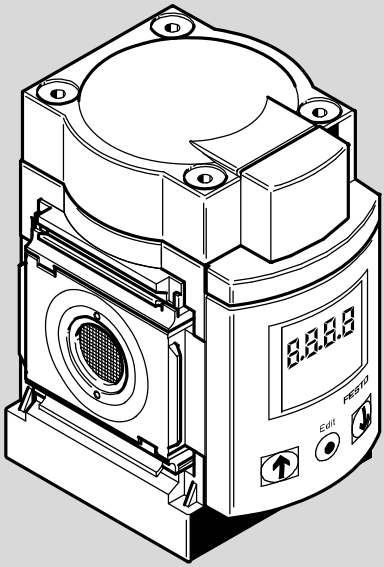
Flow Sensor

SFAM



FESTO

en Operating instructions

8078141
2017-09c
[8068109]

Original instructions
SFAM-EN

Identification of hazards and instructions on how to prevent them:

Danger
Immediate dangers which can lead to death or serious injuries

Warning
Hazards that can cause death or serious injuries

Caution
Hazards that can cause minor injuries

Other symbols:

Note
Material damage or loss of function

Recommendations, tips, references to other documentation

Essential or useful accessories

Information on environmentally sound usage

Text designations:
- Activities that may be carried out in any order

1. Activities that should be carried out in the order stated

– General lists

➔ Result of an action/References to more detailed information

English – Flow Sensor SFAM

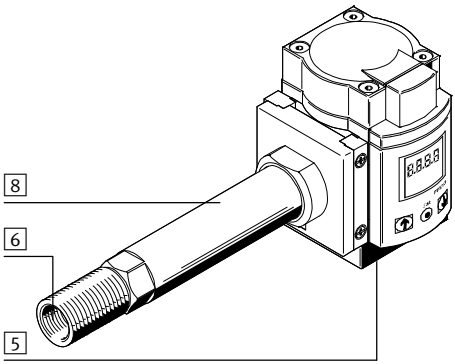
Table of contents

1 Product description

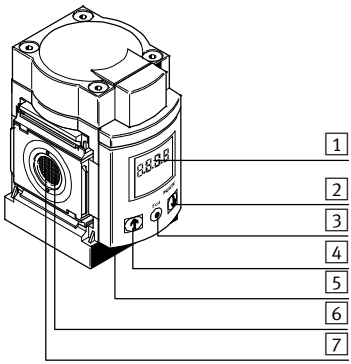
For all available product documentation ➔ www.festo.com/pk

1.1 Overview

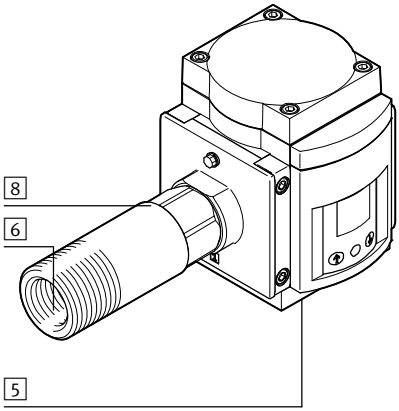
SFAM-62- ... -T



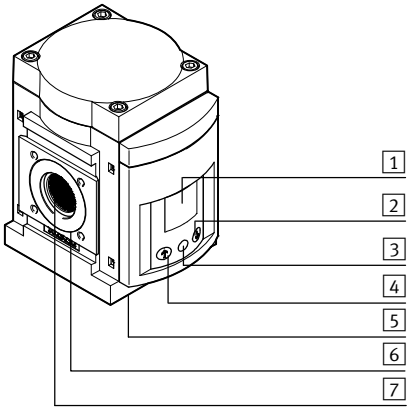
SFAM-62- ... -M



SFAM-90- ... -T



SFAM-90- ... -M



1 Display
2 B pushbutton
3 Edit button
4 A pushbutton
5 Plug for electrical connection
6 Supply port
7 Laminar flow cartridge
8 Stabilizing zone

Fig. 1 Operating elements and ports

1.2 Characteristics

Feature	Order code	Specification
Type	SFAM	Flow sensor
Grid dimension	-62	62 mm
	-90	90 mm
Flow measuring range	-1000[1)]	Max. 1000 l/min
	-3000[1)]	Max. 3000 l/min
	-5000	Max. 5000 l/min
	-10000[2)]	Max. 10000 l/min
	-15000[2)]	Max. 15000 l/min
Flow input	L	Unidirectional from left
	R	Unidirectional from right
Type of mounting	-M	Manifold assembly
	-T	Threaded mounting
	-W[1)]	Threaded mounting with wall fastener
Pneumatic connection	G12[1)]	G½
	N12[1)]	½" NPT
	G1[2)]	G1
	N1[2)]	1" NPT
	G112[2)]	G1½
	N112[2)]	1½" NPT
Electrical output	-2SA	2x PNP or NPN, 1 analogue output 4 ... 20 mA
	-2SV	2x PNP or NPN, 1 analogue output 0 ... 10 mA
Electrical connection	-M12	Plug connector; M12x1, 5-pin; A-coded
Electrical accessories[3)]	-2.5S	Connecting cable, straight socket, cable length 2.5 m
	-5S	Connecting cable, straight socket, cable length 5 m
	-2.5A	Connecting cable, angled plug socket, cable length 2.5 m
	-5 A	Connecting cable, angled plug socket, cable length 5 m

1) Only SFAM-62

2) Only SFAM-90

3) Included in the scope of delivery.

Tab. 1 Overview of variants

1.3 Factory settings

Settings	Menu item	Value/function
[SPEC]		
Standard conditions	[Option]	OFF (=DIN 1343)
Physical unit for flow rate	[FLW]	l/min
Filter time constant	[AnA.F]	A.60
Digital filter	[diG.F]	d.2
Physical unit for consumption	[ConS]	l
Switching output		PnP
Security code	[lock]	OFF
[OutA]		
Measured variable		FLW (flow rate)
Switching function		[Threshold value comparator]
Switching point	[SP]	40 % FS
Hysteresis	[Hy]	2 % FS
Switching element functions		NO (normally open contact)
Consumption switching impulse	[Ci]	30 l at FS = 1000 l/min 100 l at FS = 3000 l/min 150 l at FS = 5000 l/min 300 l at FS = 10000 l/min 500 l at FS = 15000 l/min
[OutB]		
Switching function		[Threshold value comparator]
Switching point	[SP]	60 % FS
Hysteresis	[Hy]	2 % FS
Switching element function		NO (normally open contact)
Change in colour of display		Blue (function deactivated)

Tab. 2 Factory settings

2 Function and application

The SFAM is designed to monitor changes in the flow rate and air consumption/air volume for suitable media in piping systems or terminals in industry; for suitable media ➔ Chapter 11 Technical data.
The design enables stand-alone operation of (SFAM-...-T) or assembly with service units of the MS series (SFAM-...-M).
Measurement is carried out by means of a thermal procedure. Here, the amount of heat drawn from a heated surface of the sensor by the medium flowing past it is calculated. Through the amount of heat removed, the flow rate or accumulated air consumption is determined and shown on the display. The connection to higher-level systems is implemented through 2 binary outputs (Out A/B) and one analogue output (Out C). The switching points for both binary outputs are adjustable for flow rate measurement. To measure air consumption, a consumption switching impulse is adjustable for output

A (Out A). The combination of air consumption measurement (Out A) and flow rate measurement (Out B) is possible. The flow rate value is passed on via the analogue output (Out C).

2.1 Operating statuses

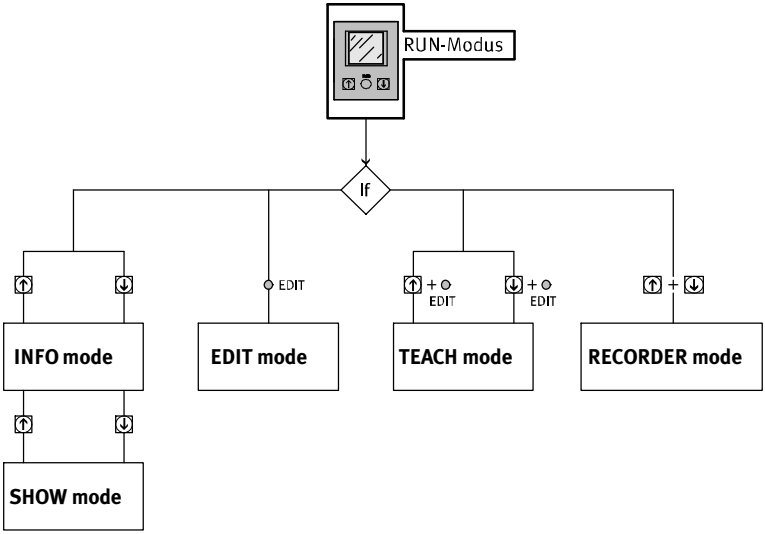


Fig. 2 SFAM operating statuses

RUN mode

In the RUN mode, the following are displayed:

- the measurement values for the flow rate (in l/min or scfm)
- the measurement values for air consumption (in m³, scf or l) and
- the signal statuses of the switching outputs Out A, Out B (set, not set).

INFO mode

In INFO mode, when air consumption measurement is active, the display of input variables (flow rate, air consumption) can be switched quickly in the display. The display can be switched by pressing the A pushbutton or B pushbutton.

SHOW mode

In SHOW mode, the current settings for the switching outputs Out A and Out B, as well as the min/max values for the flow rate or air consumption measurement, are displayed. The min/max values can be reset.

EDIT mode

In EDIT mode, the settings for the flow sensor (switching outputs, standard condition, physical unit, etc.) can be made or changed.

TEACH mode

In TEACH mode, the switching points can be taught.

RECORDER mode
In the RECORDER mode, a manual air consumption measurement can be performed.

2.2 Function range

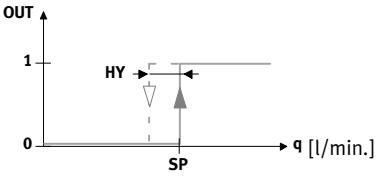
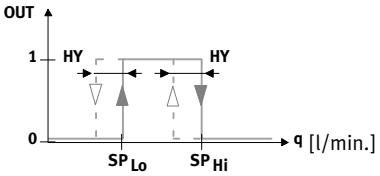
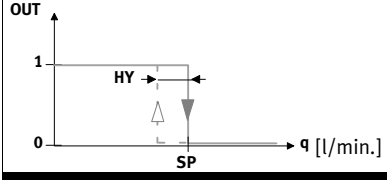
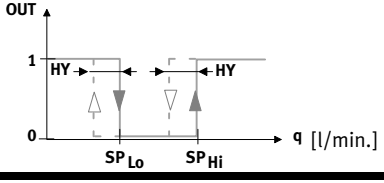
2.2.1 Switching outputs

Configuration of the switching outputs
Switching output Out A:
This can be done either with the physical input variable flow rate [FLW] or the air consumption measurement [ConS] derived from it.

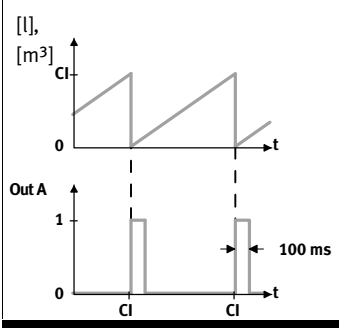
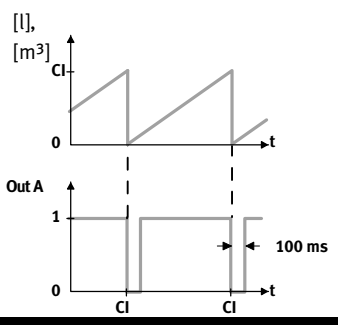
Switching output Out B:
can only be used with the physical input variable flow rate.

Switching outputs Out A/Out B can be configured according to the setting range in the technical data ➔ Tab. 13.
For the switching output Out A and Out B, the switching function threshold value or window comparator can be selected independently of one another. Each switching output can have the switching element function N/C contact (NC – normally closed) or N/O contact (NO – normally open) separately allocated to it ➔ Tab. 3.

Switching points [SP] and hysteresis [HY] can be set corresponding to the setting ranges in the technical data table ➔ Tab. 13.

Switching point and hysteresis with flow rate measurement for Out A/Out B	
Threshold value comparator	**Window comparator**
Switching element function NO (normally open contact)	
	
Switching element function NC (normally closed contact)	
	

Tab. 3 Switching point SP and hysteresis Hy setting

Consumption switching impulse [CI] with air consumption measurement	
Setting NO (normally open)	**Setting NC (normally closed)**
	

Tab. 4 Consumption switching impulse

A threshold value for air consumption can be set with the consumption switching impulse [CI]. If the set threshold value is reached, a switching impulse is emitted at the output Out A for 100 ms. With each switching impulse, measurement of the air consumption is started again.

2.2.2 Change in colour

A red colour change can be set for Out B, dependent on the switching status. This allows the system status to be seen across large distances.

The following settings can be chosen:

r.On = Display is red when the switching output is High (1).
Display is blue if the switching output is Low (0).

r.OFF = Display is red when the switching output is Low (0).
Display is blue if the switching output is High (1).

bLUE = Display is always blue; the colour change function is switched off.

2.2.3 Standard conditions

The air mass flow measured and output by the SFAM refers to standard conditions. The SFAM is calibrated at the factory to the physical standard conditions in accordance with DIN 1343 and the unit l/min.

Note
If standard conditions and/or other units that deviate from the calibrated measurement range with the unit l/min are used, there are corresponding characteristic limits for the analogue output ➔ Tab. 16 in Chapter 11 Technical data.

The following standard conditions can be selected in the menu item [Option] ➔ Chapter 5.5.3 Set special menu [SPEC].

Option		Off	1	2
Standard litres as per		DIN 1343	ISO 2533	ISO 6358
Air pressure (absolute)	[bar]	1.01325	1.01325	1
Air pressure (absolute)	[kPa]	101.325	101.325	100
Temperature	[°C]	0	15	20

Tab. 5 Standard conditions

2.2.4 Analogue filter

With the analogue filter, the filter time constant of all output signals can be changed. This changes the rise time at the analogue output (➔ Fig. 3).

2.2.5 Digital filter

The display values can be smoothed with the digital filter. The degree of smoothing can be set in 6 steps from d1 = low smoothing to d6=maximum smoothing. With increasing smoothing, the switch-on/switch-off time of the switching outputs rises. In case of d.Off, the switching times depend only on the set filter time constant of the analogue filter (➔ Fig. 3).

Signal flow from the analogue filter and digital filter

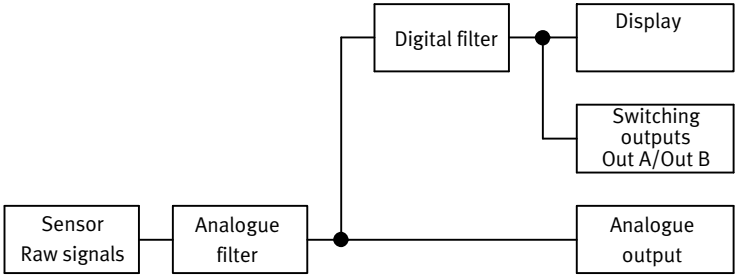


Fig. 3 Signal flow from the analogue filter and digital filter

2.2.6 Security code

To protect the setting from unauthorized access, a numerical code of up to 4 digits can be set.
The security code must be entered each time the settings are changed (EDIT mode and TEACH mode).

2.2.7 Min/max values

In SHOW mode, the min/max values for a flow rate measurement or an air consumption measurement can be shown and reset ➔ Chapter 5.4.

Note
Switching off the supply voltage resets the min/max values.

3 Requirements for product use

Warning
Depending on the functioning of the machine/system, manipulation of signal statuses may cause serious personal injury.
- Note that if the switching characteristics of the outputs are modified in Edit mode, the new characteristics will become effective immediately.
- Enable the password protection option (security code) to prevent accidental alteration by an unauthorised third party ➔ Chapter 5.5.3, section “Setting the security code”.

Warning
Use of the product in combination with prohibited media can result in personal injury.
- Do not use the product in conjunction with inflammable gases, corrosive gases, oxygen, etc. The product is intended only for measuring the flow rate of the media listed as suitable in Chapter 11 Technical data.

Caution
Condensation water, oil mist, foreign matter and other dirt in the compressed air can damage the product and cause incorrect measurements and malfunctions.
- Make sure that the specified air quality class is maintained for the operating medium ➔ Chapter 11 Technical data.

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.

- Compare the limit values specified in these operating instructions with those of your actual application (e.g. operating media, pressures, forces, torques, temperatures, loads, speeds, operating voltages, flow rates).
- Take the ambient conditions at the location of use into consideration.
- Remove all transport packing, such as protective wax, foils (polyamide), caps (polyethylene), cardboard boxes (except for the sealing elements of the pneumatic connections).
  The material used in the packaging has been specifically chosen for its recyclability (exception: oiled paper = residual waste).
- Use the product in its original status. Unauthorised modification is not permitted.

4 Installation

4.1 Mechanical/pneumatic installation

The mounting position is horizontal ±5 %. Mount the SFAM as follows:

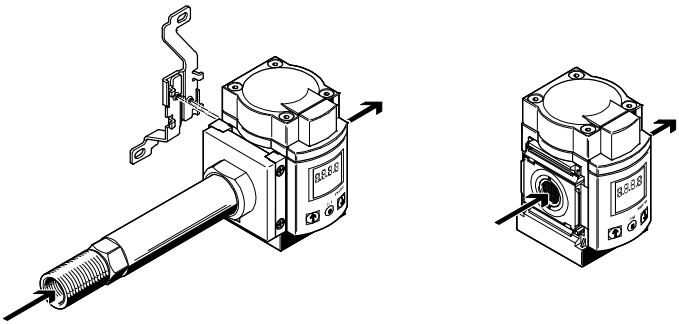


Fig. 4 Mechanical/pneumatic installation

Note
Information about mounting of the module connector, sub-base and mounting bracket (mounting bracket only for SFAM-62) can be found in the operating instructions enclosed with the relevant accessories.

The air mass flow is routed to the connection at which the laminar flow cartridge (for SFAM-...-M) or the stabilising zone (for SFAM-...-T/-W) is located. The air mass flow is taken from the opposite connection (➔ Fig. 4).

Minimum requirements of pneumatic connection
Depending on the grid dimension, the following minimum requirements are to be observed for the pneumatic connection:

SFAM	MS series pneumatic connection	Internal supply line diameter [mm]
-62	½”	10
-90	¾”	20

Tab. 6 Minimum requirements of pneumatic connection

Assembly with MS series service units
When assembled with an existing service unit of the MS series:
1. Observe the flow direction.
2. Install the SFAM only after installing service units which conform to the degree of filtration (air quality class 7.4.4.: 40 µm residual dust, +3 °C pressure dew point, 1 mg/m³ residual oil content).

Note
The compressed air must not contain ester oils.

Note
The SFAM must not be installed directly behind a pressure regulator or filter regulator to comply with the specified accuracies.
- After the filter regulator MS…-LFR or pressure regulator MS…-LR , build a branching module upstream of SFAM.
  – Grid dimension 62: MS…-FRM-½
  – Grid dimension 90: MS…-FRM-¾

3. Place the module connectors type MS…-MV in the slots of the individual devices. Accordingly, a seal is required between the individual devices.
4. Fasten the module connectors type MS…-MV with 2 screws.

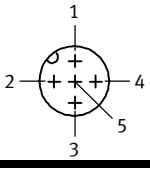
4.2 Electrical connection

Warning
Only use power sources which guarantee reliable electrical isolation of the operating voltage according to IEC/DIN EN 60204-1. Also observe the general requirements for PELV power circuits according to IEC/DIN EN 60204-1.
Switched-mode power supplies are permitted, provided that they ensure reliable separation in accordance with EN 60950/VDE 0805.

Note
Long signal lines pick up more interference.
- Make sure that the signal lines are always shorter than 30 m.

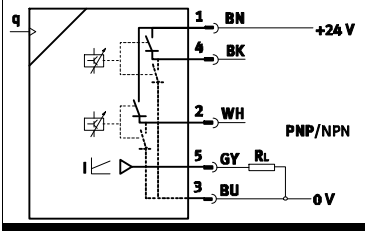
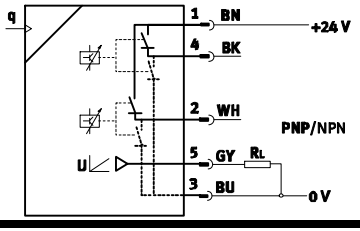
Note
The binary outputs at pin 2 and pin 4 can be wired as PNP or NPN connections as needed.
- Make sure that you also configure the binary outputs according to your wiring
  ➔ Chapter 5.5.3.

- Wire the SFAM as follows:

Pin	Allocation	Core colours[1)]	Plug connectors[2)]
1	+24 V DC operating voltage	Brown (BN)	5-pin M12 
2	Binary output B (Out B)	White (WH)	
3	0 V	Blue (BU)	
4	Binary output A (Out A)	Black (BK)	
5	Analogue output C (Out C)[3)]	Grey (GY)	

1) Using the connecting cable from the electrical accessories ➔ Chapter 1.2 Key features
2) Tightening torque for the union nut at the plug connector is max. 0.5 Nm.
3) Voltage U or current I ➔ Chapter 11 Technical data

Tab. 7 Pin allocation

Circuit diagrams	
SFAM-...-2SA	**SFAM-...-2SV**
	

Tab. 8 SFAM circuit diagrams

5 Commissioning

5.1 Symbols on the display

Symbols	Description
Out A/Out B	Switching output A/switching output B
Lock	Security code active (blocked against unauthorised programming)
Run	Accumulated air consumption measurement is active in RECORDER mode.
Option	The sensor is set to a standard condition that differs from the factory setting. ➔ Chapter 5.5.3 Setting standard conditions [option] section
Stop	Reset air consumption measurement value
■ □	Switching output set/not set
_⌐¯	Threshold value comparator
_⌐¬_	Window comparator
Cons	Air consumption switching mode (consumption – only for Out A)

Symbols	Description
CI	Trigger level for consumption switching impulse (consumption impulse)
SP	Switching point
SP.Lo	Lower switching point (switching point – low)
SP.Hi	Upper switching point (switching point – high)
HY	Hysteresis
no	Contact (normally open)
nc	Contact (normally closed)
FLOW	Switching mode flow rate (flow – only for Out A)
F.Lo	Minimum flow rate (flow low)
F.Hi	Maximum flow rate (flow high)
SPEC	Special menu
AnAF	Analogue filter
d IGF	Digital filter
r.On	Display red with switching status ON and/or logic 1 (for Out B)
r.OFF	Display red with switching status OFF and/or logic 0 (for Out B)
PnP	Positive switch output
nPn	Zero switch output
■■■■■□□□□□	Segments illuminated: Graphic display of the current measured value related to the maximum measured value of the measuring range
□□■□□□□□□□	Running light (1 segment): Air consumption measurement for Out A or RECORDER mode active
□□■■■□□□□□	3 segments flash: Hysteresis value is displayed
□□□□□■□□□□	1 segment flashes: – Segment 6: Switching point SP or SP.Lo is displayed – Segment 8: Switching point SP.Hi is displayed – Segment 1: Min. flow rate (F.Lo) is displayed – Segment 10: Max. flow rate (F.Hi) is displayed

Tab. 9 Symbols on the display

5.2 Symbols for representing the menu structure

Symbol	Significance
	Automatic return to the basic status (RUN mode) when the monitoring time has expired (here 80 seconds)
	In order to return manually to the basic status (RUN mode), press the EDIT button for 3 seconds
	Generate flow rate (for teaching the measured value – here Flow 1)

Symbol	Significance
	The symbol on the display flashes (here: Out B)
	Security code active (lock – blocked against unauthorised programming)
	Security code inactive (Lock)
	Press pushbutton (here: A pushbutton).
	Press the A pushbutton or B pushbutton. The SFAM then switches to the setting indicated by the arrow.
	Press the A pushbutton and B pushbutton simultaneously
	Press pushbutton (here A pushbutton) and the EDIT button simultaneously
	Press A pushbutton or B pushbutton and thus set the desired value
	A momentary display (here [ANA.F]) means that a value can be displayed.
	Display for a value or switching point. Value can be set.
	Press the Edit button
	Branch in the menu The setting last selected in the EDIT mode is indicated in the SHOW mode

Tab. 10 Symbols for representing the menu structure

5.3 RUN mode

In the basic status, the product is in RUN mode. The current measured value is displayed. The basic status can be reached from other modes by:

– Pressing the Edit button for 3 seconds or
– Expiration of a monitoring time, timeout

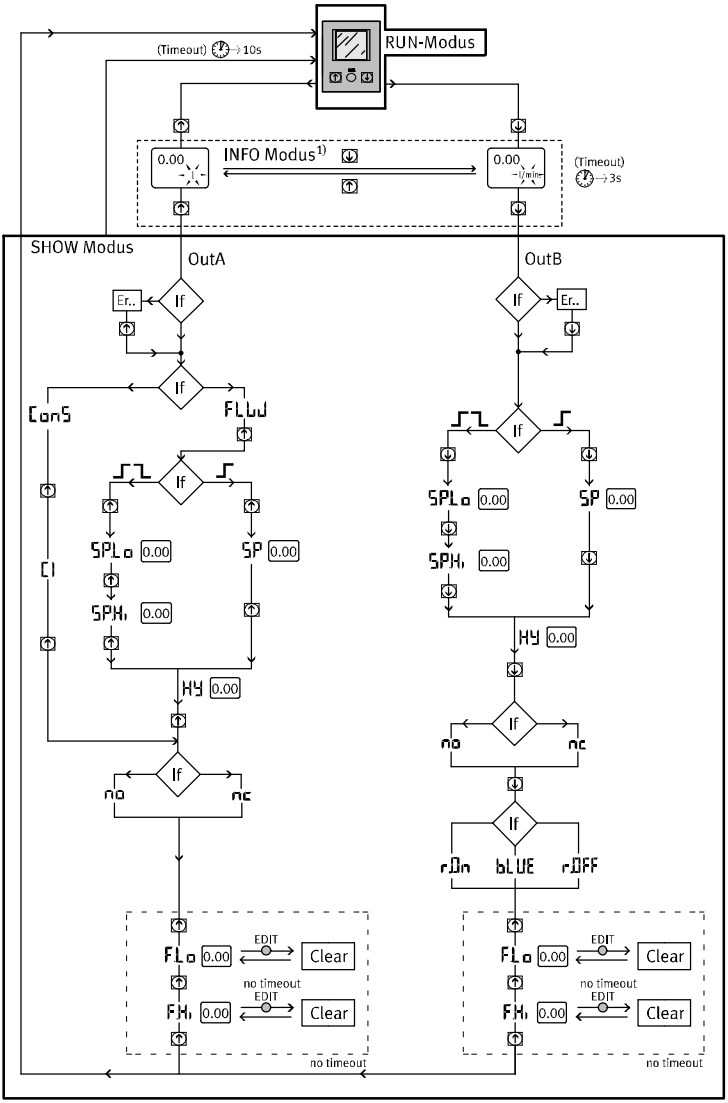
In the RUN mode, the following are displayed:

– the measurement values for the flow rate (in l/min or scfm)
– the measurement values for air consumption (in m³, scf or l) and
– the signal statuses of the switching outputs Out A, Out B (set, not set).

1. Switch on the operating voltage.
   The SFAM is in RUN mode.
2. Check the SFAM settings ➔ Chapter 5.4 SHOW mode.

Note
A flashing value means that the value was measured outside the permissible measuring range.

5.4 INFO/SHOW mode



1) INFO mode only possible when consumption measurement is active

Fig. 5 SHOW mode

In Show mode, depending on whether the A or B pushbutton is pressed, the current settings for the switching outputs Out A or Out B will be shown.

The SFAM must be in RUN mode.

- When air consumption measurement is activated, the INFO mode enables rapid changeover of the input variables flow rate and air consumption in the display by pressing the A or B pushbutton.

Note
If there are errors, pressing the A pushbutton/B pushbutton first displays corresponding error numbers.

- Repeated pressing of the A pushbutton/B pushbutton displays the settings of the respective switching output one after another.
- At the end of SHOW mode, the min value [F.Lo] and max value [F.Hi] are displayed. If no further buttons are pressed, the display remains constant (no timeout). The min and/or max display is thereby signaled by the flashing of segment 1 or segment 10 in the bar graph ➔ Tab. *9*.
- The min/max values can be reset by pressing the Edit button.
- When all settings have been displayed, the SFAM goes back into RUN mode when the A pushbutton/B pushbutton are pressed again and displays the current measurement value for the corresponding output.

5.5 EDIT mode

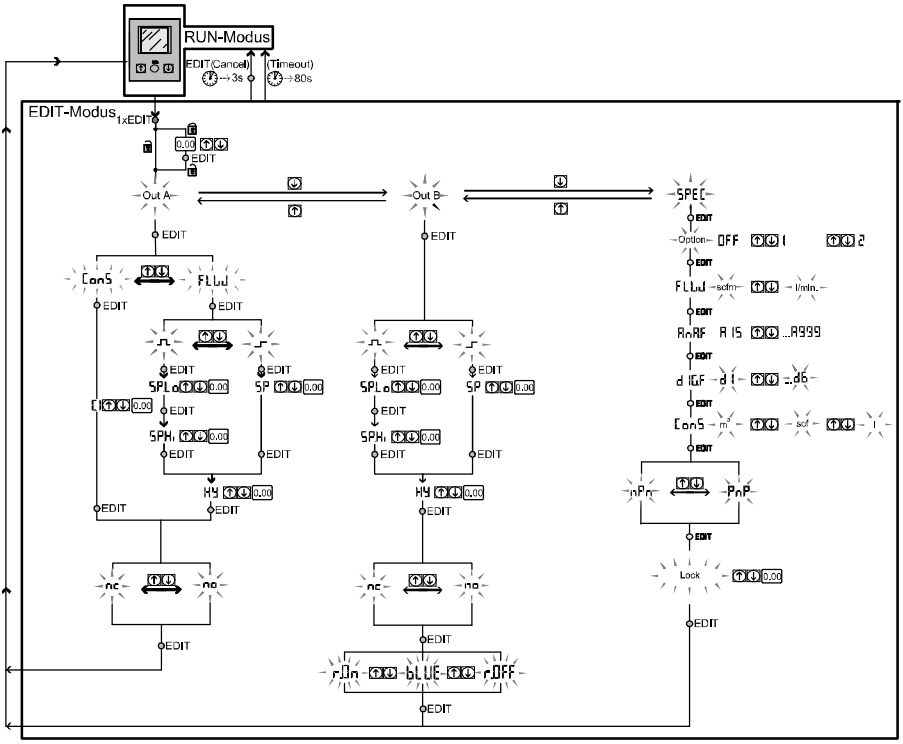


Fig. 6 EDIT mode

5.5.1 Start EDIT mode

In the EDIT mode, you can configure settings for the switching output Out A, the switching output Out B and the special menu [Spec].

Warning

Manipulation of signal statuses may cause serious personal injury, depending on the functioning of the machine/system.

- Note that if the switching status of the outputs is modified in EDIT mode, the new status will be effective immediately.

1. Press the Edit button.
   The EDIT mode is active and [Out A] flashes or, if there is an active security lock, [Lock] flashes.
2. Press the A/B pushbuttons until the chosen security code is set.
3. Press the Edit button.
   The EDIT mode is active and [Out A] flashes.
4. Press the A/B pushbutton to switch between the setting modes for Out A, Out B and the special menu.

5.5.2 Setting the switching characteristics of the switching outputs

a) Set flow rate monitoring

Note
The process for setting the switching outputs is fundamentally the same. Additionally, the switching mode [FLW] must be selected for Out A since Out A can also be configured for air consumption measurement. For Out B, the colour change for the display can also be set.
In the following, the process is described using the switching output Out A.

The SFAM is in the EDIT mode and [Out A] flashes, ➔ Chapter Start EDIT mode.

- To set Out A, proceed as follows:

1. Press the Edit button to confirm the selection.
   [FLW] or [ConS] flashes.
2. Select the flow rate measurement (FLW) with the A/B pushbutton.
3. Press the Edit button to confirm the selection.
   The currently set switching function flashes.
4. Select the desired switching function with the A/B pushbuttons.
5. Press the Edit button to confirm the selection.
   [SP] or [SP.Lo] flashes.
6. Set the switching point (SP or SP.Lo) with the A/B pushbuttons.
7. Press the EDIT button to confirm the set value.
   Only with window comparator switching function.
   [SP.Hi] flashes
   - Set the value (SP.Hi) with the A/B pushbuttons.
   - Press the EDIT button to confirm the set value.

   [Hy] flashes.
8. Set the value for the hysteresis (Hy) by using the A/B pushbuttons.
9. Press the EDIT button to confirm the set value.
   [NO] or [NC] flashes.
10. Select the switching element function (NO/NC) with the A/B pushbuttons.
11. Press the EDIT button to confirm the set value.

Only for Out B (Set colour change)

Note
If the flow rate monitoring has been configured for Out B, the colour change can be configured for the display after configuration of the switching element function.

[rON], [rOFF] or [bLUE] flashes. The setting for the colour change can be configured.

12. Select the desired setting (rON, rOFF or bLUE) with the A/B pushbutton.
13. Press the Edit button to confirm the selection.

The SFAM is in RUN mode.

Carry out a test run with various flow rates to ascertain whether the SFAM switches as desired (switching points and hysteresis).

b) Set consumption monitoring

Note
Air consumption measurement [ConS] can be activated for switching output Out A.

The SFAM is in the EDIT mode and [Out A] flashes ➔ Chapter Start EDIT mode.

1. Press the Edit button to confirm the selection.
   [FLW] or [ConS] flashes.
2. Select the air consumption measurement [ConS] with the A/B pushbuttons.
3. Press the Edit button to confirm the selection.
   [CI] flashes.
4. Set the value for the consumption impulse (CI) with the A/B pushbuttons.
5. Press the EDIT button to confirm the set value.
   [NO] or [NC] flashes.
6. Select the switching element function (NO/NC) with the A/B pushbuttons.
7. Press the EDIT button to confirm the set value.
   The SFAM is in RUN mode

Carry out a test run with various flow rates to ascertain whether the SFAM switches as desired.

5.5.3 Set special menu [SPEC]

This is how you reach the special menu:

The SFAM is in the EDIT mode and [Out A] flashes, ➔ Chapter Start EDIT mode.

1. Press the A or B pushbutton until the menu (SPEC) is selected.
   [SPEC] flashes.
2. Press the Edit button to confirm the selection.
   [Option] flashes, the standard conditions (OFF, 1 or 2) can be set.

Set standard conditions [Option]

3. Select the desired setting (OFF, 1 or 2) with the A/B pushbuttons.
4. Press the Edit button to confirm the selection.
   [FLW] is displayed and the currently chosen value flashes.
   The unit for the flow rate (l/min or scfm) can be set.

Setting the physical unit for the flow rate [FLW]

5. Select the desired setting (l/min or scfm) with the A/B pushbuttons.
6. Press the Edit button to confirm the selection.
   [AnA.F] and the currently set value are displayed. The analogue filter can be set.

Note
The configured physical unit is shown in RUN mode in the display at the bottom right.

Set analogue filter [AnA.F]

7. Select the value for the filter time constants (15 ms, 30 ms, 60 ms, 125 ms, 250 ms, 500 ms or 999 ms) with the A/B pushbuttons.
8. Press the EDIT button to confirm the set value.
   [dIG.F] and the currently selected value flash. The digital filter can be set.

Set smoothing for the digital filter [diGF]

Note
A high filter time constant and high smoothing can result in a switching time of several seconds.

9. Select the value for cushioning (d1 to d6 or d.OFF) with the A/B pushbuttons.
10. Press the EDIT button to confirm the set value.
    [ConS] is displayed and the currently selected value flashes.
    The unit for the air consumption (m^3, scf or l) can be set.

Set the physical unit for the air consumption [ConS]

11. Select the desired setting (m^3, scf or l) with the A/B pushbuttons.
12. Press the Edit button to confirm the selection.
    The currently set value [PnP] or [nPn] for the switching element output flashes. The switching element output can be set.

Set switching output characteristic [PnP] or [nPn]

13. Select the desired setting (PNP or NPN) with the A/B pushbuttons.
14. Press the Edit button to confirm the selection.
    [Lock] flashes. The current setting is then displayed.

Setting the security code

Note

Keep the security code where it can be found. If the security code has been forgotten see, the
➔ Chapter 6 Resetting SFAM to factory setting.

15. Use the A/B pushbuttons to select between an inactive security code (OFF) or a maximum 4-digit security code.
16. Press the Edit button to confirm the selection.
    The SFAM is in RUN mode.

5.6 TEACH mode

Note
The process is the same for teaching the switching outputs Out A (A button) and Out B (B button). In the following, the process is described using the switching output Out A.

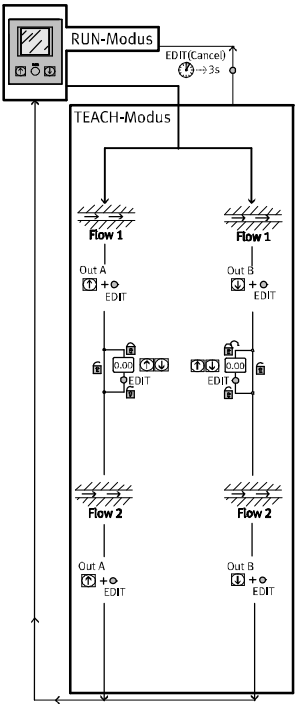


Fig. 7 TEACH mode

In TEACH mode, the switching points for flow rate monitoring can be programmed.

1. Before teaching in EDIT mode, select the desired switching function (threshold value or window comparator) ➔ Chapter 5.5. EDIT mode.

Threshold value comparator	Window comparator
The (taught) switching point is derived from the average value of both measured values SP = 1/2(Flow 1 + Flow 2) Special case: SP = Flow 1 = Flow 2	The taught switching window is derived from the measured values: SP.Lo = Flow 1 SP.Hi = Flow 2

Tab. 11 Set switch variable

For teaching the switching variables:

2. Generate a flow rate (Flow1)
3. First press the A pushbutton and then also the Edit button.
   [Out A] and bar graph flash and the measurement value is assumed as the first teach point or [Lock] flashes if the security lock is active.

Only with active security blocking [Lock] (points 4 and 5):

4. Press the A/B pushbuttons until the chosen security code is set.
5. Press the Edit button.
   [Out A] and the bar graph flash and the measurement value is assumed as the first teach point.
6. Generate a second flow rate (Flow 2).
7. First press the A pushbutton and then also the Edit button.
   The second teach point is assumed and the switching point (SP) or switching points (SP.Lo and SP.Hi) become valid.
   The SFAM is in RUN mode.

5.7 RECORDER mode

In the RECORDER mode, a manual air consumption measurement can be performed.

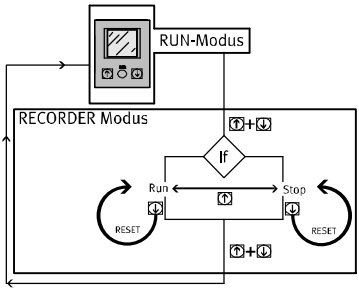


Fig. 8 RECORDER mode

1. Press the A and B pushbuttons simultaneously.
   The SFAM is in RECORDER mode
   The status of the measurement [Run] or [Stop] is displayed.
2. The measurement can be started or stopped by pressing the A pushbutton.
3. By pressing the B pushbutton, you can reset the measurement to zero.
4. Press the A and B pushbuttons simultaneously.
   The SFAM is in RUN mode.

Note
If the RECORDER mode is exited during an ongoing measurement [Run], the measurement will continue in the background.

6 Operation

Caution
Excessive internal heat will destroy the SFAM.
- Avoid high cycle rates with large pressure amplitudes. Otherwise, the admissible limiting temperatures of the used materials will be exceeded.

The air mass flow displayed by the SFAM 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 rate, amount supplied by a compressor, measured values of a flow sensor from another manufacturer) refer to the same initial conditions.
- After the supply voltage is switched on, the SFAM needs a warm-up time of 5 minutes until it achieves the specified accuracy.

Reset SFAM to factory setting
(even if the security code cannot be found)

Note
By resetting to factory settings, the current settings are lost. If required, make a note of these settings before resetting.

To reset the SFAM to the factory setting, proceed as follows:
1. Switch off the operating voltage.
2. Press and hold all three setting elements (A pushbutton + B pushbutton + the Edit button) at the same time.
3. Switch the operating voltage off and then on again.
   The SFAM is in RUN mode.

7 Maintenance and care

- Switch off the following energy sources before cleaning the exterior of the device:
  – Operating voltage
  – Compressed air.
- If necessary, clean the SFAM from the outside.
  Soap suds (max. +60 °C), petroleum ether and all non-abrasive cleaning agents may be used.

8 Disassembly

1. Switch off the following energy sources before disassembly:
   - Operating voltage
   - Compressed air
2. Disconnect the respective connections from the SFAM.

9 Fault clearance

Malfunction	Possible cause	Remedy
Incorrect measured value indicator	SFAM operated with non-permitted medium	Operate SFAM only with permitted media
	SFAM contaminated	Replace device
In case of flow rate measurement: Measured value is flashing	Measurement outside permitted measuring range	Accuracy refers only to the permitted measuring range
In case of air consumption measurement: Measured value is flashing	Measuring range end value has been exceeded at least once. Specified accuracy can therefore probably not be maintained	Make sure that the measuring range end value is not exceeded
Outputs do not switch corresponding to the setting	Short circuit or overload at corresponding output	Eliminate short circuit/overload
Settings cannot be edited (Lock)	Access protection active	Entering the security code
O.FLO	Measurement range exceeded (displayed in RUN mode)	Check operating conditions
Er1, Er2, Er4	Device defective	Replace device
Er9	Measurement range undershot (displayed in SHOW mode)	Check operating conditions
Er10	Measurement range exceeded (displayed in SHOW mode)	Check operating conditions
Er17	Undervoltage	Maintain operating voltage
		Check electrical wiring

Tab. 12 Fault clearance

10 Accessories

Please select the corresponding accessories from our catalogue.

➔ www.festo.com/catalogue/sfam

11 Technical data

SFAM		-1000	-3000	-5000	-10000	-15000
General information						
Certification certificate		RCM Mark, cULus – Recognized (OL)				
CE marking (➔ Declaration of conformity)		According to EU EMC Directive				
Note on materials		RoHS-compliant				
Input signal/measuring element						
Measured variable		Flow rate, air consumption				
Flow direction	-L	Unidirectional P1 } P2				
	-R	Unidirectional P1 { P2				
Measuring principle		Thermal				
Flow measuring range	[l/min.]	10 ... 1000	30 ... 3000	50 ... 5000	100 ... 10000	150 ... 15000
Operating pressure	[bar]	0 ... 16				
Operating pressure	[MPa]	0 ... 1.6				
Nominal pressure	[bar]	6				
Nominal pressure	[MPa]	0.6				
Operating medium		Air quality class 7:4:4 according to DIN ISO 8573-1				
		Nitrogen				
Temperature of medium	[°C]	0 ... 50				
Ambient temperature	[°C]	0 ... 50				
Nominal temperature	[°C]	23				
Signal processing						
Filter time constant (analogue filter)	[ms]	Possible settings: 15, 30, 60 (factory setting), 125, 250, 500, 999				
Filter time constant (digital filter)	[ms]	d.OFF, d1 ... d6 (factory setting: d2) d1: approx. 20 d2: approx. 40 d3: approx. 80 d4: approx. 160 d5: approx. 320 d6: approx. 640				
Output, general[1)2)]						
Accuracy of zero point ±FS[4)]	[%]	0.3				
Accuracy range ±FS[4)]	[%]	3				
Repetition accuracy, zero point ±FS	[%]	0.2				
Repetition accuracy range ±FS	[%]	0.8				

SFAM		-1000	-3000	-5000	-10000	-15000
Temperature coefficient range ±FS/K	[%]	typ. 0.1				
Pressure dependency range ± FS/bar	[%]	0.5				
Pressure dependency range ± FS/100 kPa	[%]	0.5				
Switching output						
Switching output		2x PNP or 2x NPN, adjustable				
Switching function		Window comparator or threshold value comparator, adjustable				
Switching element function		N/C or N/O contact, adjustable				
Max. output current	[mA]	100				
Voltage drop	[V]	Max. 1.5				
Inductive protective circuit		Adapted to MZ, MY, ME coils				
Analogue output						
Characteristic curve for flow rate	[l/min.]	0 ... 1000	0 ... 3000	0 ... 5000	0 ... 10000	0 ... 15000
Output characteristic curve for current	[mA]	4 ... 20				
Output characteristic curve for voltage	[V]	0 ... 10				
Max. load resistance of current output	[Ohm]	500				
Min. load resistance of Voltage output	[kOhm]	10				
Output, additional data						
Short circuit protection		Yes				
Overload protection		Present				
Electronics						
Operating voltage range DC	[V]	15 ... 30				
Protection against incorrect polarity		For all electrical connections				
Electromechanics						
Electrical connection		Straight plug, M12x1, 5-pin				
Max. length of connecting cable	[m]	<30				
Mechanics						
Installation position		Horizontal ±5°				
Pneumatic connection		G½	G½	G½	–	
Grid dimension 62 for SFAM-...-T		NPT½	NPT½	NPT½	–	

SFAM		-1000	-3000	-5000	-10000	-15000
Pneumatic port		–	–	G1	G1	G1
Grid dimension 90 for SFAM-...-T		–	–	NPT1	NPT1	NPT1
		–	–	G1½	G1½	G1½
		–	–	NPT1½	NPT1½	NPT1½
Product weight	[g]					
– SFAM-62-...-M		600	600	600	–	–
– SFAM-62-...-T		1100	1100	1100	–	–
– SFAM-92-...-M		–	–	1500	1500	1500
– SFAM-92-...-T		–	–	2400	2750	2750
Information on housing materials		Reinforced polyamide/die-cast aluminium				
Display/operation						
Display type		Illuminated LCD, blue				
Displayable units		l/min, scfm, l, m3, scf				
Setting range for flow rate threshold value		1%FS ... 100 %FS				
Setting range for consumption impulse threshold value	[l]	3 ... 19999	10 ... 19999	15 ... 19999	30 ... 19999	50 ... 19999
	[m^3]	1 ... 19999				
	[scf]	0.1 ... 1999.9	0.4 ... 1999.9	0.5 ... 1999.9	1 ... 1999.9	2 ... 1999.9
Hysteresis setting range		0%FS ... 90 %FS				
Immissions/emissions						
Storage temperature	[°C]	–20 ... +80				
Degree of protection		IP65				
Pressure drop[3)]	[mbar]	< 100				< 200
Pressure drop[3)]	[kPa]	< 10				< 20
Protection class		III				

1) Accuracy with nominal conditions (6 bar (0.6 MPa), 23 °C and horizontal mounting position)

2) % FS = % of the measuring range end value (full-scale)

3) Measured at a flow rate of 50 %FS

4) Calculation examples ➔ p. 33

Tab. 13 Technical data

Flow measuring range[1] qn as a function of operating pressure p

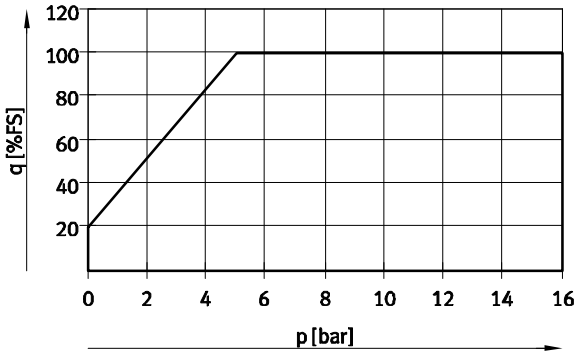
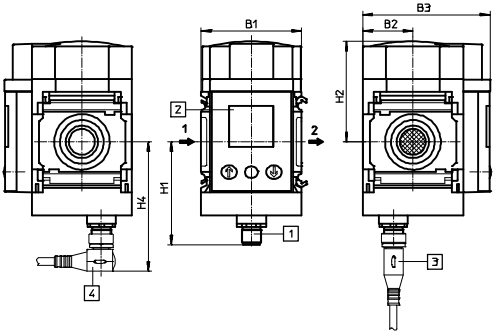


Fig. 9 Specific flow rate range

1) Within the flow rate measurement range the precision specifications apply in accordance with Tab. 13

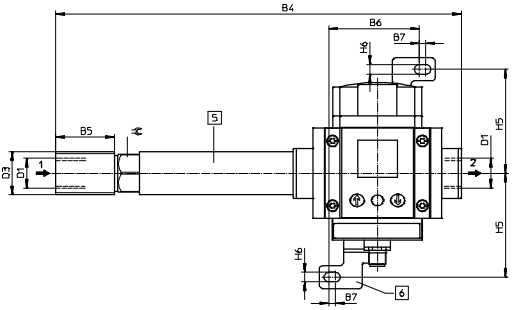
Dimensions SFAM-62

Manifold assembly SFAM-...-M



1 Plug connector M12x1 according to EN 60947-5-2
2 LCD
3 Connecting cable, straight socket
4 Connecting cable, angled plug socket

Threaded mounting SFAM-62-...-T/W



5 Stabilizing zone
6 Wall fastener (only with type of mounting -W)

Fig. 10 Dimensional drawing

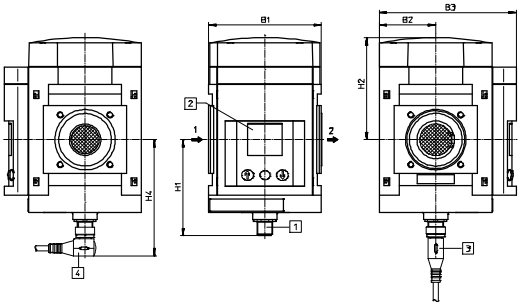
Type	B1	B2	B3	B4	B5	B6	B7	D1
SFAM-62-...-M	62	31	78.7	–	–	–	–	–
SFAM-62-...-TG12	62	31	78.7	277	40	–	–	G½
SFAM-62-...-WG12						61.9	4.5	
SFAM-62-...-TN12	62	31	78.7	277	40	–	–	NPT½
SFAM-62-...-WN12						61.9	4.5	

Type	D3	H1	H2	H4	H5	H6	⌯
SFAM-62-...-M	–	63.5	62.1	80	–	–	–
SFAM-62-...-TG12	G¾	63.5	62.1	80	–	–	26
SFAM-62-...-WG12					71	6.6	
SFAM-62-...-TN12	NPT¾	63.5	62.1	80	–	–	26
SFAM-62-...-WN12					71	6.6	

Tab. 14 Dimension table SFAM-62

Dimensions SFAM-90

Manifold assembly SFAM-...-M



1 Plug connector M12x1 according to EN 60947-5-2
2 LCD
3 Connecting cable, straight socket
4 Connecting cable, angled plug socket

Threaded mounting SFAM-...-T

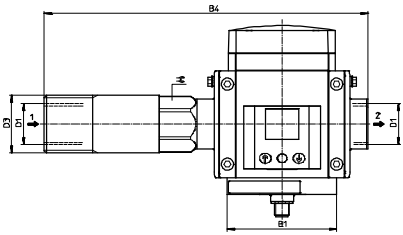


Fig. 11 Dimensional drawing SFAM-90

Type	B1	B2	B3	B4	D1
SFAM-90-...-M	90	45	109	–	–
SFAM-90-...-TG1	90	45	109	267	G1
SFAM-90-...-TG112				301	G1½
SFAM-90-...-TN12	90	45	109	267	NPT1
SFAM-90-...-TN112				301	NPT1½

Type	D3	H1	H2	H4	⌭
SFAM-90-...-M	–	76.5	81.3	93	–
SFAM-90-...-TG1	G1½	76.5	81.3	93	41
SFAM-90-...-TG112	G2				55
SFAM-90-...-TN12	NPT1½	76.5	81.3	93	41
SFAM-90-...-TN112	NPT2				55

Tab. 15 Dimension table SFAM-90

Characteristic curve for the analogue output

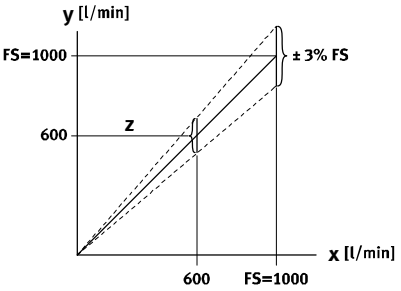
Option	Factor	Unit	Analogue output					
			0 V or 4 mA	10 V or 20 mA				
			Lower limit	Upper limit				
Standard conditions in accordance with DIN 1343 (1.01325 bar, 101.325 kPa, 0 °C)								
OFF	1	[l/min.]	0	1000	3000	5000	10000	15000
		[scfm]	0	35.31	105.9	176.6	353.1	529.7
Standard conditions in accordance with ISO 2533 (1.01325 bar, 101.325 kPa, 15 °C)								
1	1.055	[l/min.]	0	1055	3165	5275	10550	15825
		[scfm]	0	37.25	111.8	186.3	372.5	558.8
Standard conditions in accordance with ISO 6358 (1 bar, 100 kPa, 20 °C)								
2	1.087	[l/min.]	0	1087	3261	5435	10870	16305
		[scfm]	0	38.38	115.15	191.91	383.8	575.7

Tab. 16 Characteristic curve for the analogue output

Example calculations for calculating the maximum occurring characteristic curve deviation:
In the display of SFAM-1000U, a measurement value of 600 l/min will be shown for the flow rate.
How large can the actual, true flow rate that flows through the sensor be?

According to the specification the following apply for nominal conditions (6 bar, 0.6 MPa, 23 °C):
– Accuracy range: ±3 %FS
– Accuracy of zero point: ±0.3 %FS.
– (in example: FS = 1000 l/min)
The overall error during nominal conditions is made up of both of these error variables, which in the following will be considered separately.

a) Range error
A range error of the measurement signal (= error in the slope of the characteristic curve) has a stronger effect the larger the measurement value is (➔ Fig. 12). A range error can be designated a sensitivity or slope error.



x = measured variable (flow rate)
y = measurement value (display)
z = display value error sought

Fig. 12 Range error

The maximum error results from the largest full-scale measured value (in the example FS = 1000 l/min). According to the specification, the error is specified at ±3 %FS.
The maximum error is calculated as follows:

±3 %FS = ±3 % x 1000 l/min =±3/100 x 1000 l/min = ±30.00 l/min

If a measurement value of 600 l/min is displayed, the maximum range error is calculated as follows:

±30 l/min × (600 l/min)/(1000 l/min)= ±18 l/min

Because of the range error, with a display of 600 l/min at the sensor, the actual flow rate through the sensor values can have values in the range 582 ... 618 l/min.

Along with the range error, the zero point error must still be taken into account.

b) Zero point error
A zero point error in the measurement signal affects every point of the characteristic curve equally, which means that it is independent of the measurement value considered (➔ Fig. 13).

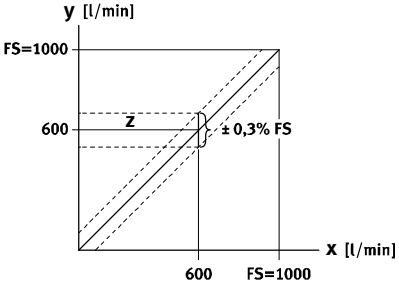


Fig. 13 Zero point error

The error is specified at ±0.3 %FS according to specification. In our case, FS = 1000 l/min. The error is calculated as follows:

±0.3 %FS = ±0.3/100 x 1000 l/min = ±3 l/min

Because of the zero point error, with a display of 600 l/min at the sensor, the actual flow rate through the sensor values can have values in the range 597 ... 603 l/min.

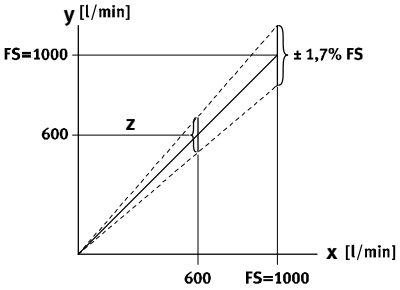
c) Total errors under nominal conditions
To the total errors under nominal conditions, the error margin of ±18.00 l/min and zero point of ±3.00 l/min must be added, so that at 600 l/min the following total error results:

600 l/min ±21.00 l/min

With a display of 600 l/min at the sensor, because of the zero point error the actual flow rate through the sensor values can have values in the range of 579 ... 621 l/min.
d) Temperature fault
If the sensor is not operated at nominal conditions (6 bar, 0.6 MPa, 23 °C), e.g. at a pressure of 6 bar/0.6 MPa and a temperature of 40°C, which is outside nominal conditions with regard to temperature.
In this case, a temperature error must be added to the overall error worked out under nominal conditions.
According to specification:
– Temperature coefficients: typ. ±0.1 %FS/K.

As a deviation to the nominal condition, a temperature difference of 17 °C at 40 °C results. The temperature error range is calculated from the temperature difference and the temperature coefficient as follows:

±0.1 %FS/K x 17 K = ±1.7 %FS. (➔ Fig. 14)



x = measured variable (flow rate)
y = measurement value (display)
z = display value error sought

Fig. 14 Temperature fault

The maximum temperature error is calculated as follows:

±1.7 %FS = ±1.7 % x 1000 l/min =±1.7/100 x 1000 l/min = ±17.00 l/min

If a measured value of 600 l/min is displayed, the maximum temperature error range is thus calculated as follows:

±17 l/min x (600 l/min)/(1000 l/min)= ±10.2 l/min

With a display of 600 l/min at the sensor and an ambient temperature of 40 °C, due to the temperature error range the actual flow rate through the sensor values can have values in the range 589.8 ... 610.2 l/min.

The total error of the sensor at 6 bar/0.6 MPa and 40 °C is calculated as follows:

Total error = (±precision error range) + (± precision error zero point) + (±temperature error range at 40 °C)

= (±18 l/min) + (±3 l/min) + (±10.2 l/min)
= ±31.2 l/min

With a display of 600 l/min at the sensor and an ambient temperature of 40 C, the actual flow rate through the sensor can have values in the range 568.8 ... 631.2 l/min.

e) Error cause by pressure influence
If the sensor is also not operated in the pressure range at nominal conditions (6 bar, 23 °C), a pressure-dependent range must also be taken into account in determining the overall error. In determining the error as a result of the pressure dependency, the same approach should be used as when determining the temperature error.

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