ABLE ACCUMULATORS

PISTON ACCUMULATORS

The boost you need for your system

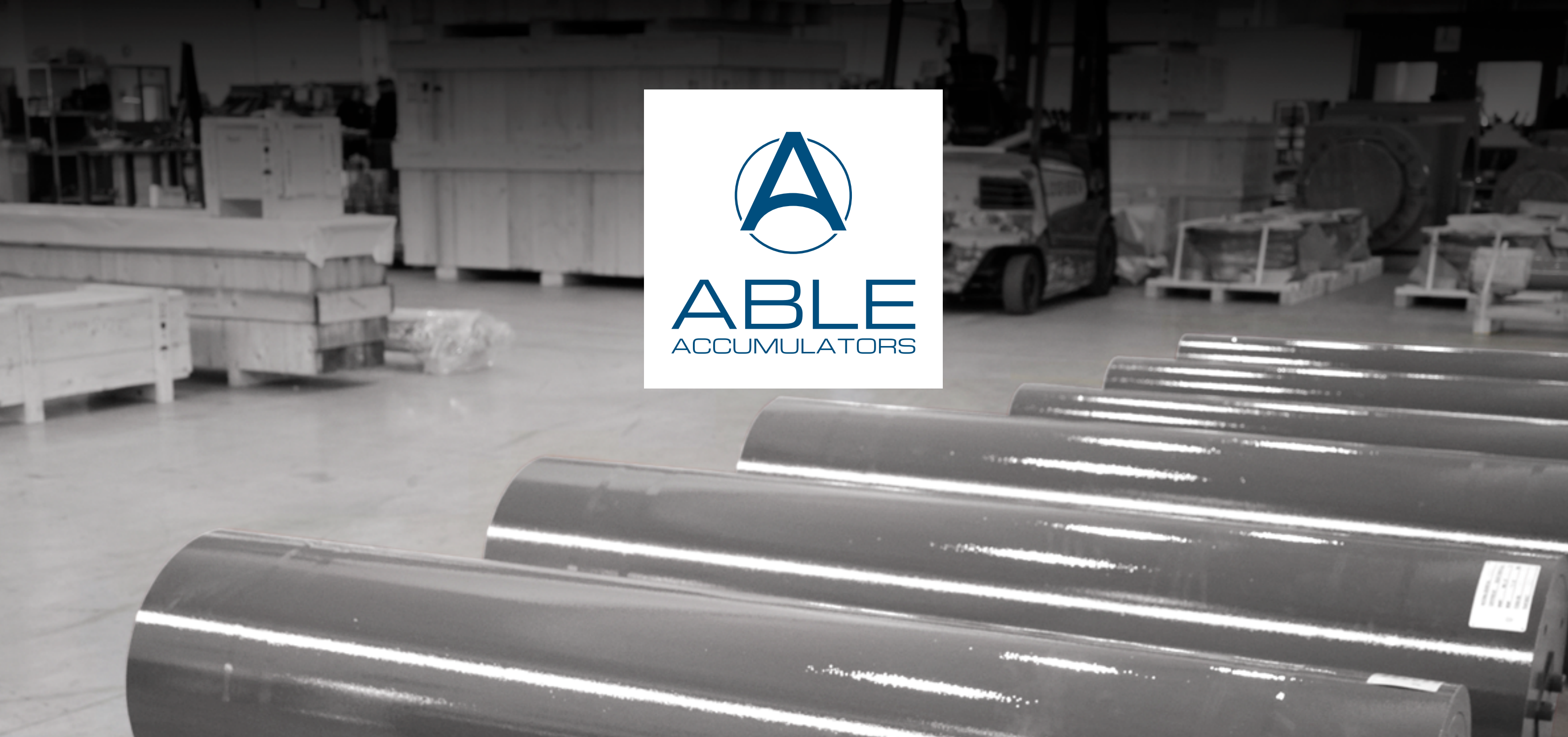
Series PED + ASME

ABLE
ACCUMULATORS

LEADING MANUFACTURER OF HYDRAULIC AND PNEUMATIC SOLUTIONS

INDEX

Introduction	Page
Description	5
Construction features	6
Range of applications	8
Advantages	8
Overview Able piston accumulators	9
Rules and regulations	
Design and homologation	10
CE Series FPA-E	
CE Series FPA-E Ordering code	11
CE Series FPA-E-150 - 5/60 l	12
CE Series FPA-E-250 - 30/180 l	13
CE Series FPA-E-370 - 100/400 l	14
CE Series FPA-E-540 - 200/800 l	15
ASME Series FPA-A	
ASME Series FPA-A Ordering code	17
ASME Series FPA-A-150 - 5/60 l	18
ASME Series FPA-A-250 - 30/180 l	19
ASME Series FPA-A-370 - 100/400 l	20
ASME Series FPA-A-540 - 200/800 l	21
Connections and accessories	
Gas side port	22
Fluid side port	23
Accessories	24
Calculation	
Accumulator calculation form	26



DESCRIPTION

Able piston accumulators are devices that can be adopted in a large number of applications to store and exchange energy with the hydraulic system to which they are connected.

The piston accumulator consists of two chambers separated by a floating piston equipped with proper seal and guides system. One of the chambers is filled with gas (usually nitrogen) under opportune pressure and the second one is connected to the hydraulic circuit.

The gas pressure must be chosen according to the working conditions of the accumulator and represents the pre-charge pressure.

When the hydraulic system reaches a pressure value higher than the pre-charge one, the fluid flows into its chamber forcing the piston to move accordingly and pressing the gas contained in the opposite chamber. During this phase, the compressibility of gas allows the accumulator to store energy that will be release to the hydraulic system once its pressure value will be less than the gas one.

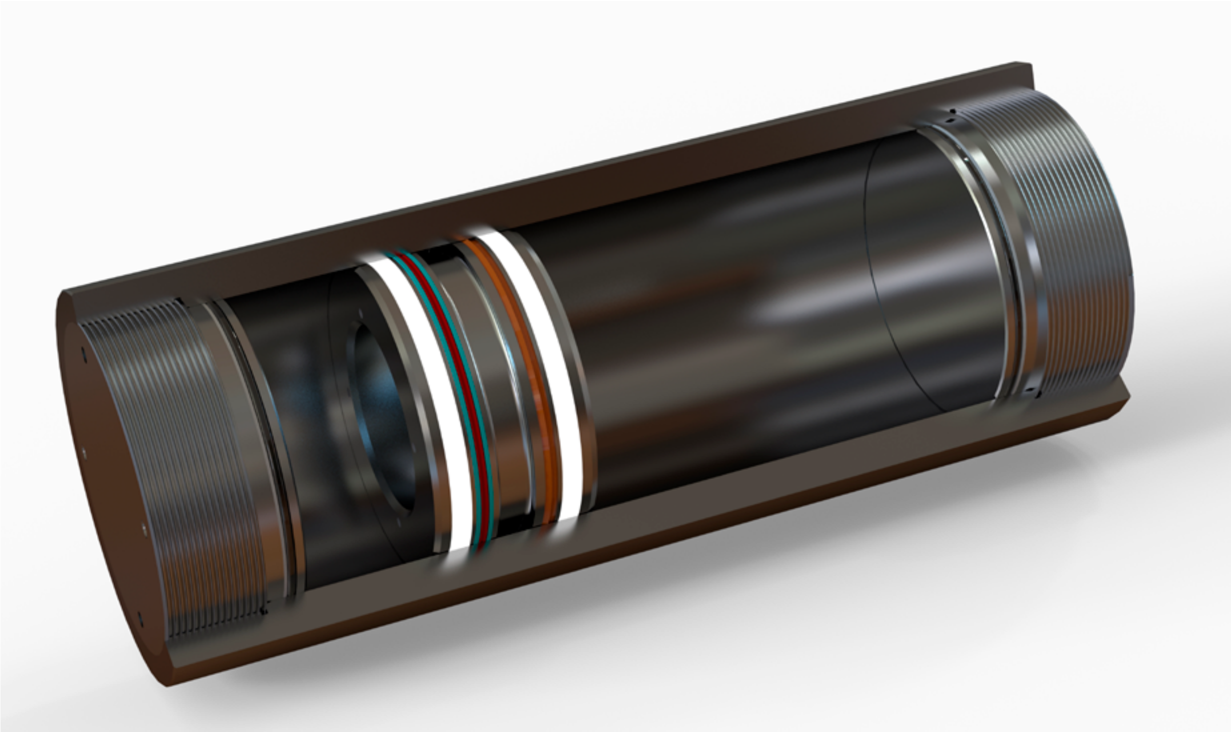
CONSTRUCTION FEATURES

The piston accumulator consists of a steel cylinder, closed at both ends with screwed covers, in which slides a piston.

To maximize the time response of the system and to avoid the generation of pressure peaks, the piston is made of aluminum and its construction is lightened by a cavity, facing the gas chamber in order to increase the accumulation volume. As piston accumulator can be in a state of total fluid discharge with the piston lean on to the fluid side end, a concave cavity is also realized on the piston fluid side so that the pressure acts on almost its entire surface.

Together with the slender construction of the piston, the efficiency of the accumulator is assured by a special seals and guides system studied with the aim of component life, smoothness of movements and reduction of stick slip phenomena; the lower is the differential pressure necessary to move the piston, the better is the response speed of the accumulator.

The sealing materials are strictly correlated to the working temperature and to the nature of fluids and gas they separate. A wide range of solutions is available to meet the customer needs. The following table resumes the different disposable options.



Seals compatibility		
Fluid	Elastomer	Temperature range °C
Fluids based on mineral oil (HL; HLP)	NBR / HNBR	-20°C …+80 °C
Hardly flammable fluids (HFA; HFB; HFC)		
Water		
Many acids, bases and brines during low temperatures		
Fluids based on mineral oil (HL; HLP)	VITON (FKM)	-15 °C …+180 °C
Fluids based on Synthetic ester (HEES) (HFD)		
Water free synthetic fluids		
Fuels		
Concentrates of inorganic or organic acids and bases		
Mineral oil (HL; HLP)	NBR / EPDM	-30 °C …+80 °C
Hardly flammable fluids (HFA)		

For different temperature range or different fluid contact Able.

The long-life terms of the accumulator make possible a progressive wearing in the seals and guides system resulting in a loss of pre-charge pressure value. As this parameter is easy to estimate it is usually considered an indicator of the seal's condition.

The cylinder body of the accumulator is made of low carbon steel, the material grade is according to EN14359-17 or ASME VIII Div.1.

The internal surface of the cylinder is honed to 0.3 micron of roughness. Due to the fluids and gas contained, the cylinder and end covers can either be superficially treated or made of stainless steel.

The gas side end cover is screwed to the cylinder body; the seal is guaranteed by an O-ring gasket, complete with anti-extrusion ring.

In the standard version, this end cap has a threaded seat in which the pre-charged valve is placed. "Table 1 - Gas side port" (see page 22) resumes the different disposable options.

The fluid side end cover is also screwed to the cylinder body and is sealed with the same solution of opposite end.

This end cap has a coupling to connect it to the system, either threaded or flanged, in accordance to the customer requirements. "Table 2 - Fluid side port" (see page 23) resumes the different disposable options.

All the Able accumulators are subjected to accurate controls and tested according to either PED or ASME standards, depending on the model selected.

RANGE OF APPLICATIONS

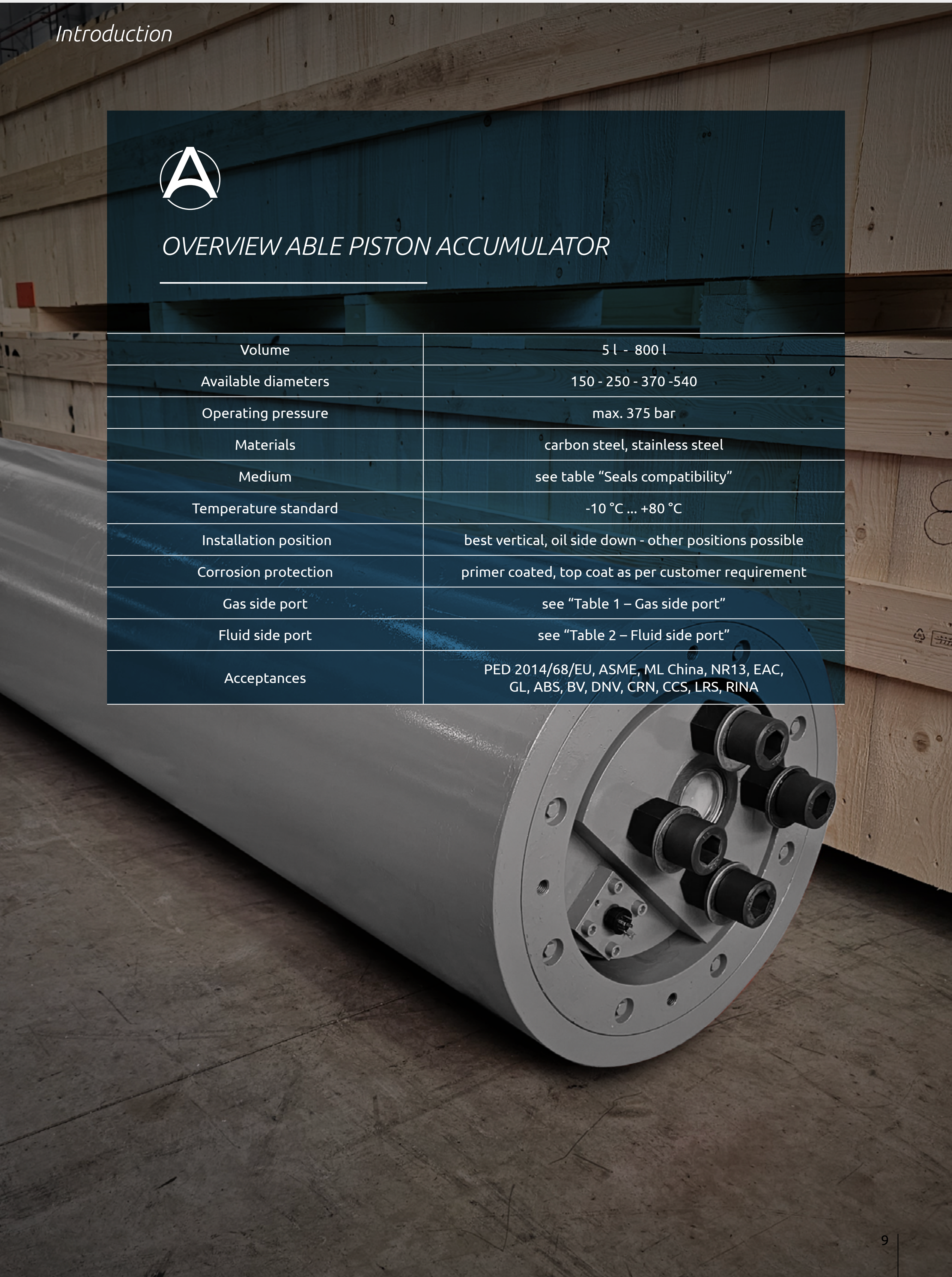
The Able piston accumulator is a product designed to ensure high performances and low maintenance even in extreme climatic conditions, multiple options in terms of reference codes and maximum working pressures, with a large variety of volumes to meet the market needs. More, a long list of accessories makes the piston accumulator able to be customized to fulfill the requirements of any applications.

ADVANTAGES

- **Various and fully customizable volumes available, by selecting the combination of diameter and length**
- **Optional piston position monitoring system**
- **Either vertical or horizontal installation position**
- **Total discharge is possible**
- **Low friction sealing system for long life**
- **Maintainable design**
- **Very low gas permeability compared to bladder or diaphragm accumulators**
- **Light piston construction for high dynamic performances**
- **Different connections available on both fluid and gas side cover ends**
- **In case of failure no sudden gas loss**
- **Sealing systems available for different kinds of operating liquids, wide temperature range and applications**

OVERVIEW ABLE PISTON ACCUMULATOR

Volume	5 l - 800 l
Available diameters	150 - 250 - 370 -540
Operating pressure	max. 375 bar
Materials	carbon steel, stainless steel
Medium	see table “Seals compatibility”
Temperature standard	-10 °C ... +80 °C
Installation position	best vertical, oil side down - other positions possible
Corrosion protection	primer coated, top coat as per customer requirement
Gas side port	see “Table 1 – Gas side port”
Fluid side port	see “Table 2 – Fluid side port”
Acceptances	PED 2014/68/EU, ASME, ML China, NR13, EAC, GL, ABS, BV, DNV, CRN, CCS, LRS, RINA



DESIGN AND HOMOLOGATION

Able Hydraulics accumulators are manufactured respecting European and American standard but can meet any international standard.

In case of specific request please contact our technical department.

The European version is designed in accordance with the Pressure Equipment Directive "PED 2014/68/EU" – see FPA-E series.

The American version is designed as per ASME Code (American Society of Mechanical Engineers). Able has been licensed to supply pressure vessels "U" stamped under Section VIII Div. 1 of the ASME Code since 2022 – see FPA-A series.

Each accumulator is individually final pressure tested, at the presence of authorized inspector. If homologated and/or requested they are delivered with a documentation comprising a certificate of conformity, an as-built drawing and part list with material summary and wearing part list.

CE Series FPA-E Ordering code

1	2	3	4	5		6	7		8	9	10	11		12	13	14
FPA	E	L	370	200	/	B	N	/	C	M	G22	F46	/	20	S10	

1 Series

Series
Able Piston accumulator = FPA

2 Reference code

Reference code	
PED 2014 / 68 / EU	= E
EN 14359-17	

3 Max working pressure (bar)

Max working pressure (bar)	
250	= L
375 / 350	= H

4 Internal diameter

Internal diameter	
Ø 150 mm	= 150
Ø 250 mm	= 250
Ø 370 mm	= 370
Ø 540 mm	= 540

5 Nominal Capacity

Nominal Capacity	
Ø 150 mm	5 ÷ 60 litres
Ø 250 mm	30 ÷ 180 litres
Ø 370 mm	100 ÷ 400 litres
Ø 540 mm	200 ÷ 800 litres

6 Piston material

Piston material	
Aluminium	= B
Stainless steel	= X

7 Piston seal material

Piston seal material	
Nitrile rubber (NBR)	= N
Fluorocarbon (FKM)	= V
Teflon (PTFE)	= T
Hydrogenated nitrile	= Y
Poliurethane (HPU)	= P
Hydrogenated nitrile for low temperature	= W

8 Jacket and end caps material

Jacket and end caps material	
Carbon steel	= C
Stainless steel	= Z
Nickel coated carbon steel thk. 35 microns	= K

9 End caps seal material

End caps seal material	
Nitrile rubber (NBR)	= M
Fluorocarbon (FKM)	= U
Hydrogenated nitrile for low temperature	= O

10 Gas side port

Gas side port
See Table 1 - pag. 22

11 Fluid side port

Fluid side port
See Table 2 - pag. 23

12 Precharge pressure (bar)

Precharge pressure (bar)
Range value 20 ÷ 200 (Standar 20 bar)

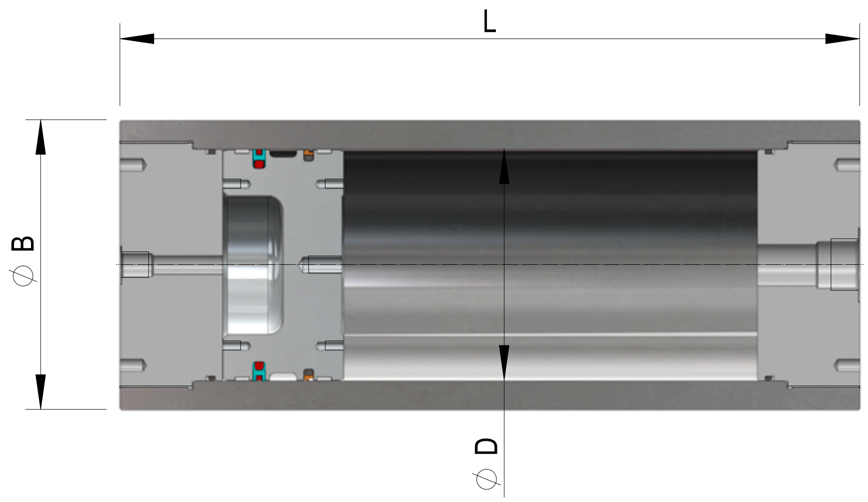
13 Accessories

Accessories
See Table 3 - pag. 24

14 Test and certification

Test and certification	
Europe Standard	=
Russia (EAC)	= R

CE Series FPA-E 150



CE Series FPA-E-L-150-***/*

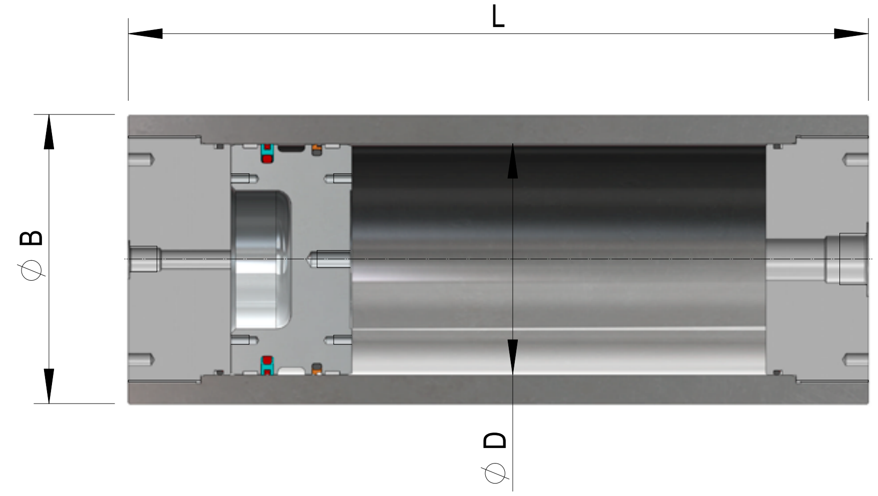
Piston diameter	Fluid volume	Max pressure	External diameter	Length	Weight approx.	Model code
D			B	L		
mm	*litres*	*bar*	*mm*	*mm*	*kg*	
150	5	250	172	485	42	FPA-E-L-150-5/*
	10			770	54	FPA-E-L-150-10/*
	20			1335	79	FPA-E-L-150-20/*
	30			1900	104	FPA-E-L-150-30/*
	40			2465	129	FPA-E-L-150-40/*
	50			3035	153	FPA-E-L-150-50/*
	60			3600	178	FPA-E-L-150-60/*

CE Series FPA-E-H-150-***/*

Piston diameter	Fluid volume	Max pressure	External diameter	Length	Weight approx.	Model code
D			B	L		
mm	*litres*	*bar*	*mm*	*mm*	*kg*	
150	5	375	188	485	59	FPA-E-H-150-5/*
	10			770	81	FPA-E-H-150-10/*
	20			1335	126	FPA-E-H-150-20/*
	30			1900	171	FPA-E-H-150-30/*
	40			2465	216	FPA-E-H-150-40/*
	50			3030	261	FPA-E-H-150-50/*
	60			3600	306	FPA-E-H-150-60/*

Note: *Accumulators with volumes different from the ones shown in tables may be manufactured upon request.*
In the event of an order, a binding drawing will be issued for approval for non-standard products.

CE Series FPA-E 250



CE Series FPA-E-L-250-***/*

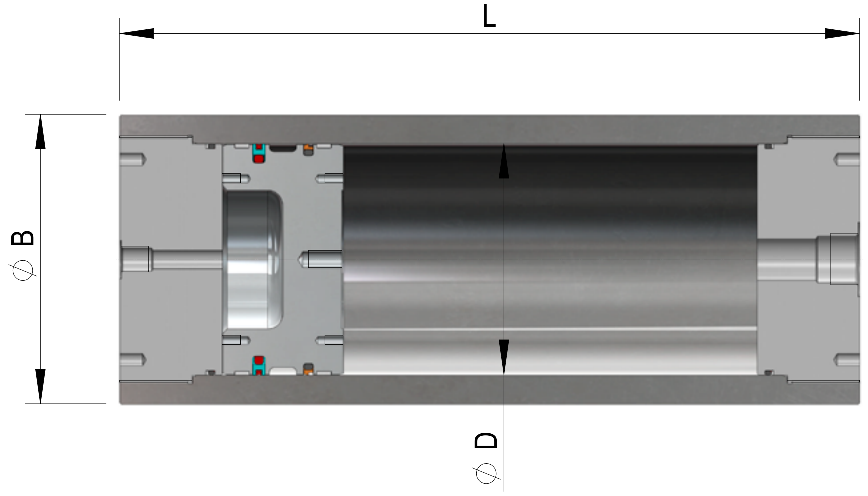
Piston diameter	Fluid volume	Max pressure	External diameter	Length	Weight approx.	Model code
D			B	L		
mm	*litres*	*bar*	*mm*	*mm*	*kg*	
250	30	250	290	980	228	FPA-E-L-250-30/*
	50			1385	282	FPA-E-L-250-50/*
	80			2000	363	FPA-E-L-250-80/*
	100			2405	418	FPA-E-L-250-100/*
	120			2815	472	FPA-E-L-250-120/*
	150			3425	554	FPA-E-L-250-150/*
	180			4035	635	FPA-E-L-250-180/*

CE Series FPA-E-250-H-***/*

Piston diameter	Fluid volume	Max pressure	External diameter	Length	Weight approx.	Model code
D			B	L		
mm	*litres*	*bar*	*mm*	*mm*	*kg*	
250	30	375	300	980	266	FPA-E-H-250-30/*
	50			1385	336	FPA-E-H-250-50/*
	80			2000	441	FPA-E-H-250-80/*
	100			2405	510	FPA-E-H-250-100/*
	120			2815	580	FPA-E-H-250-120/*
	150			3425	685	FPA-E-H-250-150/*
	180			4035	790	FPA-E-H-250-180/*

Note: *Accumulators with volumes different from the ones shown in tables may be manufactured upon request.*
In the event of an order, a binding drawing will be issued for approval for non-standard products.

CE Series FPA-E 370



CE Series FPA-E-L-370-***/*

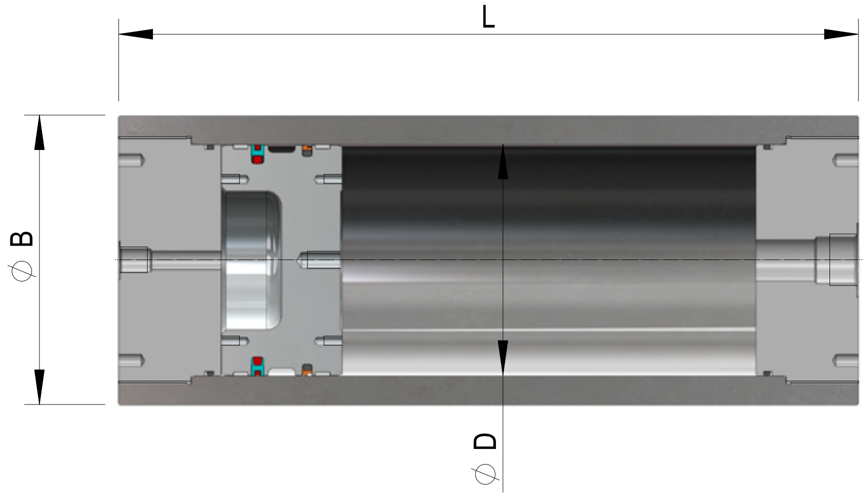
Piston diameter	Fluid volume	Max pressure	External diameter	Length	Weight approx.	Model code
D			B	L		
mm	*litres*	*bar*	*mm*	*mm*	*kg*	
370	100	250	425	1430	682	FPA-E-L-370-100/*
	150			1895	807	FPA-E-L-370-150/*
	200			2360	932	FPA-E-L-370-200/*
	250			2825	1058	FPA-E-L-370-250/*
	300			3290	1183	FPA-E-L-370-300/*
	350			3755	1309	FPA-E-L-370-350/*
	400			4220	1434	FPA-E-L-370-400/*

CE Series FPA-E-H-370-***/*

Piston diameter	Fluid volume	Max pressure	External diameter	Length	Weight approx.	Model code
D			B	L		
mm	*litres*	*bar*	*mm*	*mm*	*kg*	
370	100	375	450	1430	874	FPA-E-H-370-100/*
	150			1895	1062	FPA-E-H-370-150/*
	200			2360	1250	FPA-E-H-370-200/*
	250			2825	1438	FPA-E-H-370-250/*
	300			3290	1626	FPA-E-H-370-300/*
	350			3755	1814	FPA-E-H-370-350/*
	400			4220	2003	FPA-E-H-370-400/*

Note: *Accumulators with volumes different from the ones shown in tables may be manufactured upon request.*
In the event of an order, a binding drawing will be issued for approval for non-standard products.

CE Series FPA-E 540



CE Series FPA-E-L-540-***/*

Piston diameter	Fluid volume	Max pressure	External diameter	Length	Weight approx.	Model code
D			B	L		
mm	*litres*	*bar*	*mm*	*mm*	*kg*	
540	200	250	614	1560	1708	FPA-E-L-540-200/*
	300			1995	1938	FPA-E-L-540-300/*
	400			2435	2168	FPA-E-L-540-400/*
	500			2870	2398	FPA-E-L-540-500/*
	600			3305	2628	FPA-E-L-540-600/*
	700			3745	2857	FPA-E-L-540-700/*
	800			4180	3087	FPA-E-L-540-800/*

CE Series FPA-E-H-540-***/*

Piston diameter	Fluid volume	Max pressure	External diameter	Length	Weight approx.	Model code
D			B	L		
mm	*litres*	*bar*	*mm*	*mm*	*kg*	
540	200	350	652	1560	2170	FPA-E-H-540-200/*
	300			1995	2529	FPA-E-H-540-300/*
	400			2435	2889	FPA-E-H-540-400/*
	500			2870	3248	FPA-E-H-540-500/*
	600			3305	3608	FPA-E-H-540-600/*
	700			3745	3967	FPA-E-H-540-700/*
	800			4180	4326	FPA-E-H-540-800/*

Note: *Accumulators with volumes different from the ones shown in tables may be manufactured upon request.*
In the event of an order, a binding drawing will be issued for approval for non-standard products.


SANDVIK

ASME Series FPA-A Ordering code

1	2	3	4	5		6	7		8	9	10	11		12	13	14
FPA	A	H	250	110	/	B	N	/	C	M	G4	F74	/	30	S30	C

1 Series

Series
Able Piston accumulator = FPA

2 Reference code

Reference code	
ASME VIII Div.1	= A
Latest edition	

3 Max working pressure (bar)

Max working pressure (bar)	
210	= L
350	= H

4 Internal diameter

Internal diameter	
Ø 150 mm	= 150
Ø 250 mm	= 250
Ø 370 mm	= 370
Ø 540 mm	= 540

5 Nominal Capacity

Nominal Capacity	
Ø 150 mm	5 ÷ 60 litres
Ø 250 mm	30 ÷ 180 litres
Ø 370 mm	100 ÷ 400 litres
Ø 540 mm	200 ÷ 800 litres

6 Piston material

Piston material	
Aluminium	= B
Stainless steel	= X

7 Piston seal material

Piston seal material	
Nitrile rubber (NBR)	= N
Fluorocarbon (FKM)	= V
Teflon (PTFE)	= T
Hydrogenated nitrile	= Y
Poliurethane (HPU)	= P
Hydrogenated nitrile for low temperature	= W

8 Jaket and end caps material

Jaket and end caps material	
Carbon steel	= C
Stainless steel	= Z
Nickel coated carbon steel thk. 35 microns	= K

9 End caps seal material

End caps seal material	
Nitrile rubber (NBR)	= M
Fluorocarbon (FKM)	= U
Hydrogenated nitrile for low temperature	= O

10 Gas side port

Gas side port
See Table 1 - pag. 22

11 Fluid side port

Fluid side port
See Table 2 - pag. 23

12 Precharge pressure (bar)

Precharge pressure (bar)
Range value 20 ÷ 200 (Standar 20 bar)

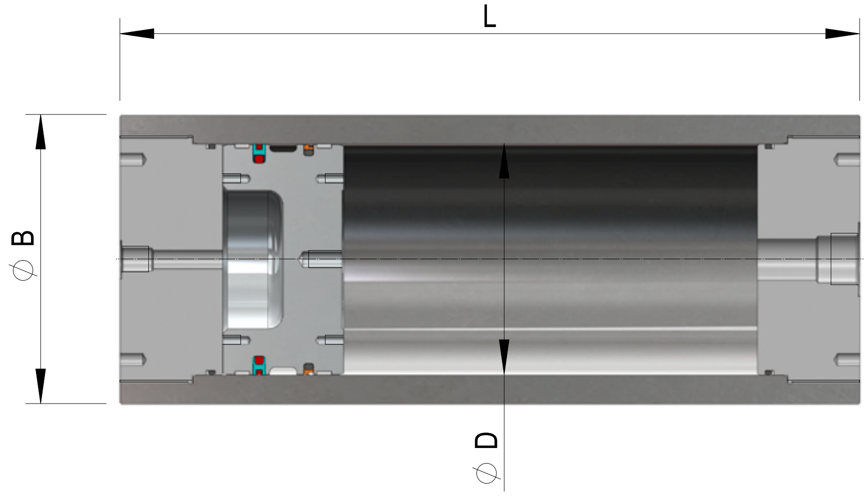
13 Accessories

Accessories
See Table 3 - pag. 24

14 Test and certification

Test and certification	
USA Standard	=
Canada	= C
Malaysia Dosh	= D

ASME Series FPA-A 150



ASME Series FPA-A-L-150-***/*

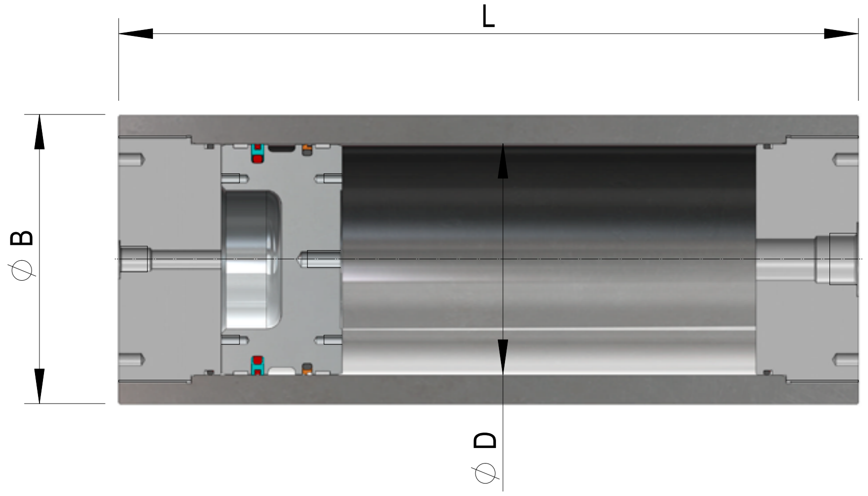
Piston diameter	Fluid volume	Max pressure	External diameter	Length	Weight approx.	Model code
D			B	L		
mm	*litres*	*bar*	*mm*	*mm*	*kg*	
150	5	210	188	485	59	FPA-A-L-150-5/*
	10			770	82	FPA-A-L-150-10/*
	20			1335	126	FPA-A-L-150-20/*
	30			1900	171	FPA-A-L-150-30/*
	40			2465	216	FPA-A-L-150-40/*
	50			3030	261	FPA-A-L-150-50/*
	60			3600	306	FPA-A-L-150-60/*

ASME Series FPA-A-H-150-***/*

Piston diameter	Fluid volume	Max pressure	External diameter	Length	Weight approx.	Model code
D			B	L		
mm	*litres*	*bar*	*mm*	*mm*	*kg*	
150	5	350	212	525	99	FPA-A-H-150-5/*
	10			810	138	FPA-A-H-150-10/*
	20			1375	216	FPA-A-H-150-20/*
	30			1940	295	FPA-A-H-150-30/*
	40			2505	373	FPA-A-H-150-40/*
	50			3070	451	FPA-A-H-150-50/*
	60			3640	530	FPA-A-H-150-60/*

Note: *Accumulators with volumes different from the ones shown in tables may be manufactured upon request.*
In the event of an order, a binding drawing will be issued for approval for non-standard products.

ASME Series FPA-A 250



ASME Series FPA-A-L-250-***/*

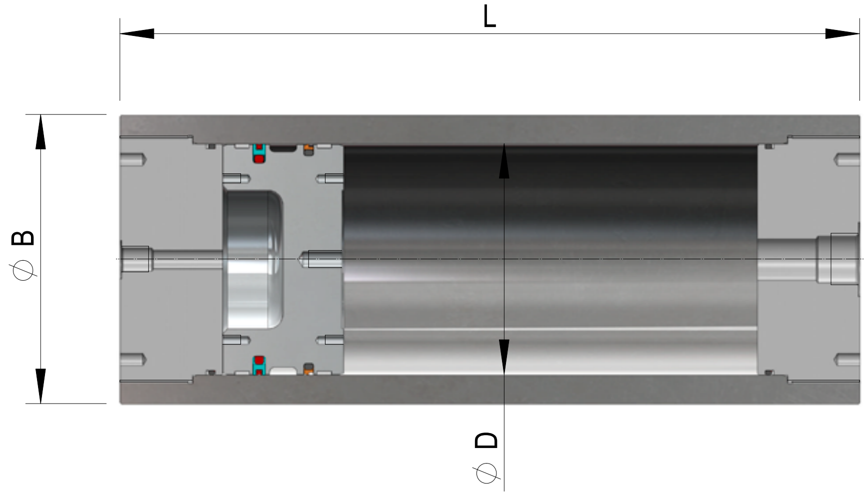
Piston diameter	Fluid volume	Max pressure	External diameter	Length	Weight approx.	Model code
D			B	L		
mm	*litres*	*bar*	*mm*	*mm*	*kg*	
250	30	210	318	980	331	FPA-A-L-250-30/*
	50			1385	428	FPA-A-L-250-50/*
	80			2000	574	FPA-A-L-250-80/*
	100			2405	671	FPA-A-L-250-100/*
	120			2815	768	FPA-A-L-250-120/*
	150			3425	913	FPA-A-L-250-150/*
	180			4035	1059	FPA-A-L-250-180/*

ASME Series FPA-A-H-250-***/*

Piston diameter	Fluid volume	Max pressure	External diameter	Length	Weight approx.	Model code
D			B	L		
mm	*litres*	*bar*	*mm*	*mm*	*kg*	
250	30	350	342	1025	458	FPA-A-H-250-30/*
	50			1430	595	FPA-A-H-250-50/*
	80			2040	800	FPA-A-H-250-80/*
	100			2450	937	FPA-A-H-250-100/*
	120			2855	1074	FPA-A-H-250-120/*
	150			3470	1279	FPA-A-H-250-150/*
	180			4080	1485	FPA-A-H-250-180/*

Note: *Accumulators with volumes different from the ones shown in tables may be manufactured upon request.*
In the event of an order, a binding drawing will be issued for approval for non-standard products.

ASME Series FPA-A 370



ASME Series FPA-A-L-370-***/*

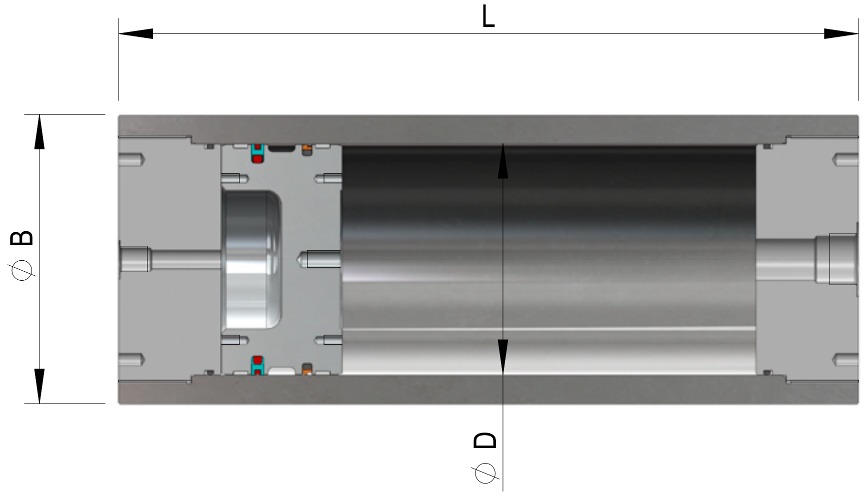
Piston diameter	Fluid volume	Max pressure	External diameter	Length	Weight approx.	Model code
D			B	L		
mm	*litres*	*bar*	*mm*	*mm*	*kg*	
370	100	210	450	1430	874	FPA-E-L-370-100/*
	150			1895	1062	FPA-E-L-370-150/*
	200			2360	1250	FPA-E-L-370-200/*
	250			2825	1438	FPA-E-L-370-250/*
	300			3290	1626	FPA-E-L-370-300/*
	350			3755	1814	FPA-E-L-370-350/*
	400			4220	2003	FPA-E-L-370-400/*

ASME Series FPA-A-H-370-***/*

Piston diameter	Fluid volume	Max pressure	External diameter	Length	Weight approx.	Model code
D			B	L		
mm	*litres*	*bar*	*mm*	*mm*	*kg*	
370	100	350	510	1515	1515	FPA-A-H-370-100/*
	150			1980	1868	FPA-A-H-370-150/*
	200			2445	2222	FPA-A-H-370-200/*
	250			2910	2575	FPA-A-H-370-250/*
	300			3375	2928	FPA-A-H-370-300/*
	350			3840	3281	FPA-A-H-370-350/*
	400			4305	3635	FPA-A-H-370-400/*

Note: *Accumulators with volumes different from the ones shown in tables may be manufactured upon request.*
In the event of an order, a binding drawing will be issued for approval for non-standard products.

ASME Series FPA-A 540



ASME Series FPA-A-L-540-***/*

Piston diameter	Fluid volume	Max pressure	External diameter	Length	Weight approx.	Model code
D			B	L		
mm	*litres*	*bar*	*mm*	*mm*	*kg*	
540	200	210	650	1560	2144	FPA-E-L-540-200/*
	300			1995	2497	FPA-E-L-540-300/*
	400			2435	2850	FPA-E-L-540-400/*
	500			2870	3202	FPA-E-L-540-500/*
	600			3305	3555	FPA-E-L-540-600/*
	700			3745	3907	FPA-E-L-540-700/*
	800			4180	4259	FPA-E-L-540-800/*

ASME Series FPA-A-H-540-***/*

Piston diameter	Fluid volume	Max pressure	External diameter	Length	Weight approx.	Model code
D			B	L		
mm	*litres*	*bar*	*mm*	*mm*	*kg*	
540	200	350	745	1665	3780	FPA-A-H-540-200/*
	300			2100	4489	FPA-A-H-540-300/*
	400			2540	5198	FPA-A-H-540-400/*
	500			2975	5908	FPA-A-H-540-500/*
	600			3410	6617	FPA-A-H-540-600/*
	700			3850	7326	FPA-A-H-540-700/*
	800			4285	8035	FPA-A-H-540-800/*

Note: *Accumulators with volumes different from the ones shown in tables may be manufactured upon request.*
In the event of an order, a binding drawing will be issued for approval for non-standard products.

Gas side port

Table 1 - **Gas side port**

Type of connection	Size	Code
SAE port UN	#5 _ 1/2"-20	G0
	#6 _ 9/16"-18	G1
	#8 _ 3/4"-16	G2
	#10 7/8"-14	G3
	#12 _ 1 1/16"-12	G4
	#14 _ 1 3/16"-12	G5
	#16 _ 1 5/16"-12	G6
	#20 _ 1 5/8"-12	G7
	#24 _ 1 7/8"-12	G8
	#32 _ 2 1/2"-12	G9
SAE flange ISO 6162-1 3000 psi	1/2"	G20
	3/4"	G21
	1"	G22
	1" 1/4	G23
	1"1/2	G24
	2"	G25
	2"1/2	G26
	3"	G27
SAE flange ISO 6162-2 6000 psi	1/2"	G30
	3/4"	G31
	1"	G32
	1" 1/4	G33
	1"1/2	G34
	2"	G35
	2"1/2	G36
	3"	G37

Type of connection	Size	Code
Thread ISO 228-1	1/8"	G40
	1/4"	G41
	3/8"	G42
	1/2"	G43
	3/4"	G44
	1"	G45
	1" 1/4	G46
	1"1/2	G47
	2"	G48
	2"1/2	G49
	3"	G50
Pre-charge valve	5/8" UNF	G60
	5/8"UNF Inox	G61
	M28x1,5	G62
	7/8" UNF	G63
CETOP 250	1/2"	G70
	3/4"	G71
	1"	G72
	1" 1/4	G73
	1"1/2	G74
	2"	G75
	2"1/2	G76
	3"	G77
	3" 1/2	G78
	4"	G79

Customized port (customer drawing)	G200

Fluid side port

Table 2 **- Fluid side port**

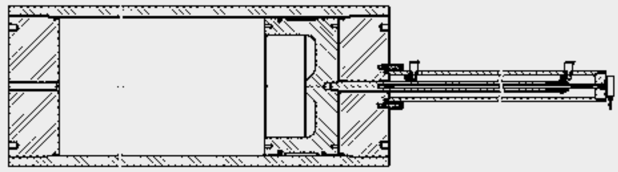
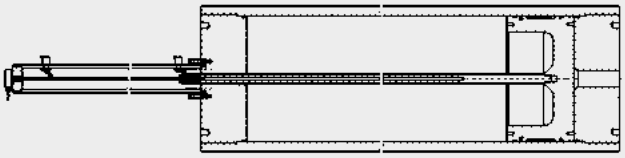
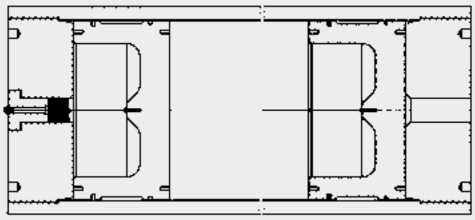
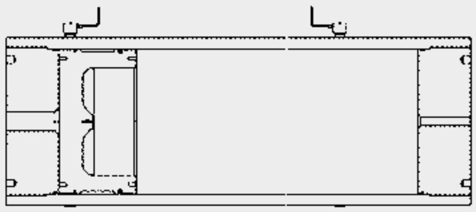
Type of connection	Size	Code
SAE port UN	#5 _ 1/2"-20	F0
	#6 _ 9/16"-18	F1
	#8 _ 3/4"-16	F2
	#10 7/8"-14	F3
	#12 _ 1 1/16"-12	F4
	#14 _ 1 3/16"-12	F5
	#16 _ 1 5/16"-12	F6
	#20 _ 1 5/8"-12	F7
	#24 _ 1 7/8"-12	F8
	#32 _ 2 1/2"-12	F9
SAE flange ISO 6162-1 3000 psi	1/2”	F20
	3/4”	F21
	1”	F22
	1” 1/4	F23
	1”1/2	F24
	2”	F25
	2”1/2	F26
	3”	F27
SAE flange ISO 6162-2 6000 psi	1/2”	F30
	3/4”	F31
	1”	F32
	1” 1/4	F33
	1”1/2	F34
	2”	F35
	2”1/2	F36
	3”	F37

Type of connection	Size	Code
Thread ISO 228-1	1/8”	F40
	1/4”	F41
	3/8”	F42
	1/2”	F43
	3/4”	F44
	1”	F45
	1” 1/4	F46
	1”1/2	F47
	2”	F48
	2”1/2	F49
	3”	F50
CETOP 250	1/2”	F70
	3/4”	F71
	1”	F72
	1” 1/4	F73
	1”1/2	F74
	2”	F75
	2”1/2	F76
	3”	F77
	3" 1/2	F78
	4"	F79

Customized port (customer drawing)	F200

Accessories

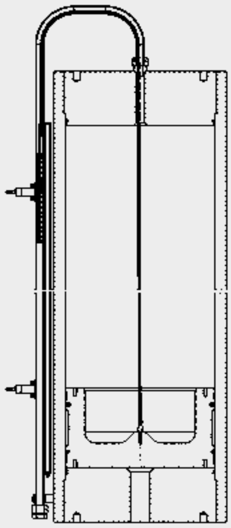
Table 3 **- Accessories**

Protruding rod fluid side	Code	
Mechanical switches (qty 2)	S0	
Position transducer	S1	
Position transducer and mechanical switches (qty 2)	S2	
Protruding rod gas side	**Code**	
Mechanical switches (qty 2)	S10	
Position transducer	S11	
Position transducer and mechanical switches (qty 2)	S12	
Wire tension measurement system	**Code**	
	S20	
Ultrasonic sensor	**Code**	
	S30	

The drawing is only for reference; the technical solution adopted could be different from the one shown in Table depending also on customer's requirements.

Accessories

Table 4 **- Accessories**

External stainless steel pipe gas side	Code	
Magnetic switches (qty 2)	S40	
Magnetic flag	S41	
Position transducer	S42	
Position transducer and magnetic flag	S43	
Position transducer and magnetic flag and switches (qty 2)	S44	
Magnetic flag and switch	S45	
Customer requirements	S200	
None	SS	

The drawing is only for reference; the technical solution adopted could be different from the one shown in Table depending also on customer's requirements.

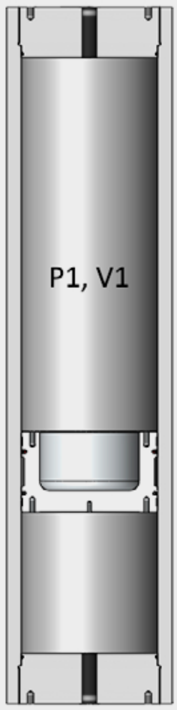
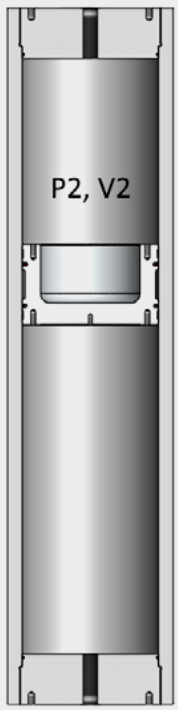
Accumulator calculation form

Able accumulator is a device containing both fluid and gas.

As at the usual working pressures the fluid can be considered non-compressible the behaviour of the accumulator is mainly determined by the transformations occurring to the gas.

Hereafter are shown three different limit conditions.

Table 5 **- Accumulator working conditions**

Pre-charge condition	Minimum working system pressure	Maximum working system pressure
		
P0 [bar] = nitrogen pre-charge pressure measured with no oil in accumulator and with a temperature of 20±2°C	**P1** [bar] = minimum working pressure of the hydraulic system; it must be higher than P0	**P2** [bar] = maximum working pressure of the hydraulic system; it must be higher than P1
V0 [liter] = maximum volume of gas	**V1** [liter] = volume of gas under P1 pressure	**V2** [liter] = volume of gas under P2 pressure

The simplest approach to study the accumulator is to consider the gas he contains as an ideal gas and hence the equation describing its change of state (a transformation involving at least two of the following variables: pressure, volume and temperature) is:

$$P_0 * V_0^n = P_1 * V_1^n = P_2 * V_2^n = const.$$

When the charging and discharging of the accumulator is very slow it could be assumed that the transformation allows a full thermal exchange with the environment and the temperature of gas remains unchanged. It is possible to refers to these transformations as “Isothermal change of state”. The corresponding exponent is:

n = 1 and the equation become: $P_0 * V_0 = P_1 * V_1 = P_2 * V_2 = const.$

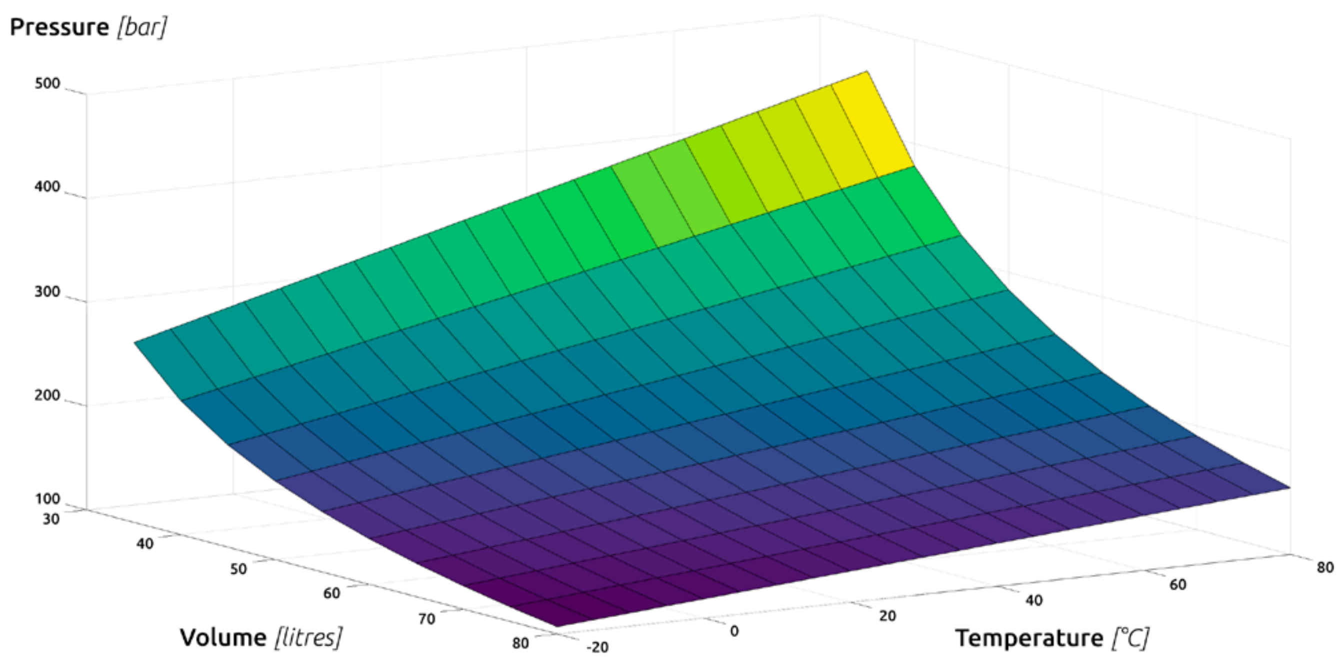
On the other hand, when the charging and discharging of the accumulator is very fast it could be assumed that no heat exchange occurs with the environment. It is possible to refers to these transformations as “Adiabatic change of state”. The corresponding exponent, measured at 0°C and 1 bar and considering the 2-atoms nature of nitrogen, is:

n = 1,4 and the equation become: $P_0 * V_0^{1,4} = P_1 * V_1^{1,4} = P_2 * V_2^{1,4} = const.$

Among the isothermal and adiabatic changes of state there are infinite transformations characterized by different amount of work and heat exchanges with the environment. It is possible to refers to these transformation as “Politropic change of state”. The corresponding exponent lays between the adiabatic one and the isothermal one.

Unfortunately the behaviour of the gas cannot be described accurately with the above mentioned equations especially at low temperature and at high pressure as the “real gas” is much more complex.

So other equations have been developed to better approximate the “real gas”. Per example the Benedict-Webb-Rubin equation (BWR EOS) relates pressure, volume and temperature with a polynomial formula involving several experimental parameters specific for the nitrogen. By mean of this equation each combination of possible pressure, volume and temperature value can be estimated to obtain a surface describing the gas state.



Another possibility is to use the equations for ideal gas and to introduce correctional factors.
Referring to Table 5 it is possible to set:

$$\Delta P = P_2 - P_1 \qquad \Delta V = V_1 - V_2 \qquad V_1 = \frac{K_{i,a} * \Delta V * P_2}{\Delta P} \qquad V_0 = \frac{V_1 * P_1}{P_0} \qquad V_2 = V_1 - \Delta V$$

For the isothermal transformations the coefficient K_i should be read in the following table.

Table 6 - **Isothermal corrective factor K_i**

$\Delta P / P_2$	P_2						
	100	**150**	**200**	**250**	**300**	**350**	**400**
0,1	1,00000	1,04000	1,10000	1,18000	1,28000	1,40000	1,52000
0,15	0,99875	1,03750	1,09125	1,16250	1,25875	1,37000	1,48125
0,2	0,99750	1,03500	1,08250	1,14500	1,23750	1,34000	1,44250
0,25	0,99625	1,03250	1,07375	1,12750	1,21625	1,31000	1,40375
0,3	0,99500	1,03000	1,06500	1,11000	1,19500	1,28000	1,36500
0,35	0,99375	1,02750	1,05625	1,09250	1,17375	1,25000	1,32625
0,4	0,99250	1,02500	1,04750	1,07500	1,15250	1,22000	1,28750
0,45	0,99125	1,02250	1,03875	1,05750	1,13125	1,19000	1,24875
0,5	0,99000	1,02000	1,03000	1,04000	1,11000	1,16000	1,21000

For the adiabatic transformations the coefficient K_a should be read in the following table.

Table 7 - **Adiabatic corrective factor K_a**

$\Delta P / P_2$	P_2						
	100	**150**	**200**	**250**	**300**	**350**	**400**
0,1	1,43000	1,50000	1,59000	1,69000	1,86000	2,02000	2,17000
0,15	1,41500	1,48000	1,56250	1,65875	1,81625	1,96500	2,10875
0,2	1,40000	1,46000	1,53500	1,62750	1,77250	1,91000	2,04750
0,25	1,38500	1,44000	1,50750	1,59625	1,72875	1,85500	1,98625
0,3	1,37000	1,42000	1,48000	1,56500	1,68500	1,80000	1,92500
0,35	1,35500	1,40000	1,45250	1,53375	1,64125	1,74500	1,86375
0,4	1,34000	1,38000	1,42500	1,50250	1,59750	1,69000	1,80250
0,45	1,32500	1,36000	1,39750	1,47125	1,55375	1,63500	1,74125
0,5	1,31000	1,34000	1,37000	1,44000	1,51000	1,58000	1,68000

PISTON ACCUMULATORS

The boost you need
for your system

ABLE
ACCUMULATORS

ABLE
ACCUMULATORS