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FILTERS

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FILTERS

Fluid contamination

Fluid contamination defines the presence of foreign particles and substances into the hydraulic fluid, classified in 3 families (solid, water and air contamination), which produce different effects on hydraulic components.
This aspect is a main issue for all hydraulic systems, being responsible for failures and increased machine downtime with consequent heavy costs for end users.

The purpose of this document is to provide general information about type, sources and effects of fluid contamination on hydraulic components.
In particular it is focused on the solid contamination, most commonly present in hydraulic systems, with a description of international methods for its measurement and classification.

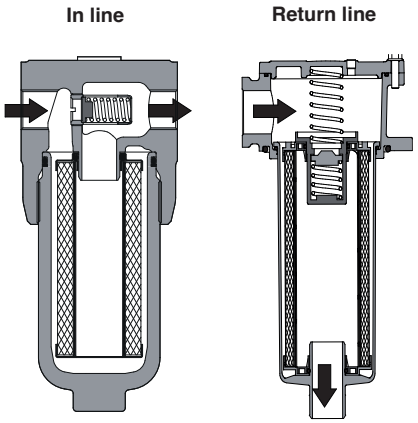
1 SOLID CONTAMINATION

It is responsible for wearing and damages of hydraulic components causing approximately 80% of hydraulic systems failures.
Solid contaminants can enter into the hydraulic system from the external environment or they can be generated during the system operation. A detailed analysis about the potential causes of fluid contamination is described in section 4

Effects: solid contamination causes accelerated wear and sticking phenomena, with consequent increased internal leakages and inaccurate regulation of hydraulic components. In the worst cases it may lead to the components breakage.
A detailed analysis of the effects of solid contamination on hydraulic components is described in section 5

Removal methods: the solid contamination cannot be completely removed but it can be consistently reduced at acceptable levels by means **of hydraulic filters (in line and return line type)**.
Contamination coming from external environment can be also prevented using specific air filters and pressurized tanks.

An extensive description of filter types, contamination classes and suggested filtration circuits is described in the technical table LF020



2 WATER CONTAMINATION

Water can be present into the hydraulic fluid as dissolved water (emulsion) or free water, depending to its concentration and fluid temperature.
Water can enter into the hydraulic system during oil filling operations, through the tank cover or by the air moisture present in the ambient.

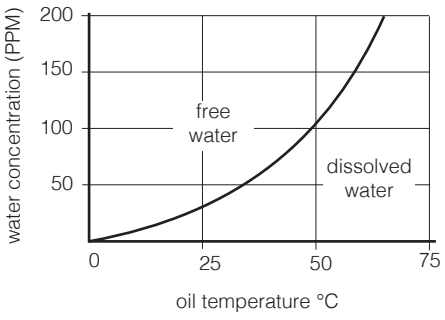
Effects: water contamination causes oxidation and corrosion of metal parts, plus alteration of chemical proprieties of the hydraulic fluid.

Removal methods: sealed tanks are normally used in case of system out-doors installation to prevent water dropping.

Centrifugal separators are a valid solution to remove the water emulsion from the hydraulic fluid.

Breather filters are normally used to remove the humidity form the air entering the oil tank.

Note: consult Atos Technical Office for detailed information about water contamination removal



3 AIR CONTAMINATION

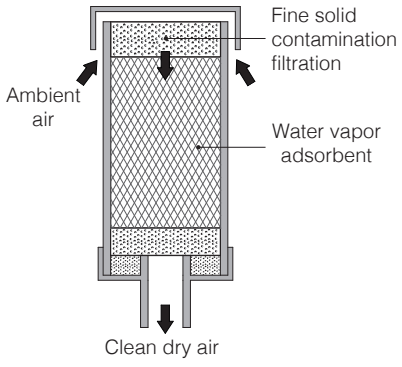
Air is always present into the hydraulic system before its commissioning, or it can be introduced during maintenance.

Effects: the presence of air may cause pumps damage due to cavitation, inaccurate valve regulation and vibrations.

Removal methods: air bleeding points are normally present in the upper side of the hydraulic system and in hydraulic components. The complete air bleeding procedure must be performed at the system commissioning of after maintenance operations.

Note: consult Atos Technical Office for detailed information about air bleeding procedures. See also www.atos.com, tech. table P002 for system commissioning

Breather filter



4 SOURCES OF SOLID CONTAMINATION

The solid contamination has two main sources:

- **Fluid original contamination**, caused by poor quality hydraulic fluids, or fluids stored in dirty tanks
- **System progressive contamination**, generated during the system working and caused by wearing of metal parts and rubber pipes

In a more detailed analysis, following causes of contamination can be identified:

4.1 First fluid filling

Oil coming from shipping containers usually has a contamination level higher than the standards acceptable for most hydraulic systems: oil cannot be assumed to be clean unless it has been carefully filtered.

4.2 Built-in contamination

Different contaminants can be found in new systems and they can be directly related to manufacturing and assembling operations.

4.3 Self-generated contamination

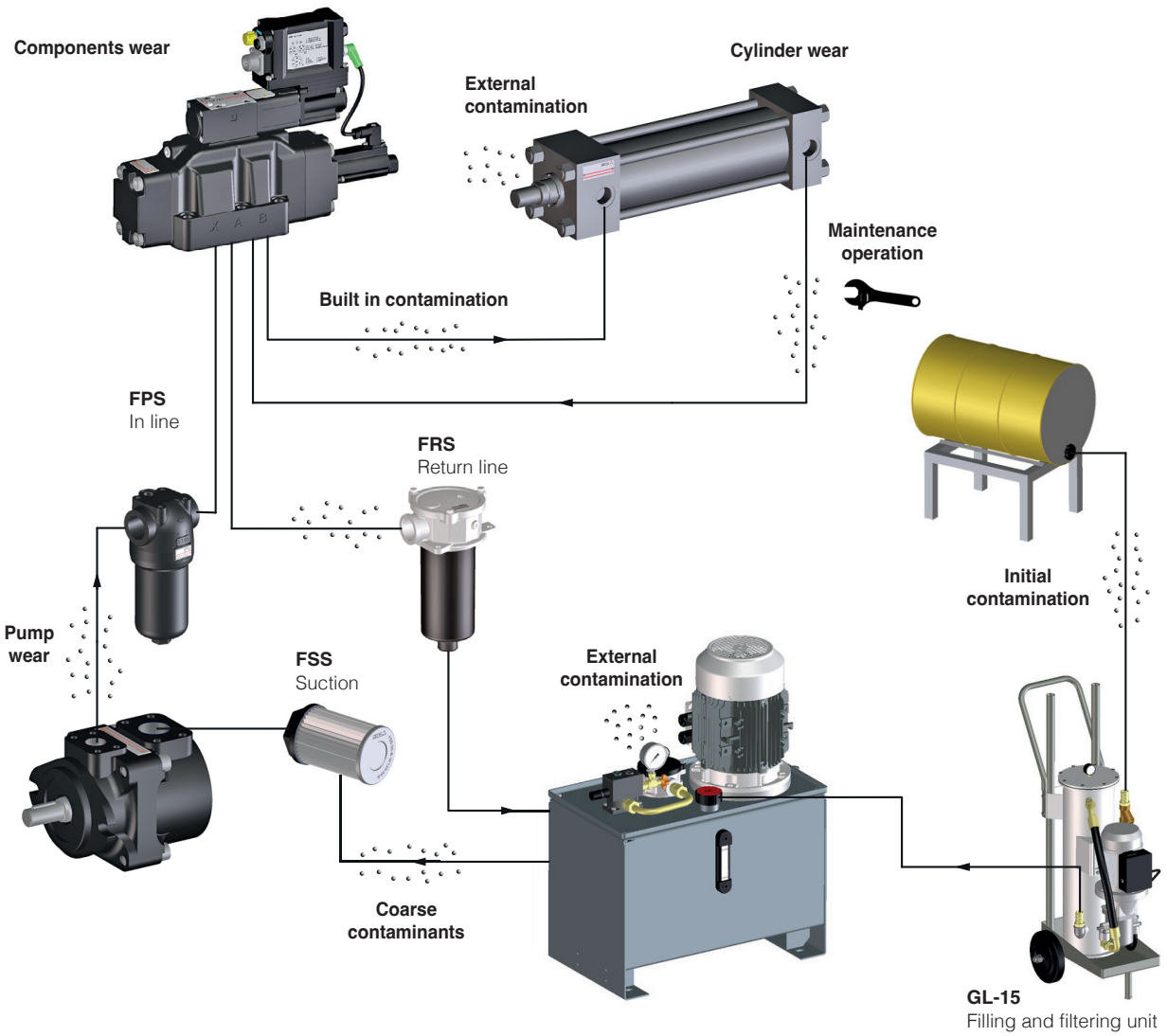
The major source of contamination directly comes from the normal hydraulic system operation. Most of contaminant are due to rubber released from the inner walls of flexible hoses, some from with moving parts of hydraulic components, like pumps and valves

4.4 External contamination

Contaminants coming from the surrounding environment can enter the hydraulic fluid through reservoir breather caps and worn cylinder rod seals.

4.5 Maintenance-induced contamination

Contaminants coming from the surrounding environment can enter the system during maintenance operations. Inaccurate cleaning of the pipes after the replacement of failed components can be the source of further contamination.



5 EFFECTS OF SOLID CONTAMINATION

The presence of solid contaminants into the hydraulic fluid have harmful effects on the correct operation and service life of hydraulic components as pumps, valves and actuators.

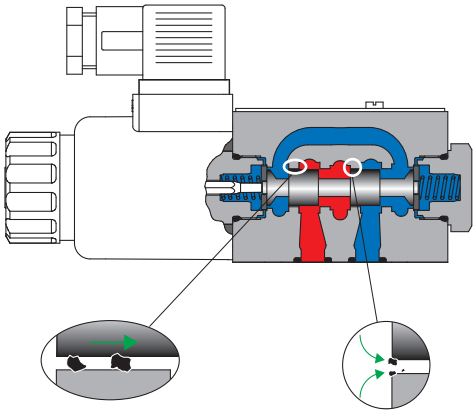
They mainly cause abrasion, erosion and fatigue effects on components surface with following main consequences:

- increased internal leakages
- sticking effects
- permanent wear of moving parts

Typical failures produced by solid contamination can be classified as:

- **Transitory failures**, when particles enter components causing its temporarily malfunction. The components returns to correctly operate as soon the particles are removed by the oil flow.
- **Progressive deterioration**, when particles cause micro-erosion and abrasion of the component surfaces. This failure causes a progressive degradation of performances until the functionality of the component is definitively compromised.
- **Irreparable failure**, when particles enter the gap between mobile parts causing the sudden sticking. This failure could be solved by cleaning the internal parts of the component, in the worst cases the whole components must be replaced

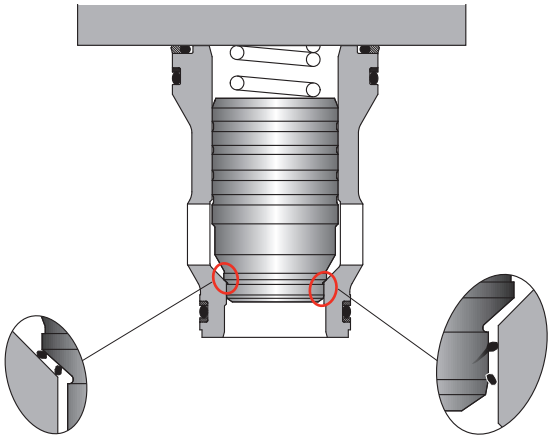
Typical failures in spool valve



Transitory failure:
sticking effects
(control inaccuracy)

Progressive degradation:
erosion of the spool, leakages

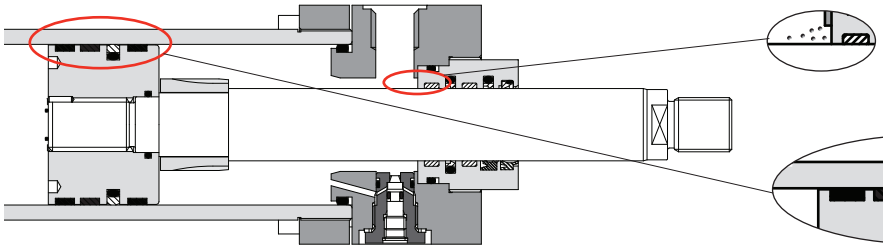
Typical failures in poppet cartridges



Transitory failure:
leakages

Progressive degradation:
erosion of the poppet

Typical failures in cylinders



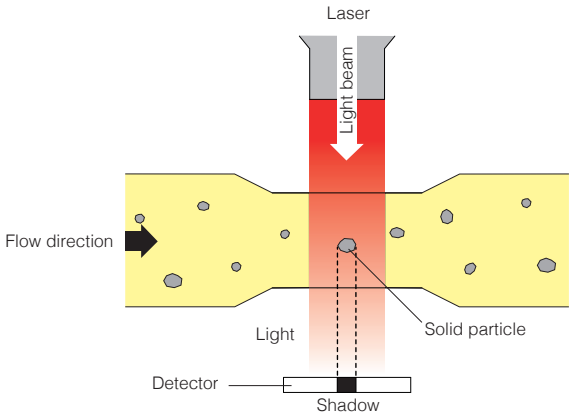
Progressive degradation:
loss of holding ability
loss of rod alignment

Transitory failure:
sticking effect

6 MEASUREMENT OF SOLID CONTAMINATION

One of the most common methods used by the industry for solid contamination analysis is the Automatic Particles Counter (APC). It is based on the principle of a light beam projected through the sample of fluid to be analyzed.

As a solid particle passes through the light beam, it results in a measurable energy drop that is proportional to the size of the particle.
This method permits to measure the quantity and dimensions of solid particles present in the fluid and it is used for the classification of the fluid contamination level, as described in section 5



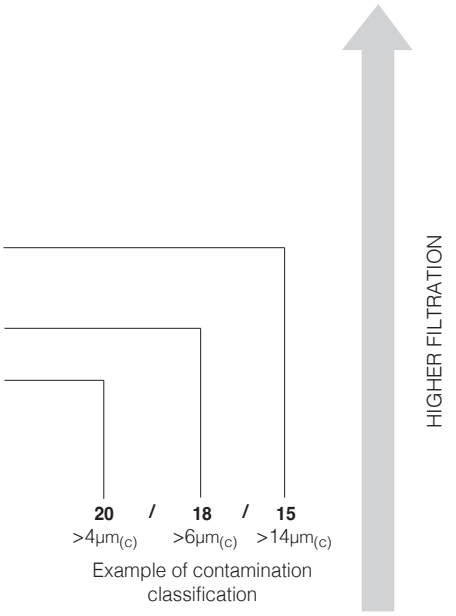
7 CLASSIFICATION OF CONTAMINATION LEVEL

The contamination level identifies the quantity and dimensions of solid particles present into the hydraulic fluid.
It is classified according to the European standard ISO 4406/1999, while for North America it is classified by SAE AS 4059 or NAS 1638 standards.

7.1 ISO 4406 classification

ISO 4406 is the European standard being used extensively within the industrial hydraulics to measure and classify the fluid contamination.
The contamination level is measured by counting the number of particles of a certain dimension present into a 100 ml of fluid.
It is expressed by a combination of 3 codes, i.e: **20 / 18 / 15**, respectively identifying the quantity of contaminants with dimension > 4 $\mu m_{(c)}$, > 6 $\mu m_{(c)}$ and > 14 $\mu m_{(c)}$, as per following table

ISO CODE (to ISO 4406)	Particle quantity / 100 ml from	to
5	16	32
6	32	64
7	64	130
8	130	250
9	250	500
10	500	1.000
11	1.000	2.000
12	2.000	4.000
13	4.000	8.000
14	8.000	16.000
15	16.000	32.000
16	32.000	64.000
17	64.000	130.000
18	130.000	260.000
19	260.000	500.000
20	500.000	1.000.000
21	1.000.000	2.000.000
22	2.000.000	4.000.000
23	4.000.000	8.000.000
24	8.000.000	16.000.000
25	16.000.000	32.000.000
26	32.000.000	64.000.000
27	64.000.000	130.000.000
28	130.000.000	250.000.000



Example of contamination classification

7.2 SAE AS 4059 classification

This classification is normally adopted in North America, particularly in aerospace industry.The contamination level is classified by a combination of 3 codes, i.e. **7B/6C/5D** identifying the quantity of contaminants of a certain dimension present into 100 ml of fluid

Dimensions code		A	B	C	D	E	F
Particle dimensions		> 4 $\mu m_{(c)}$	> 6 $\mu m_{(c)}$	> 14 $\mu m_{(c)}$	> 21 $\mu m_{(c)}$	> 38 $\mu m_{(c)}$	> 70 $\mu m_{(c)}$
		Particle quantity /100 ml					
Contamination classes	**000**	195	76	14	3	1	0
	00	390	152	27	5	1	0
	0	780	304	54	10	2	0
	1	1.560	609	109	20	4	1
	2	3.120	1.220	217	39	7	1
	3	6.250	2.430	432	76	13	2
	4	12.500	4.860	864	152	26	4
	5	25.000	9.730	1.730	306	53	8
	6	50.000	19.500	3.460	612	106	16
	7	100.000	38.900	6.920	1.220	212	32
	8	200.000	77.900	13.900	2.450	424	64
	9	400.000	156.000	27.700	4.900	848	128
	10	800.000	311.000	55.400	9.800	1.700	256
	11	1.600.000	623.000	111.000	19.600	3.390	1.020
	12	3.200.000	1.250.000	222.000	39.200	6.780	

7.3 NAS 1638 classification

NAS 1638 (National Aerospace Standard) is a type of classification used in North America.

It divides the dimensional distribution of the particles into intervals (5-15 µm, 15-25 µm, etc.) and assigns a code to each interval, according to the following table in which is reported also a comparison with ISO 4406 and SAE AS 4059 standards.

ISO 4406	SAE AS 4059	NAS 1638
14/12/09	4A/3B/3C	3
15/13/10	5A/4B/4C	4
16/14/11	6A/5B/5C	5
17/15/12	7A/6B/6C	6
18/16/13	8A/7B/7C	7
19/17/14	9A/8B/8C	8
20/18/15	10A/9B/9C	9
21/19/16	11A/10B/10C	10
22/20/17	12A/11B/11C	11
23/21/18	13A/12B/12C	12

Filtration guidelines

Cleanliness of hydraulic fluid is a priority aspect in the design of all hydraulic systems as approximately 80% of failures are caused by the presence of solid contamination.

The solid contamination cannot be completely removed, but it can be consistently reduced and controlled by means of hydraulic filters (in line and return line type, see section 2) so that the quantity and dimensions of particles present into the fluid (contamination class) are acceptable for the specific type of system.

The purpose of this document is to provide information on the different types of filters and suggestions for their correct use. Through an optimized filtration system it is possible to obtain appropriate fluid cleanliness and thus reduce the damages caused by contamination, extending the life of the machines and preventing production downtime.

1 RECOMMENDED CONTAMINATION CLASSES

The **recommended fluid contamination class** is the max level of contamination acceptable for a certain hydraulic system and it depends to the filtration system architecture.

The fluid contamination class must be evaluated taking into account several parameters as:

- type of hydraulic components installed in the system: the required cleanliness level has to be determined according to the most sensitive component, i.e. presence of servoproportional valves
- type of application and surrounding environment: particular dusty environments , i.e. ceramic presses, require specific filtration circuits and methods to prevent that the solid contamination enters the system tank (pressurized tank)
- duty cycle: heavy duties and high pressure values require better contamination classes
- expected system lifetime
- typical operation and start-up temperatures

The fluid contamination level of a specific hydraulic system corresponds to the contaminant level measured in the tank.

The following table provides the suggested contamination classes, depending on the hydraulic components and their expected operating life.
The contamination class has to be selected according to the most sensitive component installed in the system.

Standard	**Typical contamination classes**						
ISO 4406	15/13/10	16/14/11	17/15/12	18/16/13	19/17/14	20/18/15	21/19/16
NAS 1638	4	5	6	7	8	9	10
SAE 5049	5A/4B/4C	6A/5B/5C	7A/6B/6C	8A/7B/7C	9A/8B/8C	10A/9B/9C	11A/10B/10C
Recommend filter element	F03	F03 F06	F06	F06 F10	F10 F20	F20 F25	
Component							
Proportional valves		longer life		normal operation			
Solenoid & conventional valves					longer life	normal operation	
Variable displacement pumps				longer life		normal operation	
Fixed displacement pumps					longer life		normal operation
Cylinders					longer life	normal operation	

2 HYDRAULIC FILTERS TYPE

The architecture of a filtration system involves the use of different type of hydraulic filters with specific characteristics; typically they are “in line” and “return line” filters.

The type of fluid used in the hydraulic system influences the choice of filter.

It is always recommended to verify the compatibility of the fluid characteristics with the selected filter.

2.1 In line filters

In line filters are normally installed in the system main line, immediately after the pump or before valve’s manifold, in order to protect all downstream components from contamination.

They have to be sized in accordance with the maximum system pressure and flow rate.

Atos in line filters **FPS** (threaded ports) and **FPH** (SAE 6000 flanged ports) are suitable for max operating pressure up to 420 bar.

FPB in line filters, flange mounting, are designed for direct assembling on manifolds and they are suitable for max pressure up to 250 bar

FPS

In line filters are provided with or without by-pass valve:

- filters with by-pass valve are used to permit the flow passage in case of clogged filtering element. This is an extreme condition to be always avoided by a correct maintenance
- filters without by-pass valves are used to protect critical components like servoproportional valves; in this execution the filter element can withstand a higher differential pressure (collapse pressure)

FPH

In line filters can be provided with a clogging indicator, notifying the status of the filter element and allowing its replacement before the filter by-pass opening (if present), see section 6.

2.2 Return line filters

They perform the **filtration of the fluid returning back to the tank from the hydraulic circuit**, ensuring that all the contaminants generated by components wear do not enter the tank and will not be recirculated into the system.

They have to be sized considering the maximum flow on return line during the whole machine cycle; particularly, in case of differential cylinders the return flow could be greater than the pump flow.

FPB

Return line filters can be installed in line or on the top of the hydraulic tank and have to be selected considering return line pressure.

Atos return line filters type **FRS** are designed for tank top mounting and to withstand max operating pressure up to 8 bar.

Return line filters are provided with a by-pass valve to prevent dangerous excessive back-pressure in the return line caused by the clogged filer element.

The filter outlet must be always located below the fluid level, in all operating conditions, to prevent possible foaming of the fluid in the tank.

FRS

2.3 Suction filters

These filters are used to **protect the pump from ingestion of coarse contamination**. Atos suction filters type **FSS** are designed to be directly fit on the pumps suction line.

To avoid the risk of pump cavitation, suction filters are generously sized, with high filtration ratings and low differential pressures.

Suction filters have to be sized also considering cold start-up operations, because low oil temperatures could boost up cavitation phenomenon.

Due to cavitation reasons they are normally avoided for variable displacement piston pumps.

FSS

2.4 Filter elements

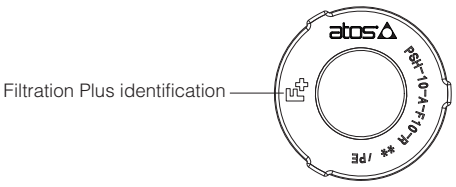
Atos **Filtration Plus** filter elements provide excellent performance in terms of efficiency (βeta Ratio > 1.000) and stability Vs. pressure drop increase.

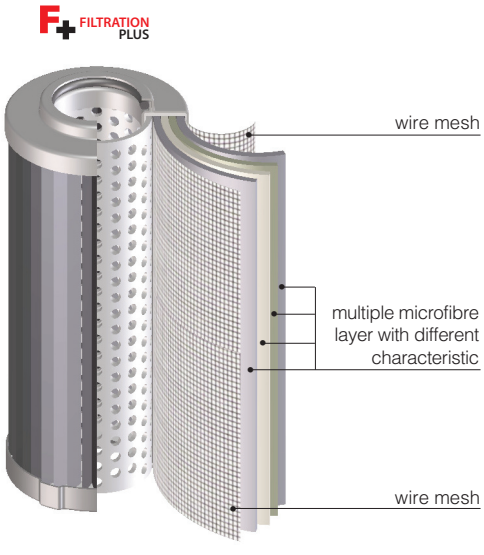
Thanks to the special construction based on microfiber media, these elements are characterized by a very high Dirt Holding Capacity (DHC) - see section 4, up to 30% higher than other media packs.

The higher DHC combined with a lower pressure drop, contribute to significantly increase the operating life of the filter element, and therefore a reduction of maintenance costs.

F+ Filtration Plus filter elements are available with standard filtration rating:
5µm, 7µm, 12µm, 22µm for in line filters type FPS, FPH and FPB
7µm, 12µm, 27µm for return line filter FRS

Filtration rating 4µm$_{(C)}$ is available on request for FPS and FPH filters for applications requiring extremely high fluid cleanliness.



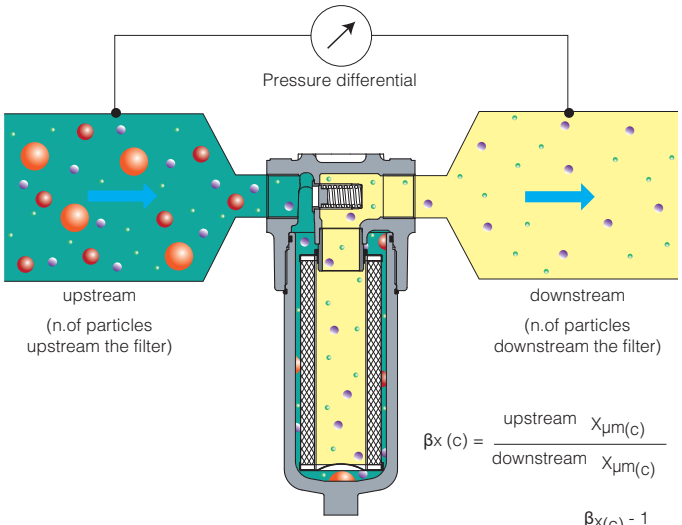


PSH filter element

3 FILTER EFFICIENCY AND BETA RATIO

The filter efficiency is the capability of the filter to block a certain quantity of particles equal or greater than a defined dimension.
The most commonly used rating in the industry is the **Beta ratio βx (c)**, defined as the number of particles of a given size upstream the filter, divided by the number of particles of the same size counted downstream the filter. The higher the Beta Ratio, the higher is the filter efficiency.

n. of particles upstream the filter	n. of particles downstream the filter	Beta ratio $\beta_{x(c)}$	Efficiency %
1.000.000	500.000	2	50
	100.000	10	90
	50.000	20	95
	13.000	75	98,7
	5.000	200	99,5
	1.000	1.000	99,9



3.1 Standards for Beta ratio determination

Since 1999 the **ISO16889** has been introduced as international standard to regulate the execution of Multi-Pass Tests to assess the Beta value of a filter element, replacing old ISO 4578.

ISO16889 considers the filter efficiency = 99,9% (β ratio > 1000), while for old ISO4572 the efficiency was lower = 99,5% (βratio > 200),

To avoid misunderstandings, particles measured to ISO16889 are identified as **$\mu m_{(c)}$**

The table below reports the Beta values of Atos filter elements, according to the considered standard.

Microfibre filter element	$\beta_{x(c)} > 1000$ (ISO16889)	$\beta_x > 200$ (ISO4572)
F03	5 $\mu m_{(c)}$	3 μm
F06	7 $\mu m_{(c)}$	6 μm
F10	12 $\mu m_{(c)}$	10 μm
F20	22 $\mu m_{(c)}$	20 μm
F25	27 $\mu m_{(c)}$	25 μm

Cellulose filter element	$\beta_{x(c)} > 2$ (ISO16889)	$\beta_x > 2$ (ISO4572)
C10	10 $\mu m_{(c)}$	10 μm
C25	25 $\mu m_{(c)}$	25 μm

Contamination classes and pressure drop values remain unchanged between ISO4572 and ISO16889

4 DIRT-HOLDING CAPACITY

The Beta ratio does not give any indication about the total amount of contaminant that can be trapped by the filter during its life.

This parameter is defined **DIRT-HOLDING CAPACITY (DHC)** and it defines the quantity of contaminant that the filter element can trap and hold before the maximum allowable back pressure or delta P level is reached.
Generally, a filter element with a larger effective filtration surface has a greater dirty holding capacity and therefore a longer service life.

5 FILTRATION CIRCUIT

The solid contamination caused by normal component's wear is the main source of fluid contamination.
To avoid malfunctioning and progressive deterioration of the components installed in the hydraulic system, a proper filtration circuit has to be designed.

The following recommendations support the user in designing of an optimized filtration circuit.
The table below suggests the selection of a filtration circuit according to the targeted contamination class, see section 1 for recommended contamination classes.

COMPLEXITY

Filtration Circuit								
	D							
	C							
	B							
	A							
		21/19/16	20/18/15	19/17/14	18/16/13	17/15/12	16/14/11	15/13/10
	Contamination classes							

HIGHER FILTRATION

General rules to be followed to ensure optimal operating conditions for the hydraulic systems:

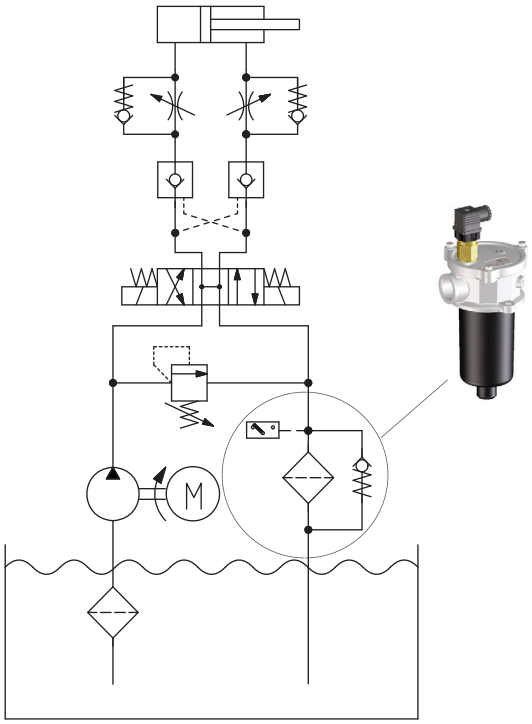
- the hydraulic tank has to be properly designed to limit the ingress of external contamination
- maintenance operations must be performed to avoid the ingress of contamination.

Consult Atos technical office for additional support for proper design of filtration circuits.

CIRCUIT A

Return line filter ensures that all the contaminants generated during system operations are correctly filtered before entering the tank.
It is a cost effective solution mainly used in systems with on-off valves.

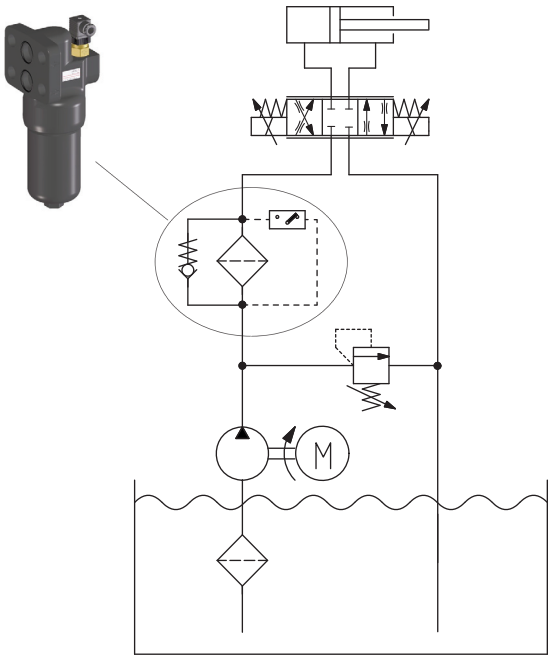
This configuration can't ensure protection of hydraulic components from wear generated by the pump.



CIRCUIT B

In line filter is normally installed immediately after the pump, to guarantee a correct filtration of the fluid before it reaches the hydraulic components.
It is a solution particularly used to protect proportional and servoproportional valves.

This configuration can't ensure protection of hydraulic components from contaminants generated further downstream and of the pump from dirt returned to the tank.

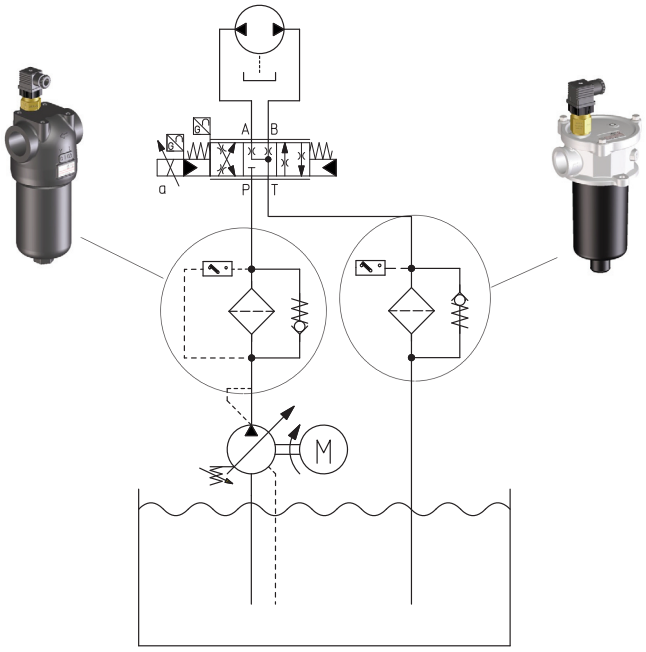


CIRCUIT C

This example shows a circuit with **both in line and return line filters.**
It is an ideal solution to enhance the whole system efficiency.

This system configuration will ensure:
- correct protection of components from wear generated by the pump
- correct filtration of the fluid flowing back to the tank, removing all the contamination entered in the system as consequence of components wear.

An efficient contamination control is guaranteed if the whole pump flow is passing through the filters.
As consequence, this system configuration is not indicated for circuits with variable displacement pumps operating for long time in null flow.



CIRCUIT D

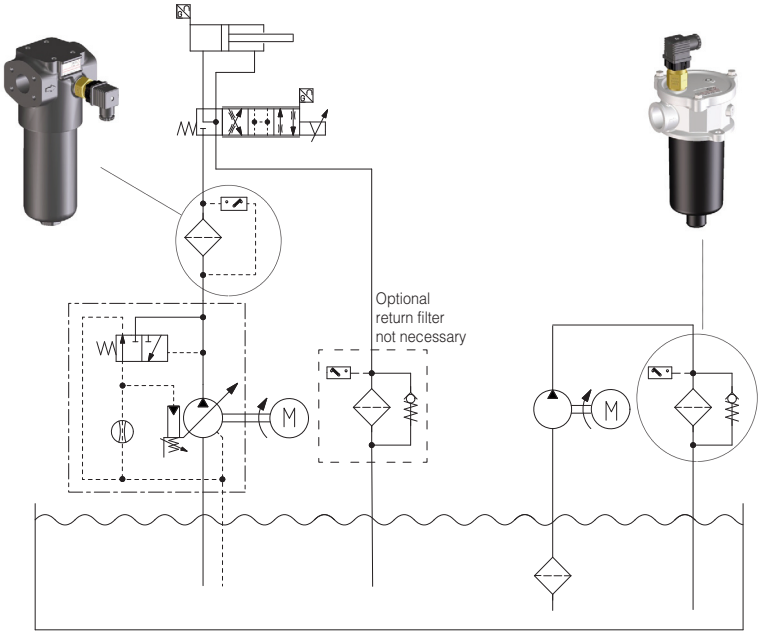
This example is similar to circuit C but implemented with an **additional off-line filtration system.**

It is an ideal solution when wide change in system flow rates are expected or for systems equipped with variable displacement pumps operating for long time in null flow.

The additional off-line filtration system allows to maintain a constant filtration of the fluid in the tank, avoiding the accumulation of contamination particles

This system configuration will ensure:
- excellent cleanliness level, independently of the operating cycles of the main circuit
- higher dirt-holding capacity along with higher filtration efficiency
- easier maintenance operations thanks to the possibility of replacing the filter element without stopping the machine.

To protect critical components like servoproportional valves, in line filter without by-pass valves is suggested.



6 CLOGGING INDICATORS

They notify to the operator when the filter element is near to be clogged and then it must be replaced.
Their use is recommended for in line and return line filters to avoid that the high pressure caused by the clogged filter element causes the filter by-pass opening and the consequent release of contaminants into the hydraulic circuit.

Depending on the type of hydraulic filter, different clogging indicators are used:

- **Visual indicator**, Atos type **CIA-V**, normally used with **return line filters**
  It is a pressure gauge which measures the pressure before the filer element and indicates the clogged condition by means of coloured sectors:
  Green (range 0 to 3 bar) = filter element in good condition;
  Red (> 3) = filter element to be immediately replaced
  It requires a constant visual inspection by the operator to verify the filter condition

CIA-V

- **Electrical indicator**, Atos type **CIA-E**, normally used with **return line filters**
  It is a pressure switch which measures the pressure before the filer element and it indicates the clogged condition by means of switching contact (NO or NC)
  The switching pressure if factory set at 2 bar corresponding to 70% of the by-pass valve cracking pressure
  The electric contact is normally interfaced with the machine CNC for the automatic monitoring of the filter condition

CIA-E

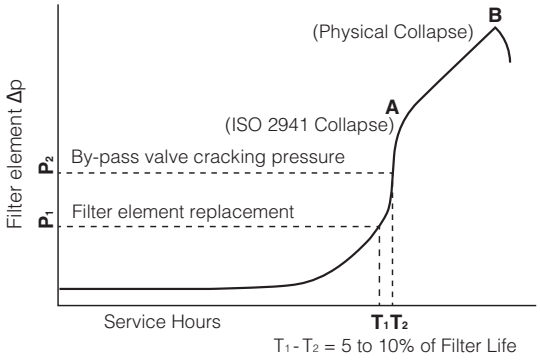
- **Visual differential indicator**, Atos type **CID-V**, normally used with **in line filters**
  It is a pressure switch which measures the Δp across the filer element and it indicates the clogged condition by means of coloured bands:
  Green = filter element in good condition;
  Red = filter element to be immediately replaced
  The switching pressure if factory set at 5 bar corresponding to 80% of the by-pass valve cracking pressure
  For filters without by-pass valve the switching pressure if factory set at 8 bar
  It requires a constant visual inspection by the operator to verify the filter condition

CID-V

- **Electrical differential indicator**, Atos type **CID-M**, normally used with **in line filters**
  It is a pressure switch which measures the Δp across the filer element and it indicates the clogged condition by means of switching contact (NO or NC)
  The switching pressure if factory set at 5 bar corresponding to 80% of the by-pass valve cracking pressure
  For filters without by-pass valve the switching pressure if factory set at 8 bar
  The electric contact is normally interfaced with the machine CNC for the automatic monitoring of the filter condition
  Optional version, Atos code **CID-L**, is provided with additional LED to indicate the filer clogged condition

CID-E

Notes about Electrical differential indicator function
The electrical differential clogging indicator switches at pressure P1, signalling the necessity to replace the filter element, before the by-pass valve cracking pressure P2.
To protect the system from contamination, the set value P1 of the clogging indicator is always lower than the cracking pressure P2 of the by-pass valve.
For in line filters without by-pass valve, the continued operation at higher Δp can cause the degradation of the filtration performances (point A in the diagram). In the worst case the filter element may collapse, losing its integrity (point B in the below diagram).
For this reason, in line filters without by-pass valves are usually provided with filter element having high collapse pressure value.



7 ISO STANDARDS

The following lists is intended to provide a documentation of the actual ISO norms relevant to hydraulic filtration

ISO 2941 Hydraulic fluid power – Filter element – verification of collapse/burst pressure rating

ISO 2942 Hydraulic fluid power – Filter element – verification of fabrication integrity and determination of the first bubble point

ISO 2943 Hydraulic fluid power – Filter element – verification of material compatibility with fluids

ISO 3723 Hydraulic fluid power – Filter element – method for end load test

ISO 3724 Hydraulic fluid power – Filter element – determination of resistance to flow fatigue using particulate contaminant

ISO 3968 Hydraulic fluid power – Filters – evaluation of differential pressure versus flow characteristics

ISO 4406 Hydraulic fluid power – Fluids – method for coding the level of contamination by solid

ISO 16889 Hydraulic fluid power – Filters – multi-pass method for evaluating filtration performance of a filter element

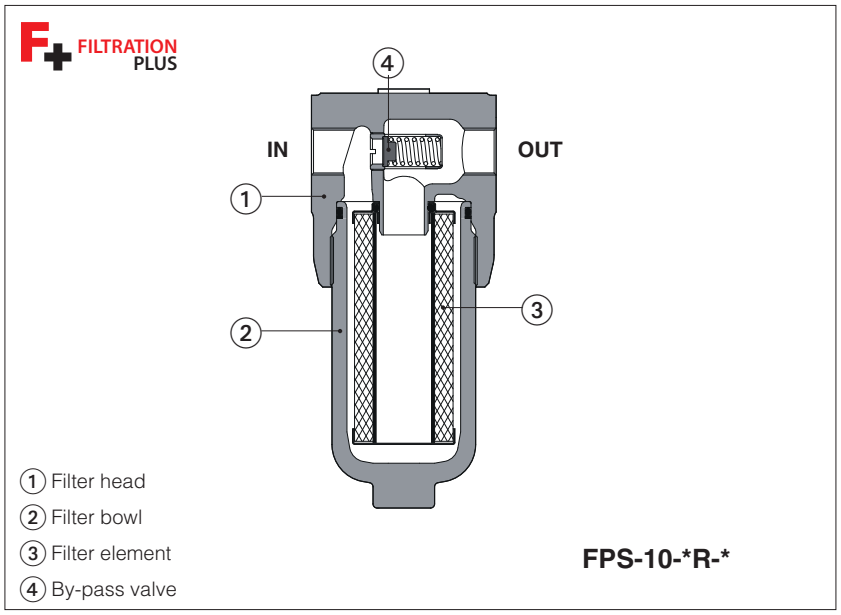
ISO 23181 Hydraulic fluid power – Filter element – determination of resistance to flow fatigue using high viscosity fluid

ISO 11170 Hydraulic fluid power – sequence of tests for verifying performance characteristics of filter elements

ISO 10771-1 Hydraulic fluid power – fatigue pressure testing of metal pressure-containing envelopes – test method

In line filters, high pressure type FPS

Threaded ports



FPS

In line filters are designed for installation on the pressure line downstream the pump, to ensure a high cleanliness of the fluid circulating into the hydraulic system. They protect sensible components from contamination present in the working fluid and they are particularly recommended for systems with proportional valves.

- three head sizes
- port sizes: G1/2" to G1 1/2"
  SAE-16, SAE-20, SAE-24
- **Filtration Plus** microfiber elements ensure high efficiency, low pressure drop, high DHC and long lasting performance. Collapse pressure 21 bar for filters equipped with by-pass valve or 210 bar for filters without by-pass
- filtration rating 5 - 7 - 12 - 22 µm(c)
  (βx (c) >1000, ISO 16889).
- versions without or with by-pass valve with cracking pressure 6 bar.
- without or with differential clogging indicator

Max flow **450 l/min**

Max working pressure **420 bar**

1 MODEL CODE OF COMPLETE FILTERS

FPS	-	10	-	A	-	F10	-	01	-	R	-	*	-	W	*	/	*

FPS — In line filter, high pressure

Filter size (ports size):
10 = G1/2" ÷ G1" or SAE-16
20 = G1" ÷ G1 1/4" or SAE-20
30 = G1 1/4" ÷ G1 1/2" or SAE-24

Filter length:	Max flow [l/min] **(1)** FPS-10	FPS-20	FPS-30
A =	115	191	256
B =	137	205	361
C =	-	226	406
D =	-		450

Filter element:
SN = only body, without filter element
F+ microfibre filter element βx(c) >1000 - ISO 16889:
F03 = 5 µm (c) **F10** = 12 µm (c)
F06 = 7 µm (c) **F20** = 22 µm (c)
Filter element **F01** = 4 µm (c) available on request

Ports size:	FPS-10	FPS-20	FPS-30
BSPP threaded:	**00** = G 1/2" **01** = G 3/4" **02** = G 1"	**02** = G 1" **03** = G 1 1/4"	**03** = G 1 1/4" **04** = G 1 1/2"
SAE J1926-1 threaded:	FPS-10 **42** = SAE-16	FPS-20 **43** = SAE-20	FPS-30 **44** = SAE-24 (1 1/2")

Differential clogging indicator see sect. 14 **(2)**:
W = without, indicator port with plastic plug **(3)**
P = without, indicator port with steel plug
L = electrical indicator with LED
M = electrical indicator without LED
V = visual indicator
see also note (4)

Options see sect. 10 :
- = none
AR = anti-back flow valve and reverse valve

By-pass valve see sect. 9:
R = by-pass valve with cracking pressure 6 bar
(filter element PSH-*-R with collapse pressure 21 bar)
N = without by-pass
(filter element PSH-*-N with collapse pressure 210 bar)

Series number

Seals material:
- = NBR
PE = FKM

Note: filters for use in potentially explosive atmosphere are available on request, contact Atos Technical Office

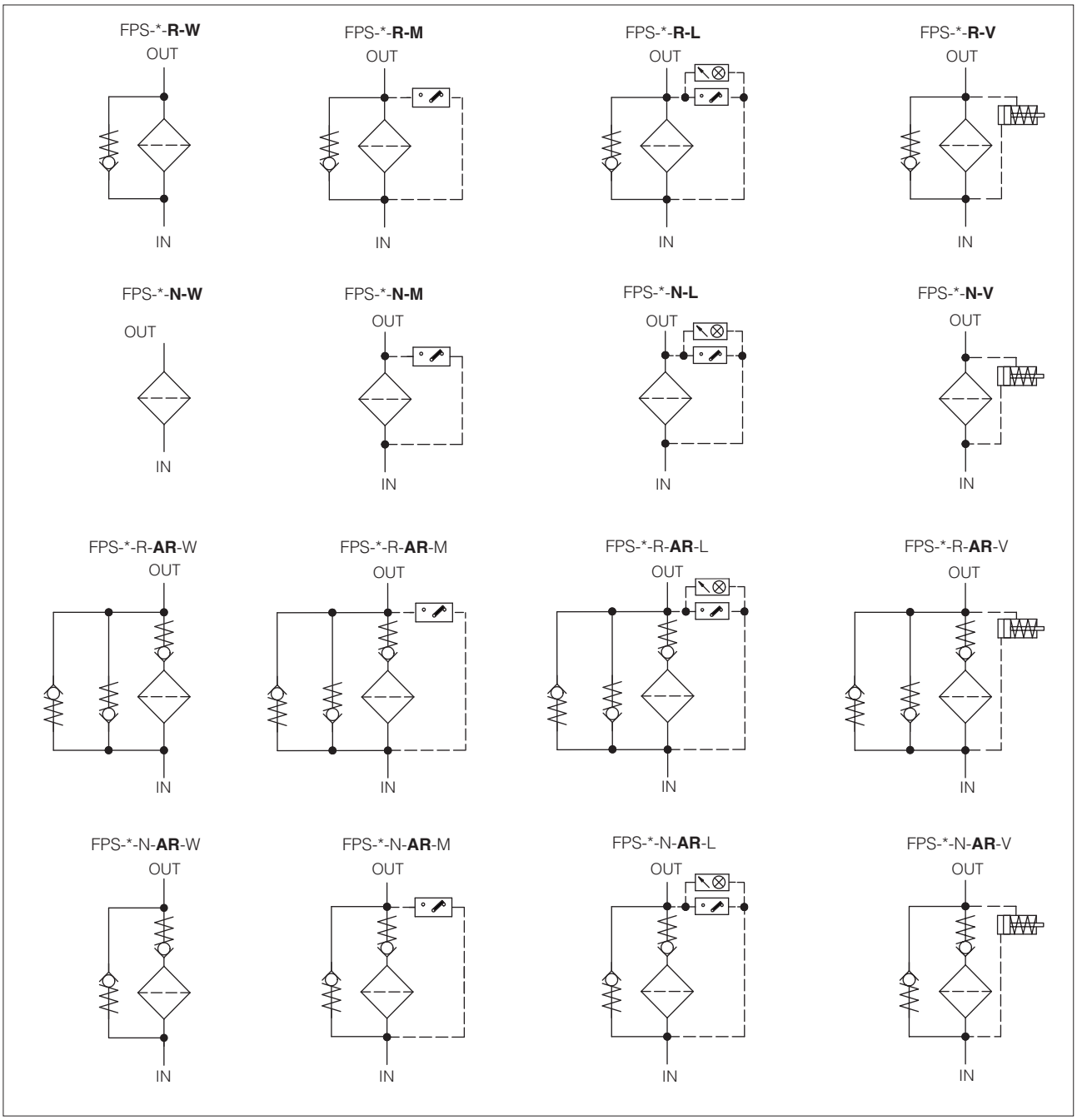
(1) Max flow rates are measured with: Δp 1 bar, filter element F20, largest port size, option -R, oil viscosity 32 mm²/s - see also section 6
In case of different conditions see section 11 for filter sizing

(2) The clogging indicator is supplied disassembled from the filter. The indicator port on filter head is plugged with plastic plug

(3) The plastic plug (option W) is factory assembled to prevent impurities from entering the filter through the clogging indicator port.
A clogging indicator must be fitted on the filter before commissioning. Do not install the filter with the plastic cap on the hydraulic system

(4) Differential clogging indicator CID-E*-M/UL with cURus certification is available on request, see section 4
Differential thermostated indicator CID-T and differential electronic transmitter with output signal 4÷20 mA CID-Z are available on request, see section 4

2 HYDRAULIC SYMBOLS (representation according to ISO 1219-1)



3 MODEL CODE OF FILTER ELEMENTS - only for spare **(1)**

PSH	-	10	-	A	-	F10	-	R	*	/	*

Spare filter element for in line filter type FPS

Filter element size:

10 = for FPS-10
20 = for FPS-20
30 = for FPS-30

Filter element length:

for FPS-10	for FPS-20	for FPS-30
A	**A**	**A**
B	**B**	**B**
	C	**C**
		D

Series number

Seals material:
- = NBR
PE = FKM

R = filter element with collapse pressure 21 bar, for filter FPS-*-R with by-pass valve

N = filter element with collapse pressure 210 bar, for filter FPS-*-N without by-pass valve

Microfibre filter element, βx(c) >1000 - ISO 16889:

F03 = 5 µm (c)
F06 = 7 µm (c)
F10 = 12 µm (c)
F20 = 22 µm (c)
Filter element **F01** = 4 µm (c) available on request

(1) Select the filter element according to the model code reported on the filter nameplate, see section 18

4 MODEL CODE OF DIFFERENTIAL CLOGGING INDICATORS - only for spare - see section 14 and 15

CID	-	E	05	-	M	*	/	*

Spare differential clogging indicator for in line filter

Type of indicator:

E = electrical
V = visual
T = thermostated (available on request)
Z = electronic transmitter 4÷20 mA (available on request)

Differential switching pressure (only for CID-E and CID-V):

05 = 5 bar for filters with by-pass valve
08 = 8 bar for filters without by-pass valve

Series number

Seals material:
- = NBR
PE = FKM

Optional LED - only for CID-E

L = with LED
M = without LED
M/UL = without LED, certified according to North American Standard cURus (available on request)

5 GENERAL CHARACTERISTICS

Assembly position / location		Vertical position with the bowl downward
Ambient temperature range		**Standard** = -20°C ÷ +70°C **/PE** option = -20°C ÷ +70°C
Storage temperature range		**Standard** = -20°C ÷ +80°C **/PE** option = -20°C ÷ +80°C
Materials	Filter head	Cast iron
	Filter bowl	Carbon steel
Surface protection		Zinc coating with black passivation
Corrosion resistance		Salt spray test (EN ISO 9227) > 600 h
Fatigue strength		min. 1 x 10^6 cycles at 420 bar
Compliance		Tested to NFPA T3.10.5.1, ISO 10771, ISO 3968 RoHS Directive 2011/65/EU as last update by 2015/863/EU REACH Regulation (EC) n°1907/2006

6 HYDRAULICS CHARACTERISTICS - based on mineral oil ISO VG 46 at 50 °C (viscosity 32mm²/s)

Filter size		FPS-10						FPS-20						FPS-30							
Ports size code		00		01		02, 42		02			03, 43			03				04, 44			
Ports dimension		G1/2"		G3/4		G1", SAE-16		G1"			G1"1/4, SAE-20			G1"1/4				G1/"1/2, SAE-24			
Filter length		A	B	A	B	A	B	A	B	C	A	B	C	A	B	C	D	A	B	C	D
Max flow (l/min) at Δp= 1 bar Filter with by-pass **-R** (see note)	**F03**	36	56	40	62	43	73	73	84	105	80	93	118	88	164	213	259	91	172	226	277
	F06	48	69	53	79	61	98	100	112	135	112	127	154	127	225	277	330	132	239	297	356
	F10	63	79	72	92	86	120	135	148	170	154	170	195	183	275	321	380	193	295	347	414
	F20	78	87	90	101	115	137	166	178	196	191	205	226	240	333	373	412	256	361	406	450
Max flow (l/min) at Δp= 1 bar Filter without by-pass **-N** (see note)	**F03**	31	43	34	48	36	53	60	70	88	65	76	98	71	120	191	215	74	125	202	228
	F06	47	55	52	61	58	71	83	94	116	91	105	131	93	187	228	290	97	197	242	311
	F10	54	75	60	87	70	111	117	130	153	133	149	176	158	245	298	343	166	260	321	372
	F20	72	85	82	99	103	131	154	166	187	177	192	215	210	315	367	380	223	340	400	414
Max operating pressure [bar]		**420**																			
Burst pressure [bar]		**> 1260**																			

Note: Max flow rates are measured with Δp= 1 bar and viscosity 32mm²/s. In case of different conditions see section 11 for filter sizing

7 FILTER ELEMENTS

Material		Inorganic microfibre
Filtration rating as per ISO16889	**F03**	$\beta_{4,5\mu m\,(c)} \geq 1000$
	F06	$\beta_{7\mu m\,(c)} \geq 1000$
	F10	$\beta_{12\mu m\,(c)} \geq 1000$
	F20	$\beta_{22\mu m\,(c)} \geq 1000$
Filter element collapse pressure	**R** = for filter with by-pass valve	21 bar
	N = for filter without by-pass valve	210 bar

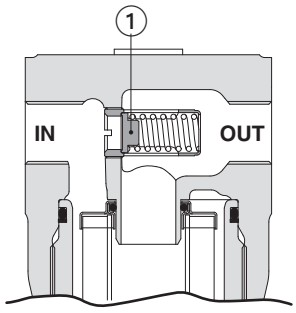
8 SEALS AND HYDRAULIC FLUIDS - for other fluids not included in below table, consult our technical office

Seals, recommended fluid temperature	NBR seals (standard) = -30°C ÷ +100°C FKM seals (/PE option) = -25°C ÷ +120°C		
Recommended viscosity	15 ÷ 100 mm²/s - max allowed range 2.8 ÷ 500 mm²/s		
Hydraulic fluid	**Suitable seals type**	**Classification**	**Ref. Standard**
Mineral oils	NBR, FKM	HL, HLP, HLPD, HVLP, HVLPD	DIN 51524
Flame resistant without water	FKM	HFDU, HFDR	ISO 12922

9 BY-PASS VALVE

Filter with by-pass valve - version **-R**

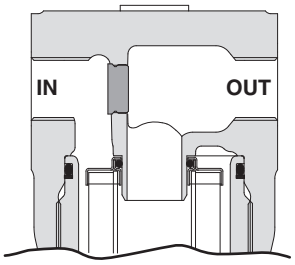
The filter with by-pass valve (1) is used in combination with filter elements PSH-*-R with collapse pressure 21 bar.
The by-pass valve allows the oil flow to by-pass the filter element in particular conditions:
- it protects the filter element from pressure peaks that could be generated, especially at the cold system start-up. In these cases the valve opens only for the instant necessary to discharge the pressure peak, limiting the quantity of oil that bypasses the filter.
- it allows the free passage of the oil flow in case of completely clogged filter element (Δp > 6 bar). This situation should be carefully avoided, by means of a scheduled maintenance, otherwise the contaminated oil will pass to the clean side of the filter and then it will circulate in the hydraulic system. The filter element must be replaced before the clogging condition, at this purpose the use of a differential clogging indicator CID-V (visual, option V) or CID-E (electrical, options L or M) is highly recommended.



FPS-*-R

Filter without by-pass valve - version **-N**

The filter version without by-pass is recommended when the hydraulic system must be absolutely protected by contamination, then avoiding the risk that the contaminant passes though the by-pass valve.
The filter without by pass must be used in combination with filter elements PSH-N with high collapse pressure 210 bar



FPS-*-N

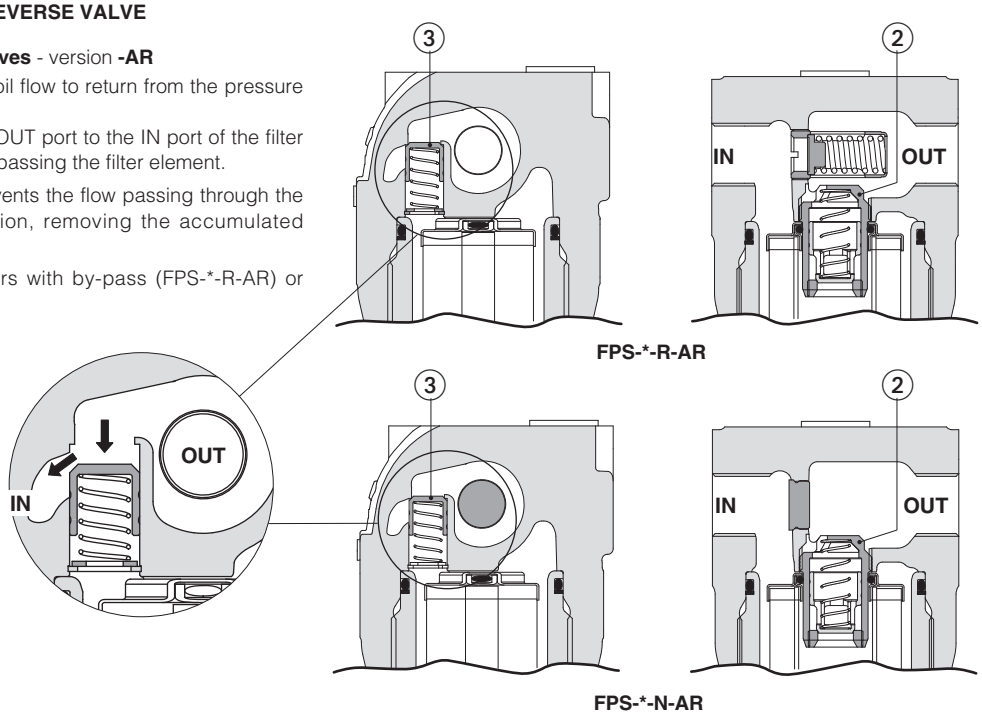
10 ANTI BACK-FLOW AND REVERSE VALVE

Anti-back flow and Reverse valves - version **-AR**

The filter version -AR allows the oil flow to return from the pressure line back to the pump.
The return flow passes from the OUT port to the IN port of the filter through the reverse valve (3), bypassing the filter element.

The anti-back flow valve (2) prevents the flow passing through the filter element in reverse direction, removing the accumulated contaminant.

Version **AR** is available for filters with by-pass (FPS-*-R-AR) or without by-pass (FPS-*-N-AR)



FPS-*-R-AR

FPS-*-N-AR

11 FILTERS SIZING

For the filter sizing it is necessary to consider the Total Δp at the maximum flow at which the filter must work.
The Total Δp is given by the sum of filter head Δp plus the filter element Δp:

Total Δp = filter head Δp + filter element Δp

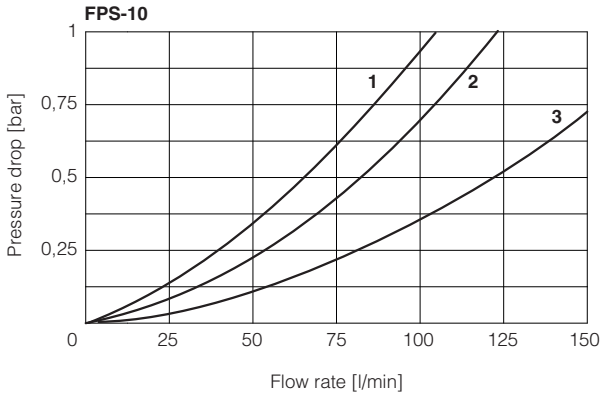
In the best conditions the total Δp should not exceed 1,0 bar
See below sections to calculate the Δp of filter head and Δp of the filter element

11.1 Q/Δp DIAGRAMS OF FILTER HEAD

The pressure drop of filter head mainly depends on the ports size and fluid density
In the following diagrams are reported the Δp characteristics of filter head based on mineral oil with density 0,86 kg/dm^3 and viscosity 30 mm^2/s

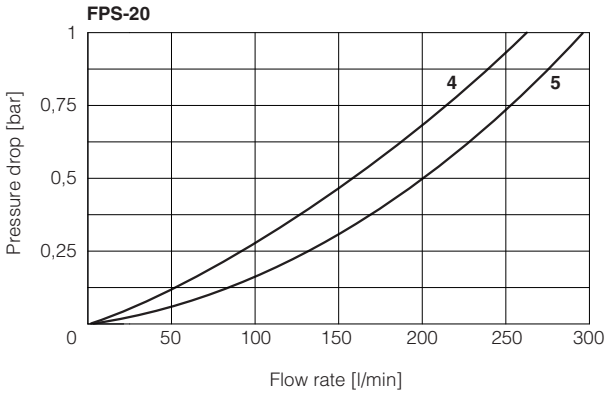
FPS-10

1 = FPS-10*** 00 (G 1/2")
2 = FPS-10*** 01 (G 3/4")
3 = FPS-10*** 02 (G 1")
FPS-10*** 42 (SAE-16)



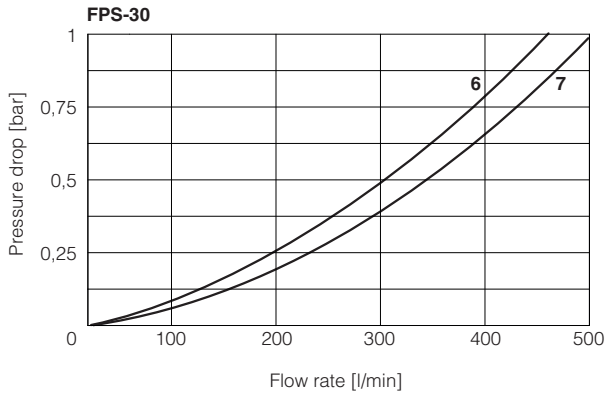
FPS-20

4 = FPS-20*** 02 (G 1")
5 = FPS-20*** 03 (G 1¼")
FPS-20*** 43 (SAE-20)



FPS-30

6 = FPS-30*** 03 (G 1¼")
7 = FPS-30*** 04 (G 1½")
FPS-30*** 44 (SAE-24)



11.2 FILTER ELEMENT Δp

The pressure drop through the filter depends to:
- size of filter element
- filtration rating
- fluid viscosity

The Δp of filter element is given by the formula:

$$\Delta p \text{ of filter element} = Q \times \frac{Gc}{1000} \times \frac{\text{Viscosity}}{32}$$

Q = working flow (l/min)

Gc = Gradient coefficient (mbar/(l/min)).
The Gc values are reported in the following table

Viscosity = effective fluid viscosity in the working conditions (mm²/s)

Gradient coefficient Gc of PSH filter elements

Filter element size		10		20			30			
Filter element length		A	B	A	B	C	A	B	C	D
Filter element type	Filtration rating	**Gc** Gradient coefficient								
R for filter with bypass valve	**F03**	21.30	10.84	11.07	9.23	6.74	10.26	4.82	3.27	2.30
	F06	13.97	6.79	7.27	6.06	4.43	6.73	2.98	1.99	1.26
	F10	8.39	4.42	4.45	3.71	2.71	4.12	2.02	1.36	0.70
	F20	4.78	2.93	2.87	2.39	1.75	2.66	1.21	0.77	0.40
N for filter without bypass valve	**F03**	26.03	16.72	14.19	11.83	8.64	13.00	7.15	3.87	3.21
	F06	14.77	11.25	9.50	7.92	5.79	9.63	4.00	2.93	1.80
	F10	11.57	5.25	5.66	4.72	3.45	5.05	2.57	1.67	1.10
	F20	6.13	3.34	3.41	2.84	2.07	3.33	1.44	0.83	0.70

Example:

Calculation of Total Δp for filter type FPS-10-B-F10-02-R at Q = 80 l/min and viscosity 46 mm²/s (filter element PSH-10-B-F10-R)

Δp of filter head = 0,24 bar
Gr = 4,42 mbar/(l/min)

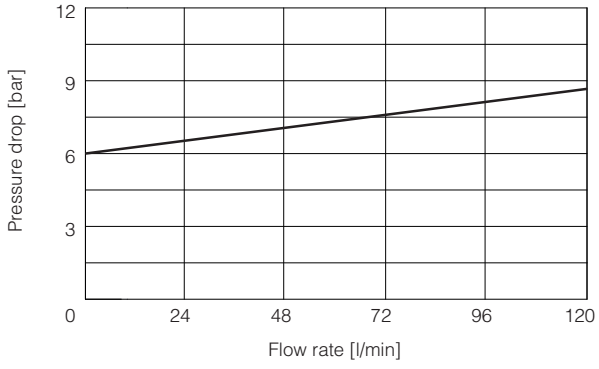
Filter element Δp = $80 \times \frac{4{,}42}{1000} \times \frac{46}{32} = 0{,}51$ bar

Total Δp = 0,24 + 0,51 = **0,75 bar**

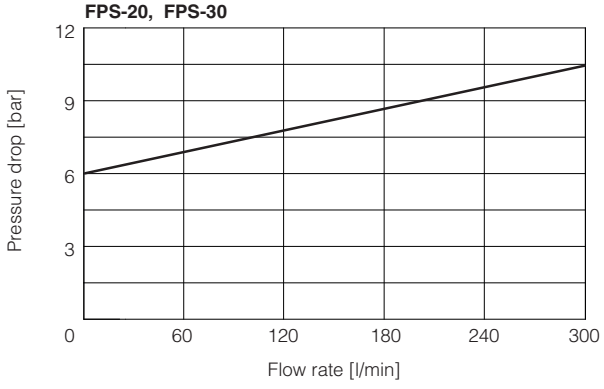
12 **BY-PASS VALVE** - based on mineral oil ISO VG46 at 50°C (viscosity = 32 mm²/s)

Q/Δp diagrams of flow through the by-pass valve

FPS-10

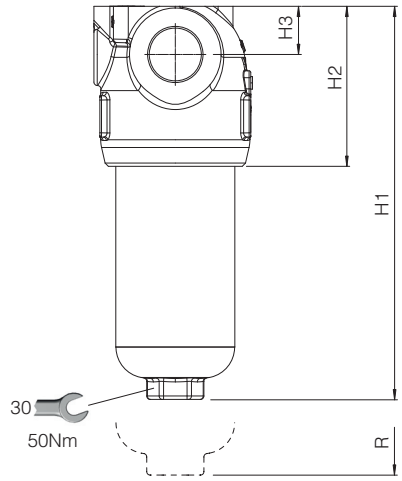


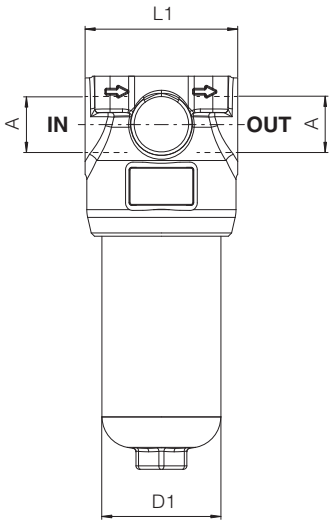
FPS-20, FPS-30

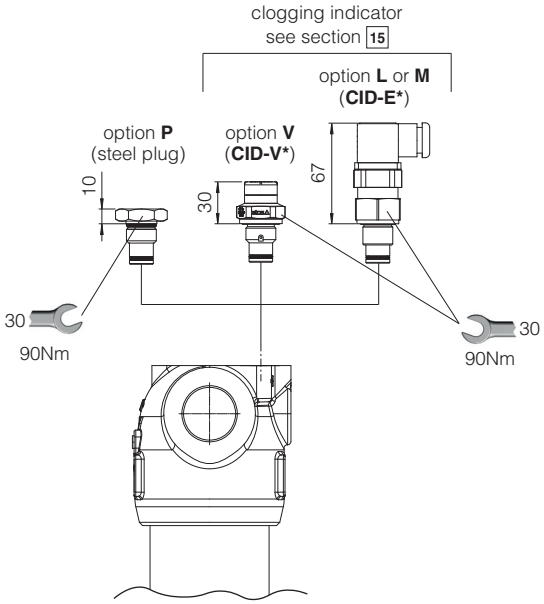


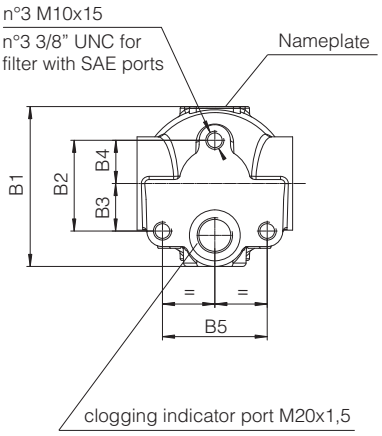
13 INSTALLATION DIMENSIONS OF FPS FILTERS [mm]

FPS -10





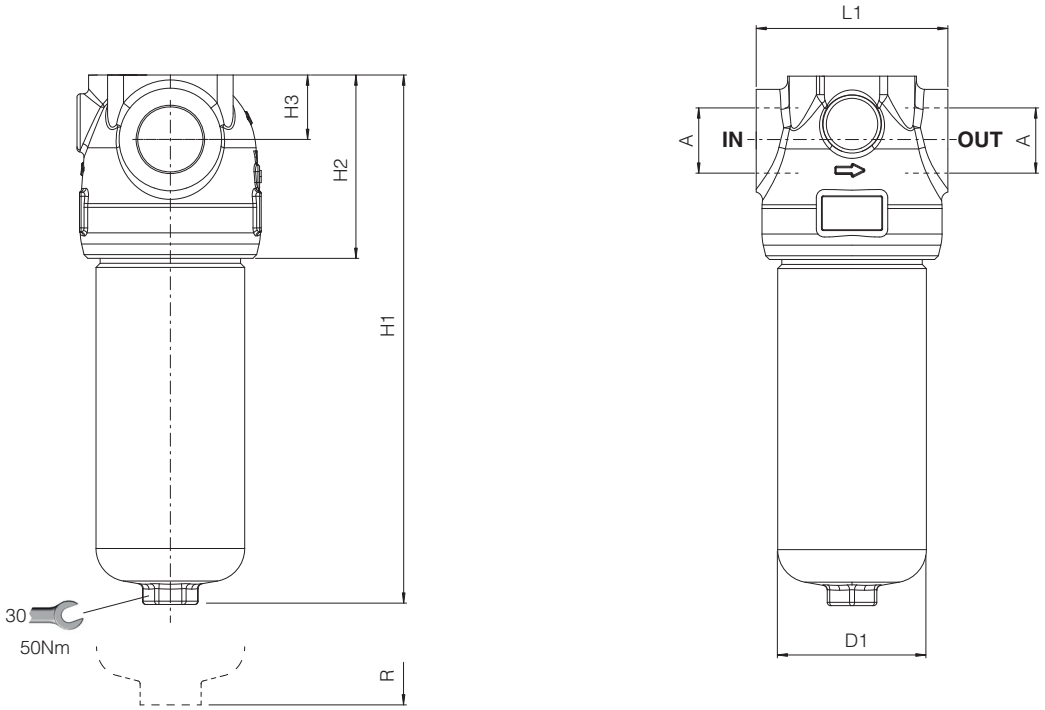


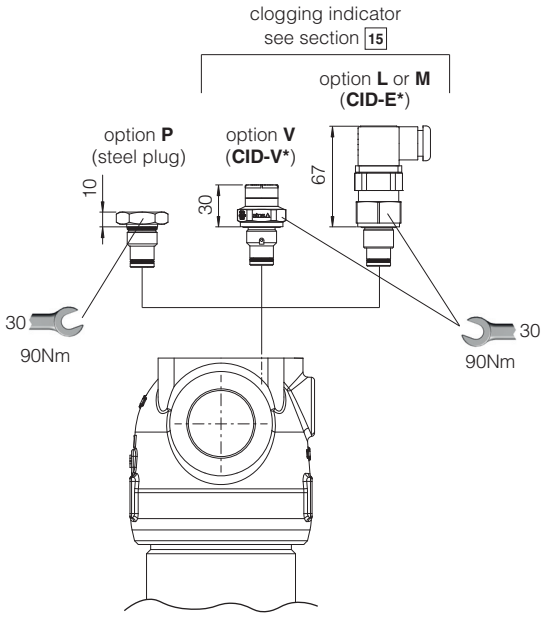


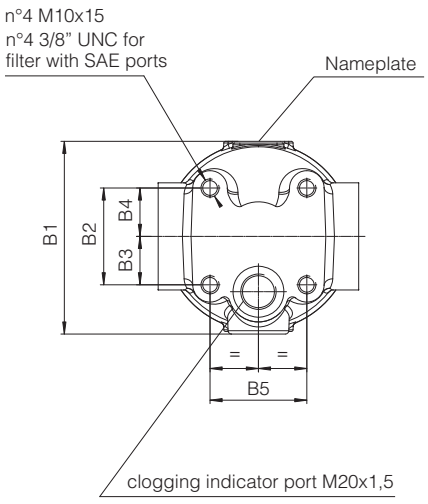
Code	A	B1	B2	B3	B4	B5	D1	H1	H2	H3	L1	R (element removal)	Mass (Kg)
FPS-10-A	1/2" BSPP 3/4" BSPP 1" BSPP SAE-16 **(1)**	93.5	52.5	27.5	25	60.6	70	203	93	28	90	110	4
FPS-10-B								296					5

(1) SAE-16 thread size 1" 5/16-12-UN-2B

FPS -20



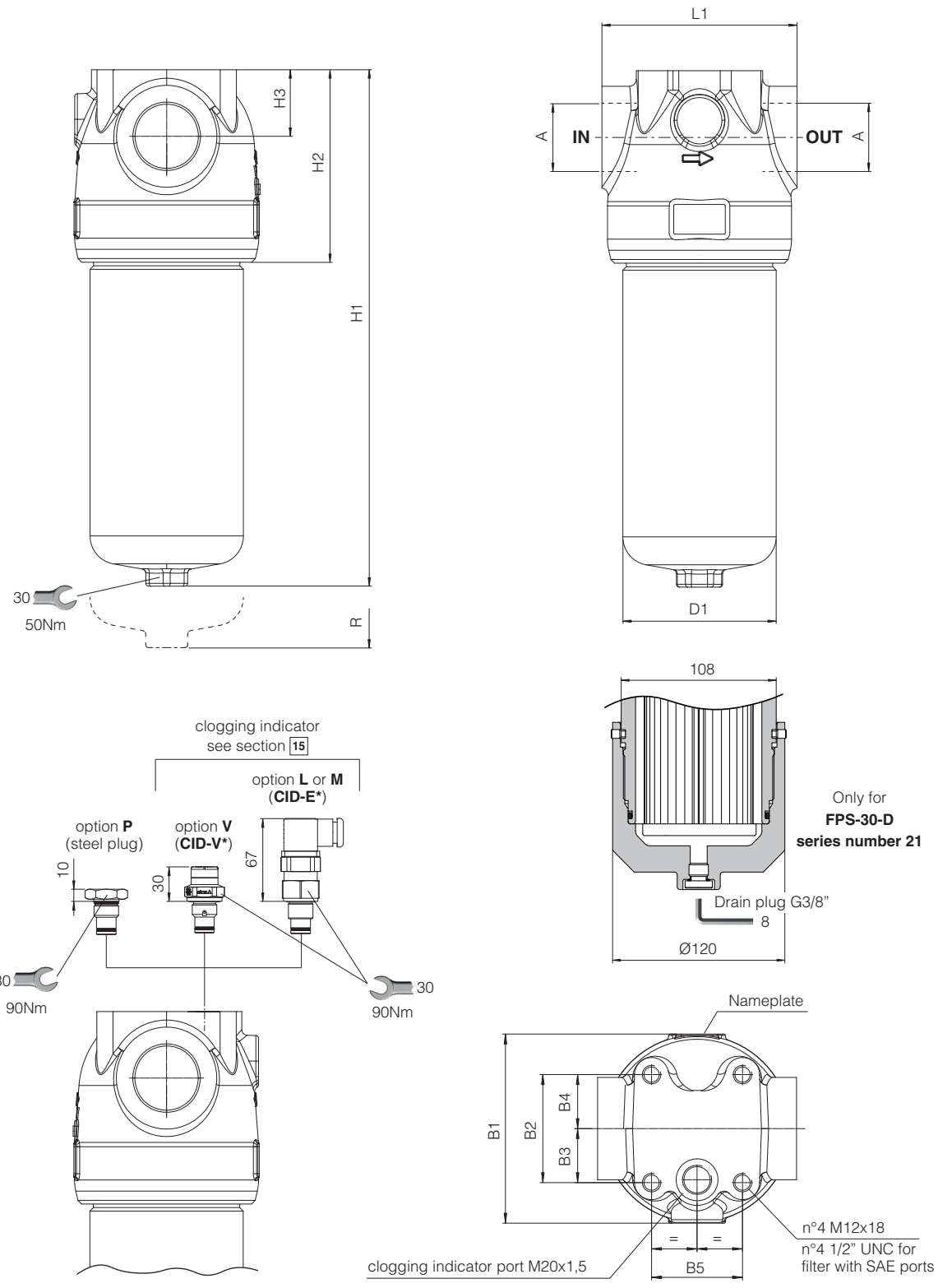




Code	A	B1	B2	B3	B4	B5	D1	H1	H2	H3	L1	R (element removal)	Mass (Kg)
FPS-20-A	1" BSPP 1 1/4" BSPP SAE-20 **(1)**	111.5	56	28	28	56	90	261	111	39	116	120	7.4
FPS-20-B								320					8.5
FPS-20-C								390					9.9

(1) SAE-20 thread size 1" 5/8-12-UN-2B

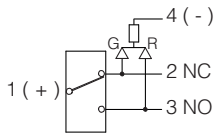
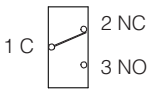
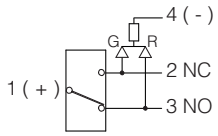
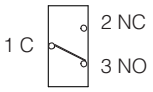
FPS -30



Code	A	B1	B2	B3	B4	B5	D1	H1	H2	H3	L1	R (element removal)	Mass (Kg)
FPS-30-A	1 1/4" BSPP 1 1/2 BSPP SAE-24 **(1)**	133.5	76	38	38	64	110	240.5	136	47	140	130	10.5
FPS-30-B								333.5					13
FPS-30-C								453.5					16.4
FPS-30-D								552.5					19

(1) SAE-24 thread size 1" 7/8-12-UN-2B

14 CHARACTERISTICS OF DIFFERENTIAL CLOGGING INDICATORS

Model code		CID-E* ELECTRICAL		CID-V* VISUAL
Differential switching pressure	CID-E05, CID-V05	5 bar ± 10%		5 bar ± 15%
	CID-E08, CID-V08	8 bar ± 10%		8 bar ± 10%
Max pressure		450 bar		420 bar
Max differential pressure		200 bar		
Ambient temperature		-25°C ÷ +100°C		-25°C ÷ +80°C
Hydraulic connection		M20x1,5		
Duty factor		100%		
Mechanical life		1 x 10^6 operations		
Mass (Kg)		0,16		0,11
Electric connection		Electric plug connection as per DIN 43650 with cable gland type PG7		-
Power supply	CID-E05-L, CID-E08-L	24 VDC ± 10%		-
	CID-E05-M, CID-E08-M	14 VDC ÷ 30 VDC	125 VAC ÷ 250 VAC	-
Max current - resistive (inductive)		5 A (4 A) ÷ 4 A (3 A)	5 A (3 A) ÷ 3 A (2 A)	-
Protection degree to DIN EN 60529		IP65 with mating connector		-
Switching scheme		**CID-*-L**	**CID-*-M**	
	clean filter element			GREEN
	clogged filter element			RED

15 DIMENSIONS OF DIFFERENTIAL CLOGGING INDICATORS

ELECTRICAL INDICATOR

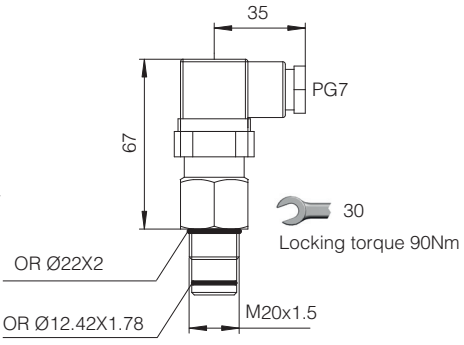
CID-E05-L
CID-E08-L

Electric connector
DIN 43650
Transparent
with internal Led

CID-E05-M
CID-E08-M
CID-E05-M/UL
CID-E08-M/UL

Electric connector
DIN 43650
Black colour

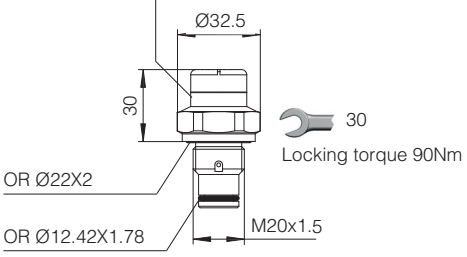
Led signal:
Green = clean filter element
Red = clogged filter element
(filter elements to be replaced)



VISUAL INDICATOR

CID-V05
CID-V08

Visual signal:
Green = clean filter element
Red = clogged filter element
(filter elements to be replaced)



Note: the electrical connector can be oriented at steps of 90°

NOTE: Differential thermostated indicator CID-T and differential electronic transmitter with output signal 4÷20 mA CID-Z are available on request

16 INSTALLATION AND COMMISSIONING

The max operating pressure of the system must not exceed the max working pressure of the filter (420 bar).
During the filter installation, pay attention to respect the flow direction, shown by the arrow on the filter head.
The filter should be preferably mounted with the bowl downward.
The filter should be properly secured using the threaded fixing holes on the filter head.
Make sure that there is enough space for the replacement of the filter element, see dimension "**R**" at section 13.
Never run the system without the filter element.

For filters ordered with clogging indicator:
- remove the plastic plug from the indicator port on the filter head
- install the clogging indicator and lock it at the specified torque

During the cold start up (fluid temperature lower than 30°C), a false clogging indicator signal can be given due to the high fluid viscosity.
To avoid false signal, a differential threaded clogging indicator CID-T can be used.

17 MAINTENANCE

The filter element must be replaced as soon as the clogging indicator switches to highlight the filter clogged condition.
For filters without clogging indicator, the filter element must be replaced according to the system manufacturer's recommendations.
Select the new filter element according to the model code reported on the filter nameplate, see section 18.

For the replacement of the filter element, proceed as follow:
- releases the system pressure; the filter has no pressure bleeding device
- pay attention to the fluid and filter surface temperature. Always use suitable gloves and protection glasses
- unscrew the bowl ② from the filter head ① by turning counterclockwise (view from bottom side)
- remove the dirty filter element ③ pulling it carefully
- lubricate the seal of new filter element and insert it over the spigot in the filter head
- clean the bowl internally, check the o-ring ⑥ and replace it if damaged
- lubricate the o-ring, the threads and screw by hand the bowl to the filter head by turning clockwise (view from bottom side). Tighten at the recommended torque.

WARNING: The dirty filter elements cannot be cleaned and re-used. They are classified as "dangerous waste material", then they must be disposed of by authorized Companies, according to the local laws.

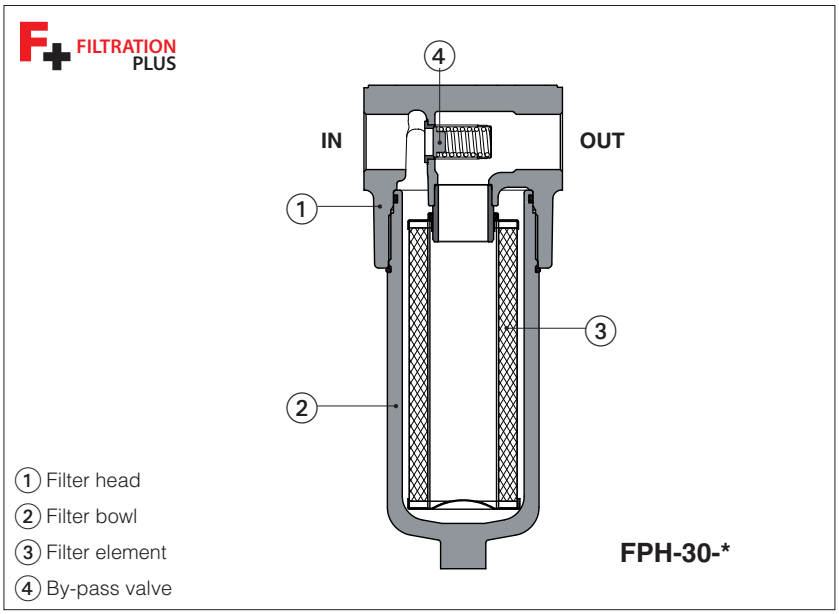
17.1 SEALS KIT

Filter type	Seal kit code (NBR)	Seal kit code (FKM)	Seal kit composition
FPS-10	GUARN FPS-10	GUARN FPS-10 /PE	④+⑤+⑥+⑦
FPS-20	GUARN FPS-20	GUARN FPS-20 /PE	④+⑤+⑥+⑦
FPS-30	GUARN FPS-30	GUARN FPS-30 /PE	④+⑤+⑥+⑦+⑧+⑨ **(1)**

(1) Seals ⑧ and ⑨ are supplied in seal kit but used only for FPS-30-D

In line filters, high pressure type FPH

SAE flanged ports



FPH

In line filters are designed for installation on the pressure line downstream the pump, to ensure a high cleanliness of the fluid circulating into the hydraulic system. They protect sensible components from contamination present in the working fluid and they are particularly recommended for systems with proportional valves.

- two head sizes
- SAE 6000 flanged ports, from 3/4" to 1 1/2"
- **Filtration Plus** microfiber filter elements ensure high efficiency, low pressure drop, high DHC and long lasting performance. Collapse pressure 21 bar for filters equipped with by-pass valve or 210 bar for filters without by-pass
- filtration rating 5 - 7 - 12 - 22 µm(c) (βx (c) >1000, ISO 16889).
- versions without or with by-pass valve with cracking pressure 6 bar.
- without or with differential clogging indicator

Max flow **410 l/min**

Max working pressure **420 bar**

1 MODEL CODE OF COMPLETE FILTERS

FPH	-	10	-	A	-	F10	-	21	-	R	-	W	**	/	*

FPH: In line filter, high pressure

Filter size:
- **10** = ports size 3/4" ÷ 1" SAE6000 flange
- **30** = ports size 1 1/4" ÷ 1 1/2 SAE6000 flange

Filter length:

	Max flow [l/min] **(1)**	
	FPH-10	FPH-30
A =	100	242
B =	120	334
C =	-	371
D =	-	410

Filter element:

SN = only body, without filter element

F+ microfibre filter element βx(c) >1000 - ISO 16889:
F03 = 5 µm (c) **F10** = 12 µm (c)
F06 = 7 µm (c) **F20** = 22 µm (c)
Filter element **F01** = 4 µm (c) available on request

Ports size:
SAE 6000 flange with metric bolts:

FPH-10	FPH-30
21 = 3/4"	**23** = 1 1/4"
22 = 1"	**24** = 1 1/2"

By-pass:
- **R** = by-pass valve with cracking pressure 6 bar (filter element with collapse pressure 21 bar)
- **N** = without by-pass (filter element with collapse pressure 210 bar)

Differential clogging indicator see sect. 9 :
- **W** = without, indicator port with plastic plug **(2)**
- **P** = without, indicator port with steel plug
- **L** = electrical indicator with LED **(3)**
- **M** = electrical indicator without LED **(3)**
- **V** = visual indicator **(3)**

See also note **(4)**

Series number

Seals material:
- - = NBR
- **PE** = FKM

Note: filters for use in potentially explosive atmosphere are available on request, contact Atos Technical Office

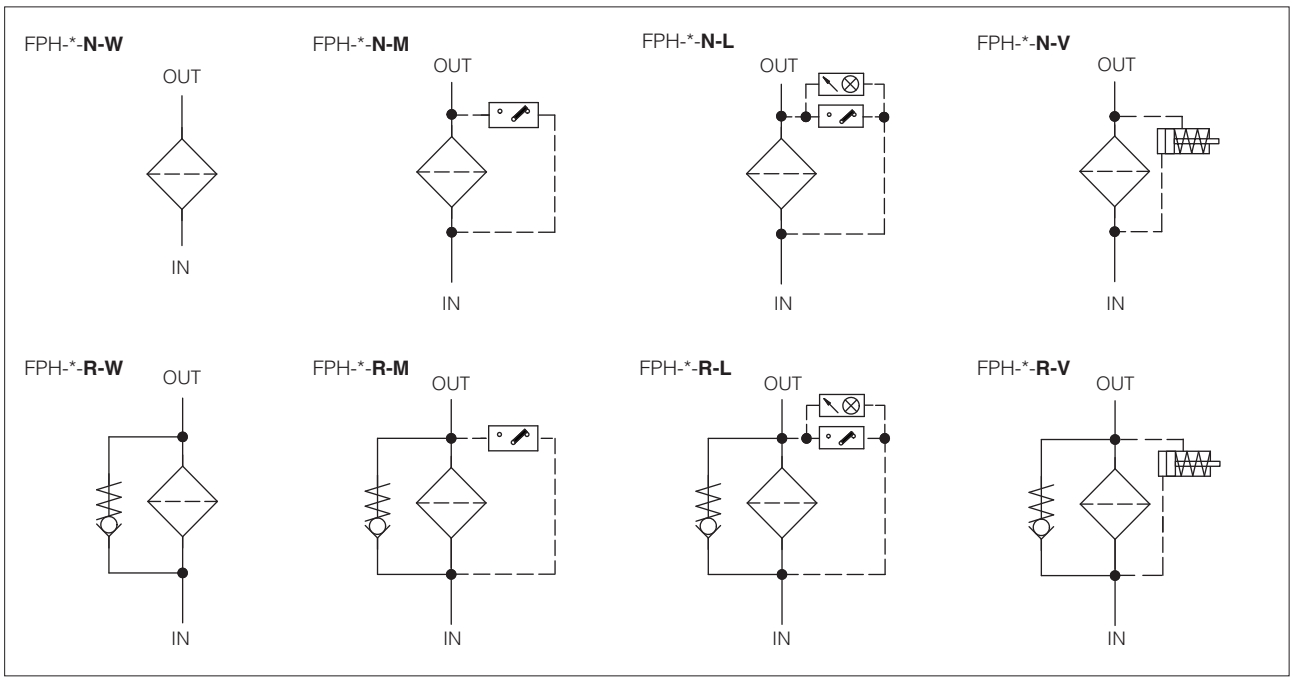
(1) Max flow rates are measured with: Δp 1 bar, filter element F20, largest port size, option -R, oil viscosity 32 mm²/s - see also section 6
In case of different conditions see section 11 for filter sizing

(2) The plastic plug (option W) is factory assembled to prevent impurities from entering the filter through the clogging indicator port. A clogging indicator must be fitted on the filter before commissioning. Do not install the filter with the plastic cap on the hydraulic system

(3) The clogging indicator is supplied disassembled from the filter. The indicator port on filter head is plugged with plastic plug

(4) Differential thermostated indicator CID-T and differential electronic transmitter with output signal 4÷20 mA CID-Z are available on request, see section 4

2 HYDRAULIC SYMBOLS (representation according to ISO 1219-1)



3 MODEL CODE OF FILTER ELEMENTS - only for spare **(1)**

PSH	-	10	-	A	-	F10	-	R	*	/	*

Spare filter element for in line filter type FPH

Filter element size:
10 = for FPH-10
30 = for FPH-30

Filter element length:

for FPH-10	for FPH-30
A	**A**
B	**B**
	C
	D

Series number

Seals material:
- = NBR
PE = FKM

R = filter element with collapse pressure 21 bar, for filter FPH-*-R with by-pass valve
N = filter element with collapse pressure 210 bar, for filter FPH-*-N without by-pass valve

Microfibre filter element, βx(c) >1000 - ISO 16889:
F03 = 5 µm (c)
F06 = 7 µm (c)
F10 = 12 µm (c)
F20 = 22 µm (c)
Filter element **F01** = 4 µm (c) available on request

(1) Select the filter element according to the model code reported on the filter nameplate, see section 17

4 MODEL CODE OF DIFFERENTIAL CLOGGING INDICATORS - only for spare - see section 13 and 14

CID	-	E	05	-	M	*	/	*

Spare differential clogging indicator for in line filter

Type of indicator:
E = electrical
V = visual
T = thermostated (available on request)
Z = electronic transmitter (available on request)

Differential switching pressure (only for CID-E and CID-V):
05 = 5 bar for filters with by-pass valve
08 = 8 bar for filters without by-pass valve

Series number

Seals material:
- = NBR
PE = FKM

Optional LED - only for CID-E
L = with LED
M = without LED

5 GENERAL CHARACTERISTICS

Assembly position / location		Vertical position with the bowl downward
Ambient temperature range		**Standard** = -20°C ÷ +70°C **/PE** option = -20°C ÷ +70°C
Storage temperature range		**Standard** = -20°C ÷ +80°C **/PE** option = -20°C ÷ +80°C
Materials	Filter head	Cast iron
	Filter bowl	Carbon steel
Surface protection		Zinc coating with black passivation
Fatigue strength		min. 1 x 10^6 cycles at 420 bar
Compliance		RoHS Directive 2011/65/EU as last update by 2015/863/EU REACH Regulation (EC) n°1907/2006

6 HYDRAULICS CHARACTERISTICS - based on mineral oil ISO VG 46 at 50 °C (viscosity 32mm²/s)

Filter size		FPH-10				FPH-30							
Ports size code		21		22		23				24			
Ports dimension	SAE 6000 flange	3/4"		1"		1 1/4"				1 1/2"			
Filter length		A	B	A	B	A	B	C	D	A	B	C	D
Max flow (l/min) at Δp= 1 bar Filter with by-pass **-R** (see note)	**F03**	36	58	39	66	84	158	204	246	86	164	214	260
	F06	50	73	55	87	122	216	263	309	126	227	279	329
	F10	66	84	77	104	176	262	302	352	184	277	322	377
	F20	82	93	100	120	230	312	346	378	242	334	371	410
Max flow (l/min) at Δp= 1 bar Filter without by-pass **-N** (see note)	**F03**	31	44	33	48	68	116	184	207	69	119	192	217
	F06	48	57	53	64	90	180	218	274	92	188	230	291
	F10	56	80	63	98	153	234	282	320	158	246	300	342
	F20	75	90	91	114	202	297	341	352	212	316	365	380
Max operating pressure	[bar]	**420**											
Burst pressure	[bar]	**> 1260**											

Note: Max flow rates are measured with Δp= 1 bar and viscosity 32mm²/s. In case of different conditions see section 11 for filter sizing

7 FILTER ELEMENTS

Material		Inorganic microfibre
Filtration rating as per ISO16889	**F03**	$\beta_{4,5\mu m\,(c)} \geq 1000$
	F06	$\beta_{7\mu m\,(c)} \geq 1000$
	F10	$\beta_{12\mu m\,(c)} \geq 1000$
	F20	$\beta_{22\mu m\,(c)} \geq 1000$
Filter element collapse pressure	**R** = for filter with by-pass valve	21 bar
	N = for filter without by-pass valve	210 bar

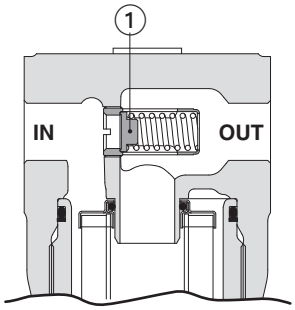
8 SEALS AND HYDRAULIC FLUIDS - for other fluids not included in below table, consult our technical office

Seals, recommended fluid temperature	NBR seals (standard) = -25°C ÷ +100°C FKM seals (/PE option) = -25°C ÷ +100°C		
Recommended viscosity	15 ÷ 100 mm²/s - max allowed range 2.8 ÷ 500 mm²/s		
Hydraulic fluid	**Suitable seals type**	**Classification**	**Ref. Standard**
Mineral oils	NBR, FKM	HL, HLP, HLPD, HVLP, HVLPD	DIN 51524
Flame resistant without water	FKM	HFDU, HFDR	ISO 12922

9 BY-PASS VALVE

Filter with by-pass valve - version **-R**

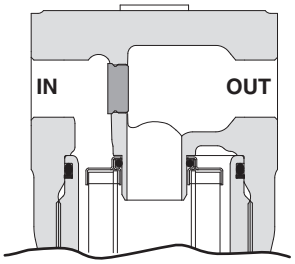
The filter with by-pass valve (1) is used in combination with filter elements PSH-*-R with collapse pressure 21 bar.
The by-pass valve allows the oil flow to by-pass the filter element in particular conditions:
- it protects the filter element from pressure peaks that could be generated, especially at the cold system start-up. In these cases the valve opens only for the instant necessary to discharge the pressure peak, limiting the quantity of oil that bypasses the filter.
- it allows the free passage of the oil flow in case of completely clogged filter element (Δp > 6 bar). This situation should be carefully avoided, by means of a scheduled maintenance, otherwise the contaminated oil will pass to the clean side of the filter and then it will circulate in the hydraulic system. The filter element must be replaced before the clogging condition, at this purpose the use of a differential clogging indicator CID-V (visual, option V) or CID-E (electrical, options L or M) is highly recommended.



FPH-*-R

Filter without by-pass valve - version **-N**

The filter version without by-pass is recommended when the hydraulic system must be absolutely protected by contamination, then avoiding the risk that the contaminant passes though the by-pass valve.
The filter without by pass must be used in combination with filter elements PSH-N with high collapse pressure 210 bar.

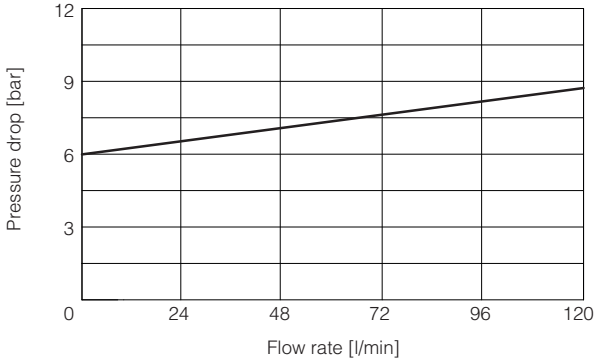


FPH-*-N

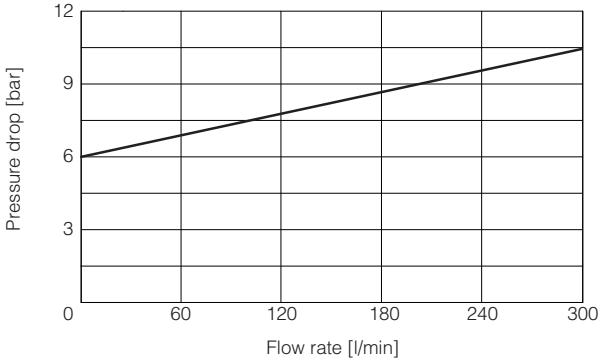
10 BY-PASS VALVE - based on mineral oil ISO VG46 at 50°C (viscosity = 32 mm²/s)

Q/Δp diagrams of flow through the by-pass valve

FPH-10



FPH-30



11 FILTERS SIZING

For the filter sizing it is necessary to consider the Total Δp at the maximum flow at which the filter must work.
The Total Δp is given by the sum of filter head Δp plus the filter element Δp:

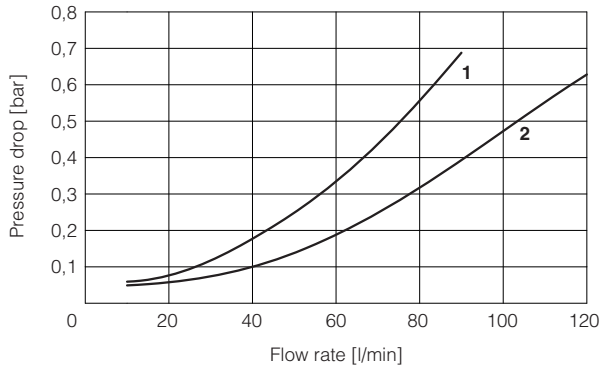
Total Δp = filter head Δp + filter element Δp

In the best conditions the total Δp should not exceed 1,0 bar
See below sections to calculate the Δp of filter head and Δp of the filter element

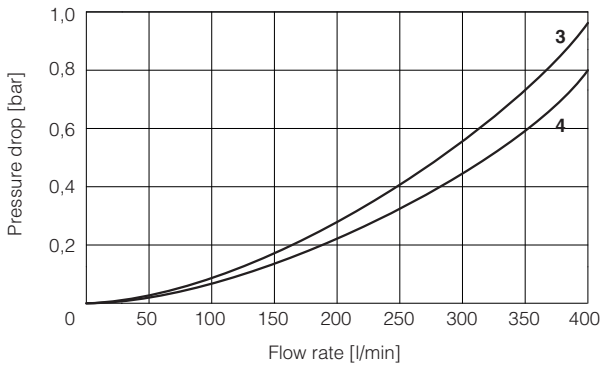
11.1 Q/Δp DIAGRAMS OF FILTER HEAD

The pressure drop of filter head mainly depends on the ports size and fluid density
In the following diagrams are reported the Δp characteristics of filter head based on mineral oil with density 0,86 kg/dm³ and viscosity 30 mm²/s

FPH-10



FPH-30



1 = FPH-10*** 21 (3/4" SAE 6000) **2** = FPH-10*** 22 (1" SAE 6000)

3 = FPH-30*** 23 (1 1/4"SAE 6000) **4** = FPH-30*** 24 (G 1 1/2"SAE 6000)

11.2 FILTER ELEMENT Δp

The pressure drop through the filter depends to:
- size of filter element
- filtration rating
- fluid viscosity

The Δp of filter element is given by the formula:

$$\Delta p \text{ of filter element} = Q \times \frac{Gc}{1000} \times \frac{\text{Viscosity}}{32}$$

Q = working flow (l/min)

Gc = Gradient coefficient (mbar/(l/min)).
The Gc values are reported in the following table

Viscosity = effective fluid viscosity in the working conditions (mm²/s)

Gradient coefficient Gc of PSH filter elements

Filter element size		10		20			30			
Filter element length		A	B	A	B	C	A	B	C	D
Filter element type	Filtration rating	**Gc** Gradient coefficient								
R for filter with bypass valve	**F03**	21.30	10.84	11.07	9.23	6.74	10.26	4.82	3.27	2.30
	F06	13.97	6.79	7.27	6.06	4.43	6.73	2.98	1.99	1.26
	F10	8.39	4.42	4.45	3.71	2.71	4.12	2.02	1.36	0.70
	F20	4.78	2.93	2.87	2.39	1.75	2.66	1.21	0.77	0.40
N for filter without bypass valve	**F03**	26.03	16.72	14.19	11.83	8.64	13.00	7.15	3.87	3.21
	F06	14.77	11.25	9.50	7.92	5.79	9.63	4.00	2.93	1.80
	F10	11.57	5.25	5.66	4.72	3.45	5.05	2.57	1.67	1.10
	F20	6.13	3.34	3.41	2.84	2.07	3.33	1.44	0.83	0.70

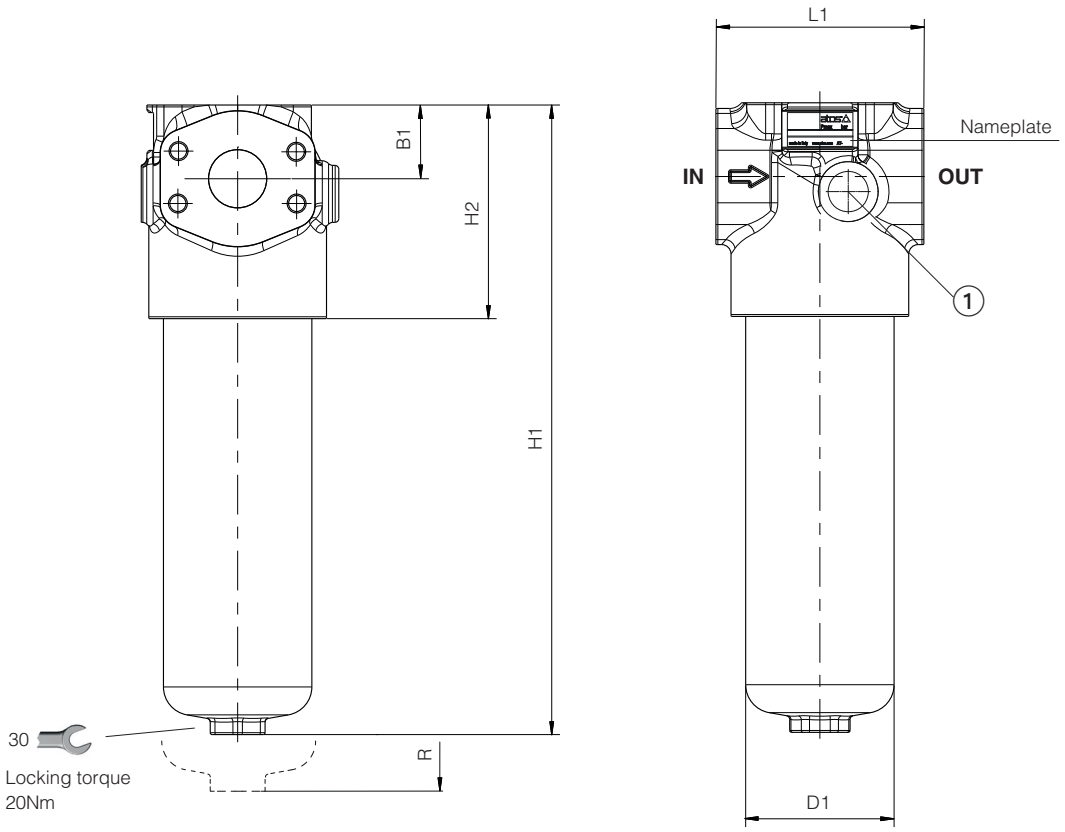
Example:
Calculation of Total Δp for filter type FPH-10-B-F10-22-R at Q = 80 l/min and viscosity 46 mm²/s (filter element PSH-10-B-F10-R)
Δp of filter head = 0,32 bar
Gr = 4,42 mbar/(l/min)

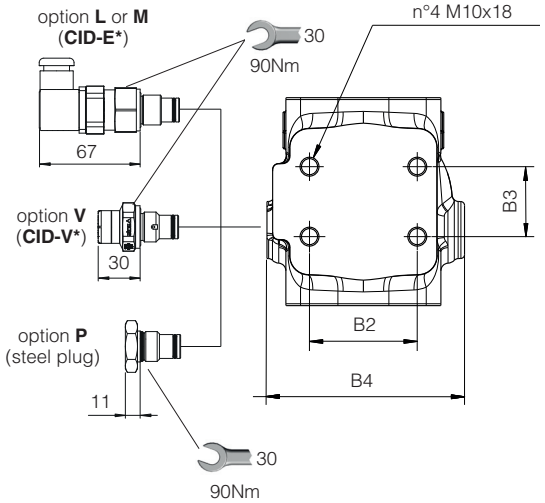
$$\textbf{Filter element } \Delta p = 80 \times \frac{4{,}42}{1000} \times \frac{46}{32} = 0{,}51 \text{ bar}$$

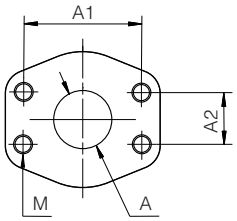
Total Δp = 0,32 + 0,51 = **0,83 bar**

12 INSTALLATION DIMENSIONS OF FPH FILTERS [mm]

FPH -10





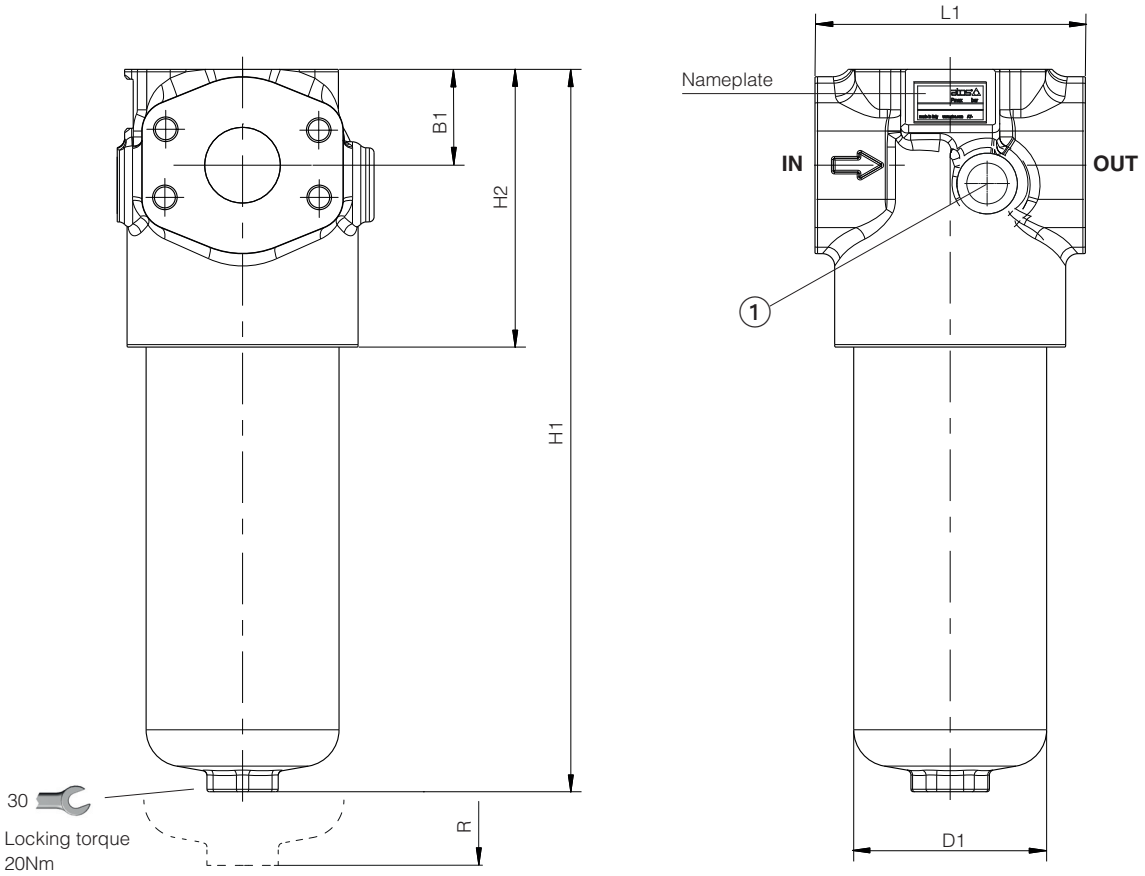


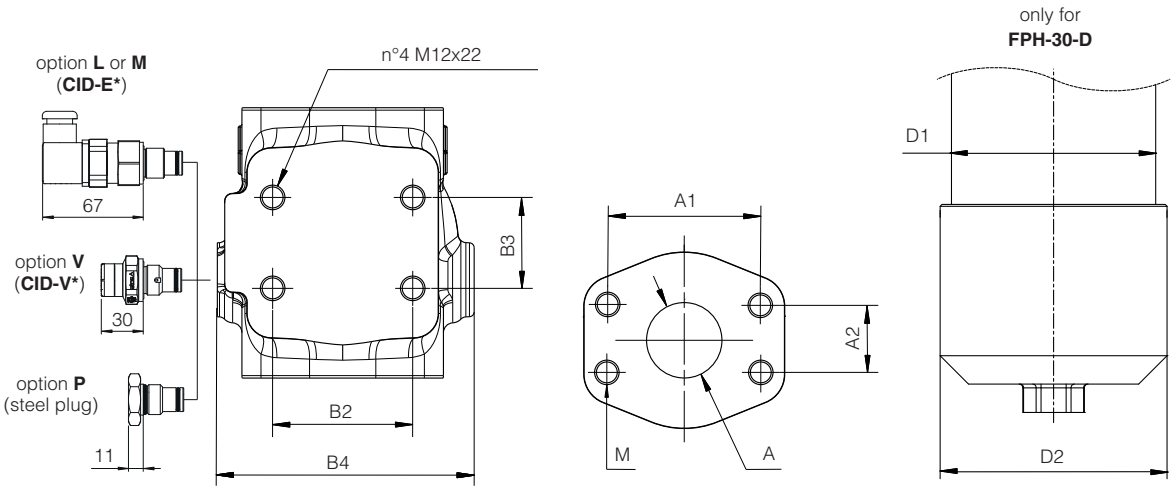
SAE J518-6000 FLANGE	A	A1	A2	M
3/4"	19	50.8	23.8	M10
1"	22	57.2	27.8	M12

(1) Clogging indicator port M20x1.5

Code	B1	B2	B3	B4	D1	D2	F	H1	H2	L1	R (element removal)	Mass (Kg)
FPH-10-A	39	57	37	105	78,5	-	68	222	113	110	130	6,7
FPH-10-B								333				8,4

FPH -30



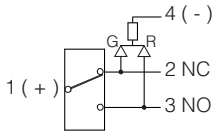
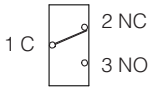
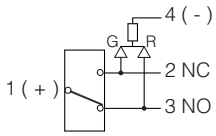
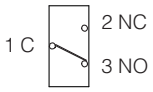


SAE J518-6000 FLANGE	A	A1	A2	M
1 1/4”	32	66.7	31.8	M14
1 1/2”	38	79.4	36.5	M16

(1) Clogging indicator port M20x1.5

Code	B1	B2	B3	B4	D1	D2	F	H1	H2	L1	R (element removal)	Mass (Kg)
FPH-30-A	47	76	64	140	107	-	68	262	145	140	140	13,2
FPH-30-B								355				15,5
FPH-30-C								475				18,4
FPH-30-D						120		568				22,8

13 CHARACTERISTICS OF DIFFERENTIAL CLOGGING INDICATORS

Model code		CID-E* ELECTRICAL		CID-V* VISUAL
Differential switching pressure	CID-E05, CID-V05	5 bar ± 10%		5 bar ± 15%
	CID-E08, CID-V08	8 bar ± 10%		8 bar ± 10%
Max pressure		450 bar		420 bar
Max differential pressure		200 bar		
Ambient temperature		-25°C ÷ +100°C		-25°C ÷ +80°C
Hydraulic connection		M20x1,5		
Duty factor		100%		
Mechanical life		1 x 10^6 operations		
Mass (Kg)		0,16		0,11
Electric connection		Electric plug connection as per DIN 43650 with cable gland type PG7		-
Power supply	CID-E05-L, CID-E08-L	24 VDC ± 10%		-
	CID-E05-M, CID-E08-M	14 VDC ÷ 30 VDC	125 VAC ÷ 250 VAC	-
Max current - resistive (inductive)		5 A (4 A) ÷ 4 A (3 A)	5 A (3 A) ÷ 3 A (2 A)	-
Protection degree to DIN EN 60529		IP65 with mating connector		-
Switching scheme		**CID-*-L**	**CID-*-M**	
	clean filter element			GREEN
	clogged filter element			RED

14 DIMENSIONS OF DIFFERENTIAL CLOGGING INDICATORS

ELECTRICAL INDICATOR

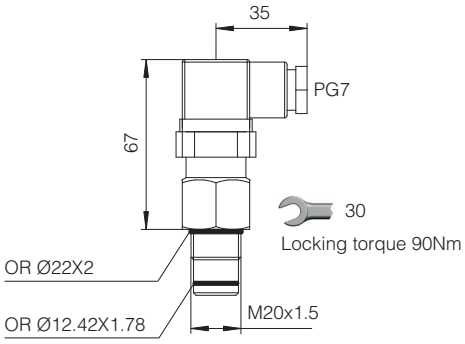
CID-E05-L
CID-E08-L

Electric connector
DIN 43650
Transparent
with internal Led

CID-E05-M
CID-E08-M

Electric connector
DIN 43650
Black colour

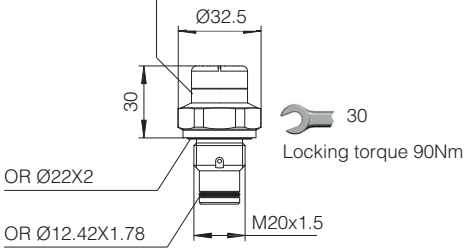
Led signal:
Green = clean filter element
Red = clogged filter element
(filter elements to be replaced)



VISUAL INDICATOR

CID-V05
CID-V08

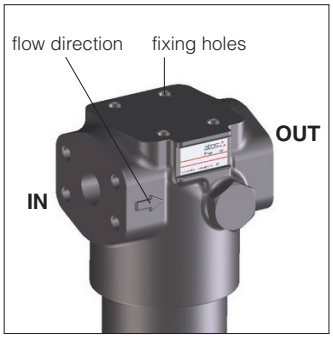
Visual signal:
Green = clean filter element
Red = clogged filter element
(filter elements to be replaced)



Note: the electrical connector can be oriented at steps of 90°

NOTE: Differential thermostated indicator CID-T and differential electronic transmitter with output signal 4÷20 mA CID-Z are available on request

15 INSTALLATION AND COMMISSIONING

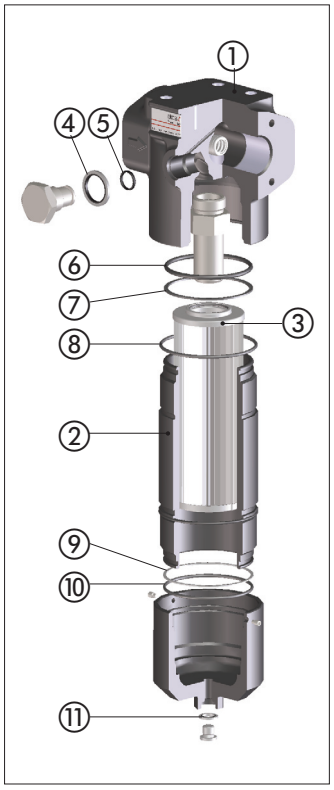


The max operating pressure of the system must not exceed the max working pressure of the filter (420 bar).
During the filter installation, pay attention to respect the flow direction, shown by the arrow on the filter head.
The filter should be preferably mounted with the housing downward.
The filter should be properly secured using the threaded fixing holes on the filter head.
Make sure that there is enough space for the replacement of the filter element, see dimension "**R**" at section 13.
Never run the system without the filter element.

For filters ordered with clogging indicator:
- remove the plastic plug from the indicator port on the filter head
- install the clogging indicator and lock it at the specified torque

During the cold start up (fluid temperature lower than 30°C), a false clogging indicator signal can be given due to the high fluid viscosity.
To avoid false signal, a differential threaded clogging indicator CID-T can be used.

16 MAINTENANCE



The filter element must be replaced as soon as the clogging indicator switches to highlight the filter clogged condition
For filters without clogging indicator, the filter element must be replaced according to the system manufacturer's recommendations.
Select the new filter element according to the model code reported on the filter nameplate, see section 17.

For the replacement of the filter element, proceed as follow:
- releases the system pressure; the filter has no pressure bleeding device
- pay attention to the fluid and filter surface temperature. Always use suitable gloves and protection glasses
- unscrew the bowl ② from the filter head ① by turning counterclockwise (view from bottom side)
- remove the dirty filter element ③ pulling it carefully
- lubricate the seal of new filter element and insert it over the spigot in the filter head
- clean the bowl internally, check the o-ring ⑥ ⑧ and replace them if damaged
- lubricate the o-ring and threads and screw by hand the bowl to the filter head by turning clockwise (view from bottom side). Tighten at the recommended torque.

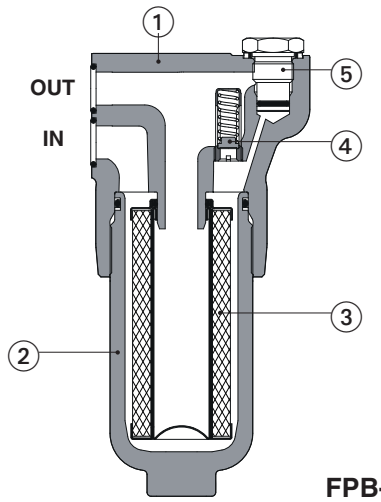
WARNING: The dirty filter elements cannot be cleaned and re-used. They are classified as "dangerous waste material", then they must be disposed of by authorized Companies, according to the local laws.

16.1 SEALS KIT

Filter type	Seal kit code (NBR)	Seal kit code (FKM)	Seal kit composition
FPH-10	GUARN FPH-10	GUARN FPH-10 /PE	④+⑤+⑥+⑦+⑧
FPH-30	GUARN FPH-30	GUARN FPH-30 /PE	④+⑤+⑥+⑦+⑧
FPH-30-D	GUARN FPH-30-D	GUARN FPH-30-D /PE	④+⑤+⑥+⑦+⑧+⑨+⑩+⑪

In line filters type FPB

Flange mounting for manifolds



FPB-10-*R-*

1 Filter head
2 Filter bowl
3 Filter element
4 By-pass valve
5 Port for clogging indicator (options L, M, V) or steel plug (option P)

FPB

In line filters flange mounting, designed for installation on manifolds, to ensure a high cleanliness of the fluid circulating into the hydraulic system. They protect sensible components from contamination present in the working fluid and they are particularly recommended for systems with proportional valves.

- four head sizes, with three different mounting flanges
- port sizes: Ø16 to Ø30 mm
- **Filtration Plus** microfiber elements ensure high efficiency, low pressure drop, high DHC and long lasting performance. Collapse pressure 21 bar for filters equipped with by-pass valve or 210 bar for filters without by-pass
- filtration rating 5 - 7 - 12 - 22 µm(c) (βx (c) >1000, ISO 16889).
- versions without or with by-pass valve with cracking pressure 6 bar.
- without or with differential clogging indicator

Max flow **400 l/min**
Max working pressure **250 bar**

1 MODEL CODE OF COMPLETE FILTERS

FPB	-	10	-	A	-	F10	-	R	-	W	*	/	*

FPB: In line filter

Filter size (ports size):
10 = 2 fixing bolts, ports Ø16 mm
15 = 4 fixing bolts, ports Ø20 mm
20 = 4 fixing bolts, ports Ø30 mm **(1)**
30 = 4 fixing bolts, ports Ø30 mm **(1)**

Filter length:	Max flow [l/min] **(2)** FPB-10	FPB-15	FPB-20	FPB-30
A =	90	132	225	261
B =	100	160	246	343
C =	-	-	281	375
D =	-	-	-	400

Filter element:
SN = only body, without filter element
F+ microfibre filter element βx(c) >1000 - ISO 16889:
F03 = 5 µm (c) **F10** = 12 µm (c)
F06 = 7 µm (c) **F20** = 22 µm (c)
Filter element **F01** = 4 µm (c) available on request

By-pass valve see sect. 9:
R = by-pass valve with cracking pressure 6 bar (filter element PSH-*-R with collapse pressure 21 bar)
N = without by-pass (filter element PSH-*-N with collapse pressure 210 bar)

Differential clogging indicator see sect. 14 **(3)** :
W = without, indicator port with plastic plug **(4)**
P = without, indicator port with steel plug
L = electrical indicator with LED
M = electrical indicator without LED
V = visual indicator
see also note (5)

Series number

Seals material:
- = NBR
PE = FKM

Note: filters for use in potentially explosive atmosphere are available on request, contact Atos Technical Office

(1) Filter size 20 and 30 have the same mounting flange but different blow size

(2) Max flow rates are measured with: Δp 1 bar, filter element F20, option -R, oil viscosity 32 mm²/s - see also section 6
In case of different conditions see section 10 for filter sizing

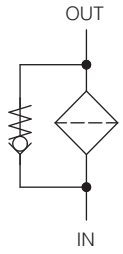
(3) The clogging indicator is supplied disassembled from the filter. The indicator port on filter head is plugged with plastic plug.

(4) The plastic plug (option W) is factory assembled to prevent impurities from entering the filter through the clogging indicator port. A clogging indicator must be fitted on the filter before commissioning. Do not install the filter with the plastic cap on the hydraulic system

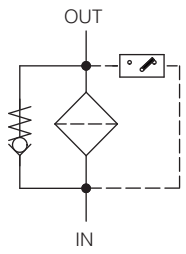
(5) Differential clogging indicator CID-E*-M/UL with cURus certification is available on request, see section 4
Differential thermostated indicator CID-T and differential electronic transmitter with output signal 4÷20 mA CID-Z are available on request, see section 4

2 HYDRAULIC SYMBOLS (representation according to ISO 1219-1)

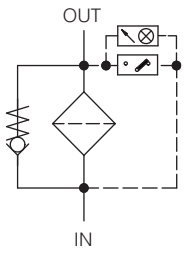
FPB-*-**R-W**



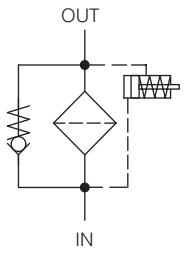
FPB-*-**R-M**



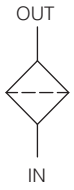
FPB-*-**R-L**



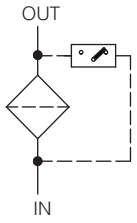
FPB-*-**R-V**



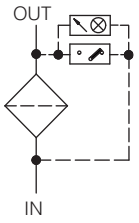
FPB-*-**N-W**



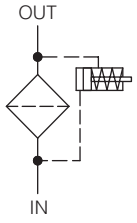
FPB-*-**N-M**



FPB-*-**N-L**



FPB-*-**N-V**



3 MODEL CODE OF FILTER ELEMENTS - only for spare **(1)**

PSH	-	**10**	-	**A**	-	**F10**	-	**R**	*****	/	*****

Spare filter element for in line filter type FPB

Series number

Seals material:
- = NBR
PE = FKM

Filter element size:
10 = for FPB-10 and FPB-15
20 = for FPB-20
30 = for FPB-30

R = filter element with collapse pressure 21 bar, for filter FPB-*-R with by-pass valve
N = filter element with collapse pressure 210 bar, for filter FPB-*-N without by-pass valve

Filter element length:

for FPB-10 and PFB-15	for FPB-20	for FPB-30
A	**A**	**A**
B	**B**	**B**
	C	**C**
		D

Microfibre filter element, βx(c) >1000 - ISO 16889:
F03 = 5 µm (c)
F06 = 7 µm (c)
F10 = 12 µm (c)
F20 = 22 µm (c)
Filter element **F01** = 4 µm (c) available on request

(1) Select the filter element according to the model code reported on the filter nameplate, see section 17

4 MODEL CODE OF DIFFERENTIAL CLOGGING INDICATORS - only for spare - see section 13 and 14

CID	-	**E**	**05**	-	**M**	*****	/	*****

Spare differential clogging indicator for in line filter

Series number

Seals material:
- = NBR
PE = FKM

Type of indicator:
E = electrical
V = visual
T = thermostated (available on request)
Z = electronic transmitter 4÷20 mA (available on request)

Optional LED - only for CID-E
L = with LED
M = without LED
M/UL = without LED, certified according to North American Standard cURus (available on request)

Differential switching pressure (only for CID-E and CID-V):
05 = 5 bar for filters with by-pass valve
08 = 8 bar for filters without by-pass valve

5 GENERAL CHARACTERISTICS

Assembly position / location		Vertical position with the bowl downward
Ambient temperature range		**Standard** = -20°C ÷ +70°C **/PE** option = -20°C ÷ +70°C
Storage temperature range		**Standard** = -20°C ÷ +80°C **/PE** option = -20°C ÷ +80°C
Materials	Filter head	Cast iron
	Filter bowl	Carbon steel
Surface protection		Zinc coating with black passivation
Corrosion resistance		Salt spray test (EN ISO 9227) > 600 h
Fatigue strength		min. 1 x 10^6 cycles at 0 ÷ 250 bar
Compliance		Tested to NFPA T3.10.5.1, ISO 10771, ISO 3968 RoHS Directive 2011/65/EU as last update by 2015/863/EU REACH Regulation (EC) n°1907/2006

6 HYDRAULICS CHARACTERISTICS - based on mineral oil ISO VG 46 at 50 °C (viscosity 32mm²/s)

Filter size		FPB-10		FPB-15		FPB-20			FPB-30			
Filter length		A	B	A	B	A	B	C	A	B	C	D
Max flow (l/min) at Δp= 1 bar Filter with by-pass **-R** (see note)	**F03**	42	65	44	79	83	98	127	96	182	234	279
	F06	57	82	64	109	119	138	173	140	246	295	340
	F10	75	93	95	137	172	194	232	203	294	333	380
	F20	90	100	132	160	225	246	281	261	343	375	400
Max flow (l/min) at Δp= 1 bar Filter without by-pass **-N** (see note)	**F03**	35	51	36	55	66	78	103	76	133	211	237
	F06	55	65	61	76	95	111	142	102	207	249	306
	F10	64	89	75	126	145	165	202	176	265	314	350
	F20	85	98	116	154	204	226	263	232	328	369	380
Max operating pressure [bar]		**250**										
Burst pressure [bar]		**> 750**										

Note: Max flow rates are measured with Δp= 1 bar and viscosity 32mm²/s. In case of different conditions see section 10 for filter sizing

7 FILTER ELEMENTS

Material		Inorganic microfibre
Filtration rating as per ISO16889	**F03**	$\beta_{5\mu m\,(c)} \geq 1000$
	F06	$\beta_{7\mu m\,(c)} \geq 1000$
	F10	$\beta_{12\mu m\,(c)} \geq 1000$
	F20	$\beta_{22\mu m\,(c)} \geq 1000$
Filter element collapse pressure	**R** = for filter with by-pass valve	21 bar
	N = for filter without by-pass valve	210 bar

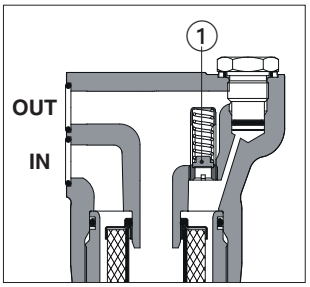
8 SEALS AND HYDRAULIC FLUIDS - for other fluids not included in below table, consult our technical office

Seals, recommended fluid temperature	NBR seals (standard) = -30°C ÷ +100°C FKM seals (/PE option) = -25°C ÷ +120°C		
Recommended viscosity	15 ÷ 100 mm²/s - max allowed range 2.8 ÷ 500 mm²/s		
Hydraulic fluid	**Suitable seals type**	**Classification**	**Ref. Standard**
Mineral oils	NBR, FKM	HL, HLP, HLPD, HVLP, HVLPD	DIN 51524
Flame resistant without water	FKM	HFDU, HFDR	ISO 12922

9 BY-PASS VALVE

Filter with by-pass valve - version **-R**

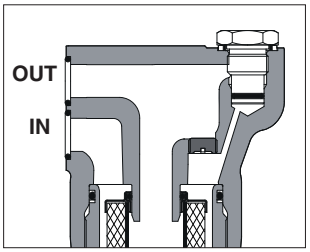
The filter with by-pass valve (1) is used in combination with filter elements PSH-*-R with collapse pressure 21 bar.
The by-pass valve allows the oil flow to by-pass the filter element in particular conditions:
- it protects the filter element from pressure peaks that could be generated, especially at the cold system start-up. In these cases the valve opens only for the instant necessary to discharge the pressure peak, limiting the quantity of oil that bypasses the filter.
- it allows the free passage of the oil flow in case of completely clogged filter element (Δp > 6 bar). This situation should be carefully avoided, by means of a scheduled maintenance, otherwise the contaminated oil will pass to the clean side of the filter and then it will circulate in the hydraulic system. The filter element must be replaced before the clogging condition, at this purpose the use of a differential clogging indicator CID-V (visual, option V) or CID-E (electrical, options L or M) is highly recommended.



FPB-*-R

Filter without by-pass valve - version **-N**

The filter version without by-pass is recommended when the hydraulic system must be absolutely protected by contamination, then avoiding the risk that the contaminant passes though the by-pass valve.
The filter without by pass must be used in combination with filter elements PSH-N with high collapse pressure 210 bar



FPB-*-N

10 FILTERS SIZING

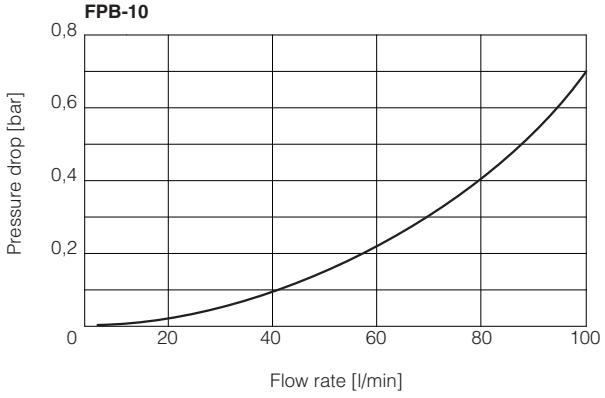
For the filter sizing it is necessary to consider the Total Δp at the maximum flow at which the filter must work.
The Total Δp is given by the sum of filter head Δp plus the filter element Δp:

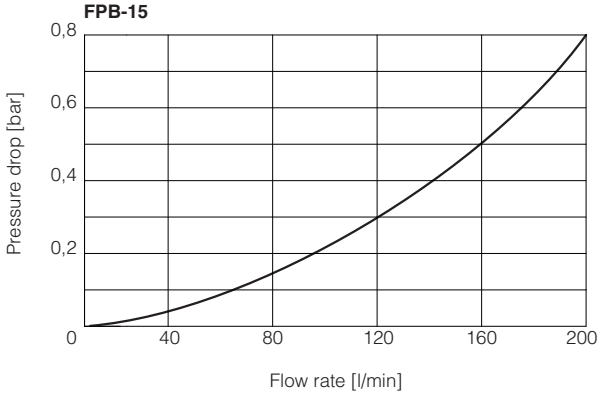
Total Δp = filter head Δp + filter element Δp

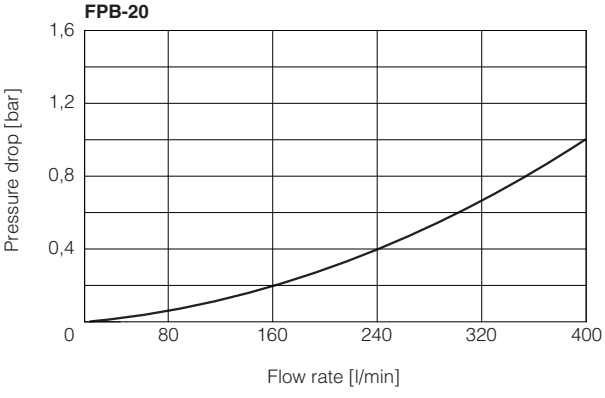
In the best conditions the total Δp should not exceed 1,0 bar
See below sections to calculate the Δp of filter head and Δp of the filter element

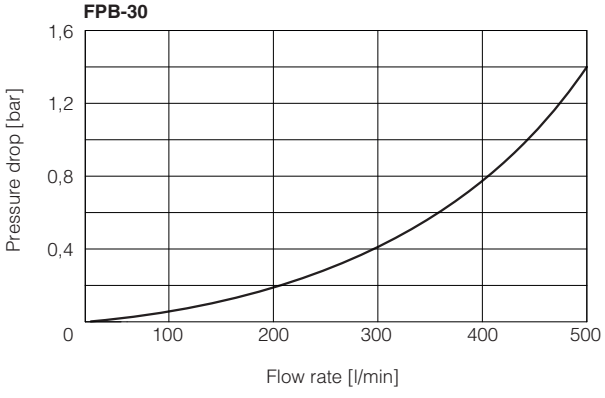
10.1 Q/Δp DIAGRAMS OF FILTER HEAD

The pressure drop of filter head mainly depends on the ports size and fluid density
In the following diagrams are reported the Δp characteristics of filter head based on mineral oil with density 0,86 kg/dm³ and viscosity 32 mm²/s









10.2 FILTER ELEMENT Δp

The pressure drop through the filter depends to:
- size of filter element
- filtration rating
- fluid viscosity

The Δp of filter element is given by the formula:

$$\Delta p \text{ of filter element} = Q \times \frac{Gc}{1000} \times \frac{\text{Viscosity}}{32}$$

Q = working flow (l/min)

Gc = Gradient coefficient (mbar/(l/min)).
The Gc values are reported in the following table

Viscosity = effective fluid viscosity in the working conditions (mm²/s)

Gradient coefficient Gc of PSH filter elements

Filter element size		10		20			30			
Filter element length		A	B	A	B	C	A	B	C	D
Filter element type	Filtration rating	**Gc** Gradient coefficient								
R for filter with bypass valve	**F03**	21.30	10.84	11.07	9.23	6.74	10.26	4.82	3.27	2.30
	F06	13.97	6.79	7.27	6.06	4.43	6.73	2.98	1.99	1.26
	F10	8.39	4.42	4.45	3.71	2.71	4.12	2.02	1.36	0.70
	F20	4.78	2.93	2.87	2.39	1.75	2.66	1.21	0.77	0.40
N for filter without bypass valve	**F03**	26.03	16.72	14.19	11.83	8.64	13.00	7.15	3.87	3.21
	F06	14.77	11.25	9.50	7.92	5.79	9.63	4.00	2.93	1.80
	F10	11.57	5.25	5.66	4.72	3.45	5.05	2.57	1.67	1.10
	F20	6.13	3.34	3.41	2.84	2.07	3.33	1.44	0.83	0.70

Example:

Calculation of Total Δp for filter type FPB-10-B-F10-R at Q = 80 l/min and viscosity 46 mm²/s (filter element PSH-10-B-F10-R)

Δp of filter head = 0,41 bar
Gr = 4,42 mbar/(l/min)

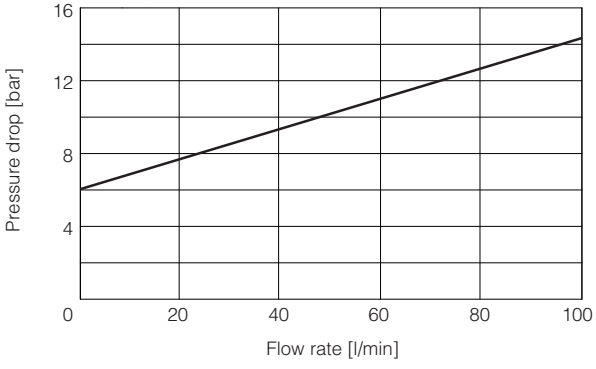
Filter element Δp = $80 \times \frac{4{,}42}{1000} \times \frac{46}{32} = 0{,}51$ bar

Total Δp = 0,41 + 0,51 = **0,92 bar**

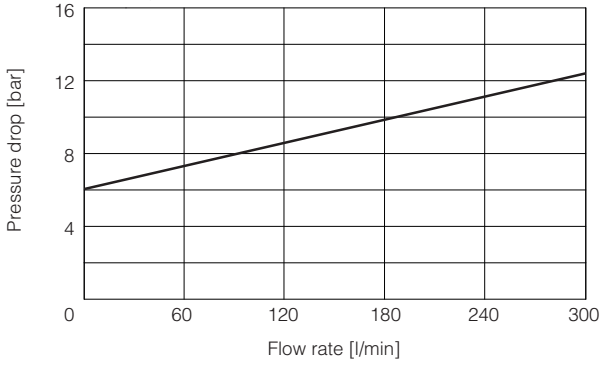
11 **BY-PASS VALVE** - based on mineral oil ISO VG46 at 50°C (viscosity = 32 mm²/s)

Q/Δp diagrams of flow through the by-pass valve

FPB-10, FPB-15

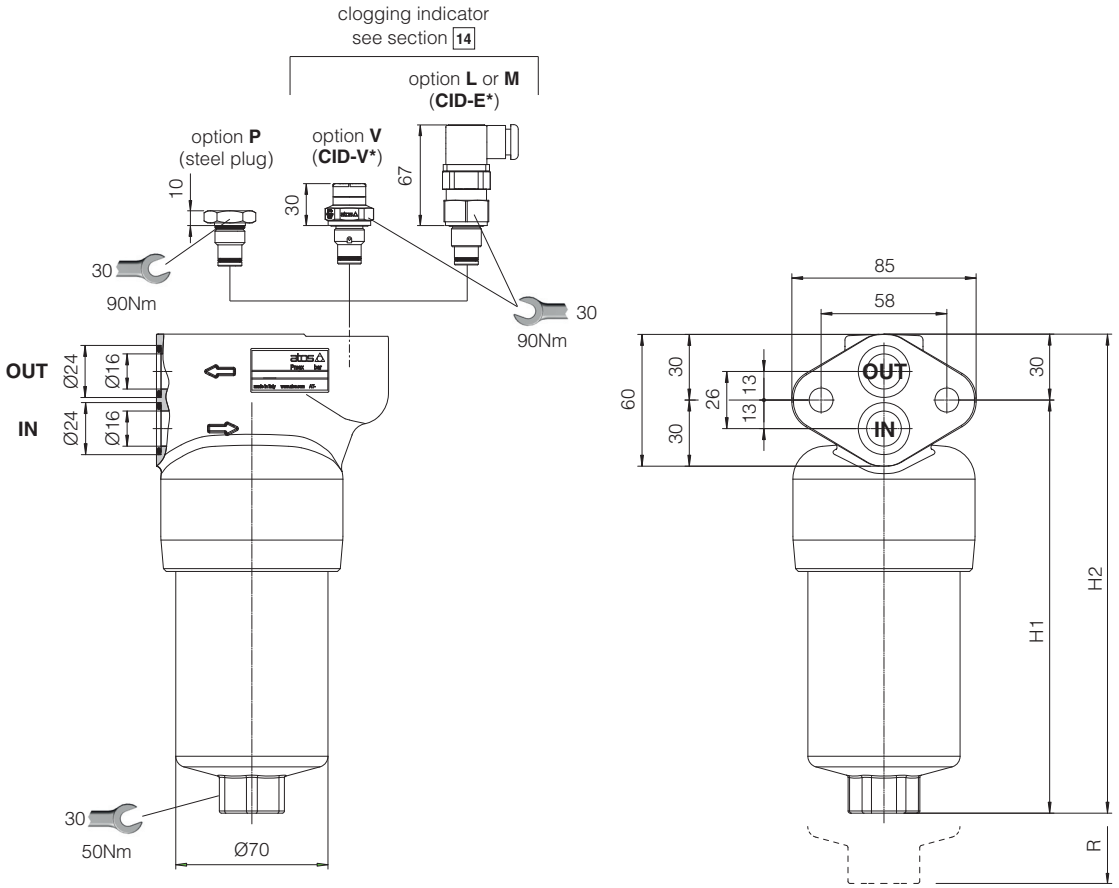


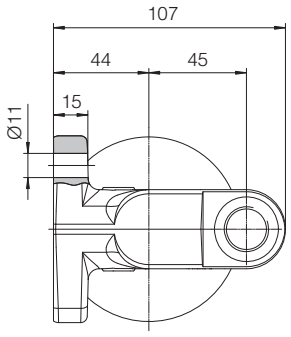
FPB-20, FPB-30



12 INSTALLATION DIMENSIONS OF FPB FILTERS [mm]

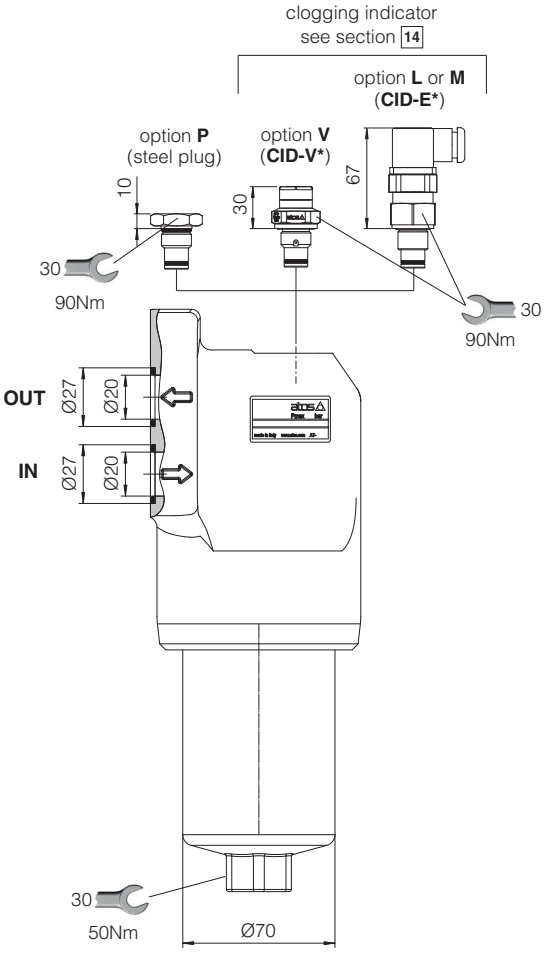
FPB -10

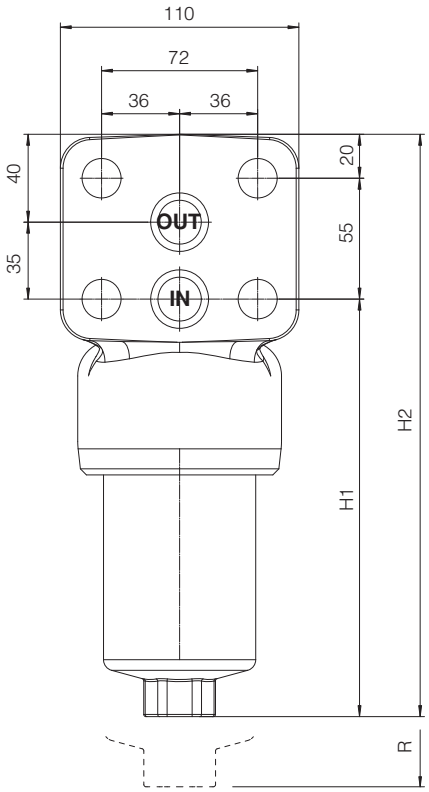


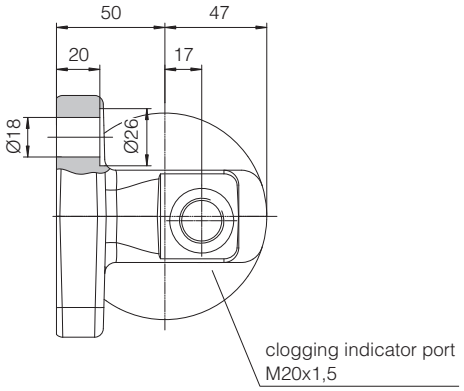


Code	H1	H2	R (element removal)	Mass (Kg)
FPB-10-A	188	226	110	3.8
FPB-10-B	281	319		4.9

FPB -15

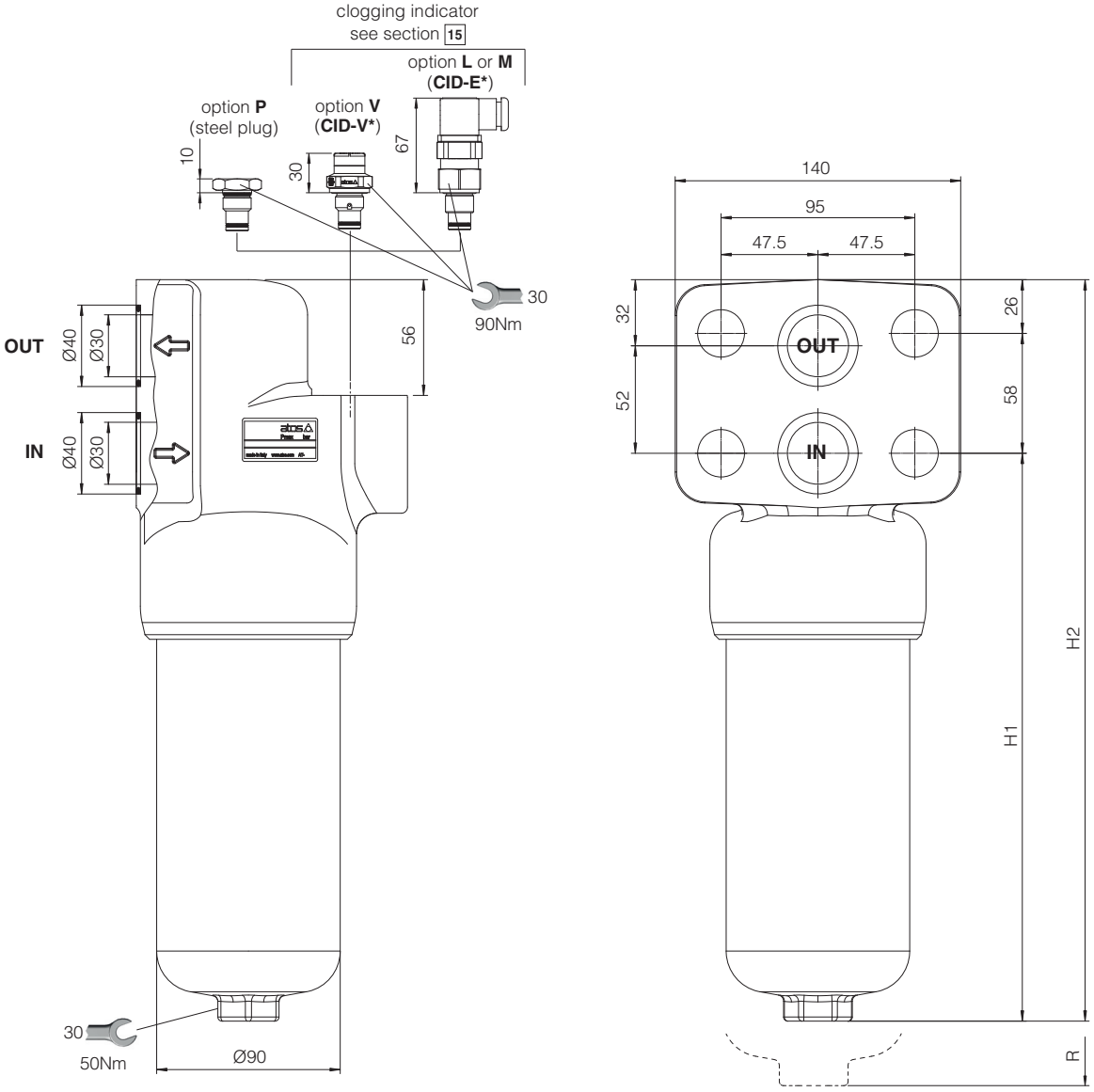


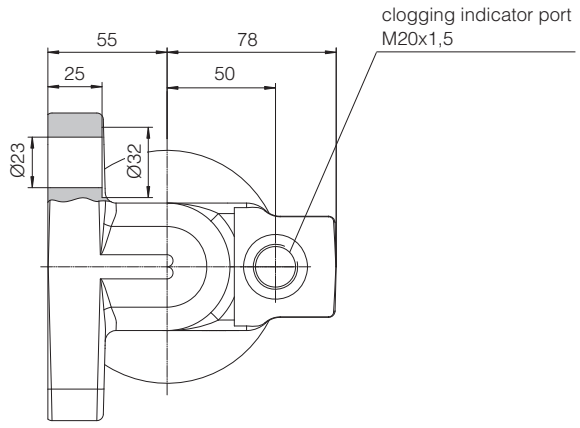




Code	H1	H2	R (element removal)	Mass (Kg)
FPB-15-A	190	265	110	6
FPB-15-B	283	358		7.1

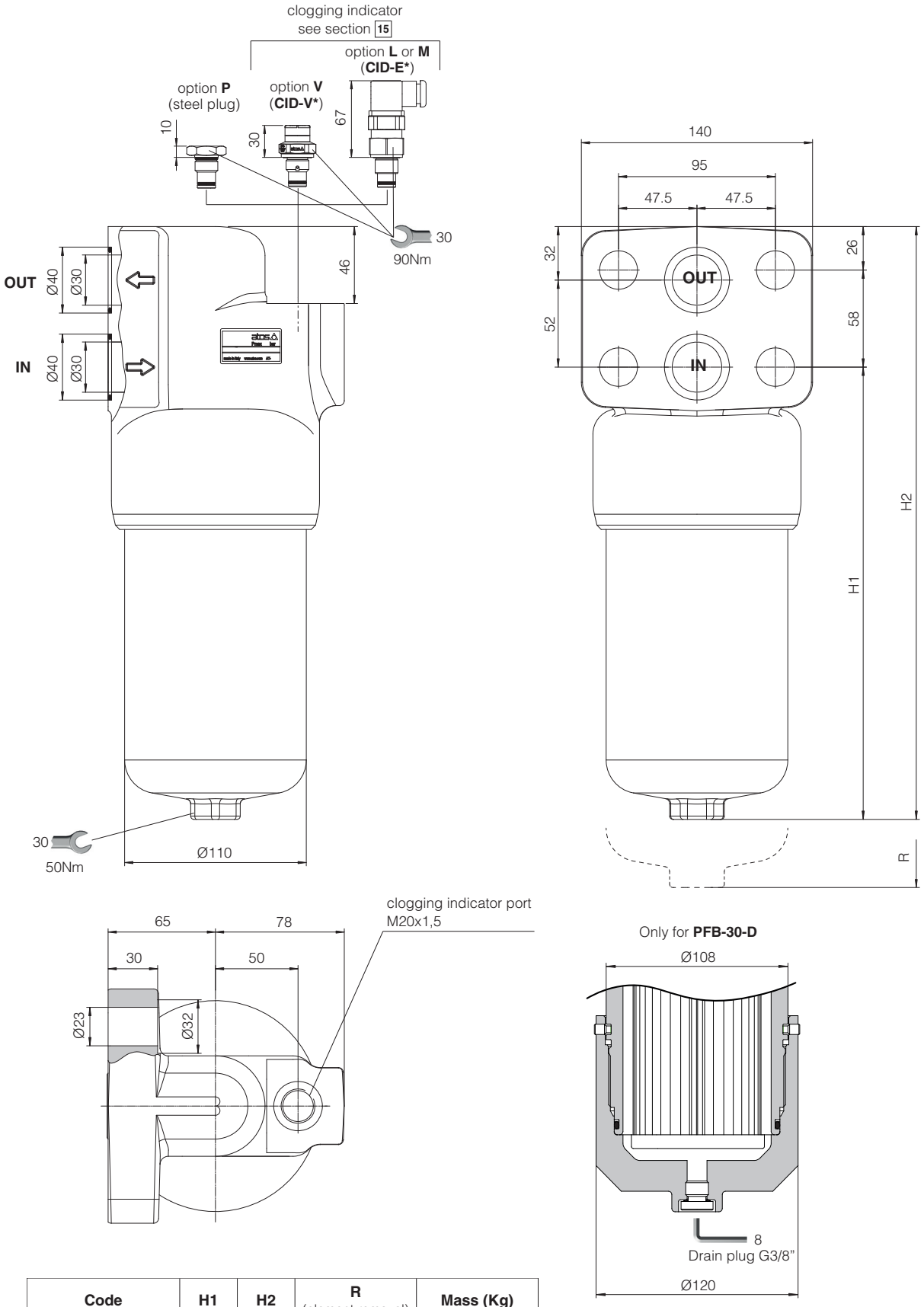
FPB -20





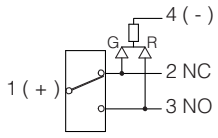
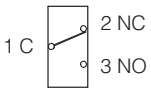
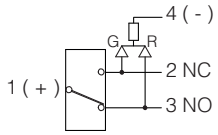
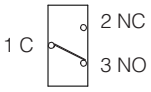
Code	H1	H2	R (element removal)	Mass (Kg)
FPB-20-A	240	324	120	9.8
FPB-20-B	299	383		11
FPB-20-C	369	453		12.3

FPB -30



Code	H1	H2	R (element removal)	Mass (Kg)
FPB-30-A	202	287	130	12.2
FPB-30-B	295	380		14.8
FPB-30-C	415	500		18
FPB-30-D	514	599		20.8

13 CHARACTERISTICS OF DIFFERENTIAL CLOGGING INDICATORS

Model code		CID-E* ELECTRICAL		CID-V* VISUAL
Differential switching pressure	CID-E05, CID-V05	5 bar ± 10%		5 bar ± 15%
	CID-E08, CID-V08	8 bar ± 10%		8 bar ± 10%
Max pressure		450 bar		420 bar
Max differential pressure		200 bar		
Ambient temperature		-25°C ÷ +100°C		-25°C ÷ +80°C
Hydraulic connection		M20x1,5		
Duty factor		100%		
Mechanical life		1 x 10^6 operations		
Mass (Kg)		0,16		0,11
Electric connection		Electric plug connection as per DIN 43650 with cable gland type PG7		-
Power supply	CID-E05-L, CID-E08-L	24 VDC ± 10%		-
	CID-E05-M, CID-E08-M	14 VDC ÷ 30 VDC	125 VAC ÷ 250 VAC	-
Max current - resistive (inductive)		5 A (4 A) ÷ 4 A (3 A)	5 A (3 A) ÷ 3 A (2 A)	-
Protection degree to DIN EN 60529		IP65 with mating connector		-
Switching scheme		**CID-*-L**	**CID-*-M**	
	clean filter element			GREEN
	clogged filter element			RED

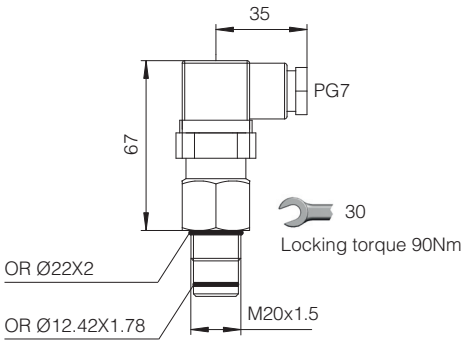
14 DIMENSIONS OF DIFFERENTIAL CLOGGING INDICATORS

ELECTRICAL INDICATOR

CID-E05-L
CID-E08-L

Electric connector
DIN 43650
Transparent
with internal Led

Led signal:
Green = clean filter element
Red = clogged filter element
(filter elements to be replaced)



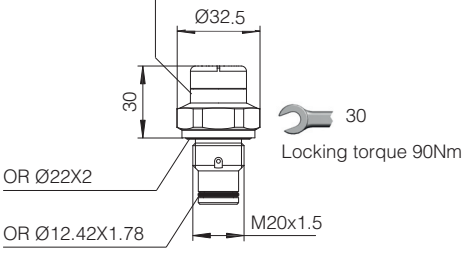
CID-E05-M
CID-E08-M
CID-E05-M/UL
CID-E08-M/UL

Electric connector
DIN 43650
Black colour

VISUAL INDICATOR

CID-V05
CID-V08

Visual signal:
Green = clean filter element
Red = clogged filter element
(filter elements to be replaced)

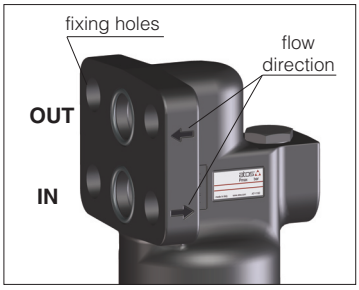


Note: the electrical connector can be oriented at steps of 90°

NOTE: Differential thermostated indicator CID-T and differential electronic transmitter with output signal 4÷20 mA CID-Z are available on request

15 INSTALLATION AND COMMISSIONING

The max operating pressure of the system must not exceed the max working pressure of the filter (350 bar).
During the filter installation, pay attention to respect the flow direction, shown by the arrows on the filter head.
The filter should be preferably mounted with the bowl downward.
Make sure that there is enough space for the replacement of the filter element, see dimension "**R**" at section 13.
Never run the system without the filter element.



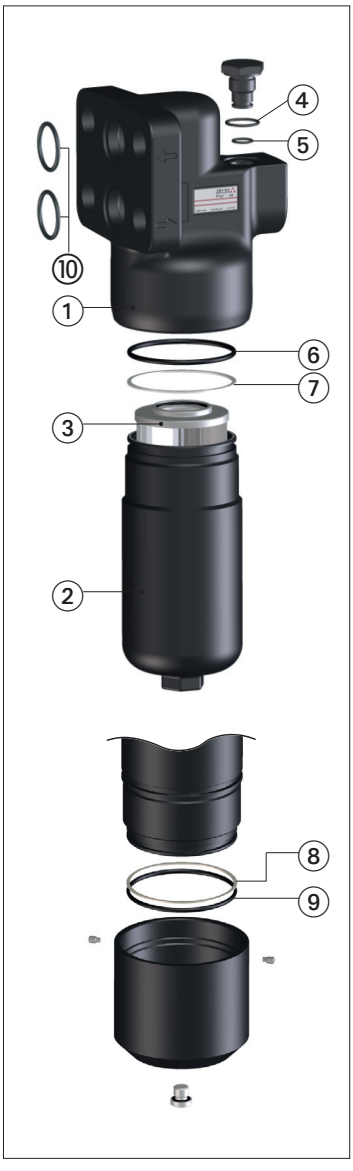
For filters ordered with clogging indicator:
- remove the plastic plug from the indicator port on the filter head
- install the clogging indicator and lock it at the specified torque

During the cold start up (fluid temperature lower than 30°C), a false clogging indicator signal can be given due to the high fluid viscosity.
To avoid false signal, a differential thermostated clogging indicator CID-T can be used.

16 MAINTENANCE

The filter element must be replaced as soon as the clogging indicator switches to highlight the filter clogged condition.
For filters without clogging indicator, the filter element must be replaced according to the system manufacturer's recommendations.
Select the new filter element according to the model code reported on the filter nameplate, see section 18.

For the replacement of the filter element, proceed as follow:
- releases the system pressure; the filter has no pressure bleeding device (only for PFB-30-D has a drain plug G1/4" at the bottom of the blow)
- pay attention to the fluid and filter surface temperature. Always use suitable gloves and protection glasses
- unscrew the bowl ② from the filter head ① by turning counterclockwise (view from bottom side)
- remove the dirty filter element ③ pulling it carefully
- lubricate the seal of new filter element and insert it over the spigot in the filter head
- clean the bowl internally, check the o-ring ⑥ and replace it if damaged
- lubricate the o-ring, the threads and screw by hand the bowl to the filter head by turning clockwise (view from bottom side). Tighten at the recommended torque.



WARNING: The dirty filter elements cannot be cleaned and re-used. They are classified as "dangerous waste material", then they must be disposed of by authorized Companies, according to the local laws.

16.1 SEALS KIT

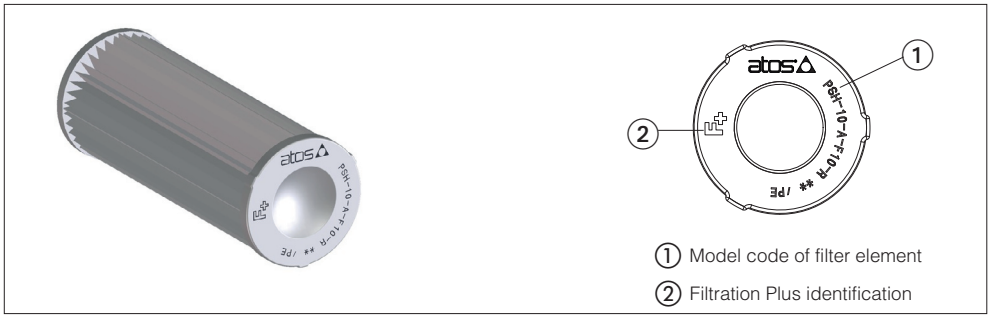
Filter type	Seal kit code (NBR)	Seal kit code (FKM)	Seal kit composition
FPB-10	GUARN FPB-10	GUARN FPB-10 /PE	④+⑤+⑥+⑦
FPB-15	GUARN FPB-15	GUARN FPB-15 /PE	④+⑤+⑥+⑦
FPB-20	GUARN FPB-20	GUARN FPB-20 /PE	④+⑤+⑥+⑦
FPB-30	GUARN FPB-30	GUARN FPB-30 /PE	④+⑤+⑥+⑦+⑧+⑨+⑩

(1) Seals ⑧ and ⑨ are supplied in seal kit but used only for FPB-30-D

17 FILTER IDENTIFICATION NAMEPLATE

① Model code of complete filter
② Model code of filter element
③ Max working pressure
④ Filter matrix code

17.1 IDENTIFICATION OF FILTER ELEMENT



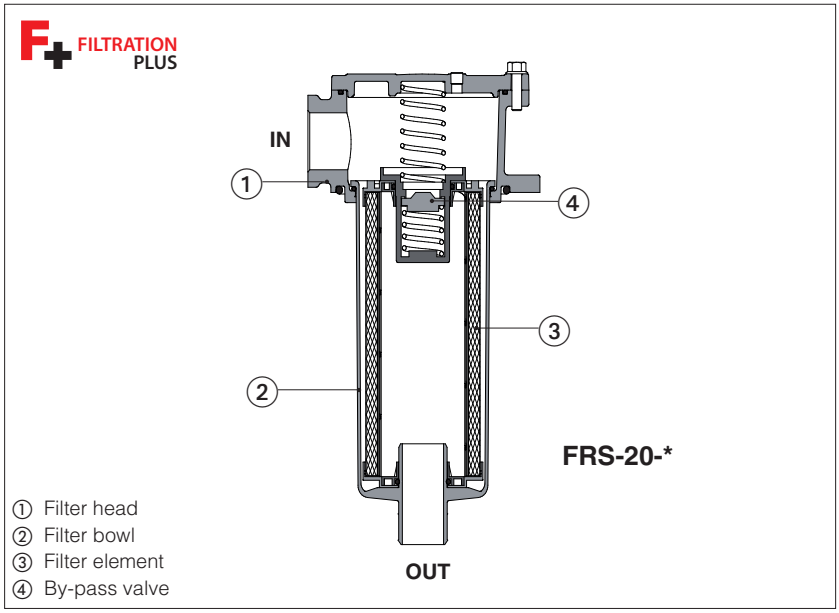
① Model code of filter element
② Filtration Plus identification

18 RELATED DOCUMENTATION

LF010	Fluid contamination
LF020	Filtration guidelines

Return line filters, tank-top type FRS

Threaded ports



FRS

Return filters are designed to ensure cleanliness of fluid back to the tank from contamination collected downstream of the hydraulic circuit.

They are specific for installation on the top of the hydraulic tank.

- four head sizes
- ports size: G1/2" to G2"
  SAE-12 to SAE-32
- by-pass valve with cracking pressure 3 bar
- **Filtration Plus** microfiber filter elements ensure low pressure drop, high DHC and long lasting performance,
- filtration rating 7 - 12 - 27 µm(c) (βx (c) >1000, ISO 16889)
- cellulose filter elements with filtration rating 10 or 25 µm (βx (c) >2, ISO 16889)
- without or with electrical or visual clogging indicators

Max flow **750 l/min**

Max working pressure **8 bar**

1 MODEL CODE OF COMPLETE FILTERS

FRS	-	10	-	A	-	F10	-	00	-	R	-	W	**	/	*

FRS: Return line filter

Filter size (ports size):
10 = G1/2" ÷ G3/4" or SAE-12
20 = G1/2" ÷ G1¼" or SAE-16
30 = G1" ÷ G1½" or SAE-24
40 = G1¼" ÷ G2" or SAE-32

Filter length:		Max flow [l/min] **(1)** FRS-10	FRS-20	FRS-30	FRS-40
A	=	50	75	290	370
B	=	80	125	310	600
C	=	-	200	-	650
D	=	-	260	-	430 **(2)**
E	=	-	-	-	750

SN = only body, without filter element

F+ microfibre filter element, βx(c) >1000 - ISO 16889:
F06 = 7 µm (c)
F10 = 12 µm (c)
F25 = 27 µm (c)

Cellulose filter element, βx (c) >2 - ISO 16889:
C10 = 10 µm (c)
C25 = 25 µm (c)

Ports size:
BSPP threaded:

FRS-10	FRS-20	FRS-30	FRS-40
00 = G 1/2"	**00** = G 1/2"	**02** = G 1"	**03** = G 1 1/4"
01 = G 3/4"	**01** = G 3/4"	**03** = G 1 1/4"	**04** = G 1 1/2"
	02 = G 1"	**04** = G 1 1/2"	**05** = G 2"
	03 = G 1 1/4"		

SAE J1926-1 threaded **(3)**:

FRS-10	FRS-20	FRS-30	FRS-40
41 = SAE-12	**42** = SAE-16	**44** = SAE-24	**45** = SAE-32

Series number

Seals material:
- = NBR
PE = FKM

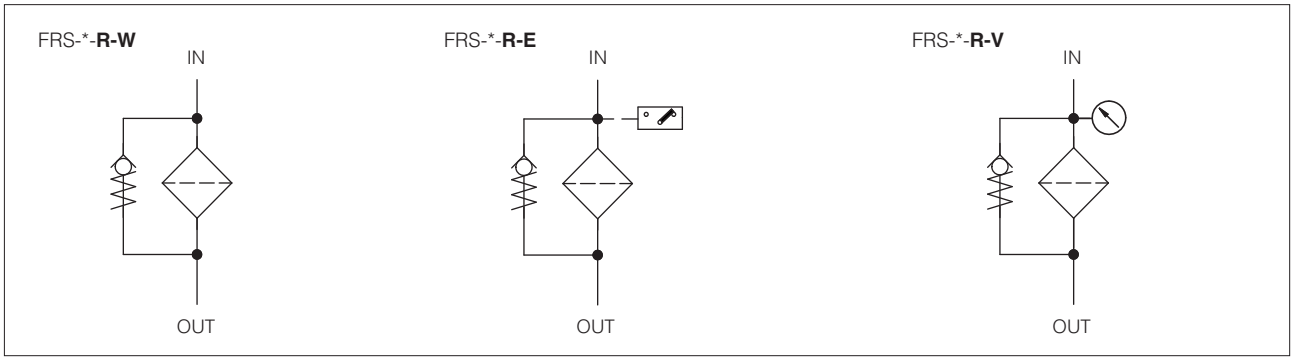
Clogging indicator see sect. 12 **(4)**:
W = without, indicator port plugged with steel plug
E = electrical indicator **(5)**
V = visual indicator

By-pass:
R = by-pass valve with cracking pressure 3 bar

Note: filters for use in potentially explosive atmosphere are available on request, contact Atos Technical Office

(1) Max flow rates are measured with: Δp 0,5 bar, filter element F25, largest port size, oil viscosity 32 mm²/s - see also section 6
In case of different conditions see section 9 for filter sizing
(2) Filters type FRS-40-D has the same length to FRS-40-B but it uses filter elements with smaller internal diameter
(3) Filters with SAE threaded ports are available on request
(4) The clogging indicator is supplied disassembled from the filter. The indicator port on filter head is factory plugged with steel plug
(5) Clogging indicator CIA-E/UL with cURus certification is available on request, see section 4

2 HYDRAULIC SYMBOLS (representation according to ISO 1219-1)



3 MODEL CODE OF FILTER ELEMENTS - only for spare **(1)**

PRS	-	**10**	-	**A**	-	**F10**	******	/	*****

Spare filter element for return line filter type FRS

Filter element size:
10 = for FRS-10
20 = for FRS-20
30 = for FRS-30
40 = for FRS-40

Filter element length:

for FRS-10	for FRS-20	for FRS-30	for FRS-40
A	**A**	**A**	**A**
B	**B**	**B**	**B**
	C		**C**
	D		**D**
			E

Microfibre filter element, βx(c) >1000 - ISO 16889:
F06 = 7 µm (c)
F10 = 12 µm (c)
F25 = 27 µm (c)

Cellulose filter element, βx (c) >2 - ISO 16889:
C10 = 10 µm
C25 = 25 µm

Series number

Seals material:
- = NBR
PE = FKM **(2)**

(1) Select the filter element according to the model code reported on the filter nameplate, see section 17
(2) Filters with FKM seals are available on request
note: the spare filter element includes the by-pass valve

4 MODEL CODE OF CLOGGING INDICATORS - only for spare - see section 13 and 14

CIA	-	**V**	******

Clogging indicator for return line filter type FRS

Type of indicator:
E = Electrical - pressure switch, switching pressure 2 bar
E/UL = As type E, certified according to North American Standard cURus (available on request)
V = Visual - pressure gauge, range 0 ÷ 10 bar **(1)**

Series number

(1) Visual clogging indicator with rear side connection **CIA-V/P** available on request

5 GENERAL CHARACTERISTICS

Assembly position / location		Vertical position with the bowl downward
Ambient temperature range		**Standard** = -20°C ÷ +70°C **/PE** option = -20°C ÷ +70°C
Storage temperature range		**Standard** = -20°C ÷ +80°C **/PE** option = -20°C ÷ +80°C
Materials	Filter head	Aluminium alloy
	Filter bowl	Nylon PA6 reinforced
Fatigue strength		min. 1 x 10^6 cycles at 0 ÷ 8 bar
Compliance		Tested to NFPA T3.10.5.1, ISO 10771, ISO 3968 RoHS Directive 2011/65/EU as last update by 2015/863/EU REACH Regulation (EC) n°1907/2006

6 HYDRAULICS CHARACTERISTICS

FRS-10, FRS-20

Filter size		10				20															
Port size code		00		01, 41		00				01				02, 42				03			
Ports dimension		G1/2"		G3/4" SAE12		G1/2"				G3/4"				G1", SAE16				G1 1/4"			
Filter length		A	B	A	B	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
Max flow (l/min) at Δp 0,5 bar **-see note-**	F06	14	36	15	38	32	50	66	82	35	57	79	100	35	58	93	133	36	62	93	135
	F10	30	54	31	58	48	65	83	100	52	77	103	125	53	78	138	195	56	90	140	200
	F25	48	73	50	80	58	79	96	110	67	97	123	141	67	100	189	240	75	125	200	260
	C10	70	87	76	97	75	88	102	110	90	111	132	146	92	115	216	263	113	160	225	277
	C25	75	94	92	105	90	105	114	120	115	138	152	163	118	144	288	300	168	243	305	300
Max operating pressure		8 bar																			
Direction of filtration		See the arrow on the filter head																			

FRS-30, FRS-40

Filter size		30						40													
Port size code		02		03		04		03					04					05, 45			
Ports dimension		G1"		G1 1/4"		G1 1/2" SAE24		G1 1/4"					G1 1/2"					G2", SAE32			
Filter length		A	B	A	B	A	B	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
Max flow (l/min) at Δp 0,5 bar **-see note-**	F06	180	190	175	185	180	190	203	286	310	233	430	208	300	330	240	460	210	310	338	245	500
	F10	250	260	250	270	270	280	314	429	492	353	540	329	478	565	374	607	340	500	594	387	640
	F25	265	275	280	293	290	310	340	495	525	386	590	358	570	611	412	708	370	600	650	430	750
	C10	280	290	311	315	326	330	365	515	546	401	606	387	597	642	430	732	400	630	679	446	780
	C25	330	355	380	390	400	409	473	594	640	495	648	513	714	782	540	790	536	750	800	564	800
Max operating pressure		8 bar																			
Direction of filtration		See the arrow on the filter head																			

Note: Max flow rates are measured with Δp= 0,5 bar and viscosity 32mm²/s. In case of different conditions see section 11
For a correct sizing of the filter, it is suggested not to exceed **750 l/min** to limit the maximum speed of the fluid in connecting pipes

7 FILTER ELEMENTS

Material		Inorganic microfibre FILTRATION PLUS	Cellulose
Filtration rating as per ISO16889	F06	$\beta_{06\mu m\,(c)} \geq 1000$	-
	F10	$\beta_{12\mu m\,(c)} \geq 1000$	-
	F25	$\beta_{27\mu m\,(c)} \geq 1000$	-
	C10	-	$\beta_{10\mu m\,(c)} \geq 2$
	C25	-	$\beta_{25\mu m\,(c)} \geq 2$

8 SEALS AND HYDRAULIC FLUIDS - for other fluids not included in below table, consult our technical office

Seals, recommended fluid temperature	NBR seals (standard) = -25°C ÷ +100°C FKM seals (/PE option) = -25°C ÷ +100°C		
Recommended viscosity	15 ÷ 100 mm²/s - max allowed range 2.8 ÷ 500 mm²/s		
Hydraulic fluid	**Suitable seals type**	**Classification**	**Ref. Standard**
Mineral oils	NBR, FKM	HL, HLP, HLPD, HVLP, HVLPD	DIN 51524
Flame resistant without water	FKM	HFDU, HFDR	ISO 12922

9 FILTERS SIZING

For the filter sizing it is necessary to consider the Total Δp at the maximum flow at which the filter must work.
The Total Δp is given by the sum of filter head Δp plus filter bowl Δp plus the filter element Δp:

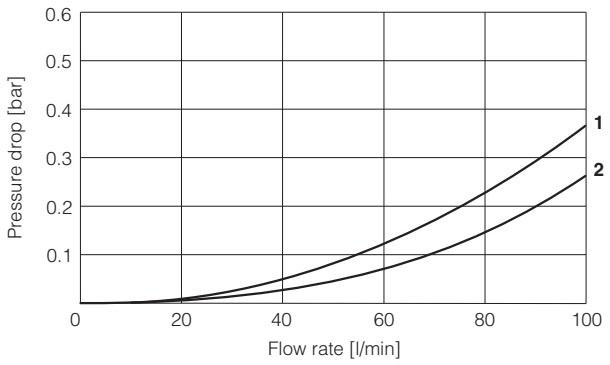
Total Δp = filter head Δp + filter bowl Δp + filter element Δp

In the best conditions the total Δp should not exceed 0,5 bar
See below sections to calculate the Δp of filter head and Δp of the filter element

9.1 Q/Δp DIAGRAMS OF FILTER HEAD + FILTER BOWL

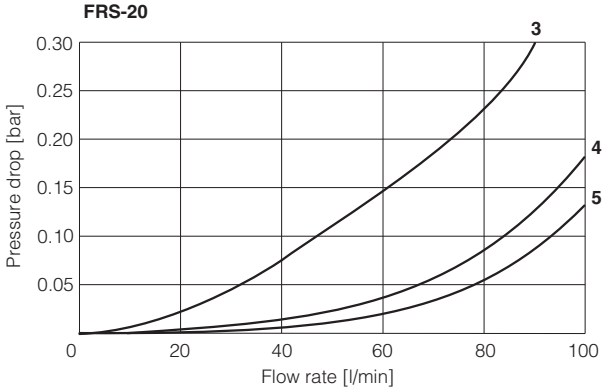
The pressure drop mainly depends on the ports size and fluid density
In the following diagrams are reported the Δp characteristics based on mineral oil with density 0,86 kg/dm³ and viscosity 32 mm²/s

FRS-10



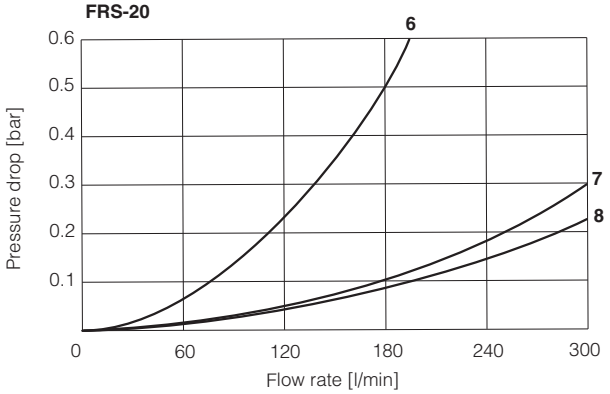
1 = FRS-10-*-00 (G 1/2")
2 = FRS-10-*-01 (G 3/4")
FRS-10-*-41 (SAE-12)

FRS-20



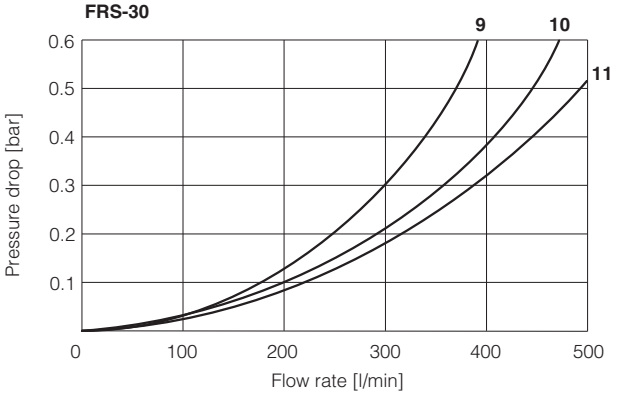
3 = FRS-20-*-00 (G 1/2")
4 = FRS-20-A-01 (G 3/4")
FRS-20-B-01 (G 3/4")
5 = FRS-20-A-02 (G 1")
FRS-20-B-02 (G 1")
FRS-20-A-42 (SAE-16)
FRS-20-B-42 (SAE-16)

FRS-20



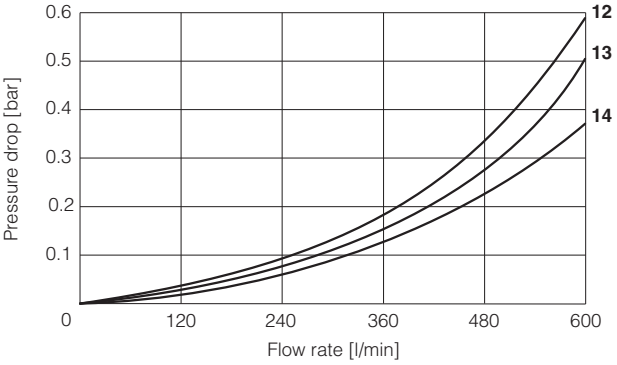
6 = FRS-20-C-01 (G 3/4")
FRS-20-D-01 (G 3/4")
8 = FRS-20-*-03 (G 1 1/4")
7 = FRS-20-C-02 (G 1")
FRS-20-D-02 (G 1")
FRS-20-C-42 (SAE-16)
FRS-20-D-42 (SAE-16)

FRS-30



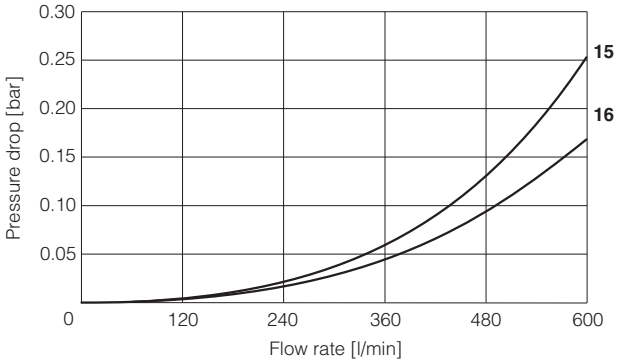
9 = FRS-30-*-02 (G 1")
10 = FRS-30-*-03 (G 1 1/4")
11 = FRS-30-*-04 (G 1 1/2")
FRS-30-*-44 (SAE-24)

FRS-40



12 = FRS-40-A-03 (G 1 1/4")
FRS-40-D-03 (G 1 1/4")
13 = FRS-40-A-04 (G 1 1/2")
FRS-40-D-04 (G 1 1/2")
14 = FRS-40-A-05 (G 2")
FRS-40-D-45 (G 2")
FRS-40-A-45 (SAE-32)
FRS-40-D-45 (SAE-32)

FRS-40



15 = FRS-40-B-04 (G 1 1/2")
FRS-40-C-04 (G 1 1/2")
FRS-40-E-04 (G 1 1/2")
16 = FRS-40-B-05 (G 2")
FRS-40-C-05 (G 2")
FRS-40-E-05 (G 2")
FRS-40-B-45 (SAE-32)
FRS-40-C-45 (SAE-32)
FRS-40-E-45 (SAE-32)

9.2 FILTER ELEMENT Δp

The pressure drop through the filter depends to:
- size of filter element
- filtration rating
- fluid viscosity

The Δp of filter element is given by the formula:

$$\Delta p \text{ of filter element} = Q \times \frac{Gc}{1000} \times \frac{\text{Viscosity}}{32}$$

Q = working flow (l/min)

Gc = Gradient coefficient (mbar/(l/min)).
The Gc values are reported in the following table

Viscosity = effective fluid viscosity in the working conditions (mm^2/s)

Gradient coefficient Gc of FRS filter elements

Filter element size	10		20				30		40				
Filter element length	A	B	A	B	C	D	A	B	A	B	C	D	E
Filtration rating	**Gc** Gradient coefficient												
F06	33.84	12.28	13.85	7.80	5.09	3.34	2.43	2.25	2.40	1.49	1.32	1.80	0.80
F10	15.68	7.32	8.65	5.27	3.19	1.94	1.31	1.21	1.11	0.74	0.52	0.88	0.43
F25	8.81	4.28	6.32	3.60	2.06	1.26	1.10	1.00	0.96	0.51	0.42	0.71	0.24
C10	4.83	2.74	4.09	2.70	1.64	1.06	0.85	0.83	0.82	0.45	0.36	0.64	0.20
C25	4.13	2.06	2.52	1.41	0.82	0.42	0.39	0.35	0.34	0.23	0.12	0.26	0.10

Examples:

1) calculation of Total Δp for filter type FRS-20-B-F10-02-R at Q = 50 l/min and viscosity 46 mm^2/s (filter element PRS-20-B-F10)

Δp of filter head + filter bowl = 0,03 bar
Gc = 5,27 mbar/(l/min)

Filter element Δp = $50 \times \frac{5,27}{1000} \times \frac{46}{32} = 0,379$ bar

Total Δp = 0,03 + 0,379 = **0,40 bar**

2) calculation of Total Δp of filter type FRS-40-C-F25-05-R at Q = 500 l/min and viscosity 46 mm^2/s (filter element PRS-40-C-F25)

Δp of filter head + filter bowl = 0,13 bar
Gc = 0,42 mbar/(l/min)

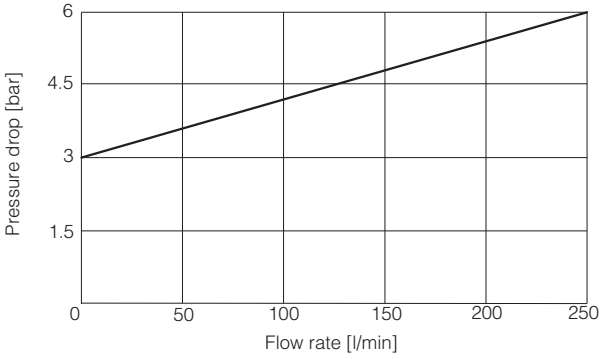
Filter element Δp = $500 \times \frac{0,42}{1000} \times \frac{46}{32} = 0,302$ bar

Total Δp = 0,13 + 0,302 = **0,43 bar**

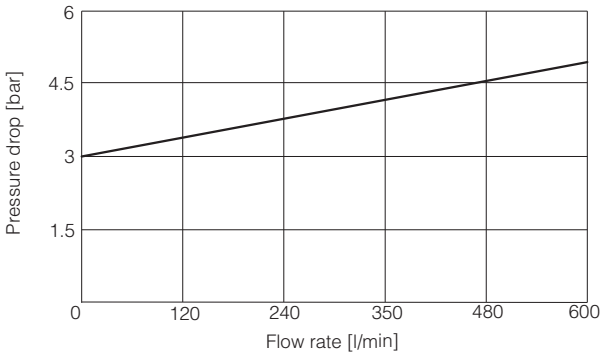
10 **BY -PASS VALVE** - based on mineral oil ISO VG46 at 50°C (viscosity = 32 mm^2/s)

Q/Δp diagrams of flow trough the by pass valve

FRS-10
FRS-20

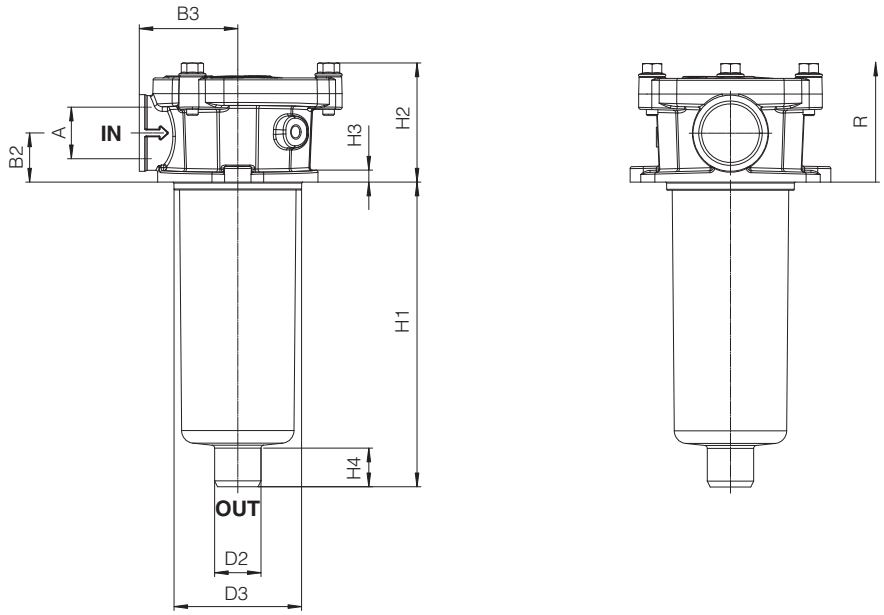


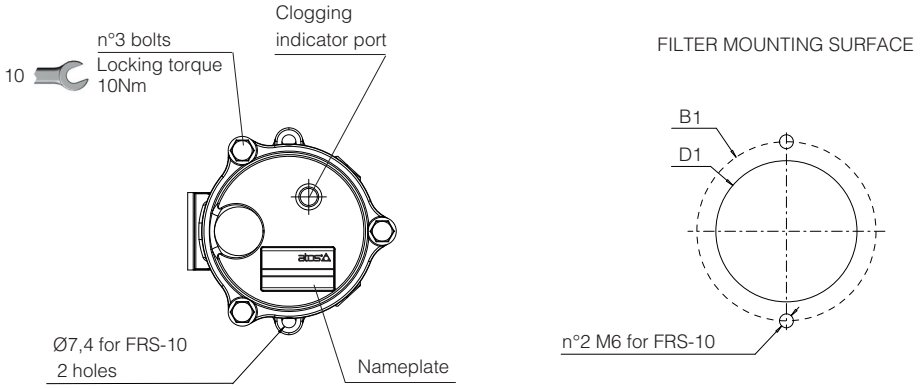
FRS-30
FRS-40



11 INSTALLATION DIMENSIONS OF FRS FILTERS [mm]

FRS-10

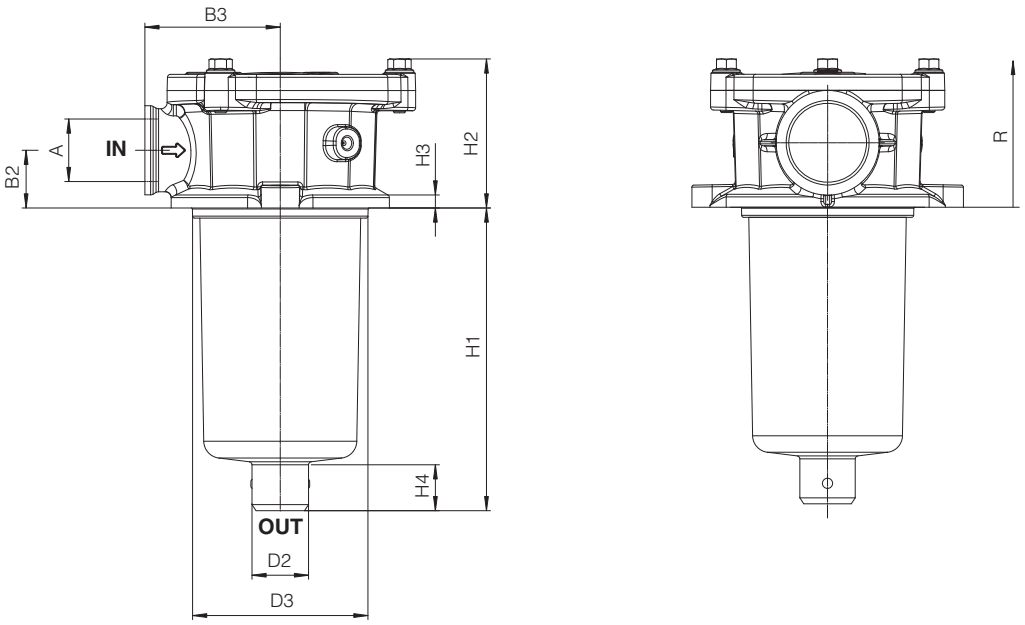


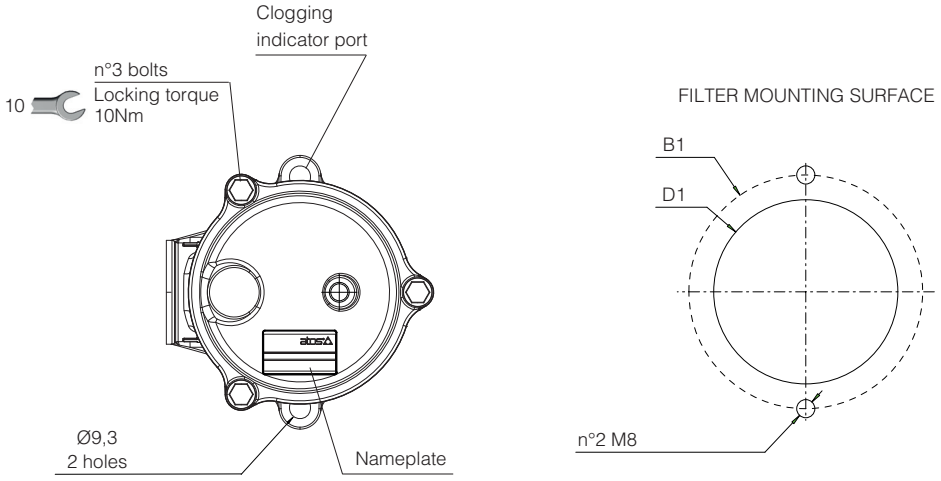


Code	A	B1	B2	B3	D1	D2	D3	H1	H2	H3	H4	R (element removal)	Mass (Kg)
FRS-10-A	1/2" BSPP 3/4" BSPP SAE-12	89	25	51	67,5	24	67	85	60	8	22	150	0,45
FRS-10-B								158				220	0,60

(1) SAE-12 thread size 1" 1/16-12-UN-2B

FRS-20

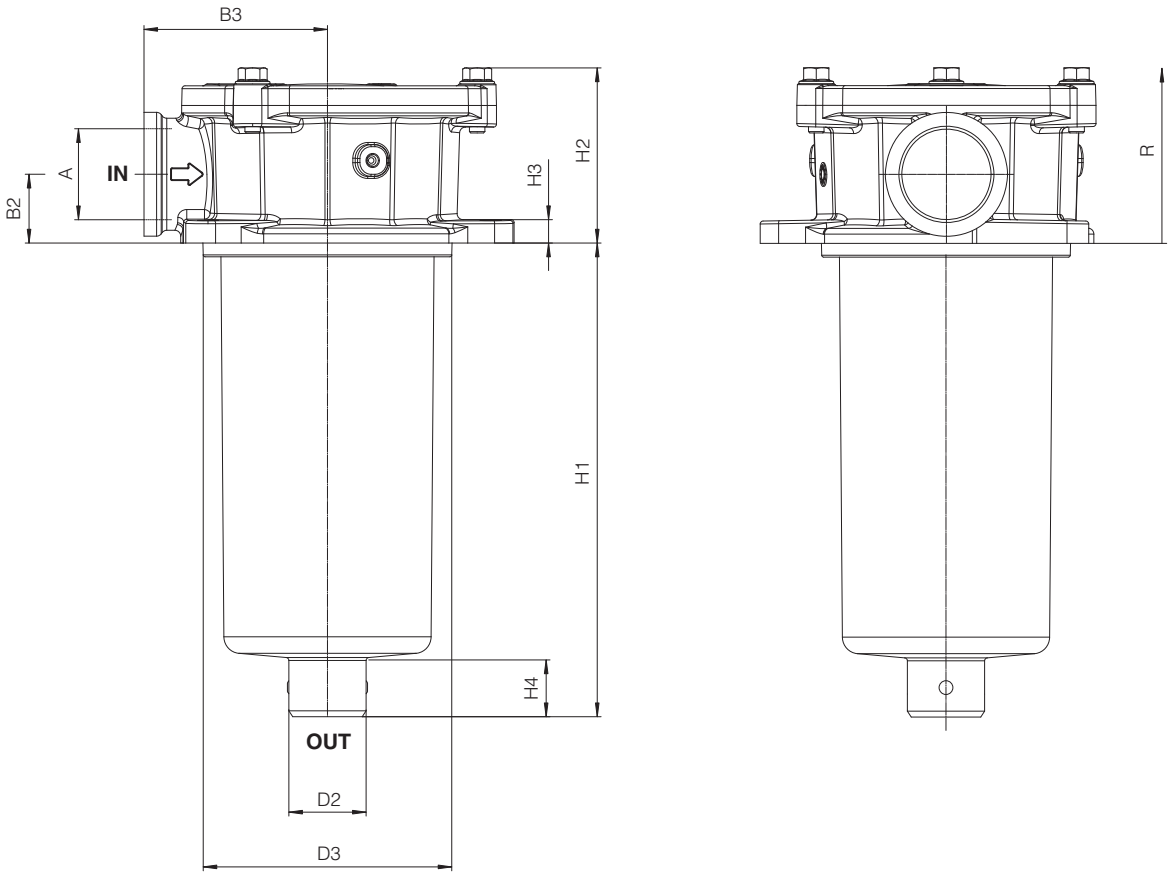


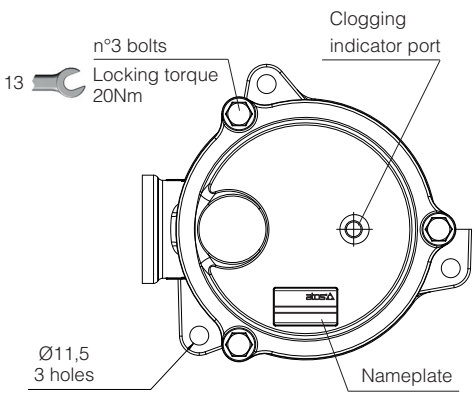


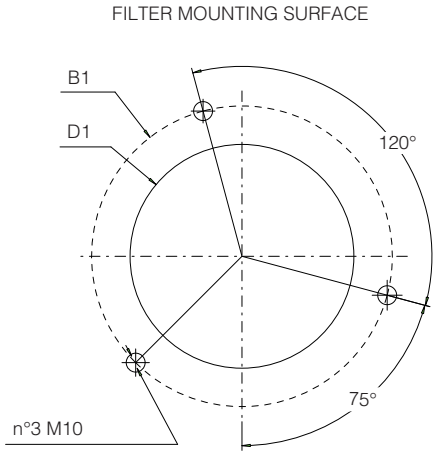
Code	A	B1	B2	B3	D1	D2	D3	H1	H2	H3	H4	R (element removal)	Mass (Kg)
FRS-20-A	1/2" BSPP 3/4" BSPP 1" BSPP 1 1/4" BSPP SAE-16 **(1)**	115	28,5 **(2)**	67	88,5	40	87	95	73	11	24	170	0,80
FRS-20-B								140				220	0,90
FRS-20-C			32 **(3)**					221				295	1,10
FRS-20-D								325				400	1,30

(1) SAE-16 thread size 1" 5/16-12-UN-2B
(2) For port size 1/2", 3/4", 1" and SAE-16
(3) For port size 1 1/4"

FRS-30



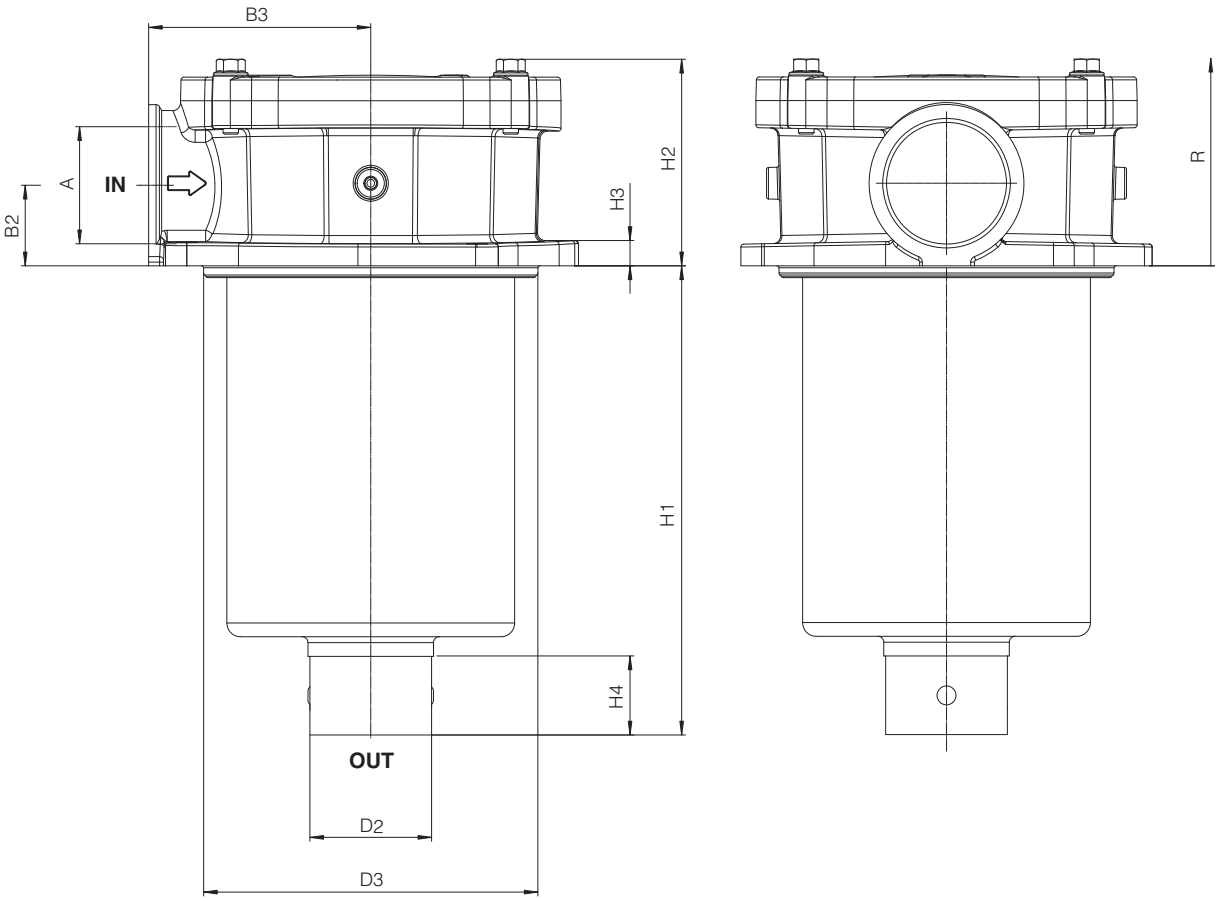


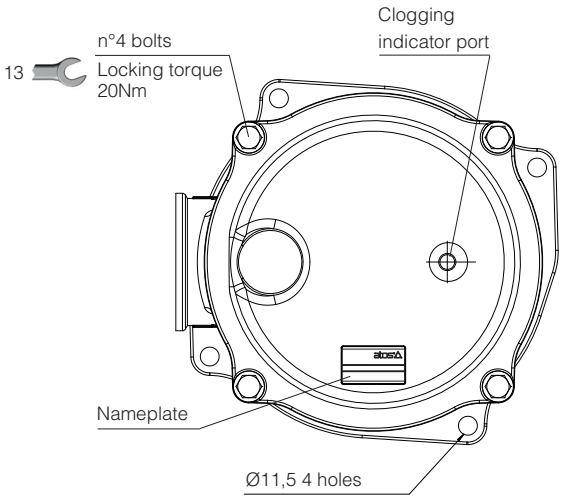


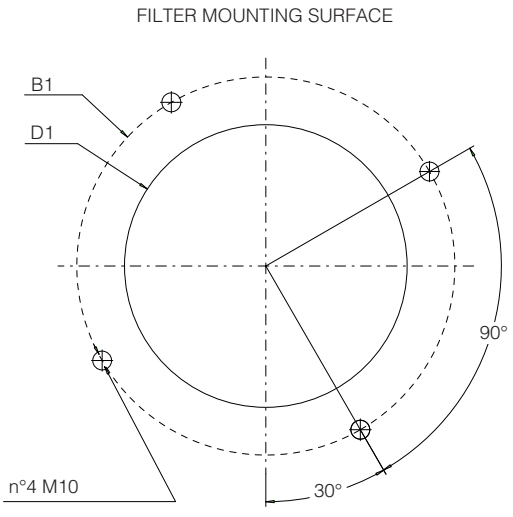
Code	A	B1	B2	B3	D1	D2	D3	H1	H2	H3	H4	R (element removal)	Mass (Kg)
FRS-30-A	1" BSPP 1 1/4" BSPP 1 1/2" BSPP SAE-24 **(1)**	175	35	95	130	40	129	226	90	11	30	320	2,10
FRS-30-B								256				360	2,40

(1) SAE-24 thread size 1" 7/8-12-UN-2B

FRS-40







Code	A	B1	B2	B3	D1	D2	D3	H1	H2	H3	H4	R (element removal)	Mass (Kg)
FRS-40-A	1 1/4" BSPP 1 1/2" BSPP 2" BSPP SAE-32 **(2)**	220	42	115	175	65	174	170	105	11	37	270	3,20
FRS-40-B								223				330	3,60
FRS-40-C								273				380	4,20
FRS-40-D **(1)**								223				330	3,60
FRS-40-E								423				530	4,00

(1) Filter type FRS-40-D has the same length of FRS-40-B but it uses filter elements with smaller internal diameter

(2) SAE-32 thread size 2" 1/2-12-UN-2B

12 ACCESSORIES - to be ordered separately

Following accessories can be assembled on return filters type FRS-20, FRS-30 and FRS-40 (not available for FRS-10) to avoid the foam or air/oil emulsion inside the tank caused by the return flow.

The discharge ending pipes **DSC-END-*** are used to extend the outlet port of the FRS filters below the oil level in the tank.
They are available with length 250 (200 mm for FRS-40) and 500 mm

The diffusers **DIFF-FRS** are used in case of high flow rates to evenly distribute the return flow inside the tank.
They can be mounted directly on the filter bowl or using the connecting pipes **CONN-END-***, available with lengths of 250 (200 for FRS-40) and 500 mm.

MODEL CODE OF DISCHARGE ENDING PIPES (1)

DSC-END	-	250	FRS-20/30
Discharge ending pipe		**Pipe length** for **FRS-20** and **FRS-30**: 250 = 250 mm 500 = 500 mm **Pipe length** for **FRS-40**: 200 = 200 mm 500 = 500 mm	**Filter type**: FRS-20/30 = for FRS-20 and FRS-30 FRS-40 = for FRS-40

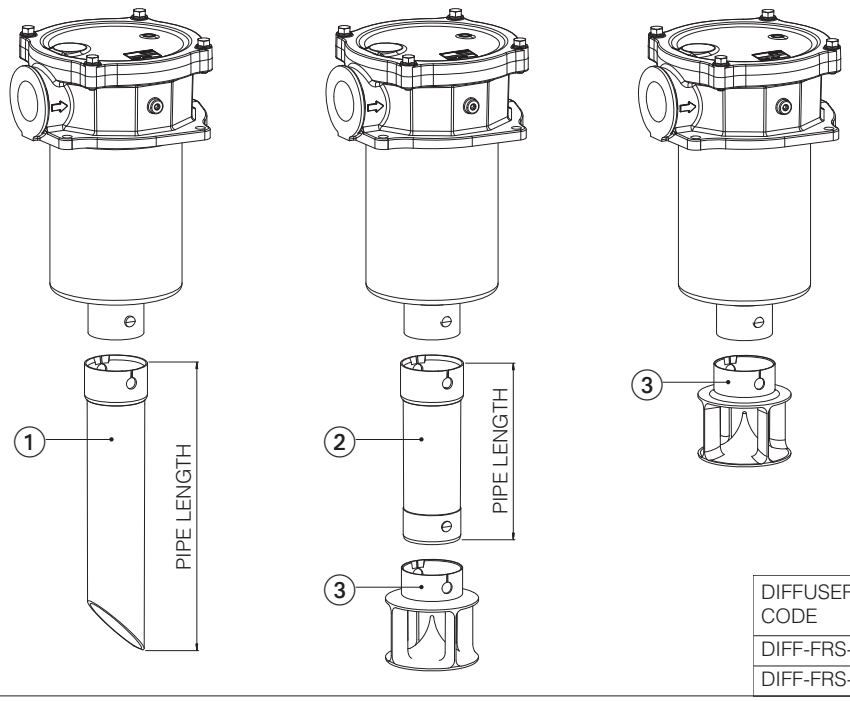
MODEL CODE OF CONNECTING ENDING PIPES (2)

CONN-END	-	250	FRS-20/30
Connecting ending pipe		**Pipe length** for **FRS-20** and **FRS-30**: 250 = 250 mm **Pipe length** for **FRS-40**: 200 = 200 mm (for FRS-40) 500 = 500 mm (for FRS-40)	**Filter type**: FRS-20/30 = for FRS-20 and FRS-30 FRS-40 = for FRS-40

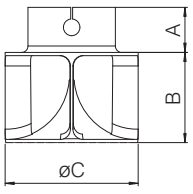
MODEL CODE OF DIFFUSERS (3)

DIFF	-	FRS-20/30
Diffuser		**Filter type**: FRS-20/30 = for FRS-20 and FRS-30 FRS-40 = for FRS-40

DISCHARGE ENDING PIPE **CONNECTING ENDING PIPE** **DIFFUSER**

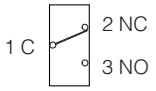


DIFFUSER DIMENSIONS



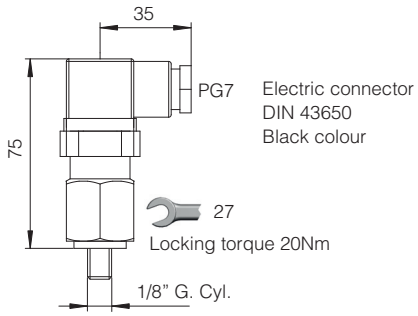
DIFFUSER CODE	DIMENSIONS		
	A	B	C
DIFF-FRS-20, DIFF-FRS-30	30	45	75
DIFF-FRS-40	35	70	105

13 CHARACTERISTICS OF CLOGGING INDICATORS

Model code	CIA-E electrical		CIA-V visual
Switching pressure	2 bar		green sector = 0 ÷ 3 bar red sector = 3 ÷ 10 bar
Switching tolerance at 20°C	± 10% of switching pressure		-
Electric connection	Electric plug connection as per DIN 43650 with cable gland type PG7		-
Power supply	14 VDC ÷ 30 VDC	125 VAC ÷ 250 VAC	
Max current - resistive (inductive)	4 A (3 A) ÷ 3 A (2 A)	5 A (3 A) ÷ 3 A (2 A)	
Fluid temperature	-25°C ÷ +100°C		-25°C ÷ +100°C
Protection degree according to DIN 40050	IP65 with mating connector		-
Hydraulic connection	G1/8" BSP		G1/8" BSP
Duty factor	100%		100%
Mass (Kg)	0,16		0,04
Electric scheme / Hydraulic symbol	 The electric scheme shows the switch position in case of clean filter element		

14 DIMENSIONS OF CLOGGING INDICATORS

CIA-E
CIA-E/UL

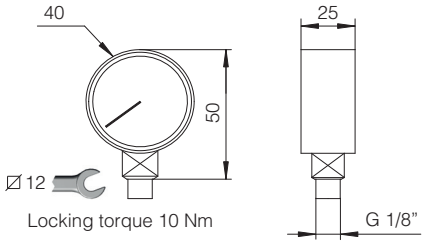


Electric connector
DIN 43650
Black colour

Locking torque 20Nm

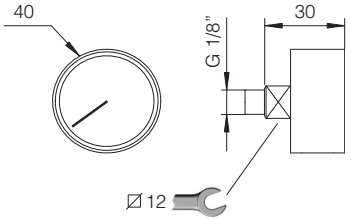
Note: add sealant on indicator threads

CIA-V



Locking torque 10 Nm

CIA-V/P
(available on request)

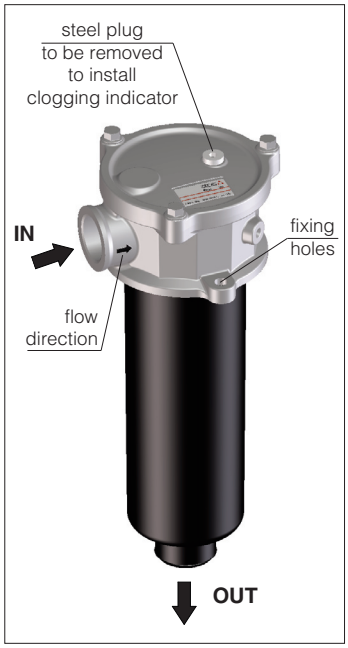


Locking torque 10 Nm

15 INSTALLATION AND COMMISSIONING

Verify that the tank flange with the filter mounting surface is clean and free of scratches.
Install the filter on the tank cover using the fixing holes on the filter head.
Connect the IN port of the filter to the system return pipe.
The OUT port of the filter must end under the oil level to avoid foam or air/oil emulsion inside the tank.
At this purpose specific accessories as connecting pipes, discharge ending pipes ad flow diffusers can be fit on the filter OUT port see section 12
Make sure that there is enough space above the filter, for the replacement of the filter element, see dimension "R" at section 11
Never run the system without the filter element.

For filters ordered with clogging indicator, code E or V:
• remove the steel plug from the indicator port on the filter head
• install the clogging indicator and lock it at the specified torque
During the cold start up (fluid temperature lower than 30°C), a false clogging indicator signal can be given due to the high fluid viscosity.

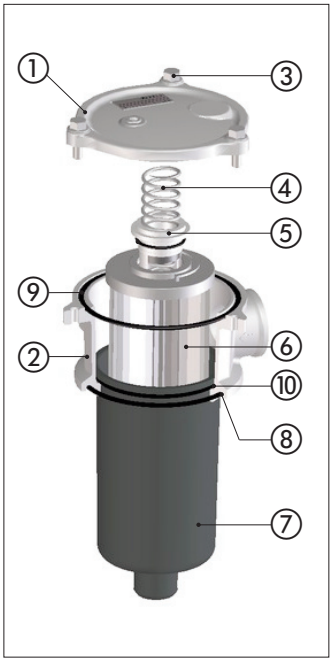


16 MAINTENANCE

The filter element must be replaced as soon as the clogging indicator switches to highlight the filter clogged condition
For filters without clogging indicator, the filter element must be replaced according to the system manufacturer's recommendations.
Select the new filter element according to the model code reported on the filter nameplate, see section 17

For the replacement of the filter element, proceed as follow:

- switch-off the system and make sure that there is no residual pressure in the filter line (i.e. pressurized tank); the filter has no pressure bleeding device
- pay attention to the fluid and filter surface temperature. Always use suitable gloves an protection glasses
- remove the cover ① from the filter head ② by releasing the bolts ③
- remove the spring ④ and the bowl ⑦
- remove the dirty filter element ⑥ pulling it upward carefully
- clean the bowl ⑦
- install the bowl ⑦ after having checked the good condition of the seal ⑧
- insert the new filter element over the spigot in the filter bowl; the filter element includes the by-pass valve ⑤
- install the spring ④
- mount the cover and lock the relevant bolts ③ after having checked the good condition of the seal ⑨



WARNING: The dirty filter elements cannot be cleaned and re-used. They are classified as "dangerous waste material", then they must be disposed of by authorized Companies, according to the local laws.

16.1 SEALS KIT

Filter type	Seal kit code (NBR)	Seal kit code (FKM)	Seal kit composition
FRS-10	GUARN FRS-10	GUARN FRS-10 /PE	⑧+⑨+⑩
FRS-20	GUARN FRS-20	GUARN FRS-20 /PE	⑧+⑨+⑩
FRS-30	GUARN FRS-30	GUARN FRS-30 /PE	⑧+⑨+⑩
FRS-40	GUARN FRS-40	GUARN FRS-40 /PE	⑧+⑨+⑩

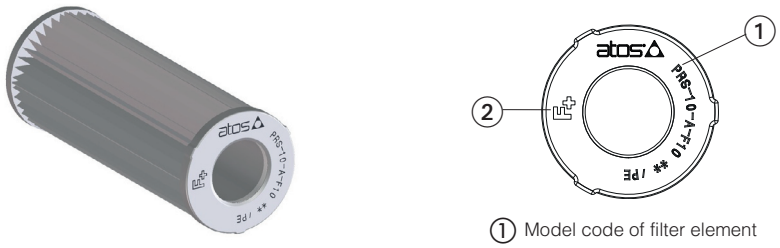
16.2 SPARE SPRING ④

Filter type	Seal kit code
FRS-10	MO-1246
FRS-20	MO-1247
FRS-30	MO-1248
FRS-40	MO-1249

17 FILTER IDENTIFICATION NAMEPLATE

① Model code of complete filter
② Model code of filter element
③ Filter matrix code

17.1 IDENTIFICATION OF FILTER ELEMENT



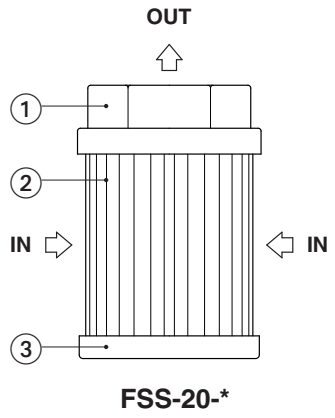
① Model code of filter element
② Filtration Plus identification

18 RELATED DOCUMENTATION

LF010	Fluid contamination
LF020	Filtration guidelines

Suction filters type FSS

Threaded ports



FSS-20-*

① Filter head
② Wire mesh
③ End cap

FSS

Suction filters are designed to protect pumps from ingestion of solid particles and coarse contamination present in the oil tank, which may cause heavy damage and seizures.

They are designed to be screwed onto the pumps suction line.

FSS filters are available with following features:

- four sizes with BSPP threaded ports, from 1/2" to 3 "
- wire mesh 125 µm (c)
- version without or with by-pass valve

Max flow **450 l/min**

1 MODEL CODE

FSS	-	10	-	A	-	W125	-	00	-	N	**

Suction filter

Filter size:
10
20
30
40

Filter length:		Max flow [l/min] **(1)** FSS-10	FSS-20	FSS-30	FSS-40
A	=	20	38	85	330
B	=	-	60	125	450
C	=	-	-	200	-

Filtration rating:
W125 = wire mesh 125 µm

Port size:
BSPP threaded:

FSS-10-A
00 = G 1/2"

FSS-20-A
01 = G 3/4"

FSS-20-B
02 = G 1"

FSS-30-A
03 = G 1 1/4"

FSS-30-B
04 = G 1 1/2"

FSS-30-C
05 = G 2"

FSS-40-A
06 = G 2 1/2"

FSS-40-B
07 = G 3"

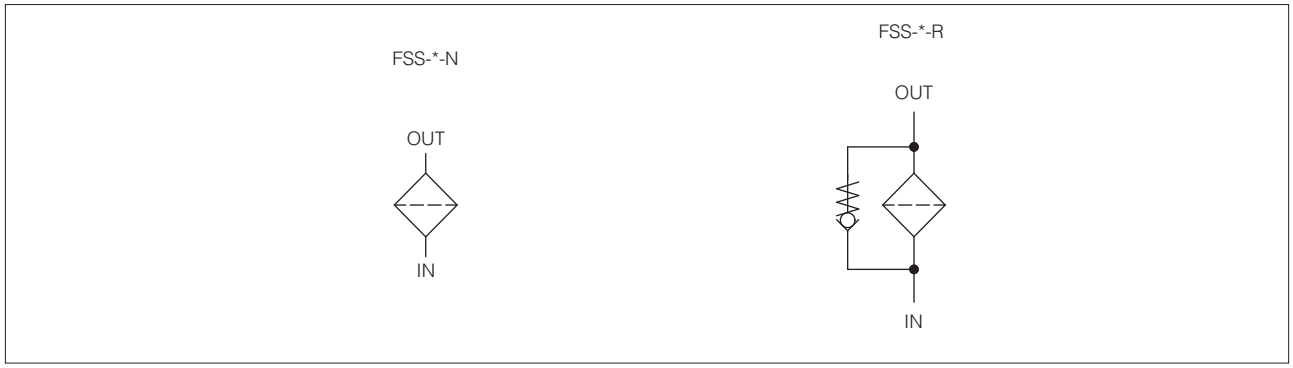
Series number

By-pass:
N = without by-pass
R = by-pass valve, cracking pressure 0,35 bar

(1) Max flow rates are performed in following conditions:
- clean filter element
- Δp = 0,015 bar
- mineral oil with viscosity 32 mm²/s

In case of different conditions see Q/Δp diagrams at section 6

2 HYDRAULIC SYMBOL (representation according to ISO 1219-1)



3 GENERAL CHARACTERISTICS

Assembly position / location		Any position
Differential collapse pressure [bar]		1
Ambient temperature range		-20°C ÷ +70°C
Storage temperature range		-20°C ÷ +80°C
Materials	Filter head	Nylon
	Filter end cap	Carbon steel, zinc plated
	Filter Mesh	Stainless steel AISI 304

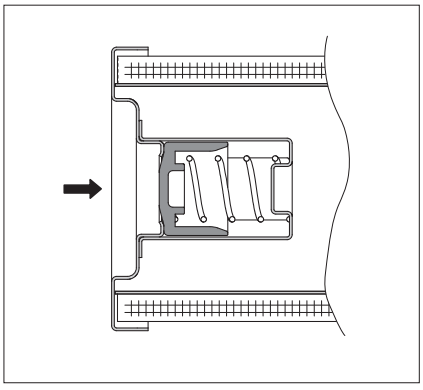
4 HYDRAULIC FLUIDS - for other fluids not included in below table, consult our technical office

Recommended fluid temperature	-25°C ÷ +100°C	
Recommended viscosity	15 ÷ 100 mm²/s - max allowed range 2.8 ÷ 500 mm²/s	
Hydraulic fluid	**Classification**	**Ref. Standard**
Mineral oils	HL, HLP, HLPD, HVLP, HVLPD	DIN 51524
Flame resistant without water	HFDU, HFDR	ISO 12922

5 BY-PASS VALVE - version -R

The by-pass valve allows the oil flow to by-pass the suction filter when the pressure drop across the element exceeds 0,35 bar, so that to avoid the pump cavitation.

This may happens in particular conditions as:
- instantaneous high flow peaks
- filter mesh clogged by contamination



6 FILTER SIZING

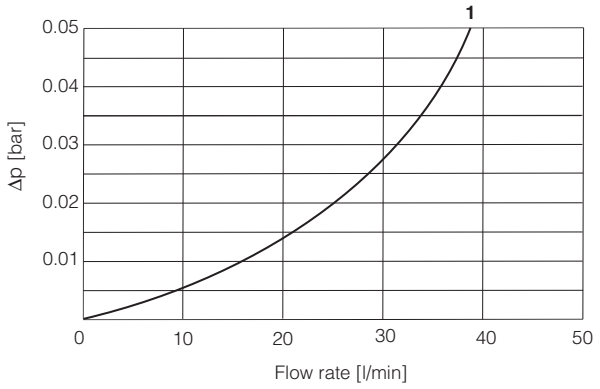
Suction filters must be largely sized to avoid the pumps cavitation. In the best conditions the Δp should not exceed 0.015 bar

6.1 Q/Δp DIAGRAMS

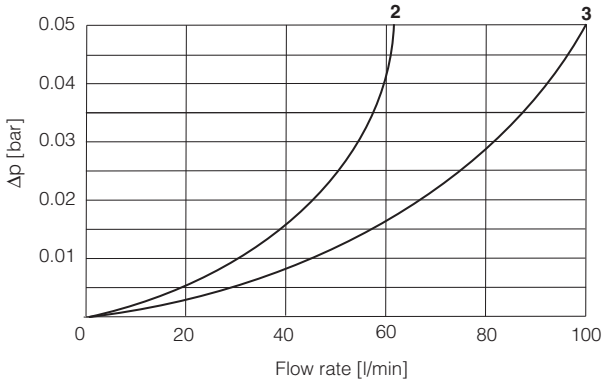
In following diagrams are reported the Δp characteristics of filter based on mineral oil with density 0,86 kg/dm² and viscosity 32 mm²/s.
in case of different viscosity the effective Δp_E is given by the formula:

$$\Delta p_E = \Delta p \times \frac{\text{viscosity}}{32}$$

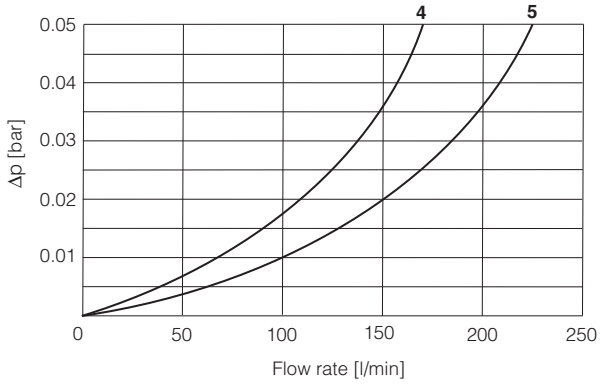
Δp_E = pressure drop calculated at the effective viscosity
Δp = pressure drop reported in the below diagrams
Viscosity = effective fluid viscosity in the working condition (mm²/s)



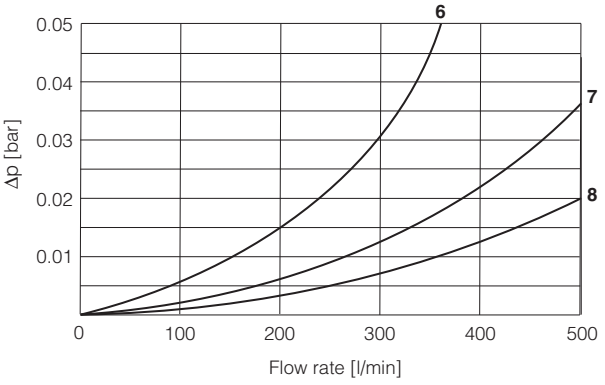
1 = FSS-10-A



2 = FSS-20-A
3 = FSS-20-B

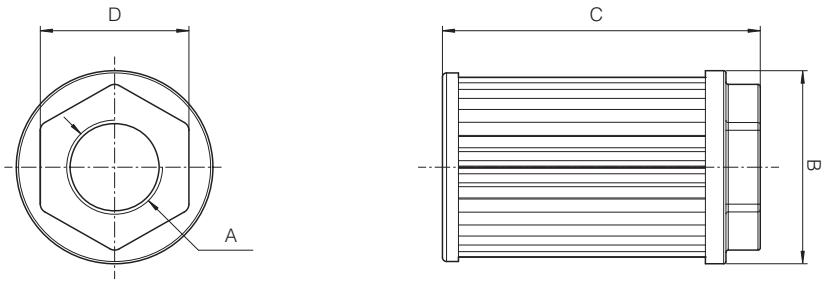


4 = FSS-30-A
5 = FSS-30-B



6 = FSS-30-C
7 = FSS-40-A
8 = FSS-40-B

7 INSTALLATION DIMENSIONS OF FSS FILTERS [mm]



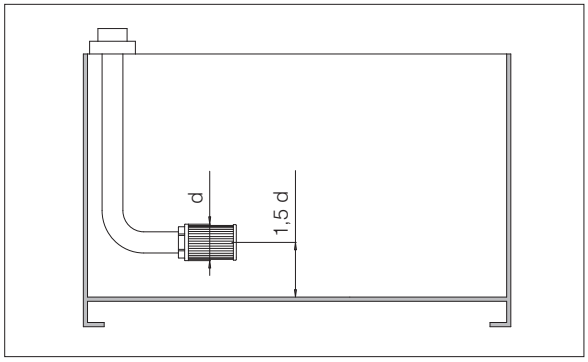
Code	A	B	C	D	Mass (Kg)
FSS-10-A	1/2" BSPP	46	106	36	0,10
FSS-20-A	3/4" BSPP	64	109	50	0,19
FSS-20-B	1" BSPP		139		0,21
FSS-30-A	1 1/4" BSPP	86		65	0,33
FSS-30-B	1 1/2" BSPP		200		0,24
FSS-30-C	2" BSPP		260	75	0,51
FSS-40-A	2 1/2" BSPP	150	212	110	1,07
FSS-40-B	3" BSPP		272		0,92

8 INSTALLATION AND COMMISSIONING

The suction filters FSS must be generously sized to avoid pump cavitation. The size of the OUT port of the FSS filter must be equal to or greater than the corresponding suction port of the pump.

The FSS filter must always remain below the oil level in the tank, in any operating condition.
During installation, a minimum distance must be observed between the filter and the bottom of the tank (see figure on the side) to avoid the possibility that the contaminant deposited on the bottom is sucked up.

The FSS filter should be installed as far as possible from the return pipe. It is advisable to use separators inside the tank to keep the suction area separate from the area affected by the return flow.



9 MAINTENANCE

The filter must be replaced according to the system manufacturer's recommendations

WARNING: The dirty filters cannot be cleaned and re-used. They are classified as "dangerous waste material", then they must be disposed of by authorized Companies, according to the local laws.

9.1 FILTER IDENTIFICATION

① Model code of filter

10 RELATED DOCUMENTATION

LF010	Fluid contamination
LF020	Filtration guidelines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