAH-50B
94	0x00005E	SFAH-100B
95	0x00005F	SFAH-200B

Tab. 12 Device ID values

Index	Sub-index	Name	Value (example)	Access[1]			Length (byte)	Format
				U	M	S		
0x0010	0	Vendor Name	Festo SE & Co. KG	R	R	R	17	String
0x0011	0	Vendor Text	http://www.festo.com	R	R	R	20	
0x0012	0	Product Name	Order code SFAH-10B-G18FS-PNLK-PNVBA-M8	R	R	R	Max. 64	
0x0013	0	Product ID	SFAH-10B	R	R	R	Max. 64	
0x0014	0	Product Text	Flow sensor for gas media	R	R	R	28	
0x0015	0	Serial Number	Product key 3S7PL9V6HHM	R	R	R	11	
0x0016	0	Hardware Revision	REV01	R	R	R	5	
0x0017	0	Firmware Revision	V51.2.13	R	R	R	8	
0x0018	0	Application Specific Tag	***[2]	R	R/W	R/W	32	
0x2101	0	Material Number	1234567	R	R	R	7	

1) Authorisation group: U = user, M = maintenance, S = specialist; Access: R = read, R/W = read and write
2) Value to be defined by user, which is not changed by the “Restore factory settings” command

Tab. 13 Identification parameters

9.4 IO-Link standard parameters and commands

Index	Sub-index	Name	Value	Access[1]			Length (byte)	Format
				U	M	S		
0x0002	0	SystemCommand	Tab. 15				1	UInteger8
0x000C	0	Device Access Locks[2]	0 = unblocked 1 = blocked	R	R/W	R/W	2	Record
0x0020	0	Error Count	0	R	R	R	2	UInteger16
0x0024	0	Device Status	0	R	R	R	1	UInteger8
0x0025	0	Detailed Device Status	Tab. 29	R	R	R	33	Array of 3 byte records
0x0028	0	ProcessDataInput	Tab. 23	R	R	R	3	Record

1) Authorisation group: U = user, M = maintenance, S = specialist; Access: R = read, R/W = read and write

2) Bit 0: block write access to parameter; Bit1: block data storage (no impact); Bit2: block entire parameterisation (EDIT and TEACH mode); Bit3: block user interface (not used)

Tab. 14 IO-Link standard parameters and commands

Value [dec]	Value [hex]	Access[1]			Command	Description	Format
		U	M	S			
65	0x41	–	W	W	SP1 Single Value Teach	Determines teach-in point for switching point SP1	UInterger8
66	0x42	–	W	W	SP2 Single Value Teach	Determines teach-in point for switching point SP2	
67	0x43	–	W	W	SP1 Two Value Teach TP1	Determines teach-in point 1 for switching point SP1	
68	0x44	–	W	W	SP1 Two Value Teach TP2	Determines teach-in point 2 for switching point SP1	
75	0x4B	–	W	W	One Action Teach	Device-specific teach-in	
79	0x4F	–	W	W	Teach Cancel	Cancels the teach-in sequence	
128	0x80	–	W	W	Device reset	Device warm start	
130	0x82	–	W	W	Restore factory settings	Resets the valid settings to factory settings	
160	0xA0	W	W	W	Reset Min PDV (InA)	Minimum measured value for the flow	
161	0xA1	W	W	W	Reset Max PDV (InA)	Reset maximum measured value for flow	
168	0xA8	W	W	W	Adjust flow zero point	User-defined setting of the flow zero point	
176	0xB0	-	W	W	Reset volume / mass recorder	Reset volume / mass recorder in RECORDER mode	
177	0xB1	-	W	W	Run volume / mass recorder	Start / resume volume / mass recorder in RECORDER mode	
178	0xB2	-	W	W	Pause volume / mass recorder	Pause volume / mass recorder in RECORDER mode	

1) Authorisation group: U = user, M = maintenance, S = specialist; Access: W = write, – = no access

Tab. 15 Additional IO-Link standard parameters and commands

9.5 Smart Sensor Profile parameters

Index	Sub-index	Name	Value	Access[1]			Length (byte)	Format
				U	M	S		
0x000D	0	Profile Characteristics		R	R	R	12	Array of UInteger16
	1	Device Profile ID	0x0001: Smart Sensor Profile	R	R	R	2	UInteger16
	2	Function Class ID	0x8000: Identification	R	R	R	2	
	3	Function Class ID	0x8001: Binary data channel (BDC)	R	R	R	2	
	4	Function Class ID	0x8002: Process data variable (PDV)	R	R	R	2	
	5	Function Class ID	0x8003: Diagnostics	R	R	R	2	
	6	Function Class ID	0x8004: Teach Channel	R	R	R	2	
0x000E	0	PD Input Descriptor		R	R	R	6	Array of OctetString 3
	1	BDC1, BDC2, BDC3	0x01, 0x03, 0x00	R	R	R	3	OctetString 3
	2	Process Data Variable	0x02, 0x0E, 0x08	R	R	R	3	OctetString 3
0x003A	0	Teach-In Channel	0: BDC1 (OutA), factory setting	-	R/W	R/W	1	Uinteger8
			1: BDC1 (OutA)					
			2: BDC2 (OutB)					
0x003B	0	Teach-In Status	0	-	R	R	1	Record
0x003B	1	Teach Flag TP2 for SP2	0 - not set, 1 - set	-	R	R	1	BooleanT
	2	Teach Flag TP1 for SP2		-	R	R	1	
	3	Teach Flag TP2 for SP1		-	R	R	1	
	4	Teach Flag TP1 for SP1		-	R	R	1	
0x003B	5	Teach State	0	-	R	R	1	UInteger4

1) Authorisation group: U = user, M = maintenance, S = specialist; Access: R = read, R/W = read and write, – = no access

Index	Sub-index	Name	Value	Access[1]			Length (byte)	Format
				U	M	S		
BDC1, Flow monitoring OutA								
0x003C	1	Setpoint SP1	1 ... 16382, Factory setting 13106	R	R/W	R/W	2	UInteger16
	2	Setpoint SP2	1 ... 16382, Factory setting 13925				2	
0x003D	1	Switchpoint logic	0 - NO, factory setting 1 - NC				1	UInteger8
	2	Switchpoint mode	1 - Single-point mode, factory setting 2 - Window mode 128 - Auto difference monitoring				1	
	3	Switchpoint hysteresis	0 ... 7373, Factory setting 41				2	UInteger16
BDC2, Flow monitoring OutB								
0x003E	1	Setpoint SP1	1 ... 16382, Factory setting 13106	R	R/W	R/W	2	UInteger16
	2	Setpoint SP2	1 ... 16382, Factory setting 13925				2	
0x003F	1	Switchpoint logic	0 - NO, factory setting 1 - NC				1	UInteger8
	2	Switchpoint mode	1 - Single-point mode, factory setting 2 - Window mode 128 - Auto difference monitoring				1	
	3	Switchpoint hysteresis	0 ... 7373, Factory setting 41				2	UInteger16
BDC3, Volume / mass impulse (pulse)								
0x4000	1	Setpoint	164 ... 4294967295, Factory setting 16383	R	R/W	R/W	4	UInteger32
	2	Not used	0					
0x4001	1	Switchpoint logic	0 - NO, factory setting 1 - NC	R	R/W	R/W	1	UInteger8
0x4001	2	Switchpoint mode	128 - Volume / mass impulse	R	R/W	R/W	1	UInteger8
	3	Not used	0				2	UInteger16

1) Authorisation group: U = user, M = maintenance, S = specialist; Access: R = read, R/W = read and write, – = no access

Tab. 16 Smart Sensor Profile parameters

9.6 Device-specific parameters

Index	Sub-index	Name	Description	Value	Access[1)]			Length (byte)	Format
					U	M	S		
0x0112	0	OutA, Auto difference monitoring, max. signal delta (s.obS)	Limit value for a constant input signal	16 ... 328, Factory setting 33	R	R	R/W	2	UInteger16
0x0113	0	OutA, Auto difference monitoring, time delta (t.obS)	Observation time for a constant input signal (ms)	5 ... 9999, Factory setting 200	R	R/W	R/W		
0x0114	0	OutA, Auto difference monitoring, switch point delta (d. SP)	Trigger level for flow rate difference	41 ... 4096, Factory setting 164	R	R/W	R/W		
0x0118	0	OutA, backlight color	Display background colour	0: always blue (factory setting) 1: Red if Out = 0 2: Red if Out = 1	R	R/W	R/W		
0x0130	0	OutB, Auto difference monitoring, max. signal delta (s.obS)	Limit value for a constant input signal	16 ... 328, Factory setting 33	R	R	R/W		

Index	Sub-index	Name	Description	Value	Access[1]			Length (byte)	Format
					U	M	S		
0x0131	0	OutB, Auto difference monitoring, time delta (t.obS)	Observation time for a constant input signal (ms)	5 ... 9999, Factory setting 200	R	R/W	R/W	2	UInteger16
0x0132	0	OutB, Auto difference monitoring, switch point delta (d. SP)	Trigger level for flow rate difference	41 ... 4096, Factory setting 164	R	R/W	R/W		
0x0136	0	OutB, backlight color	Display background colour	0: always blue (factory setting) 1: Red if Out = 0 2: Red if Out = 1	R	R/W	R/W		
0x0149	0	Volume / mass impulse length	Impulse width of the volume / mass impulse (ms)	20 ... 995 Factory setting 100	R	R/W	R/W		
0x016A	0	Analog output scaling (In.Lo)	Initial value of the input range in percent of the total range	-100 ... 80, factory setting -100[2] -100 ... 80, factory setting 0[3]	R	R/W	R/W		
0x016B	0	Analog output scaling (In.Hi)	Final value of the input range in percent of the total range	-80 ... 100, factory setting 100	R	R/W	R/W		
0x016C	0	Analog output type (Out)	Analog output type	0: 0..10 V voltage output (factory setting) 1: 1..5 V voltage output 2: 4..20 mA current output	R	R/W	R/W		

Index	Sub-index	Name	Description	Value	Access[1]			Length (byte)	Format
					U	M	S		
0x017F	0	InA unit	InA unit	0: l/min (factory setting) 1: l/h (factory setting) [4)5)] 2: scfm[6)] 3: scfh 4: gram/min	R	R/W	R/W	2	UInteger16
0x0181	0	Flow display filter (AVER)	Filter time constant for additional smoothing of the flow display for the local display indicator at the sensor (SHOW mode) (ms)	8: 256 (factory setting) 9: 512 10: 1024	R	R/W	R/W		
0x0182	0	Flow filter response time (Filt)	Smoothing the flow input signal with reaction time ⍰=1 ms x 2^n (ms)	0 = Filter off 1 = 2 2 = 4 3 = 8 4 = 16 5 = 32 6 = 64 (factory setting) 7 = 128 8 = 256 9 = 512 10 = 1024 11 = 2048	R	R/W	R/W		
0x0184	0	User zero adjustment on/off (Z.Adj)	Activation/ deactivation of the zero point synchronisation operation	0 = off, factory setting[3)] 1 = on, factory setting[2)]	R	R/W	R/W		
0x01DD	0	Local display flow value (InA)	Flow at the local sensor display	1: OutA flow (factory setting) 2: Volume / mass impulse	R	R/W	R/W		

Index	Sub-index	Name	Description	Value	Access[1]			Length (byte)	Format
					U	M	S		
0x01E2	0	Pin Y selection	Output signal at pin Y [7]	0: OutB (bin) (factory setting) 1: Analog output for flow signal (ANLG)	R	R/W	R/W	2	UInteger16
0x01E3	0	Pin X selection	Output signal at pin X [8]	0: OutA (FLOW) (factory setting) 1: Volume / mass impulse (VOL/MASS)	R	R/W	R/W		
0x01E8	0	Backlight duration (Eco)	Duty cycle of the backlight duration. Always On or time until the display switches off after the last key press (s)	0 = Always on (factory setting) 1 = 5 2 = 10 3 = 20 4 = 40 5 = 80 6 = 160 7 = 320 8 = 640	R	R/W	R/W		
0x01E9	0	Sub-display mode (Sub.d)	Lower display in the RUN mode	0 = Units, (factory setting) 1 = Bar graph 2 = Gas 3 = Flow direction [2] 4 = SP1 5 = SP2 6 = d.SP	R	R/W	R/W		
0x01EA	0	Lock code	Local parameter block: Off or safety code	0 - Off (factory setting) 1...9999 - Code	R	R/W	R/W		
0x01F0	0	Normative reference (REF Cond)	Reference condition for volume flow at the sensor display (°C)	0 = 0 1 = 15 2 = 20	R	R/W	R/W		

Index	Sub-index	Name	Description	Value	Access[1]			Length (byte)	Format
					U	M	S		
0x2001	0	PDV InA	Process value for flow measurement	0 … 2^{14} – 1	R	R	R	2	UInteger16
0x2002	0	PDV InB	Process value of the volume / mass measurement for impulse output	0 … 2^{32} – 1	R	R	R	4	UInteger32
0x2004	0	PDV InD, process value of volume / mass recorder	Process value of the volume / mass measurement in the RECORDER mode	0 … 2^{32} – 1	R	R	R		
0x2005	0	Min PDV InA	Minimum measured flow rate	0 … 2^{14} – 1	R	R	R	2	UInteger16
0x2006	0	Max PDV InA	Maximum measured flow rate	0 … 2^{14} – 1	R	R	R		
0x200E	0	Time of volume recording	Run time of volume measurement since the last reset/power-on (s)	0 … 2^{32} – 1	R	R	R	4	UInteger32
0x200F	0	Time of volume recording	Run time of volume measurement in the error status of flow measurement since the last reset/power-on (s)	0 … 2^{32} – 1	R	R	R		

1) Authorisation group: U = user, M = maintenance, S = specialist; Access: R = read, R/W = read and write

2) For bidirectional variants only

3) For unidirectional variants only

4) Standard value for SFAH-0.1... and SFAH-0.5...

5) Not selectable for SFAH-50..., SFAH-100... and SFAH-200... variants

6) Not selectable for SFAH-0.1..., SFAH-0.5... and SFAH-1... variants

7) Pin 2 for SFAH-...-M8; pin 3 for SFAH-...-L1

8) Pin 4 for SFAH-...-M8; pin 2 for SFAH-...-L1

Tab. 17 Device-specific parameters

9.7 IO-Link Teach-In

The remote Teach-In procedure via IO-Link is the same as the manual one. Instead of a press of the key, the teaching points are accepted with the help of the corresponding commands from IO-Link Smart Sensor Profile. The chronological order of determining teaching points also does not matter here.

IO-Link Teach-In, just as the local Teach-In, is only available for flow monitoring channels BDC1 (OutA) and BDC2 (OutB). All switching point functions require two accepted Teach-In flow rates.

In case of an overflow event every Teach command causes the ISDU error “Function temporarily unavailable” 0x8036, and the Teach-In procedure is cancelled. If the Teach-In procedure was not yet started, the device will remain in the run mode.

The sensor starts the Teach-In procedure as soon as a successful Teach-In command is sent. It sets the corresponding Teach point, the Teach status, the status “Successfully accepted” and waits for the second command. Keys A, B and EDIT are blocked. The display flashes alternately [t-IN / IO.link] until either the Teach-In procedure is successfully completed or aborted. The display shows the currently measured process value.

In contrast to the manual Teach-In procedure, a Teach point can be repeatedly set with the commands 0x41, 0x42, 0x43 and 0x44. In this process, the chronological order of determining the Teach points TP1 or TP2 does not matter.

In case an invalid command with respect to the current switching / Teach-In mode is sent, the device will signal the ISDU error “Function temporarily unavailable” 0x8036.

If the first Teach command comes again before the second one, then the currently measured process value will be used again for the first Teach point. After sending of the second Teach command, all successfully calculated switching points will be immediately accepted and the remote Teach-In procedure will end. The “Teach apply” command 0x40 is not used during the Teach-In process.

All Teach-In commands are in the format UInterger8. They must be sent with the index 0x0002 (system command) sub-index 0.

There is also a specific Teach-In command 0x4B, which is used in IODD to simulate key pressing in the IODD device tool. This command reflects the logic of the manual Teach-In and operates analogous to the local Teach-In via display and keys. Additionally, this command can ease the use of the Teach-In functions provided by IO-Link for customer applications.

- In the threshold value comparator mode, the first sending of this command equates to the “SP1 two value Teach TP1” command 0x43 and the second sending equates to the “SP1 two value Teach TP2” command 0x44.
- In the window comparator mode, the first sending equates to the “SP1 single value Teach” command 0x41 and the second equates to the “SP2 single value Teach” command 0x42.

For more information see IO-Link Smart Sensor Profile.

Overview of the Teach-In command sequence

					Mode		
					_I¯	_I¯I_	d_I¯I_
					Single-point mode	Window mode	Window mode
					Threshold value comparator	Window comparator	Auto difference monitoring[1]
No.	**Action**	**Out**	**Index**	**Sub-Index**	**Data**		
1	Select switching function[2]	A	0x003D	0x02	0x01	0x02	0x80
		B	0x003F	0x02			
2	Select BDC	A	0x003A	0x00	0x01		
		B	0x003A	0x00	0x02		
i	Single Value Teach-In					✓	✓
	Two Value Teach-In				✓		
3	Create the first Teach value						
4	SP1 Single Value Teach		0x0002	0x00		0x41	0x41
	SP1 Two Value Teach TP1		0x0002	0x00	0x43		
5	Create the second Teach value						
6	SP2 Single Value Teach		0x0002	0x00		0x42	0x42
	SP1 Two Value Teach TP2		0x0002	0x00	0x44		
i	Cancel Teach-In (always possible during active Teach-In process)		0x0002	0x00	0x4F		

1) Teach-In is available only for limits of the work range (SP.Lo and SP.Hi).

2) Changing the switching function can cause inconsistent parameters for switchpoint modes SP1, SP2, HY. This prevents a change of the switching function. A corresponding error message is displayed. In this case, restoring the factory settings is recommended. With the factory settings, a free choice of a switching function is always possible.

Tab. 18 Teach-In commands

9.8 Block parameterisation

This function can prevent sending of invalid parameters to a device. Individually sent parameter values are possibly not compatible with the parameter values already stored in the device. All parameters transmitted as a block will be simultaneously accepted and activated. There are four blocks of parameters for the SFAH.

9.8.1 Block parameterisation for BDC1 (OutA)

Index	Sub-Index	Name	Description
0x003C	1	Setpoint SP1	Threshold value SP1
	2	Setpoint SP2	Threshold value SP2
0x003D	2	Switchpoint mode (Fctn)	Switchpoint mode (Fctn)
	3	Hysteresis (HY)	Hysteresis (HY)
0x0112	0	Auto difference monitoring, max. signal delta (s.obS)	Limit value for a constant signal
0x0113	0	Auto difference monitoring, time delta (t.obS)	Time period for a constant signal
0x0114	0	Auto difference monitoring, switchpoint delta (d.SP)	Determination of the monitoring area

Tab. 19 Block of OutA coherent parameters

9.8.2 Block parameterisation for BDC2 (OutB)

Index	Sub-Index	Name	Description
0x003E	1	Setpoint SP1	Threshold value SP1
	2	Setpoint SP2	Threshold value SP2
0x003F	2	Switchpoint mode (Fctn)	Switchpoint mode (Fctn)
	3	Hysteresis (HY)	Hysteresis (HY)
0x0130	0	Auto difference monitoring, max. signal delta (s.obS)	Limit value for a constant signal
0x0131	0	Auto difference monitoring, time delta (t.obS)	Time period for a constant signal
0x0132	0	Auto difference monitoring, switchpoint delta (d.SP)	Determination of the monitoring area

Tab. 20 Block of OutB coherent parameters

9.8.3 Block parameterisation for BDC3 (pulse)

Index	Sub-Index	Name	Description
0x4000	1	Setpoint SP1	Threshold value SP1
0x0149	0	Pulse impulse length	Puls impulse length

Tab. 21 Block of coherent Pulse parameters

9.8.4 Block parameterisation for analog output

Index	Sub-Index	Name	Description
0x016A	0	Analog output scaling (In.Lo)	Entrance area starting value (In.Lo) in %FS
0x016B	0	Analog output scaling (In.Hi)	Final value of entrance area (In.Hi) in %FS

Tab. 22 Block of coherent parameters for the analog output

9.9 Process data IN

Bit	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8
Meaning	Not used		MSB													LSB
Process data			PDV flow													
Data content			14 bit PDV measured value (InA)													
Index			0x0028													
Sub-Index			1													
Data type			UInteger14													

Bit	7	6	5	4	3	2	1	0
Process data	Not used					BDC3	BDC2	BDC1
Data content						Pulse	OutB	OutA
Index						0x0028		
Sub-Index						2	3	4
Data type						Boolean		

Tab. 23 Mapping the IN process data

9.10 Conversion factors

The conversion factors are necessary for the correct representation of the measurement values and process value related parameters in different physical units in the control unit.
The conversion factors of the volume units are valid for reference standard DIN1343 and the media gas air.

– For other reference standards and media gases, use the scaling factors for gradient and offset from the following chapters:
  ➔ Chapter 9.10.4 Scaling factors for different standards
  ➔ Chapter 9.10.4 Scaling factors for different gases for gradient and offset.

9.10.1 Conversion factors for process data variable, process data variable min, process data variable max, and setpoint values SP1, SP2

Range		Flow units				
[l/min.]		l/min	l/h	scft/min	scft/h	g/min
-0.1 ... 0.1	G[1)]	0.000012207776	0.000732466581	0.000000431114	0.000025866838	0.000015783434
	O[1)]	-0.1	-6	-0.00353147	-0.2118882	-0.12929
-0.5 ... 0.5	G	0.000061038882	0.003662332906	0.000002155570	0.000129334188	0.00007891717
	O	-0.5	-30	-0.01765735	-1.059441	-0.64645
-1 ... 1	G	0.000122077764	0.007324665812	0.000004311140	0.000258668376	0.00015783434
	O	-1.0	-60	-0.03531470	-2.118882	-1.2929
-5 ... 5	G	0.000610388818	0.036623329061	0.000021555698	0.001293341879	0.000789171702
	O	-5.0	-300	-0.1765735	-10.59441	-6.4645
-10 ... 10	G	0.001220777635	0.073246658121	0.000043111396	0.002586683758	0.001578343405
	O	-10	-600	-0.35314700	-21.18882	-12,929
-50... 50	G	0.006103888177	0.366233290606	0.000215556980	0.012933418788	0.007891717024
	O	-50	-3000	-1.76573500	-105.9441	-64,645
-100 ... 100	G	0.012207776354	0.732466581212	0.000431113960	0.025866837576	0.015783434047
	O	-100	-6000	-3.53147000	-211.8882	-129.29
-200 ... 200	G	0.024415552707	1.464933162424	0.000862227919	0.051733675151	0.031566868095
	O	-200	-12000	-7.06294000	-423.7764	-258.58

1) Gradient, O = offset

Tab. 24 Conversion factors for process data variable, process data variable min, process data variable max, and setpoint values SP1, SP2

9.10.2 Conversion factors for the hysteresis, switchpoint d.SP and max signal delta (s.obS)

Range		Flow units				
[l/min.]		l/min	l/h	scft/min	scft/h	g/min
-0.1 ... 0.1	G[1)]	0.000012207776	0.000732466581	0.000000431114	0.000025866838	0.000015783434
	O[1)]	0	0	0	0	0
-0.5 ... 0.5	G	0.000061038882	0.003662332906	0.000002155570	0.000129334188	0.00007891717
	O	0	0	0	0	0
-1 ... 1	G	0.000122077764	0.007324665812	0.000004311140	0.000258668376	0.00015783434
	O	0	0	0	0	0
-5 ... 5	G	0.000610388818	0.036623329061	0.000021555698	0.001293341879	0.000789171702
	O	0	0	0	0	0
-10 ... 10	G	0.001220777635	0.073246658121	0.000043111396	0.002586683758	0.001578343405
	O	0	0	0	0	0
-50... 50	G	0.006103888177	0.366233290606	0.000215556980	0.012933418788	0.007891717024
	O	0	0	0	0	0
-100 ... 100	G	0.012207776354	0.732466581212	0.000431113960	0.025866837576	0.015783434047
	O	0	0	0	0	0
-200 ... 200	G	0.024415552707	1.464933162424	0.000862227919	0.051733675151	0.031566868095
	O	0	0	0	0	0

1) Gradient, O = offset

Tab. 25 Conversion factors for hysteresis, switchpoint d.SP and max signal delta (s.obS)

9.10.3 Conversion factors for volume / mass units

Range		Volume /mass units		
[l/min.]		l	scft	G
-0.1 ... 0.1	Gradient	0.000006103888	0.000000215557	0.000007891717
	Offset	0	0	0
-0.5 ... 0.5	Gradient	0.000030519441	0.000001077785	0.000039458585
	Offset	0	0	0
-1 ... 1	Gradient	0.000061038882	0.000002155570	0.000078917170
	Offset	0	0	0
-5 ... 5	Gradient	0.000305194409	0.000010777849	0.000394585851
	Offset	0	0	0
-10 ... 10	Gradient	0.000610388818	0.000021555698	0.000789171702
	Offset	0	0	0
-50... 50	Gradient	0.003051944088	0.00010777849	0.003945858512
	Offset	0	0	0
-100 ... 100	Gradient	0.006103888177	0.00021555698	0.007891717024
	Offset	0	0	0
-200 ... 200	Gradient	0.012207776354	0.00043111396	0.015783434047
	Offset	0	0	0

Tab. 26 Conversion factors for volume / mass units

9.10.4 Scaling factors for standards

Instead of:	Standard	Factor
DIN 1343	ISO 2533	1.055
	ISO 6358	1.087

Tab. 27 Scaling factors for standards

9.10.5 Scaling factors for gases

Instead of:	Gas	Factor
Air	Nitrogen (N2)	0.987

Tab. 28 Scaling factors for gases

9.11 Fault clearance IO-Link

Event code	Event type	Mode	Device status	Local display	Possible cause	Remedy
0x1802	Error	Event appears (disappears)	Failure	Main display: Er02 Sub-display: ASIC	IO-Link driver failure	Replace sensor
0x1803	Error	Event appears (disappears)	Failure	Main display: Er03 Sub-display: SEnS	Sensor unit failure Device defective	Replace sensor
0x1809	Warning	Event appears (disappears)	Outside the specification	Main display: measurement value of sub-display: Er09 / UNdR	Range of flow detection InA not reached	Maintain specified range
0x180A	Warning	Event appears (disappears)	Outside the specification	Main display: measurement value Sub-display: Er10 / OVER	Flow detection range InA has been exceed	Maintain specified range
0x1815	Error	Event appears (disappears)	Outside the specification	Main display: measurement value Sub-display: Er21 / SHRt	Overload or short circuit at the switching output OutA/Puls	Eliminate short circuit
0x1816	Error	Event appears (disappears)	Outside the specification	Main display: measurement value Sub-display: Er22 / SHRt	Overload or short circuit at the switching output OutB	Eliminate short circuit

Event code	Event type	Mode	Device status	Local display	Possible cause	Remedy
0x181F	Notification	Simple message	Device is operating properly	No effect	Volume / mass recorder overflow	
0x4000	Error	Event appears (disappears)	Failure	Main display: measurement value Sub-display: Er20/ tEMP	Temperature error in IO-Link driver	Eliminate short circuit/overload (➔ Chap. 12 fault clearance)
0x5000	Error	Event appears (disappears)	Failure	Main display: Er01 Sub-display: FAIL	Device hardware fault	Replace sensor
0x5111	Warning	Event appears (disappears)	Outside the specification	Main display: measurement value Sub-display: Er17 / SUPL	Power supply too low	Check power supply

Tab. 29 IO-Link events

10 Operation

After the supply voltage is switched on, the SFAH needs a warm-up time of 10 minutes until it achieves the specified accuracy.
The flow rate displayed by the SFAH refers to the standard conditions that were set under Options in the special menu.
When comparing volumetric flow rates:

- Make sure that the volumetric flow rates to be compared (e.g. operating volume flow, amount supplied by a compressor, measured values of a flow sensor from another manufacturer) refer to the same initial conditions.

10.1 Restoring factory settings (restore)

Note

By resetting to factory settings, the current settings are lost.

- If required, make a note of these settings before resetting

But resetting is also possible over an IO-Link command ➔ Tab. 15.

1. Switch off the operating voltage.
2. Keep the A- and B-keys pressed down simultaneously.
3. Switch on the operating voltage.
4. Additionally press the Edit button.
   ➔ [RSto PArM] appears. All parameters are reset to the factory settings.

11 Disassembly

1. Turn off energy source and compressed air.
2. Separate connections from the sensor.
3. Loosen the mountings.

12 Fault clearance

Fault clearance under IO-Link ➔ Chapter 9.11

Malfunction	Possible cause	Remedy
No display	No operating voltage or impermissible operating voltage	• Apply permissible operating voltage
	Electrical connections swapped	• Connect the device in accordance with the circuit diagram
	Device defective	• Replace device
	Eco mode on	• Press key or switch off Eco mode
Indicator or switching output does not react as expected	Short circuit or overload at the output	• Eliminate short circuit or overload
	Incorrect switching point taught (e.g. at 0 l/min)	• Repeat Teach procedure
	Incorrect standard condition set for volumetric flow rate	• Correct standard condition
	Device defective	• Replace device
	Parameter incorrect	• Reset to factory settings
[Er01] / [FAIL][1)]	Device defective	• Replace device
[Er02] / [ASIC][1)]	Device defective	• Replace device
[Er03] / [SEnS][1)]	Device defective	• Replace device
[Er09] / [UndR]	Below sensing range	• Stay in sensing range
[Er10] / [OVER]	Sensing range exceeded	• Stay in sensing range
[Er17] / [SUPL][2)]	Undervoltage	• Maintain permissible operating voltage
[Er20] / [t.Hi][2)]	Temperature error	• Check operating conditions • Check ambient temperature • Check wiring • Replace device
[Er21] / [SHRt][2)]	Short circuit at OutA/Puls	• Eliminate short circuit
[Er22] / [SHRt][2)]	Short circuit at OutB	• Eliminate short circuit
[Err] / [bUSY]	OutA/Puls is switched active in the device sensor	• Check device settings
[Err] / [Id]	Device ID error, devices do not have the same design	• When replicating, use sensor with the same flow rate measurement range (same device ID)
[Err] / [COM]	IO-Link communication error	• Check settings of the device sensor • Check line

1) Display flashes red
2) Display illuminates red

Tab. 30

13 Technical data

General	
Certification	RCM compliance mark
CE marking (➔ Declaration of conformity)	In accordance with EU EMC Directive
Note on materials	RoHS-compliant

Input signal/measuring element		
Measured variable		Volumetric flow rate, mass flow rate
Flow direction		Unidirectional, bidirectional
Measuring principle		Thermal
Warm-up time	[min]	10
Method of measurement		Heat transfer
Operating pressure	[bar] / [Mpa]	-0.9...10 / - 0.09...1
Operating medium		Compressed air to ISO 8573-1:2010 [6:4:4], nitrogen
Temperature of medium	[°C]	0...50
Ambient temperature	[°C]	0...50
Nominal conditions for determination of the accuracy specification		• Operating pressure: 0 bar (0 Mpa) relative (In calibration, the sensors are exhausted to the atmosphere) • Medium and ambient temperature: 23 °C • Analogue output: voltage with 20 kΩ load • Switching output: load current in the switched status 5 mA • Mounting position: horizontal, display upwards • Inflow: ➔ Chap. 7.3

Flow measuring range unidirectional and bidirectional		**-0.1**	**-0.5**	**-1**	**-5**	**-10**	**-50**	**-100**	**-200**
Starting value	[l/min.]	0.002	0.01	0.02	0.1	0.2	1	2	4
End value	[l/min.]	0.1	0.5	1	5	10	50	100	200

Flow measuring range bidirectional, additional		**-0.1B-**	**-0.5B-**	**-1B-**	**-5B-**	**-10B-**	**-50B-**	**-100B-**	**-200B-**
Start value	[l/min.]	-0.002	-0.01	-0.02	-0.1	-0.2	-1	-2	-4
End value	[l/min.]	-0.1	-0.5	-1	-5	-10	-50	-100	-200

Output, general		
Accuracy of zero point	[% FS]	± 1
Accuracy of span	[% FS]	± 2 (± 3 with use of the current output)
Repetition accuracy Zero point	[% FS]	± 0.2
Repetition accuracy range	[% FS]	± 0.8
Temperature coefficient of margin	[% FS/ K]	Typ. ± 0.15 (max. ± 0.3)
Temperature co-efficient zero point	[% FS/ K]	Max. ± 0.05 (typ. 0)
Pressure influence span	[% FS]	Typ. ± 1 in the pressure range - 0.7...10 bar / -0.07...0.1 MPa[1)]
Position dependency of zero point with vertical installation	[% FS/ bar]	± 0.5

1) In the pressure range -0.9...-07 bar / -0.07...0.1 MPa, an additional pressure influence span of typ. ±-4 %FS can be expected.

Switching output		
Switching output		2x PNP or 2x NPN, switchable
Switching function		Threshold value comparator, window comparator Auto difference monitoring
Switching element function		N/C contact or N/O contact, switchable
Switch-on time	[ms]	Max. 6 (with Filt=OFF)
Switch-off time	[ms]	Max. 5 (with Filt=OFF)
Max. output current	[mA]	100
Voltage drop	[V]	Max. 1
Pull-down resistor	[ms]	PNP: integrated
Pull-up resistor	[ms]	NPN: not integrated (load current of at least 2 mA required)
Inductive protective circuit		Present

Analogue output		Variant	SFAH-...U-	SFAH-...B-
Characteristic flow rate curve	[l/min.]	-0.1...-	0...0.1	-0.1...0.1
		-0.5...-	0...0.5	-0.5...0.5
		-1...-	0...1	-1...1
		-5...-	0...5	-5...5
		-10...-	0...10	-10...10
		-50...-	0...50	-50...50
		-100...-	0...100	-100...100
		-200...-	0...200	-200...200
Output characteristic curve for voltage	[V]	All	0...10 or 1...5	
Output characteristic curve for current	[mA]	All	4...20	
Rise time	[ms]	All	Max. 3 with FILT = OFF	
Max. load resistance of current output	[Ω]	All	500	
Min. load resistance Voltage output	[kΩ]	All	20	

Output, additional data	
Short circuit protection	Yes
Overload protection	Present

Electronics		
Operating voltage range DC	[V]	22...26
Idle current	[mA]	Max. 25
Reverse polarity protection		For all electrical connections

Electromechanical Components	SFAH-...-M8-	SFAH-...-L1-
Connection type	Plug	
Connection technology	M8x1, A-coded, to EN 61076-2-104	Plug pattern L1J
Number of pins/wires	4	
Max. connecting cable length [m]	30 (20 for IO-Link operation)	

Mechanical		
Installation position		Optional
Pneumatic port		➔ Fig. 1, Tab. 8
Product weight	[g]	Approx. 90
Information on housing materials		Reinforced polyamide
Materials in contact with medium		– NBR – PA reinforced – High-alloy stainless steel – Wrought aluminium alloy, anodised – Silicon – Silicon nitride – Epoxide

Display/operation	Variant	
Displayable units[1)]	-0.1...- -0.5...- -1...-	l/min, l/h, scft/h, g/min, l, scft, g
	-5...- -10...-	l/min, l/h, scft/min, scft/h, g/min, l, scft, g
	-50...- -100...- -200...-	l/min, scft/min, scft/h, g/min, l, scft, g

1) The following volumes / load units are permanently assigned to the flow rate units:
l/min, l/h - l | scft/min, scft/h - scft | g/min - g

Display/operation		Variant	
Setting range, threshold value volume		-0.1	0.001...*9.999* l; 0.001...*9.999* sft³; 0.001...*9.999* g
		-0.5 -1	0.01...*99.99* l; 0.001...*9.999* sft³; 0.01...*99.99* g
		-5	0.1...*999.9* l; 0.001...*9.999* sft³; 0.1...*999.9* g
		-10	0.1...*999.9* l; 0.01...*99.99* sft³; 0.1...*999.9* g
		-50	1...*9999* l; 0.01...*99.99* sft³; 1...*9999* g
		-100 -200	1...*9999* NL; 0.1...*999.9* sft³; 1...*9999* g
Zero range hiding	[% FS]	All	‹ 1.5 (Z.Adj = OFF)

Immissions/emissions		-0.1	-0.5	-1	-5	-10	-50	-100	-200
Storage temperature	[°C]	-20...80							
Degree of protection		IP40							
Maximum permissible leakage	[l/h]	0.1							
Pressure drop with 6 bar at input and q max.	[mbar]	‹5					12	15	16
Pressure drop with 0.6 MPa at the input and q max.	[kPa]	‹5					1.2	1.5	1.6
Pressure drop with 0 bar at the output and q max.	[mbar]	‹5					75	100	300
Pressure drop with 0 MPa at the output and q max.	[kPa]	‹5					7.5	10	30
Standard nominal flow rate (6 -› 5 bar / 0.6 -› 0.5 MPa)	[l/min.]	57	93	121	361	445	458	490	870

14 Example for calculating the maximum display error

Measurement range of flow rate: 1 ... 50 l/min (FS = 50 l/min)
Measured value: 35 l/min

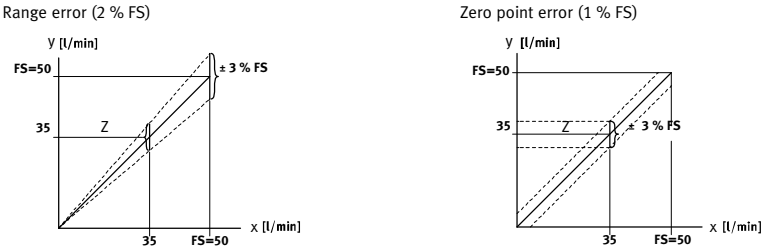


Fig. 2

x= measured variable, y= measured value (display), z= maximum display error

Range error and zero point error with nominal conditions:
The range error is proportional to the measured value. With the measurement value 35 l/min, the range error is 35/50 of 2 % of 50 l/min = 0.7 l/min.
The zero point error is independent of the measured value. It is 1 % of 50 l/min (FS) = 0.5 l/min.

Display error with nominal conditions (0 bar relative, 23 °C):
The display error at nominal conditions is the result of adding the range and zero error.
The actual flow rate is therefore in the range of 35 ± (0.7 +0.5) l/min = 35 ± 1.2 l/min.

Display error with deviating nominal conditions (e.g. 6 bar relative, 40 °C, mounting position vertical and display toward the front):
Typical temperature and pressure errors are range errors. The temperature error at 40 °C and the measurement value 35 l/min is 35/50 of 0.15 % of 50 l/min * (40 °C – 23 °C) = ± 0.89 l/min.
The pressure error at 6 bar and the measurement value 35 l/min is 35/50 of 1 % of 50 l/min = ± 0.35 l/min.
The error due to position dependence is a zero point error. This error, with vertical mounting position and display forward, with the measured value 35 l/min = 0.5 % of 50 l/min * 6 = ± 1.5 l/min.
The display error with deviating nominal conditions results from adding all of the error values (range, zero point, temperature, pressure and mounting position).
The actual flow rate is in the range of 35 ± (0.7 + 0.5 + 0.89 + 0.35 + 1.5) l/min = 35 ± 3.94 l/min.

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