ENERPAC®

POWERFUL SOLUTIONS. GLOBAL FORCE.

WORKHOLDING

US

E215

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Yellow Pages

Refer to the "Yellow Pages" of this catalog for:

- Safety instructions
- Basic hydraulic information
- Advanced hydraulic technology
- FMS (Flexible Machining Systems) technology
- Conversion charts and hydraulic symbols

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All information in this catalog can be changed due to product improvements without prior notice.

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The World Class Brand

A complete range of quality Workholding products for all production applications, with local availability and after sale service anywhere in the world….this is what makes Enerpac a global leader in hydraulic Workholding.

Across every continent, Enerpac's network of authorized distributors and service centers provide sales and support of products designed to enhance productivity and performance, while making the work place safer.

With over 150 sales specialists and a network of service and engineering support in 17 countries across the globe, Enerpac is a valuable partner for customers involved in production manufacturing using hydraulic clamping components and those who support them with custom tooling.

Always at the leading edge of technology, Enerpac continues to develop its range of time and cost saving products, utilizing modern engineered materials to improve productivity and minimize operator fatigue.

Enerpac's commitment to the continued development of quality hydraulic Workholding products ensures that the products you purchase are the best in the industry. We will continue to lead the way in the development of quality hydraulic Workholding products for industrial production applications.

Enerpac Workholding Value Proposition

- Expert Design
- Highly Reliable
- Service Excellence
- Worldwide Experience
- Application Support
- Availability
- Quality
- Value
- Innovative Products
- Systems Solutions

Total Quality

Our products are tested to the most exacting standards. These high standards guarantee the quality, price and performance requirements of the markets we serve around the globe.

Global Network

Enerpac has an extensive network of authorized distributors and service centers located in more than 90 countries worldwide. You can rely on Enerpac for the products and technical support you need to get your job done, anywhere in the world.

Logistics Excellence

Enerpac's mission is to maintain service excellence in the ever-changing world of modern distribution. Providing our extensive range of products to our thousands of distributors worldwide demands a logistic expertise only a market leader can provide.

A Tradition of Innovation

Enerpac has a long history of finding new solutions to better meet the challenges of the industries we serve. We were the first to develop a swing clamp with an internal rotation system. Our Collet-Lok® clamping products have provided our customers with both automation and security by combining hydraulic clamping actuation with an internal lock to mechanically retain the clamping force. The ZW-Class series of electric pumps are designed to run cool, be more energy efficient and easy to configure to your application. Our Auto-coupler connection system provides an automated connection to the fixture, perfect for robotic loaded applications. To support our production machining customers, Enerpac continues to identify new solutions for your most challenging applications.

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A Guide to Your New Enerpac Workholding Catalog

The New Enerpac Workholding catalog;

... helps you design more efficient workholding fixtures,

... is a global resource of workholding solutions.

This catalog is set-up in two main sections:

1 **Imperial hydraulic product data section**
All Enerpac hydraulic workholding products shown with imperial based specifications and dimensions.

2 **Yellow Pages section**
Your guide to safety, basic hydraulics and application suggestions.

Selecting the right product for your application:

1. Select your main product category from the *main index* on page 3. This index shows page numbers of product offerings in the catalog.
2. From here you go to the selected product *range overview*. For an example see pages 20 and 21 for the swing cylinders and work supports overview. On this page you will find the main groups with regard to functional and mounting style options.
3. Proceed to pages 22 and 23 to narrow down your selection with regard to function, mounting style and clamping capacity. These application & selection pages offer a brief overview of an entire range of products within one group. Note that these pages have *yellow* columns on both sides of the spread.
4. Once you have made your product selection you can proceed to the product data pages, 24 and onwards, of the specific product series of your choice. These pages have *gray* columns on both sides of the spread.

Range overview

Application & selection pages

1 Product or range photo including basic description of the products function.

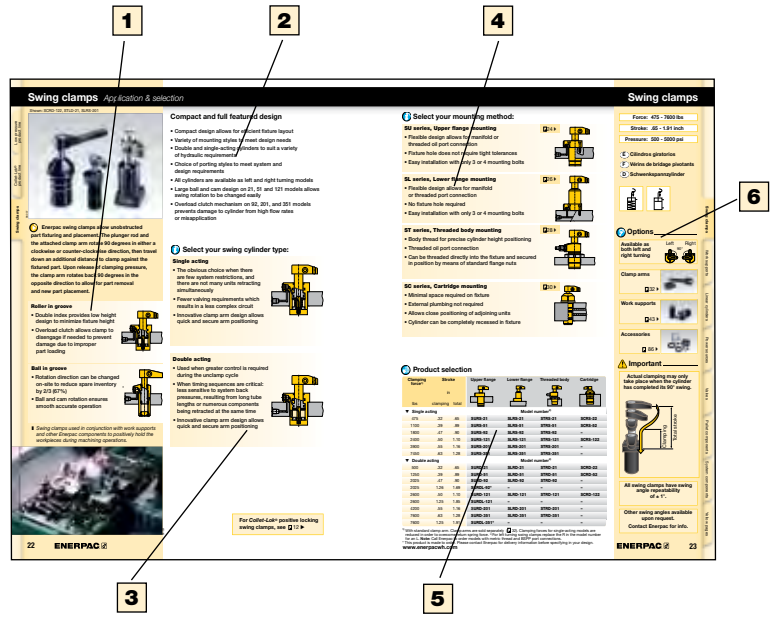
2 Listing of main product features and benefits.

3 Selection criteria from a functional standpoint.

4 Selection criteria from a mounting standpoint.

5 Main selection chart, showing product function, mounting option and capacity.

6 Product related options and accessories.



Product data pages

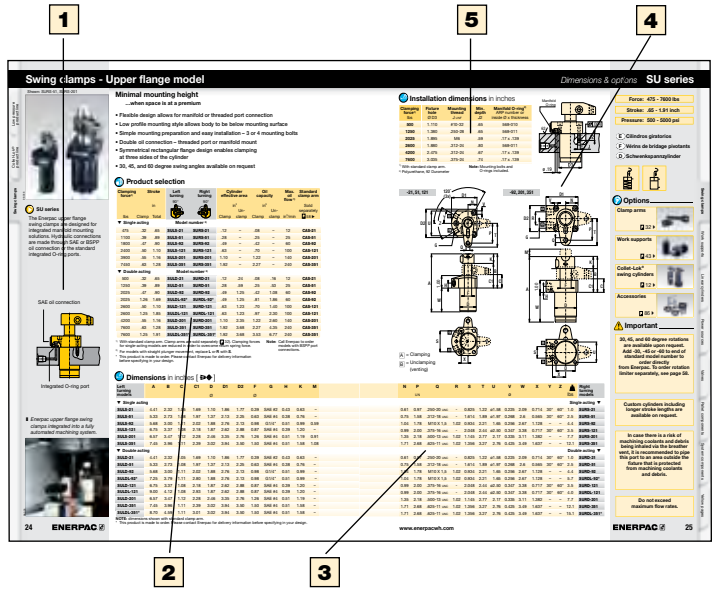
1 Application schematic including real life application example.

2 Product selection.

3 Detailed dimensional data.

4 Product dimensional drawings.

5 Installation specifications.



ENERPAC

Collet-Lok®

Enerpac Collet-Lok® products combine the automation of hydraulic actuation with the security of an internal locking mechanism. After actuation and locking, these products maintain their clamping or supporting capacity without maintaining hydraulic pressure in the circuit. Available in Swing, Push, and Work Supports models, Enerpac Collet-Lok® products are also available in numerous special configurations and modifications.

Swing Clamps

Enerpac Collet-Lok® Swing Clamps combine the rotational actuation and clamping force of a hydraulic Swing Clamp with an internal locking mechanism that maintains the applied clamping force without holding hydraulic pressure in the clamp. Ideal for use in large-scale fixtures, they are available in 1000-, 2000-, and 8500 lb. models. Standard models are available in either Threaded Body or Lower Flange configurations. Available modifications include flange top manifold porting, longer strokes, non-rotational versions and special design bodies. Viton seals are standard.

Work Supports

Enerpac Collet-Lok® Work Supports use internal spring force to lift the support rod into contact with the work piece and then maintain the support with an internal locking system. Cataloged in 2000-, 4500-, and 10,000 lb. capacities, these products are available in Threaded Body (2000 and 4,000 lb. only) and Lower Flange models (2000, 4,000, and 10,000). Available modifications include longer strokes, flange top manifold porting, and special design bodies. Viton seals are standard.

Push Cylinders

Enerpac Collet-Lok® Push Cylinders are designed for either clamping or supporting applications. The clamping or supporting force is maintained once the internal lock is engaged. Available in either 2500 or 5000 lb. capacities, these cylinders are available in both Threaded Body or Lower Flange models. Available modifications include flange top manifold porting, longer strokes, and special design bodies. Viton seals are standard.

Technical support

Refer to the "Yellow Pages" of this catalog for:

- Safety instructions
- Basic hydraulic information
- Advanced hydraulic technology
- FMS (Flexible Machining Systems) technology
- Conversion charts and hydraulic symbols

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Products

	▼ series	▼ page	
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Collet-Lok® Swing clamps	WPFL, WPTL	12-15	
Collet-Lok® Work supports	WPFS, WPTS	16-17	
Collet-Lok® Push cylinders	WPFC, WPTC	18-19	

Shown: WPTR-100V and WPFR-100V

98-037

Enerpac Collet-Lok® cylinders are designed to mechanically hold the workpiece after hydraulic pressure is removed. Clamping capacities range from 1000 lbs. to 8500 lbs.

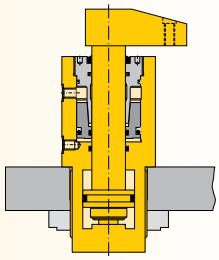
Hydraulic actuation with mechanical lock

- *Collet-Lok®* technology combines hydraulic actuation for clamping or supporting with an internal locking collet
- Clamp bodies are available in either threaded mount or flange mount
- Flange mount units feature both tubing ports and bottom manifold ports
- Flange top manifold ports available as a special
- VITON seals are standard

Collet-Lok® Designs:

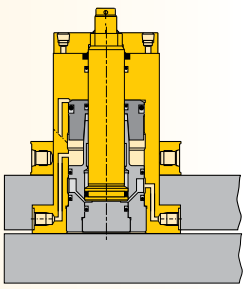
Collet-Lok® Swing Clamps

- Available in 1000-, 2000-, and 8500 lb. models
- Available in Right Hand or Left Hand Swing and Straight (guided) models



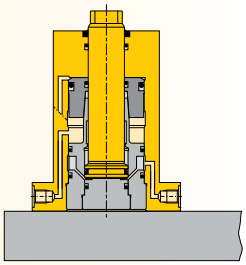
Collet-Lok® Work Supports

- Available in 2,000-, 4,000- and 10,000 lb. models
- Spring advance design to maintain contact with the work piece



Collet-Lok® Push Cylinders

- Available in 2,500- and 5,000 lb. models
- Designed for Push only
- Can be used as a heavy-duty Work Support

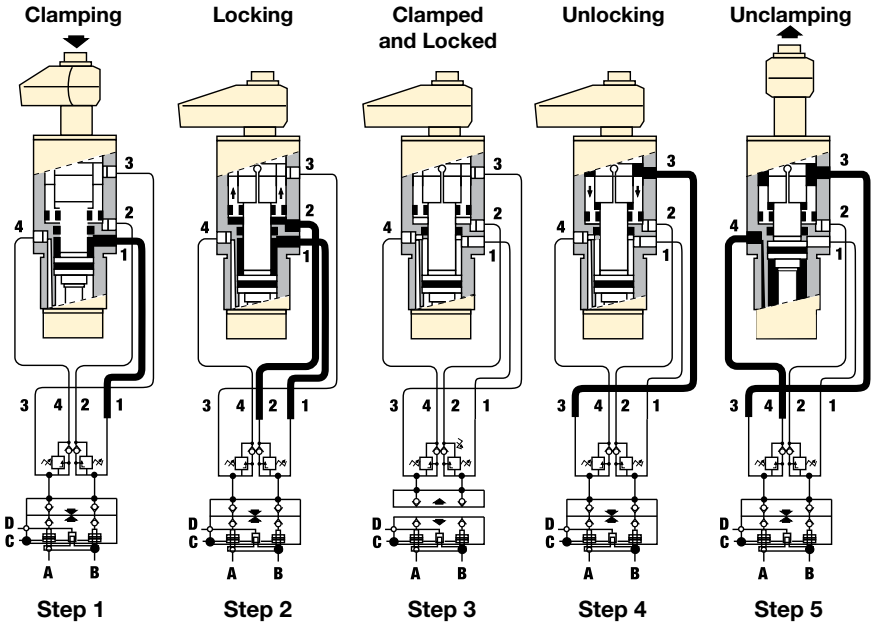


MPTL-100 and MPTR-100 Collet-Lok® Swing Clamps are used to securely clamp these exhaust manifolds.

Why use Collet-Lok®?

Collet-Lok® technology from Enerpac combines hydraulic actuation with mechanical locking to provide the automation and control of hydraulics and the long term security of a mechanical lock. Available in Swing Clamps, Push Cylinders and Work Supports, *Collet-Lok®* is a unique solution that is well suited to today's demanding manufacturing environment.

Collet-Lok® Clamping and Unclamping Cycle



WPTR-100 Collet-Lok® swing cylinder

1 = 90˚ Rotation + Clamp
2 = Lock
3 = Unlock
4 = Unclamp + 90˚ Rotation

WCA-62, WPA-62 Auto coupler

A = Pressure line from pump to swing cylinder
B = Pressure line from pump to swing cylinder
C = Auto coupler advance
D = Auto coupler retract

How Does Collet-Lok® Work?

The ports on Collet products are conveniently labeled in the order that they are used during a clamping or unclamping cycle.

The typical *Collet-Lok®* circuit pairs the Clamp circuits with the Lock circuits by using a sequence valve to delay the Lock function until the clamping pressure is almost reached. When unclamping, the Unlock and Unclamp circuits are also paired with a sequence valve so the Lock is released before the clamp extends to Unclamp. An alternate approach to controlling these circuits is to use a PLC to operate individual valves for the Clamp/Unclamp and Lock/Unlock functions.

Because *Collet-Lok®* provides a mechanical lock to hold the clamping force onto the work piece, support components used in standard hydraulic clamping circuits such as pilot operated check valves and accumulators are not needed. In typical applications, the hydraulic circuit in a fixture with *Collet-Lok®* clamps is de-pressurized after the clamping cycle is completed. This allows for complete security during the machining cycle, or if the work pieces are pre-clamped and staged in a pallet pool for extended periods of time.

Force:	1000 - 8500 lbs
Stroke:	.94 - 1.65 inch
Pressure:	1400 - 5000 psi

Collet-Lok® Sequence:

Step 1
2-passage Auto coupler connects external power source with pallet receiver and the Collet-Lok® cylinder is activated for hydraulic clamping.

Step 2
After reaching maximum clamping pressure the sequence valve is opened and actuates the internal wedge hydraulically.

Step 3
The wedge system secures the plunger position mechanically and the hydraulic pressure is taken off, then the auto coupler retracts. The work piece on the pallet is now securely clamped, without being connected to a power source.

Step 4
After being in the machine the pallet returns to the loading and unloading position and the auto coupler is connected again to release the wedge.

Step 5
The hydraulic plunger is now retracted and the pallet is free for unloading and loading.

Options

***Collet-Lok®* swing clamps**
8

Collet-Lok® work supports
16

Collet-Lok® push clamps
18

Swing cylinders - *Collet-Lok®* design

Shown: WPTR-100V, WPFR-100V

98-042

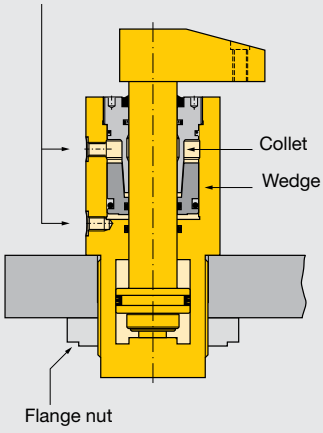
Ideal when live hydraulics are not available

- Double acting Collet-Lok® action allows fully automated operation
- Additional level of safety since live hydraulics are not required to maintain clamping force
- Collet-Lok® swing cylinders can be mounted by the flange or threaded into the fixture. Flanged models have manifold ports and tubing ports.
- Viton seals are standard

WP series

Enerpac Collet-Lok® cylinders are designed to mechanically hold the workpiece after hydraulic pressure is removed. Clamping capacities range from 1000 lbs. to 8500 lbs.

SAE oil connection



Hydraulic pressure pushes the collet up a wedge, locking the plunger in the clamping position.

Selection chart

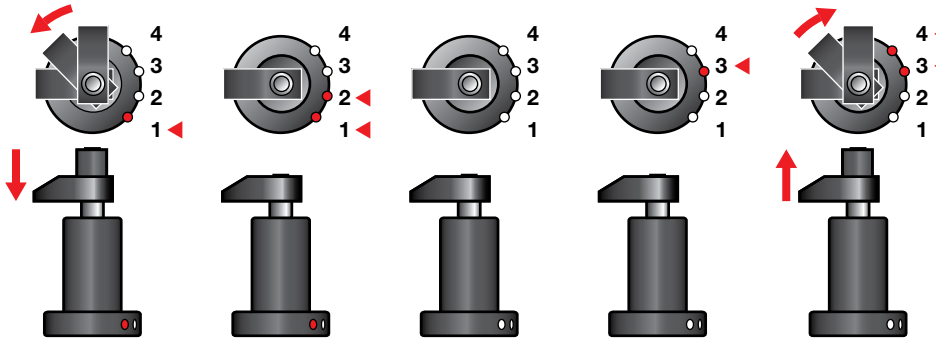
Clamping force[1] lbs	Stroke in Clamp	Stroke in Total	Left turning	Right turning	Cylinder effective area in² Clamp	Cylinder effective area in² Un-clamp	Oil capacity in³ Clamp	Oil capacity in³ Un-clamp	Max. oil flow[1] in³/min	Standard clamp arm Sold separately
▼ Lower flange			Model number							
1000	.32	.95	WPFL-50V	WPFR-50V	.25	.71	.24	.67	122	CA-540
2000	.47	1.11	WPFL-100V	WPFR-100V	.50	1.11	.55	1.22	305	CA-1050
8500	.39	1.65	WPFL-300V*	WPFR-300V*	2.05	3.45	3.40	5.70	600	CA-3070
▼ Threaded body			Model number							
2000	.47	1.11	WPTL-100V	WPTR-100V	.50	1.11	.55	1.22	305	CA-1050
8500	.39	1.65	WPTL-300V*	WPTR-300V*	2.05	3.45	3.40	5.70	600	CA-3070

[1] Using standard clamp arm. Clamp arms are sold separately (14).

Note: - Call Enerpac for models with metric thread and BSPP port connections.
- Minimum working pressure for Collet-Lok® system is 1400 psi.

* This product is made to order. Please contact Enerpac for delivery information before specifying in your design.

Collet-Lok® sequence



Step 1
Pressurize port #1.
Plunger turns 90° and clamps part.

Step 2
Keep port #1 pressurized.
Pressurize port #2.
Plunger will be locked in clamped position.

Step 3
Depressurize port #1 and #2.
Uncouple cylinder from hydraulic power source.
Part will be held in place.

Step 4
Pressurize port #3.
Plunger will be unlocked and the clamp force released.

Step 5
Keep port #3 pressurized.
Pressurize port #4.
Plunger will extend and turn to its original position.

Lower flange Collet-Lok® swing cylinder mounted on a pallet.

98-004

Product dimensions in inches [⌯]

Left turning models*	A	B	C	C1	D Ø	D1 Ø	F Ø	H1	H2	H3
▼ Lower flange										
WPFL-50V	7.92	6.97	6.74	0.98	2.28	3.35	0.75	0.39	0.49	–
WPFL-100V	8.77	7.67	6.48	0.98	2.68	3.94	0.88	0.39	0.49	–
WPFL-300V	12.67	11.02	10.82	0.98	3.53	5.19	1.38	0.43	0.49	–
▼ Threaded body										
WPTL-100V	8.39	7.28	4.78	3.56	1.875-16 UN	2.76	0.88	1.24	2.64	2.97
WPTL-300V	12.22	10.57	6.46	4.53	3.125-16 UN	3.66	1.38	1.5	3.62	3.96

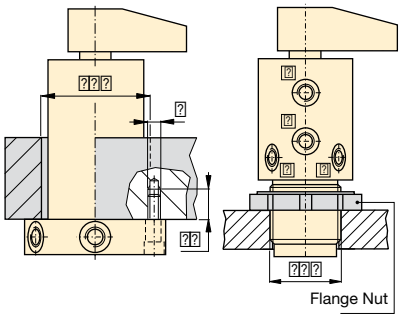
Note: Dimensions shown with standard clamp arm.
* For nonrotational model replace "L" with "N". Example: WPFN-100V

Installation dimensions
in inches

Clamping force[1] lbs	Fixture hole Ø D3	Mounting thread J mm	Minimum depth J2
▼ Lower flange			
1000	2.301 ±.012	M6 x 1,00	.68
2000	2.701 ±.012	M8 x 1,25	.72
8500	3.565 ±.012	M10 x 1,50	.72

Clamping force[1] lbs	Fixture hole Ø D3	Mounting flange Sold separately ⍓ 87 ▶	Mounting nut Sold separately ⍓ 86 ▶
▼ Threaded body			
2000	1.875-16 un	MF-481	FN-481
8500	3.125-16 un	MF-801	FN-801

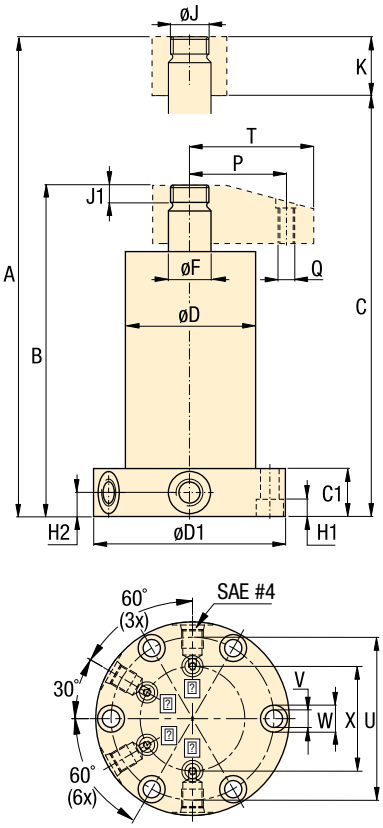
[1] With standard clamp arm.



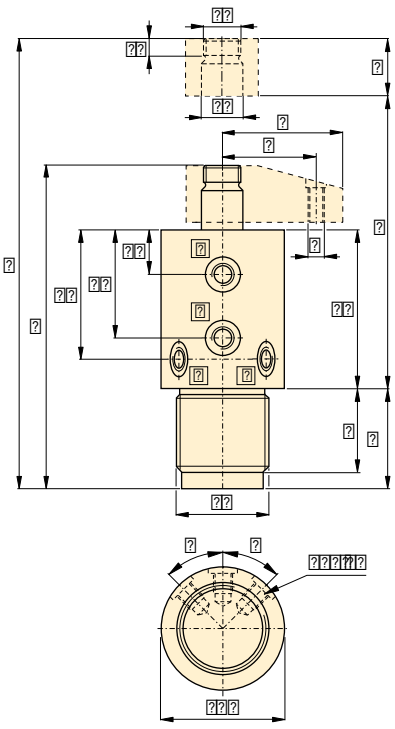
Oil port functions

1 90° Rotation and clamp
2 Locks system
3 Unlocks system
4 Unclamp and 90° rotation

WPF models



WPT models

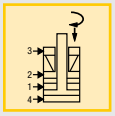


X = 45° WPT-100 models
X = 30° WPT-300 models

J Ø	J1	K	L	P	Q Ø	T	U Ø	V Ø	W	X Ø	lbs	Right turning models
												Lower flange ▼
.625-18 UNF	0.31	1.18	–	1.57	.313-24 UNF	2.13	2.76	0.35	Ø 0.55	1.89	5.1	WPFR-50V *
.750-16 UNF	0.35	1.18	–	1.97	.375-24 UNF	2.52	3.31	0.35	Ø 0.55	2.13	7.7	WPFR-100V*
1.250-12 UNF	0.39	1.85	–	2.76	.625-18 UNF	3.66	4.41	0.43	Ø 0.67	3.78	26.5	WPFR-300V*
												Threaded body ▼
.750-16 UNF	0.35	1.18	1.63	1.97	.375-24 UNF	2.52	–	–	2.44	–	6.6	WPTR-100V*
1.250-12 UNF	0.39	1.85	3.35	2.76	.625-18 UNF	3.66	–	–	3.92	–	24.2	WPTR-300V*

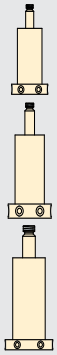
Force: 1000 - 8500 lbs
Stroke: .94 - 1.65 inch
Pressure: 1400 - 5000 psi

E Cilindros giratorios
F Vérins de bridage pivotants
D Schwenkspannzylinder

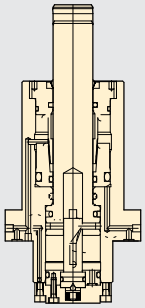


Custom Options Available

Intermediate capacities



Different flange locations



Flexible Machining Systems
See Yellow Pages (⍓ 224)

Options

Clamp arms ⍓ 14 ⊠	
Collet-Lok® work supports ⍓ 16 ⊠	
Sequence valves ⍓ 152 ⊠	
Accessories ⍓ 86 ⊠	

Important

Minimum unlock pressure must be at least 1500 psi above lock pressure.

Push cylinders - *Collet-Lok*® design

Shown: WPTC-110, WPFC-210

Ideal when live hydraulics are not available

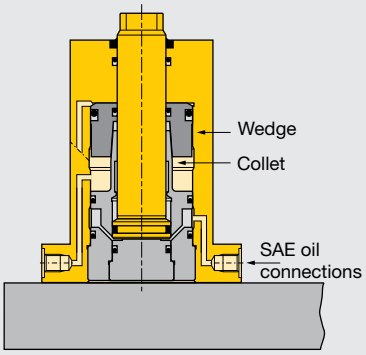
…clamping is sustained mechanically so live hydraulics are not required during the machining cycle

- Double-acting *Collet-Lok*® action allows fully automated operation
- Additional level of safety since live hydraulics are not required
- *Collet-Lok*® push cylinders can either be mounted by the flange, or threaded into the fixture
- The *Collet-Lok*® design is an industry exclusive
- Capacities up to 8800 lbs. available on request

WP series

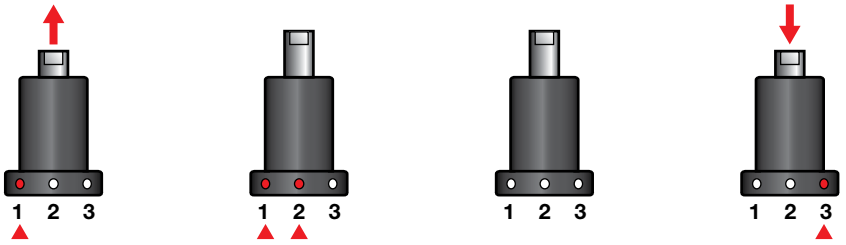
Collet-Lok® positive locking push cylinders are designed to mechanically hold the workpiece after hydraulic pressure is removed.

Push capacities range from 2500 lbs. to 5000 lbs.



Hydraulic pressure pushes the collet up a wedge, locking the plunger in the clamping position.

Collet-Lok® sequence



Step 1

Pressurize port #1. Plunger extends and clamps workpiece.

Step 2

Keep port #1 pressurized. Pressurize port #2. Plunger will be locked in clamped position.

Step 3

Depressurize port #1 and #2. Cylinder should now be uncoupled from hydraulic power source and will maintain the clamped position.

Step 4

Pressurize port #3. Plunger will be unlocked and the plunger will be released to its original position.

Product selection

Max. push force	Hydr. plunger stroke	Lower flange	Threaded body	Operating pressure		Hydraulic effective area	Oil capacity			Max. oil flow
						psi	in²			
lbs	in			min.	max.	adv.	adv.	unlock	retr.	in³/min
		Model number								
2500	.60	WPFC-110V	WPTC-110V	725	5000	.50	.30	.37	.24	600
5000	.60	WPFC-210V	WPTC-210V	725	5000	.99	.61	.61	.37	600

Maximum cycle rate: 8 cycles/min.
Note: Call Enerpac to order models with metric thread and BSPP port connections.
Capacities up to 8800 lbs. available on request.

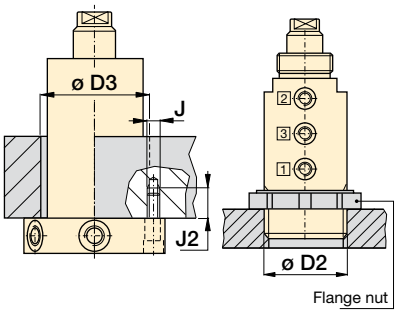
Lower flange Collet-Lok® push cylinder used for positioning a motorcycle frame.

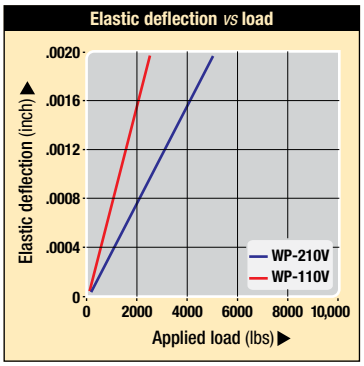
Dimensions in inches [ ]

Model number	A	B	C	C1	D	D1 Ø	D2	E Ø	E1 Ø	F Ø
▼ Lower flange										
WPFC-110V	6.09	5.49	5.16	-	Ø 2.76	3.94	–	0.62	0.59	–
WPFC-210V	6.80	6.20	5.87	-	Ø 3.07	4.33	–	0.87	0.79	–
▼ Threaded body										
WPTC-110V	6.05	5.45	5.12	0.74	2.375-12 UN	2.52	1.500-12 UNF	0.62	0.59	1.81
WPTC-210V	6.76	6.16	5.83	0.71	2.750-16 UN	2.91	1.875-16 UN	0.87	0.79	2.17

Installation dimensions in inches

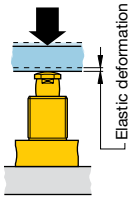
Push force lbs	Fixture hole øD3	Mounting thread J	Minimum depth J2
▼ Lower flange			
2500	2.79	M6	.68
5000	3.10	M8	.72
▼ Threaded body			
2500	2.375-12 UN	–	–
5000	2.750-16 UN	–	–



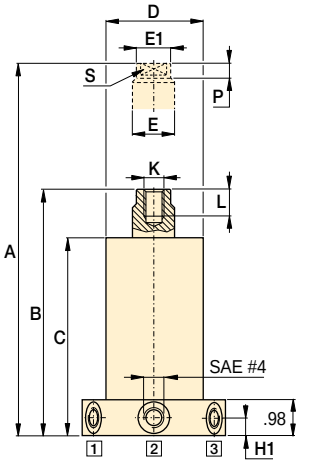


Deflection chart:

Elastic deformation of the plunger resulting from the application of load.



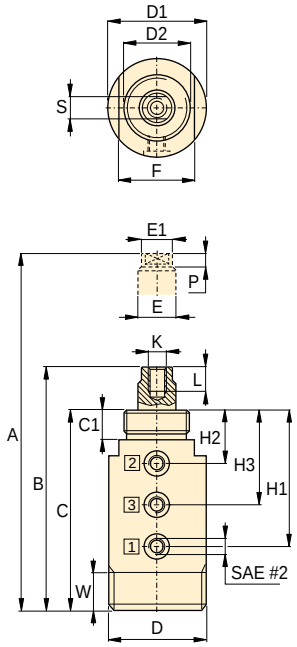
WPFC



Oil port functions

1. Clamp
2. Lock
3. Unlock/Retract

WPTC



H1	H2	H3	K	L Ø	P	S*	U Ø	V	W	X Ø	lbs	Model number
												Lower flange ▼
0.49	–	–	.313-24 UNF	0.59	0.24	Ø .11*	3.31	0.28	–	2.21	8.8	WPFC-110V
0.49	–	–	.375-24 UNF	0.79	0.2	Ø .11*	3.7	0.35	–	2.76	11.0	WPFC-210V
												Threaded body ▼
3.78	1.30	2.56	.313-24 UNF	0.59	0.24	Ø .11*	–	–	0.75	–	6.6	WPTC-110V
4.37	1.26	2.83	.375-24 UNF	0.79	0.20	Ø .11*	-	-	0.79	-	7.5	WPTC-210V

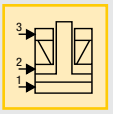
* Spanner holes (x 2)

Push force: 2500-5000 lbs

Stroke: .60 inch

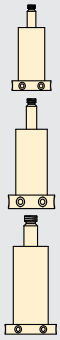
Pressure: 725-5000 psi

- **E** Cilindros de empuje
- **F** Vérins pousseurs
- **D** Gesicherter Druckzylinder

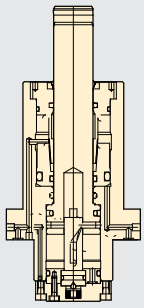


Custom Options Available

Intermediate capacities



Different flange locations



Options

Auto couplers 174 ▶

Sequence valves 152 ▶

Accessories 86 ▶

***Collet-Lok*® swing cylinders** 12 ▶

Important

For proper application, clamp force, pressures and timing, consult Enerpac for support.

Swing Clamps

Swing Clamps

Enerpac's complete line of swing clamps provides maximum clamping force in the smallest possible package. With several mounting and operation styles available, Enerpac can fit any clamping need you can think of. Our unique patented clamp arm design is an industry exclusive, and makes Enerpac's swing cylinder line more versatile than ever before. Made to the highest quality standards, Enerpac swing clamps will provide maximum performance and trouble free operation.

Technical support

Refer to the "Yellow Pages" of this catalog for:

- Safety instructions
- Basic hydraulic information
- Advanced hydraulic technology
- FMS (Flexible Machining Systems) technology
- Conversion charts and hydraulic symbols

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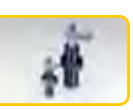
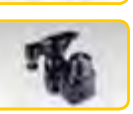
	▼ series	▼ page	
Swing cylinder range overview		**22 - 23**	
Upper flange swing clamps	SU	24 - 25	
Lower flange swing clamps	SL	26 - 27	
Threaded body swing clamps	ST	28 - 29	
Cartridge model swing clamps	SC	30 - 31	
Clamp arms	CA	32 - 33	
Pivoting T-arms	CAC CAPT	34 - 35	
Upreach clamp arms	CAU	36 - 37	
Swing clamps	SC	38	
Swing clamps	ASC	39	
Three-position swing clamps	WTR	40 - 41	

Swing clamps *Application & selection*

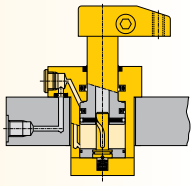
Shown: SCRD-122, STLD-21, SLRS-201

98-037

Enerpac swing clamps allow unobstructed part fixturing and placement. The plunger rod and the attached clamp arm rotate 90 degrees in either a clockwise or counter-clockwise direction, then travel down an additional distance to clamp against the fixtured part. Upon release of clamping pressure, the clamp arm rotates back 90 degrees in the opposite direction to allow for part removal and new part placement.

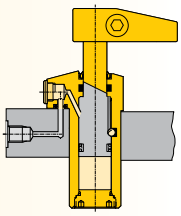
Roller in groove

- Double index provides low height design to minimize fixture height
- Overload clutch allows clamp to disengage if needed to prevent damage due to improper part loading



Ball in groove

- Rotation direction can be changed on-site to reduce spare inventory by 2/3 (67%)
- Ball and cam rotation ensures smooth accurate operation



Swing clamps used in conjunction with work supports and other Enerpac components to positively hold the workpieces during machining operations.

998-001

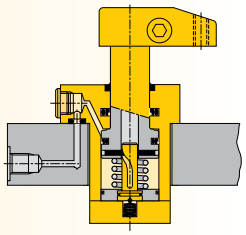
Compact and full featured design

- Compact design allows for efficient fixture layout
- Variety of mounting styles to meet design needs
- Double and single-acting cylinders to suit a variety of hydraulic requirements
- Choice of porting styles to meet system and design requirements
- All cylinders are available as left and right turning models
- Large ball and cam design on 21, 51 and 121 models allows swing rotation to be changed easily
- Overload clutch mechanism on 92, 201, and 351 models prevents damage to cylinder from high flow rates or misapplication

Select your swing cylinder type:

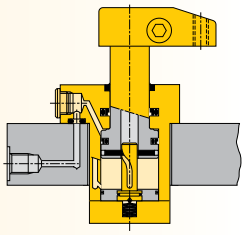
Single acting

- The obvious choice when there are few system restrictions, and there are not many units retracting simultaneously
- Fewer valving requirements which results in a less complex circuit
- Innovative clamp arm design allows quick and secure arm positioning



Double acting

- Used when greater control is required during the unclamp cycle
- When timing sequences are critical: less sensitive to system back pressures, resulting from long tube lengths or numerous components being retracted at the same time
- Innovative clamp arm design allows quick and secure arm positioning

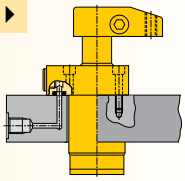


For *Collet-Lok*® positive locking swing clamps, see 12 ▶

Select your mounting method:

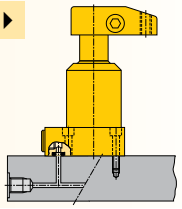
SU series, Upper flange mounting 24

- Flexible design allows for manifold or threaded oil port connection
- Fixture hole does not require tight tolerances
- Easy installation with only 3 or 4 mounting bolts



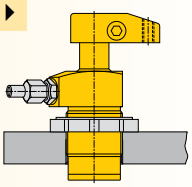
SL series, Lower flange mounting 26

- Flexible design allows for manifold or threaded port connection
- No fixture hole required
- Easy installation with only 3 or 4 mounting bolts



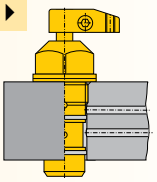
ST series, Threaded body mounting 28

- Body thread for precise cylinder height positioning
- Threaded oil port connection
- Can be threaded directly into the fixture and secured in position by means of standard flange nuts



SC series, Cartridge mounting 30

- Minimal space required on fixture
- External plumbing not required
- Allows close positioning of adjoining units
- Cylinder can be completely recessed in fixture



Product selection

Clamping force[1] lbs	Stroke in clamping	Stroke in total	Upper flange	Lower flange	Threaded body	Cartridge
▼ Single acting			Model number[2]			
475	.32	.65	SURS-21	SLRS-21	STRS-21	SCRS-22
1100	.39	.89	SURS-51	SLRS-51	STRS-51	SCRS-52
1800	.47	.90	SURS-92	SLRS-92	STRS-92	–
2400	.50	1.10	SURS-121	SLRS-121	STRS-121	SCRS-122
3900	.55	1.16	SURS-201	SLRS-201	STRS-201	–
7450	.63	1.28	SURS-351	SLRS-351	STRS-351	–
▼ Double acting			Model number[2]			
500	.32	.65	SURD-21	SLRD-21	STRD-21	SCRD-22
1250	.39	.89	SURD-51	SLRD-51	STRD-51	SCRD-52
2025	.47	.90	SURD-92	SLRD-92	STRD-92	–
2025	1.26	1.69	SURDL-92*	–	–	–
2600	.50	1.10	SURD-121	SLRD-121	STRD-121	SCRD-122
2600	1.25	1.85	SURDL-121	–	–	–
4200	.55	1.16	SURD-201	SLRD-201	STRD-201	–
7600	.63	1.28	SURD-351	SLRD-351	STRD-351	–
7600	1.25	1.91	SURDL-351*	–	–	–

[1] With standard clamp arm. Clamp arms are sold separately (32). Clamping forces for single-acting models are reduced in order to overcome return spring force. [2] For left turning swing clamps replace the R in the model number for an L. **Note:** Call Enerpac to order models with metric thread and BSPP port connections.
* This product is made to order. Please contact Enerpac for delivery information before specifying in your design.

www.enerpacwh.com

Force: 475 - 7600 lbs

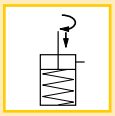
Stroke: .65 - 1.91 inch

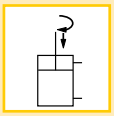
Pressure: 500 - 5000 psi

E Cilindros giratorios

F Vérins de bridage pivotants

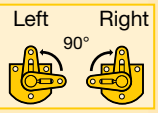
D Schwenkspannzylinder





Options

Available as both left and right turning



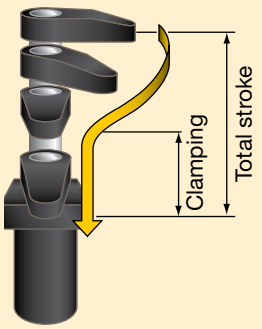
Clamp arms 32

Work supports 43

Accessories 86

Important

Actual clamping may only take place when the cylinder has completed its 90° swing.



All swing clamps have swing angle repeatability of ± 1°.

Other swing angles available upon request.

Contact Enerpac for info.

Swing clamps - Upper flange model

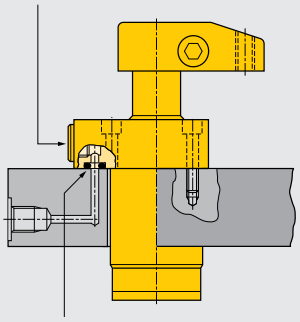
Shown: SURS-51, SURS-201

98-038

SU series

The Enerpac upper flange swing clamps are designed for integrated manifold mounting solutions. Hydraulic connections are made through SAE or BSPP oil connection or the standard integrated O-ring ports.

SAE oil connection



Integrated O-ring port

Enerpac upper flange swing clamps integrated into a fully automated machining system.

98-003

Minimal mounting height

…when space is at a premium

- Flexible design allows for manifold or threaded port connection
- Low profile mounting style allows body to be below mounting surface
- Simple mounting preparation and easy installation – 3 or 4 mounting bolts
- Double oil connection – threaded port or manifold mount
- Symmetrical rectangular flange design enables clamping at three sides of the cylinder
- 30, 45, and 60 degree swing angles available on request

Product selection

Clamping force[1]	Stroke		Left turning 90°	Right turning 90°	Cylinder effective area in²		Oil capacity in³		Max. oil flow[1]	Standard clamp arm
lbs	Clamp	Total			Clamp	Un-clamp	Clamp	Un-clamp	in³/min	Sold separately 32 ▶
▼ Single acting			Model number[2]							
475	.32	.65	SULS-21	SURS-21	.12	–	.08	–	12	CAS-21
1100	.39	.89	SULS-51	SURS-51	.28	–	.25	–	25	CAS-51
1800	.47	.90	SULS-92	SURS-92	.49	–	.42	–	60	CAS-92
2400	.50	1.10	SULS-121	SURS-121	.63	–	.70	–	100	CAS-121
3900	.55	1.16	SULS-201	SURS-201	1.10	–	1.22	–	140	CAS-201
7450	.63	1.28	SULS-351	SURS-351	1.92	–	2.27	–	240	CAS-351
▼ Double acting			Model number[2]							
500	.32	.65	SULD-21	SURD-21	.12	.24	.08	.16	12	CAS-21
1250	.39	.89	SULD-51	SURD-51	.28	.59	.25	.53	25	CAS-51
2025	.47	.90	SULD-92	SURD-92	.49	1.25	.42	1.08	60	CAS-92
2025	1.26	1.69	SULDL-92*	SURDL-92*	.49	1.25	.81	1.86	60	CAS-92
2600	.50	1.10	SULD-121	SURD-121	.63	1.23	.70	1.40	100	CAS-121
2600	1.25	1.85	SULDL-121	SURDL-121	.63	1.23	.97	2.30	100	CAS-121
4200	.55	1.16	SULD-201	SURD-201	1.10	2.35	1.22	2.60	140	CAS-201
7600	.63	1.28	SULD-351	SURD-351	1.92	3.68	2.27	4.35	240	CAS-351
7600	1.25	1.91	SULDL-351*	SURDL-351*	1.92	3.68	3.53	6.77	240	CAS-351

[1] With standard clamp arm. Clamp arms are sold separately (32). Clamping forces for single-acting models are reduced in order to overcome return spring force.

[2] For models with straight plunger movement, replace **L** or **R** with **S**.

* This product is made to order. Please contact Enerpac for delivery information before specifying in your design.

Note: Call Enerpac to order models with BSPP port connections.

Dimensions in inches [ ]

Left turning models	A	B	C	C1	D Ø	D1	D2	F Ø	G	H	K	M
▼ Single acting												
SULS-21	4.41	2.32	1.05	1.69	1.10	1.86	1.77	0.39	SAE #2	0.43	0.63	–
SULS-51	5.33	2.73	1.08	1.97	1.37	2.13	2.25	0.63	SAE #4	0.38	0.76	–
SULS-92	5.68	3.00	1.11	2.02	1.88	2.76	2.13	0.98	G1/4"	0.51	0.99	0.59
SULS-121	6.75	3.37	1.08	2.18	1.87	2.62	2.88	0.87	SAE #4	0.39	1.20	–
SULS-201	6.57	3.47	1.12	2.28	2.46	3.35	2.76	1.26	SAE #4	0.51	1.19	0.91
SULS-351	7.45	3.96	1.11	2.39	3.02	3.94	3.50	1.50	SAE #4	0.51	1.58	1.08
▼ Double acting												
SULD-21	4.41	2.32	1.05	1.69	1.10	1.86	1.77	0.39	SAE #2	0.43	0.63	–
SULD-51	5.33	2.73	1.08	1.97	1.37	2.13	2.25	0.63	SAE #4	0.38	0.76	–
SULD-92	5.68	3.00	1.11	2.02	1.88	2.76	2.13	0.98	G1/4"	0.51	0.99	–
SULDL-92*	7.25	3.79	1.11	2.80	1.88	2.76	2.13	0.98	G1/4"	0.51	0.99	–
SULD-121	6.75	3.37	1.08	2.18	1.87	2.62	2.88	0.87	SAE #4	0.39	1.20	–
SULDL-121	9.00	4.12	1.08	2.93	1.87	2.62	2.88	0.87	SAE #4	0.39	1.20	–
SULD-201	6.57	3.47	1.12	2.28	2.46	3.35	2.76	1.26	SAE #4	0.51	1.19	–
SULD-351	7.45	3.96	1.11	2.39	3.02	3.94	3.50	1.50	SAE #4	0.51	1.58	–
SULDL-351*	8.70	4.59	1.11	3.01	3.02	3.94	3.50	1.50	SAE #4	0.51	1.58	–

NOTE: dimensions shown with standard clamp arm.

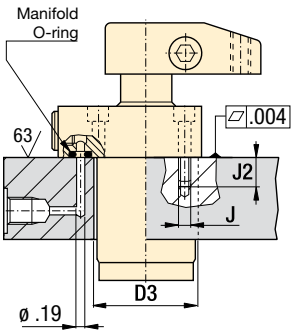
* This product is made to order. Please contact Enerpac for delivery information before specifying in your design.

Installation dimensions in inches

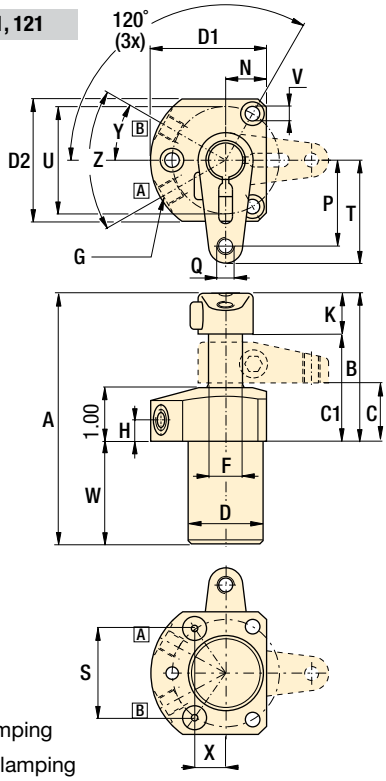
Clamping force[1] lbs	Fixture hole Ø D3	Mounting thread J UNF	Min. depth J2	Manifold O-ring[2] ARP number or inside Ø x thickness
500	1.110	#10-32	.65	568-010
1250	1.380	.250-28	.65	568-011
2025	1.895	M6	.59	.17 x .139
2600	1.880	.312-24	.80	568-011
4200	2.475	.312-24	.67	.17 x .139
7600	3.035	.375-24	.74	.17 x .139

[1] With standard clamp arm.
[2] Polyurethane, 92 Durometer

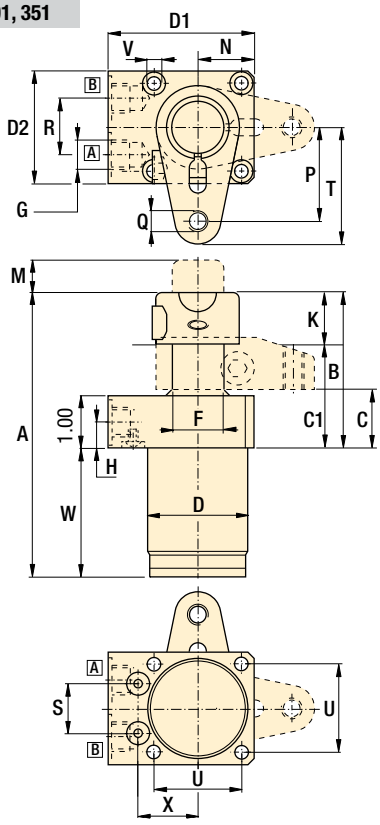
Note: Mounting bolts and O-rings included.



-21, 51, 121



-92, 201, 351



A = Clamping
B = Unclamping (venting)

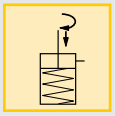
N	P UN	Q	R	S	T	U	V ø	W	X	Y	Z	lbs	Right turning models
													Single acting ▼
0.61	0.97	.250-20 UNC	-	0.825	1.22	ø1.58	0.225	2.09	0.714	30°	60°	1.0	**SURS-21**
0.75	1.58	.312-18 UNC	-	1.614	1.89	ø1.97	0.268	2.6	0.565	30°	60°	2.5	**SURS-51**
1.04	1.78	M10 X 1,5	1.02	0.934	2.21	1.65	0.256	2.67	1.128	–	–	4.4	**SURS-92**
0.99	2.00	.375-16 UNC	-	2.048	2.44	ø2.50	0.347	3.38	0.717	30°	60°	3.5	**SURS-121**
1.35	2.18	.500-13 UNC	1.02	1.145	2.77	2.17	0.335	3.11	1.382	–	–	7.7	**SURS-201**
1.71	2.68	.625-11 UNC	1.02	1.356	3.27	2.76	0.425	3.49	1.637	–	–	12.1	**SURS-351**
													Double acting ▼
0.61	0.97	.250-20 UNC	-	0.825	1.22	ø1.58	0.225	2.09	0.714	30°	60°	1.0	**SURD-21**
0.75	1.58	.312-18 UNC	-	1.614	1.89	ø1.97	0.268	2.6	0.565	30°	60°	2.5	**SURD-51**
1.04	1.78	M10 X 1,5	1.02	0.934	2.21	1.65	0.256	2.67	1.128	–	–	4.4	**SURD-92**
1.04	1.78	M10 X 1,5	1.02	0.934	2.21	1.65	0.256	2.67	1.128	–	–	5.7	**SURDL-92***
0.99	2.00	.375-16 UNC	-	2.048	2.44	ø2.50	0.347	3.38	0.717	30°	60°	3.5	**SURD-121**
0.99	2.00	.375-16 UNC	-	2.048	2.44	ø2.50	0.347	3.38	0.717	30°	60°	4.0	**SURDL-121**
1.35	2.18	.500-13 UNC	1.02	1.145	2.77	2.17	0.335	3.11	1.382	–	–	7.7	**SURD-201**
1.71	2.68	.625-11 UNC	1.02	1.356	3.27	2.76	0.425	3.49	1.637	–	–	12.1	**SURD-351**
1.71	2.68	.625-11 UNC	1.02	1.356	3.27	2.76	0.425	3.49	1.637	–	–	15.1	**SURDL-351***

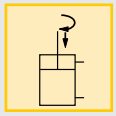
Force: 475 - 7600 lbs

Stroke: .65 - 1.91 inch

Pressure: 500 - 5000 psi

E Cilindros giratorios
F Vérins de bridage pivotants
D Schwenkspannzylinder





Options

Clamp arms ▸ 32

Work supports ▸ 43

Collet-Lok® swing cylinders ▸ 12

Accessories ▸ 86

Important

30, 45, and 60 degree rotations are available upon request. Add -30, -45 or -60 to end of standard model number to order directly from Enerpac. To order rotation limiter separately, see page 58.

Custom cylinders including longer stroke lengths are available on request.

In case there is a risk of machining coolants and debris being inhaled via the breather vent, it is recommended to pipe this port to an area outside the fixture that is protected from machining coolants and debris.

Do not exceed maximum flow rates.

Swing clamps - Lower flange models

Shown: SLRD-51, SLRS-201

98-039

No fixture hole required

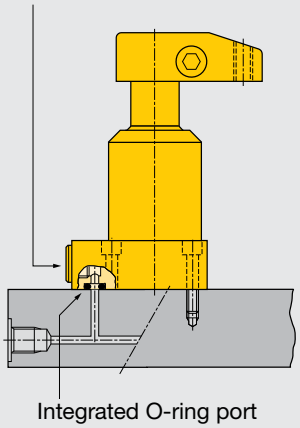
...cylinder can be bolted directly to fixture

- Flexible design allows for manifold or threaded port connection
- No fixture hole preparation required
- Easiest mounting preparation in the swing cylinder line
- Symmetrical rectangular flange design enables clamping at three sides of the cylinder
- Allows extra large parts to be clamped
- 30, 45 and 60 degree swing angles available on request

SL series

Enerpac lower flange series swing clamps can be bolted to the fixture, allowing easy installation of the unit and does not require machined fixture holes. Hydraulic connections are made through SAE or BSPP oil connection or the standard integrated O-ring ports.

SAE oil connection



Integrated O-ring port

Lower flange swing clamps mounted to the face of the fixture.

Product selection

Clamping force[1]	Stroke in		Left turning 90°	Right turning 90°	Cylinder effective area in²		Oil capacity in³		Max. oil flow[1]	Standard clamp arm
lbs	Clamp	Total			Clamp	Un-clamp	Clamp	Un-clamp	in³/min	Sold separately ▣ 32 ▶
▼ **Single acting**			**Model number** [2]							
475	.32	.65	**SLLS-21**	**SLRS-21**	.12	–	.08	–	12	**CAS-21**
1100	.39	.89	**SLLS-51**	**SLRS-51**	.28	–	.25	–	25	**CAS-51**
1800	.47	.90	**SLLS-92**	**SLRS-92**	.49	–	.42	–	60	**CAS-92**
2400	.50	1.10	**SLLS-121**	**SLRS-121**	.63	–	.70	–	100	**CAS-121**
3900	.55	1.16	**SLLS-201**	**SLRS-201**	1.10	–	1.22	–	140	**CAS-201**
7450	.63	1.28	**SLLS-351**	**SLRS-351**	1.92	–	2.27	–	240	**CAS-351**
▼ **Double acting**			**Model number** [2]							
500	.32	.65	**SLLD-21**	**SLRD-21**	.12	.24	.08	.15	12	**CAS-21**
1250	.39	.89	**SLLD-51**	**SLRD-51**	.28	.59	.25	.52	25	**CAS-51**
2025	.47	.90	**SLLD-92**	**SLRD-92**	.49	1.25	.42	1.08	60	**CAS-92**
2600	.50	1.10	**SLLD-121**	**SLRD-121**	.63	1.23	.70	1.40	100	**CAS-121**
4200	.55	1.16	**SLLD-201**	**SLRD-201**	1.10	2.35	1.22	2.60	140	**CAS-201**
7600	.63	1.28	**SLLD-351**	**SLRD-351**	1.92	3.68	2.27	4.35	240	**CAS-351**

[1] With standard clamp arm. Clamp arms are sold separately (page 32). Clamping forces for single-acting models are reduced in order to overcome return spring force.»

[2] For models with straight plunger movement, replace **L** or **R** with **S**.

Note: Call Enerpac to order models with BSPP port connections.

Dimensions in inches [⊕]

Left turning models	A	C	C1	D ø	D1	D2	F ø	G	H	K	M
▼ **Single acting**											
SLLS-21	4.41	3.13	3.78	1.10	1.86	1.77	0.39	SAE #2	0.54	0.63	–
SLLS-51	5.33	3.68	4.57	1.37	2.13	2.25	0.63	SAE #4	0.55	0.76	–
SLLS-92	5.99	4.10	5.01	1.88	2.76	2.13	0.98	G1/4"	0.49	0.99	0.59
SLLS-121	6.75	4.46	5.56	1.87	2.62	2.88	0.87	SAE #4	0.61	1.2	–
SLLS-201	6.89	4.54	5.70	2.51	3.35	2.76	1.26	SAE #4	0.49	1.19	0.91
SLLS-351	7.77	4.91	6.19	3.14	3.94	3.50	1.50	SAE #4	0.49	1.58	1.08
▼ **Double acting**											
SLLD-21	4.41	3.13	3.78	1.10	1.86	1.77	0.39	SAE #2	0.54	0.63	–
SLLD-51	5.33	3.68	4.57	1.37	2.13	2.25	0.63	SAE #4	0.55	0.76	–
SLLD-92	5.99	4.10	5.01	1.88	2.76	2.13	0.98	G1/4"	0.49	0.99	–
SLLD-121	6.75	4.46	5.56	1.87	2.62	2.88	0.87	SAE #4	0.61	1.2	–
SLLD-201	6.89	4.54	5.70	2.51	3.35	2.76	1.26	SAE #4	0.49	1.19	–
SLLD-351	7.77	4.91	6.19	3.14	3.94	3.50	1.50	SAE #4	0.49	1.58	–

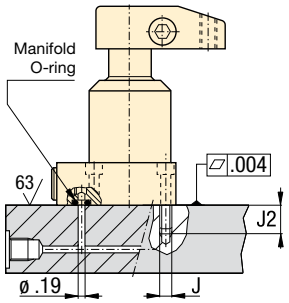
NOTE: dimensions shown with standard clamp arm.

Installation dimensions in inches

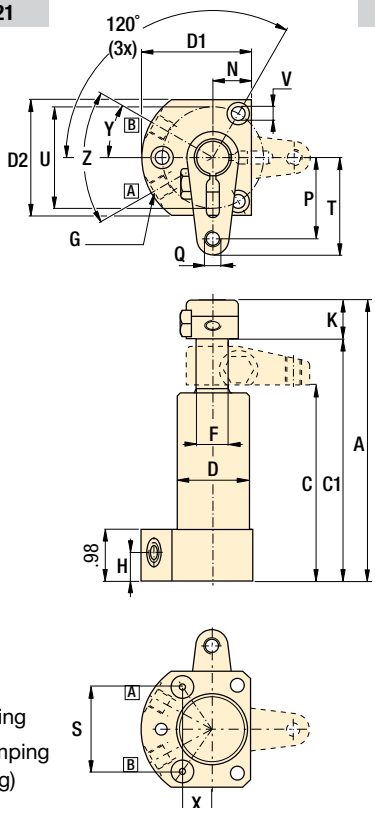
Clamping force[1] lbs	Mounting thread J	Minimum thread depth J2	Manifold O-ring [2] ARP number or inside Ø x thickness
500	#10-32	.65	568-010
1250	.250-28	.65	568-011
2025	M6	.59	.17 x .139
2600	.312-24	.80	568-011
4200	.312-24	.67	.17 x .139
7600	.375-24	.74	.17 x .139

[1] With standard clamp arm.
[2] Polyurethane, 92 Durometer

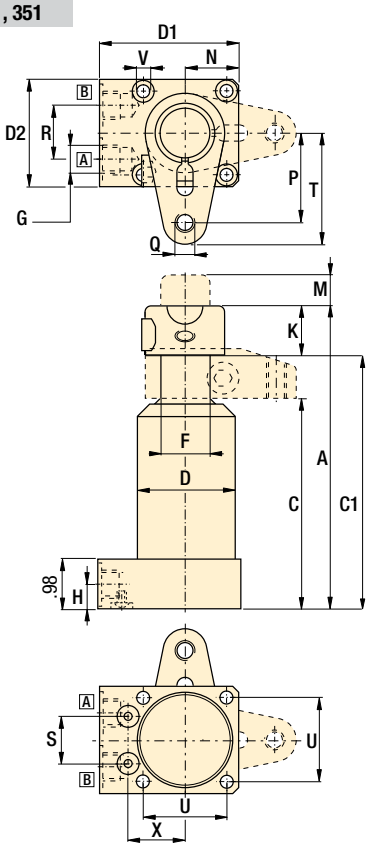
Note: Mounting bolts and O-rings included.



-21, 51, 121



-92, 201, 351



A = Clamping
B = Unclamping (venting)

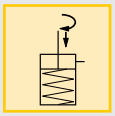
N	P	Q UN	R	S	T	U ø	V	X	Y	Z	lbs	Right turning models
												Single acting ▼
0.61	0.97	.250-20 UNC	-	0.825	1.22	1.58	0.23	0.714	30°	60°	1.0	**SLRS-21**
0.75	1.58	.312-18 UNC	-	1.614	1.89	1.97	0.27	0.565	30°	60°	2.5	**SLRS-51**
1.04	1.78	M10 x 1,5	1.02	0.934	2.21	1.65	0.26	1.128	–	–	4.4	**SLRS-92**
0.99	2.03	.375-16 UNC	-	2.048	2.44	2.5	0.35	0.717	30°	60°	3.5	**SLRS-121**
1.35	2.18	.500-13 UNC	1.02	1.145	2.77	2.17	0.33	1.382	–	–	7.7	**SLRS-201**
1.71	2.68	.625-11 UNC	1.02	1.356	3.27	2.76	0.43	1.637	–	–	12.1	**SLRS-351**
												Double acting ▼
0.61	0.97	.250-20 UNC	-	0.825	1.22	1.58	0.23	0.714	30°	60°	1.0	**SLRD-21**
0.75	1.58	.312-18 UNC	-	1.614	1.89	1.97	0.27	0.565	30°	60°	2.5	**SLRD-51**
1.04	1.78	M10 x 1,5	1.02	0.934	2.21	1.65	0.26	1.128	–	–	4.4	**SLRD-92**
0.99	2.03	.375-16 UNC	-	2.048	2.44	2.5	0.35	0.717	30°	60°	3.5	**SLRD-121**
1.35	2.18	.500-13 UNC	1.02	1.145	2.77	2.17	0.33	1.382	–	–	7.7	**SLRD-201**
1.71	2.68	.625-11 UNC	1.02	1.356	3.27	2.76	0.43	1.637	–	–	12.1	**SLRD-351**

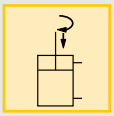
Force: 475 - 7600 lbs

Stroke: .65 - 1.28 inch

Pressure: 500 - 5000 psi

E Cilindros giratorios
F Vérins de bridage pivotants
D Schwenkspannzylinder





Options

Clamp arms 32 ▶

Work supports 43 ▶

Collet-Lok® swing cylinders 12 ▶

Accessories 86 ▶

Important

30, 45, and 60 degree rotations are available upon request. Add -30, -45 or -60 to end of standard model number to order directly from Enerpac. To order rotation limiter separately, see page 32.

Custom cylinders including longer stroke lengths are available on request.

In case there is a risk of machining coolants and debris being inhaled via the breather vent, it is recommended to pipe this port to an area outside the fixture that is protected from machining coolants and debris.

Do not exceed maximum flow rates.

Swing clamps - Threaded body models

Shown: STRD-51, STRD-201

98-040

Cylinders can be threaded directly into fixture

...can be secured at any height

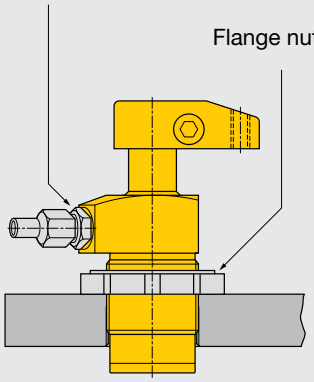
- Body thread for precise cylinder height positioning
- Threaded port connection
- Easy installation and removal
- Greatest flexibility in fixture design
- 30, 45 and 60 degree swing angles available on request

ST series

Enerpac threaded body swing clamps are threaded directly into the fixture.

The cylinder height is adjusted to the appropriate height, and then locked in place using a jam nut (□86).

SAE oil connection



Threaded body swing clamps allow the clamp to be buried in the fixture to minimize the required area, while the height remains adjustable.

98-014

Product selection

Clamping force[1]	Stroke		Left turning 90°	Right turning 90°	Cylinder effective area		Oil capacity		Max. oil flow[1]	Standard clamp arm
	in				in²		in³			Sold separately □32 ▶
lbs	Clamp	Total			Clamp	Un-clamp	Clamp	Un-clamp	in³/min	
▼ Single acting			**Model number [2]**							
475	.32	.65	**STLS-21**	**STRS-21**	.12	–	.08	–	12	**CAS-21**
1100	.39	.89	**STLS-51**	**STRS-51**	.28	–	.25	–	25	**CAS-51**
1800	.47	.90	**STLS-92**	**STRS-92**	.49	–	.42	–	60	**CAS-92**
2400	.50	1.09	**STLS-121**	**STRS-121**	.63	–	.70	–	100	**CAS-121**
3900	.55	1.16	**STLS-201**	**STRS-201**	1.10	–	1.22	–	140	**CAS-201**
7450	.63	1.28	**STLS-351**	**STRS-351**	1.92	–	2.27	–	240	**CAS-351**
▼ Double acting			**Model number [2]**							
500	.32	.65	**STLD-21**	**STRD-21**	.12	.24	.08	.15	12	**CAS-21**
1250	.39	.89	**STLD-51**	**STRD-51**	.28	.59	.25	.52	25	**CAS-51**
2025	.47	.90	**STLD-92**	**STRD-92**	.49	1.25	.42	1.08	60	**CAS-92**
2600	.50	1.09	**STLD-121**	**STRD-121**	.63	1.23	.70	1.40	100	**CAS-121**
4200	.55	1.16	**STLD-201**	**STRD-201**	1.10	2.35	1.22	2.60	140	**CAS-201**
7600	.63	1.28	**STLD-351**	**STRD-351**	1.92	3.68	2.27	4.35	240	**CAS-351**

[1] With standard clamp arm. Clamp arms are sold separately (□32). Clamping forces for single-acting models are reduced in order to overcome return spring force.

[2] For models with straight plunger movement, replace **L** or **R** with **S**.

Note: Call Enerpac to order models with BSPP port connections.

Dimensions in inches [⊳⊕]

Left turning models	A	B	C	C1	C2	D Ø	D1	D2	F Ø	G	H	J1
▼ Single acting												
STLS-21	4.41	2.32	1.04	1.69	0.98	1.125-16 UN	1.54	1.29	0.39	SAE#2	0.39	2.09
STLS-51	5.33	2.73	1.08	1.97	0.98	1.375-18 UNEF	1.88	1.49	0.63	SAE#4	0.38	2.60
STLS-92	5.68	3.21	1.32	2.22	1.19	M48 X 1,5	2.47	1.90	0.98	G1/4"	0.51	1.70
STLS-121	6.75	3.37	1.09	2.18	1.00	1.875-16 UN	2.38	2.00	0.87	SAE#4	0.38	3.38
STLS-201	6.57	3.74	1.40	2.56	1.26	2.500-16 UN	2.99	2.56	1.26	SAE#4	0.52	2.06
STLS-351	7.45	4.24	1.38	2.66	1.26	3.125-16 UN	3.48	3.15	1.50	SAE#4	0.51	2.45
▼ Double acting												
STLD-21	4.41	2.32	1.04	1.69	0.98	1.125-16 UN	1.54	1.29	0.39	SAE#2	0.39	2.09
STLD-51	5.33	2.73	1.08	1.97	0.98	1.375-18 UNEF	1.88	1.49	0.63	SAE#4	0.38	2.60
STLD-92	5.68	3.21	1.32	2.22	1.19	M48 X 1,5	2.47	1.90	0.98	G1/4"	0.51	1.70
STLD-121	6.75	3.37	1.09	2.18	1.00	1.875-16 UN	2.38	2.00	0.87	SAE#4	0.38	3.38
STLD-201	6.57	3.74	1.40	2.56	1.26	2.500-16 UN	2.99	2.56	1.26	SAE#4	0.52	2.06
STLD-351	7.45	4.24	1.38	2.66	1.26	3.125-16 UN	3.48	3.15	1.50	SAE#4	0.51	2.45

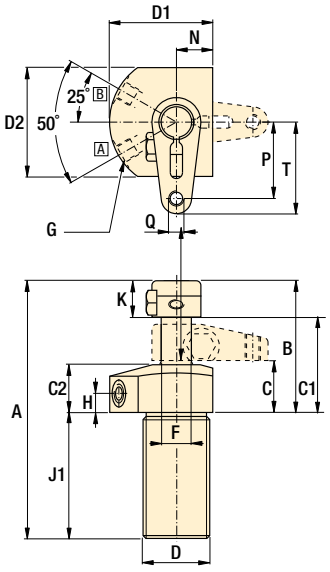
NOTE: dimensions shown with standard clamp arm.

Accessory Chart

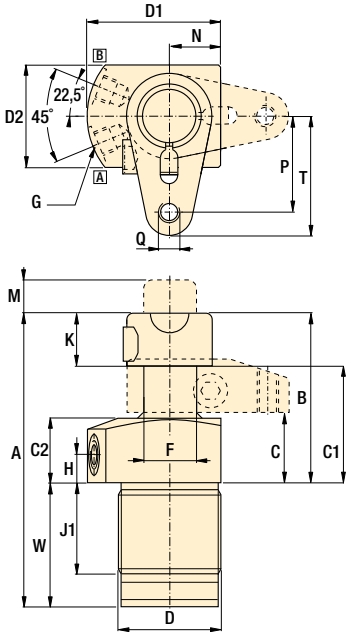
Model Nos. Left turning	Right turning	Mounting flange Sold Separately	Flange nut Sold Separately
▼ Single acting			
STLS-21	STRS-21	—	MF-281	FN-281
STLS-51	STRS-51	AW-5	MF-351	FN-351
STLS-92	STRS-92	—	MF-482	FN-482
STLS-121	STRS-121	AW-89	MF-481	FN-481
STLS-201	STRS-201	AW-19	MF-651	FN-651
STLS-351	STRS-351	AW-90	MF-801	FN-801
▼ Double acting			
STLD-21	STRD-21	—	MF-281	FN-281
STLD-51	STRD-51	AW-5	MF-351	FN-351
STLD-92	STRD-92	—	MF-482	FN-482
STLD-121	STRD-121	AW-89	MF-481	FN-481
STLD-201	STRD-201	AW-19	MF-651	FN-651
STLD-351	STRD-351	AW-90	MF-801	FN-801

Mounting flange Sold Separately ▶ 87
Flange nut Sold Separately ▶ 86

-21, 51, 121



-92, 201, 351



A = Clamping
B = Unclamping (venting)

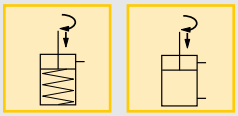
K	M	N	P	Q	T	W	Y	Z	lbs	Right turning models
										Single acting ▼
0.63	-	0.60	0.97	.250-20 UNC	1.22	–	25°	50°	1.1	STRS-21
0.76	-	0.75	1.58	.312-18 UNC	1.89	–	25°	50°	2.5	STRS-51
0.99	0.59	0.95	1.78	M10 x 1,5	2.21	2.47	22.5°	45°	4.4	STRS-92
1.20	-	1.00	2.03	.375-16 UNC	2.44	-	25°	50°	3.5	STRS-121
1.19	0.91	1.28	2.18	.500-13 UNC	2.77	2.83	22.5°	45°	7.1	STRS-201
1.58	1.08	1.57	2.68	.625-11 UNC	3.27	3.22	22.5°	45°	12.1	STRS-351
										Double acting ▼
0.63	-	0.60	0.97	.250-20 UNC	1.22	–	25°	50°	1.1	STRD-21
0.76	-	0.75	1.58	.312-18 UNC	1.89	–	25°	50°	2.5	STRD-51
0.99	-	0.95	1.78	M10 x 1,5	2.21	2.47	22.5°	45°	4.4	STRD-92
1.20	-	1.00	2.03	.375-16 UNC	2.44	–	25°	50°	3.5	STRD-121
1.19	-	1.28	2.18	.500-13 UNC	2.77	2.83	22.5°	45°	7.7	STRD-201
1.58	–	1.57	2.68	.625-11 UNC	3.27	3.21	22.5°	45°	12.1	STRD-351

Force: 475- 7600 lbs

Stroke: .65 - 1.28 inch

Pressure: 500 - 5000 psi

E Cilindros giratorios
F Vérins de bridage pivotants
D Schwenkspannzylinder



Options

Clamp arms ▶ 32

Work supports ▶ 43

Collet-Lok® swing cylinders ▶ 12

Accessories ▶ 86

Important

30, 45, and 60 degree rotations are available upon request. Add -30, -45 or -60 to end of standard model number to order directly from Enerpac. To order rotation limiter separately, see page 32.

Custom cylinders including longer stroke lengths are available on request.

In case there is a risk of machining coolants and debris being inhaled via the breather vent, it is recommended to pipe this port to an area outside the fixture that is protected from machining coolants and debris.

Do not exceed maximum flow rates.

Swing clamps - Cartridge models

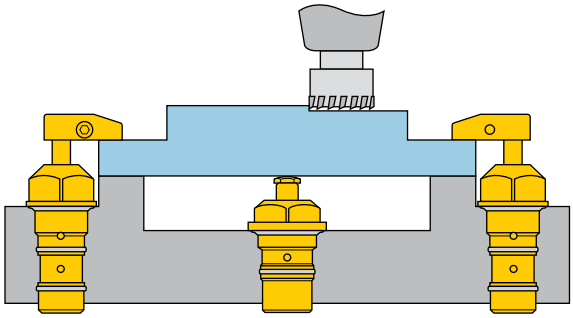
Shown: SCRD-122, SCRD-52

98-041

Eliminates the need for tubing and fittings

- Minimal space required on fixture
- Can be completely recessed in fixture
- External plumbing not required
- Allows close positioning of adjoining units
- 30, 45 and 60 degree swing angles available on request

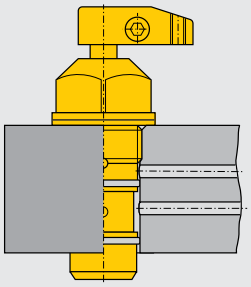
Enerpac compact design cartridge model swing clamps used in conjunction with a cartridge model work support in a typical clamping application.



SC series

Enerpac cartridge swing clamps are designed for integrated manifold mounting. This eliminates the need for fittings and tubing on the fixture.

Cartridge swing clamps simplify mounting and optimize clamping effectiveness.



Hydraulic fixture with components on two faces for more efficient production.

30007-4

Product selection

Clamping force[1]	Stroke		Left turning	Right turning	Cylinder effective area		Oil capacity		Max. oil flow [1]	Standard clamp arm
	in			90°	in²		in³			Sold separately ▯ 32 ▶
lbs	Clamp	Total			Clamp	Un-clamp	Clamp	Un-clamp	in³/min	
▼ **Single acting**			**Model number** [2]							
475	.32	.66	**SCLS-22**	**SCRS-22**	.12	-	.08	-	12	**CAS-21**
1100	.39	.89	**SCLS-52**	**SCRS-52**	.28	-	.25	-	25	**CAS-51**
2400	.50	1.09	**SCLS-122**	**SCRS-122**	.63	-	.70	-	100	**CAS-121**
▼ **Double acting**			**Model number** [2]							
500	.32	.66	**SCLD-22**	**SCRD-22**	.12	.24	.08	.15	12	**CAS-21**
1250	.39	.89	**SCLD-52**	**SCRD-52**	.28	.59	.25	.52	25	**CAS-51**
2600	.50	1.09	**SCLD-122**	**SCRD-122**	.63	1.23	.70	1.40	100	**CAS-121**

[1] With standard clamp arm. Clamp arms are sold separately (▯32). Clamping forces for single-acting models are reduced in order to overcome return spring force.

[2] For models with straight plunger movement, replace **L** or **R** with **S**.

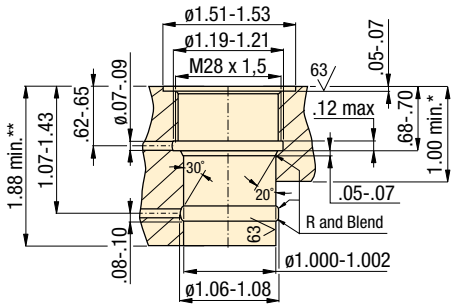
Dimensions in inches [⊕]

Left turning models	A	B	C	C1	C2	D1 Ø	D2 Ø	E hexagon	F
▼ **Single acting**									
SCLS-22	4.41	2.26	0.98	1.63	0.94	1.51	1.00	1.37	0.39
SCLS-52	5.33	3.14	1.49	2.39	1.39	2.23	1.37	1.99	0.63
SCLS-122	6.75	3.8	1.52	2.61	1.43	2.99	2.25	2.74	0.87
▼ **Double acting**									
SCLD-22	4.41	2.26	0.98	1.63	0.94	1.51	1.00	1.37	0.39
SCLD-52	5.33	3.14	1.49	2.39	1.39	2.23	1.37	1.99	0.63
SCLD-122	6.75	3.80	1.52	2.61	1.43	2.99	2.25	2.74	0.87

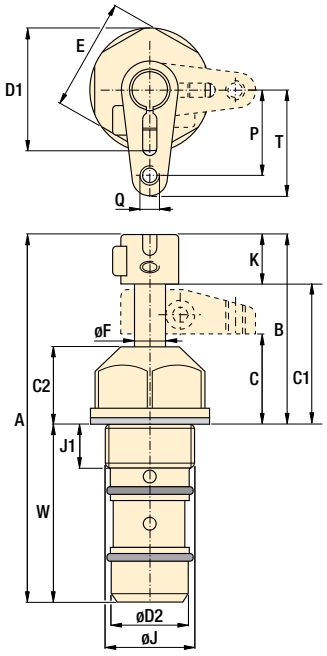
NOTE: dimensions shown with standard clamp arm.

Installation dimensions
in inches

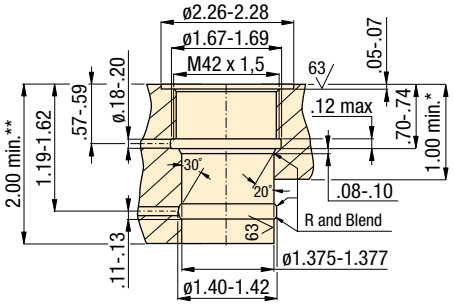
-22 models



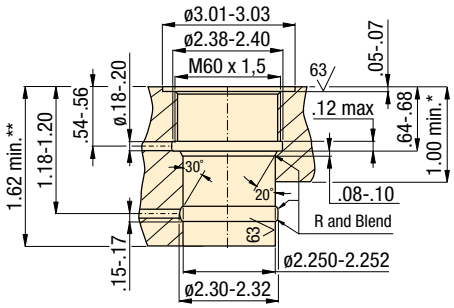
-22, 52, 122 models



-52 models



-122 models



* Minimum plate height for single-acting models.

** Minimum plate height for double-acting models.

J	J1	K	P	Q	T	W	lbs	Right turning models
								Single acting ▼
M28 x 1,5	0.5	0.63	0.97	.250-20 UNC	1.22	2.15	1.0	SCRS-22
M42 x 1,5	0.54	0.76	1.58	.312-18 UNC	1.89	2.19	2.0	SCRS-52
M60 x 1,5	0.52	1.20	2.03	.375-16 UNC	2.44	2.95	5.5	SCRS-122
								Double acting ▼
M28 x 1,5	0.50	0.63	0.97	.250-20 UNC	1.22	2.15	1.0	SCRD-22
M42 x 1,5	0.54	0.76	1.58	.312-18 UNC	1.89	2.19	2.0	SCRD-52
M60 x 1,5	0.52	1.20	2.03	.375-16 UNC	2.44	2.95	5.5	SCRD-122

Force: 475 - 2600 lbs

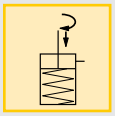
Stroke: .66 - 1.09 inch

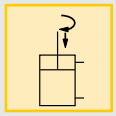
Pressure: 500 - 5000 psi

E Cilindros giratorios

F Vérins de bridage pivotants

D Schwenkspannzylinder





Options

Clamp arms 32 ▸

Work supports 43 ▸

Collet-Lok® swing cylinders 12 ▸

Accessories 86 ▸

Sequence valves 152 ▸

Important

30, 45, and 60 degree rotations are available upon request. Add -30, -45 or -60 to end of standard model number to order directly from Enerpac. To order rotation limiter separately, see page 32.

Custom cylinders including longer stroke lengths are available on request.

In case there is a risk of machining coolants and debris being inhaled via the breather vent, it is recommended to pipe this port to an area outside the fixture that is protected from machining coolants and debris.

Do not exceed maximum flow rates.

Clamp arms *for swing clamps*

Shown: CAS-121, CAL-122

98000

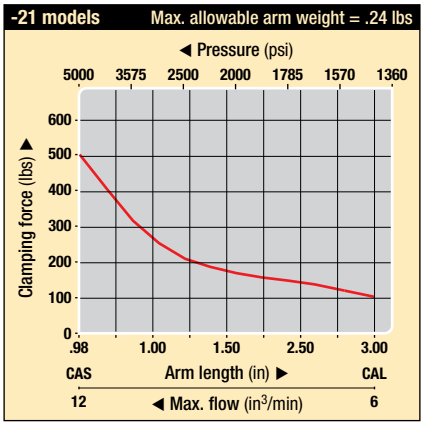
Patented Design

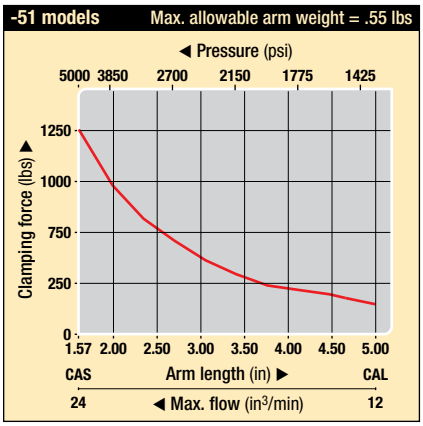
- Easy and precise location of the clamp arm in any position
- Arm can be easily installed and fastened while the cylinder is mounted in the fixture to allow exact arm positioning
- Vise not required for fastening arms

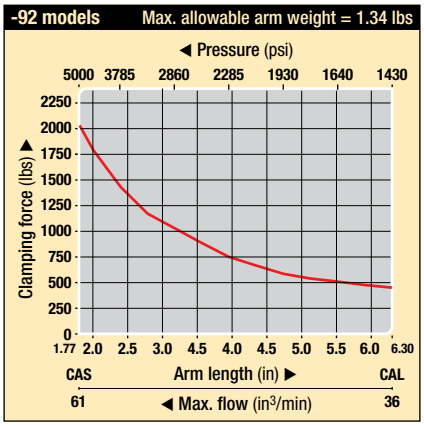
Enerpac's patented clamp arm design attaches to the hydraulic swing cylinder, allowing parts to be clamped at various distances from the hydraulic cylinder. Clamp arms are available in a variety of lengths, or you can use custom machining dimensions to create your own clamp arm configuration.

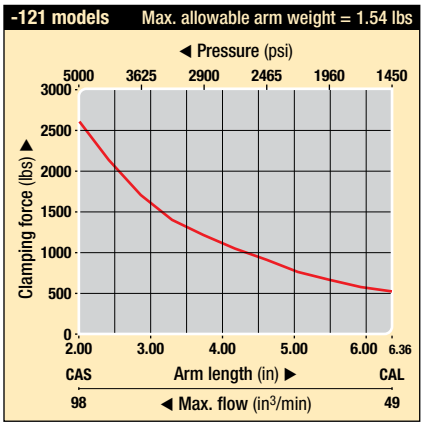
Pressure vs clamping force

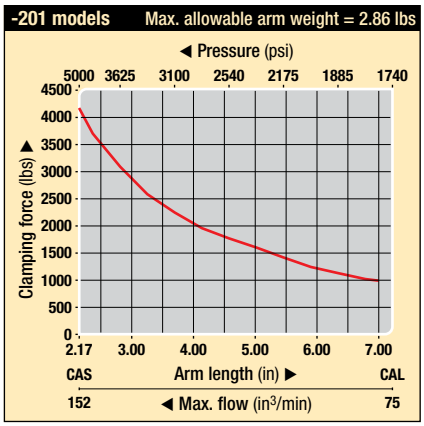
The use of different length clamp arms requires reduction in applied pressure and resulting clamp force. The charts below show this relationship.

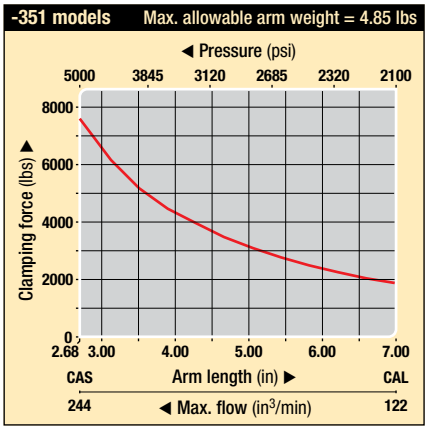












Ordering rotation limiting spacers

BUILD YOUR PART NUMBER:

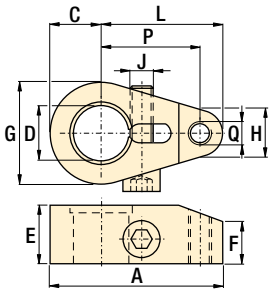
SP -		- 186
Clamp force		Angle
02 = 500 lbs		**30**
05 = 1250 lbs		**45**
09 = 2025 lbs		**60**
12 = 2600 lbs		
20 = 4200 lbs		
35 = 7600 lbs		

Example:

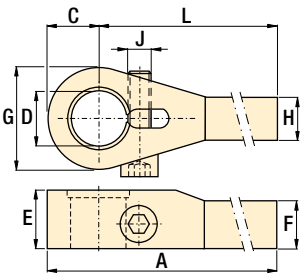
SP-12 45-186 converts a 2600 lb. swing cylinder to 45 degree rotation.

The addition of this spacer requires minor disassembly of the clamp. If you are uncomfortable doing this, please contact an authorized Enerpac Service Center.

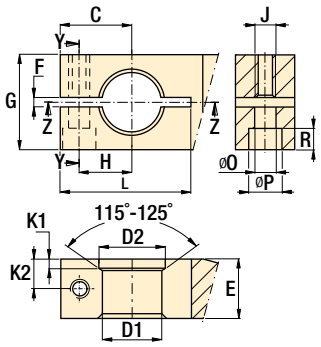
CAS models **Standard clamp arms**



CAL models **Long clamp arms**



Custom design (for SU, SL, ST and SC models only)



Dimensions in inches [ ]

Clamp. force lbs	Model number	A	C	D Ø	E	F	G Ø	H	J	L	P	Q UNC	lbs
▼ **Standard clamp arms**													
500	**CAS-21**	1.60	0.38	.393-.395	0.63	0.4	0.76	0.5	.250-28 UNF	1.22	0.97	.250-20	0.1
1250	**CAS-51**	2.39	0.50	.630-.631	0.76	0.45	1.00	0.62	.312-24 UNF	1.89	1.58	.312-18	0.8
2025	**CAS-92**	2.99	0.79	.985-.986	0.99	0.62	1.58	0.86	M10 X 1,25	2.21	1.78	M10x1.5	0.7
2600	**CAS-121**	3.13	0.70	.876-.877	1.20	0.64	1.40	0.82	.375-24 UNF	2.44	2.03	.375-16	1.0
4200	**CAS-201**	3.72	0.95	1.260-1.262	1.19	0.83	1.90	1.18	.500-20 UNF	2.77	2.18	.500-13	1.0
7600	**CAS-351**	4.65	1.38	1.497-1.498	1.58	1.17	2.76	1.18	.625-18 UNF	3.27	2.68	.625-11	3.0
▼ **Long clamp arms**													
500	**CAL-22**	3.63	0.38	.393-.395	0.63	0.42	0.76	0.45	M6x1.0	3.25	–	–	0.2
1250	**CAL-52**	5.81	0.50	.630-.631	0.76	0.45	1.00	0.56	M8x1.0	5.31	–	–	1.0
2025	**CAL-92**	7.09	0.79	.985-.986	0.99	0.63	1.58	0.71	M10x1,25	6.30	–	–	1.2
2600	**CAL-122**	7.06	0.70	.876-.877	1.20	0.63	1.40	0.73	M10x1,5	6.36	–	–	1.5
4200	**CAL-202**	7.95	0.95	1.260-1.262	1.19	0.83	1.90	1.00	M12x1,25	7.00	–	–	1.5
7600	**CAL-352**	8.47	1.38	1.497-1.498	1.58	1.33	2.76	1.19	M16x1,50	7.09	–	–	4.2

Clamp. force lbs	C	D1[1] Ø	D2 Ø	E	F	G	H	J	K1	K2	L	O Ø	P Ø	R
▼ **Custom design clamp arms** [2] (Recommended machining dimensions)														
500	.61	.393-.394	.495-.497	.63	.06-.12	.79	.37	M5x0,8	.122-.138	.33	.98-1.10	.22	.49	.22
1250	.79	.623-.631	.727-.729	.75	.06-.12	1.18	.53	M6x1,0	.161-.177	.39	1.38-1.57	.26	.43	.26
2025	1.18	.984-.985	1.096-1.100	.98	.06-.12	1.57	.87	M8x1,25	.154-.165	.49	2.17-2.36	.35	.55	.35
2600	1.12	.8756-.8766	1.002-1.006	1.18	.06-.12	1.38	.70	.375-24 UNF	.272-.287	.50	2.05-2.25	.39	.63	.31
4200	1.38	1.260-1.261	1.398-1.402	1.18	.06-.12	2.36	.98	M10x1,5	.201-.217	.59	2.44-2.64	.43	.67	.43
7600	1.57	1.496-1.497	1.634-1.638	1.57	.06-.12	2.76	1.18	M10x1,5	.193-.209	.79	3.15-3.35	.43	.67	.43

[1] Surface roughness for D1 should be 63 micro inches.
[2] Not for use with Collet-Lok swing clamps.

Force: 500 - 7600 lbs

Pressure: 500 - 5000 psi

- **E** **Brazos de amarre**
- **F** **Bras de bridage**
- **D** **Spannarme**

Options

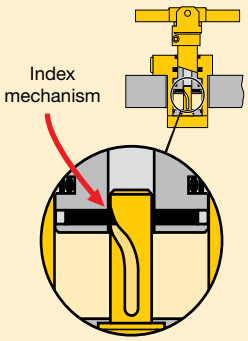
Gauges and accessories 190

Flow control valves 155

Important

Do not exceed maximum oil flow.

If flow rates are exceeded, swing cylinder indexing mechanism may be permanently damaged.



When designing custom clamp arms, the flow rates must be further reduced. This rating should be in proportion to the mass and the center of gravity of the clamp arm.

Example:

If the mass of the arm is twice that of the long arm, flow rates must be reduced by 50%.

Pivoting T-Arms *for double-acting swing clamps*

Shown: CAC-202, CAPT-202; CAC-352, CAPT-352

01_001_1

Clamping two workpieces with one cylinder

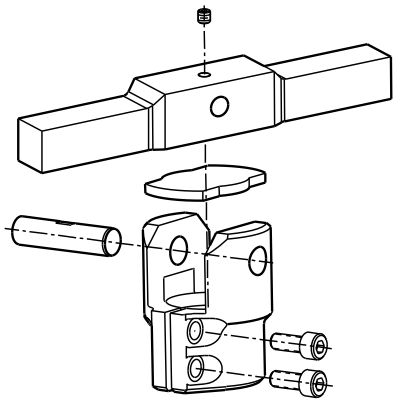
...quick and precise clamp arm positioning

- Easy and precise location of the clamp arm in any position
- Arm can be easily installed and fastened while the cylinder is mounted in the fixture to allow exact arm positioning
- Vise not required for fastening arms or threaded into the fixture
- CAC-92, -202 and -352 are only to be used on double-acting cylinders

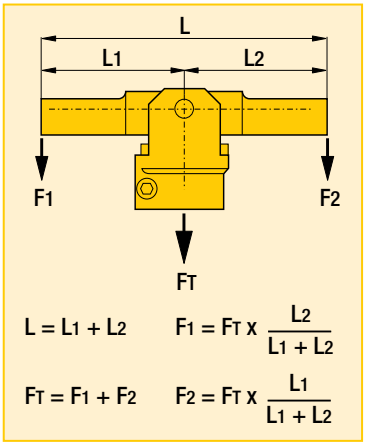
Clamp arms are used to transmit the force generated by the swing cylinder to the workpiece. The T-arm clamps two workpieces simultaneously with one swing cylinder. Enerpac recommends using the pivoting T-arms with double-acting swing clamps of the SU, SL, ST and SC-series.

Allowable flow vs arm length

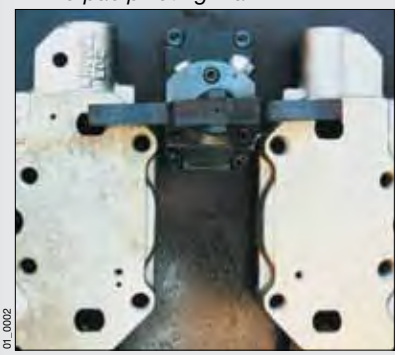
The distribution of the clamp arm force is based upon the length of the T-arm as measured from the pivoting point.



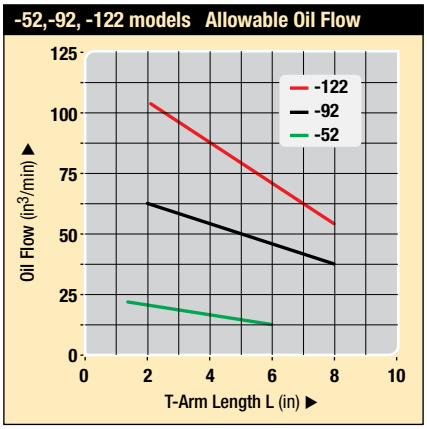
Important

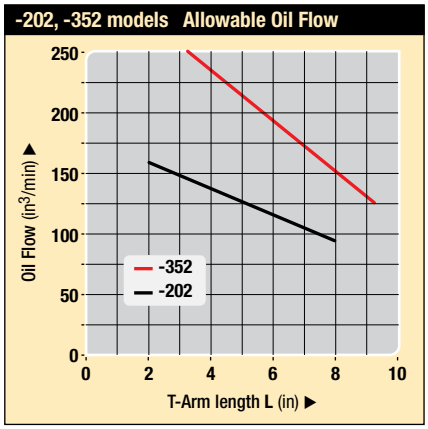


Two workpieces are clamped simultaneously with one double-acting swing cylinder by using the Enerpac pivoting T-arm.



01_0002

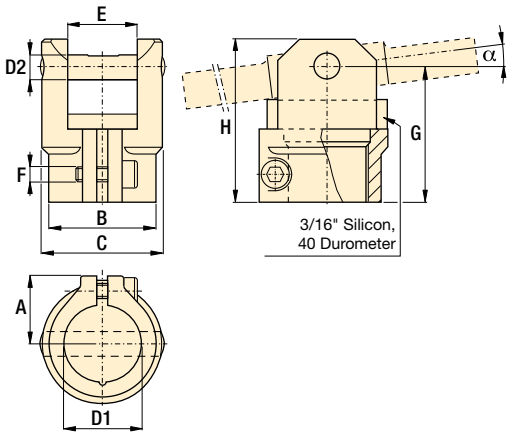




Shown: CAC-202

01_003

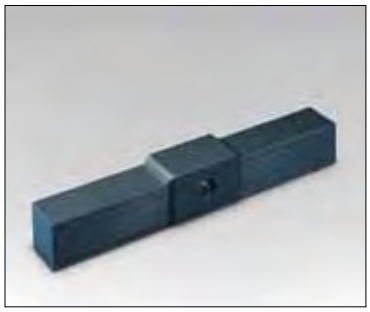
CA models **Collars for T-arms**



Collars - Dimensions in inches [⌲ ⌖]

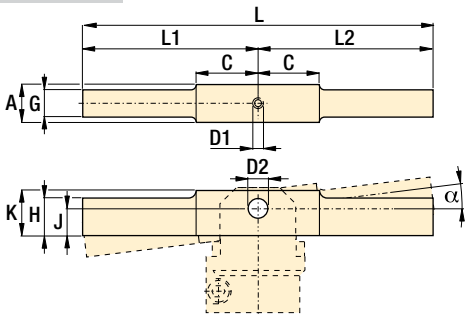
Clamp. force lbs	Model number	Max. tilt angle α	A	B	C	D1	D2	E	F	G	H	lbs
									mm			
▼ **Collars for T-arms**												
1250	**CAC-52**	20°	.65	.95	1.10	.63	.24	.63	M4x0,7	1.26	88	.20
2025	**CAC-92**	14°	.87	1.36	1.54	.99	.32	.89	M5x0,8	1.70	115.72	.44
2600	**CAC-122**	14°	.87	1.36	1.54	.88	.32	.89	M5x0,8	1.70	115.72	.44
4200	**CAC-202**	10°	1.07	1.84	2.15	1.26	.39	1.13	M6x1,0	2.02	138.60	1.03
7600	**CAC-352**	10°	1.34	2.15	2.48	1.50	.55	1.39	M8x1,25	2.50	173.80	1.76

Shown: CAPT-202



01_004

CAPT models **T-arms** (for SU, SL, ST and SC swing clamps)



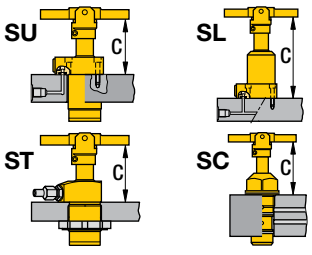
T-arms – Dimensions in inches [⌲ ⌖]

Clamp. force lbs	Model number	A	C	D1*	D2	G	H	J	K	L	L1	L2	lbs
				mm									
▼ **Pivoting T-arms**													
1250	**CAPT-52**	.61	1.00	M3x0,5	.237-.241	.50	.50	.39	.75	6.00	3.00	3.00	.59
2025	**CAPT-92**	.87	1.50	M4x0,7	.316-.320	.72	.72	.59	.87	8.01	4.00	4.00	1.45
2600	**CAPT-122**	.87	1.50	M4x0,7	.316-.320	.72	.72	.59	.87	8.01	4.00	4.00	1.45
4200	**CAPT-202**	1.12	1.25	M6x1,0	.395-.399	.87	.87	.64	1.13	8.01	4.00	4.00	2.11
7600	**CAPT-352**	1.37	.99	M6x1,0	.552-.556	1.18	1.18	.73	1.37	9.01	4.50	4.50	3.92

* Note: D1 equals set screw thread size. Set screw must be long enough to secure the pivot pin.

Installation dimensions in inches [⌲ ⌖]

Clamping force lbs	T-arm model	SU-series C	SU-L-series C	SL-series C	ST-series C	SC-series C
▼ **T-arm installation dimensions - Fully unclamped position**						
1250	-52	2.90	–	5.50	2.90	3.19
2025	-92	3.13	3.91	6.13	3.32	–
2600	-122	3.55	4.28	6.93	3.55	3.87
4200	-202	3.57	–	6.99	3.97	–
7600	-352	4.04	4.69	7.84	4.31	–



Force: 1250 - 7600 lbs

Pressure: 500 - 5000 psi

E **Brazos de amarre**

F **Bras de bridage**

D **Spannarme**

Options

Gauges and accessories 190

Flow control valves 155

Download CAD files from www.enerpacwh.com

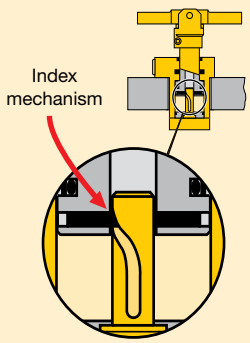
30, 45, and 60 degree rotations are available upon request.

Important

For high cycle applications use double-acting cylinders.

Do not exceed maximum oil flow.

If flow rates are exceeded, swing cylinder indexing mechanism may be permanently damaged.



When designing custom clamp arms, the flow rates must be further reduced. This rating should be in proportion to the mass and the center of gravity of the clamp arm.

Example:

If the mass of the arm is twice that of the long arm, flow rates must be reduced by 50%.

Upreach clamp arms *for swing clamps*

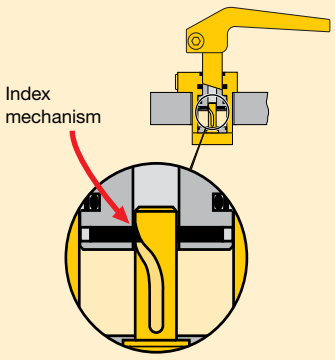
Shown: CAU-352, CAU-122, CAU-22

Enerpac's patented upreach clamp arm design attaches to the hydraulic swing cylinder, allowing parts to be clamped at various distances from the hydraulic cylinder. Clamp arms are available in an extended length which can be machined to fit your unique requirements.

Important

Do not exceed maximum oil flow.

If flow rates are exceeded, swing cylinder indexing mechanism may be permanently damaged.



When designing custom clamp arms, the flow rates must be further reduced. This rating should be in proportion to the mass and the center of gravity of the clamp arm.

Example:

If the mass of the arm is twice that of the long arm, flow rates must be reduced by 50%.

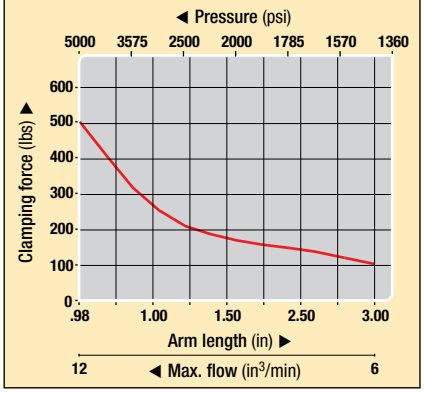
Patented Design

- Upreach design allows more flexible part clamping
- Arm can be easily installed and fastened while the cylinder is mounted in the fixture to allow exact arm positioning
- Vise not required for fastening arms
- Arm length can be cut to desired size
- Angled arm with minimal deflection achieves maximum workpiece contact

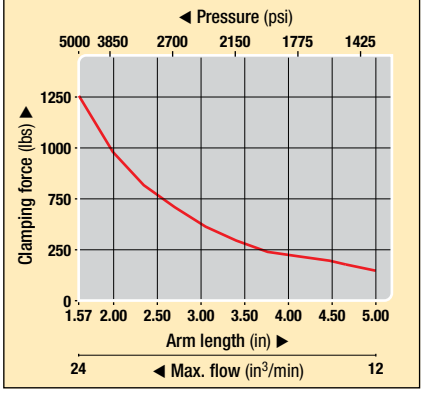
Pressure vs clamping force

The use of different length clamp arms requires reduction in applied pressure and resulting clamp force. The charts below show this relationship.

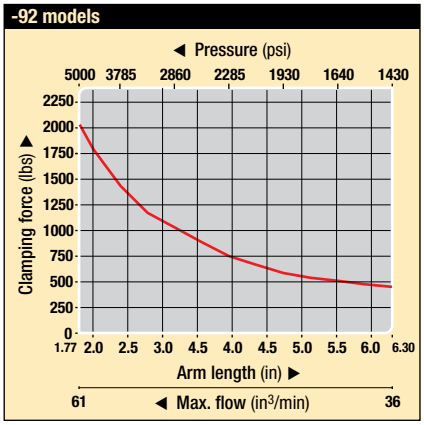
-22 models



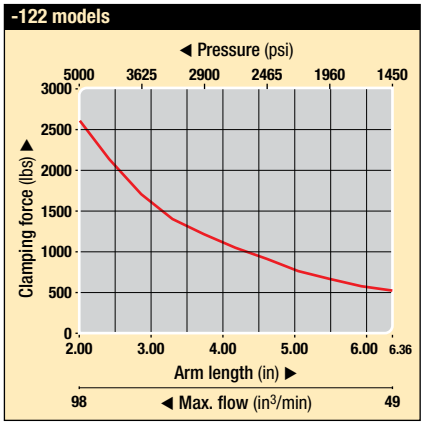
-52 models



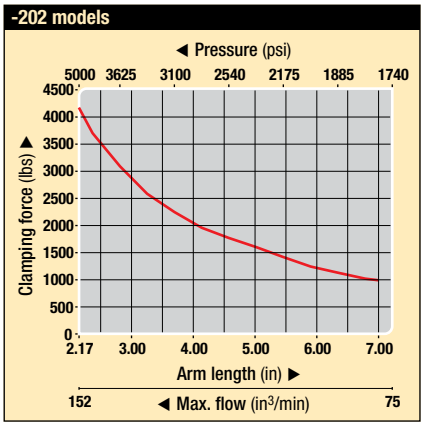
-92 models



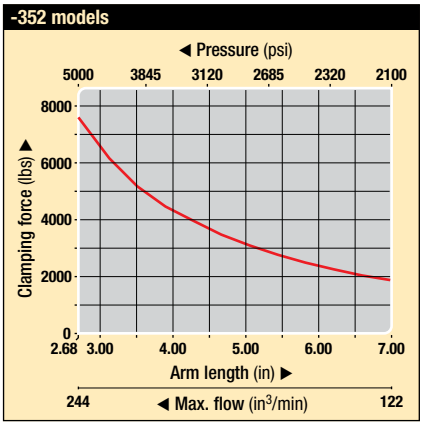
-122 models



-202 models



-352 models

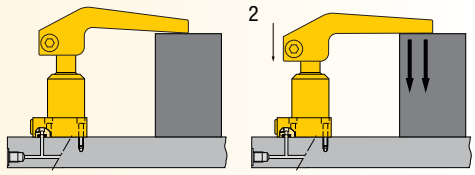


Angled arms use deflection to improve clamping

Angled arms

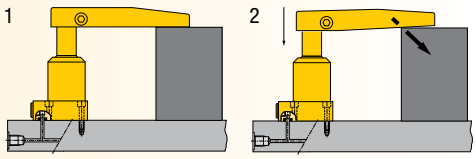
Tip engages part first and contact increases as clamping force is applied.

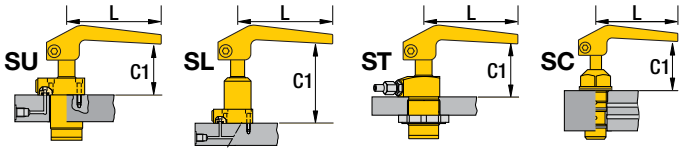
Eliminates “push” effect caused by straight arms deflecting under load.



Straight Arms

Great for most applications, but standard deflection can cause part movement and lower the true clamping force.

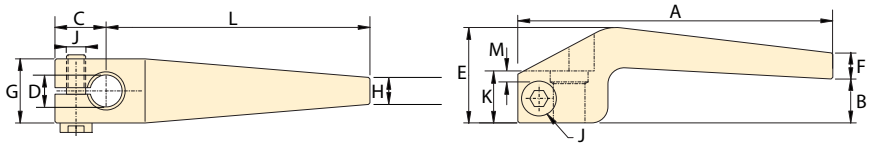




Installation dimensions in inches [⌲⌾]

Model number	Clamp force	L	SU-Series C1	SL-Series C1	ST-Series C1	SC-Series C1
▼ Stock length dimensions						
CAU-22	100	3.25	2.23	4.32	2.23	2.09
CAU-52	200	5.31	2.82	5.42	2.82	3.10
CAU-92	450	6.30	2.90	5.89	3.10	-
CAU-122	500	6.36	3.29	6.67	3.29	3.61
CAU-202	1000	6.99	3.47	6.90	3.75	-
CAU-352	1900	7.09	3.90	7.56	4.18	-
▼ Minimum length dimensions						
CAU-22	500	0.98	2.35	4.44	2.35	2.21
CAU-52	1250	1.57	3.02	5.62	3.02	3.30
CAU-92	2025	1.77	3.14	6.13	3.34	-
CAU-122	2600	2.00	3.52	6.90	3.52	3.84
CAU-202	4200	2.17	3.72	7.15	4.00	-
CAU-352	7600	2.68	4.21	7.87	4.49	-

CAU models **Upreach clamp arms**



Dimensions in inches [⌲⌾]

Model number	A	B	B	C	D	E	F	F	G	H	H	J	K	L	L	M	
		Std.	Min.				Std.	Min.		Std.	Min.	mm		Std.	Min.		lbs
CAU-22	3.88	0.54	0.66	0.63	.393-.394	1.17	0.32	0.54	0.79	0.33	0.82	M6 x 1,0	0.64	3.25	0.98	0.04	0.3
CAU-52	6.10	0.85	1.05	0.79	.630-631	1.65	0.26	0.57	1.18	0.47	1.25	M6 x 1,0	0.75	5.31	1.57	0.05	0.9
CAU-92	7.48	0.93	1.17	1.18	.985-.986	1.89	0.43	0.76	1.57	0.57	1.61	M8 x 1,25	0.98	6.30	1.77	0.09	1.7
CAU-122	7.48	1.11	1.34	1.12	.876-.877	2.25	0.50	1.15	1.50	0.65	1.56	M10 x 1,5	1.18	6.36	2.00	0.15	2.2
CAU-202	8.37	1.27	1.52	1.38	1.260-1.261	2.41	0.52	0.96	2.36	0.68	2.14	M10 x 1,5	1.18	6.99	2.17	0.11	3.7
CAU-352	8.66	1.62	1.93	1.57	1.497-1.498	3.14	0.74	1.35	2.60	0.62	2.13	M10 x 1,5	1.58	7.09	2.68	0.07	5.9

Refer to clamping force charts on page 36.
Never cut shorter than indicated minimum length.

Force: 100 - 7600 lbs

Pressure: 500 - 5000 psi

- **E** Brazos de amarre
- **F** Bras de bridage
- **D** Spannarme

Options

Sequence valves 152

Flow control valves 155

Download CAD files from www.enerpacwh.com

Shown: SC-3, SC-1

SC series

These swing clamps rotate 90˚ as they begin their stroke, continuing without rotation for the final clamping stroke. Cylinders can be changed to left swing, right swing, or pull applications by loosening the side plug and then rotating the plunger to a desired position.

The SC-1 and SC-3 include a retract spring for single-acting operation. Both cylinders can be operated as double-acting cylinders by connecting a retract line to the vent port.

Changeable swing function

...with 360° fully adjustable clamp arm

- Changeable swing function: clamp arm movement can be adjusted to left or right swing, or straight pull function
- 88-92° clamp arm swing arc
- Easy installation: built-in mountings and brackets
- Compact design for use in limited space applications
- Easy and precise locating of arm for clamp positioning
- Single or double-acting cylinders to suit variety of hydraulic requirements

Force: 500 - 2164 lbs

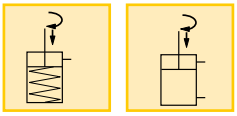
Stroke: .78 - 1.49 inch

Pressure: 1500 - 3000 psi

E Cilindros giratorios

F Vérins de bridage pivotants

D Schwenkspannzylinder



Arm length in	Max. pressure psi	Clamping force lbs
▼ SC-1		
–	3000	2640
2.00[2]	3000	2164
3.00	3000	1960
4.00	3000	1740
5.00	2400	1200
6.00	2000	840
▼ SC-3		
–	3000	700
1.00[2]	3000	500
2.00	2000	250

[2] Standard clamp arm (included).

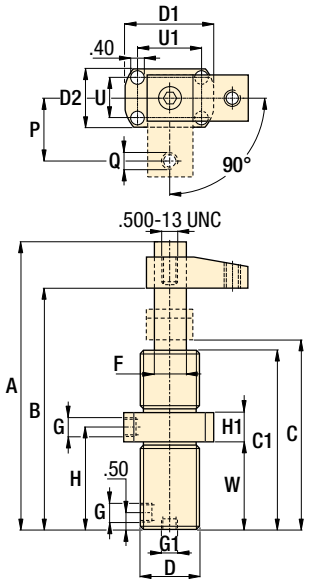
Selection chart

Clamping force[1] lbs	Stroke in Clamp	Stroke in Total	Model number	Cylinder effective area in² Pull	Cylinder effective area in² Push	Oil capacity in³ Pull	Oil capacity in³ Push
2164	.50	1.49	SC-1	.98	1.767	1.47	2.65
500	.25	.78	SC-3	.245	.442	.184	.331

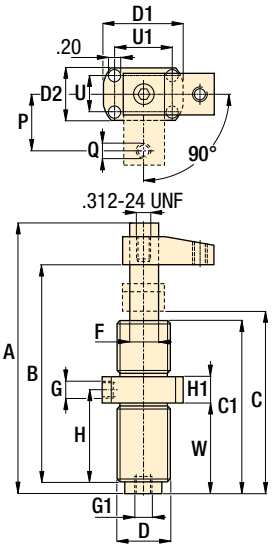
[1] With standard clamp arm (included with cylinder).

Note: - Long clamps arms can be fabricated by the user.
- For long clamp arms, use VFC series flow control valves.

SC-1



SC-3



Product dimensions in inches [⊳◎]

Model number	A	B	C	C1	D	D1	D2	F Ø	G NPT	G1 NPT	H	H1	P	Q UNC	U	U1	W	lbs
SC-1	8.88	7.37	5.87	5.74	1.875-16UN	2.90	1.88	1.00	.250-18	.125-27	3.31	.88	2.00	.375-16	1.28	2.06	2.87	6
SC-3	5.27	4.26	3.71	3.48	1.00-12UNF	2.00	1.13	.50	.125-27	.125-27	2.15	.63	1.00	.250-20	.75	1.50	2.03	2

Force: 1375 - 4375 lbs

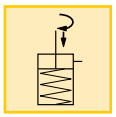
Stroke: .25 - .43 inch

Pressure: 1200 - 2500 psi

(E) **Cilindros giratorios**

(F) **Vérins de bridage pivotants**

(D) **Schwenkspannzylinder**



Adjustable clamping stroke

...turns clockwise or counter-clockwise

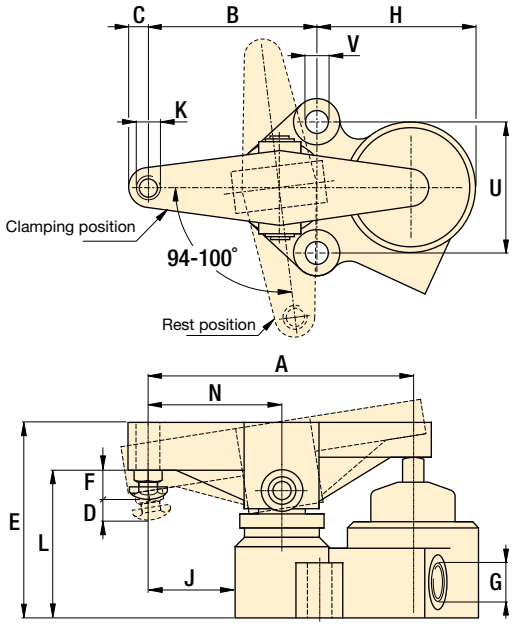
- Adjustable bolt in clamp arm for clamping stroke adjustment
- Low profile, ideal for limited space applications
- Quick swing action allows clamp arm to swing free of cutter and reclamp after it has passed
- 94-100° clamp arm swing arc

Shown: ASC-30

ASC series

Clamping arm rotates 97° clockwise or counter-clockwise (requires easily changed rotation spring) to position itself over the workpiece. Then, a vertical plunger exerts an upward thrust on the back end of the swing arm providing a powerful downward pressure to clamp the workpiece.

ASC-30, -100



Important

For high cycle applications use double-acting cylinders.

Selection chart

Clamping force	Stroke	Model number	Operating pressure	Cylinder effective area	Oil capacity	Max. oil flow	
lbs	in		psi	in^2	in^3	in^3/min	lbs
1375	.25	**ASC-30**	1200 - 2500	.55	.30	115	6
4375	.43	**ASC-100**	1200 - 2500	1.76	1.22	115	18

View of a machining fixture with ASC-30 clamping cylinders.

Product dimensions in inches [⌖]

Model number	A	B	C	D	E	F	G NPT	H	J	K UN	L	N	U	V Ø
ASC-30	5.00	3.38	.50	.25	3.50	.75	.125-27	2.75	1.63	.500-13	2.75	2.50	2.50	.41
ASC-100	7.00	4.50	.53	.43	5.25	.73	.125-27	4.25	2.25	.500-13	4.00	3.50	3.50	.63

Three-position swing cylinder *Application & selection*

Shown: WTR-24

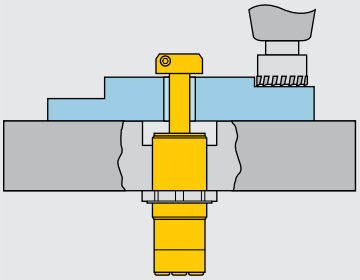
98-043

Unobstructed part loading

- Plunger rotates only when cylinder is fully extended, to minimize obstructions
- Ideal for mounting beneath the fixture, as the clamp does not rotate until the workpiece has been cleared
- Stainless steel body for additional corrosion resistance
- Three port design for fewer hydraulic connections
- Fully threaded body for easy installation
- Standard two sided clamp arm included
- Clamp arm design makes mounting easy

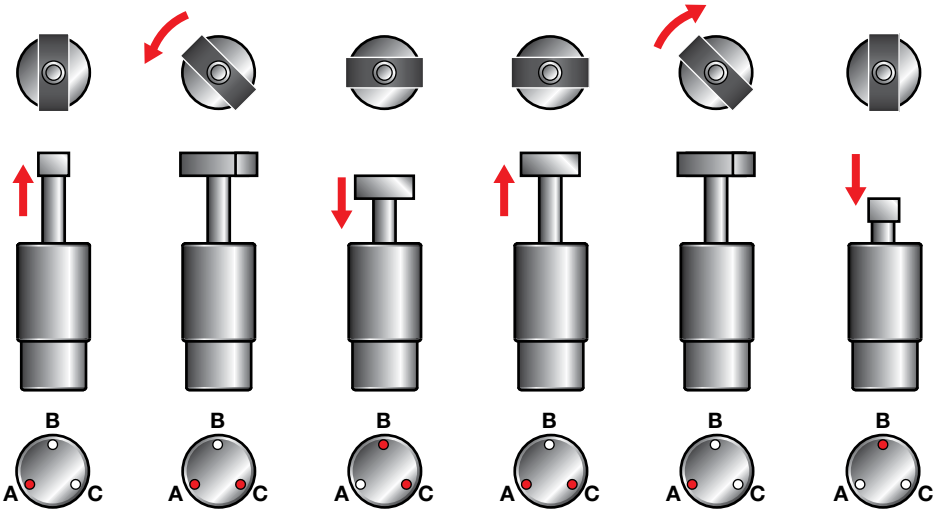
WTR series

The three position swing cylinder rotates 90° only after the plunger has completely extended. This feature allows the clamp to be mounted beneath the workpiece, where the clamp travels through the part for clamping.



Operation sequence

The three position swing cylinder is ideal for parts which have a through hole. The clamp allows completely unobstructed part loading.



Step 1
Pressurize port A.
Plunger extends through workpiece.

Step 2
Keep port A pressurized.
Pressurize port C.
Plunger makes 90° flat rotation.

Step 3
Keep port C pressurized.
Pressurize port B.
Plunger retracts: clamp force is applied.

Step 4
Keep port C pressurized.
Pressurize port A.
Plunger extends: clamp force is released.

Step 5
Keep port A pressurized.
Depressurize port C.
Plunger makes 90° flat rotation.

Step 6
Pressurize port B.
Plunger retracts through workpiece.

Selection chart

Clamping force [1]	Stroke	Model number [2]	Cylinder effective area		Oil capacity		Max. oil flow	Maximum cycle rate
			in²		in³			
lbs	in		Clamp.	Unclamp.	Clamp.	Unclamp.	in³/min	cycles /min
5000	2.50	**WTR-24***	.98	1.77	2.5	4.4	116	4

[1] When using optional CA-28 clamp arm, max. operating pressure is 2000 psi.
[2] Standard clamp arm included.
* This product is made to order. Please contact Enerpac for delivery information before specifying in your design.

Force: 1960 - 5000 lb

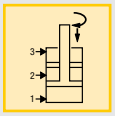
Stroke: 2.50 inch

Pressure: 2000 - 5000 psi

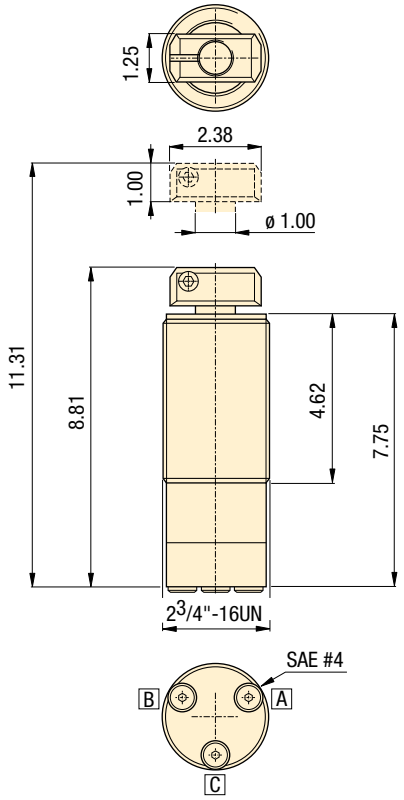
E Cilindros giratorios

F Vérins de bridage pivotants

D Schwenkspannzylinder



WTR-24



A = Advance
B = Retract
C = Rotate 90°

Options

High pressure filters 193 ▸

Fittings 194 ▸

Valves 136 ▸

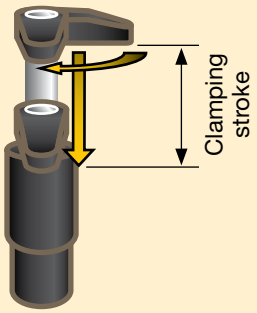
Important

It is highly recommended that system filtration be used to ensure reliable operation.

Do not exceed maximum pressure and flow rates.

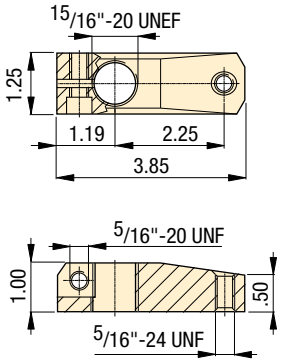
For recommended valving schemes, please refer to page 42.

Clamp arm movement: 90° ± 3° flat rotation.



Optional CA-28 clamp arm

The WTR-24 has a two-sided standard clamp arm included. The CA-28 clamp arm can be used to secure the workpiece on one side only, though the clamping pressure must be reduced to 2000 psi maximum.



WTR-series schematics

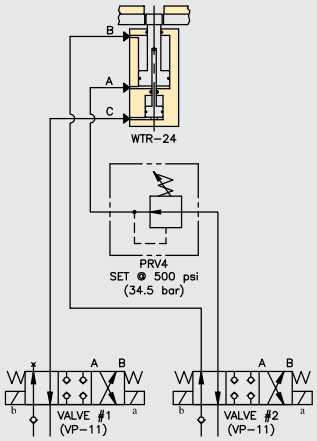
Important

Circuit must include a Pressure Reducing Valve (PRV-4) in the "A" port circuit to reduce the pressure in Unclamp to prevent damage to the cylinder.

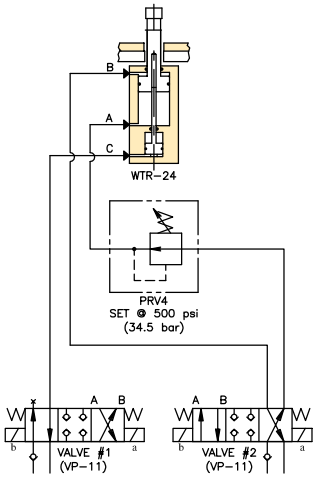
Recommended valving system for WTR-24

- 4-way 3-position closed center valves are recommended
- Valves can be manual or solenoid operated
- Valves must be cycled as shown for proper actuation of the WTR-24

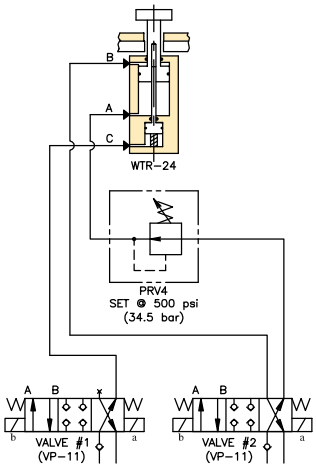
Home Position (Power Off)



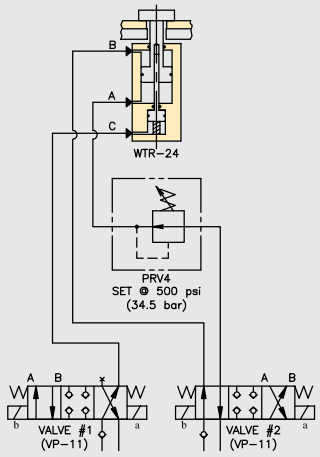
Extend



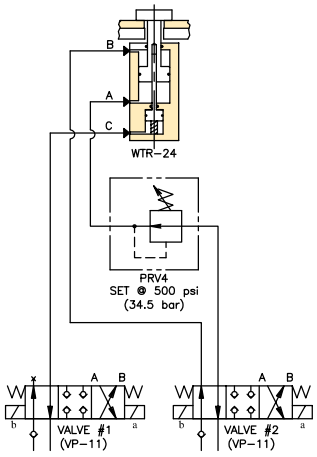
90° Flat Rotation



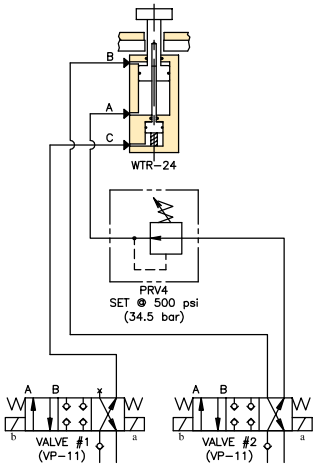
Clamp



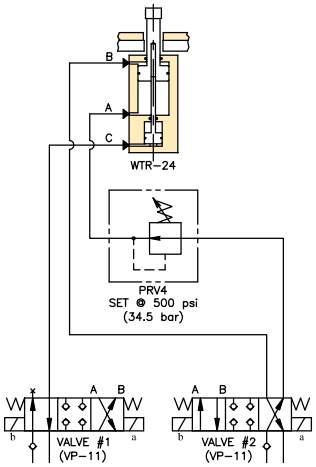
Clamp Hold



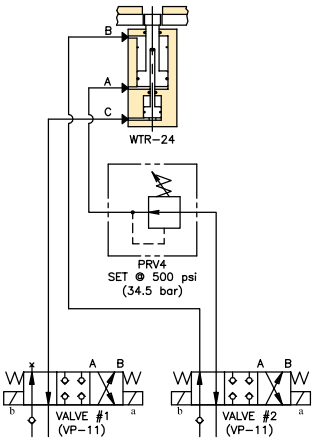
Unclamp



-90° Flat Rotation

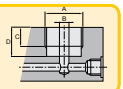


Home Position



ENERPAC

Work supports

	▼ series	▼ page	
Work support range overview		**44 - 45**	
Hydraulic advance work supports	**WF**	**46 - 47**	
Spring advance work supports	**WS**	**48 - 49**	
Work support mounting dimensions	**WF, WS**	**50 - 51**	

Work Supports

Enerpac's line of work support cylinders gives you maximum holding force in a compact package. Incorporating innovative material combinations, our work supports feature the lowest lock-up pressures in the industry. Also, the use of corrosion resistant materials enables Enerpac work supports to stand up time and time again to even the most abrasive applications.

Technical support

Refer to the "Yellow Pages" of this catalog for:

- Safety instructions
- Basic hydraulic information
- Advanced hydraulic technology
- FMS (Flexible Machining Systems) technology
- Conversion charts and hydraulic symbols

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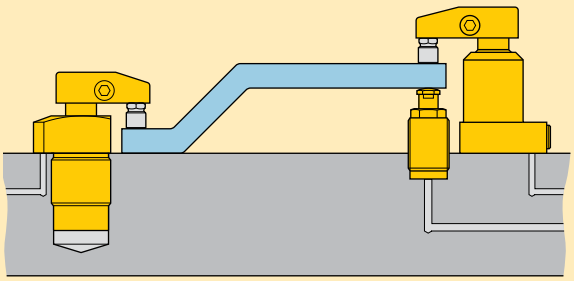
Work supports

Shown: WFL-111, WFC-72, WFL-441

98-046

The Enerpac work support is a hydraulic means of positively supporting the workpiece to minimize deflections.

The work support automatically adjusts to the contour of the workpiece, and then locks in position. This support then adds rigidity to the fixtured component to minimize machining variations.



Lower flange work supports, placed close to the machining area to minimize deflection of the workpiece.

99-044

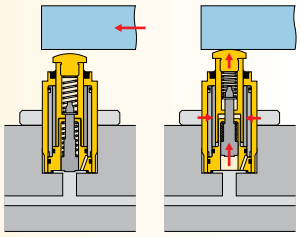
Wide range of sizes and types to efficiently support workpiece

- Low pressure lock-up capability enables the use of machine tool hydraulic systems
- High rated support capacities allow for more compact fixture design
- Corrosion resistant materials, compatible with most coolants and environments
- Threaded and manifold air vent ports allow fixturing that prevents coolants from being drawn into the system
- Minimized deflection increases machining accuracy
- Multiple mounting configurations allow design flexibility

Select your work support method:

WF series, Hydraulic advance

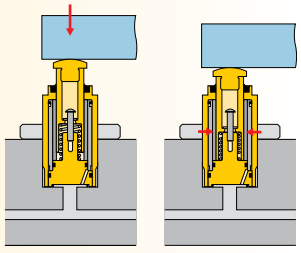
- Retracted plunger allows unobstructed workpiece loading.
- Internal hydraulic plunger advances allowing external plunger to advance under spring load. Bronze sleeve squeezes and holds plunger in fixed position.



46 ▸

WS series, Spring advance

- Workpiece weight compresses the spring of the extended plunger.
- When pressurized, the internal bronze sleeve squeezes and holds the plunger in fixed position.
- Can be operated as air advance.



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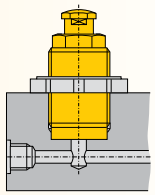
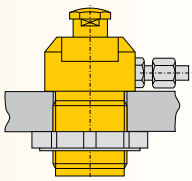
Select your mounting method:

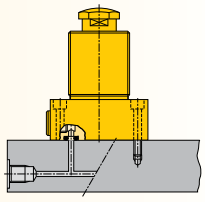
Manifold mount
- Does not require external plumbing
- Compact design, when space is at a premium
- Internal plunger thread for optional contacts



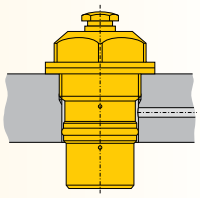
Threaded body
- Ability to adjust height
- Plumbed from either side or bottom
- Internal plunger thread for optional contacts



Lower flange
- Plumbed directly or manifold mounted
- No fixture hole required
- Easy to assemble or disassemble
- Internal plunger thread for optional contacts



Cartridge style
- Does not require external plumbing
- Allows close clustering of work supports
- Compact design, when space is at a premium
- Internal plunger thread for optional contacts



Product selection

Maximum support force	Stroke	Manifold mount	Threaded body	Lower flange	Cartridge style
lbs	in				
▼ Hydraulic advance			Model number		
1650	.39	WFM-71	–	–	–
1650	.40	–	WFT-71	–	–
2500	.40	–	–	WFL-111	–
5000	.41	–	–	WFL-221	–
7500	.53	–	–	WFL-331	–
10,000	.65	–	–	WFL-441	–
1650	.39	–	–	–	WFC-72
2500	.36	–	–	–	WFC-112
5000	.41	–	–	–	WFC-222
▼ Spring advance			Model number		
1650	.38	WSM-71	–	–	–
1650	.38	–	WST-71	–	–
2500	.38	–	–	WSL-111	–
5000	.38	–	–	WSL-221	–
7500	.54	–	–	WSL-331	–
10,000	.66	–	–	WSL-441	–
1650	.38	–	–	–	WSC-72
2500	.38	–	–	–	WSC-112
5000	.47	–	–	–	WSC-222

Force: 1650 - 10,000 lbs

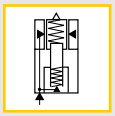
Stroke: .36 - .65 inch

Pressure: 700 - 5000 psi

(E) Cilindros de soporte

(F) Vérin anti-vibreur

(D) Abstützzylinder



Options

Swing cylinders 22

Accessories 86

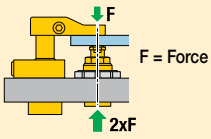
In-line filters 193

Sequence valves 152

Important

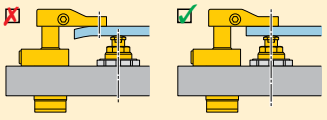
WARNING!

Support force and clamping force must be matched. Support force should be at least 150% of clamping force.



Do not exceed maximum flow rates to avoid premature lockup.

Always center load over work support.



Work supports - Hydraulic advance

Shown: WFM-71, WFL-111

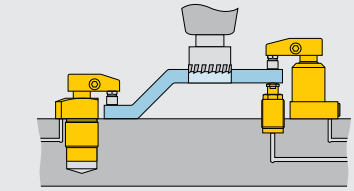
98-047

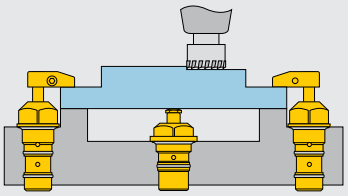
For unobstructed part loading

- Plunger stays retracted until pressure is applied allowing unobstructed loading
- Low pressure lock-up capability enables the use of machine tool hydraulic systems
- High rated support capacities allow for more compact fixture design
- Corrosion resistant materials – compatible with most coolants and environments
- Threaded and manifold air vent ports allow fixturing that prevents coolants and debris from being ingested into the mechanism
- Minimized deflection increases machining accuracy
- Multiple mounting configurations for design flexibility
- Contact bolt included

WF series

Enerpac work supports provide either additional non-fixed location points to the clamps, or support to larger or thin section workpiece components, always in order to minimize workpiece deflection during machining.





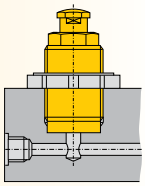
In order to load the workpiece sideways over the work supports, hydraulic advanced models are being used.

99-045

Four mounting styles

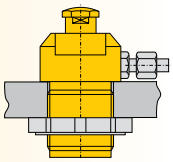
WFM series, Manifold models

Eliminates the need for fittings and tubing on the fixture.



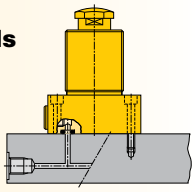
WFT series, Threaded models

Offers the flexibility of side or bottom porting.



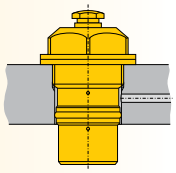
WFL series, Lower flange models

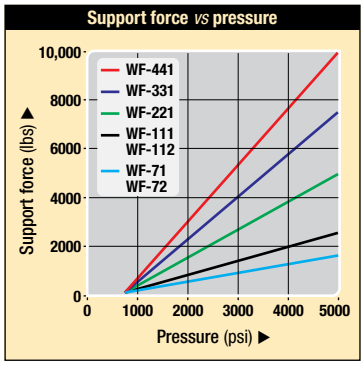
Plumbed directly – no fixture hole required.

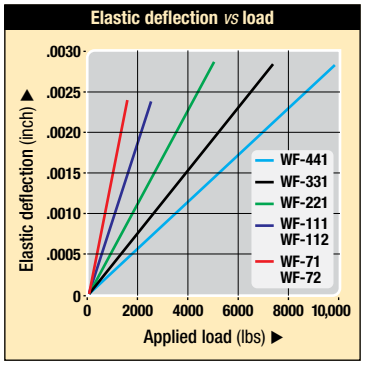


WFC series, Cartridge models

Can be designed into narrow fixture plates as thru-hole mounting is fully functional.

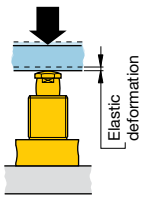






Deflection chart:

Elastic deformation of the work support resulting from the application of load.

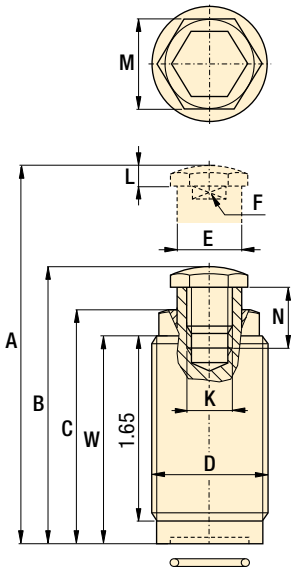


Product selection

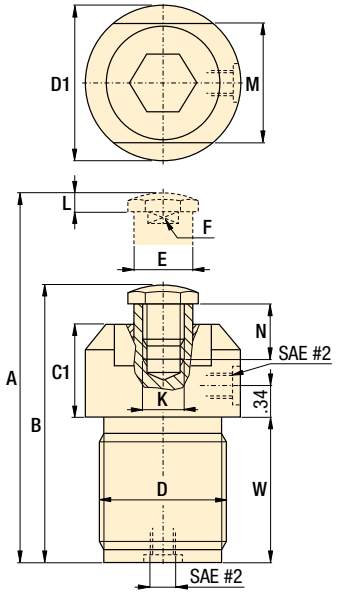
Max. support force	Support plunger stroke	Manifold mount	Threaded body	Lower flange	Cartridge style	Operating pressure		Plunger contact spring force		Oil capacity	Max. oil flow
						psi		lbs			
lbs	in					min.	max.	ext.	retr.	in³	in³/min
1650	.39	**WFM-71**	–	–	–	700	5000	2.0	5.8	.04	40
1650	.40		**WFT-71**	–	–	700	5000	2.0	5.8	.04	40
2500	.40	–	–	**WFL-111**	–	700	5000	3.4	5.2	.06	60
5000	.41	–	–	**WFL-221**	–	700	5000	2.1	19.5	.19	190
7500	.53	–	–	**WFL-331**	–	700	5000	4.0	17.5	.24	240
10,000	.65	–	–	**WFL-441***	–	700	5000	3.3	22.0	.30	300
1650	.39		–	–	**WFC-72**	700	5000	2.0	5.8	.04	40
2500	.36	–	–	–	**WFC-112**	700	5000	3.4	5.2	.06	60
5000	.41	–	–	–	**WFC-222**	700	5000	2.1	19.5	.19	190

* This product is made to order. Please contact Enerpac for delivery information before specifying in your design.

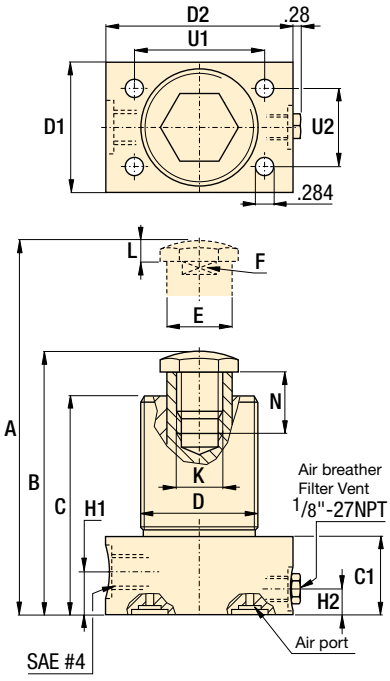
WFM series



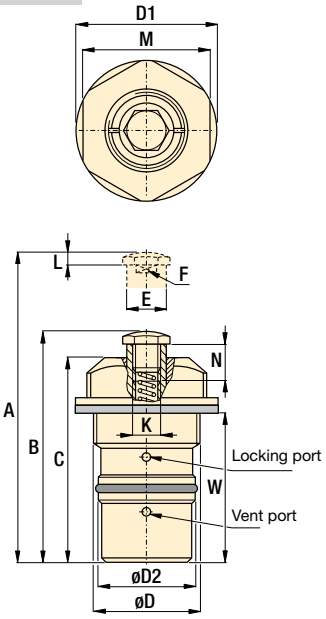
WFT series



WFL series



WFC series



Force: 1650 - 10,000 lbs

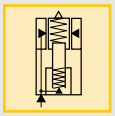
Stroke: .36 - .65 inch

Pressure: 700 - 5000 psi

E Cilindros de soporte

F Vérin anti-vibreur

D Abstützzylinder



Options

Accessories

86 ▸

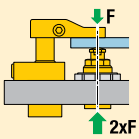
In-line filters

193 ▸

Important

WARNING!

Support force and clamping force must be matched. Support force should be at least 150% of clamping force.



Do not exceed maximum flow rates to avoid premature lockup.

Custom cylinders including longer stroke lengths are available on request.

Mounting dimensions 50 ▸

Product dimensions in inches [ ]

Model number	Capacity	A	B	C	C1	D	D1	D2	E	F	H1	H2	K	L	M	N**	U1	U2	W	
	lbs								Ø				mm							lbs
WFM-71	1650	3.02	2.63	2.20	–	1.250-16 UN	–	–	0.591	0.51	–	–	M10x1,5	0.18	0.95	0.51	–	–	2.00	.5
WFT-71	1650	3.53	3.13	–	1.03	1.375-18 UNEF	1.72	–	0.591	0.51	–	–	M10x1,5	0.18	1.34	0.51	–	–	1.65	.5
WFL-111	2500	3.93	3.54	3.10	1.08	1.375-18 UNEF	1.50	2.38ø	0.629	0.49	.56	.70	M10x1,5	0.18	–	0.73	1.62	0.94	–	1.4
WFL-221	5000	4.13	3.72	3.07	1.04	2.625-20 UN	2.75	3.25	1.496	1.00	.55	.52	M20x2,5	0.24	–	0.92	2.19	2.19	–	4.8
WFL-331	7500	4.42	3.89	3.46	1.07	2.88ø	3.00	3.50	1.771	1.18	.53	.43	M20x2,5	0.24	–	0.93	2.44	2.44	–	6.3
WFL-441*	10,000	5.09	4.44	4.06	1.19	3.37ø	3.50	4.00	2.165	1.44	.53	.43	M20x2,5	0.24	–	1.24	2.94	2.94	–	9.5
WFC-72	1650	3.22	2.83	2.46	–	M33x1,5	1.66	1.18	0.591	0.51	–	–	M10x1,5	0.18	1.50	0.51	–	–	1.98	.9
WFC-112	2500	4.03	3.67	3.23	–	M42x1,5	2.25	1.50	0.629	0.49	–	–	M10x1,5	0.18	2.00	0.73	–	–	2.37	2.0
WFC-222	5000	4.56	4.15	3.60	–	M60x1,5	3.00	2.25	1.496	1.00	–	–	M20x2,5	0.24	2.75	0.92	–	–	2.72	4.0

* This product is made to order. Please contact Enerpac for delivery information before specifying in your design.
** **Note:** Dimension N is factory set. May change on types **221, 331** and **441** due to adjusted contact spring force.
Note: For manifold mounting dimensions (50).

Work supports - Spring advance

Shown: WSL-111, WSM-71

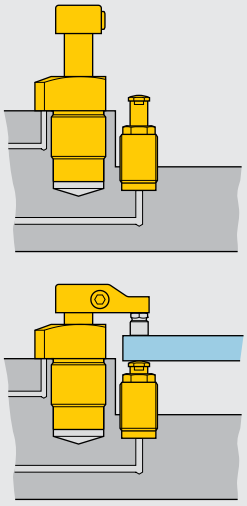
99-048

Spring advance work support contacts workpiece as it is loaded into fixture

- Low pressure lock-up capability enables the use of machine tool hydraulic systems
- High rated support capacities allow for more compact fixture design
- Corrosion resistant materials, compatible with most coolants and environments
- Threaded and manifold air vent ports allow fixturing that prevents coolants from being drawn into the system
- Minimized deflection increases machining accuracy
- Multiple mounting configurations allow design flexibility
- Can be operated as air advance by removing the spring and applying air pressure on the vent port

WS series

Enerpac work supports provide either additional non-fixed location points to the clamps, or support to larger or thin section workpiece components, always in order to minimize workpiece deflection during machining.



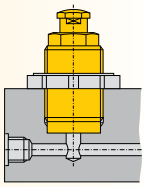
Spring advance work supports with extended plungers, waiting for the next workpiece.

99-046

Mounting style

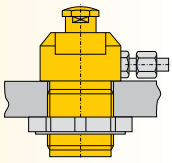
WSM series, Manifold mount

Eliminates the need for fittings and tubing on the fixture.



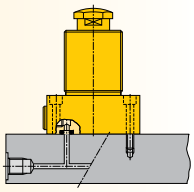
WST series, Threaded body

Offers the flexibility of side or bottom porting.



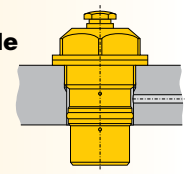
WSL series, Lower flange

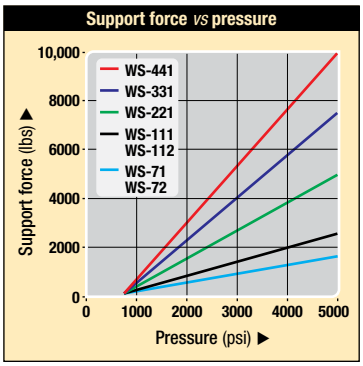
Plumbed directly – no fixture hole required.

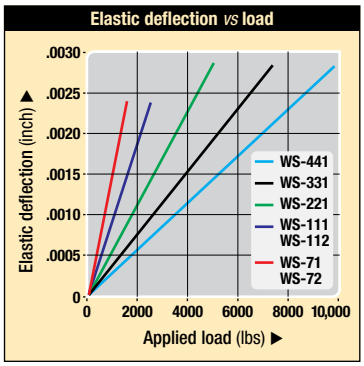


WSC series, Cartridge mount style

Can be designed into narrow fixture plates as thru-hole mounting is fully functional.

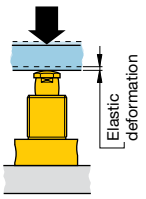






Deflection chart:

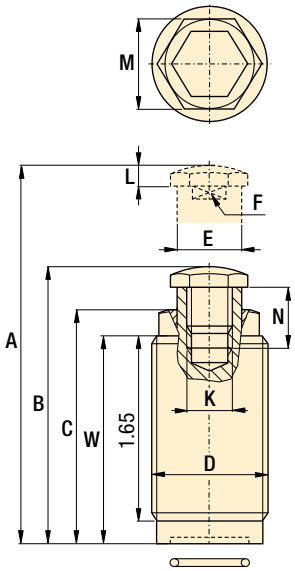
Elastic deformation of the work support resulting from the application of load.



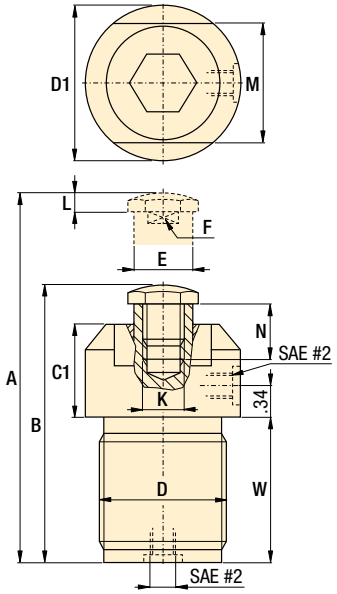
Product selection

Max. support force lbs	Support plunger stroke in	Manifold mount	Threaded body	Lower flange	Cartridge style	Operating pressure psi min.	Operating pressure psi max.	Plunger contact spring force lbs ext.	Plunger contact spring force lbs retr.	Oil capacity in³	Max. oil flow in³/min
1650	.38	**WSM-71**	–	–	–	700	5000	2.0	5.8	.04	40
1650	.38		**WST-71**	–	–	700	5000	2.0	5.8	.04	40
2500	.38	–	–	**WSL-111**	–	700	5000	3.4	5.2	.06	60
5000	.38	–	–	**WSL-221**	–	700	5000	2.1	19.5	.19	190
7500	.54	–	–	**WSL-331**	–	700	5000	4.0	17.5	.24	240
10,000	.66	–	–	**WSL-441***	–	700	5000	3.3	22.0	.30	300
1650	.38		–	–	**WSC-72**	700	5000	2.0	5.8	.04	40
2500	.38	–	–	–	**WSC-112**	700	5000	3.4	5.2	.06	60
5000	.47	–	–	–	**WSC-222**	700	5000	2.1	19.5	.19	190

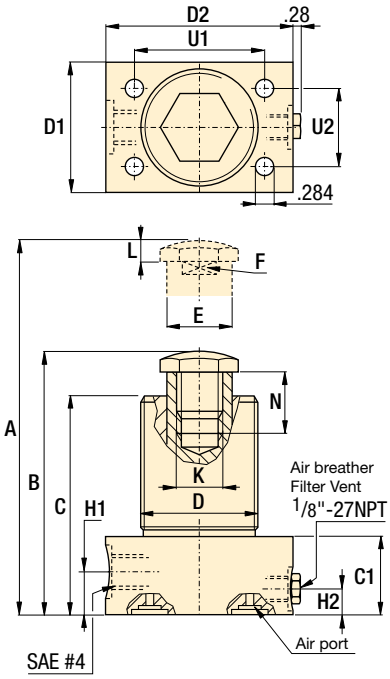
WSM series



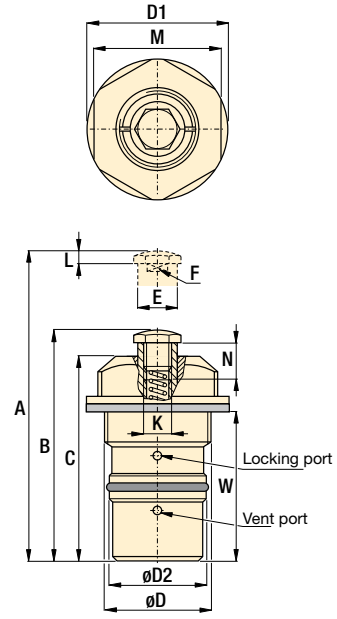
WST series



WSL series



WSC series



Force: 1650 - 10,000 lbs

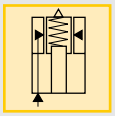
Stroke: .38 - .66 inch

Pressure: 700 - 5000 psi

E Cilindros de soporte

F Vérin anti-vibreur

D Abstützzylinder



Options

Accessories

86 ▸

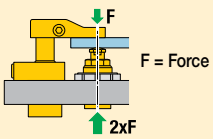
In-line filters

193 ▸

Important

WARNING!

Support force and clamping force must be matched. Support force should be at least 150% of clamping force.



Do not exceed maximum flow rates to avoid premature lockup.

Custom cylinders including longer stroke lengths are available on request.

Mounting dimensions 50 ▸

Product dimensions in inches [ ]

Model number	Capacity	A	B	C	C1	D	D1	D2	EØ	F	H1	H2	K	L	M	N**	U1	U2	W	
	lbs												mm							lbs
WSM-71	1650	3.00	2.62	2.20	–	1.250-16 UN	–	–	.591	.51	–	–	M10x1,5	.18	.95	.51	–	–	2.00	.5
WST-71	1650	3.51	3.13	–	1.03	1.375-18 UNEF	1.72 ø	–	.591	.51	–	–	M10x1,5	.18	1.34	.51	–	–	1.65	.5
WSL-111	2500	3.36	2.98	2.54	.95	1.375-18 UNEF	1.50	2.38	.629	.49	.44	.39	M10x1,5	.18	–	.73	1.62	.94	–	1.4
WSL-221	5000	3.91	3.53	2.95	.98	2.625-20 UN	2.75	3.25	1.496	1.00	.48	.40	M20x2,5	.24	–	.92	2.19	2.19	–	4.8
WSL-331	7500	4.29	3.75	3.37	1.07	2.88 ø	3.00	3.50	1.771	1.18	.51	.37	M20x2,5	.24	–	.93	2.44	2.44	–	6.3
WSL-441*	10,000	4.99	4.33	4.04	1.19	3.37 ø	3.40	4.00	2.165	1.44	.53	.43	M20x2,5	.24	–	1.24	2.94	2.94	–	9.5
WSC-72	1650	3.20	2.82	2.46	–	M33x1,5	1.67ø	1.18	.591	.51	–	–	M10x1,5	.18	1.50	.51	–	–	1.98	0.9
WSC-112	2500	3.38	3.00	2.56	–	M42x1,5	2.25 ø	1.50	.629	.49	–	–	M10x1,5	.18	2.00	.73	–	–	1.70	2.0
WSC-222	5000	3.98	3.51	3.00	–	M60x1,5	3.00 ø	2.25	1.496	1.00	–	–	M20x2,5	.24	2.75	.92	–	–	2.12	4.0

* This product is made to order. Please contact Enerpac for delivery information before specifying in your design.
** **Note:** Dimension N is factory set. May change on types **221, 331** and **441** due to adjusted contact spring force.
Note: For manifold mounting dimensions (50).

Mounting dimensions *for work supports*

Shown: WFL-221 holding a casting in place.

Foto B

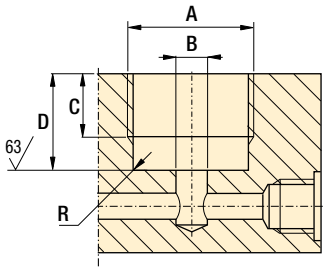
Mounting work supports

Enerpac work supports are offered in a wide variety of mounting styles. Dimensions for fixture holes and cavity preparation are specified for each mounting style separately.

Manifold work support mounting dimensions

Eliminates the need for fittings and tubing on the fixture. Use a flange nut to secure your manifold work support.

WFM/WSM



Product dimensions in inches [⌖]

Model number	A	B ø	C	D	R	Manifold O-ring [1]	Flange nut
▼ For manifold mount work supports							
WFM-71	1.250-16 UN 2B	.37-.39	.58-.60	.93-.95	.015	ARP-017	FN-301
WSM-71	1.250-16 UN 2B	.37-.39	.58-.60	.93-.95	.015	ARP-017	FN-301

[1] Polyurethane 92 duro.

Threaded work support mounting dimensions

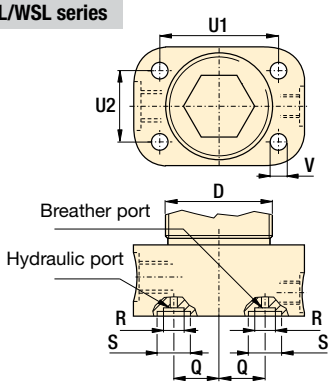
Threaded body work supports can be mounted directly into a fixture. The thread size (D) can be found in the dimension charts on ⌑47 (WFT) and ⌑49 (WST models). Use a flange nut to secure your threaded work support in the required position.

Lower flange work support mounting dimensions

Lower flange work supports can be bolted straight onto a fixture, or can be mounted into a fixture. Flange nuts can be used to secure the cylinders at the required height.

Note: It is critical to keep breather port open to clean dry location.

WFL/WSL series



The combination of Enerpac swing cylinders and work supports guarantee clamping without deformation.

30007_5

Product dimensions in inches [⌖]

Model numbers	D	Q	R ø	S ø	U1	U2	V	Manifold O-ring [1]	Flange nut
▼ For lower flange work supports									
WFL-111	1.375-18UNEF	.57	.23	.37	1.62	.94	.284	ARP-010	FN-351
WFL-221	2.625-20UN	1.08	.34	.56	2.18	2.18	.284	ARP-110	—
WFL-331	2.88	1.20	.34	.56	2.44	2.44	.284	ARP-110	—
WFL-441	3.38	1.44	.34	.56	2.94	2.94	.284	ARP-110	—
WSL-111	1.375-18UNEF	.57	.23	.34	1.62	.94	.284	ARP-010	FN-351
WSL-221	2.625-20UN	1.08	.34	.56	2.18	2.18	.284	ARP-110	—
WSL-331	2.88	1.20	.34	.56	2.44	2.44	.284	ARP-110	—
WSL-441	3.38	1.44	.34	.56	2.94	2.94	.284	ARP-110	—

[1] Polyurethane 92 duro.

Cartridge work support mounting dimensions

Can be designed onto narrow fixture plates as thru-hole mounting is fully functional.

Force: 1650 - 10,000 lbs

Stroke: .36 - .66 inch

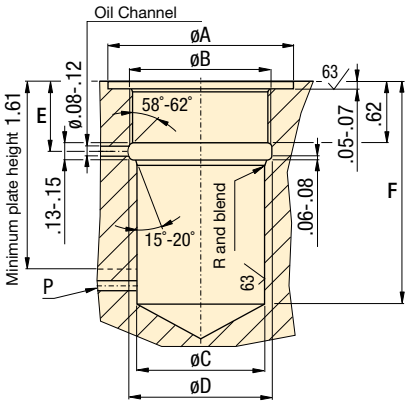
Pressure: 700 - 5000 psi

E **Cilindros de soporte**

F **Vérin anti-vibreur**

D **Abstützzylinder**

WFC/WSC



Dimensions in inches [⌲ ⌖]

Model numbers	A	B	C	D	E	F	Ventilation below force required
		mm				min.	
▼ **Hydraulic advance**							
WFC-72	1.68-1.70	M33x1,5	1.182-1.184	1.31-1.33	.62-.68	2.08	No
WFC-112	2.26-2.28	M42x1,5	1.499-1.501	1.67-1.69	.69-.75	2.46	Yes
WFC-222	3.01-3.03	M60x1,5	2.249-2.251	2.38-2.40	.69-.72	2.80	Yes
▼ **Spring advance**							
WSC-72	1.68-1.70	M33x1,5	1.182-1.184	1.31-1.33	.62-.68	2.08	No
WSC-112	2.26-2.28	M42x1,5	1.499-1.501	1.67-1.69	.69-.75	1.80	Yes
WSC-222	3.01-3.03	M60x1,5	2.249-2.251	2.38-2.40	.69-.72	2.20	Yes

Note: Ventilation required on WFC-112, 222 below 1.61 inch when mounted in blind cavity.

Options

Accessories 86

In-line filters 193

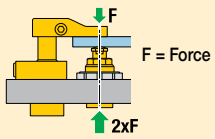
Fittings 194

Swing cylinders 22

Important

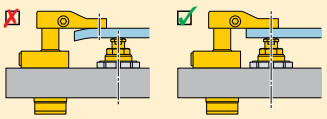
WARNING!

Support force and clamping force must be matched. Support force should be at least 150% of clamping force.



Do not exceed maximum flow rates to avoid premature lockup.

Always center load over work support.



Linear cylinders

Linear Cylinders

A wide variety of styles and features make Enerpac's linear cylinder line the most complete in the industry. Ranging from compact short stroke spring return cylinders to heavy-duty industrial grade double-acting automation cylinders, Enerpac has the cylinder to meet every application need. Whether you have to push it, pull it, clamp it, punch it, stamp it, press it, or hold it in place for days at a time, Enerpac has the cylinder to meet your need.

Technical support

Refer to the "Yellow Pages" of this catalog for:

- Safety instructions
- Basic hydraulic information
- Advanced hydraulic technology
- FMS (Flexible Machining Systems) technology
- Conversion charts and hydraulic symbols

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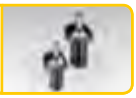
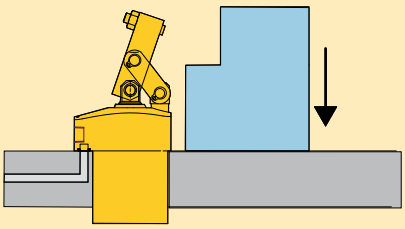
	▼ series	▼ page	
Link clamp / Link clamp arms	LU LCA	54 - 55 56 - 57	
Pull cylinder range overview		**58 - 59**	
Upper flange pull cylinders	PU	60 - 61	
Lower flange pull cylinders	PL	62 - 63	
Threaded body pull cylinders	PT	64 - 65	
Linear cylinders		**66 - 93**	
Threaded cylinders	CST, CDT	66 - 67	
Additional threaded cylinders	CYDA, WMT, WRT	68 -69	
Manifold cylinders	CSM	70 - 71	
Block cylinders	CSB CDB	72 - 75	
Pull down clamps	ECH, ECM	76 - 77	
Hollow plunger cylinders	CY, HCS, QDH, RWH	78 - 79	
Positive clamping cylinders	MRS	80 - 81	
Single-acting universal cylinders	RW, MRW, REB, REP	82 - 83	
Double-acting universal cylinders	RD, AD	84 - 85	
Cylinder accessories		86 - 87	
Tie rod cylinder	TR	88 - 92	
Tie rod accessories	TR	93	

Link clamp *Application & selection*

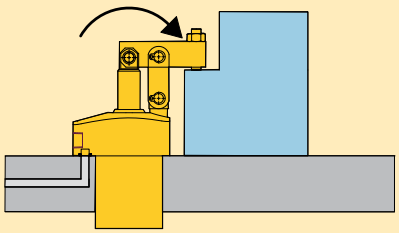
Shown: LUCS-31

Link clamp allows unobstructed part loading and high clamping forces. The hydraulic cylinders extend to provide clamping force, and retract to allow part removal.

Arm completely retracts to allow part loading.

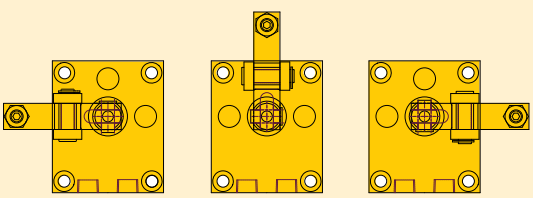


As cylinder extends, arm pivots to clamp part in place.



Arm location is changed easily without the use of tools.

Left Center Right



Quick and accurate clamping action

- Hydraulic cylinder pushes linkage, pivoting clamp arm into position
- Design ensures repeatable clamping location
- Linkage can be re-positioned to clamp at 90, 180, or 270 degrees from ports
- Clamps can be mounted using supplied bolts or held in place with flange nut
- Standard arm or long arm ordered separately

Product selection

Clamping force[1)] lbs	Stroke in	Model number	Cylinder effective area in²	Oil capacity in³	Standard clamp arm (Sold separately)	Long clamp arm (Sold separately)
▼ **Single acting**						
675	0.73	**LUCS-31**	0.19	0.14	**LCAS-32**	**LCAL-32**
1750	0.92	**LUCS-81**	0.48	0.44	**LCAS-82**	**LCAL-82**
2650	1.17	**LUCS-121**	0.64	0.77	**LCAS-122**	**LCAL-122**
4200	1.36	**LUCS-191**	0.99	1.38	**LCAS-192**	**LCAL-192**
6100	1.76	**LUCS-281***	1.49	2.76	**LCAS-282**	**LCAL-282**
▼ **Double acting**						
700	0.73	**LUCD-31**	0.19	0.14	**LCAS-32**	**LCAL-32**
1800	0.92	**LUCD-81**	0.48	0.44	**LCAS-82**	**LCAL-82**
2700	1.17	**LUCD-121**	0.64	0.77	**LCAS-122**	**LCAL-122**
4300	1.36	**LUCD-191**	0.99	1.38	**LCAS-192**	**LCAL-192**
6300	1.76	**LUCD-281***	1.49	2.76	**LCAS-282**	**LCAL-282**

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Contact Enerpac for models with metric threads and BSPP ports.

* This product is made to order. Please contact Enerpac for delivery information before specifying in your design.

Dimensions in inches [⊕]

Model number	Port Size	C1	C2	C3	D	D1	D2	E
▼ **Single acting**								
LUCS-31	SAE#2	1.10	1.44	2.17	1.875-16UN	2.44	2.20	27.9°
LUCS-81	SAE#2	1.18	1.63	2.56	2.50-16UN	3.23	2.76	31.1°
LUCS-121	SAE#4	1.46	1.95	3.12	3.125-16 UN	4.02	3.46	28.5°
LUCS-191	SAE#4	1.57	2.30	3.66	3.50-16 UN	4.69	4.02	28.3°
LUCS-281*	SAE#4	1.97	2.60	4.36	4.125-16 UN	5.31	4.72	24.8°
▼ **Double acting**								
LUCD-31	SAE#2	1.10	1.44	2.17	1.875-16 UN	2.44	2.20	27.9°
LUCD-81	SAE#2	1.18	1.63	2.56	2.50-16 UN	3.23	2.76	31.1°
LUCD-121	SAE#4	1.46	1.95	3.12	3.125-16 UN	4.02	3.46	28.5°
LUCD-191	SAE#4	1.57	2.30	3.66	3.50-16 UN	4.69	4.02	28.3°
LUCD-281*	SAE#4	1.97	2.60	4.36	4.125-16 UN	5.31	4.72	24.8°

Contact Enerpac for models with metric threads and BSPP ports.

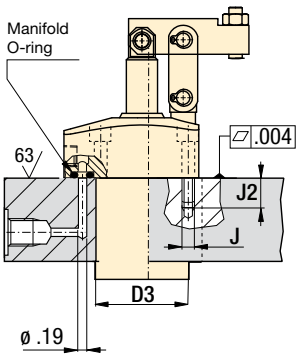
* This product is made to order. Please contact Enerpac for delivery information before specifying in your design.

Installation dimensions in inches

Clamp[1] force lbs	Fixture hole Ø D3	Mounting thread J UNF	Min. depth J2	Manifold O-ring [2] ARP No. or Inside Ø x thickness
700	1.885	.250-28	0.65	-010
1800	2.510	.312-24	0.75	-010
2700	3.135	.312-24	0.75	-010
4300	3.515	.375-24	0.88	-010
6300	4.140	.500-20	0.94	-010

[1] With standard clamp arm.
[2] Polyurethane, 92 Durometer

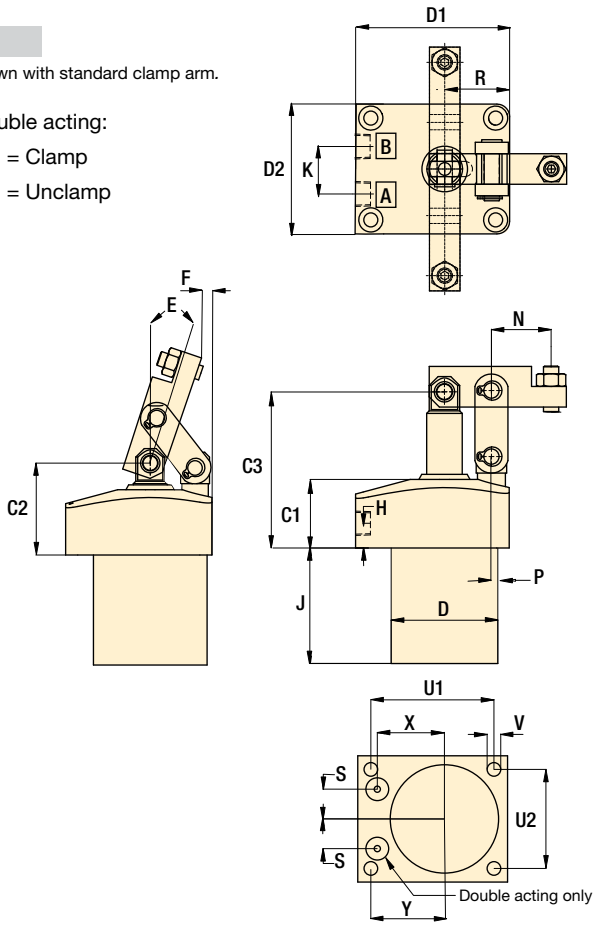
Note: Mounting bolts and O-rings included.



all models

Dimensions shown with standard clamp arm.

Double acting:
A = Clamp
B = Unclamp



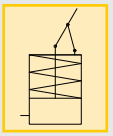
F	H	J	K	N	P	R	S	U1	U2	V Ø	X	Y	lbs
													Single acting ▼
0.04	0.43	1.85	-	0.93	0.33	1.10	0.411	2.05	1.81	0.26	1.128	1.14	2.7
0.02	0.43	2.48	-	1.25	0.35	1.38	0.552	2.68	2.20	0.32	1.517	1.57	5.5
0.03	0.47	2.80	-	1.48	0.47	1.73	0.633	3.46	2.91	0.32	1.739	2.01	10.0
0.03	0.59	3.46	-	1.63	0.59	2.01	0.714	3.98	3.23	0.41	1.961	2.32	15.2
0.08	0.79	3.90	-	2.01	0.63	2.36	0.821	4.53	3.94	0.51	2.257	2.56	25.9
													Double acting ▼
0.04	0.43	1.85	0.79	0.93	0.33	1.10	0.849	2.05	1.81	0.26	0.807	1.14	2.7
0.02	0.43	2.48	0.94	1.25	0.35	1.38	1.000	2.68	2.20	0.32	1.191	1.57	5.5
0.03	0.47	2.80	1.18	1.48	0.47	1.73	1.039	3.46	2.91	0.32	1.484	2.01	10.0
0.03	0.59	3.46	–	1.63	0.59	2.01	1.112	3.98	3.23	0.41	1.926	2.32	15.2
0.08	0.79	3.90	1.50	2.01	0.63	2.36	1.181	4.53	3.94	0.51	2.046	2.56	25.9

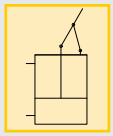
Clamp force: 675-6300 lbs

Stroke: 0.73-1.76 inch

Pressure: 500-5000 psi

E Cilindros Amarre de enlace
F Bride basculante
D Gelenkspanner





Options

Clamp arms
57 ▶

Work supports
43 ▶

Important

Single-acting cylinders use a regenerative circuit; oil is sent to both sides of the piston at the same time. This eliminates the breather port, reducing damage from coolant and contamination.

Clamp arm should be parallel to cylinder mounting surface within 3° to avoid damage to cylinder and linkage. Use the included set screw to adjust clamp arm alignment.

Clamp arms *for link clamps*

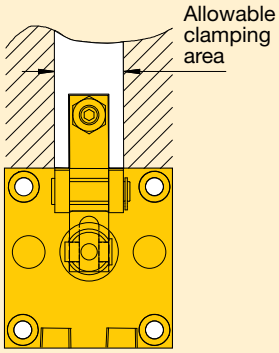
Shown: LCAS-31

1207300029

Standard arms are readily available from Enerpac to meet most applications. In applications that require a custom designed arm, the machining information is supplied on page 57.

Important

Clamp point must be within the boundaries of the anchor links on the clamp. Clamping outside of this area will cause damage to the linkage, leading to premature failure.

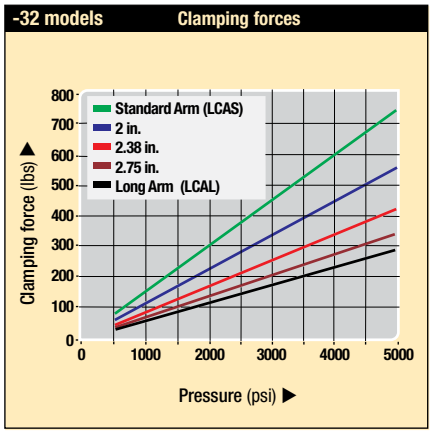


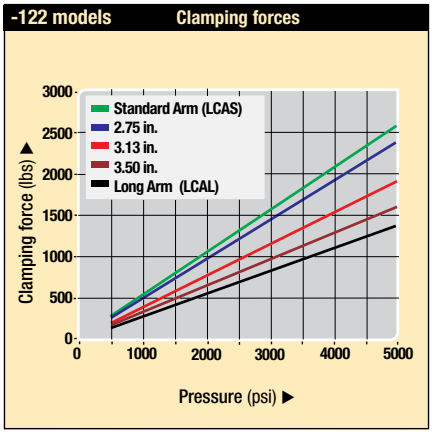
Standard or custom built

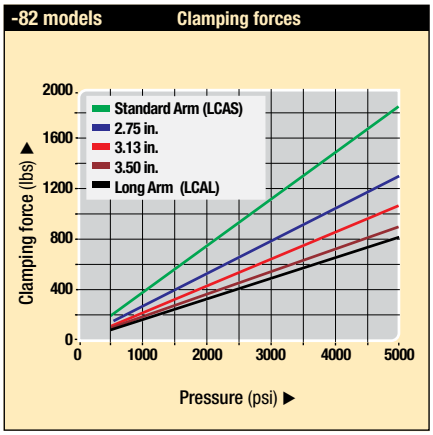
- Available from Enerpac in standard or extended length
- Standard arm includes set screw and lock nut
- Long arm is machinable
- Make your own custom arm to suit specific applications

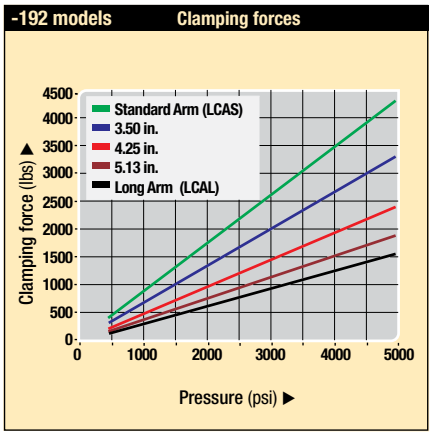
Pressure vs clamping force

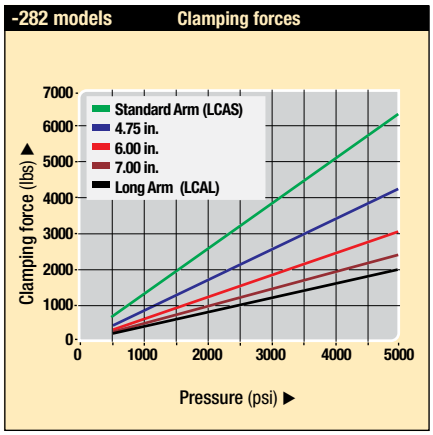
Different length clamp arms will determine the amount of clamping force transferred to the workpiece. As the length increases, the clamping force decreases.



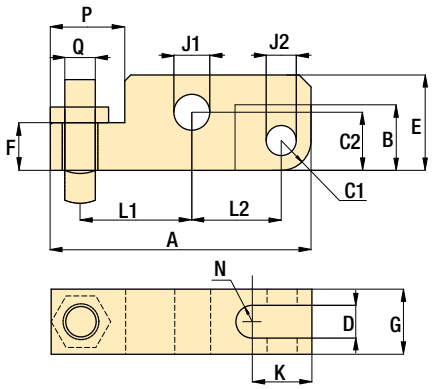








LCAS models Standard Arm

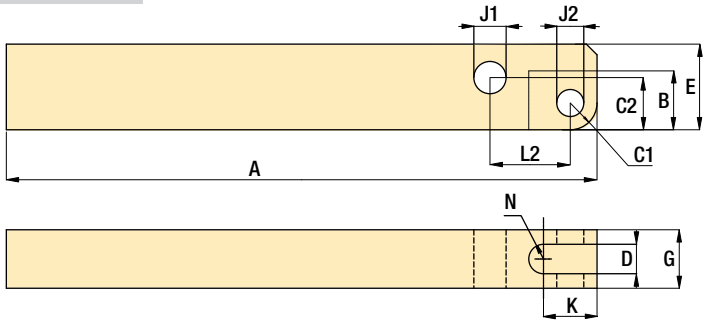


Dimensions in inches [⊕]

Clamp capacity lbs	Model number	A	B	C1	C2	D	E	F	G
▼ Standard clamp arms									
700	LCAS-32	2.13	0.51	0.24	0.37	0.24	0.63	0.31	0.47
1800	LCAS-82	2.93	0.69	0.31	0.61	0.39	0.98	0.51	0.74
2700	LCAS-122	3.44	0.87	0.39	0.77	0.43	1.26	0.63	0.86
4300	LCAS-192	4.04	1.02	0.43	0.94	0.51	1.50	0.87	0.98
6300	LCAS-282	4.92	1.20	0.51	1.14	0.63	1.77	1.06	1.25

Clamp. capacity lbs	Model number	J1	J2	K	L1	L2	N	P	Q mm
▼ Standard clamp arms									
700	LCAS-32	0.237-0.239	0.237-0.239	0.51	0.93	0.73	0.12	0.51	M6 x 1,0
1800	LCAS-82	0.396-0.398	0.317-0.319	0.63	1.26	0.96	0.20	0.87	M10 x 1,5
2700	LCAS-122	0.474-0.476	0.396-0.398	0.79	1.48	1.18	0.22	0.98	M12 x 1,75
4300	LCAS-192	0.593-0.595	0.474-0.476	0.94	1.63	1.42	0.26	1.22	M16 x 2,0
6300	LCAS-282	0.711-0.713	0.593-0.595	1.10	2.01	1.73	0.31	1.50	M20 x 2,5

LCAL models Long Arm



NOTE: Custom arms should be manufactured using this print. Make sure to follow all precautions listed.

Dimensions in inches [⊕]

Clamp. capacity lbs	Model number	A	B	C1	C2	D	E	G	J1	J2	K	L2	N
▼ Long clamp arms													
800	LCAL-32	3.35	0.51	0.24	0.37	0.24	0.63	0.47	0.237-0.239	0.237-0.239	0.51	0.73	0.12
1800	LCAL-82	4.13	0.69	0.31	0.61	0.39	0.98	0.74	0.396-0.398	0.317-0.319	0.63	0.96	0.20
2700	LCAL-122	4.33	0.87	0.39	0.77	0.43	1.26	0.86	0.474-0.476	0.396-0.398	0.79	1.18	0.22
4300	LCAL-192	6.30	1.02	0.43	0.94	0.51	1.50	0.98	0.593-0.595	0.474-0.476	0.94	1.42	0.26
6300	LCAL-282	8.66	1.20	0.51	1.14	0.63	1.77	1.25	0.711-0.713	0.593-0.595	1.10	1.73	0.31

Force: 700-6300 lbs

Pressure: 500-5000 psi

- (E) Brazos de amarre
- (F) Bras de bridage
- (D) Spannarme

Options

Work supports

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Accessories

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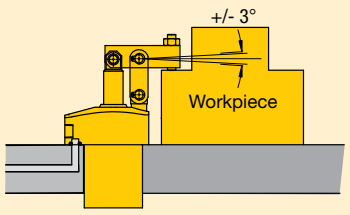
Important

Clamp arm should be parallel to cylinder mounting surface within 3° to avoid damage to cylinder and linkage. Use the included set screw to adjust clamp arm alignment.



Pull cylinders *Application & selection*

Shown: PLSS-121, PUSD-121

Hydraulic pull cylinders utilize hydraulic pressure to hold down parts in a fixture. The guided plunger maintains orientation during the full clamping cycle, eliminating the need for an external guide. Internally threaded plunger ends accept various custom attachments to assist in the clamping process.

Enerpac offers both single- and double-acting pull cylinders, with capacities ranging from 1250 to 9600 lbs. for pulling and 2950 to 18,400 lbs. for pushing applications.

Hydraulic fixture with pull and swing cylinders, manifold and threaded cylinders for positioning and holding the work piece during milling process of gun breeches.

99062-2

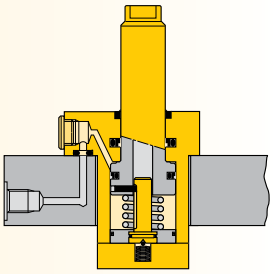
Compact and full featured design

- Guided linear plunger movement
- Compact design allows for efficient fixture layout
- Variety of mounting styles to meet design needs
- Internal plunger thread and flats across plunger top allow easy mounting of attachments
- Choice of porting styles to meet system and design requirements
- Single- and double-acting cylinders to suit a variety of hydraulic requirements

Select your pull cylinder type:

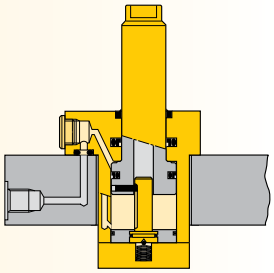
Single acting

- The obvious choice when there are few system restrictions, and there are not many units retracting simultaneously
- Valving and plumbing is less complex



Double acting

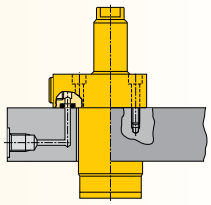
- When greater control is required during the unclamp cycle
- When heavy attachments are being used
- When timing sequences are critical: less sensitive to system back pressures resulting from long tube lengths or numerous components being retracted at the same time



Select your mounting method:

PU series, Upper flange mounting

- Flexible design allows for manifold or threaded oil port connection
- Fixture hole does not require tight tolerances
- Easy installation with only 3 or 4 mounting bolts



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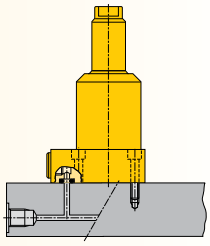
PL series, Lower flange mounting

- Flexible design allows for manifold or threaded port connection
- No fixture hole required
- Easy installation with only 3 or 4 mounting bolts



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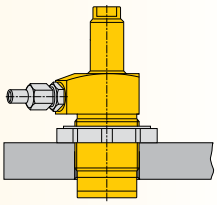
PT series, Threaded body mounting

- Body thread for precise cylinder height positioning
- Threaded oil port connection
- Can be threaded directly into the fixture and secured in position by means of standard flange nuts



64

Pull force: 1250-9600 lbs

Push force: 2950-18,400 lbs

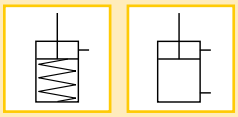
Stroke: 0.87-1.20 inch

Pressure: 500-5000 psi

(E) Cilindros de tracción

(F) Verins traction

(D) Zugzylinder



Product selection

Cylinder capacity lbs Pull	Cylinder capacity lbs Push	Stroke in	Upper flange	Lower flange	Threaded body
▼ Single acting				Model number	
1250	–	.89	PUSS-51	PLSS-51	PTSS-51
2950	–	1.10	PUSS-121	PLSS-121	PTSS-121
▼ Double acting				Model number	
1400	2950	.89	PUSD-51	PLSD-51	PTSD-51
2475	6300	.87	PUSD-92	PLSD-92	PTSD-92
3150	6150	1.10	PUSD-121	PLSD-121	PTSD-121
9600	18,400	1.20	PUSD-351	PLSD-351	PTSD-351

Note: - Call Enerpac to order models with metric thread and BSPP port connections.
- Pull forces for single-acting cylinders reduced due to spring force.

www.enerpacwh.com

Options

Accessories 86

Collet-Lok® push cylinders 18

Work supports 43

Swing cylinders 22

Sequence valves 152

Pull cylinders - Upper flange models

Shown: PUSS-51, PUSD-121

99_063

Minimal mounting height

...when space is at a premium

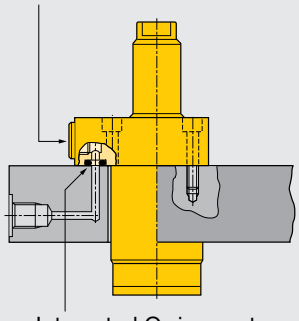
- Guided linear plunger movement
- Flexible design allows for manifold or threaded port connection
- Low profile mounting style allows body to be below mounting surface
- Internal plunger thread allows easy mounting of attachments
- Simple mounting preparation
- Easy to machine fixture hole: does not require tight tolerances
- Easy assembly: 3 or 4 mounting bolts
- Double oil connection: threaded port or manifold mount

PU series

Upper flange pull cylinders are designed for integrated manifold mounting solutions.

Hydraulic connections are made through SAE or BSPP oil connection or the standard integrated O-ring ports.

Oil connection



Integrated O-ring port

Product selection

Cylinder capacity lbs Pull	Cylinder capacity lbs Push	Stroke in	Model number	Cylinder effective area in² Pull	Cylinder effective area in² Push	Oil capacity in³ Pull	Oil capacity in³ Push
▼ Single acting							
1250	–	.89	**PUSS-51**	.28	–	.25	–
2950	–	1.10	**PUSS-121**	.63	–	.70	–
▼ Double acting							
1400	2950	.89	**PUSD-51**	.28	.59	.25	.53
2475	6300	.87	**PUSD-92**	.49	1.25	.42	1.08
3150	6150	1.10	**PUSD-121**	.63	1.23	.70	1.40
9600	18,400	1.20	**PUSD-351**	1.92	3.68	2.27	4.35

Note: - Call Enerpac to order models with BSPP oil connections.
- Pull forces for single-acting cylinders reduced due to spring force.

Enerpac upper flange pull cylinders in a fixture for gun breech production.

98_063-2

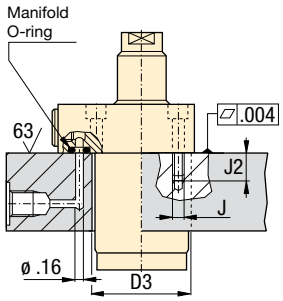
Dimensions in inches [⌲⌖]

Model number	A	B	C1	D Ø	D1	D2	E Ø	E1 Ø	F	H
▼ Single acting										
PUSS-51	5.07	4.18	0.98	1.37	2.13	2.25	0.63	0.59	0.51	0.55
PUSS-121	6.31	5.21	1.00	1.87	2.62	2.88	0.87	0.82	0.68	0.61
▼ Double acting										
PUSD-51	5.07	4.18	0.98	1.37	2.13	2.25	0.63	0.59	0.51	0.55
PUSD-92	5.43	4.57	0.98	1.88	2.76	2.13	0.98	0.93	0.70	0.49
PUSD-121	6.31	5.21	1.00	1.87	2.62	2.88	0.87	0.82	0.68	0.61
PUSD-351	8.04	6.83	0.98	3.14	3.94	3.50	1.50	1.42	1.13	0.49

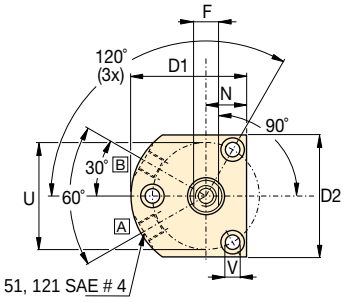
Installation dimensions in inches

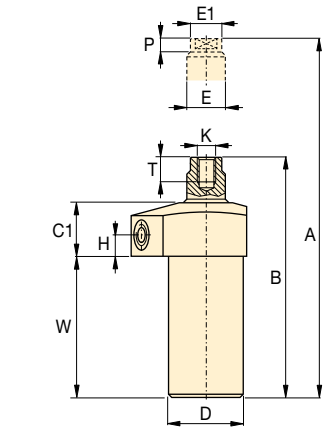
Pull force lbs	Fixture hole Ø D3	Mounting thread J UNF	Min. depth J2	Manifold O-ring [1] ARP numbers or Inside Ø x thickness
1400	1.39	.250-28	.65	568-011
2475	1.93	M6	.59	.17 x .139
3150	1.89	.312-24	.80	568-011
9600	3.06	.375-24	.74	.17 x .139

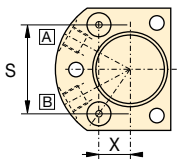
[1] O-ring material: polyurethane, 92 Durometer



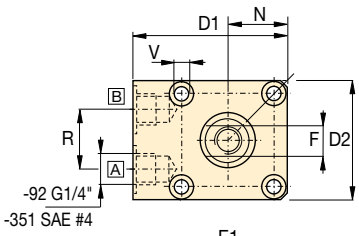
-51, 121

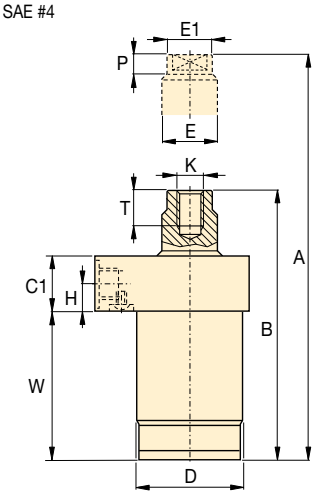


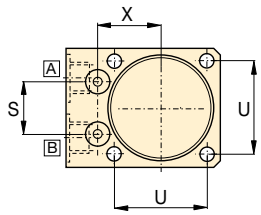




-92, 351







A = Pull
B = Push (venting)

K	N	P	R	S	T	U	V Ø	W	X	lbs	Model number
											Single acting ▼
.312-24 UNF	0.75	0.23	–	1.614	0.62	1.97	0.27	2.60	0.565	2.5	**PUSS-51**
.500-20 UNF	0.99	0.37	–	2.048	0.75	2.50	0.35	3.38	0.717	3.5	**PUSS-121**
											Double acting ▼
.312-24 UNF	0.75	0.23	–	1.614	0.62	1.97	0.27	2.60	0.565	2.5	**PUSD-51**
M10 x 1.50	1.04	0.41	1.02	0.934	0.63	1.65	0.26	2.99	1.128	4.4	**PUSD-92**
.500-20 UNF	0.99	0.37	–	2.048	0.75	2.50	0.35	3.38	0.717	3.5	**PUSD-121**
M16 x 2.00	1.71	0.51	1.02	1.356	1.22	2.76	0.43	3.80	1.637	12.3	**PUSD-351**

Pull force: 1250-9600 lbs

Push force: 2950-18,400 lbs

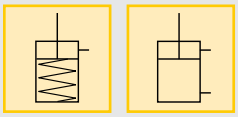
Stroke: .87-1.20 inch

Pressure: 500-5000 psi

E Cilindros de tracción

F Verins traction

D Zugzylinder



Options

Accessories 86 ▸

Collet-Lok® push cylinders 18 ▸

Swing cylinders 22 ▸

Sequence valves 152 ▸

Important

Single-acting cylinders can be vented through the manifold port.

The upper flange pull cylinder has a bolt pattern which is identical to its lower flange equivalent, enabling interchangeability.

In case there is a risk of machining coolants and debris being inhaled via the breather vent, it is recommended to pipe this port to an area outside the fixture that is protected from machining coolants and debris.

Pull cylinders - Lower flange models

Shown: PLSS-51, PLSS-121

99_064

Minimal mounting height

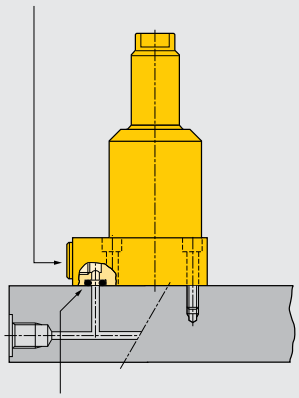
...when space is at a premium

- Guided linear plunger movement
- Flexible design allows for manifold or threaded port connection
- Low profile mounting style allows body to be below mounting surface
- Internal plunger thread allows easy mounting of attachments
- Easiest mounting preparation in the line
- Easy to machine fixture hole: does not require tight tolerances
- Easy assembly: 3 or 4 mounting bolts
- Double oil connection: threaded port or manifold mount

PL series

The lower flange cylinders are designed for integrated manifold mounting solutions. Hydraulic connections are made through SAE or BSPP oil connection or the standard integrated O-ring ports.

Oil connection



Integrated O-ring port

Product selection

Cylinder capacity lbs Pull	Cylinder capacity lbs Push	Stroke in	Model number	Cylinder effective area in² Pull	Cylinder effective area in² Push	Oil capacity in³ Pull	Oil capacity in³ Push
▼ **Single acting**							
1250	–	.89	**PLSS-51**	.28	–	.25	–
2950	–	1.10	**PLSS-121**	.63	–	.70	–
▼ **Double acting**							
1400	2950	.89	**PLSD-51**	.28	.59	.25	.53
2475	6300	.87	**PLSD-92**	.49	1.25	.42	1.08
3150	6150	1.10	**PLSD-121**	.63	1.23	.70	1.40
9600	18,400	1.20	**PLSD-351**	1.92	3.68	2.27	4.35

Note: - Call Enerpac to order models with BSPP oil connections.
- Pull forces for single-acting cylinders reduced due to spring force.

Dimensions in inches [⌯]

Model number	A	B	C1	D Ø	D1	D2	E Ø	E1 Ø	F	H
▼ **Single acting**										
PLSS-51	5.07	4.18	0.98	1.37	2.13	2.25	0.63	0.59	0.51	0.55
PLSS-121	6.31	5.21	1.00	1.87	2.62	2.88	0.87	0.82	0.68	0.61
▼ **Double acting**										
PLSD-51	5.07	4.18	0.98	1.37	2.13	2.25	0.63	0.59	0.51	0.55
PLSD-92	5.43	4.57	0.98	1.88	2.76	2.13	0.98	0.93	0.7	0.49
PLSD-121	6.31	5.21	1	1.87	2.62	2.88	0.87	0.82	0.68	0.61
PLSD-351	8.04	6.83	0.98	3.14	3.94	3.5	1.5	1.42	1.13	0.49

Product selection

Piston diameter in	Rod diameter in	Stroke in	Clevis mount	Foot mount	Flange mount
1.50	1.00	2	TRCM-1502	TRFM-1502	TRFL-1502
1.50	1.00	4	TRCM-1504	TRFM-1504	TRFL-1504
1.50	1.00	6	TRCM-1506	TRFM-1506	TRFL-1506
1.50	1.00	10	TRCM-1510*	TRFM-1510	TRFL-1510
1.50	1.00	12	TRCM-1512*	TRFM-1512	TRFL-1512
2.00	1.38	2	TRCM-2002	TRFM-2002	TRFL-2002
2.00	1.38	4	TRCM-2004	TRFM-2004	TRFL-2004
2.00	1.38	6	TRCM-2006	TRFM-2006	TRFL-2006
2.00	1.38	10	TRCM-2010	TRFM-2010	TRFL-2010
2.00	1.38	12	TRCM-2012	TRFM-2012	TRFL-2012
2.50	1.75	2	TRCM-2502	TRFM-2502	TRFL-2502
2.50	1.75	4	TRCM-2504	TRFM-2504	TRFL-2504
2.50	1.75	6	TRCM-2506	TRFM-2506	TRFL-2506
2.50	1.75	10	TRCM-2510	TRFM-2510	TRFL-2510
2.50	1.75	12	TRCM-2512	TRFM-2512	TRFL-2512
3.25	2.00	2	TRCM-3202	TRFM-3202	TRFL-3202
3.25	2.00	4	TRCM-3204	TRFM-3204	TRFL-3204
3.25	2.00	6	TRCM-3206	TRFM-3206	TRFL-3206
3.25	2.00	10	TRCM-3210	TRFM-3210	TRFL-3210
3.25	2.00	12	TRCM-3212	TRFM-3212	TRFL-3212
4.00	2.50	2	TRCM-4002	TRFM-4002	TRFL-4002
4.00	2.50	4	TRCM-4004	TRFM-4004	TRFL-4004
4.00	2.50	6	TRCM-4006	TRFM-4006	TRFL-4006
4.00	2.50	10	TRCM-4010	TRFM-4010	TRFL-4010
4.00	2.50	12	TRCM-4012	TRFM-4012	TRFL-4012

Cushions are available for all cylinder models. Cushions slow down heavy loads prior to end of stroke, preventing damage to the cylinder of the machine. To add cushions to your Enerpac Tie Rod cylinder, simply add the letter "C" to the end of any model number. Note: the addition of cushions does not affect the outside dimensions of the cylinder.

* These models are only rated to 4000 psi due to constraints on the mechanical properties of the rod.

Custom build your Tie Rod cylinder

TR	CM	15	12	C
1	2	3	4	5

1 Product Type
TR = Tie Rod

2 Mounting
CM = Clevis Mount
FM = Foot Mount
FL = Flange Mount

3 Bore Diameter
15 = 1.5"
20 = 2.0"
25 = 2.5"
32 = 3.25"
40 = 4.0"

4 Stroke
02 = 2"
04 = 4"
06 = 6"
10 = 10"
12 = 12"

5 Cushions
Blank = None
C = Cushions both ends

Seal and repair kits

Seal kits include piston, rod and barrel seals. Repair kits include seal kit plus rod bushing and rear bearing ring.

Product dimensions in inches

Bore diameter in	Rod diameter in	Seal kit	Repair kit
1.50	1.00	TR15SK	TR15RK
2.00	1.38	TR20SK	TR20RK
2.50	1.75	TR25SK	TR25RK
3.25	2.00	TR32SK	TR32RK
4.00	2.50	TR40SK	TR40RK

Force: 8850-62,850 lbs.

Stroke: 2-12 inches

Pressure: 500-5000 psi

E Cilindros Atirantados
F Vérins à tirants
D Zugankerzylinder

Options

Accessories
93

ZW Series Pumps
114

VP Series Valves
136

Fittings
194

Important

Consult individual product selection pages for application and installation criteria specific to each mounting style. If you are unsure of an application, contact Enerpac directly.

Enerpac can provide many other tie rod cylinders in a wide variety of mounting styles, bore and stroke sizes. Contact Enerpac directly and talk to our Custom Products group for a quotation.

5000 psi Tie Rod cylinders TRCM-series

Shown: TRCM-3204

98-037

Flexibility of motion

- Clevis mount cylinders include pivot pin for mounting in your machine
- Standard rod eyes and rod clevises available for each bore size.
- NFPA style MP1
- Designed to carry shear loads
- Pivot pins should be carried by rigidly held bearings and closely fit for the entire length of the pin

Force: 8850-62,850 lbs.

Stroke: 2-12 inches

Pressure: 500-5000 psi

(E) **Cilindros Atirantados**

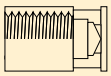
(F) **Vérins à tirants**

(D) **Zugankerzylinder**

TR series clevis mount

Enerpac clevis mount 5000 psi Tie Rod cylinders provide for motion in two axis, increasing the range of motion on your machine with only one cylinder.

Special rod ends



- Either internal or external threads available
- Custom designs to match your tooling requirements

Options

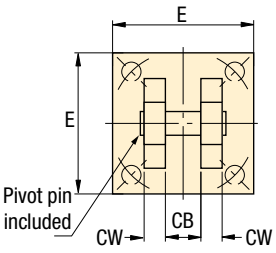
Accessories 93

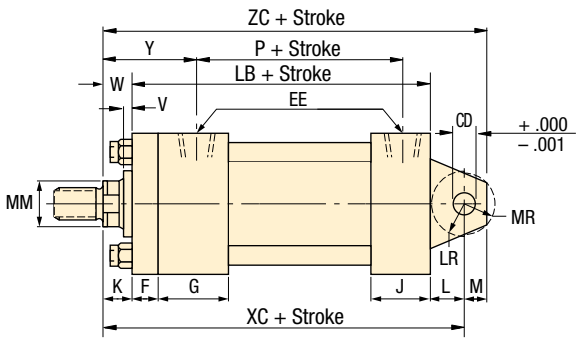
ZW Series Pumps 114

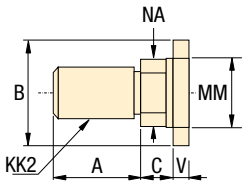
VP Series Valves 136

Fittings 194

TRCM models Clevis mount







Dimensions in inches [⌲ ⌖]

Bore diameter	Rod diameter	Model number	A	B	C	CB	CD	CW	D*	E	EE	F	G	J	K
1.50	1.00	**TRCM-15xx****	1.13	1.50	0.50	0.75	0.50	0.50	0.88	2.50	SAE #10	0.38	1.75	1.50	0.50
2.00	1.38	**TRCM-20xx**	1.63	2.00	0.63	1.25	0.75	0.63	1.13	3.00	SAE #10	0.63	1.75	1.50	0.63
2.50	1.75	**TRCM-25xx**	2.00	2.38	0.75	1.25	0.75	0.63	1.50	3.50	SAE #10	0.63	1.75	1.50	0.63
3.25	2.00	**TRCM-32xx**	2.25	2.63	0.88	1.50	1.00	0.75	1.69	4.50	SAE #12	0.75	2.00	1.75	0.75
4.00	2.50	**TRCM-40xx**	3.00	3.13	1.00	2.00	1.38	1.00	2.06	5.00	SAE #12	0.88	2.00	1.75	0.75

* D = Distance across plunger wrench flats.
** 10 and 12 inch models are rated at only 4000 psi.

Bore diameter	Rod diameter	Model number	KK2	L	LB	LR	M	MM	MR	NA	P	V	W	XC	Y	ZC	lbs
1.50	1.00	**TRCM-15xx**	3/4"-16	0.75	5.00	0.63	0.50	1.00	0.66	0.97	2.13	0.50	1.00	6.75	2.38	7.25	***
2.00	1.38	**TRCM-20xx**	1"-14	1.25	5.25	1.13	0.75	1.38	0.94	1.34	2.88	0.38	1.00	7.50	2.63	8.25	***
2.50	1.75	**TRCM-25xx**	1-1/4"-12	1.25	5.38	1.13	0.75	1.75	0.94	1.70	3.00	0.50	1.25	7.88	2.88	8.63	***
3.25	2.00	**TRCM-32xx**	1-1/2"-12	1.50	6.25	1.25	1.00	2.00	1.19	1.95	3.59	0.38	1.25	9.00	3.09	10.00	***
4.00	2.50	**TRCM-40xx**	1-7/8"-12	2.13	6.63	1.88	1.38	2.50	1.38	2.45	3.88	0.38	1.38	10.13	3.31	11.50	***

*** For product weights, please reference the price list or contact Enerpac customer service for more information.

Force: 8850-62,850 lbs.

Stroke: 2-12 inches

Pressure: 500-5000 psi

(E) **Cilindros Atirantados**

(F) **Vérins à tirants**

(D) **Zugankerzylinder**

Options

Accessories 93

ZW Series Pumps 114

VP Series Valves 136

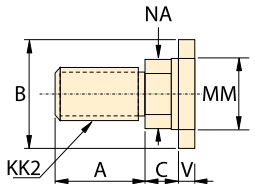
Fittings 194

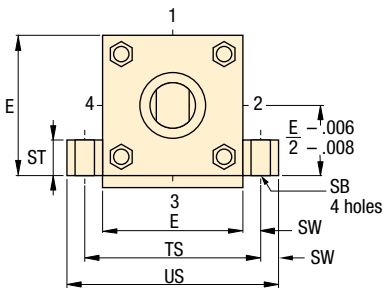
Ease of installation

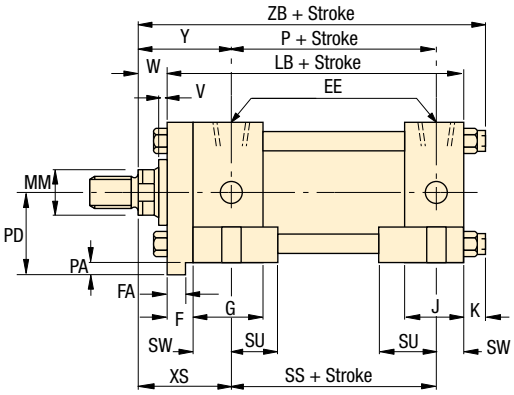
- Foot mount cylinders provide simplest mounting option with just four bolt holes required
- Standard key mount is included ensuring proper mounting and adding rigidity
- NFPA style MS2
- Compact mounting fits in tight spaces where other cylinders cannot

Shown: TRFM-1506

TRFM models Foot Mount







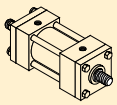
TR series foot mount

Enerpac foot mount 5000 psi Tie Rod cylinders provide a high quality positioning solution using a minimal amount of space.

Important

Some custom options may require reduction of working pressure or special installation considerations. Contact Enerpac Technical Service to discuss your application.

Special rod ends



Double rod ends

- Available on all models except clevis mounts
- The two rod ends can be different on the same cylinder

Dimensions in inches [⊟ ⌖]

Bore diameter	Rod diameter	Model number	A	B	C	D*	E	EE	F	FA	G	J	K	KK2	LB	MM
1.50	1.00	**TRFM-15xx**	1.13	1.50	0.50	0.88	2.50	SAE #10	0.38	0.310-0.312	1.75	1.50	0.50	3/4"-16	5.00	1.00
2.00	1.38	**TRFM-20xx**	1.63	2.00	0.63	1.13	3.00	SAE #10	0.63	0.560-0.562	1.75	1.50	0.63	1"-14	5.25	1.38
2.50	1.75	**TRFM-25xx**	2.00	2.38	0.75	1.50	3.50	SAE #10	0.63	0.560-0.562	1.75	1.50	0.63	1-1/4"-12	5.38	1.75
3.25	2.00	**TRFM-32xx**	2.25	2.63	0.88	1.69	4.50	SAE #12	0.75	0.684-0.687	2.00	1.75	0.75	1-1/2"-12	6.25	2.00
4.00	2.50	**TRFM-40xx**	3.00	3.13	1.00	2.06	5.00	SAE #12	0.88	0.809-0.812	2.00	1.75	0.75	1-7/8"-12	6.63	2.50

* D = Distance across plunger wrench flats.

Bore diameter	Rod diameter	Model number	NA	P	PA	PD	SB	SS	ST	SU	SW	TS	US	V	W	XS	Y	ZB	lbs
1.50	1.00	**TRFM-15xx**	0.97	2.88	0.19	1.44	0.44	3.88	0.50	0.94	0.38	3.25	4.00	0.50	1.00	1.75	2.38	6.50	***
2.00	1.38	**TRFM-20xx**	1.34	2.88	0.31	1.81	0.56	3.63	0.75	1.25	0.50	4.00	5.00	0.38	1.00	2.13	2.63	6.88	***
2.50	1.75	**TRFM-25xx**	1.70	3.00	0.31	2.06	0.81	3.38	1.00	1.56	0.69	4.88	6.25	0.50	1.25	2.56	2.88	7.25	***
3.25	2.00	**TRFM-32xx**	1.95	3.59	0.38	2.63	0.81	4.13	1.00	1.56	0.69	5.88	7.25	0.38	1.25	2.69	3.09	8.25	***
4.00	2.50	**TRFM-40xx**	2.45	3.88	0.44	2.94	1.06	4.00	1.25	2.00	0.88	6.75	8.50	0.38	1.38	3.13	3.31	8.75	***

*** For product weights, please reference the price list or contact Enerpac customer service for more information.

5000 psi Tie rod cylinders TRFL-series

Shown: TRFL-3206

Extra strong

- Flange mount is part of the cylinder end cap, providing maximum strength and rigidity
- Allows length of cylinder to be mounted inside the machine
- NFPA style ME5
- Simple four bolt mounting pattern makes installation easy
- Mounting is best suited for tension applications

Force: 8850-62,850 lbs.

Stroke: 2-12 inches

Pressure: 500-5000 psi

(E) **Cilindros Atirantados**

(F) **Vérins à tirants**

(D) **Zugankerzylinder**

TR series flange mount

Enerpac flange mount 5000 psi Tie Rod cylinders provide the most rigid mounting ensuring long life and high accuracy on your machine.

Options

Accessories 86 ▶

ZW Series Pumps 114 ▶

VP Series Valves 136 ▶

Fittings 194 ▶

Special rod ends

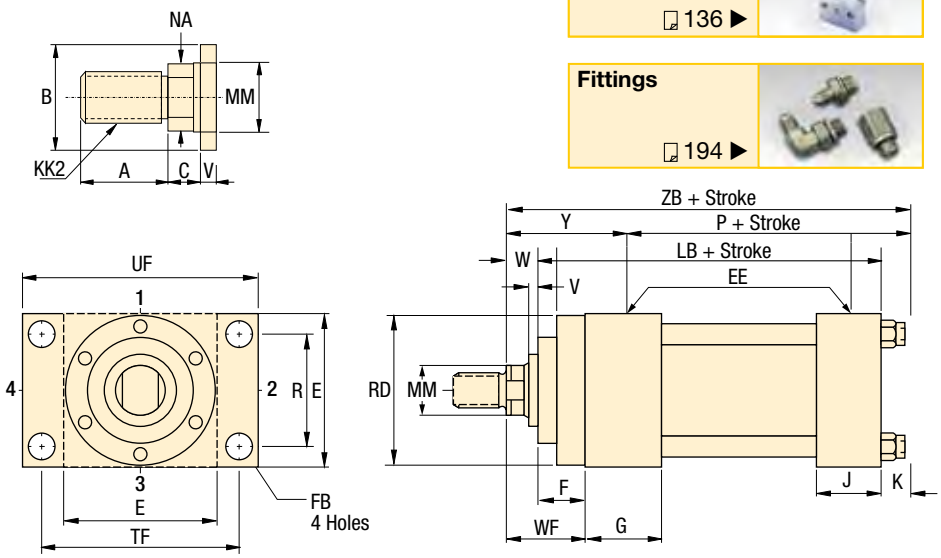
Rod boots

- Rod boots are made from neoprene coated fabric
- Impervious to oil grease and water
- Rated for temperatures from 0° F to 200° F

Metallic wipers

- Recommended in applications where contaminants tend to cling to the rod surface
- Available on all rod diameters

TRFL models Flange Mount



Dimensions in inches [⊳◎]

Bore diameter	Rod diameter	Model number	A	B	C	D*	E	EE	F	FB	G	J	K	KK2
1.50	1.00	**TRFL-15xx**	1.13	1.50	0.50	0.88	2.50	SAE #10	0.38	0.44	1.75	1.50	0.50	3/4"-16
2.00	1.38	**TRFL-20xx**	1.63	2.00	0.63	1.13	3.00	SAE #10	0.63	0.56	1.75	1.50	0.63	1"-14
2.50	1.75	**TRFL-25xx**	2.00	2.38	0.75	1.50	3.50	SAE #10	0.63	0.56	1.75	1.50	0.63	1-1/4"-12
3.25	2.00	**TRFL-32xx**	2.25	2.63	0.88	1.69	4.50	SAE #12	0.75	0.69	2.00	1.75	0.75	1-1/2"-12
4.00	2.50	**TRFL-40xx**	3.00	3.13	1.00	2.06	5.00	SAE #12	0.88	0.69	2.00	1.75	0.75	1-7/8"-12

* D = Distance across plunger wrench flats.

Bore diameter	Rod diameter	Model number	LB	MM	NA	P	R	RD	TF	UF	V	W	WF	Y	ZB	lbs
1.50	1.00	**TRFL-15xx**	5.00	1.00	0.97	2.88	1.63	-	3.44	4.25	0.50	1.00	1.38	2.38	6.50	***
2.00	1.38	**TRFL-20xx**	5.25	1.38	1.34	2.88	2.05	-	4.13	5.13	0.38	1.00	1.63	2.63	6.88	***
2.50	1.75	**TRFL-25xx**	5.38	1.75	1.70	3.00	2.55	-	4.63	5.63	0.50	1.25	1.88	2.88	7.25	***
3.25	2.00	**TRFL-32xx**	6.25	2.00	1.95	3.59	3.25	4.00	5.88	7.13	0.38	1.25	2.00	3.09	8.25	***
4.00	2.50	**TRFL-40xx**	6.63	2.50	2.45	3.88	3.82	4.50	6.38	7.63	0.38	1.38	2.25	3.31	8.75	***

*** For product weights, please reference the price list or contact Enerpac customer service for more information.

For high production applications

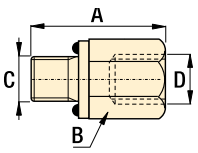
- Fit any style of Enerpac tie-rod cylinder
- Rod eyes and rod clevises
  - Required for proper mounting of TRCM series cylinders
  - Pivot pins supplied separately
- Pivot pins for rod eyes and clevises
  - Provided with cotter pins
  - Must be ordered separately
- Linear alignment coupler
  - Prevents binding caused by misalignment
  - Reduces rod seal and bearing wear

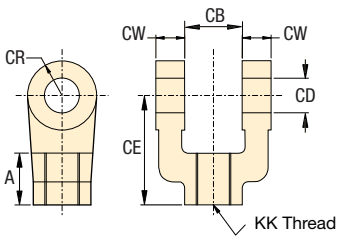
Shown: RRE-15, TRCC-15, TRPP-15, TRAC-15

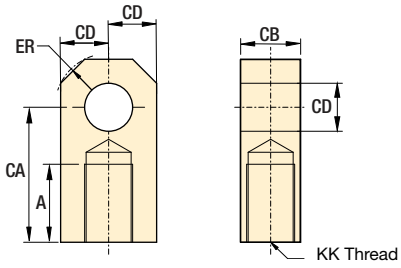
Enerpac 5000 psi Tie-Rod cylinder accessories allow you to complete your design making installation on your machine a simple project.

Fittings dimensions in inches [⊳◎]

From	To	Model number	A	B	C	D
SAE #10	3/8" NPT	**FZ2077**	1.31	1.00	SAE #10	3/8" NPT
SAE #12	3/8" NPT	**FZ2078**	1.00	1.25	SAE #12	3/8" NPT
SAE #10	SAE #6	**FZ2079**	1.26	1.00	SAE #10	SAE #6
SAE #12	SAE #6	**FZ2080**	1.00	1.25	SAE #12	SAE #6

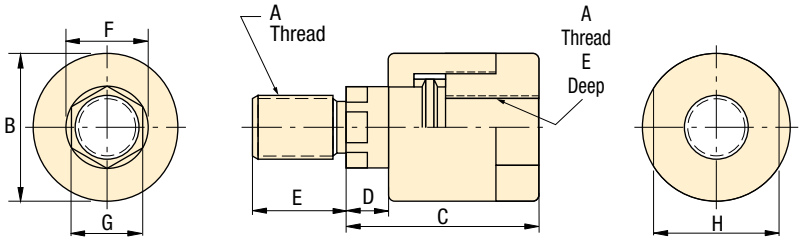






Rod Clevis and Rod Eye dimensions in inches [⊳◎]

Rod clevis model number	Rod eye model number	Maximum tension load lbs	KK	A	CA	CB	CD	CE	CR	CW	ER	Clevis Pin
TRRC-15	**TRRE-15**	12,372	3/4"-16	1.13	2.06	1.25	0.75	2.38	0.75	0.63	0.94	**TRPP-15**
TRRC-20	**TRRE-20**	20,433	1"-14	1.63	2.81	1.50	1.00	3.13	1.00	0.75	1.13	**TRPP-20**
TRRC-25	**TRRE-25**	30,483	1-1/4"-12	2.00	3.44	2.00	1.38	4.13	1.38	1.00	1.56	**TRPP-25**
TRRC-32	**TRRE-32**	49,479	1-1/2"-12	2.25	4.00	2.50	1.75	4.50	1.63	1.25	1.88	**TRPP-32**
TRRC-40	**TRRE-40**	70,095	1-7/8"-12	3.00	5.00	2.50	2.00	5.50	2.00	1.25	2.00	**TRPP-40**



Linear Alignment Coupler in inches [⊳◎]

Model number	Maximum tension load lbs	A	B	C	D	E	F	G	H
TRAC-15	8500	3/4"-16	1.75	2.31	0.50	1.13	0.97	0.88	1.50
TRAC-20	16,000	1"-14	2.50	2.94	0.50	1.63	1.38	1.16	2.25
TRAC-25	19,500	1-1/4"-12	2.50	2.94	0.50	1.63	1.38	1.16	2.25
TRAC-32	33,500	1-1/2"-12	3.25	4.38	0.81	2.25	1.75	1.50	3.00
TRAC-40	60,000	1-7/8"-12	3.75	5.44	0.88	3.00	2.00	1.88	3.50

Power sources

Power sources

Whether you need to run your parts once a day or 24 hours a day, Enerpac has the power source to help you get the job done. Power sources range from simple manual pumps to air operated, to fully customizable electric motor driven units.

With a wide variety of accessories to choose from, Enerpac power units are easily the most versatile and reliable in the industry.

Technical support

Refer to the "Yellow Pages" of this catalog for:

- Safety instructions
- Basic hydraulic information
- Advanced hydraulic technology
- FMS (Flexible Machining Systems) technology
- Conversion charts and hydraulic symbols

197 ▶

	▼ series	▼ page	
Choosing a Pump		96 - 97	
Turbo II air-hydraulic pumps	PA	98 - 101	
Air-hydraulic pumps	ZAJ	102	
Air-hydraulic pumps	PA	103	
Air-hydraulic boosters	AHB, B	104 - 105	
Air valves and accessories	VA, VR RFL	106 - 107	
Economy electric pumps	WU	108 - 109	
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Electric pumps and ordering matrix	ZW	114 - 117	
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Valve manifold	ZW	121	
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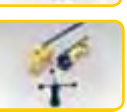
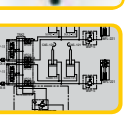
Continuous connection pumps	ZW	124 - 125	
Single station D03 pumps	ZW	126 - 127	
Electric driven workholding pump	ZW5	128 - 131	
Hand pumps	P, SP	132	
Enerpac system solutions		133	

Choosing a pump

Flow rate: 40-640 in³/min

Pressure: 960-10,000 psi

Reservoir: Up to 10 gal

Options

Manual valves

143, 148-151

Electric valves

136-142

Air operated valves

140

Important

231 cubic inches = 1 US gal.

61 cubic inches = 1 liter

1 US gallon = 3.785 liters

Select your pump type

Air operated pump

Best choice for medium circuits with intermittent or medium duty applications. Air operated pumps have lower flow rates than electric pumps, but are more economical.

98-103

Air hydraulic booster

Best choice for small circuits with intermittent or medium-duty applications. Air hydraulic boosters provide a single shot of oil to your circuit at high pressure.

104-105

Economy electric operated pump

The Economy pump is best suited to power small to medium size fixtures. Its lightweight and compact design makes it ideal for applications which require easy transport of the pump. The universal motor works well on long extension cords.

108-109

Electric submerged pump

Enerpac two stage electric submerged pumps are a quiet, economical workholding power source. Submerged in oil the motor stays cooler when used on an intermittent basis.

110-113

Electric operated pump

Best choice for large circuits with medium or high-duty applications. Electric operated pumps have the highest flow rates available and can be configured with many different accessories.

114-131

Select your pump options

Reservoir size

Choose a reservoir size that holds enough oil to fill all of your lines, manifolds and cylinders, with enough reserve for future needs. Each Enerpac cylinder has an oil capacity listed on its product page, and each power unit has a reservoir capacity listed.

Valve type

Directional valves allow you control over what portion of the circuit receives oil. Valves can be operated manually, by electric solenoid or by air pilot pressure. Multiple valves can be used with one power unit to control multiple circuits.

Accessories

For increased automation, electric pumps can be outfitted with additional accessories, including pressure switches, level switches, and control pendants. These options can either be factory installed or added to an existing power unit in the future.

Flow: 40-640 in³/min

Pressure: 5000 psi max

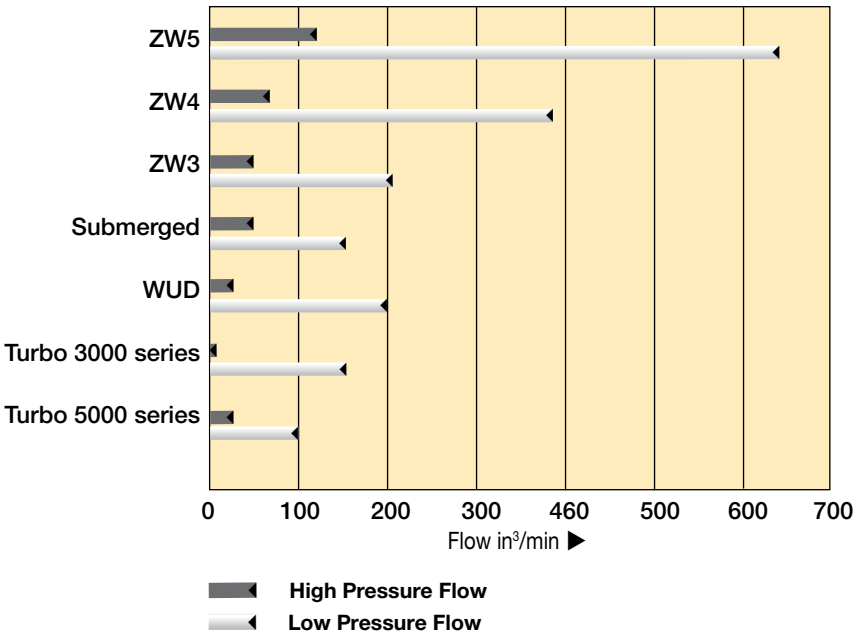
Reservoir: up to 10 gallons

Factors to consider when choosing a pump

- ? Is an air or electric pump preferred
- ? How frequently will the pump cycle
- ? Are there size constraints where the pump would be mounted
- ? What is the oil volume of the clamps actuated together in each group
- ? Is there an accumulator? What is the oil volume
- ? Are there sequence valves? What is the setting of the first one
- ? Are the control valves to be controlled by the machine controller

ENERPAC Workholding Pump Comparision Chart

What flow is right for you?



Type of pump	High pressure flow (in³/min)	Low pressure flow (in³/min)
ZW5	120	640
ZW4	60	380
ZW3	40	205
Submerged	40	150
WUD	20	200
Turbo 3000 series	5	150
Turbo 5000 series	20	100

Turbo II air-hydraulic pumps *Application & selection*

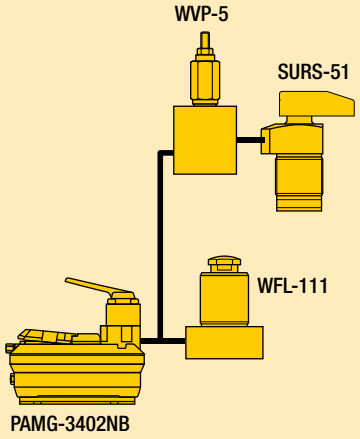
Shown: PAMG-5402NB, PACG-3102NB, PATG-3102NB, PATG-5105NB

Turbo II air hydraulic pumps generate the hydraulic pressure you need using the air pressure you have available. The Air Saver Piston reduces air consumption and operating costs.

They are ideal for providing the power and speed desired in simple clamping circuits. Turbo II air-hydraulic pumps are best suited to medium and lower cycle applications. At only 75 dBA, the Turbo II series helps to keep noise level to a minimum.

Quick and powerful hydraulic supply in an economical air-powered unit

- On-demand stall-restart operation maintains system pressure, providing clamping security
- External adjustable pressure relief valve (behind sight glass)
- Internal pressure relief valve provides overload protection
- Reduced noise level to 75 dBA
- Operating air pressure: 50-125 psi – enables pump to start at low air pressure**
- Reinforced heavy-duty lightweight reservoir for applications in tough environments
- Five valve mounting options provide flexibility in setup and operation
- Fully serviceable air motor assembly



Select the required output

3000 series

- Hydraulic to air ratio: 45:1

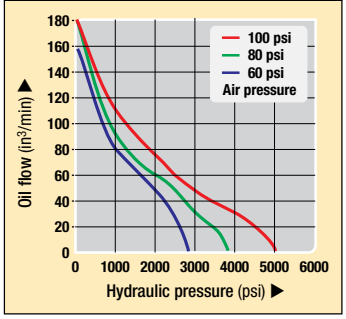
5000 series

- Hydraulic to air ratio: 60:1

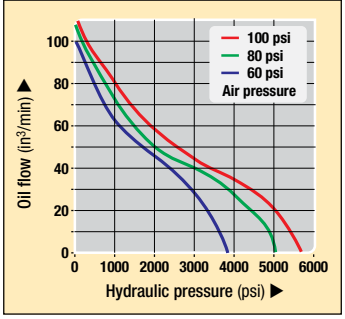
** **NOTE:** From 50-125 psi air inlet pressure. Performance is significantly diminished below 50 psi. Performance may vary compared to listed values due to seal friction, internal pressure drops and manufacturing tolerances. Be sure to allow some flexibility on air inlet pressure.

Output oil flow vs pressure

3000 series – Flow *vs* hydraulic pressure



5000 series – Flow *vs* hydraulic pressure



Select the required output:

Oil Flow: 180 in³/min

Pressure: 5000 psi max

Sound level: 75 dBA

Air: 12 scfm

Reservoir: 70-462 in³

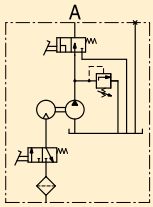
(E) Bombas hidroneumáticas

(F) Pompes hydro-pneumatiques

(D) Lufthydraulische pumpen

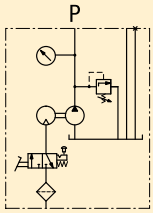
PATG series

- Momentary air inlet treadle for operation of single-acting cylinders
- Provides advance, hold and retract functions



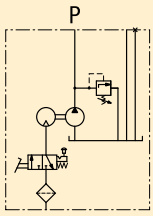
PACG series

- Momentary or continuous air inlet treadle
- A remote valve is required for operation of cylinders



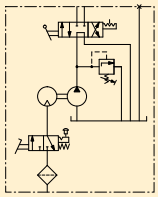
PASG series

- Momentary or continuous air inlet treadle
- Suitable for mounting any single- or double-acting valve with a DO3 mounting configuration
- Available with multiple valve manifold (2-gallon only)



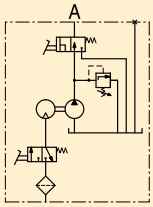
PAMG series

- Momentary or continuous air inlet treadle
- Manual 4-way, 3-position, tandem center valve for single- or double-acting operation



PARG series

- Includes 15 ft. air pendant for remote control of single-acting cylinders
- Provides advance, hold and retract functions



Options

Gauges and accessories
190 ▶

Regulator-filter-lubricator
106,158 ▶

Important

For high cycle applications electric pumps are recommended.

PA series *Dimensions & options*

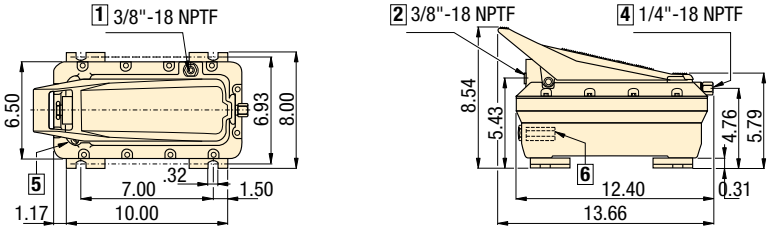
Shown: PACG30S8S-WM10

2 Gallon Turbo Pump

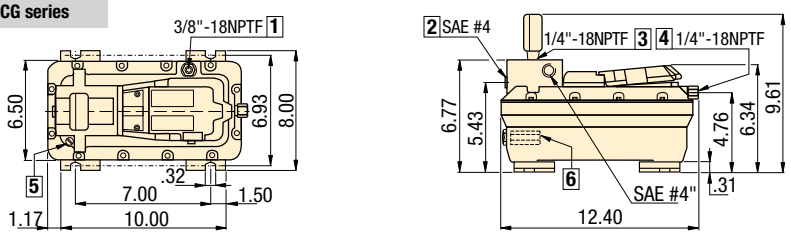
The 2 gallon Turbo pump models feature a drawn steel reservoir with an oil level sight glass. Choose from models with a P & T manifold for use with remote mount valves, a single station D03 manifold, the standard treadle or manual 4 way valve models. The PARG series uses an air operated pendant to control the pump functions. Or build a system pump with multiple Enerpac VP valve series, VP03 series or VSS/VST series D03 mount valves. The VMMD series D03 Manual valves can also be used.

1/2 Gallon reservoir

PATG series

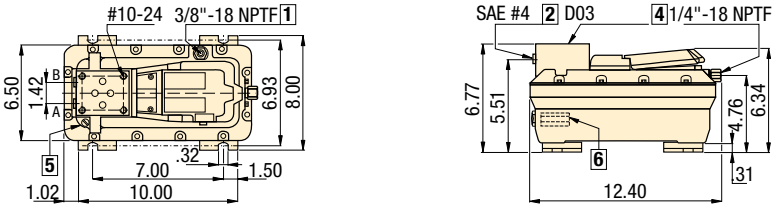


PACG series

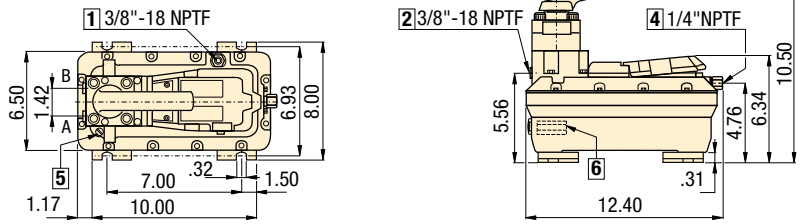


PACG series include pressure gauge **G-2517L**.

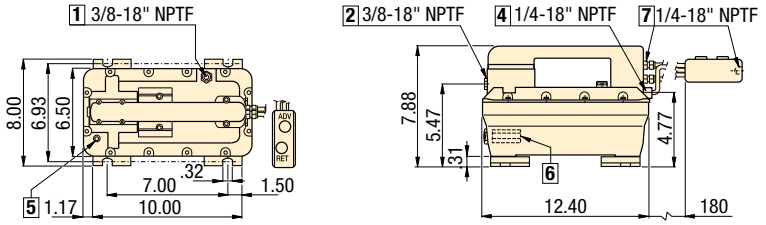
PASG series



PAMG series



PARG series



All dimensions in inches.

1. Auxiliary vent/tank fill port
2. Hydraulic output
3. Gauge mounting port
4. Swivel air input with filter
5. Filtered permanent tank vent
6. Adjustable pressure relief valve
7. Air pendant air input

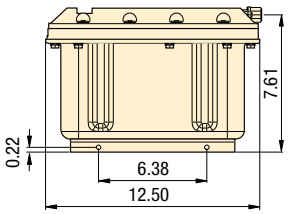
Product selection

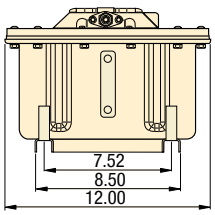
Description	Model numbers 3000 series	Model numbers 5000 series	Usable oil capacity[2] horizontal mount	Usable oil capacity[2] vertical mount	Air pressure range	Air consumption	
	180 in³ min [1]	120 in³ min [1]	in³		psi	scfm	lbs
▼ **Factory supplied valves**							
Hand/foot 3-way	**PATG-3102NB**	**PATG-5102NB**	127	70	50-125	12	19
Hand 4-way	**PAMG-3402NB**	**PAMG-5402NB**	127	70	50-125	12	25
Remote 3-way pendant	**PARG-3102NB**	**PARG-5102NB**	127	70	50-125	12	23
▼ **User supplied valves**							
Remote mount	**PACG-3002SB**	**PACG-5002SB**	127	70	50-125	12	19
Pump mount, single DO3 Valve	**PASG-3002SB**	**PASG-5002SB**	127	70	50-125	12	19

[1] At 0 psi hydraulic and 100 psi air pressure.
[2] Turbo air-hydraulic pumps are also available with 305 in³ reservoir. To order replace **2** in model number with **5**.

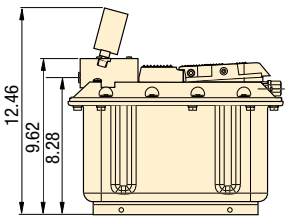
2-Gallon reservoir

All models

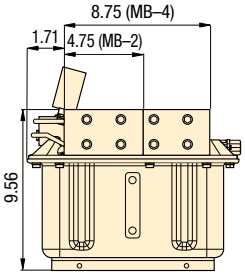


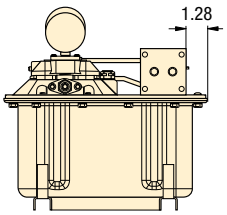


PACG series

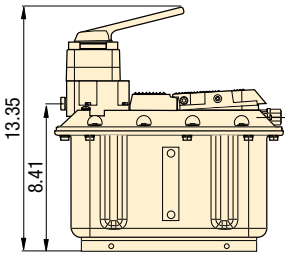


PACG with MB2 or MB4

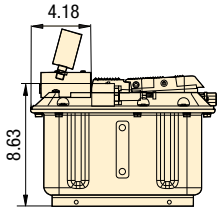


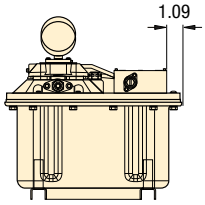


PAMG series

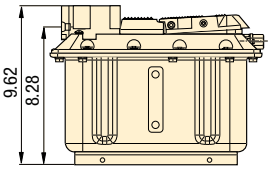


PACG with WM10

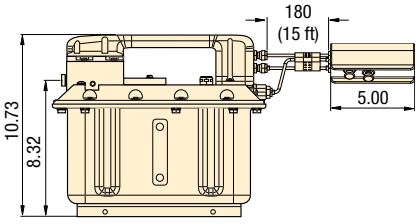




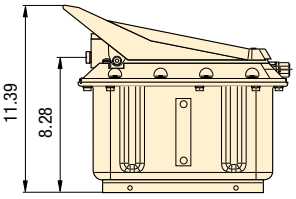
PASG series



PARG series



PATG series



Oil Flow: 180 in³/min

Pressure: 5000 psi max

Sound level: 75 dBA

Air: 12 scfm

Reservoir: 70-462 in³

(E) **Bombas hidroneumáticas**

(F) **Pompes hydro-pneumatiques**

(D) **Lufthydraulische pumpen**

Options

Gauges and accessories
190

Regulator-filter-lubricator
106,158

Product selection

Description	Model numbers 3000 series 180 in³ min [1]	Model numbers 5000 series 120 in³ min [1]	Usable oil capacity in³	Air pressure range psi	Air consumption scfm	 lbs
▼ **Factory supplied valves**						
Hand/foot 3-way	**PATG-31S8N**	**PATG-51S8N**	462	50-125	12	54
Hand 4-way	**PAMG-34S8N**	**PAMG-54S8N**	462	50-125	12	60
Remote 3-way pendant	**PARG-31S8N**	**PARG-51S8N**	462	50-125	12	58
▼ **User supplied valves**						
Remote mount	**PACG-30S8S**	**PACG-50S8S**	462	50-125	12	54
Pump mount, Single DO3 Valve	**PASG-30S8S**	**PASG-50S8S**	462	50-125	12	54
Pump mount, Two DO3 Valves	**PACG-30S8S-MB2**	**PACG-50S8S-MB2**	462	50-125	12	58
Pump mount, Four DO3 Valves	**PACG-30S8S-MB4**	**PACG-50S8S-MB4**	462	50-125	12	61
Pump mount, (1-8) VP Valves	**PACG-30S8S-WM10**	**PACG-50S8S-WM10**	462	50-125	12	56

[1] At 0 psi hydraulic and 100 psi air pressure.

Shown: ZAJ-06505S2C

ZAJ-065 series air driven pump

These heavy-duty air driven pumps are well suited for use in production applications.

Available with a P & T manifold for use with remote mounted VP, VP03, VSS or VST zero leakage class valves, or with either single or dual pump mounted 2-position/3-way Normally Closed valves 24 VDC solenoid valves.

Heavy-duty Air Powered Pump

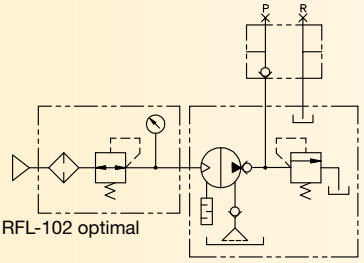
- Suited for use in production applications
- 1-gallon steel reservoir with sight glass, mounting flange

Flow: 124 in³/min at 100 psi
62 in³/min at 2000 psi

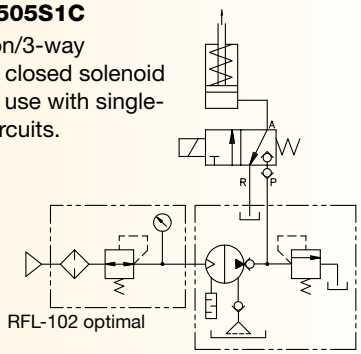
Pressure: 5000 psi max

(E) Bombas hidroneumáticas
(F) Pompes hydro-pneumatiques
(D) Lufthydraulische pumpen

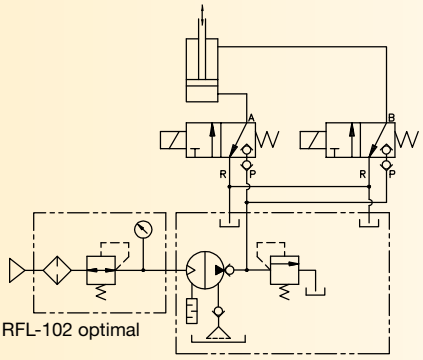
ZAJ-06505M1
Pressure and tank manifold for use with remote mounted valves.



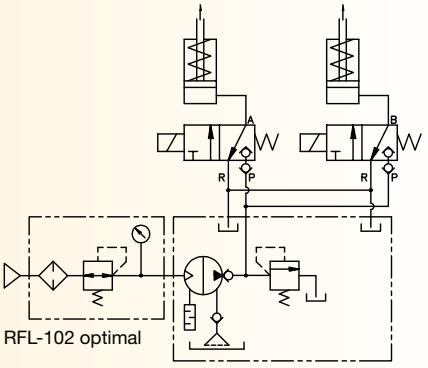
ZAJ-06505S1C
2-position/3-way normally closed solenoid valve for use with single-acting circuits.

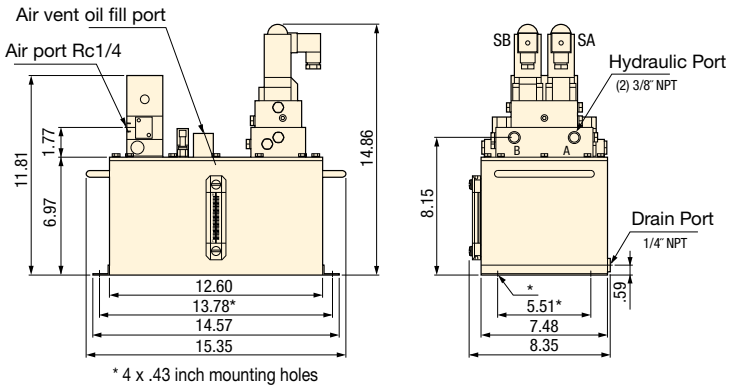


ZAJ-06505S2C
Dual 2 position/3 way normally closed solenoid valves for use with double-acting circuits.



ZAJ-06505S2C
Dual 2 position/3 way normally closed solenoid valves for use with two independent single-acting circuits.





Supplied valving	Valve solenoid voltage	Model number	Air pressure range	Oil ports	Air consumption scfm	Air consumption lbs
Pressure and tank manifold	–	**ZAJ-06505M1**	15-100	3/8" NPT	18	49
Single 2 pos./3 way solenoid valve	24 VDC	**ZAJ-06505S1C**	15-100	3/8" NPT	18	49
Dual 2 pos./3 way solenoid valve	24 VDC	**ZAJ-06505S2C**	15-100	3/8" NPT	18	49

Max. flow: 60-120 in³/min

Pressure: 5000 psi max

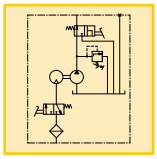
Air: 12 scfm

Reservoir: 36.6 in³

(E) **Bombas hidroneumáticas**

(F) **Pompes hydro-pneumatiques**

(D) **Lufthydraulische pumpen**



Portable air hydraulic power

- Patented air saver design - minimal air usage for lower cost operation
- Quiet internal air muffler 80 dBa
- 360° swivel oil and air fittings for easier system setup
- External adjustable relief valve
- Built-in 3-way, 2-position valve provides advance-retract cycle operation for single-acting cylinders

Shown: PA-135, -136

PA series

Compact, lightweight, air driven power source. Treadle start on pump activates pump operation. Best choice for single-acting cylinders.

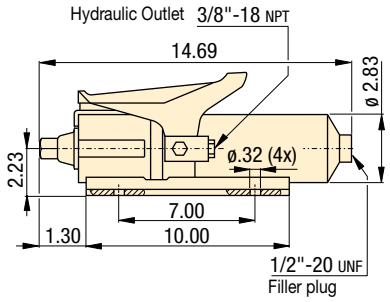
Options

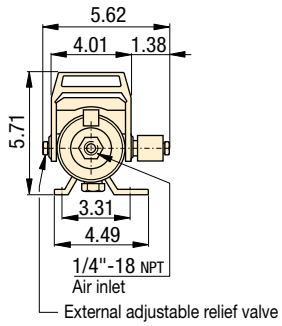
Regulator-filter-lubricator

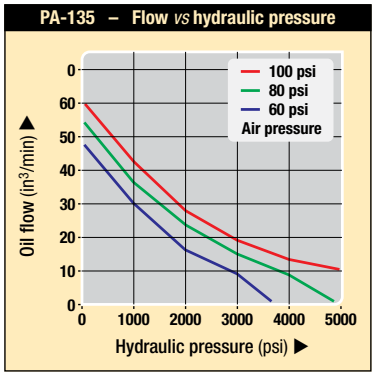
106,158 ▶

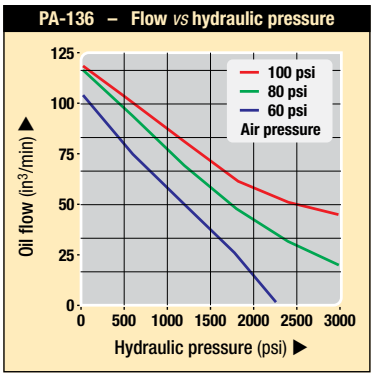
Fittings

194 ▶









Product selection

Usable oil capacity	Max. oil flow [1]	Max. hydraulic pressure	Model number	Valve function	Air pressure range	Air consumption	
in³	in³/min	psi			psi	scfm	lbs
36.6	60	5000	**PA-135**	Advance/Retract	60-100	12	14.3
36.6	120	3000	**PA-136**	Advance/Retract	60-100	12	14.3

[1] At 0 psi hydraulic pressure.

Note: Seal material: Buna-N, Teflon, Polyurethane.

www.enerpacwh.com

These PA series air hydraulic pumps operate in all positions. Here, a PA-135 is mounted vertically to a clamping fixture.

Air hydraulic boosters *Application & selection*

Shown: AHB-46, B-5003, B-3006

99_07_2

AHB and B series boosters

Large effective area of air piston allows compressed air to generate high output hydraulic pressure.

For high production applications

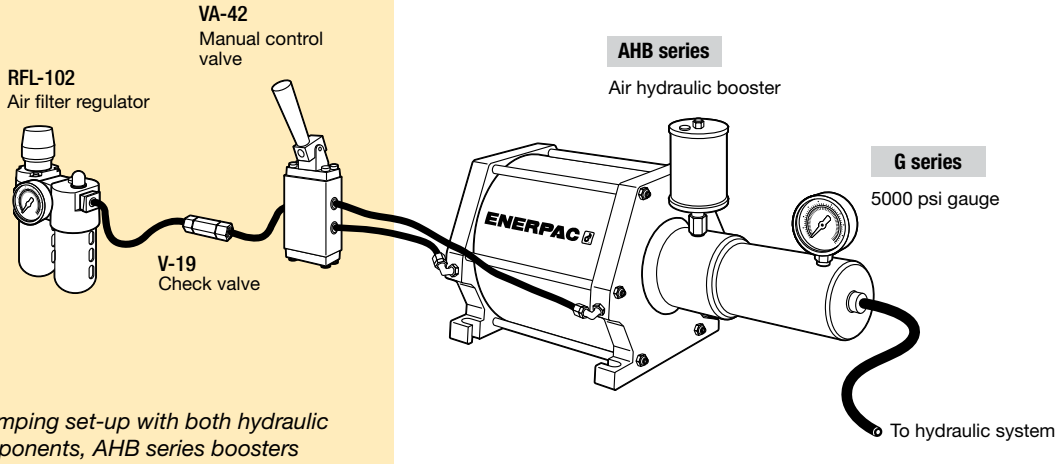
- High speed operation
- Extended service life
- Constant hydraulic output
- Large oil delivery per stroke allows quick filling of cylinders for clamping or punching

AHB series boosters

- Fiberglass wound air chamber eliminates possibility of rust due to moisture in air system
- Designed for fully automated production applications
- Double-acting, one-shot, high speed operation of air piston

B series boosters

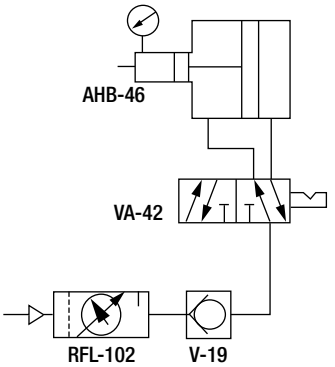
- One-shot spring return
- Steel and cast iron construction
- **Built-in stroke sensor for automatic cycle operation**
  30 VDC switch closes 1 inch before end of full air piston stroke
- **Internal self-bleeding**
  Automatically purges air from system when booster piston is at highest point in circuit

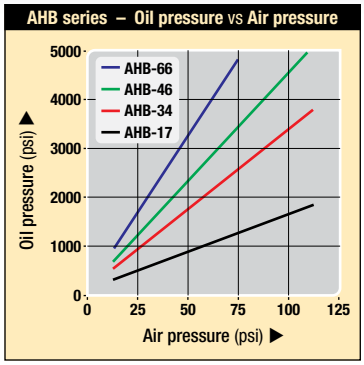


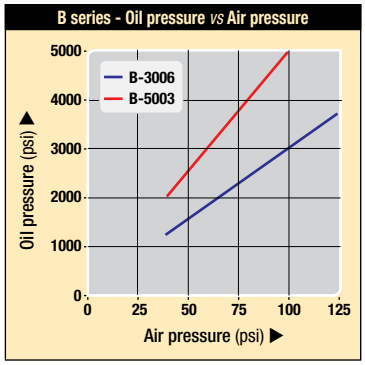
In an automated clamping set-up with both hydraulic and pneumatic components, AHB series boosters are used as a power source for the hydraulic system.

Hydraulic system schematics

Complete power systems eliminate the guesswork of selecting valves and other system components. Plug in your 15 to 115 psi shop air line and connect your hydraulic components for a total system.







Ratio: 1:16-1:64

Pressure: 1600-5000 psi

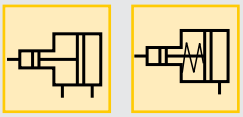
Oil flow: 3.7-18.0 in³/stroke

Air: .95-2.2 scfm/cycle

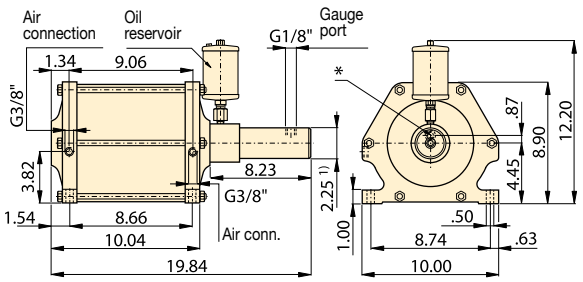
(E) Multiplicadores

(F) Multiplicateurs

(D) Druckübersetzer



AHB series



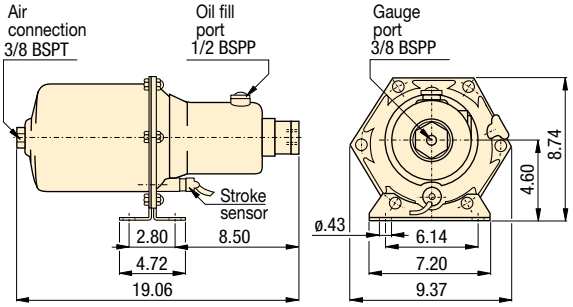
1) Ø 2.83" for model **AHB-17**

* Oil connection (G1/4")

*** Adapter to 3/8" NPT air connection is included.

NOTE: FZ-2060 Adaptor available for gauge port.

B series



Options

Air valves ▶ 106,158

Regulator-filter-lubricator ▶ 106,158

Fittings ▶ 194

Important

Boosters can provide high oil flow rates based on the volume of in-coming air.

Do not exceed the flow rate requirements of the components being used.

For vertical mounting of booster, an elbow fitting is recommended for the oil reservoir.

Selection chart

Oil pressure at 75 psi air pressure	Oil pressure at 100 psi air pressure	Oil volume per stroke in³	Air to oil pressure ratio	Model number	Air consumption per cycle 1) ft³ at 85 psi air	Air piston diameter in	Hydraulic piston diameter in	Hydraulic stroke in	Air operating pressure psi	lbs
▼ **AHB series**										
1200	1600	18.0	1:16	**AHB-17**	2.2	8.00	2.00	5.71	15-115	41.4
2550	3460	8.5	1:34	**AHB-34**	2.2	8.00	1.38	5.71	15-115	37.2
3450	4600	6.1	1:46	**AHB-46**	2.2	8.00	1.18	5.71	15-115	36.1
4800	–	4.5	1:64	**AHB-66**	2.2	8.00	1.00	5.71	15-75	35.4
▼ **B series**										
2250	3000	6.2	1:30	**B-3006**	.95	7.10	1.22	5.20	40-125	31.0
3750	5000	3.7	1:50	**B-5003**	.95	7.10	.94	5.20	40-125	31.0

1) One cycle = advance + retract stroke.

Note: Seal material: Buna-N, Polyurethane.

Shown: VA-42, VAS-42

99-110

Air valves

Enerpac's line of directional air valves and accessories complete your workholding system. Used to control air operated hydraulic units, they increase your productivity and efficiency.

Application

VA-series directional air valves provide either manual or electric control to air operated hydraulic units. Accessories such as rapid exhaust, check valves, silencers and regulators complete the air control system.

- Accessory valves provide greater safety and more efficient clamping cycles
- Recommended for use with all air powered units
- Directional valves to control booster and pump air supply
- Remote air valve permits either hand or foot operation

Important

Valving help
See Basic System Set-up and Valve information in our "Yellow Pages".

To control and regulate air supply

VA-42 Manual operated air valve 5-way, 2-position

- For control of boosters
- Viton seals standard

VAS-42 Solenoid operated air valve 5-way, 2-position

- For control of pump and boosters air supply
- Viton seals standard
- Solenoid: 120 VAC, 50/60Hz
  Amperage: inrush .11 Amps, holding .07 Amps
- Maximum cycle rate: 600 cycles per minute

VR-3 Rapid exhaust valve

- Enables booster to advance and retract faster
- Instantly exhaust air supply from booster to atmosphere

V-19 Air check valve

- Prevent rapid drop of air pressure to the booster in the event of sudden loss of input air

RFL-102 Regulator-Filter-Lubricator

- Regulates air pressure
- Filter air input
- Lubricates air motors with a fine oil vapor mist
- Maximum air flow 48 scfm

HV-1000A Air pilot holding valve

- Holds fluid under pressure offering independent control of different branches of the same fixture
- Valve can control the pilot air and the booster in sequence
- Max. oil flow 305 in^3/min
- Works with the VA-42 four-way air valve and a booster

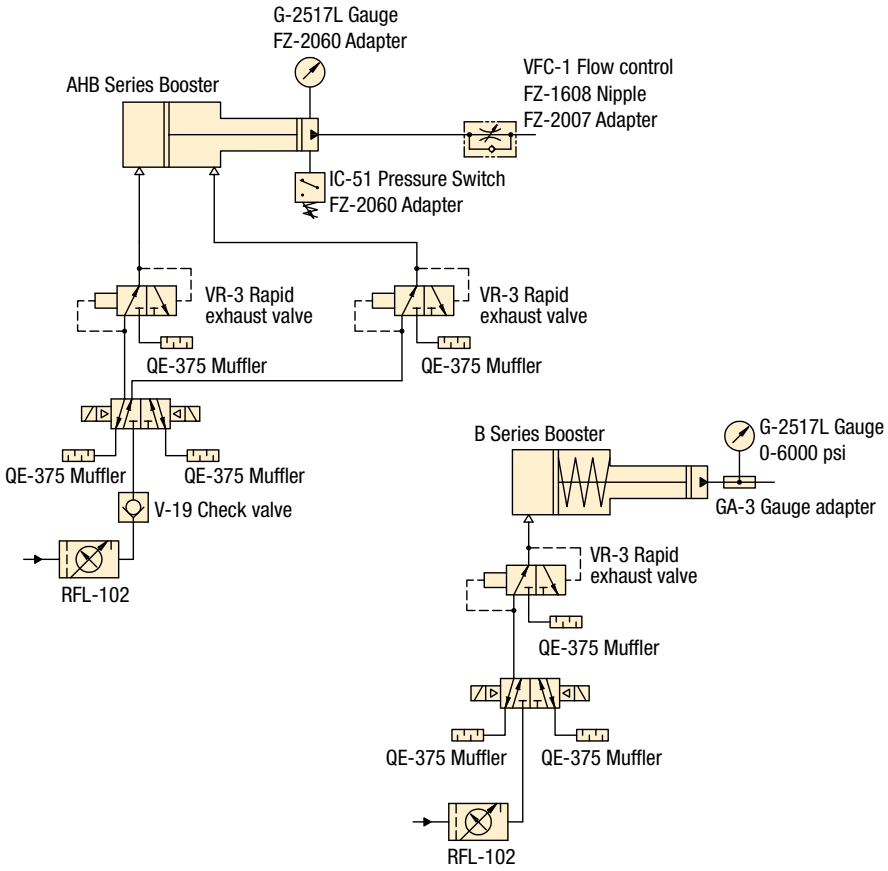
QE-375 Muffler

- Use with VR-3 or VAS/VA-42
- Reduces noise level of exhaust air from pump

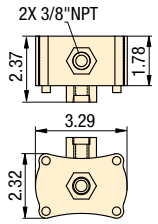
Product selection

Maximum pressure psi	Model number
▼ **Air valves**	
30-150	**VA-42**
30-150	**VAS-42**
0-100	**VR-3**
0-100	**V-19**
▼ **Holding Valve**	
0-100	**HV-1000A***
▼ **Accessories**	
0-125	**RFL-102**
0-125	**QE-375**

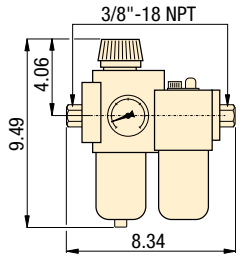
* Maximum hydraulic pressure: 3000 psi.



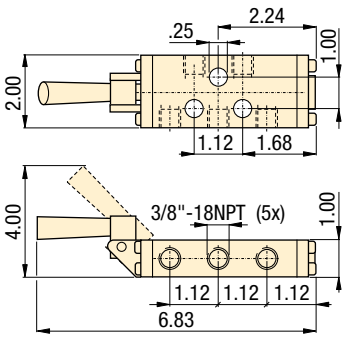
VR-3



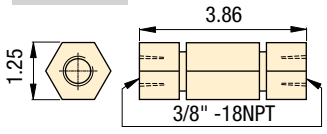
RFL-102



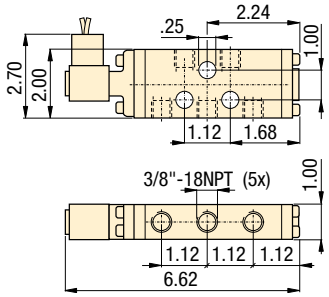
VA-42



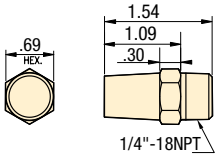
V-19



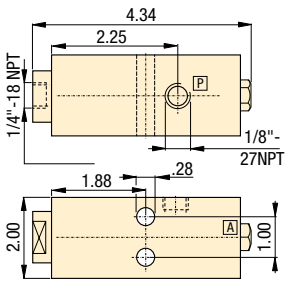
VAS-42



QE-375

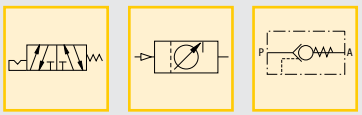


HV-1000A



Air Pressure: 0-150 psi

(E) **Válvulas de aire**
(F) **Valves à air**
(D) **Luftventile**



Options

Gauges and adaptors 190

Hoses 192

Fittings 194

Important

Valving help
See Basic System Set-up and Valve information in our "Yellow Pages".

197

Economy electric pumps *Application & selection*

Shown: WUD-1301B

The Economy pump is best suited to power small to medium size fixtures. Its lightweight and compact design makes it ideal for applications which require easy transport of the pump. The universal motor works well on long extension cords.

Heavy on performance, light on weight

- Lightweight and compact design, 26 lbs
- Large easy-carry handle for maximum portability
- Two-speed operation reduces cycle times for improved productivity
- 115 VAC 50/60- or 220 VAC 50/60-cycle universal motor will operate on voltage as low as 60 volts
- 24 VDC remote motor control, 10-ft length for operator safety
- Starts under full load
- High strength molded shroud with integral handle, protects motor from contamination and damage
- Designed for intermittent duty cycle

WUD-1100 series

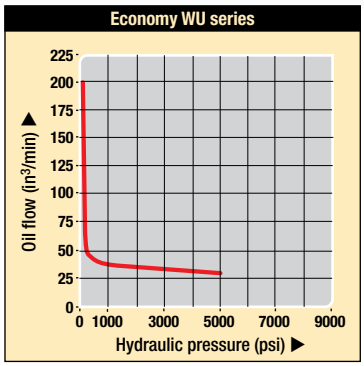
- Provides advance/auto-retract of single-acting cylinders
- 10-foot pendant controls motor and valve operation
- Use with AP500

WUD-1300 series

- Provides advance/hold/retract of single-acting cylinders
- 10-foot pendant controls motor and valve operation
- Ideal for applications requiring remote valve operation
- Use with ACBS22 or ACBS202

Product selection

Model number	Used with cylinder	Pressure rating (psi)	
		1st stage	2nd stage
WUD-1100B	single-acting	200	5,000
WUD-1101B	single-acting	200	5,000
WUD-1100E	single-acting	200	5,000
WUD-1101E	single-acting	200	5,000
WUD-1300B	single-acting	200	5,000
WUD-1301B	single-acting	200	5,000
WUD-1300E	single-acting	200	5,000
WUD-1301E	single-acting	200	5,000



Flow: 25 in³/min

Pressure: 5000 psi max

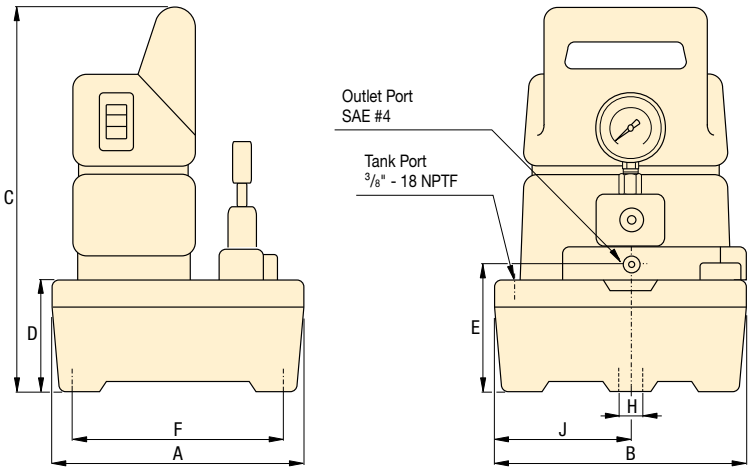
Motor: .5 hp

Reservoir: 0.5-1 gallon

(E) **Bombas eléctricas**

(F) **Centrale hydraulique**

(D) **Tauchpumpe**



Standard equipment

Gauge, filter and pressure switch

Pumps are supplied with a manifold mounted 6000 psi gauge for convenient reading of pump pressure.

A filter at the pressure port helps to protect the pump from contamination.

A manifold mounted adjustable pressure switch provides control of the pump shut-off pressure.

Product dimensions in inches [ ]

Usable oil capacity gal	Model number	A	B	C	D	E	F	H	J	lbs
.50	**WUD-1100B**	9.62	9.62	14.25	4.00	4.72	8.00	.40	5.25	26
1.0	**WUD-1101B**	14.50	12.18	14.72	4.15	5.12	12.74	.40	5.62	35
.50	**WUD-1100E**	9.62	9.62	14.25	4.00	4.72	8.00	.40	5.25	26
1.0	**WUD-1101E**	14.50	12.18	14.72	4.15	5.12	12.74	.40	5.62	35
.50	**WUD-1300B**	9.62	9.62	14.25	4.00	4.72	8.00	.40	5.25	26
1.0	**WUD-1301B**	14.50	12.18	14.72	4.15	5.12	12.74	.40	5.62	35
.50	**WUD-1300E**	9.62	9.62	14.25	4.00	4.72	8.00	.40	5.25	26
1.0	**WUD-1301E**	14.50	12.18	14.72	4.15	5.12	12.74	.40	5.62	35

Output flow rate in³/min 1st stage	Output flow rate in³/min 2nd stage	Valve type amps	Current draw VAC	Motor voltage	Sound level dBA	Model number
200	25	Dump*	9.5	115	85	**WUD-1100B**
200	25	Dump*	9.5	115	85	**WUD-1101B**
200	25	Dump*	9.5	220	85	**WUD-1100E**
200	25	Dump*	9.5	220	85	**WUD-1101E**
200	25	Dump and Hold	9.5	115	85	**WUD-1300B**
200	25	Dump and Hold	9.5	115	85	**WUD-1301B**
200	25	Dump and Hold	9.5	220	85	**WUD-1300E**
200	25	Dump and Hold	9.5	220	85	**WUD-1301E**

* Electric dump valve for auto-retract of cylinders.

Electric submerged pumps

Shown: WEM-1401B

99_088

WE series

Enerpac two stage electric submerged pumps are a quiet, economical workholding power source. Submerged in oil the motor stays cooler when used on an intermittent basis.

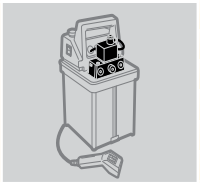
Best performance for mid-range cylinders

- Reduce cycle times for improved productivity
- Two-speed pump unit provides rapid cylinder advance
- Submerged dual voltage induction motor, runs cooler and quieter (60-70 dBA)
- Available with heat exchanger for higher duty cycle applications
- Externally adjustable relief valve – no need to open pump when reducing pressure
- Reservoir mounting holes for easy mounting to fixed surface
- Full length side tube for easy monitoring of oil level
- Auxiliary return port, eliminates the need for a separate adapter

Select your pump type

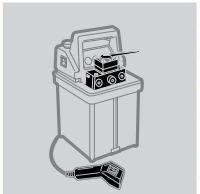
WED-series with dump valve

- For use when load holding is not required
- Ideal for palletized workholding for single acting circuits
- Motor is on only during work cycle



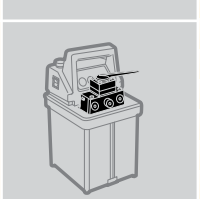
WEJ-series with remote jog

- Manual valve control
- Motor can be turned on and off by remote pendant for jogging capability



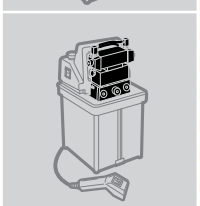
WEM-series with manual valve

- Manual valve control
- Manual motor control
- Simple and economical solution to your workholding power source needs



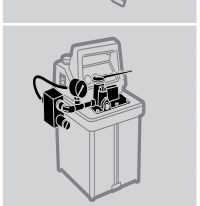
WER-series with remote actuated solenoid

- Solenoid directional with shear seal design
- Remote valve operation



WES/WET-series with pressure switch

- Pressure switch turns motor on and off
- Used when pressure must be maintained over a period of time
- With pressure gauge



Pressure switch specifications: - Classification NEMA 1
- Pressure range: IC-51: 3000-7500 psi
IC-31: 500-3500 psi

Flow: 40 in³/min

Pressure: 5,000 psi max

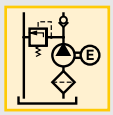
Motor: .5 hp

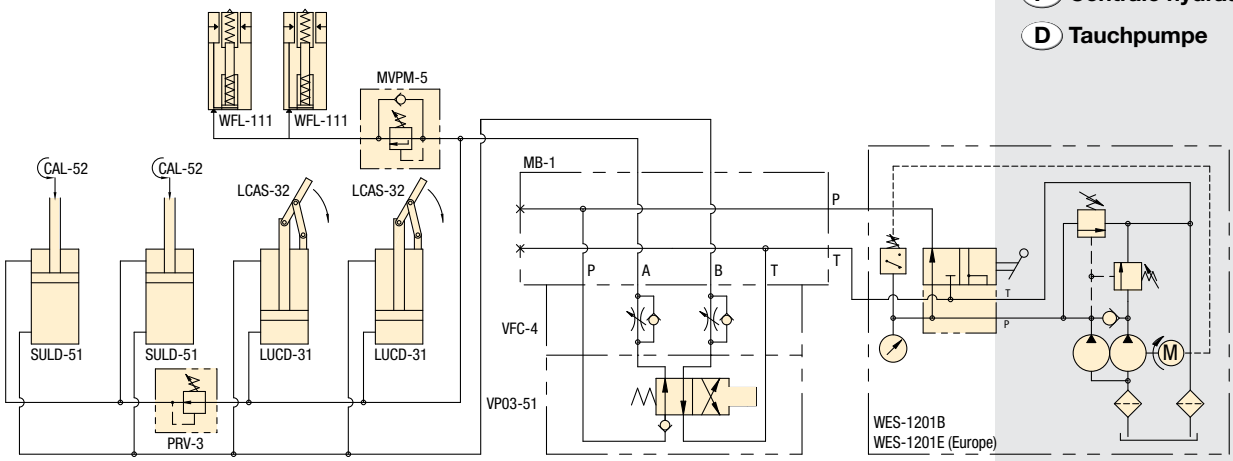
Reservoir: 1.5 gal

(E) **Bombas eléctricas**

(F) **Centrale hydraulique**

(D) **Tauchpumpe**





Used with cylinder	Valve function	Valve type	Model number	Motor voltage 50/60 Hz	Heat exchanger
Single-Acting	Advance / Retract	Dump	**WED-1101B**	115V	
Single-Acting	Advance / Retract	Dump	**WED-1101E**	230V	
Single-Acting	Advance / Retract	Jog	**WEJ-1201B**	115V	
Single-Acting	Adv. / Hold / Retr.	Jog	**WEJ-1301B**	115V	
Double-Acting	Adv. / Hold / Retr.	Jog	**WEJ-1401B**	115V	
Single-Acting	Advance / Retract	Manual 3/2	**WEM-1201B**	115V	
Single-Acting	Advance / Retract	Manual 3/2	**WEM-1201D**	115V	●
Single-Acting	Advance / Retract	Manual 3/2	**WEM-1201E**	230V	
Single-Acting	Advance / Retract	Manual 3/2	**WEM-1201F**	230V	●
Single-Acting	Adv. / Hold / Retr.	Manual 3/3	**WEM-1301B**	115V	
Single-Acting	Adv. / Hold / Retr.	Manual 3/3	**WEM-1301F**	230V	●
Double-Acting	Adv. / Hold / Retr.	Manual 4/3	**WEM-1401D**	115V	●
Double-Acting	Adv. / Hold / Retr.	Manual 4/3	**WEM-1401E**	230V	
Single-Acting	Adv. / Hold / Retr.	Solenoid	**WER-1301B**	115V	
Single-Acting	Adv. / Hold / Retr.	Solenoid	**WER-1301D**	115V	●
Single-Acting	Adv. / Hold / Retr.	Solenoid	**WER-1301E**	230V	
Double-Acting	Adv. / Hold / Retr.	Solenoid	**WER-1401B**	115V	
Double-Acting	Adv. / Hold / Retr.	Solenoid	**WER-1401D**	115V	●
Double-Acting	Adv. / Hold / Retr.	Solenoid	**WER-1401F**	230V	●
Single-Acting	Advance / Retract	Manual 3/2	**WES-1201B**	115V	
Single-Acting	Advance / Retract	Manual 3/2	**WET-1201B**	115V	
Single-Acting	Adv. / Hold / Retr.	Manual 3/3	**WES-1301B**	115V	
Single-Acting	Adv. / Hold / Retr.	Manual 3/3	**WES-1301E**	230V	
Double-Acting	Adv. / Hold / Retr.	Manual 4/3	**WES-1401B**	115V	
Double-Acting	Adv. / Hold / Retr.	Manual 4/3	**WES-1401E**	230V	

Options

G-series pressure gauges 190

FL-series high-pressure filters 193

FZ-series fittings 194

HF-series hydraulic oil 193

Important

Oil should be replaced every 500 working hours to ensure long life. Change filters when changing oil or 4 times a year whichever comes first.

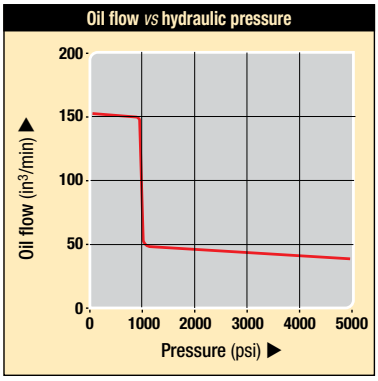
Heat exchanger cools oil in pumps used in higher duty cycle applications.

Output flow rate should be matched to hydraulic components used in the system.

WE-Series, Submerged Electric Pumps

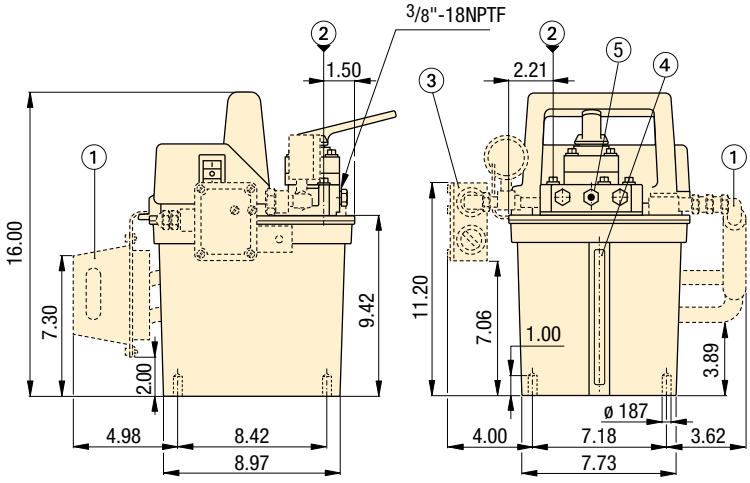
Shown: WEM-1401B

For full features see page 110.



WER series

Enerpac submerged motor pumps are available in a wide range of configurations to fit any requirement.



Dimensions shown in inches.

① Heat Exchanger (optional for all models)
② Fill Port
③ Pressure Switch (WES-Series, optional for other models)
④ Oil Level Indicator
⑤ Adjustable Relief Valve

Product selection

Motor voltage	Motor capacity	Amperage draw	Maximum oil flow** at 60Hz in³/min		Pressure rating psi		Usable oil capacity	Adjustable relief valve	
50/60 Hz 1 ph	hp	amps	1st stage	2nd stage	1st stage	2nd stage	gal	psi	lbs
115V-1ph	.50	13.5	150	40	1000	5000	1.5	1000 - 5000	63 [1]
230V-1ph	.50	6.75	150	40	1000	5000	1.5	1000 - 5000	63 [1]

[1] Weight for WES and WET models is 83 lbs.
** All flow data at 60 Hz, 50 Hz data will be 5/6 th this number.

Custom build your submerged pump

▼ This is how a submerged pump model number is built up:

If the submerged pump that would best fit your application cannot be found in the chart on page 111, you can easily build your custom submerged pump here.

W	E	M	-	1	3	01	B
1 Product Type	2 Motor Type	3 Pump Type		4 Pump Series	5 Valve Type	6 Res. Capacity	7 Motor Voltage

1 Product Type
W = Workholding Pump

2 Motor Type
E = Electric motor

3 Pump Type
D = Dump
J = Jog
M = Manual
R = Remote (solenoid)
S = Pressure switch (IC-51)
T = Pressure switch (IC-31)

4 Pump Series
1 = .5 hp 10,000 psi

5 Valve Type
0 = No valve (WER only)
1 = Dump
2 = 3-way, 2-position, normally open
3 = 3-way, 3-position, tandem center
4 = 4-way, 3-position, tandem center
5 = Custom VE-series valve (WER only) See example 2 below.

6 Reservoir Capacity
01 = 1.5 gallon

7 Motor Voltage and Heat Exchanger
B = 115 V, 1 Ph, 50/60 Hz
D = 115 V, 1 Ph, 50/60 Hz with heat exchanger
E = 230 V, 1 Ph, 50/60 Hz
F = 230 V, 1 Ph, 50/60 Hz with heat exchanger
I = 230 V, 1 Ph, 60 Hz*

* To order WER models, for 60 Hz applications, replace the "E" suffix for "I".

Ordering example 1

Ordering example 2

Examples

Model number:
WER-1301B

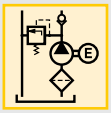
The **WER-1301B** is a .5 hp, 5,000 psi, submerged electric pump, with 1.5 gallon usable oil capacity, a 3-way, 3-position modular, remote solenoid valve (VEF-series) and a 115 V, 1 Phase, 50/60 Hz motor.

Model number:
WER-1501B- VED15000D

The WER-1501B is a .5 hp, 5,000 psi, submerged electric pump, with 1.5 gallon usable oil capacity. The valve, model VED15000D is a 115 V, 60 Hz solenoid valve. (For details and options for all VE-series valves see pages 146-147.)

Flow: 40 in³/min
Pressure: 5,000 psi max
Motor: .5 hp
Reservoir: 1.5 gal

E Bombas eléctricas
F Centrale hydraulique
D Tauchpumpe



Important

WER series pumps use the VE-series valves shown on page 146. WER-13 series uses VEF-series valve. WER-14 series uses VEC-series valve.

WES series pumps use IC-51 pressure switch, adjustable from 3000-7500 psi.

WET series pumps use IC-31 pressure switch, adjustable from 500-3500 psi.

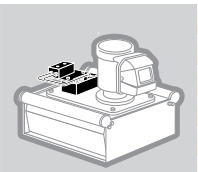
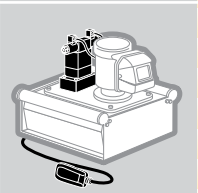
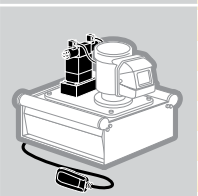
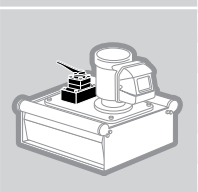
Electric pumps *Application & selection*

Shown: ZW5020HB-FT21

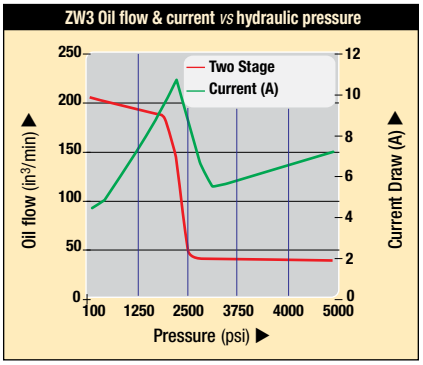
Z-Class electric pumps are designed for use in the harshest manufacturing environments. The pumps provide reliable and durable performance in a wide variety of configurations.

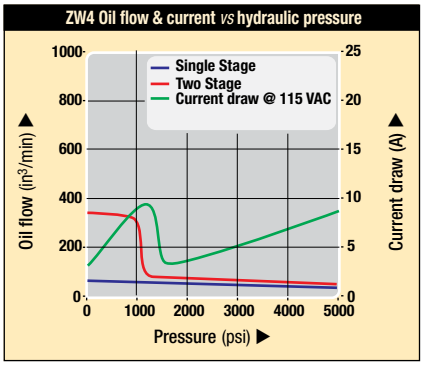
The standard for workholding applications

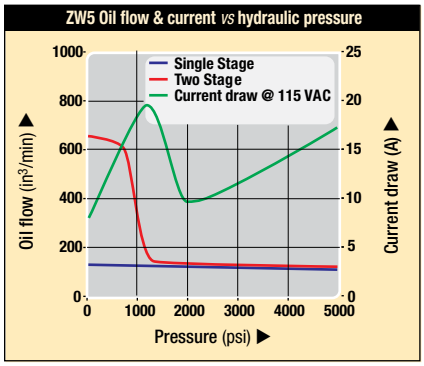
- Features Z-Class high-efficiency pump design; higher oil flow and by-pass pressure, cooler running and requires 18% less current than comparable pumps
- Totally enclosed, fan cooled industrial electric motors supply extended life and stand up to harsh industrial environments
- Multiple valve and reservoir configurations provide application specific models to match the most demanding workholding applications
- High-strength, molded electrical enclosure protects electronics, power supplies and LCD readout from coolant and contamination

Basic configurations All pumps listed in this chart include LCD electrical box, 5 gallon reservoir, return line filter and either 0-6000 psi pressure gauge or pressure transducer (solenoid valve models). For additional options, see the complete pump matrix on page 117.	**Pump type**	**Valve/manifold type**	**Motor voltage** 50/60 Hz
ZW-Series with manifold • Used when supplying pressure to multiple valve circuits • Valves must be supplied separately		Pressure and tank ports	230 VAC, 3 ph
		Single station DO3	230 VAC, 3 ph
		Enerpac VP-series	230 VAC, 3 ph
		Two station DO3	230 VAC, 3 ph
		Four station DO3	230 VAC, 3 ph
ZW-Series with pallet coupling valve • Provides momentary pressure and flow to fixture • Ideal for pallet disconnect systems		4-way, 3-pos. solenoid operated	115 VAC, 1 ph
		4-way, 3-pos. solenoid operated	230 VAC, 3 ph
		4-way, 3-pos. solenoid operated	460 VAC, 3 ph
ZW-Series with continuous connection valve • Provides solenoid control of one single or double-acting circuit • Control valve supplied with integrated pilot operated check to ensure positive pressure holding		4-way, 3-pos. solenoid operated	115 VAC, 1 ph
		4-way, 3-pos. solenoid operated	230 VAC, 3 ph
		4-way, 3-pos. solenoid operated	460 VAC, 3 ph
ZW-Series with manual valve • Provides manual control of one single or double-acting circuit • Control valve supplied with center holding function to ensure positive position holding		4-way, 3-pos. manually operated	115 VAC, 1 ph
		4-way, 3-pos. manually operated	230 VAC, 3 ph
		4-way, 3-pos. manually operated	460 VAC, 3 ph

Output oil flow and current draw







ZW3 Series Output oil flow at 5000 psi 40 in³/min LCD Electric Model Number	ZW4 Series Output oil flow at 5000 psi 60 in³/min LCD Electric Model Number	ZW5 Series Output oil flow at 5000 psi 120 in³/min LCD Electric Model Number
ZW3020HG-FG01	ZW4020HG-FG01	ZW5020HG-FG01
ZW3020HG-FG11	ZW4020HG-FG11	ZW5020HG-FG11
ZW3020HG-FG12	ZW4020HG-FG12	ZW5020HG-FG12
ZW3020HG-FG21	ZW4020HG-FG21	ZW5020HG-FG21
ZW3020HG-FG41	ZW4020HG-FG41	ZW5020HG-FG41
ZW3420DB-FT	ZW4420DB-FT	ZW5420DB-FT
ZW3420DG-FT	ZW4420DG-FT	ZW5420DG-FT
ZW3420DJ-FT	ZW4420DJ-FT	ZW5420DJ-FT
ZW3420FB-FT	ZW4420FB-FT	ZW5420FB-FT
ZW3420FG-FT	ZW4420FG-FT	ZW5420FG-FT
ZW3420FJ-FT	ZW4420FJ-FT	ZW5420FJ-FT
ZW3420LB-FG	ZW4420LB-FG	ZW5420LB-FG
ZW3420LG-FG	ZW4420LG-FG	ZW5420LG-FG
ZW3420LJ-FG	ZW4420LJ-FG	ZW5420LJ-FG

Flow rate: 40-120 in³/min

Pressure: 5000 psi max

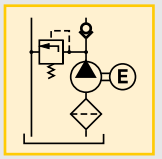
Motor: 1.0 & 1.5 hp

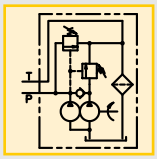
Reservoir: 2-10 gal

(E) Bombas eléctricas

(F) Centrale hydraulique

(D) Tauchpumpe





Important

All *Z-Class* electric pumps are CSA and CE compliant.

LCD electrical package is required for pumps utilizing electric valves, or optional accessories such as the pressure transducer, level switch, pressure switch or heat exchanger.

Single-stage pumps provide constant flow throughout the entire pressure range via a radial piston pump. Two-stage pumps provide high flow via a gear pump until the bypass pressure is reached. At pressures above the bypass setting, the radial piston pump provides flow to the maximum pressure.

Electric pumps *Dimensions & options*

Shown: ZW5020HB-FT21

- Efficient design reduces heat generation and reduces power consumption
- Balanced pump section reduces vibration improving durability and sound levels
- Optional back-lit LCD readout provides hour and cycle counts, low voltage warnings and pressure read-out when used with pressure transducer
- Low-voltage pendant on solenoid valve models with sealed switches improves operator safety
- ***Z-Class*** electric pumps can be supplied with factory installed accessories such as valve manifold, pressure transducer, and return line filter, creating a complete power unit solution

Flow: 40-120 in³/min

Pressure: 5000 psi

Motor: 1.0 & 1.5 hp

Reservoir: 2-10 gallon

(E) **Bombas eléctricas**

(F) **Centrale hydraulique**

(D) **Tauchpumpe**

ZPF series

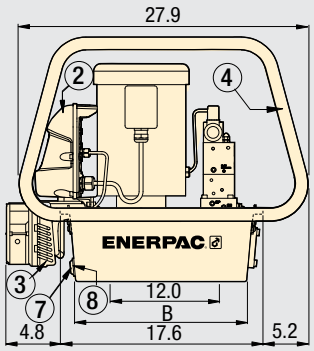
The oil filter kit removes contaminants from the return oil flow before allowing it back into the reservoir, reducing component damage.

Options

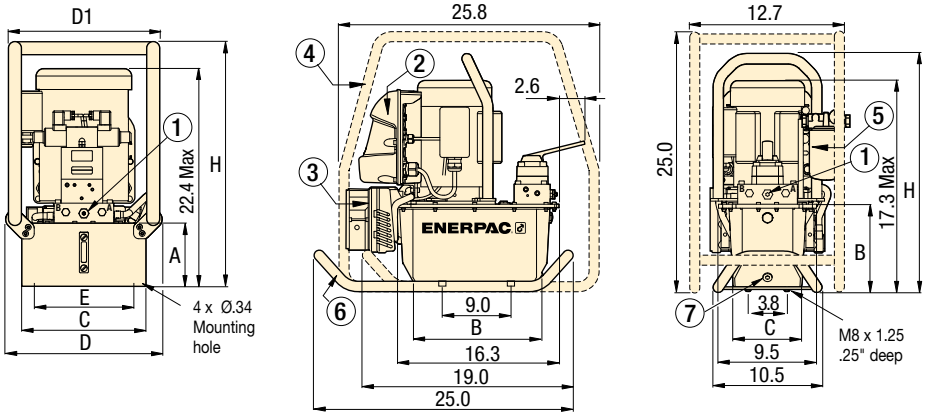
User adjustable relief valve

All ZW-Series have a user adjustable relief valve to allow the operator to easily set the optimum working pressure.

2.5, 5, 10 gallon



2 gallon



① Pump mounted manifold
- User adjustable relief valve
- 3/8" NPTF on A and B ports
- 1/4" NPTF on auxiliary ports

② Electric Box (Optional w/manual valve)
③ Heat Exchanger (Optional)
④ Roll Bar (Optional)
⑤ Return Line Filter (Optional)
⑥ Skid Bar (Optional)
⑦ Oil Drain
⑧ Oil Level/Temperature Switch (Optional)

Product dimensions in inches [⊟ ⌖]

Usable oil capacity	ZW Series pump dimensions (in)						
gal	A	B	C	D	D1	E	H
2.0	8.1	11.3	6.6	-	-	-	22.6
2.5	6.1	16.5	12.0	15.1	14.6	11.0	23.6
5.0	7.1	16.5	16.6	19.7	19.2	15.6	24.6
10.0	10.6	15.7	19.9	22.7	22.5	18.9	28.1

Product selection

Output flow rate in³/min)					Pump series	Motor size	Relief Valve adjustment range	Sound level
100 psi	700 psi	1700 psi	3000 psi	5000 psi		hp	psi	dBA
203	196	170	40	**40**	**ZW3***	1.0	1,000-5,000	75
350	305	-	63	**60**	**ZW4**	1.0	1,000-5,000	75
650	602	-	123	**120**	**ZW5**	1.5	1,000-5,000	75

* Constant flow rate for single-stage models.

Custom build your pump

▼ This is how a ZW series Model number is built:

Z	W	4	0	20	H	G	-	FG	01
1 Product Type	2 Motor Type	3 Flow Group	4 Valve Type	5 Usable Oil Capacity	6 Valve Operation	7 Voltage		8 Options	9 Manifold Options

1 Product type
Z = *Z-Class* Pump

2 Motor type
W = Workholding Electric

3 Flow group
3 = 40 in³/min
4 = 60 in³/min
5 = 120 in³/min

4 Valve type
0 = No valve or valve manifold
2 = 3-way, 2-position, manual valve
3 = 3-way, 3-position, manual valve
4 = 4-way, 3-position, manual or solenoid valve
6 = 3-way, 3-position, tandem center w/P.O. check (manual only)
8 = 4-way, 3-position, tandem center w/P.O. check (manual only)

5 Usable oil capacity
8 = 8 Liters (2 gallon)
10 = 10 Liters (2.5 gallon)
20 = 20 Liters (5 gallon)
40 = 40 Liters (10 gallon)

6 Valve operation
D = Solenoid valve (pallet coupling) with pendant and LCD (valve type **4**)
F = Solenoid valve (continuous connection) with pendant and LCD (valve type **4**)
G = Valve manifold without LCD (valve type **0**)
H = Valve manifold with LCD (valve type **0**)
L = Manual valve with LCD (without pendant, valve type **2, 3, 4, 6** or **8**)
M = Manual valve without LCD (valve type **2, 3, 4, 6** or **8**)
N = No valve, without LCD (valve type **0**)
W = No valve with LCD (valve type **0**)

Example

The **ZW5810LG-FT** is a 120 in³/min, 2-stage pump with a manual 4-way, 3 position tandem center valve, integrated P.O. check, LCD electrical box, 2.5 gallon reservoir, 208-240 volt 3-phase motor, return line filter and pressure transducer.

7 Power supply
Single Phase
B = 115V, 1 ph, 50-60 Hz*3
E = 208-240V, 1 ph, 50-60 Hz European plug
I = 208-240V, 1 ph, 50-60 Hz USA plug
Three Phase
M = 190-200V, 3 ph, 50/60 Hz
G = 208-240V, 3 ph, 50/60 Hz
W = 380-415V, 3 ph, 50/60 Hz
K = 440V, 3 ph, 50/60 Hz
J = 460-480V, 3 ph, 50/60 Hz
R = 575V, 3 ph, 50/60 Hz

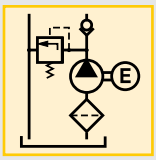
8 Options*2
F = Return line filter, 25 micron
G = 0-6000 psi pressure gauge, 21/2"*5
H = Heat exchanger*4
L = Level/temperature switch*4
N = No handles (lifting eyes only)*2
P = Pressure switch*4
R = Roll bars
S = Single stage
T = Pressure transducer*4
U = Foot switch*4

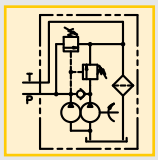
9 Manifold options*5 (Pump types G and H only)
01 = Pressure & tank porting manifold
11 = Single station D03
12 = VP series manifold
13 = Single station CETOP
21 = 2 station D03
22 = 2 station CETOP
41 = 4 station D03
42 = 4 station CETOP

*1 Options should be specified in alphabetical order.
*2 Unless specified, all pumps are supplied with reservoir handles.
*3 115 volt pumps are supplied with CE and CSA approved 15 amp plug for intermittent use. 20 A circuit recommended for frequent full pressure use.
*4 These options require LCD electrical package.
*5 Pressure gauge not available on pump models with pressure transducer. Pressure transducer provides digital pressure readout on LCD display.
*6 Pressure switch option is only used as input to a customer control. It is not used with the LCD electrical package.

Flow: 40-120 in³/min
Pressure: 5000 psi max
Motor: 1.0 & 1.5 hp
Reservoir: 2.0-10 gal.

(E) Bombas eléctricas
(F) Centrale hydraulique
(D) Modulare Spannpumpe





Example

ZW4020GB-FGS21 is a 60 in³/min, single-stage pump with a 2 station D03 manifold, standard electric without LCD, 5 gallon reservoir, 115 volt, 50/60 Hz motor, return line filter and 0-6000 psi pressure gauge.

ZW4410DJ-T is a 60 in³/min, 2-stage pump with a pallet de-coupling valve, LCD electrical box, 2.5 gallon reservoir, 460-480 volt 3-phase motor and pressure transducer.

ZW5040HJ-FGL01 is a 120 in³/min, 2-stage pump with a pressure and tank manifold, LCD electrical box, 10 gallon reservoir, 460-480 volt 3-phase motor, return line filter, 0-6000 psi pressure gauge and level and temperature shutdown switch.

Shown: ZPF

ZPF series

The oil filter kit removes contaminants from the return oil flow before allowing it back into the reservoir, reducing component damage.

Extend life of hydraulic components

...increase system reliability

- 25 micron nominal filter cleans oil to increase system life
- Internal bypass valve to prevent damage if the filter is dirty
- All installation components included
- Kit assembles quickly and easily to Enerpac pump and manifold
- Maintenance indicator included

Filtration: 25 micron

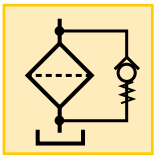
Pressure: max. 200 psi

Max. flow: 12.0 GPM

(E) Filtro

(F) Filtre

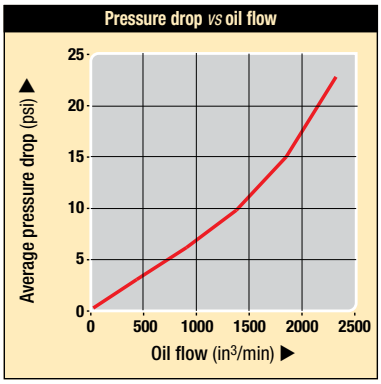
(D) Filter



Options

PF-25 replacement filter element

For best performance, replace filter element on a regular basis. Change filters when changing oil or four times a year, whichever comes first.



Product selection

Nominal filtration	Model number	Maximum pressure	Maximum oil flow	Bypass pressure setting	Filter gauge service indicator	
micron		psi	gpm	psi		lbs
25	**ZPF**	200	12.0	25	✔	3.2

Transfer: 900 Btu/h

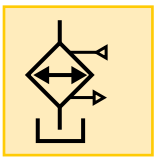
Pressure: max. 300 psi

Voltage: 24V

(E) **Intercambiador de calor**

(F) **Échangeur de chaleur**

(D) **Wärmetauscher**



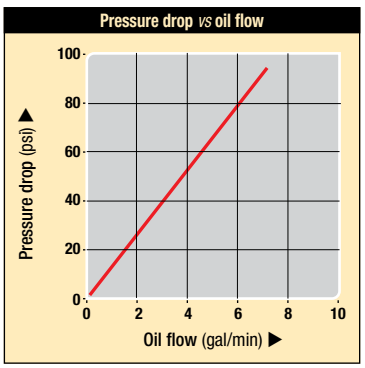
Extends system life

- Electrical connector factory installed
- All installation components included
- Stabilizes oil temperature at a maximum of 130° F at 70° F ambient temperature
- Stabilizes oil viscosity, increasing oil life and reduces wear of pump and other hydraulic components

Shown: ZHE-E10

ZHE series

Heat exchanger removes heat from the return oil to provide cooler operation.



Important

ZHE- Series Heat Exchangers

Heat exchanger stabilizes oil temperature at 130^0 F at 70^0 F ambient temperature. Thermal transfer at 5 GPM and 70^0 F ambient temperature: 900 Btu/hour.

Do not exceed maximum oil flow of 7.0 GPM and maximum pressure of 300 psi. Not suitable for water-glycol or high water based fluids.

Product selection

Voltage	Model number	Thermal transfer*		Amperage draw	Maximum pressure	Maximum oil flow	
		Btu/h	kJoule	A	psi	gpm	lbs
24 VDC	**ZHE-E10**	900	950	.95	300	7.0	9.0

*At 0.5 g/min and ambient temperature of 70° F.

Shown: ZLS-U4

ZLS series

Oil level indicator for pump reservoir. If the pump is mounted in a remote area that does not provide visual access to the external oil level sight glass, the level/temp switch will turn off the pump before internal damage can occur due to cavitations.

Electronic level/temp switch for feedback on pump oil level

- Drop-in design allows for easy installation to pump reservoir
- Electrical connector included
- Built-in thermal sensing provides feedback on oil temperature
- Senses low oil level in pump reservoir

Temp. set point: 175 °F

Voltage: 24 VDC

(E) Indicador del nivel/temp.

(F) Interrupteur de niveau/temp.

(D) Ölstand/Temperaturschalter

Product Selection

Fixed temperature signal	Model number	Voltage	Thermostat rating setting	Maximum pressure	
°F			Amps	psi	lbs
175	**ZLS-U4**	24 VDC	2.6	150	0.11

Shown: ZPT-U4, ZPS-W4

ZPT/ZPS series

ZPT pressure transducer provides constant pressure monitoring for automated pump control. ZPS can be used to provide a pressure signal to an external control.

Control your pump, monitor pressure

ZPT pressure transducer

- More durable than analog gauges (against mechanical and hydraulic shock)
- More accurate than analog gauges (0.5% full scale)
- Calibration can be fine tuned for certification
- "Auto-mode" provides automatic pressure make-up
- Display pressure in psi, bar or MPa

ZPS-E3 pressure switch

- Includes glycerin filled gauge, G2536L
- Can be used to provide pressure input to customer provided controls
- Not to be used with LCD control
- For pressure based input to the LCD control, use the ZPT-U4 transducer

Pressure: 50-10,000 psi

Voltage: 115 VAC / 24 VDC

(E) Presión transductor

(F) Pressostats

(D) Druckschalter

Important

The pressure transducer is factory installed in the "A" port on pumps supplied with valves, and in the "P" port on models with manifolds.

Product Selection

Adustable pressure range	Electrical specification	Model number	Accuracy (full scale)	Deadband	
psi				psi	lbs
▼ **Mechanical adjustment**					
50-10,000	4-20 mA	**ZPT-U4**	0.5%	50	0.3
500-10,000	115 VAC/ 24 VDC N.O.	**ZPS-W4**	2%	115-550	2.7

Note: Electrical harness included with kit. ZPS-W4 includes 0-6000 psi pressure gauge.

Pressure: 5000 psi

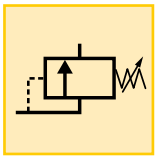
Stations: 1-4 valves horizontal

Stations: 1-8 valves vertical

(E) **Colectores**

(F) **Manifolds**

(D) **Verkettungsblöcke**



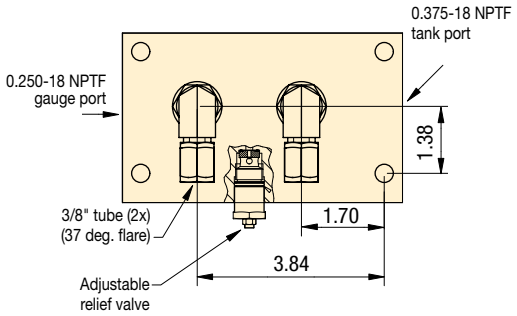
Increased flexibility for complex systems

- Manifolds provide hydraulic connection to remote or pump mounted valves
- Used when multiple valves are required for controlling several independent circuits
- Available for 2 and 4 station D03 as well as Enerpac VP series mounting
- Pressure and tank porting manifold available for use with remote valve sticks
- Manifolds include integrated relief valve for system pressure control

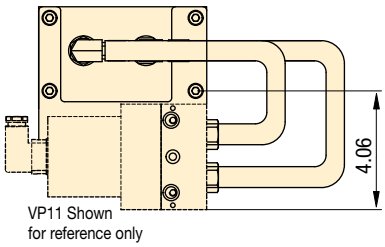
Shown: MB-2, -4

Manifolds allow the use of multiple valves powered by a single hydraulic pump. Manifolds are available factory installed on your Z-Class workholding power unit, or separately for future system upgrades.

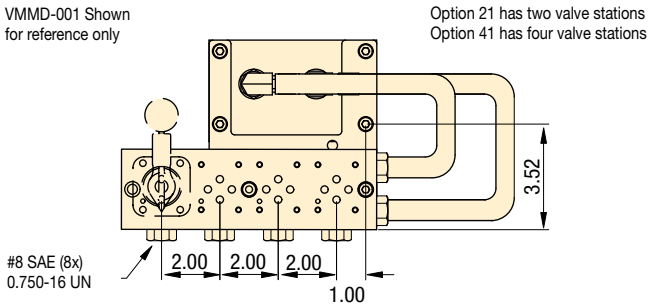
Option 01



Option 12



Option 21, 41



Options

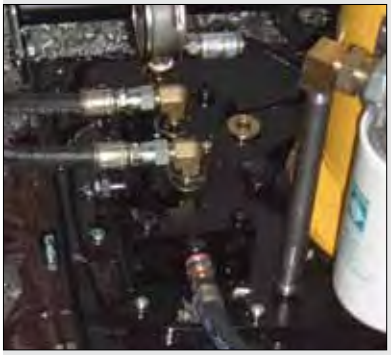
Pressure transducer

120

Level switch

120

Enerpac porting manifold provides pressure and tank line to remote mounted valve stack on a machining center.



Product Selection

Valve mounting pattern	Option code (see page 117)	Number of stations	Coverplate model number
Porting manifold, SAE ports	**01**	–	–
Enerpac VP Series	**12**	1-8	–
2 station DO3	**21**	2	MC-1
4 station DO3	**41**	4	MC-1
2 station CETOP3	**22**	2	MC-3
4 station CETOP3	**42**	4	MC-3

Pallet coupling pumps *Application & selection*

Shown: ZW4420DB-FT

The new Enerpac Pallet Coupling Pump provides three modes of operation:

Manual mode
Pump runs as long as operator holds down pendant button.

AUTO mode *without timer*
Pump runs until user-adjustable pressure setting is reached.

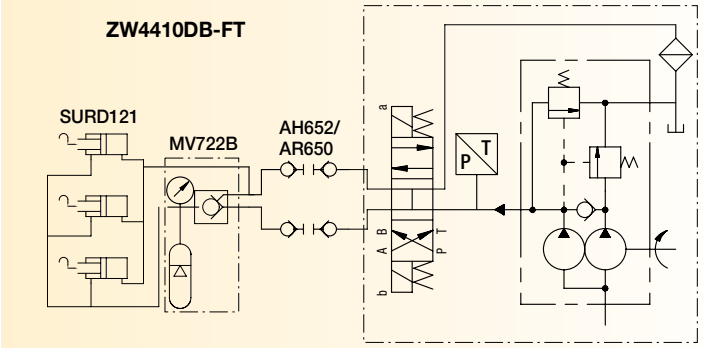
AUTO mode *with timer*
Pump runs until pressure setting is reached, and adjustable timer runs out.

Automatic pressure control for palletized fixtures

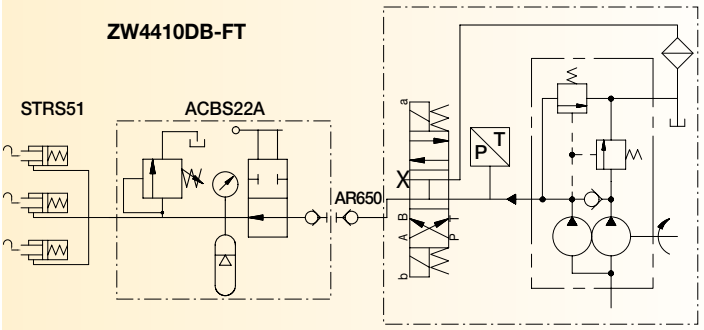
- Programmable clamp and unclamp pressure settings increase automation capability
- Programmable dwell settings ensure desired pressure level is maintained on large circuits or circuits with accumulators
- Low-voltage pendant features sealed switches and operates at 15 VDC for improved operator safety
- Backlit LCD provides pump usage information, hour and cycle counts

Example Circuits

- Double-acting circuit



- Single-acting circuit



ZW5410DB-FT *used to connect and disconnect a palletized fixture.*

Product selection

Output flow rate @ max. pressure	Motor size	Motor voltage	Model number	Pressure range	Sound level	Usable oil capacity	
in³/min	hp			psi	dBA	gal	lbs
40	1.0	115-1-60	**ZW3408DB-FT**	1000-5000	75	2	115
		115-1-60	**ZW3410DB-FT**		75	2.5	134
		230-1-60	**ZW3408DI-FT**		75	2	115
		230-1-60	**ZW3410DI-FT**		75	2.5	134
60	1.0	115-1-60	**ZW4410DB-FT**	1000-5000	75	2.5	120
		230-3-60	**ZW4410DG-FT**				
		460-3-60	**ZW4410DJ-FT**				
120	1.5	115-1-60	**ZW5410DB-FT**	1000-5000	75	2.5	130
		230-3-60	**ZW5410DG-FT**				
		460-3-60	**ZW5410DJ-FT**				

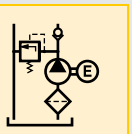
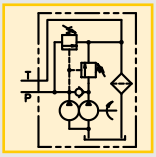
Operation – pallet coupling pump

Manual mode
Motor and pump operate only when operator presses and holds the up (or down) arrow on the pendant. When button is released, pressure in the hoses is relieved.

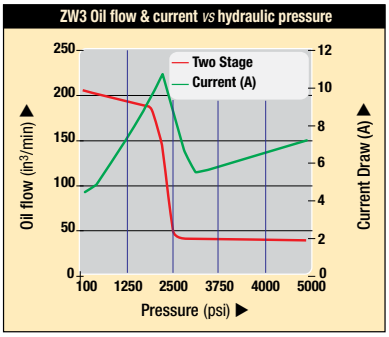
AUTO mode
With DWELL timer set equal to zero, operator starts the motor by pressing and holding the up (or down) arrow on the pendant. Pump builds to pressure on the clamp (or unclamp) circuit until it reaches customer programmed setting. The motor immediately turns off and pressure in the hoses is relieved.

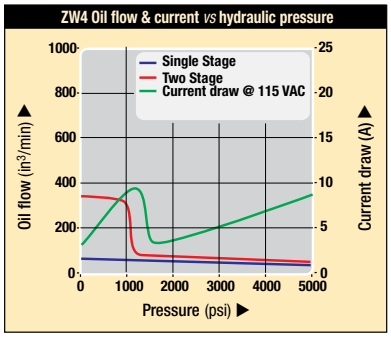
With DWELL timer set greater than zero, operator starts the motor by pressing the up (or down) arrow on the pendant. Once the pump reaches the programmed setting, the DWELL timer starts. When the timer runs out, the motor stops and pressure in the hoses is relieved.

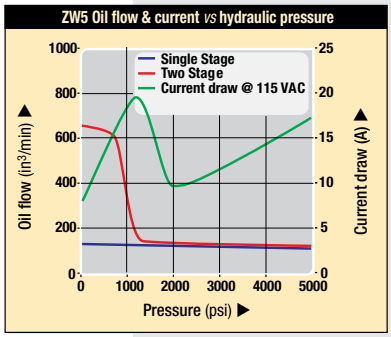
Flow: 40-120 in³/min
Pressure: 5000 psi max
Motor: 1.0 or 1.5 hp
Reservoir: 2.0-10.0 gal

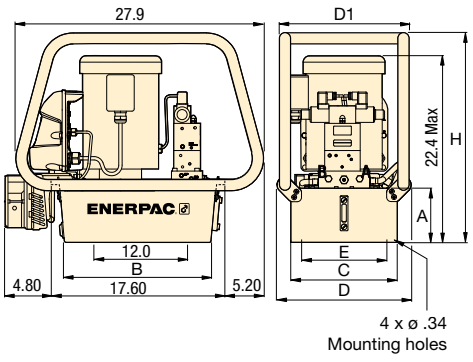
Output oil flow and current draw



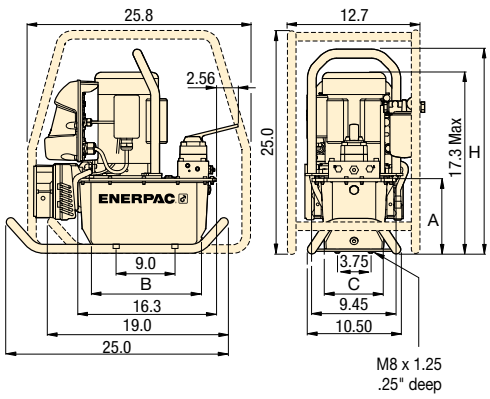




2.5, 5, 10 gallon



2 gallon



Important

Enerpac recommends a pressure differential of no less than 200 psi for most applications. If you believe your application requires a tighter differential, please contact us directly.

For complete ordering matrix of all factory-installed options see page 117.

Options

Heat exchanger ▶119

Level switch ▶120

Pressure transducer ▶120

Return line filter ▶118

Product dimensions in inches [⊳⊕]

Usable oil capacity gal	Modelo number	A	B	C	D	D1	E	H	lbs ZW3	ZW4	ZW5
2.0	**ZW**xx**08**xx	8.1	11.0	8.1	—	—	—	22.6	93	93	103
2.5	**ZW**xx**10**xx	6.1	16.5	12.0	15.1	14.6	11.0	23.6	107	107	115
5.0	**ZW**xx**20**xx	7.1	16.5	16.6	19.7	19.2	15.6	24.6	134	134	142
10.0	**ZW**xx**40**xx	10.6	15.7	19.9	22.7	22.5	18.9	28.1	184	184	192

Continuous connection pumps *Application & selection*

Shown: ZW4420FB-FT

The new Enerpac Continuous Connection Pump provides two modes of operation:

Manual mode
Pump runs continuously, building pressure as long as operator holds down pendant button.

AUTO mode
Pump runs continuously, maintaining user-set pressure window on clamp circuit as long as necessary.

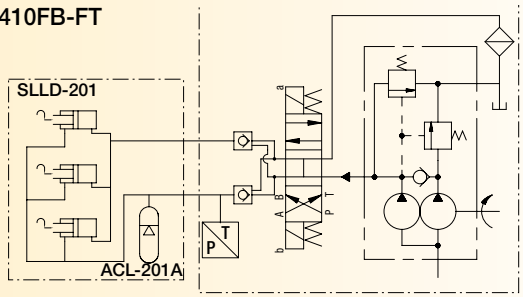
Automatic pressure control for continuous connection fixtures

- Programmable pressure setting allows pump to maintain system pressure continuously
- Includes pilot operated check valve ensuring pressure is maintained in circuit
- *Z-Class* high-efficiency pump design; featuring higher oil flow and by-pass pressure than comparable pumps
- High-strength, molded electrical enclosure protects electronics, power supplies and LCD readout from harsh industrial environments

Example Circuits

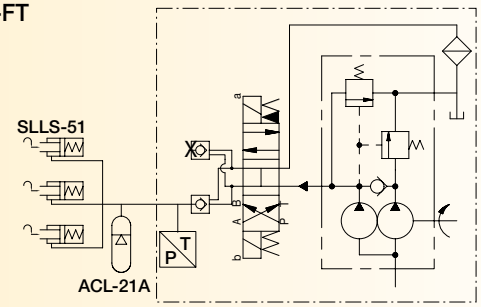
- Double-acting circuit

ZW4410FB-FT



- Single-acting circuit

ZW4410FB-FT



ZW5410FB-FT *used to control clamping cycle on a horizontal machining center.*

Product selection

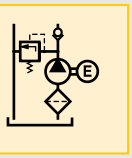
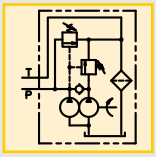
Output flow rate @ max. pressure	Motor size	Motor voltage	Model number	Pressure range	Sound level	Usable oil capacity	
in³/min	hp			psi	dBA	gal	lbs
40	1.0	115-1-60	**ZW3408FB-FT**	1000-5000	75	2	115
		115-1-60	**ZW3410FB-FT**		75	2.5	134
		230-1-60	**ZW3408FI-FT**		75	2	115
		230-1-60	**ZW3410FI-FT**		75	2.5	134
60	1.0	115-1-60	**ZW4410FB-FT**	1000-5000	75	2.5	120
		230-3-60	**ZW4410FG-FT**				
		460-3-60	**ZW4410FJ-FT**				
120	1.5	115-1-60	**ZW5410FB-FT**	1000-5000	75	2.5	130
		230-3-60	**ZW5410FG-FT**				
		460-3-60	**ZW5410FJ-FT**				

Operation – continuous connection pump

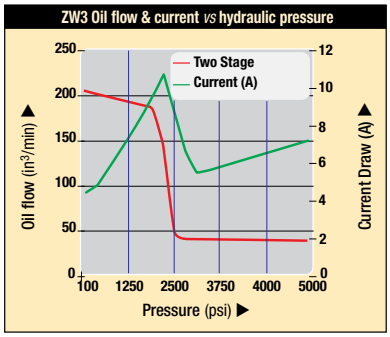
Manual mode
The operator turns the pump motor on, and then presses and holds the up arrow on the pendant. When the button is released, the valve shifts to neutral, but pressure is maintained in the clamp circuit by the pilot-operated check valve. When the operator presses and holds the down arrow on the pendant, pressure in the clamp circuit will release, and the fixture will unclamp.

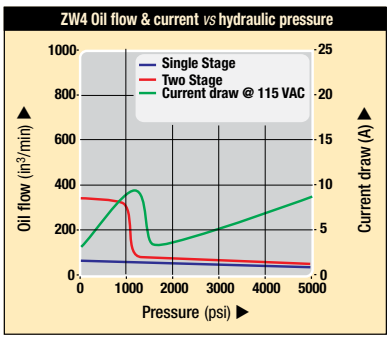
AUTO mode
The operator turns the pump motor on, and then presses and holds the up arrow on the pendant. When the customer-programmed HI PRESS setting is reached, the valve shifts to neutral, but pressure is maintained in the clamp circuit by the pilot-operated check valve. If pressure drops below the LO PRESS setting, the valve will re-activate and build pressure in the clamp circuit again. The pump will maintain this cycle until the operator presses and holds the down arrow on the pendant. When the down arrow is pressed, pressure in the clamp circuit will release, and the fixture will unclamp.

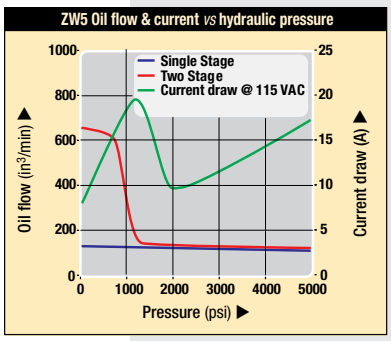
Flow: 40-120 in³/min
Pressure: 5000 psi max
Motor: 1.0 or 1.5 hp
Reservoir: 2.0-10.0 gal

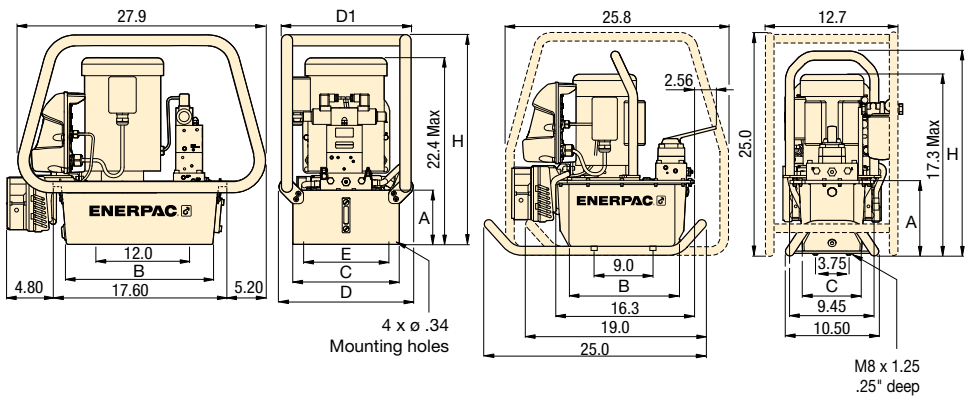



Output oil flow and current draw









Important

Enerpac recommends a pressure differential of no less than 200 psi for most applications. If you believe your application requires a tighter differential, please contact us directly.

For complete ordering matrix of all factory-installed options see page 117.

Options

Heat exchanger ▶119

Level switch ▶120

Pressure transducer ▶120

Return line filter ▶118

Product dimensions in inches [▷⊕]

Usable oil capacity gal	Modelo number	A	B	C	D	D1	E	H	lbs ZW3	ZW4	ZW5
2.0	**ZW**xx**08**xx	8.1	11.0	8.1	—	—	—	22.6	93	93	103
2.5	**ZW**xx**10**xx	6.1	16.5	12.0	15.1	14.6	11.0	23.6	107	107	115
5.0	**ZW**xx**20**xx	7.1	16.5	16.6	19.7	19.2	15.6	24.6	134	134	142
10.0	**ZW**xx**40**xx	10.6	15.7	19.9	22.7	22.5	18.9	28.1	184	184	192

Single station D03 pumps *Application & selection*

Shown: ZW4010GB-11

Pump accepts any industry standard D03 style directional valve. Also available with 2 station and 4 station manifolds.

Industry standard mounting for electric or manual valves

- Highly efficient design provides increased flow rates, reduced heat generation and a decrease in power consumption
- Extensive list of accessories including
  – Heat exchanger
  – Roll-bars
  – Pressure transducer
  – Level and temperature switches
- Replaceable piston check-valves increase service life of major pump components
- Optional backlit LCD provides pump usage information, hour and cycle counts
- Also available with 2 station and 4 station manifolds

Important

Be aware of leakage rates of any valve installed on an Enerpac pump. Many standard spool valves have excessive leakage rates at higher pressures that can limit the performance of the electric pump. Be sure to consult Enerpac if you are unsure of your choice of valve.

▮ **ZW5020HB-F11** *with customer installed valve used to provide pressure to a clamping fixture.*

Product selection

Output flow rate @ max. pressure	Motor size	Motor voltage	Model number	Pressure range	Sound level	Usable oil capacity	
in³/min	hp			psi	dBA	gal	lbs
40	1.0	115-1-60	**ZW3008GB-11**	1000-5000	75	2	115
		115-1-60	**ZW3010GB-11**		75	2.5	134
		230-1-60	**ZW3008GI-11**		75	2	115
		230-1-60	**ZW3010GI-11**		75	2.5	134
60	1.0	115-1-60	**ZW4010GB-11**	1000-5000	75	2.5	120
		230-3-60	**ZW4010GG-11**				
		460-3-60	**ZW4010GJ-11**				
120	1.5	115-1-60	**ZW5010GB-11**	1000-5000	75	2.5	130
		230-3-60	**ZW5010GG-11**				
		460-3-60	**ZW5010GJ-11**				

Operation – single station D03 pumps

The Single Station D03 pumps are supplied without the standard LCD electrical control. This configuration is intended to be used with user supplied controls. Control requirements include: Motor Starter or Contactor, and remote control of the pump mounted valve. Typical applications include: Special Machines and CNC Machines where the control of the pump and valve will be done by PLC or machine control.

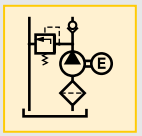
The use of the ZPF Return Line Filter is recommended. If the pump is to be run at pressure at a relief valve setting, the ZHE-E10 Heat Exchanger is also recommended. For monitoring of the oil level and temperature, use the ZLS-U4 Level/Temp Switch. For pump shutdown at pressure, the ZPS-W4 Pressure Switch Kit can provide an input to the customer supplied controls. As these accessories are designed to be used with the standard Enerpac LCD control, the customer assumes responsibility to adapt the standard leads to their controls.

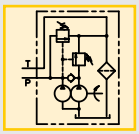
Flow: 40-120 in³/min

Pressure: 5000 psi max

Motor: 1.0 or 1.5 hp

Reservoir: 2.0-10.0 gal



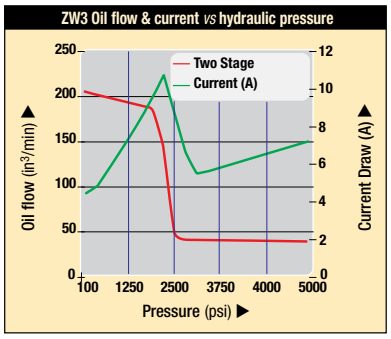


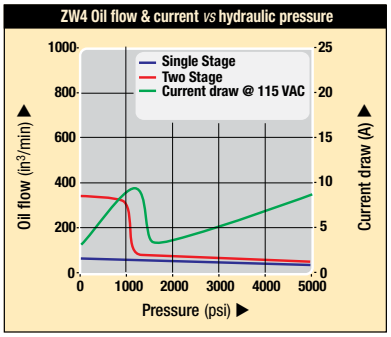
Important

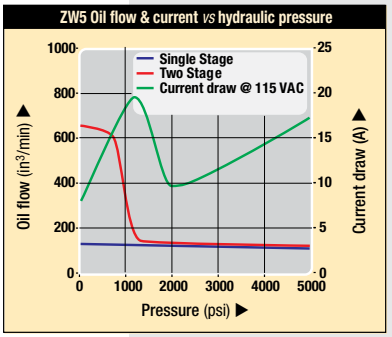
Enerpac recommends a pressure differential of no less than 200 psi for most applications. If you believe your application requires a tighter differential, please contact us directly.

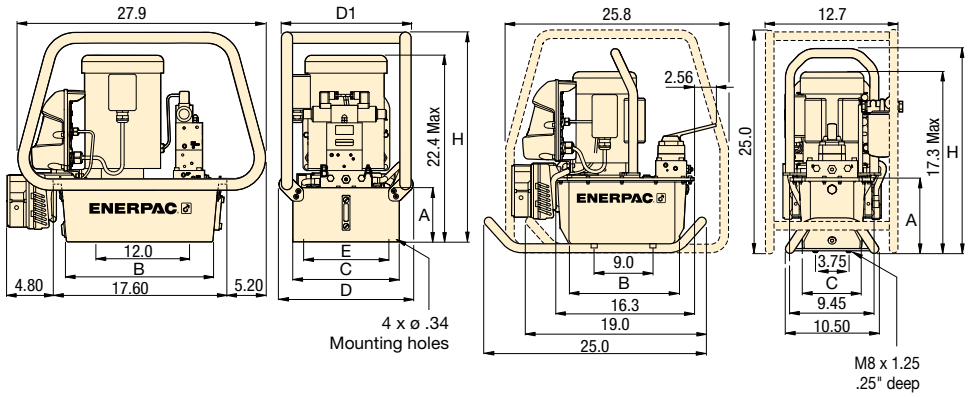
For complete ordering matrix of all factory-installed options see page 117.

Output oil flow and current draw









Options

Heat exchanger ▶119

Level switch ▶120

Pressure transducer ▶120

Return-line filter ▶118

VP03 solenoid valves ▶141

VMM series manual valves ▶143

Product dimensions in inches [⊳◎]

Usable oil capacity gal	Modelo number	A	B	C	D	D1	E	H	lbs ZW3	lbs ZW4	lbs ZW5
2.0	**ZW**xx**08**xx	8.1	11.0	8.1	–	–	–	22.6	93	93	103
2.5	**ZW**xx**10**xx	6.1	16.5	12.0	15.1	14.6	11.0	23.6	107	107	115
5.0	**ZW**xx**20**xx	7.1	16.5	16.6	19.7	19.2	15.6	24.6	134	134	142
10.0	**ZW**xx**40**xx	10.6	15.7	19.9	22.7	22.5	18.9	28.1	184	184	192

Electric Driven Workholding Pumps *Application & selection*

Shown: **ZW5111SWE100**

Enerpac's workholding pump unit features an innovative range of zero leakage, poppet design, directional valves. With the modular valve design, various independent single-acting or double-acting circuits can be realized.

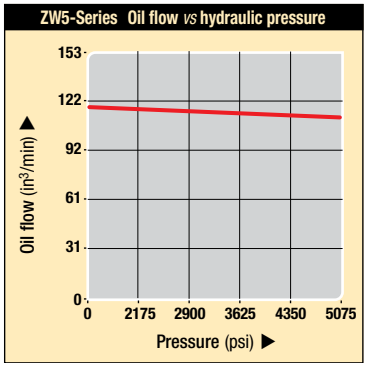
Application

These advanced workholding pumps, operating at maximum 5000 psi hydraulic pressure, are highly suitable for production tooling applications – offering the optimum in terms of compact size for required oil flow and pressure rating and customization to your specific needs.

Enerpac electric pump used in conjunction with swing cylinders, work supports, directional valves, control valves and sequence valves can provide a complete clamping solution. The pressure switch allows the unit to be fully automated.

Customize to your needs

- Various models including electric controls and pressure switch
- Stackable to 8 VP-series valve stations high
- Customer adjustable relief valve
- Glycerine dampened pressure gauge G-2517L on pumps with VP-series valves
- 230/460/3/50/60 Hz 1.5 hp motor

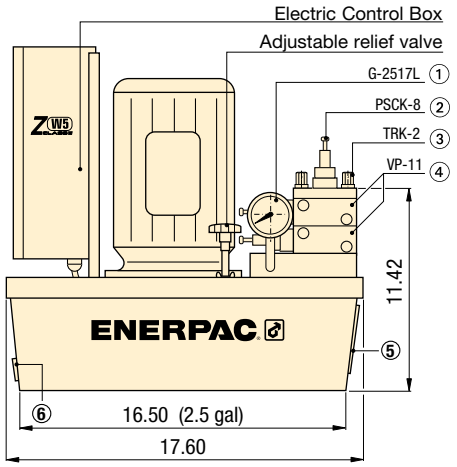


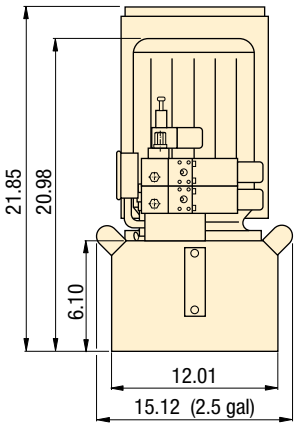
Product selection

Oil flow rate	Pressure range	Voltage and current 60Hz	Usable oil capacity[2]	Valve models included	Model number	
in³/min	psi	V @ A	gal.			lbs
▼ With manifold for VP-series modular valves, no electric controls						
120	1450-5000	230 @ 4.8	2.5	–	**ZW5VPSEE100**	143
120	1450-5000	460 @ 2.4	2.5	–	**ZW5VPSJE100**	143
▼ With manifold for CETOP 03 valves, no electric controls						
120	1450-5000	230 @ 4.8	2.5	–	**ZW5C03SEE100**	143
120	1450-5000	460 @ 2.4	2.5	–	**ZW5C03SJE100**	143
▼ For 2x single-acting circuits						
120	1450-5000	230 @ 4.8	2.5	1x VP-41	**ZW5141SEE100**	170
120	1450-5000	460 @ 2.4	2.5	1x VP-41	**ZW5141SJE100**	170
▼ For 1x double-acting circuits + isolating valve [1] for A-port						
120	1450-5000	230 @ 4.8	2.5	1x VP-11	**ZW5111SEE100**	170
120	1450-5000	460 @ 2.4	2.5	1x VP-11	**ZW5111SJE100**	170
▼ For 2x double-acting circuits + isolating valves [1] for all A-ports						
120	1450-5000	230 @ 4.8	2.5	2x VP-11	**ZW5211SEE100**	176
120	1450-5000	460 @ 2.4	2.5	2x VP-11	**ZW5211SJE100**	176

[1] Isolating valve is pressure switch PSCK-8.
[2] ZW5-series pumps comes standard with 2 gallon reservoir. (1, 2, 5 or 10 gallon reservoir is optional).

ZW5-series Shown: **ZW5211SEE100** with standard 10 litres reservoir



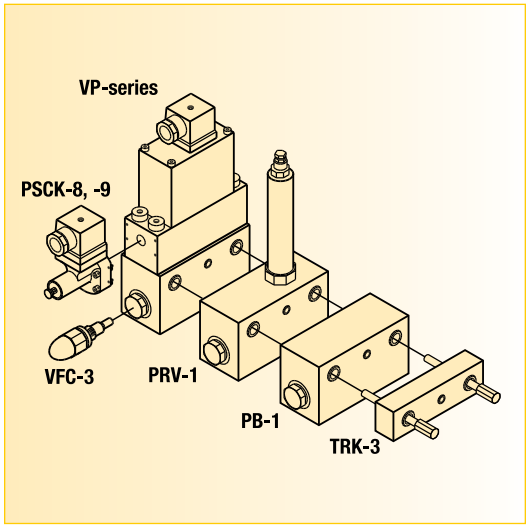


① Pressure gauge
② Pressure switch
③ Tie Rod Kit
④ Directional valve
⑤ Oil level glass
⑥ Oil drain

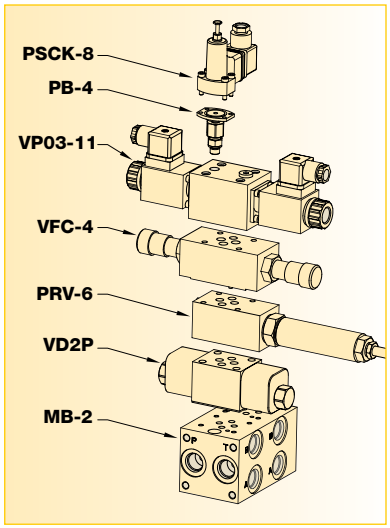
Product selection

Pump series	Voltage	Phase	Continuous operation at 5000 psi	Motor capacity	Motor speed	Motor protection class	Sound Level
	Volt			hp	RPM		dBA
ZW5....	230	1	50%	1.5	1725	IP54	75
ZW5.....	460	3	50%	1.5	1725	IP54	75

Valve options



See page 136 for VP-series valves and available options.



See page 141 for VP03-series valves and available options.

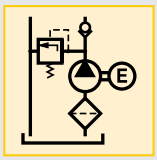
Flow: 120 in³/min

Pressure: 1450-5000 psi

Motor: 1.5 hp

Reservoir: 1-10 gallon

(E) **Bombas eléctricas**
(F) **Centrale hydraulique**
(D) **Modulare Spannpumpe**



Options

VP-series, modular valves 136 ▶

VFC-3 flow control valve (VP series) 137

Pressure switches 188 ▶

Hoses and couplers 192 ▶

High-pressure filters 193 ▶

Fittings 194 ▶

Electric Driven Workholding Pumps *Application & selection*

Shown: **ZW5111SWE100**

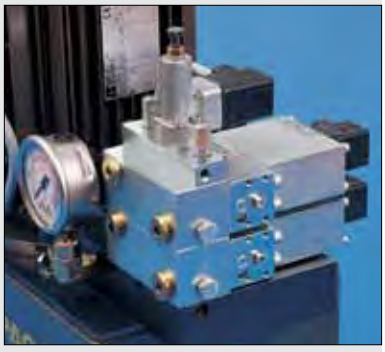
ZW5 series

These advanced workholding pumps, operating at maximum 5000 psi hydraulic pressure, are highly suitable for production tooling applications – offering the optimum in terms of compact size for required oil flow and pressure rating and customization to your specific needs.

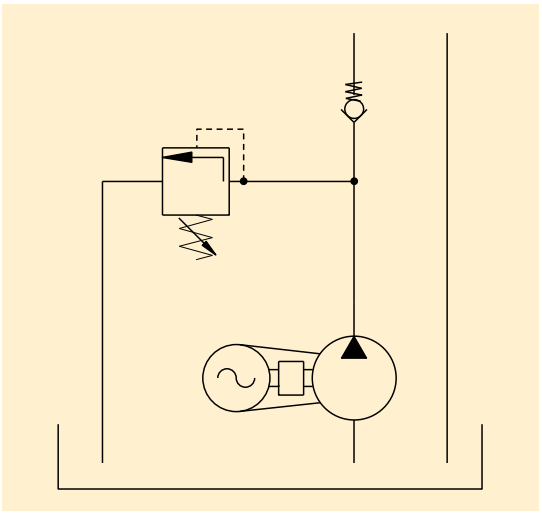
Application

Enerpac electric pump used in conjunction with swing cylinders, work supports, directional valves, control valves and sequence valves can provide a complete clamping solution. The pressure switch allows the unit to be fully automated.

▮ *Enerpac VP-series valves stackbuilt on ZW5211SJE100. The pressure switch PSCK-8 is mounted directly onto the endplate of Tie Rod Kit TRK-2.*



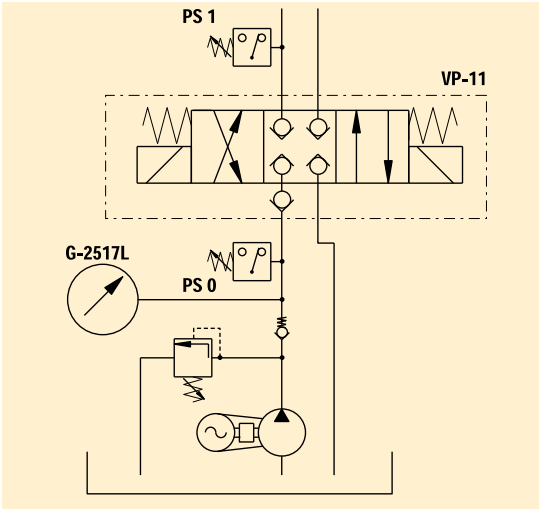
ZW5VPSEE100 with manifold for VP-series or CETOP 03 valves, without electric controls and gauge



Basic pumps

Customize to your needs with the Enerpac VP-series valves and options or choose your own D03 valve.

ZW5111SEE100 For 1x Double-Acting circuit and Isolating Valve for A-port



Isolating valves

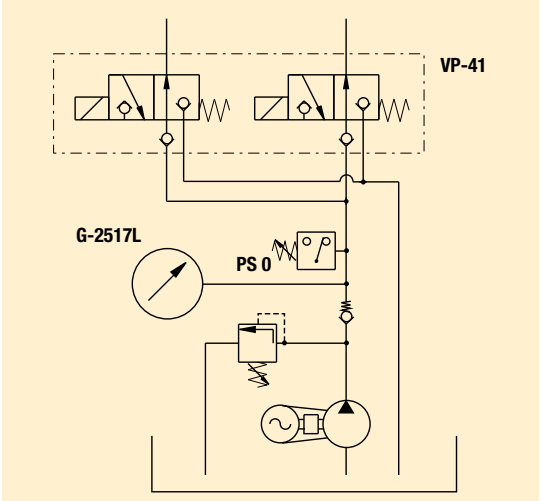
For applications where clamping pressure has to be maintained, isolating valves are an economic and safe solution.

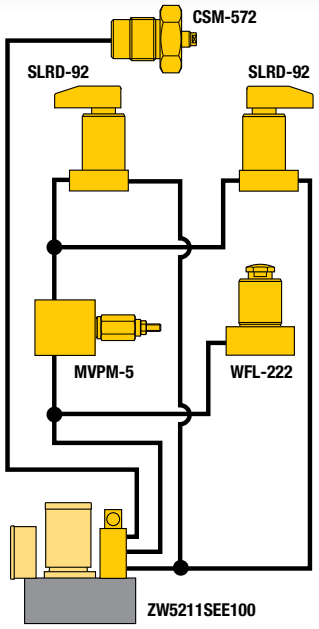
The pressure switch (PS 1) switches in the hydraulic line to the cylinder actuates the valve with a closed center position and isolates the circuit when the preset pressure has been reached. In case of pressure drop the switch opens the valve to compensate.

For some particular applications, i.e., when a workpiece has to be positioned and clamped with different forces, you can set different isolating valve pressures for the independent circuits.

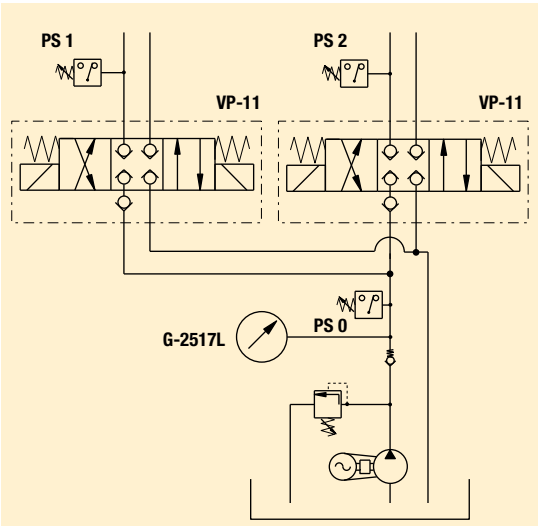
Pressure switch (PS 0) switches the motor off at maximum pressure; in case of pressure drop due to activating circuits, the motor restarts.

ZW5141SEE100 For 2x Single-Acting circuits





ZW5211SEE100 for 2x Double-Acting circuit and Isolating Valve for all A-ports



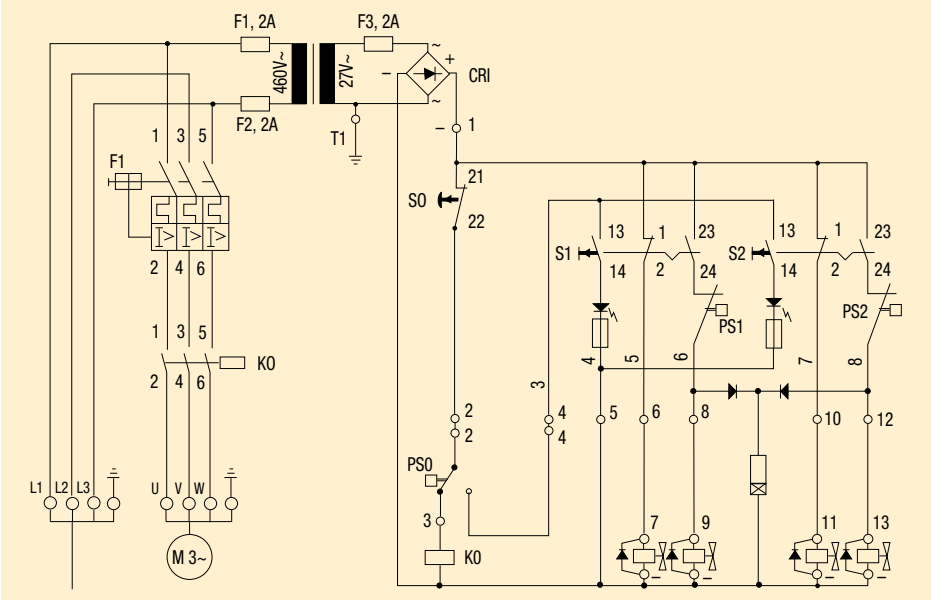
Application example

Building the right workholding system for a specific production tooling requirement is best achieved by observing the Basic System Set-up in our "Yellow Pages" (202).

Electric Scheme

Shown the electric scheme of the ZW5211SJE100 (460 volt) for two double-acting circuits and isolating valves (pressure switches) in both A-lines.

ZW5211SJE100



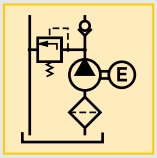
Flow: 120 in³/min

Pressure: 1450-5000 psi

Motor: 1.5 hp

Reservoir: 1-10 gallon

(E) Bombas eléctricas
(F) Centrale hydraulique
(D) Modulare Spannpumpe



Options

Sequence valves 152

Flow control valves 155

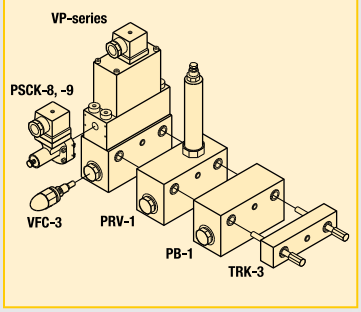
Hoses and couplers 192

High pressure filters 193

Hydraulic oil 193

Fittings 194

VP-series valve options 136



Shown: SP-621, P-51, P-142

99-103

P series

Single and two-speed hand operated pumps for operation of single-acting cylinders.

SP-621 Screw pump

Single speed non-vented, internally sealed screw pump to operate single-acting cylinders. Can be mounted in any position and used to operate a single fixture. The piston is screwed into the pump, forcing the oil in the hydraulic system.

Exclusively from Enerpac

...to power single-acting cylinders

- Internal pressure relief valve (except SP-621) prevents over-pressurization
- Two speed operation reduces handle strokes by as much as 78% over single speed pumps
- Low handle effort minimizes operator fatigue
- Compact size – enables easy conversion of manual fixtures to hydraulic power

Flow: .055-.25 in³/stroke

Pressure: 3000-10,000 psi

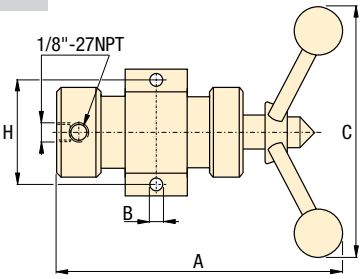
Reservoir: 6.2-55 in³

(E) **Bombas manuales**

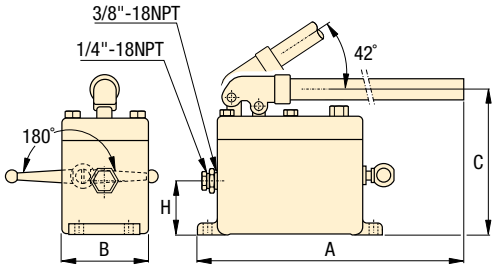
(F) **Pompes à main**

(D) **Handpumpen**

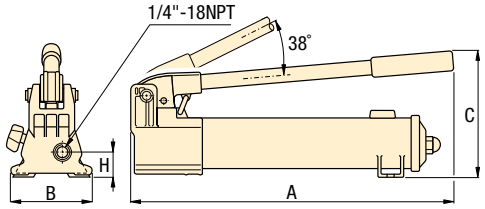
SP-621



P-51



P-141, -142, -202



Options

Fittings 194

Hoses 192

Hydraulic oil 193

Important

P-141, P-142 and P-202 are designed for a maximum operating pressure of 10,000 psi.

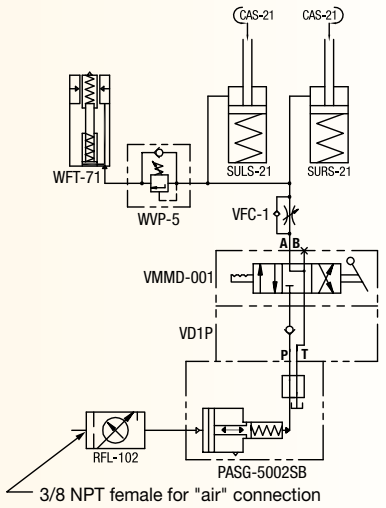
Product selection

Maximum hydraulic pressure	Usable oil capacity	Model number	Pressure rating		Oil volume per stroke		Piston stroke	Maximum handle effort	Dimensions (inches)				
psi	in³		psi 1st stage	2nd stage	in³ 1st stage	2nd stage	in	lbs	A	B	C	H	lbs
▼ **Single speed**													
3000	6.2	**SP-621**	–	3000	–	[1]	[1]	60 [2]	10.10	.41	12.40	2.81	7.0
3000	50	**P-51**	–	3000	–	.25	1.00	61	26.00	3.63	6.31	2.25	12.0
10,000	20	**P-141**	–	10,000	–	.055	.50	72	13.25	3.75	5.63	1.13	4.5
▼ **Two speed**													
5000	20	**P-142**	200	10,000	.221	.055	.50	78	13.25	3.75	5.63	1.13	4.5
5000	20	**P-142-5000**	200	5,000	.221	.055	.50	78	13.25	3.75	5.63	1.13	4.5
10,000	55	**P-202**	200	10,000	.221	.055	.50	63	20.06	3.75	5.69	1.13	7.5

1) Handle travel of SP-621 is 2.50 inches; 25 handle rotations displace 6.2 in³ of oil.
2) Handle effort on SP-621 is 60 ft.lbs at 3000 psi.

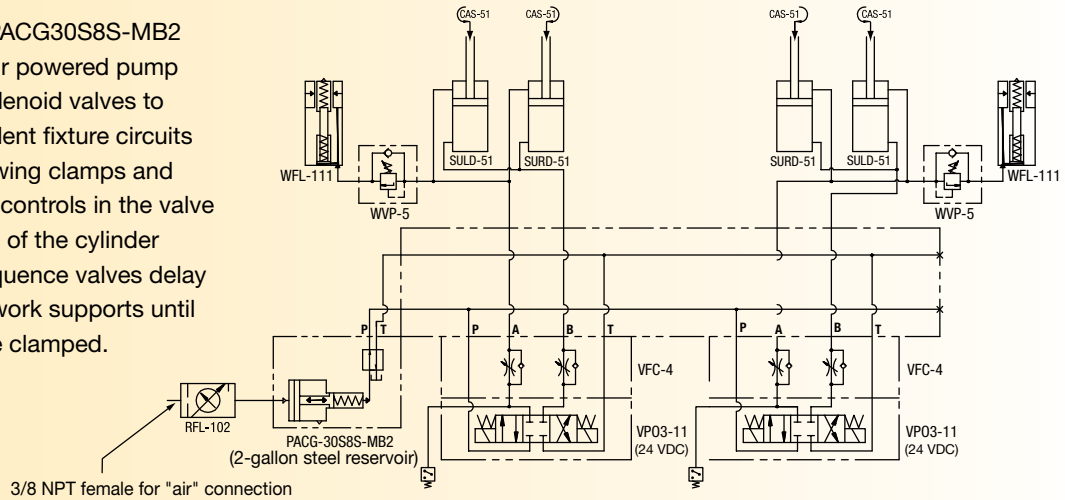
Air Powered Pump with Manual Valve

This system uses a PASG5002SB Turbo II air powered pump with a VMMD-001 manual valve to control a fixture circuit with single acting swing clamps and work supports. A VDP-1 check module in the valve stack locks the pressure in the system. A WVP-5 sequence valve delays the actuation of the works support until the swing clamp is clamped.



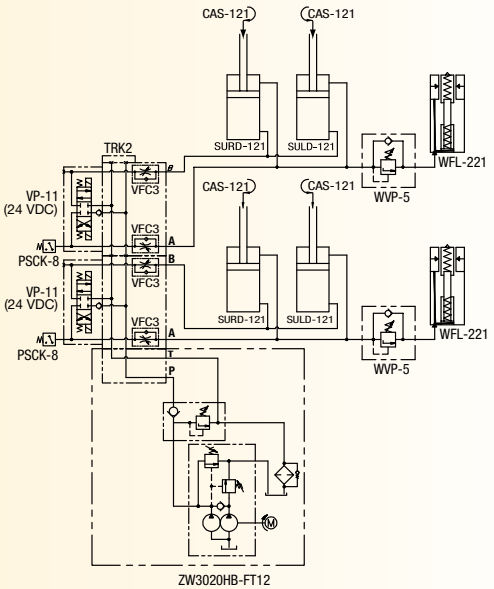
Air Powered Pump with Dual Solenoid Valves

This system uses a PACG30S8S-MB2 Two gallon Turbo II air powered pump with two VP03-11 solenoid valves to control two independent fixture circuits with double acting swing clamps and work supports. Flow controls in the valve stack provide control of the cylinder actuation speed. Sequence valves delay the actuation of the work supports until the swing clamps are clamped.



Electric Pump with Dual Solenoid Valves

This system uses a ZW3020HB-FT12 electric pump and two VP-11 solenoid valves to control two independent fixture circuits with double acting swing clamps and work supports. Flow controls mounted in the valves provide control of the cylinder actuation speed. Pressure switches on the “clamp” circuit can provide confirmation of clamping pressure. Sequence valves delay the actuation of the work supports until the swing clamps are clamped.



ENERPAC

Valves

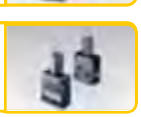
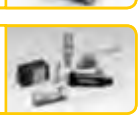
Technical support

Refer to the "Yellow Pages" of this catalog for:

- Safety instructions
- Basic hydraulic information
- Advanced hydraulic technology
- FMS (Flexible Machining Systems) technology
- Conversion charts and hydraulic symbols

197 ▶

Controlling the operation of your clamping system requires the use of many specialized directional, pressure and flow control valves. Enerpac has the complete line of valving components to complement any hydraulic system. Choose from either manual or electric directional valves, and a wide variety of pressure control, flow control and specialty valves to provide the control and automation that your application needs.

	▼ series	▼ page	
Solenoid modular poppet valve	VP	136	
Pressure switches, Flow control valve	PSCK VFC	137	
Pressure reducing valve	PRV	138, 154	
Tie rod kits, Remote/porting manifolds	TRK WM/PB	139	
Solenoid/Air operated 2-position poppet valves	VA, VS, VD	140	
Solenoid poppet, D03/CETOP3	VP03	141	
Solenoid D03 spool valves and accessories	VE	142	
Manual, D03/CETOP3 valves	VMM VMT	143	
Valve manifolds	MB	144	
Solenoid modular valves	VE	146 - 147	
3-Way directional manual control valves	V	148 - 149	
4-Way directional manual control valves	V	150 - 151	
Sequence valves	MVP WVP, V	152	
Pilot operated check valves	MV, V	153	
Flow control valves	VFC	155	
Accessory valves	MH, HV PLV, V	156 - 157	
Air valves and accessories	V, VA, VAS, VR, RFL, QE	158 - 159	

Shown: VP-12

99_017

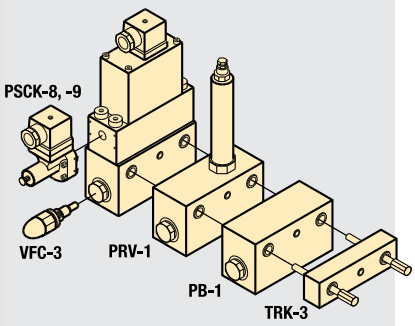
VP-series

Solenoid directional valves control the direction of the oil flow to each cylinder port.

Application

With the use of a -12 manifold, these valves allow quick and easy assembly of hydraulic control valves on your Enerpac ZW-series pump. For remote mounting of these valves use a WM-10 manifold.

VP-series



Enerpac VP-series valves mounted on -12 manifold, mounted on a ZW-series workholding pump.

99_030

Solenoid directional valves

- Dual poppet valve design for zero internal leakage
- Inlet check-valve standard
- High cycle switching
- Stackable to 8 valve stations high
- 250-5000 psi operational pressure
- Oil flow capacity 427 in³/min @ 5000 psi
- Oil flow capacity 915 in³/min @ 0 psi
- G1/4" oil connections and integrated filtration
- 24 VDC and 110 VAC available

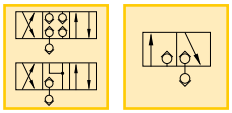
Pressure: 5000 psi

Max. Flow: 915 in³/min

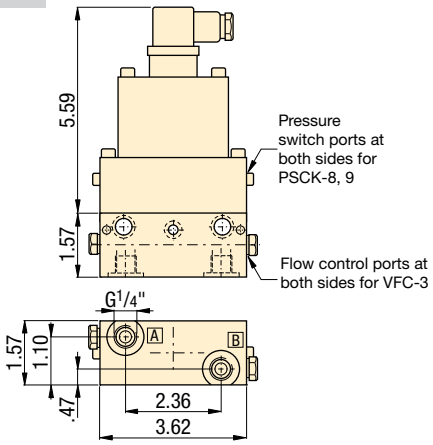
(E) **Válvulas de control**

(F) **Electrodistributeurs**

(D) **Wegesitzventile**



VP series



Options

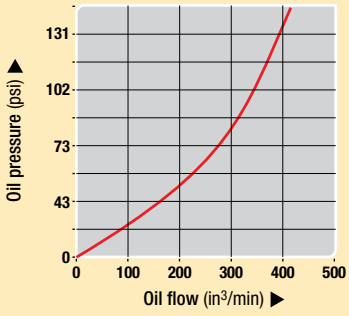
WM-10 series manifolds

139

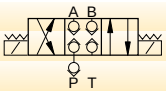
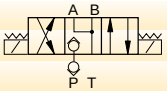
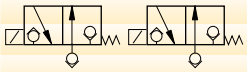
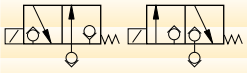
Tie rod kits

139

Oil flow *vs* pressure drop



Product selection

Voltage @ current at 50/60 Hz	Model number	Flow path	Used with cylinder(s)
▼ 4/3 Closed center			
24 VDC @ 1.13 A	VP-11		1x Dbl-act.
110 VAC @ 500 mA	VP-12		1x Dbl-act.
▼ 4/3 Float center			
24 VDC @ 1.13 A	VP-21		1x Dbl-act.
110 VAC @ 500 mA	VP-22		1x Dbl-act.
▼ 3/2 Normally closed			
24 VDC @ 1.13 A	VP-31		1x Dbl-act. / 2x Sgl-act.
110 VAC @ 500 mA	VP-32		1x Dbl-act. / 2x Sgl-act.
▼ 3/2 Normally open			
24 VDC @ 1.13 A	VP-41		1x Dbl-act. / 2x Sgl-act.
110 VAC @ 500 mA	VP-42		1x Dbl-act. / 2x Sgl-act.
▼ 3/2 1 port normally closed, 1 port normally open			
24 VDC @ 1.13 A	VP-51		1x Dbl-act. / 2x Sgl-act.
110 VAC @ 500 mA	VP-52		1x Dbl-act. / 2x Sgl-act.

Note: DIN 43650 electrical connector included. Valve weight 6.5 lbs (3,0 kg.).

Pressure: 5000 psi

Flow: 427 in³/min @ 5000 psi

Voltage: 115 VAC, 24 VDC

(E) **Presostatos**

(F) **Pressostats**

(D) **Druckschalter**

To control your hydraulic system

- Mounts directly into VP-series modular valves
- In-line installation
- Cartridge type flow control valve and pressure switches can be manifold mounted for remote use
- Lockable adjustment screw on PSCK models

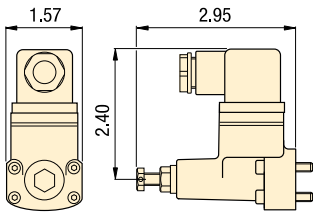
Shown: PSCK-8, VFC-3

Options

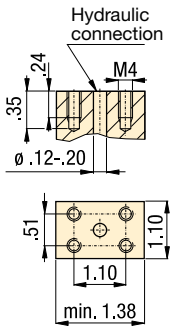
PB-1 Auxiliary block
139

Pressure reducing valves
138

PSCK-8, 9



PSCK-8, 9 mounting dimensions



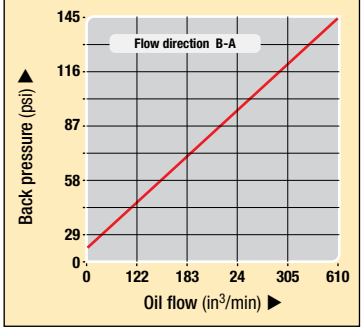
PSCK-8, 9

Adjustable pressure switches will open or close electrical contacts when the desired pressure value is reached.

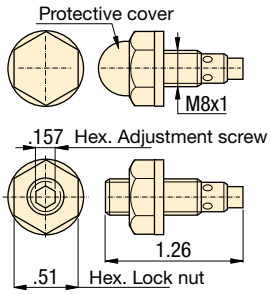
Application

To open or close an electric circuit when a preset pressure value is reached. The electrical circuit is used to control further working cycles, such as actuating control valves or to terminate a working cycle. Directly mounted into Enerpac VP-series valves.

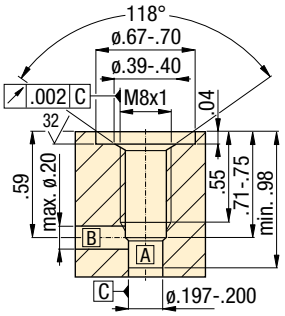
VFC-3 Back pressure *vs* flow return



VFC-3



VFC-3 mounting dimensions



VFC-3

Screw-in throttle type valve to control the amount of oil flow to the hydraulic cylinder.

Application

Used to control cylinder speed in hydraulic circuits. Directly mounted into Enerpac VP-series valves or custom made manifolds for remote applications.

Product selection

Solenoid voltage @ current	Model number	Hydraulic scheme	Pressure range	Deadband	Maximum oil flow
at 50/60 Hz			psi	psi	in³/min
▼ Pressure switch					
24 VDC @ 2 A	PSCK-8		1450 - 5000	261 - 501	427
115 VAC @ 2 A					
▼ Pressure switch					
24 VDC @ 2 A	PSCK-9		290 - 3045	87 - 218	427
115 VAC @ 2 A					
▼ Flow control valve					
screw-in					
throttle	VFC-3		0-5000	–	427
valve					

PSCK-8 and VFC-3 directly mounted on VP-valves.

Shown: PRV-1

99-021

PRV series

These valves regulates system pressure for all subsequent valves, according to the adjusted pressure. Maintains a constant pressure in a secondary circuit. Includes a check valve that prevents pressure drop on secondary side.

Application

Used when a hydraulic supply with a higher pressure (primary side) must also be used for another circuit with a lower pressure (secondary circuit). PRV-1 can be stack built between VP-series valves.

Precise control of hydraulic pressure

- Stackbuilding with VP series modular valves
- Stackable for multiple pressures on one valve stack assembly
- Tool adjustable knob can be locked
- Precise control of pressure

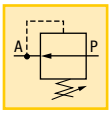
Pressure: 5000 psi

Flow: 417 in³/min

(E) Válv. reguladora de presión

(F) Valve de pression réglable

(D) Druckreduzierventil



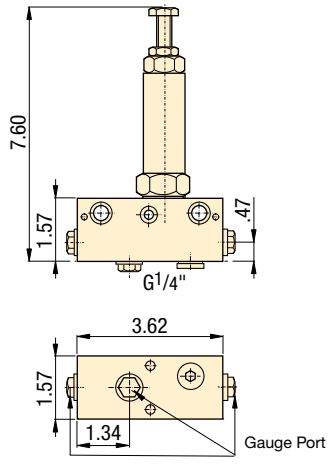
Options

VP-Modular valves 136

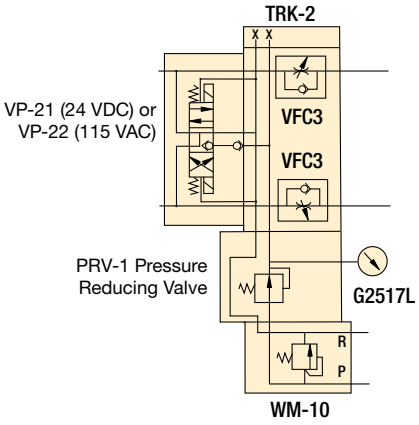
Pressure switches 188

Tie rod kits 139

PRV-1, PRV-5



Valve stacking example



PRV-1 connected with remote manifold WM-10.

99-024

Product selection

Mounting style	Adjustable pressure range	Maximum pressure	Model number	Oil ports	Maximum oil flow	
	psi	psi		BSPP	in³/min	lbs
VP-series	435 - 4350	5000	**PRV-1**	G1/4"	427	3.5
VP-series	75 - 2000	5000	**PRV-5**	G1/4"	427	3.5

Mounting: 1-8 VP valve stations

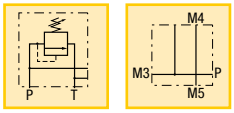
Pressure: 5000 psi max.

Flow: 915 in³/min

(E) **Pernos de montaje de válv.**

(F) **Vis de montage de distrib.**

(D) **Zugstangen**



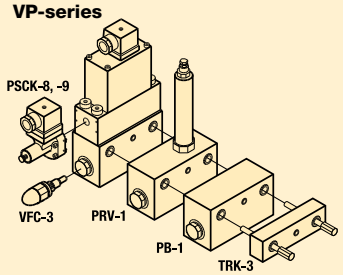
Options

Pressure switches 188

VP-series directional valves 130

Gauges 189

VP-series



Simplifies valve and accessory mounting

TRK-series tie rods

- Connects 1 to 8 VP-series valves station high
- Provide leak-free sealing valves
- G1/4" oil connection

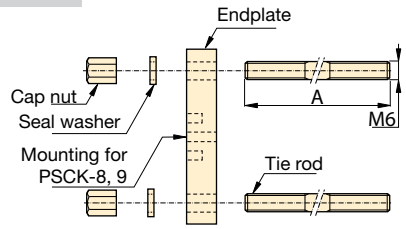
WM-10 remote manifold

- Allows remote VP-series valve mounting
- Adjustable relief valve incorporated
- G1/4" oil connection

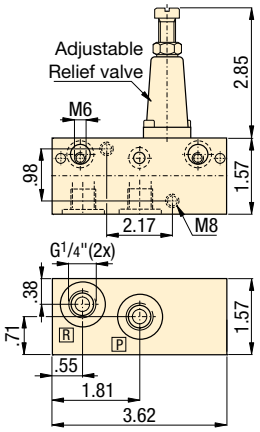
PB-1 porting manifold

- Provide 3 auxiliary pressure lines
- G1/4" oil connection

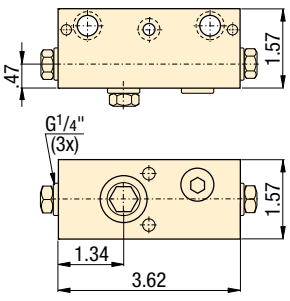
TRK



WM-10



PB-1



Shown: WM-10, TRK-4, PB-1

TRK-series

Tie Rod Kits mount Enerpac VP-series modular valves to the WM-10 manifold and can accommodate one to eight VP-valve stations.

WM-10

Remote manifold allows mounting of VP-series modular valves to a remote location from the pumping unit. This manifold has a built-in adjustable relief valve.

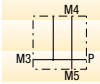
PB-1

Porting manifold provides three pressure ports for auxiliary lines or accessories, such as a pressure gauge. Mounts between VP-series modular valve stations using TRK-series tie rod kits.

Product selection

Quantity of stackable VP-series directional valves	Model number	Tie rod length A (inch)	Mounting thread (mm)
▼ Tie rod kits			
1	TRK-1	3.45	M6
2	TRK-2	4.92	M6
3	TRK-3	6.50	M6
4	TRK-4	8.07	M6
5	TRK-5	9.65	M6
6	TRK-6	11.22	M6
7	TRK-7	12.80	M6
8	TRK-8	14.37	M6

Product selection

Oil ports (BSPP)	Model number	Hydraulic schematic	Maximum pressure (psi)
▼ Remote manifold with pressure relief			
2x G1/4"	WM-10		5000
▼ Porting manifold (P port connection)			
3x G1/4"	PB-1		5000

Tie rods mount VP-series valves and accessories to manifold, providing leak-free sealing.

Shown: VST-1401D, VSS-2210D

99_111

VSS, VST-series

Solenoid and air piloted directional control valves. Poppet design for zero leakage promote system efficiency. Increases the life of your workholding pump by decreasing internal valve leakage.

Application

Advance and retract for single- and double-acting cylinders. The valves require check valves for positive load holding and can be installed for the same independent operation with single-acting cylinders by blocking the B port.

Zero leakage poppet valves increase efficiency

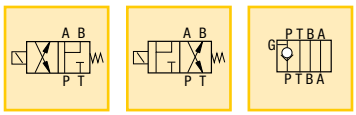
- Poppet valve design for zero leakage
- 4-way, 2-position float offset or normally open
- D03 or CETOP3 mounting pattern
- DIN-standard rectifier plugs for easy connection to power source
- Air operated models eliminate need for electricity
- Including O-rings and mounting bolts
- SAE manifold ports simplify plumbing
- Inline check valve provides positive load holding

Pressure: 0-5000 psi

Flow: 690 in³/min max.

Voltage: 115 VAC, 24 VDC

(E) Electroválvulas
(F) Electrodistributeurs
(D) Elektromagnetische Ventile



Options

D03 Manifolds MB-series
144

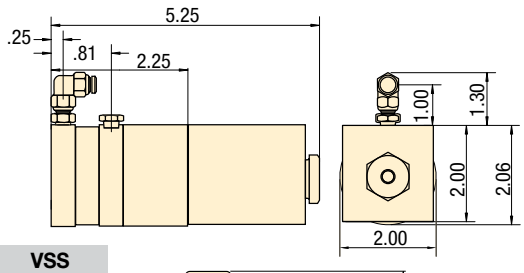
Fittings
194

Important

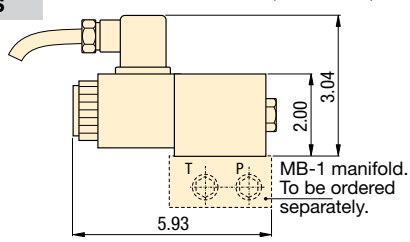
For multiple circuit applications, the VD1P inline check valve is recommended to prevent pressure drop on the holding circuit.

Order bolt kit BKD-71 to mount VD1P with VAS/VSS/VST valves.

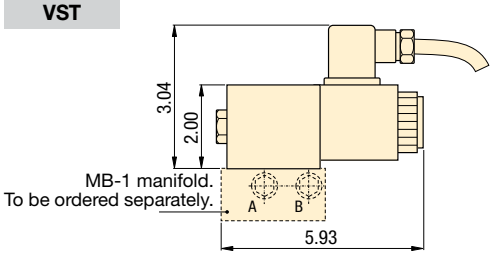
VAS/VAT



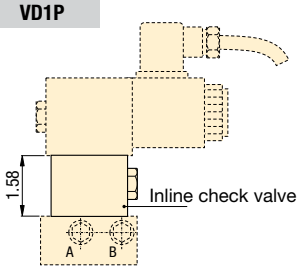
VSS



VST



VD1P



Product selection

Valve flow path	Solenoid voltage @ current at 50/60 Hz	Model number	Hydr. symbol	Pressure range psi	Pressure drop [1] psi	Max. oil flow in³/min
▼ **Solenoid poppet valves – Normally open**						
4-way, 2 position	60-100 psi max.	**VAS-0710D**		0-5000	180	690
4-way, 2 position	24VDC @ 1.60 A	**VSS-1410D**		0-5000	180	690
4-way, 2 position	115VAC @ .40 A	**VSS-2210D**		0-5000	180	690
▼ **Solenoid poppet valves – Normally closed**						
4-way, 2 position	60-100 psi max.	**VAT-0710D**		0-5000	180	690
4-way, 2 position	24VDC @ 1.60 A	**VST-1410D**		0-5000	180	690
4-way, 2 position	115VAC @ .40 A	**VST-2210D**		0-5000	180	690
▼ **Inline check valve**						
–	–	**VD1P**		0-5000	0	690

[1] Pressure drop from P-A or P-B at maximum oil flow of 690 in³/min.

VSS-2210D mounted directly on a Turbo II air pump for use on positive clamping fixture.

99_121

Pressure: 0-5000 psi

Flow: 3-15 gpm

Voltage: 24 VDC, 110 VAC

(E) **Electrovávulas**

(F) **Electrodistributeurs**

(D) **Elektromagnetische Ventile**

Options

D03 Manifolds MB-series

144

Fittings

194

VP03 Directional Valves and accessories

- D03/CETOP 3 mounting pattern
- Directional valves
- Pilot operated check valve
- Dual flow control
- Pressure reducing valve

Shown: VP03

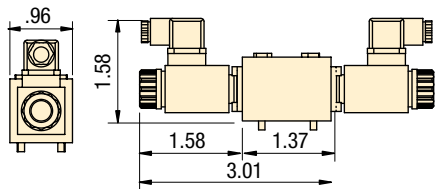
VP03-series

VP03 valves are zero leakage, solenoid operated poppet valves.

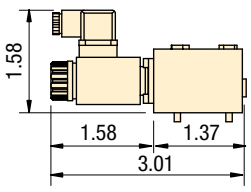
Application

Used to control the advance and retract of single acting and double acting cylinders.

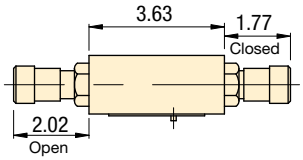
VP03-11, 12, 21, 22



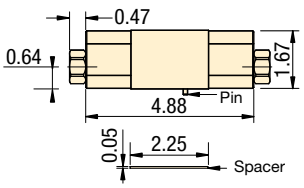
VP03-51, 52



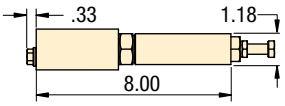
VFC-4



VD2P



PRV-6, PRV-7



Product selection

Valve flow path	Solenoid voltage 50/60 hz	Model number	Hydraulic symbol	Pressure range psi	Maximum oil flow gpm
3-position/4 way, Closed center	24 VDC	**VP03-11**		0-5000	5
	110 VAC	**VP03-12**		0-5000	5
3-position/4 way, Float center	24 VDC	**VP03-21**		0-5000	5
	110 VAC	**VP03-22**		0-5000	5
2-position/4 way	24 VDC	**VP03-51**		0-3626	4
	110 VAC	**VP03-52**		0-3626	4
Dual flow control	–	**VFC-4**		0-5000	10
Dual pilot operated check valve	–	**VD2P**		0-5000	15
Pressure reducing valve	–	**PRV-6**		435-4350	3.2
	–	**PRV-7**		75-2000	1.6

Important

VP03 series valves are zero leakage and can be used with pressure shut down electric pumps and air driven Turbo II pumps.

VP03-11 valve on PASG-3002SB Turbo pump.

Shown: VEX-11 valve

89-111

VE-series

Spool style solenoid valves and control modules are used in circuits that do not require zero leakage.

Application

Used to control the advance and retract of single acting and double acting cylinders. The dual check valve can be used to lock pressure in a group of cylinders. The dual flow control offers independent control of cylinder advance and retract speeds. The pressure reducing valve sets a circuit pressure lower than the main pump pressure.

D03 Direction Valve and accessories

- D03 mounting pattern
- Directional valves
- Pressure operated check valve
- Dual flow control
- Pressure reducing valve

Pressure: 0-5000 psi

Flow: 3-15 gpm

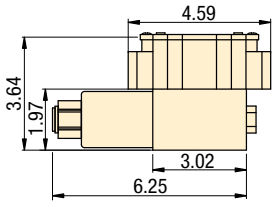
Voltage: 24 VDC

(E) Electrovávulas

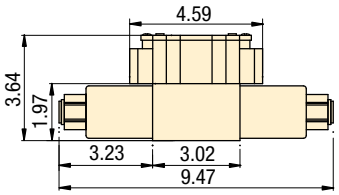
(F) Electrodistributeurs

(D) Elektromagnetische Ventile

VEW-11



VET-11, VEX-11



Options

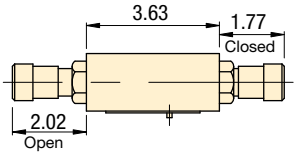
D03 Manifolds MB-series 144 ▶

Fittings 194 ▶

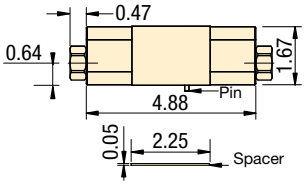
Important

To hold the pressure in a clamping circuit, use the VEX11 valve with the VD2P check module. Do not use D03 spool valves with pressure shutdown pumps.

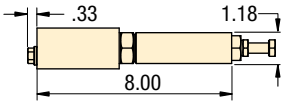
VFC-4



VD2P



PRV-6, PRV-7



Product selection

Valve flow path	Solenoid voltage 50/60 hz	Model number	Hydraulic symbol	Pressure range psi	Pressure drop psi	Maximum oil flow gpm
2-position/4 way	24 VDC 1.32 Amps	VEW-11		0-5000	125	8
3-position/4 way, Closed center	24 VDC 1.32 Amps	VET-11		0-5000	150	8
3-position/4 way, Float center	24 VDC 1.32 Amps	VEX-11		0-5000	165	8
Dual flow control	–	VFC-4		0-5000	–	10
Dual pilot operated check valve	–	VD2P		0-5000	200	15
Pressure reducing valve	–	PRV-6 / PRV-7		435-4350 75-2000	–	3

VEX-11 valve on ZW5020HG-FT21 pump.

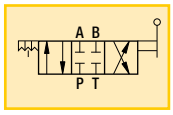
Pressure: 5000 psi

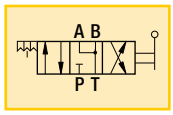
Flow: 1040 in³/min

(E) **Válvulas de control de 4 vias**

(F) **Distributeurs à 4 voies**

(D) **4-Wege-Ventiler**





Options

VD1P, Inline check valve

◀ 140

D03 Manifolds

144 ▶

Hoses and couplers

192 ▶

Fittings

194 ▶

Important

For multiple circuit applications, the VD1P inline check valve is recommended to prevent pressure drop on the holding circuit.

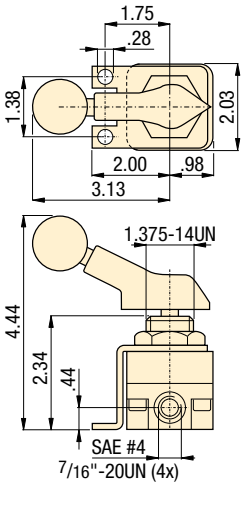
See page 145 for mounting bolt information.

Pressure on return side (tank) should not exceed 250 psi.

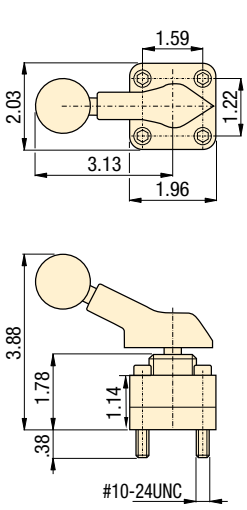
Manual control of single and double-acting cylinders

- Near zero leakage pressure seal design
- 4-way, 3-position
- Detented handle positions
- Low handle effort 12 lbs, even at full pressure
- Handle can be repositioned for side by side valve mounting
- Compact size for directly mounting on fixture for individual circuit control
- D03/CETOP 3 mounting pattern

VMTD-001, 003



VMMD-001, -003



Shown: VMMD-001, VMTD-001

VMM and VMT-series

Manual directional control valves for single- and double-acting cylinder control. Lapped pressure seal surface provide near zero leakage.

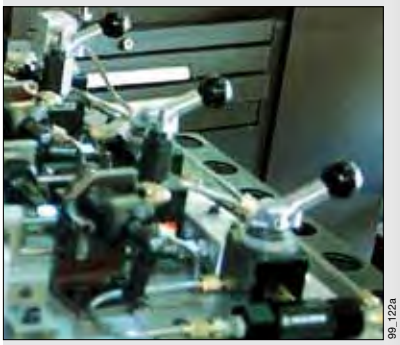
The VMTD series has threaded port connections and removable holding bracket for panel mounting.

Application

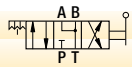
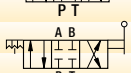
Panel mounting on fixtures for control of individual circuits. The blocked pressure port in the center position allows demand style pumps to stall out, saving energy.

The valves require check valves for positive load holding.

Several VMTD-001 valves mounted on fixture waiting to be transferred to machine.



Product selection

Valve mounting pattern	Mounting bolts included	Oil ports	Model number	Hydraulic symbol	Pressure range psi	Pressure drop [1] psi	Max. oil flow in³/min
▼ **4-way, 3-position control valves**							
Panel mtg.	–	SAE #4	**VMTD-001**		0-5000	70	1040
D03/CETOP 3	#10-24UN	–	**VMMD-001**		0-5000	70	1040
Panel mtg.	-	SAE #4	**VMTD-003**		0-5000	70	1040
D03/CETOP 3	#10-24UN	–	**VMMD-003**		0-5000	70	1040

[1] Pressure drop from P-A or P-B at maximum oil flow of 1040 in³/min.
Seal material: Buna-N, Polyurethane.

www.enerpacwh.com

Shown: MB-4, MB-1

99_101

When independent control of multiple cylinders is required

- Multi-station manifolds with SAE or CETOP 3 porting – minimizes plumbing
- Mounting patterns for: VSS/VST Valves (D03 or CETOP 3); VE Valves (D03 or CETOP 3); VP03 Valves (D03 or CETOP 3); VMMD Valves (D03 or CETOP 3)
- Manifolds allow use of accessories, such as pressure switches and gauges

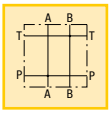
Mounting: 1-4 valves

Pressure: 5000 psi max.

(E) Colectores

(F) Manifolds

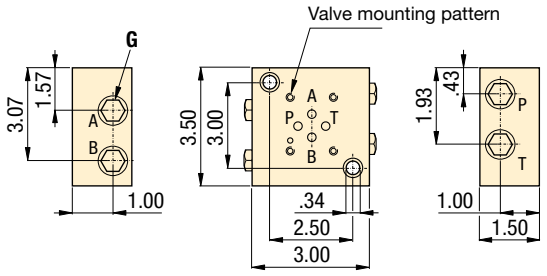
(D) Verkettungsblöcke



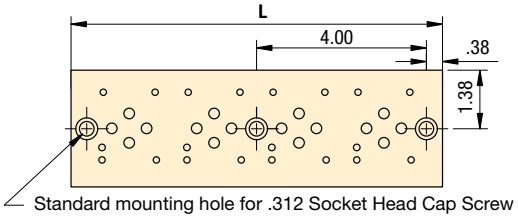
MB-series

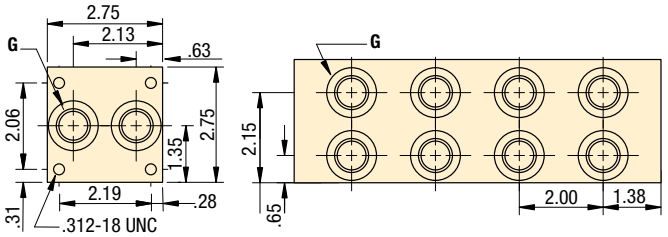
Single or multiple station manifolds allow installation of VSS and VST-series positive seal control valves or other D03/CETOP 3 valves. Ideal in applications where independent control of multiple cylinders is required.

MB-1



MB-2, -4





Options

VSS, VST-series valves 140

Pressure switches 188

Gauges and accessories 190

Fittings 194

Important

Use MC-1 / MC-3 cover plates to seal unused manifold stations.

Important

Use MC-1 (D03) / MC-3 (CETOP 3) cover plates to seal non-used manifold stations.

Each non-used valve station on manifolds must be sealed with MC-1 cover plate.

Product selection

Valve mounting pattern	Number of valve stations	Model number	Oil ports cover plate G	Coverplate model number*	Manifold L in	Manifold lbs
▼ **Single station manifold**						
D03	1	**MB-1**	SAE #4	–	–	1.0
CETOP 3	1	**MB-12**	G1/4"	–	–	1.0
▼ **Multiple station manifolds**						
D03	2	**MB-2**	SAE #8	MC-1	4.75	3.3
CETOP 3	2	**MB-22**	G3/8"	MC-3	4.75	3.3
D03	4	**MB-4**	SAE #8	MC-1	8.75	6.1
CETOP 3	4	**MB-42**	G3/8"	MC-3	8.75	6.1

***Note:** - MC-1 manifold cover plate must be ordered separately. Includes gasket and mounting bolts.

(E) Kits de fijación para válvulas

(F) Kits de montage robinet

(D) Zugstangen-Satz

Options

VD1P, Inline check valve

◀ 140

D03 Manifolds

◀ 144

Hoses and couplers

192 ▶

Fittings

194 ▶

Important

The mounting stud must project into the manifold a minimum of .375" (9,5 mm). After installation, torque the stud nuts to 45 in-lbs (5 Nm)

To calculate the required stud length, add the stud length for the directional valve and each accessory module used in the valve stack. Add .78" (19,81 mm) to this length. The mounting studs should be cut to this total length.

Use Stud Bolt Kits to assure the correct bolt length

- Studs are easily cut to length
- Stud nuts make installation easier
- Pre-mount the studs into the manifold to help guide the valve components into place

Example

Description	Model number	Stud Length	
		in	mm
Directional valve	**VP03-11**	1.87	47,49
Dual flow control	**VFC-4**	1.57	39,88
Dual P.O. check	**VD2P**	1.57	39,88
Stud nut	**VD2P**	0.40	10,16
Manifold	**V-19**	0.38	9,65
Total length:		**5.79**	**147,06**

Product selection

Description	Model number	Stud Length	
		in	mm
Imperial stud kit (#10-24)*	**BKD71**	7.00	–
Metric stud kit (M5)*	**BKD72**	–	177,80
▼ Valve mounting bolt lengths using stud kits			
Stud Nut	**BKD71, BKD72**	0.40	10,16
Manifold	**MB1, MB2, MB3**	0.38	9,65
Solenoid valve	**VAS/VSS/VST**	1.63	41,40
Solenoid valve	**VEW/VET/VEX**	1.25	31,75
Solenoid valve	**VP03**	1.87	47,49
Manual valve	**VMMD001/VMMD003**	1.13	28,70
Pressure Reducing Valve	**PRV6/PRV7**	1.57	39,88
Check valve, on "P"	**VD1P**	1.57	39,88
Dual P.O. check valve	**VD2P**	1.57	39,88
Dual flow control	**VFC-4**	1.57	39,88

*Note: Stud kit includes 4 studs and 4 stud nuts

Shown: BKD71, BKD72

BKD-series

Always have the right bolt length required to mount the components in your valve stack by using these stud bolt kits.

Refer to chart to determine the required bolt length

Solenoid modular valves *Application & selection*

Shown: VEC-15600D, VEC-15000B, VEK-15000B

99-137

VE-series

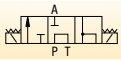
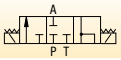
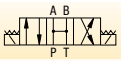
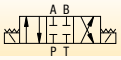
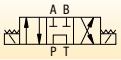
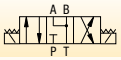
Solenoid modular valves are especially well suited for workholding and production applications. With 11 possible flowpaths and 2 manifolds, for either Enerpac's submerged pump or a remote NPT mount, you can "custom build" a valve for almost any application.

Application
Ideal when mounted on remote manifold for applications where independent control of multiple cylinders is required.

Unmatched combination of possibilities

- Relief valve and pilot-operated check accessory valves are stackable eliminating external plumbing
- Remote and pump mounting
- Mounting bolts included with each modular valve

Select the required valve flow path

Valve flow path	For cylinder	Valve code	Hydraulic symbol
▼ **2-way, 2-position (2/2)**			
Normally closed	Unloading *	**VEH**	
Normally open	Unloading *	**VEK**	
▼ **3-way, 2-position (3/2)**			
Normally open	Single-acting	**VEP**	
▼ **3-way, 3-position (3/3)**			
Tandem center	Single-acting	**VEF**	
Closed center	Single-acting	**VEG**	
▼ **4-way, 2-position (4/2)**			
Crossover offset	Double-acting	**VEE**	
Float offset	Double-acting	**VEM**	
▼ **4-way, 3-position (4/3)**			
Open center	Double-acting	**VEA**	
Closed center	Double-acting	**VEB**	
Tandem center	Double-acting	**VEC**	
Float center	Double-acting	**VED**	

* VEH and VEK valve models require the use of tank port for dump or unloading.

Product spefications

Pressure range	Maximum oil flow	Voltage @ Hz	Amperage draw	
			Amps	
psi	in^3/min		inrush	holding
0-10,000	920	24 VDC @ 50/60 Hz	–	2.5
0-10,000	920	115 VAC @ 60 Hz	3.6	1.0
0-10,000	920	220/240 VAC @ 50 Hz	1.3/1.4	.45/.53
0-10,000	920	230 VAC @ 60 Hz	1.8	.50 A

Note: Seal material: Buna-N, Polyurethane.
DIN43650 Valve plug included on remote mounted valves.

Custom build your modular valves

This is how a Solenoid Modular Valve Model Number is built up:

VEA	-	1	5	600	-	D
1 Valve Flow Path		2 Flow Capacity	3 Voltage	4 Accessory Valves		5 Manifold

1 Modular valve code

A = 4/3 Open center
B = 4/3 Closed center
C = 4/3 Tandem center
D = 4/3 Float center
E = 4/2 Crossover offset
F = 3/3 Tandem center
G = 3/3 Closed center
H = 2/2 Normally closed
K = 2/2 Normally open
M = 4/2 Float offset
P = 3/2 Normally open

2 Oil flow capacity

1 = 920 in³ per minute

3 Solenoid voltage

1 = 24 VDC, 50 / 60 Hz
2 = 230 V, 1 ph, 50 Hz
5 = 115 V, 1 ph, 60 Hz
6 = 230 V, 1 ph, 60 Hz

4 Accessory valves

000 = No accessory valves
100 = **VS-11** Relief valve only
150 = **VS-11** Relief valve and **VS-51** 3-way pilot operated *check valve VEF/VEG only*
160 = **VS-11** Relief valve and **VS-61** 4-way pilot operated check valve *VEA/VEB/VEC/VED only*
500 = **VS-51** 3-way pilot operated *check valve VEF/VEG only*
600 = **VS-61** 4-way pilot operated check valve *VEA/VEB/VEC/VED only*

5 Manifold

A = No manifold
B = Remote mounted manifold
D = Pump mounted manifold *VEA/VEC/VEF only*

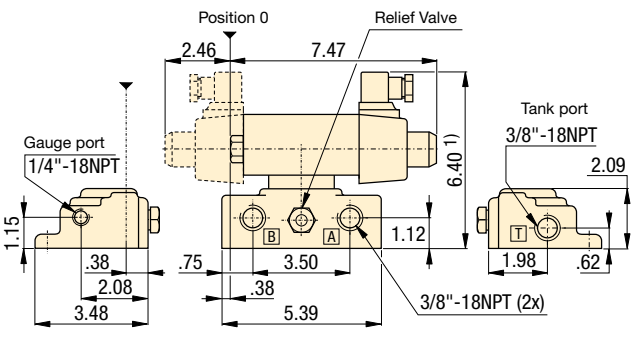
Example

The **VEA-15600-D** is a modular valve with a 4-way, 3-position open center flowpath, 115 VAC, and an integrated pilot-operated check valve, for mounting on an Enerpac pump.

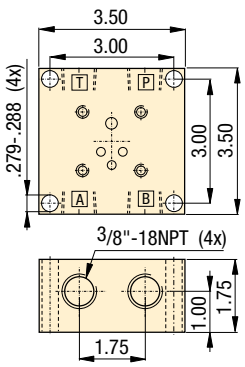
Bolt Kit **BK-2** is included.

VE series

Modular Valve Pump Mounted



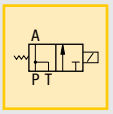
Modular Valve Remote Mounted

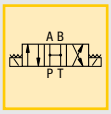


1) add 1.85 inch for each Accessory Valve.
Note: BK-1 Bolt Kit is included with each modular valve.

Pressure: 0-10,000 psi
Flow max.: 920 in³/min
Voltage: 24, 115, 230 V

E Válvulas de control
F Electrodistributeurs
D Wegesitzventile





Options

Gauges and accessories
190

Fittings
194

Accessory Valves and Bolt Kits

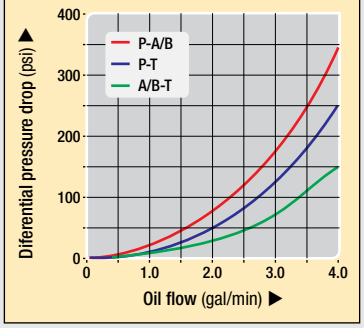
Use **VS-11** relief valve to add system pressure control to VE-series valves.

Use **VS-51** 3-way pilot operated check valve to convert 3-way VE-valve into load-holding valve.

Use **VS-61** 4-way pilot operated check valve to convert 4-way VE-valve into load-holding valve.

To install accessory valves to stack build modular valves use bolt kits:
BK-2 for 1 VS valve;
BK-3 for 2 VS valves.

Pressure drop *vs* oil flow



3-way directional manual control valves *Application & selection*

Shown: VM-2, VM-3

99-138

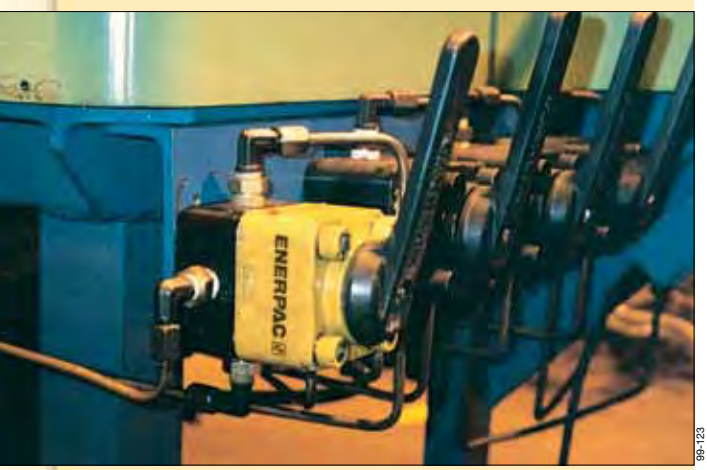
V-series

Manual operated 3-way, 2-position and 3-way, 3-position directional control valves for operation of single-acting cylinders. Remote mount valves include return line kit for connecting the valves to pump reservoir.

Application

Pump mounted valves provide centralized control of pump output for cylinder cycling. Remote mounted at any convenient point along the system where control of cylinders is needed.

Four VC-15 Enerpac manual valves mounted on fixture to give independent control of several hydraulic circuits.



99-123

Reliable control of single-acting cylinders

- Directional control valves provide advance/hold/retract operation for use with single-acting cylinders
- Remote or pump mounting on most Enerpac pumps
- Return line kit included with remote valves
- Available “locking” option on VC and VM-series valves for load-holding applications

Select the required center position

Non-locking

- Use in simple clamping circuits. Has interflow between ports when shifted.

Closed center

- For multiple valve and cylinder operation. All ports blocked in the center position.

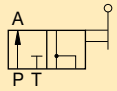
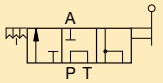
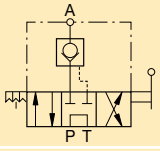
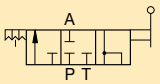
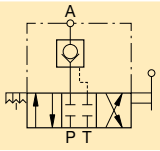
Locking center

- For positive load holding without loss of pressure. Cylinder travel can only resume by shifting valve from hold position.

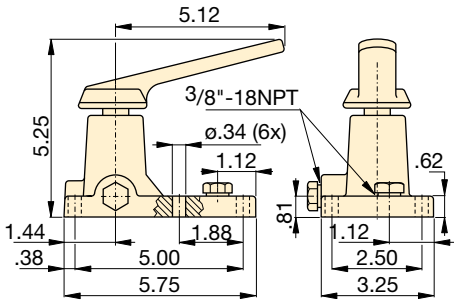
Tandem center

- For one or multiple cylinder operation. Pump flow is directed back to tank in the center position.

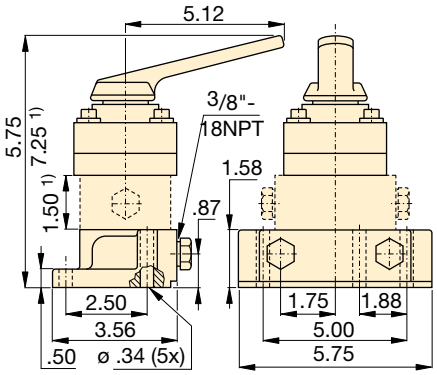
Product selection

Valve type	Valve mounting location	Model number	Hydraulic symbol
▼ Manual 3-way, 2-position (3/2)			
–	Pump	VM-2	
▼ Manual 3-way, 3-position (3/3)			
Tandem center	Pump	VM-3	
Tandem center	Remote	VC-3	
▼ Manual 3-way, 3-position (3/3)			
Tandem center, locking	Pump	VM-3L	
Tandem center, locking	Remote	VC-3L	
Closed center	Remote	VC-15	
Closed center, locking	Remote	VC-15L	

VM-2

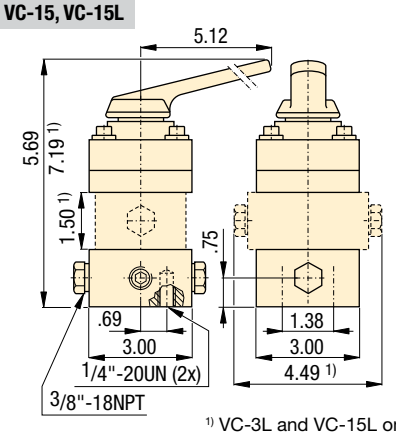


VM-3, VM-3L



1) VM-3L only

VC-3, VC-3L
VC-15, VC-15L



1) VC-3L and VC-15L only

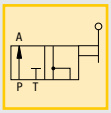
Pressure: 0-10,000 psi

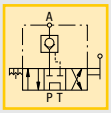
Flow max.: 1040 in³/min

E Vàlvulas de control

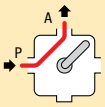
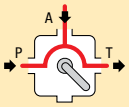
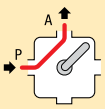
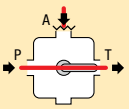
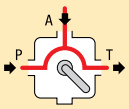
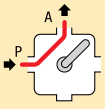
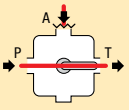
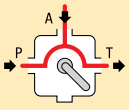
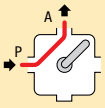
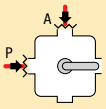
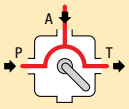
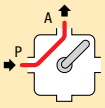
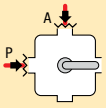
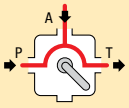
F Distributeurs à 3 voies

D 3-Wege-Ventile





Product specifications

Model number	Pressure range psi	Used for cylinder	Schematic flowpath: Advance	Hold	Retract	lbs
▼ **Manual 3-way, 2-position (3/2)**						
VM-2	0-10,000	Single-acting		–		4.8
▼ **Manual 3-way, 3-position (3/3)**						
VM-3	0-10,000	Single-acting				4.6
VC-3	0-10,000	Single-acting				6.4
▼ **Manual 3-way, 3-position (3/3)**						
VM-3L	0-10,000	Single-acting				8.6
VC-3L	0-10,000	Single-acting				10.3
VC-15	0-10,000	Single-acting				6.4
VC-15L	0-10,000	Single-acting				10.3

Options

Gauges and accessories 190

Hoses and couplers 192

Fittings 194

Important

Locking Valves

For applications that require positive load holding, most VM and VC valves are available with pilot operated check valve. This option provides hydraulic locking of the load until valve is shifted into retract position. To order this feature, place an "L" at the end of the model number.

Valving help

See Basic System Set-up and Valve information in our "Yellow Pages".

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4-way directional manual control valves *Application & selection*

Shown: VC-20, VM-4

99-139

Reliable control of double-acting cylinders

- Directional control valves provide advance/hold/retract operation for use with double-acting or two single-acting cylinders
- Remote or pump mounting on most Enerpac pumps
- Return line kit included with remote valves
- Available “locking” option on VC and VM-series valves for load-holding applications

V-series

Manual operated 4-way, 3-position directional control valves for operation of double-acting or two single-acting cylinders. Remote mount valves include return line kit for connecting the valves to pump reservoir.

Application

Pump mounted valves provide centralized control of pump output for cylinder cycling. Remote mounted at any convenient point along the system where control of cylinders is needed.

Select the required center position

Non-locking

- Use in simple clamping circuits. Has interflow between ports when shifted.

Closed center

- For multiple valve and cylinder operation. All ports blocked in the center position.

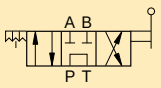
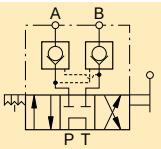
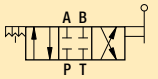
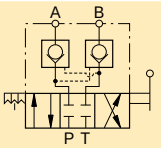
Locking center

- For positive load holding without loss of pressure. Cylinder travel can only resume by shifting valve from hold position.

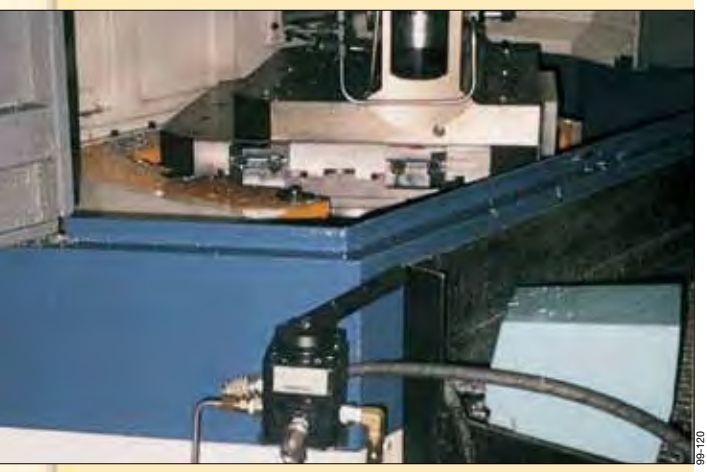
Tandem center

- For one or multiple cylinder operation. Pump flow is directed back to tank in the center position.

Product selection

Valve type	Valve mounting location	Model number	Hydraulic symbol
▼ **Manual 4-way, 3-position (4/3)**			
Tandem center	Pump	**VM-4**	
Tandem center	Remote	**VC-4**	
Tandem center, locking	Pump	**VM-4L**	
Tandem center, locking	Remote	**VC-4L**	
Closed center	Remote	**VC-20**	
Closed center, locking	Remote	**VC-20L**	

Enerpac VC-4 manual valves mounted to control hydraulic circuit on pallet fixture



99-120

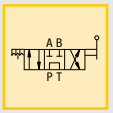
Pressure: 0-10,000 psi

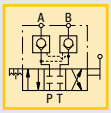
Flow max.: 1040 in³/min

E Vàlvulas de control

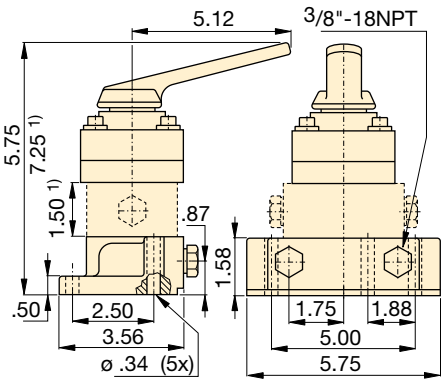
F Distributeurs à 4 voies

D 4-Wege-Ventile



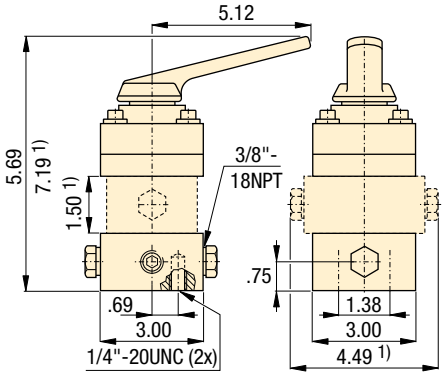


VM-4, VM-4L



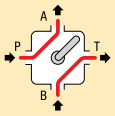
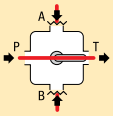
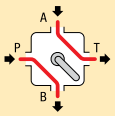
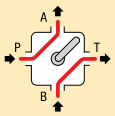
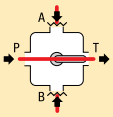
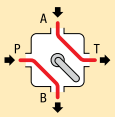
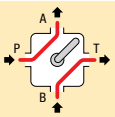
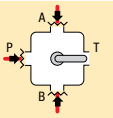
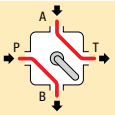
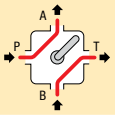
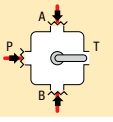
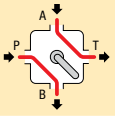
1) VM-4L only

VC-4, VC-3L
VC-20, VC-20L



1) VC-4L and VC-20L only

Product specifications

Model number	Pressure range	Used for cylinder	Schematic flowpath			
	psi		Advance	Hold	Retract	lbs
▼ Manual 4-way, 3-position (4/3)						
VM-4	0-10,000	Double-acting				4.6
VC-4	0-10,000	Double-acting				6.4
VM-4L	0-10,000	Double-acting				8.6
VC-4L	0-10,000	Double-acting				10.3
VC-20	0-10,000	Double-acting				6.4
VC-20L	0-10,000	Double-acting				10.3

Options

Gauges and accessories 190

Hoses and couplers 192

Fittings 194

Important

Locking Valves

For applications that require positive load holding, most VM and VC valves are available with pilot operated check valve. This option provides hydraulic locking of the load until valve is shifted into retract position. To order this feature, place an "L" at the end of the model number.

Valving help

See Basic System Set-up and Valve information in our "Yellow Pages".

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Shown: WVP-5, MVPM-5

Sequence valves

Sequence valves block the oil to a secondary hydraulic circuit until pressure in the primary circuit reaches a preset level. The sequence valves have a built-in check system to allow the oil to flow back without external piping.

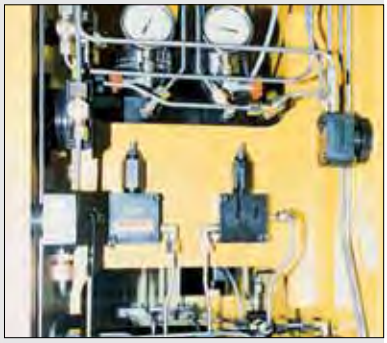
Pressure settings for the V-2000 can be adjusted by screwing the slotted pin in or out. The pressure settings for the other models is adjusted by loosening the jam nut and turn the set screw to reach your setting.

Application

The sequence valves can be mounted in-line or fixture mounted using mounting bolts.

A typical application for the sequence valve would be to build pressure within work supports before the swing cylinders are applied to the supported part, to prevent deflection in the part.

Two WVP-5 sequence valves used in conjunction with Enerpac WCA-series Auto Coupler to provide system automation.



Pressure dependent sequence control

MVPM-5, WVP-5, MVPC-5

- Direct accurate pressure setting
- Pressure setting between 500-5000 psi for secondary circuit is secured with lock nut
- Mounting holes on WVP-5, manifold mounting ports on MVPM-5
- MVPC-5 features cartridge body

V-2000

- Direct accurate pressure setting
- Pressure setting between 200-2000 psi for secondary circuit
- Flag indicator appears everytime the valve is operated

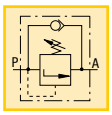
Pressure: 5000 psi

Flow: 250-366 in³/min max.

(E) **Válvulas de secuencia**

(F) **Valve de séquence**

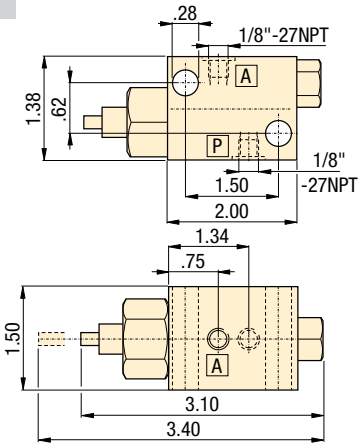
(D) **Folgeventil**



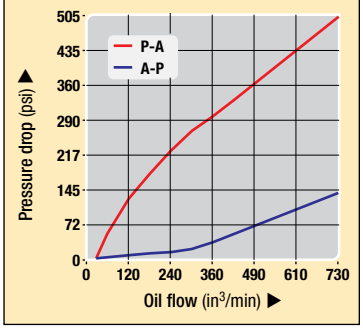
Options

Gauges and accessories 190

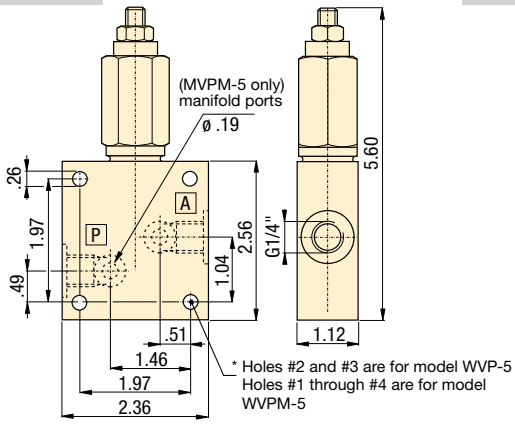
V-2000



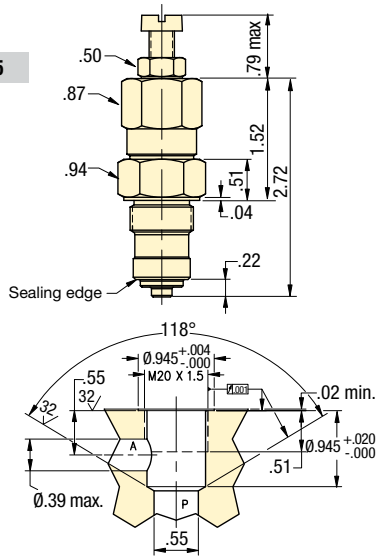
MVPM-5, WVP-5 Pressure drop *vs* oil flow



MVPM-5/WVP-5



MVPC-5



Product selection

Pressure adjustment range	Maximum pressure	Maximum oil flow	Model number	Oil ports	Opening pressure check valve	A	
psi	psi	in³/min			psi	in	lbs
200-2000	5000	250	**V-2000**	1/8"-27 NPT	—	—	2.0
500-5000	5000	620	**MVPC-5**	—	10	—	0.35
500-5000	5000	366	**MVPM-5**	G 1/4"	20	1.12	2.9
500-5000	5000	366	**WVP-5**	SAE #4	20	0.98	1.8

Seal material: Buna-N.
Manifold O-rings included with MVPM-5. For manifold mounting installation information consult Enerpac for surface preparation.

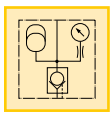
Pilot ratio: 7:1

Flow: 10 gpm max.

(E) **Válvulas antiretorno pilotada**

(F) **Clapets antiretour piloté**

(D) **Rückschlagventile**



To hold cylinder load and ensure remote unlocking

- Fast check-off response
- Hardened seats ensure long life and positive pressure holding
- Built-in accumulator to maintain system pressure
- Mounting holes
- Manifold mount body MVM-72

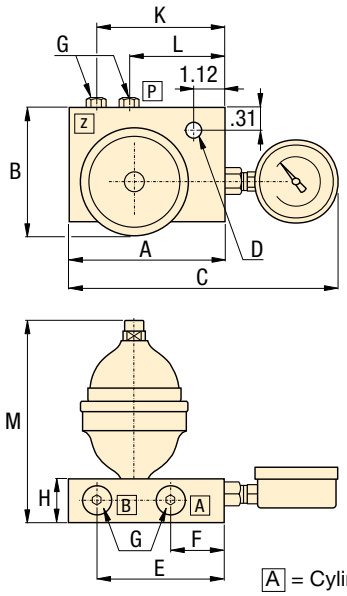
Shown: V-72

Product selection

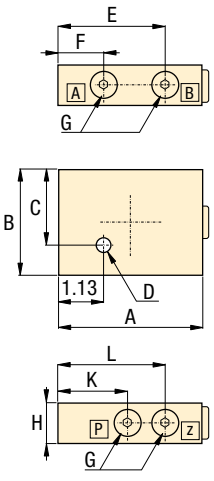
Pilot ratio	Accumulator included	Maximum oil flow	Maximum pressure	Model number	Oil ports	Optional charging tool for ACL	
		GPM	psi				lbs
7 : 1	–	10	5000	**V-72**	SAE #4	–	4.0
7 : 1	ACL-22	10	5000	**MV-722B**	G 1/4"	WAT-2	6.0
7 : 1	ACL-202	10	5000	**MV-7202B**	G 1/4"	WAT-2	7.5
7 : 1	–	10	5000	**MVM-72**	G 1/4"	–	3.0

For more information on ACL-series Accumulators see page 124.

MV-722B, -7202B

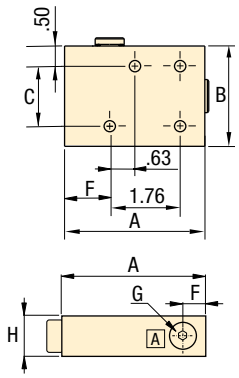


V-72

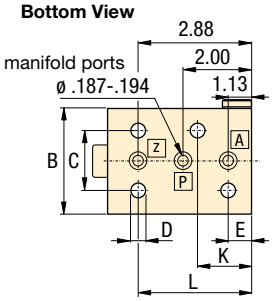


MVM-72

Top View



Bottom View



A = Cylinder advance
B = Cylinder retract
P = Pressure
Z = Pilot

Product dimensions in inches [ ]

Model number	A	B	C	D	E	F	G	H	K	L	M
V-72	3.50	2.50	2.19	.28	2.88	1.13	SAE #4	1.25	2.00	2.88	–
MV-722B	3.50	2.80	7.25	.28	2.88	1.12	G1/4"	1.25	2.88	2.00	5.71
MV-7202B	3.50	3.64	7.13	.28	2.88	1.12	G1/4"	1.25	2.88	2.00	7.28
MVM-72	3.50	2.50	1.50	.28	1.13	1.12	G1/4"	1.25	1.75	2.88	–

Seal material: Buna-N.
Manifold O-rings included with MVM-72. For manifold mounting installation information consult Enerpac for surface preparation.

www.enerpacwh.com

MV and V-series

Pilot operated check valves check the oil flow with a built-in pilot circuit providing fast, automatic check-off for your workholding applications.

The pilot operated check valves with built-in accumulator help to maintain system pressure due to minor oil loss.

Application

Added capability to open with pilot pressure to allow cylinders to retract. By using a pilot operated check valve, cylinder retraction can be accomplished automatically without operator activity.

Options

Fittings

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Shown: PRV-3

99_101

PRV series

These valves regulates system pressure for all subsequent valves, according to the adjusted pressure. Maintains a constant pressure in a secondary circuit. Includes a check valve that prevents pressure drop on secondary side.

Application

Used when a hydraulic supply with a higher pressure (primary side) must also be used for another circuit with a lower pressure (secondary circuit).

The PRVM-2 manifold can be manifold mounted or plumbed with tubing. The PRV-8 and PRV-9 use this manifold to provide a pre-assembled valve. PRV-3 and 4 are for remote mounting. The cartridge from PRV-3 and 4 can be removed from manifold for direct integration into gundrilled fixture. Order the cartridge separately as PRV-3T or PRV-4T.

Precise control of hydraulic pressure

- Tool adjustable knob can be locked
- Precise control of pressure
- G1/4" oil connection
- Remote mount
- PRVM-2 manifold has both ¼" BSPP and manifold ports
  – Gauge port- 1/8" NPT

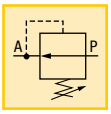
Pressure: 5000 psi

Flow: 427 in³/min

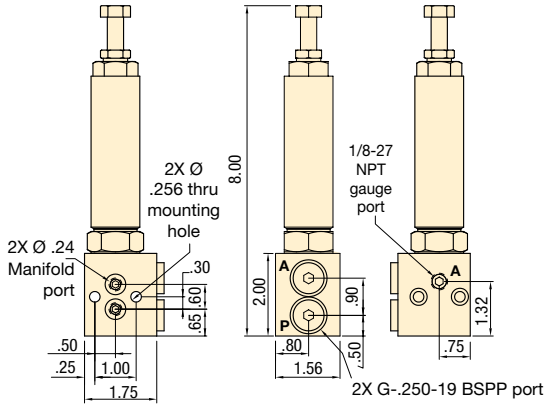
(E) Válv. reguladora de presión

(F) Valve de pression réglable

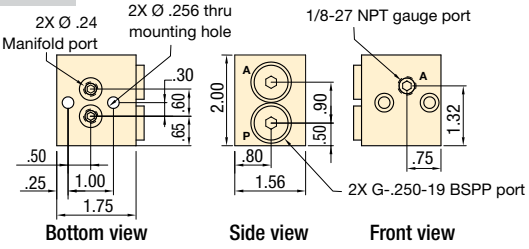
(D) Druckreduzierventil



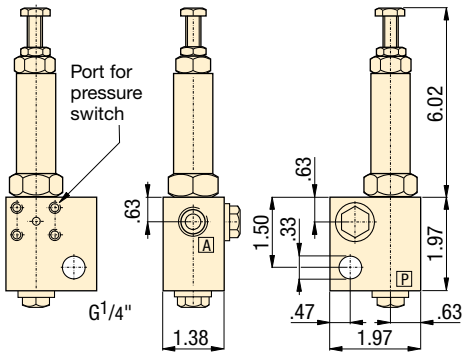
PRV-8 & PRV-9



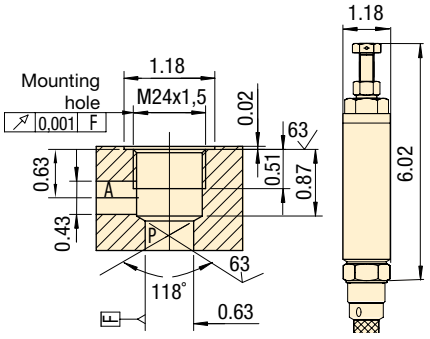
PRVM-2



PRV-3, -4



PRV-3T, -4T



Options

Gauges ▶190

Fittings ▶194

Product selection

Mounting style	Adjustable pressure range	Maximum pressure	Model number	Oil ports	Maximum oil flow	
	psi	psi		BSPP	in³/min	lbs
Remote	435 - 4350	5000	**PRV-3**	G1/4"	427	2.9
Cartridge	435 - 4350	5000	**PRV-3T**	–	427	1.5
Remote	75 - 2000	5000	**PRV-4**	G1/4"	427	2.9
Cartridge	75 - 2000	5000	**PRV-4T**	–	427	1.5
Remote	435 - 4350	5000	**PRV-8**	G1/4"	427	2.4
Remote	72 - 2000	5000	**PRV-9**	G1/4"	427	2.4
Remote	–	5000	**PRVM-2**	G1/4"	427	1.3

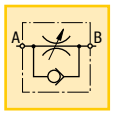
Max. Flow: 10 gpm

Pressure: 0-5000 psi

(E) **Válv. reguladoras de caudal**

(F) **Valves de control débit**

(D) **Stromregelventile**



Regulate the flow of oil

- Poppet valve design for zero leakage
- Color coded flow indicator
- Free flow return
- Fine metering capability
- Lockable
- Standard Viton seals

Shown: VFC-1

99-025

Options

Fittings

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High pressure filter

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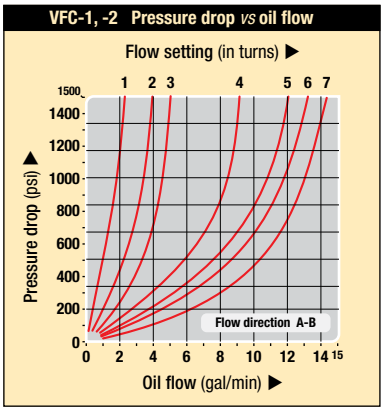
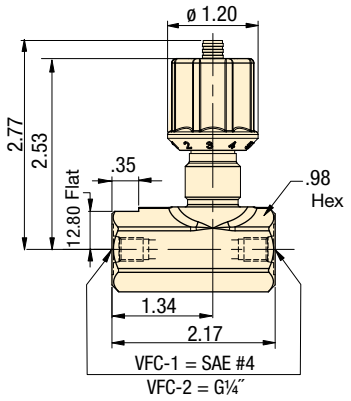


VFC-1, -2



VFC-series

Provide repeatable oil flow control. The internal check valve allows metered flow in one direction and free flow in the opposite direction. Precise control is achieved with a micro-meter style adjustment knob, which can be locked with the set screw.

Application

Use VFC-series flow control valves in-line with the Enerpac WE-series workholding pump to protect your components from damage due to high flow rates.

Product selection

Maximum oil flow (gpm)	Pressure range (psi)	Oil ports	Model number	Flow path	Maximum pressure drop (psi)	(lbs)
▼ **Flow control valves**						
10	0-5000	SAE #4	**VFC-1**		1500	1.8
10	0-5000	G 1/4"	**VFC-2**		1500	1.8

Seal material: Viton

In-line installation of a VFC-1 flow control valve.

Accessory valves *Application & selection*

Shown: HV-1000A, V-17, V-10, V-12, V-152

99-086

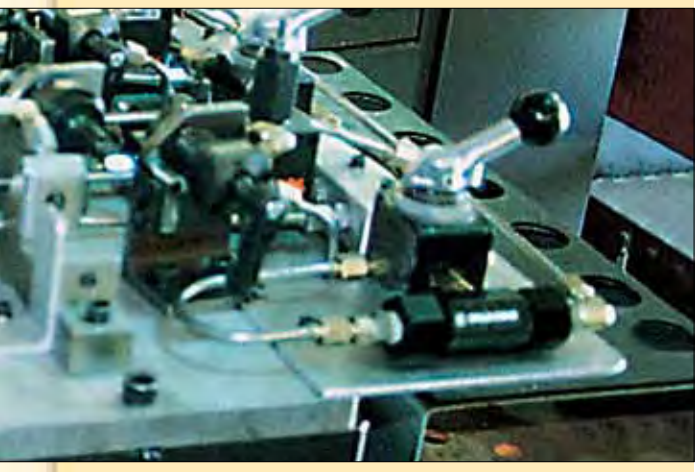
Accessory valves

Enerpac accessory valves are available in a wide variety and many configurations to control hydraulic pressure or oil flow. These valves are used in conjunction with other valves and system components to provide full automation and control.

Application

Accessory valves are used to automate clamp cycles, prevent pressure loss and provide additional operator and component safety.

V-17 Safety check valve installed on a fixture.



99-122b

Your hydraulic control solution

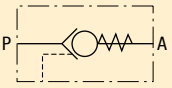
- Regulate oil flow or system pressure
- All valves feature NPT or SAE porting to insure against leakage at rated pressure
- Can easily be installed in any system
- All valves are painted, coated or plated for corrosion resistance

Product selection

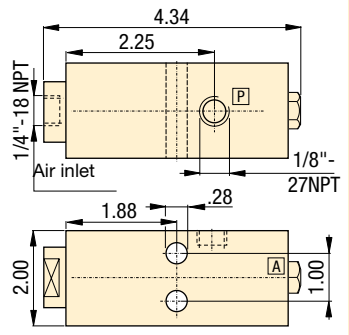
Valve type	Maximum pressure psi	Model number	Oil ports
Holding valve, air pilot	3000	**HV-1000A**	1/8" NPT
Holding valve, modular	3000	**MHV-1**	1/8" NPT
Pressure limiting valve	3000	**PLV-40013B**	1/8" NPT
Manual shut-off valve	5000	**V-12**	SAE #4
Auto-damper valve	10,000	**V-10**	1/2" NPT
Safety check valve	10,000	**V-17**	3/8" NPT
Pressure relief valve	10,000	**V-152**	3/8" NPT

Product specification

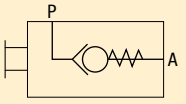
HV-1000A
Air pilot holding valve



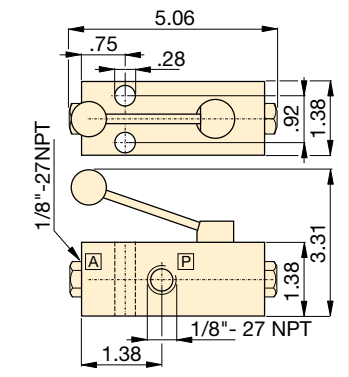
- Holds fluid under pressure offering independent control of different branches of the same fixture
- Valve can control the pilot air and the booster in sequence
- Max. oil flow 305 in³/min
- Works with the VA-42 four-way air valve and a booster



MHV-1
Modular holding valve



- Allows separate operation of clamping fixtures with a single power source
- Ideal for applications when fluid feed lines are impractical. If system pressure is interrupted, the MHV-1 will hold the pressure beyond the valve
- Max. oil flow 305 in³/min
- To release system pressure, rotate valve handle in either direction 90˚ to release and retract system pressure



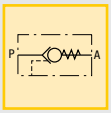
Pressure: 0-10,000 psi

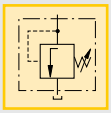
Flow max.: 305-1830 in³/min

(E) Válvulas de control

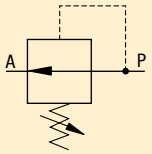
(F) Valves de contrôle

(D) Regelventile

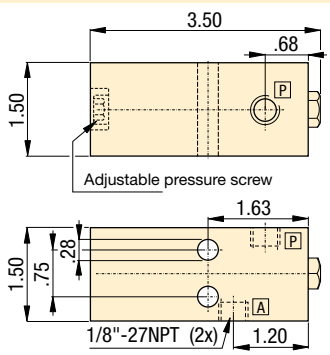




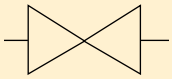
PLV-40013B
Pressure limiting valve



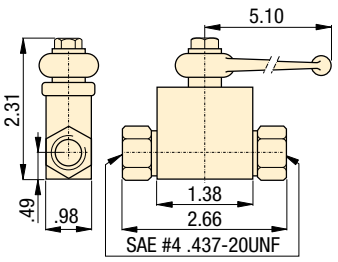
- Allows precise control of pressures reaching specific clamps
- When pressure build-up reaches a preset level, the valve closes, stabilizing pressure to that section of the fixture
- Pressure adjustment between 200 to 1500 psi
- Max. oil flow 305 in³/min



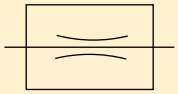
V-12
Manual shut-off valve



- Ball type valve can be used for the master system shut-off or for isolating separate circuits on a fixture
- Viton seals standard
- Straight through design for easy system plumbing and installation
- Fully open allows high flow return of oil
- Max. oil flow 732 in³/min

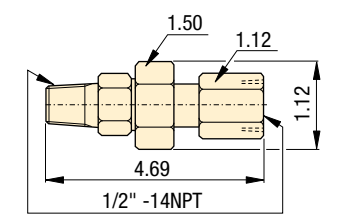


V-10 Auto-damper valve

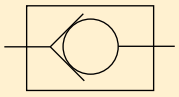


- To protect gauge during high cycle applications
- Creates a flow resistance when load is released suddenly

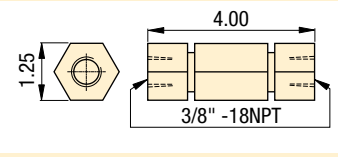
  No adjustments are necessary
- Fits directly into GA-series gauge adaptor



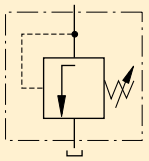
V-17 Safety check valve



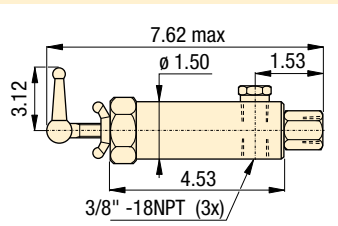
- Ruggedly built to resist shock and operate with low pressure drop
- Closes smoothly without pounding
- Max. oil flow 1830 in³/min



V-152 Pressure relief valve



- Limits pressure developed by the pump in hydraulic circuit, thus limiting the force imposed on other components
- 800-10,000 psi adjustment range; ± 3% repeatability
- Valve opens whenever preset pressure is reached. To increase pressure setting, turn handle clockwise
- Max. oil flow 1830 in³/min
- Includes 3 ft. return line hose kit



Options

VA-42 Air valve 158 ▶

Gauges and adaptors 190 ▶

Hoses and couplers 192 ▶

Fittings 194 ▶

Important

Valving help
See Basic System Set-up and Valve information in our "Yellow Pages".

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Shown: VA-42, VAS-42

Air valves

Enerpac's line of directional air valves and accessories complete your workholding system. Used to control air operated hydraulic units, they increase your productivity and efficiency.

Application

VA-series directional air valves provide either manual or electric control to air operated hydraulic units. Accessories such as rapid exhaust, check valves, silencers and regulators complete the air control system.

- Accessory valves provide greater safety and more efficient clamping cycles
- Recommended for use with all air powered units
- Directional valves to control booster and pump air supply
- Remote air valve permits either hand or foot operation

To control and regulate air supply

VA-42 Manual operated air valve 5-way, 2-position
- For control of boosters
- Viton seals standard

VAS-42 Solenoid operated air valve 5-way, 2-position
- For control of pump and boosters air supply
- Viton seals standard
- Solenoid: 120 VAC, 50/60Hz
  Amperage: inrush .11 Amps, holding .07 Amps
- Maximum cycle rate: 600 cycles per minute

VR-3 Rapid exhaust valve
- Enables booster to advance and retract faster
- Instantly exhausts air supply from booster to atmosphere

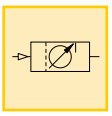
V-19 Air check valve
- Prevent rapid drop of air pressure to the booster in the event of sudden loss of input air

RFL-102 Regulator-Filter-Lubricator
- Regulates air pressure
- Filter air input
- Lubricates air motors with a fine oil vapor mist
- Maximum air flow 48 scfm

QE-375 Muffler
- Use with VR-3 or VAS/VA-42
- Reduces noise level of exhaust air from pump

Air Pressure: 0-150 psi

(E) Válvulas de aire
(F) Valves à air
(D) Luftventile



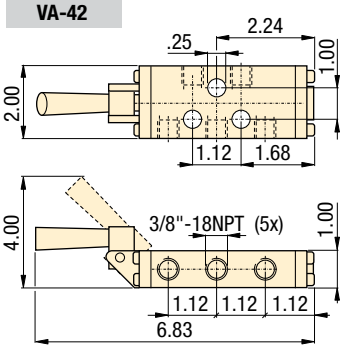
Options

Gauges and adaptors 190 ▶

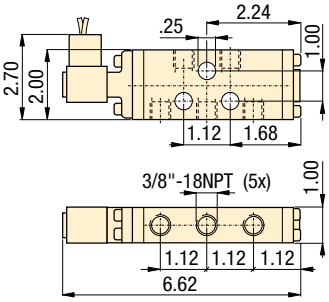
Hoses and couplers 192 ▶

Fittings 194 ▶

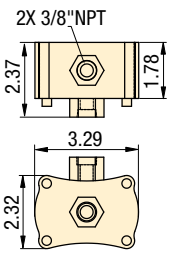
VA-42



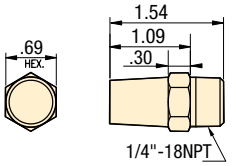
VAS-42



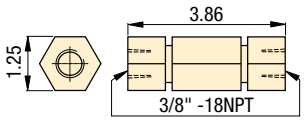
VR-3



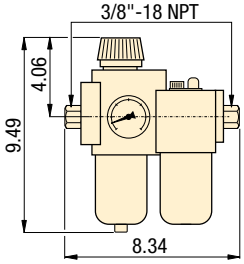
QE-375



V-19



RFL-102



Product selection

Maximum pressure psi	Model number
▼ Air valves	
30-150	VA-42
30-150	VAS-42
0-100	VR-3
0-100	V-19
▼ Accessories	
0-125	RFL-102
0-125	QE-375

Important

Valving help
See Basic System Set-up and Valve information in our "Yellow Pages".

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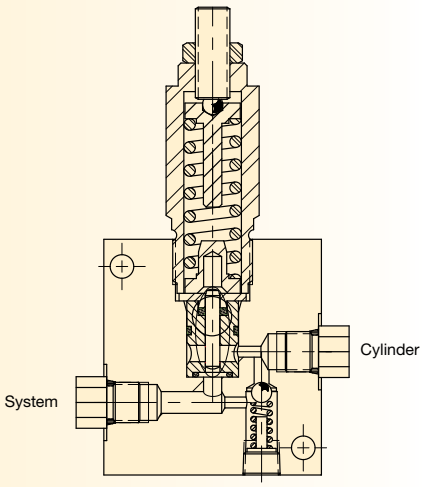
Valve Cutaways

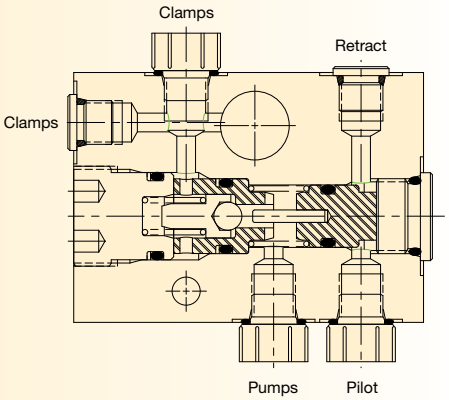
WVP-5

The opening point is set by the adjustment spring. Incoming pressure is blocked by the valve spindle in the orifice plate. When opening pressure is reached, the spindle is pushed up until fluid will pass. The system pressure level is maintained as pressure builds in the downstream circuit. Reverse flow is through a reverse check valve.



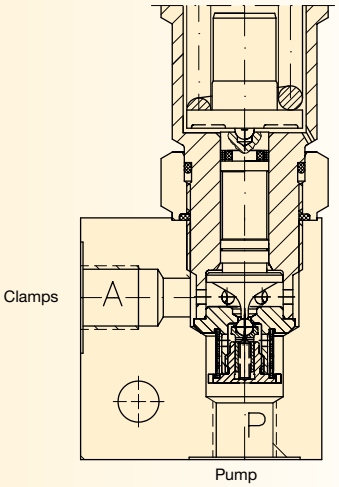
V-72

System pressure enters through the "Pump" port, flows through the check seat and past the check valve into the cylinder circuit. When system pressure drops, the check ball closes off the seat, blocking flow. To release the cylinder pressure, the "Pilot" port is pressurized, and the pilot piston pushes the check ball off of the seat, allowing reverse flow.



PRV-3

A check ball is held off of the check seat by a spring loaded spindle. The spring setting determines the closing point of the valve. As pressure builds in the cylinder side of the circuit, the spindle is lifted, and the check seats. Closing off further flow through the valve provides a reduced pressure to the cylinder.



Palletized fixture

Enerpac provides a variety of solutions for use in palletized fixtures:

- **Manual and Automated Coupler Systems for connecting/disconnecting to the fixture**
- **Rotary couplers for use with continuous connection systems**
- **Pressure intensifiers to provide increased pressure for clamping when used with machine hydraulics**
- **Safe Link for remote wireless monitoring of fixture pressure or clamp position**

Technical support

- Safety instructions
- Basic hydraulic information
- Advanced hydraulic technology
- FMS (Flexible Machining Systems) technology
- Conversion charts and hydraulic symbols

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components

	▼ series	▼ page	
Accumulators	AC WA	162 - 163	
Coupler Packages	AC, AP MHV	164 - 165	
Manual couplers	MCR MCH	166 - 171	
Activator wand & boosters	B, RA	172 - 173	
Auto-coupler systems	WCA, WPA ACCB	174 - 175	
Rotary couplers	AMP, CR CRV	176 - 177	
Pressure intensifiers	PID	178 - 179	
SafeLink	SL	180 - 185	

Shown: ACL-201A, WA-502, ACL-21A

99-054

Enerpac accumulators supply auxiliary pressure to dampen shock loads or to compensate pressure drop in applications where system pressure needs to be maintained.

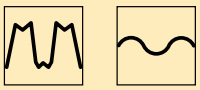
Accumulators
...maintain circuit pressure

- Ideal for high frequency and rapid discharge applications
- ACL series are pre-charged to 1450 psi
- Corrosion resistant bodies on ACL series
- Spring actuated accumulator for ACM-1
- High energy storage capacity in a compact package
- WA accumulators are piston type
- ACL accumulators are diaphragm type
- ACM accumultors use internal spring

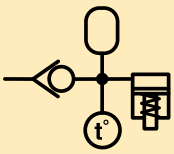
Accumulator applications:

- Energy storage
- Circuit pulsation dampening
- Thermal expansion compensation

Pulse dampening



Thermal expansion



ACBS-202 Accumulator package used to maintain pressure on a machine tool fixture

98056

Product selection

Operating pressure	Model number	Max. rated oil volume	Gas volume	Pre-charged nitrogen pressure	Usable oil capacity
					in³
psi		in³	in³	psi	at 5000 psi
▼ **Pre-charged accumulators**					
0-3000	**ACM-1**	.10	–	–	–
1500-5000	**ACL-21A**	.90	1.22	1450	.53
1500-5000	**ACL-201A**	7.70	10.37	1450	4.51
1500-5000	**ACL-502A**	20.60	27.46	1450	12.0
▼ **Uncharged accumulators**					
0-5000 [1)]	**WA-502**	2.50	2.50	–	2.50
0-5000 [1)]	**WA-5010**	10.00	10.00	–	7.50

[1)] See pre-charge chart on page 163 for hydraulic operating pressures.

Recommended pre-charge

Operating pressure psi	Model number	Nitrogen pressure psi	Usable oil capacity [1] in³
0-1000	**WA-502**	500	1.50
1000-3000	**WA-502**	1000	2.00
3000-5000	**WA-502**	1200	2.50
0-1000	**WA-5010**	500	5.50
1000-3000	**WA-5010**	1000	6.50
3000-5000	**WA-5010**	1200	7.50

[1] At maximum operating pressure.

Pressure: 0-5000 psi

Oil volume: .10-20.60 in³

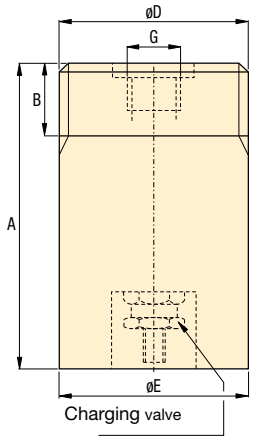
Gas volume: 1.22-27.46 in³

E Acumuladores

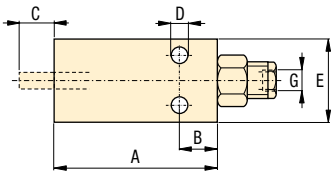
F Accumulateurs

D Druckspeicher

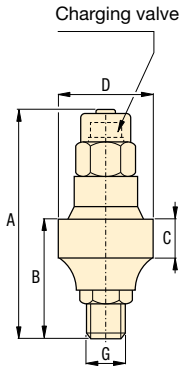
WA



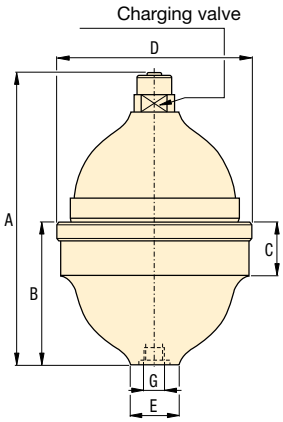
ACM-1



ACL-21A

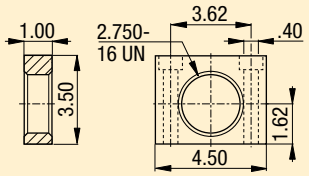


ACL-201A, 502A



Options

AW-50 Mounting block
For WA series accumulators.



Hydraulic oil
193

Fittings
194

Product dimensions in inches [⊳⊕]

Model number	A	B	C	D	E	F	G	Recommended charging tool	lbs
▼ **Pre-charged accumulators**									
ACM-1	5.25	.75	.50	.265	1.75	–	.125-27 NPT	–	2.1
ACL-21A	4.14	1.46	.71	1.69	–	–	SAE #4	WAT-2	1.0
ACL-201A	5.39	2.72	1.14	3.33	1.14	–	SAE #6	WAT-2	2.7
ACL-502A	6.73	3.50	1.38	4.49	1.57	–	G3/8"	WAT-2	6.2
▼ **Uncharged accumulators**									
WA-502	4.69	1.19	–	2.750-16 UN	2.75	–	SAE #8	WAT-1	7.0
WA-5010	7.13	1.19	–	2.750-16 UN	2.75	–	SAE #8	WAT-1	11.5

Coupler Packages *Application & selection*

Shown: AP-500, MHV-1,ACBS-22A

Accumulator packages will help maintain system pressure to your fixture when separated from the hydraulic source. The gauge will display system pressure after the circuit is disconnected.

ACBS-202 Accumulator package used to maintain pressure on a machine tool fixture

Coupler packages

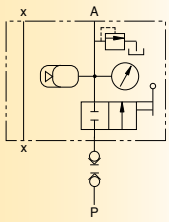
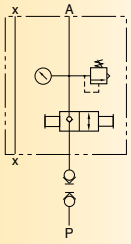
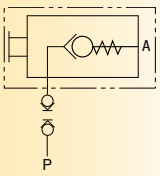
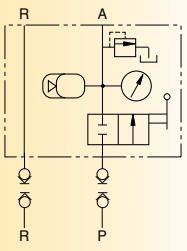
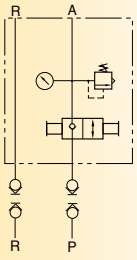
...compact design for easy use of accumulators

- Single design accommodates both single-acting or double-acting circuit
- Relief valve fitted and ball check shut-off
- Glycerin-filled gauge included
- Supplied standard with one male coupler (AH-652)
- Optional manifold mounting. O-ring seals located on bottom of block only for single-acting circuit

MHV-1 Modular holding valve

- Allows separate operation of clamping fixtures with a single power source
- Ideal for applications when fluid feed lines are impractical. If system pressure is interrupted, the MHV-1 will hold the pressure beyond the valve
- Max. oil flow 305 in³/min
- To release system pressure, rotate valve handle in either direction 90° to release and retract system pressure

Coupler package circuits

ACBS series	AP-500	MHV-1
Single-acting circuit	**Single-acting circuit**	**Single-acting circuit**
		
Double-acting circuit	**Double-acting circuit**	
		

Product selection

Operating pressure	Model number	Max. rated oil volume	Gas volume	Pre-charged nitrogen pressure	Usable oil capacity
psi		in³	in³	psi	in³ at 5000 psi
▼ Accumulator coupler packages					
1500-5000	**ACBS-22A**	0.90	1.22	1450	.53
1500-5000	**ACBS-202A**	7.70	10.37	1450	4.51
0-5000	**AP-500**	**AP-500 uses WA-502 or WA-5010[1)]**			
0-3000	**MHV-1**	–	–	–	–

[1)] See pre-charge chart on page 163 for hydraulic operating pressures.

Pressure: 0-5000 psi

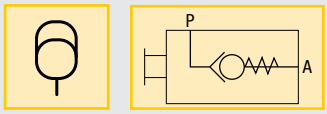
Oil volume: .10-7.70 in³

Gas volume: 1.22-10.37 in³

(E) Acopladores manuales

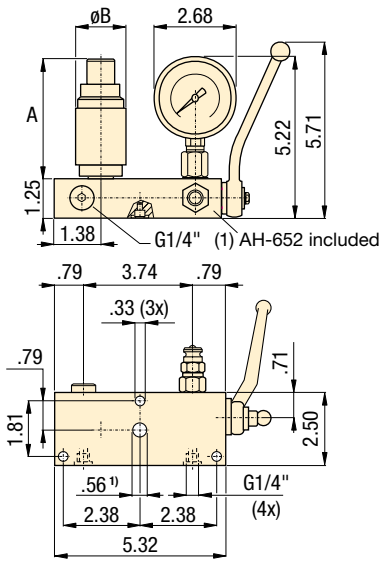
(F) Manuel coupleur

(D) Manuelle kupplung



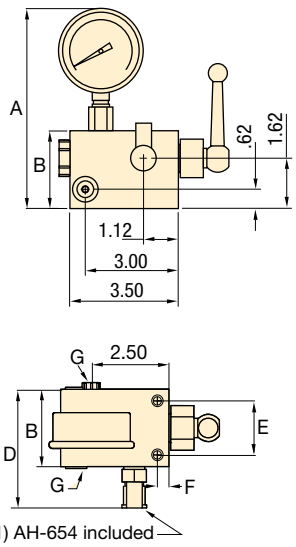
MHV-1

ACBS

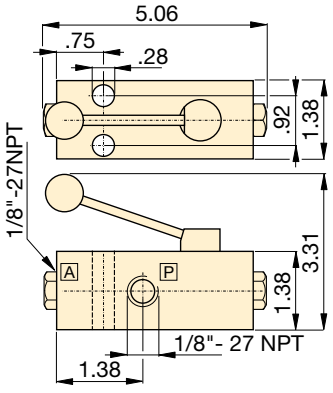


1) Manifold hole should not exceed Ø .30 inch when port is utilized.

AP-500



MHV-1



Product dimensions in inches [⊳⊕]

Model number	A	B	C	D	E	F	G	Recommended charging tool	lbs
▼ Pre-charged accumulator coupler packages									
ACBS-22A	2.69	1.65	–	–	–	–	G1/4"	WAT-2	10.1
ACBS-202A	4.18	3.33	–	–	–	–	G1/4"	WAT-2	11.8
AP-500	6.44	2.50	3.50	3.84	1.75	0.38	SAE #4	–	11.8
MHV-1	–	–	–	–	–	–	1/8" NPT	–	–

Options

Couplers 192 ▶

High pressure filters 193 ▶

Hydraulic oil 193 ▶

Fittings 194 ▶

Important

Enerpac high pressure in-line filters are required for use with these control units to prevent damage that can be caused by contaminants that have penetrated your hydraulic fluid system.

Order an additional male coupler for use in double-acting hydraulic circuits.
ACBS-Series: AH-652
AP-500: AH-654

Manual Couplers *Application & selection*

Shown: MCH-31, MCRA-11, MCRC-21, MCH-21, MCR-21

The Enerpac manual coupler is available as a dual connection model or dual connection with optional air circuit for part present sensing.
The fixture side receiver is available with or without an internal pilot operated check valve. Filtration provides protection from contamination.

Manual coupler applications:

- **With P.O. check**
  - Use MCRC-21 for a complete, unitized coupler receiver solution
- **Without P.O. check:**
  - Use MCR-21 when using a remote mounted Pilot Operated Check Valve

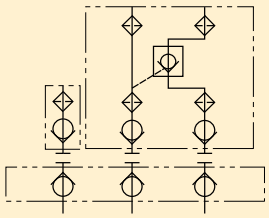
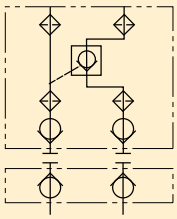
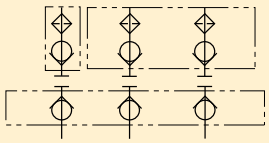
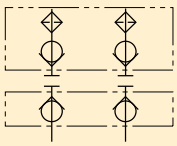
Enerpac manual couplers simplify the process of connecting and disconnecting to a palletized fixture.

Manual Couplers

…convenient connection

- Use on palletized fixtures
- Available with or without an internal pilot operated (P.O.) check valve
- Optional coupler block available to add circuit for air part present sensing
- Manifold porting
- Porting for tubing connections
- Filtration to prevent contamination
- Removable front plate provides access to the front filters and check cartridge
- Top port accommodates an accumulator or gauge

Manual Coupler Circuits

	With auxiliary air circuit	Without auxiliary air circuit
With P.O. check		
Without P.O. check		

Model number	Basic configurations	Circuits
MCRC-21	Pallet receiver with P.O. check	Two Hydraulic
MCR-21	Pallet receiver without P.O. check	Two Hydraulic
MCRA-11	Auxiliary air circuit receiver block	One Air
MCH-21	Operator handle	Two Hydraulic
MCH-31	Operator handle	Two Hydraulic, One Air
MCSB-21	Storage block	N/A
MCPS-21	Proximity switch kit	N/A

Select your components

MCRC-21 Pallet Receiver with P.O. Check

An internal pilot operated check valve and multiple ports to accommodate a gauge or accumulator make the MCRC-21 a great choice of coupler receiver for use in a palletized fixture. Internal filtration protects the check from contamination. Use with the MCH-21 operator handle.

MCR-21 Pallet Receiver

For applications where the pilot operated check valve is remote mounted in the fixture circuit, use the MCR-1. Internal filtration protects the circuit from outside contamination.

MCRA-11 Auxiliary air circuit receiver

The MCRA-11 is used to provide an additional connection for use with air part sensing circuits. Use with either the MCRC-21 or the MCR-21. Use with the MCH-31 operator handle.

MCSB-21 Operator Handle Storage Block

Proper storage of the MCH-21 or MCH-31 handle prevents contamination of the couplers, and makes sure that the handle is disconnected from the fixture. Use the MCPS-21 proximity switch to confirm proper storage as an input to the machine control.

MCH-21 Two Coupler Operator Handle

Use the MCH-21 with either the MCRC-21 or the MCR-21 pallet receiver.

MCH-31

Use the MCH-31 when using the MCRA-11 with either the MCRC-21 or MCR-21 receivers.

Operating pressure psi	Replacement hydraulic nozzle	Replacement filter kit	Voltage	Model number
100 - 5000	AH654	FI2201K	–	MCRC-21
100 - 5000	AH654	FI2201K	–	MCR-21
10 - 100*	AH654	FI2201K	–	MCRA-11
100 - 5000	AR650	–	–	MCH-21
100 - 5000	AR650	–	–	MCH-31
–	AH654	–	–	MCSB-21
–	–	–	24 VDC	MCPS-21

* Air pressure

Max. Flow: 4 GPM

Pressure: 0-5000 psi

- (E) Acopladores manuales
- (F) Manuel coupleur
- (D) Manuelle kupplung

Options

FZ Series fittings
194

Hoses and couplers
192

Pilot operated check valves
153

Accumulators
162

Important

Do not couple or uncouple with the hydraulic nozzles under pressure. This can damage the couplers.

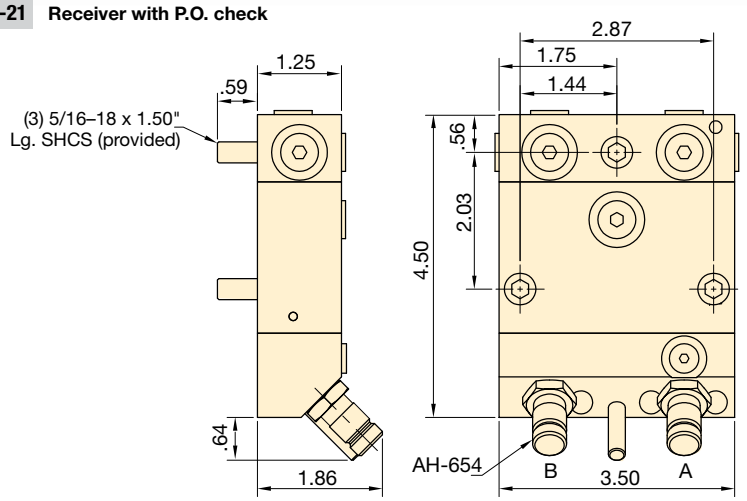
Do not exceed maximum flow and pressure.

Shown: MCH-21, MCR-21

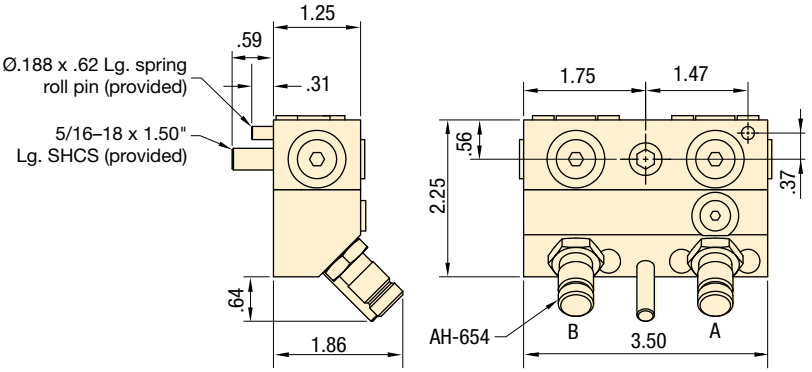
Serie MCR e MCH

The Enerpac MCH-21 two passage operator handle conveniently connects and disconnects to the MCR-21 two passage receiver utilizing a simple push-on, pull-off action.

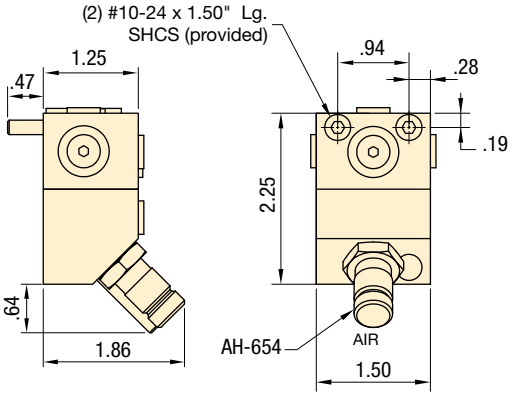
MCRC-21 **Receiver with P.O. check**



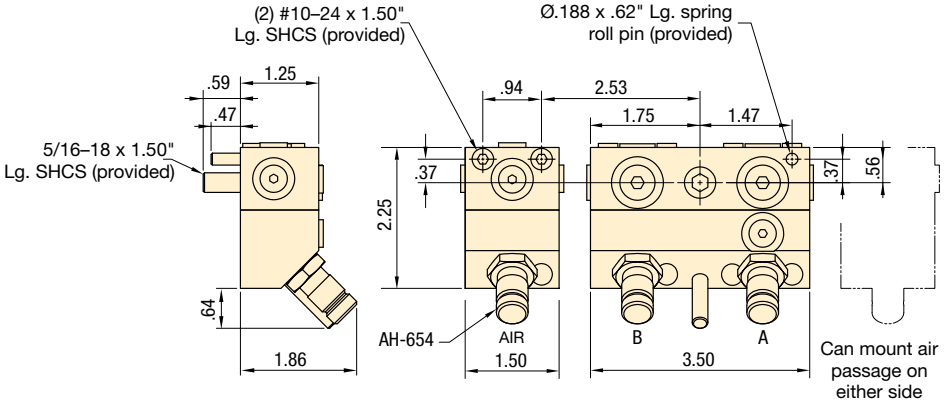
MCR-21 **Receiver without P.O. check**



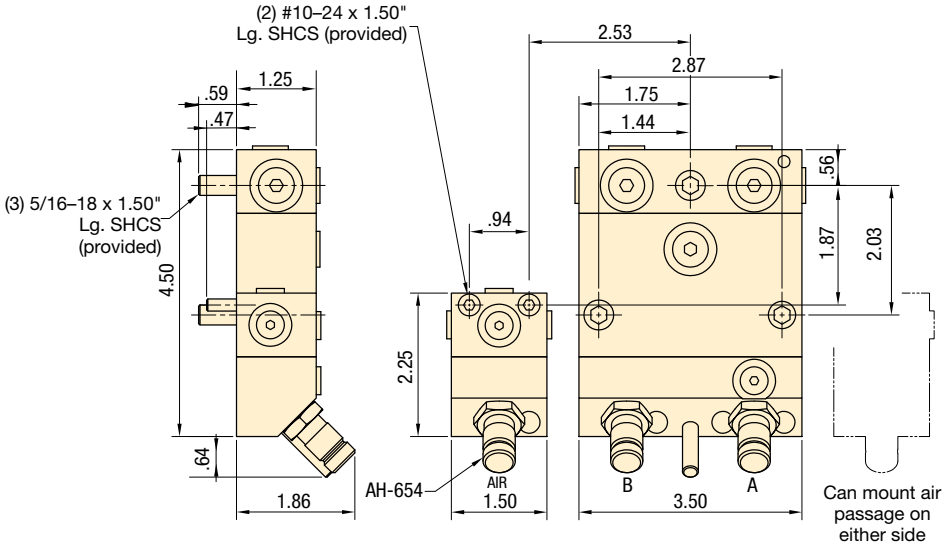
MCRA-11 **Auxiliary air circuit receiver**



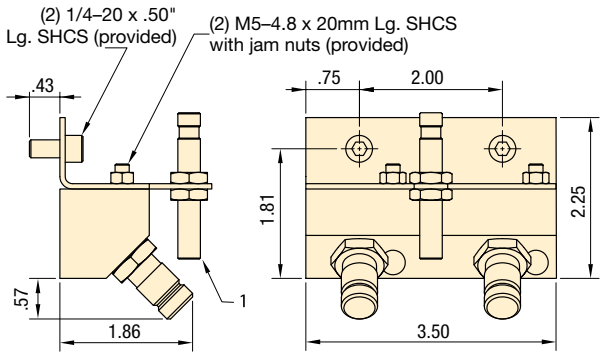
MCR-21 with MCRA-11 **Receiver with air passage and without P.O. check**



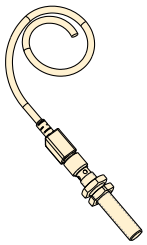
MCRC-21 with MCRA-11



MCSB-21 **Storage block**

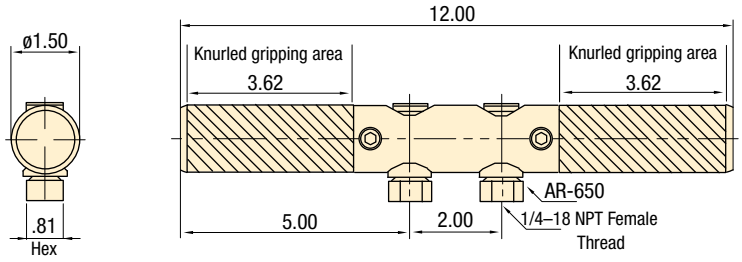


MCPS-21 **Optional proximity switch**

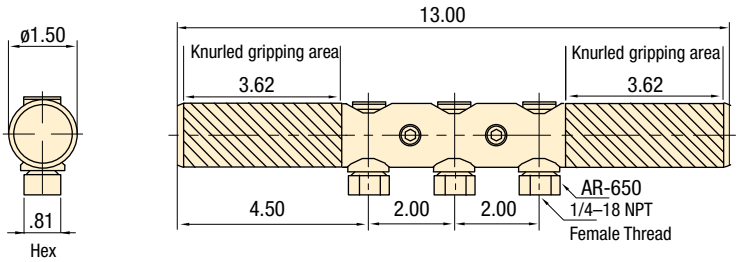


① **Optional proximity switch is available.**
See MCPS-21

MCH-21 **Operator handle**



MCH-31 **Operator handle**



Max. Flow: 4 GPM

Pressure: 0-5000 psi

- (E) **Acopladores manuales**
- (F) **Manuel coupleur**
- (D) **Manuelle kupplung**

Options

FZ Series fittings 194

Hoses and couplers 192

Pilot operated check valves 153

Accumulators 162

Important

Do not couple or uncouple with the hydraulic nozzles under pressure. This can damage the couplers.

Do not exceed maximum flow and pressure.

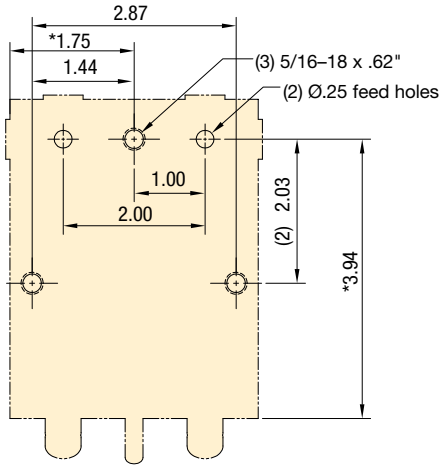
Manual Couplers *Mounting patterns*

Shown: MCR-21

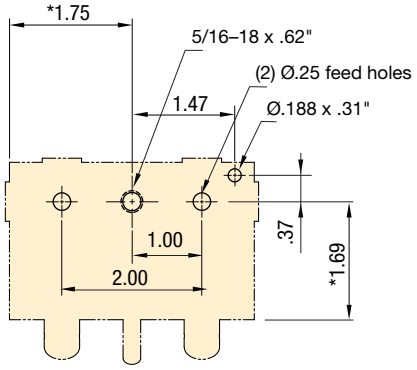
MCR series

The MCR-21 two passage receiver features multiple SAE #4 ports as well as manifold mount ports for easy plumbing to a fixture. Internal filtration in all receiver models protects the circuit from external contamination.

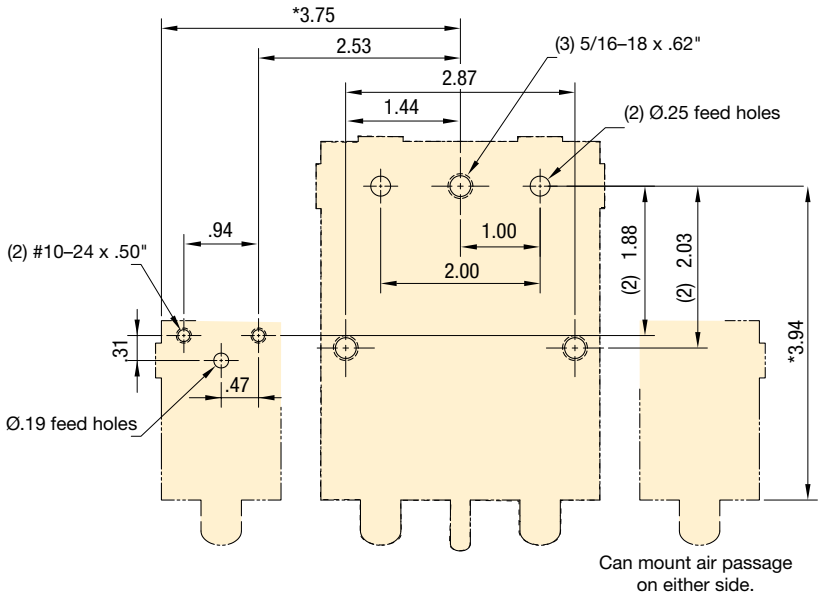
MCRC-21 **Receiver with P.O. check – Mtg. hole pattern**



MCR-21 **Receiver without P.O. check – Mtg. hole pattern**

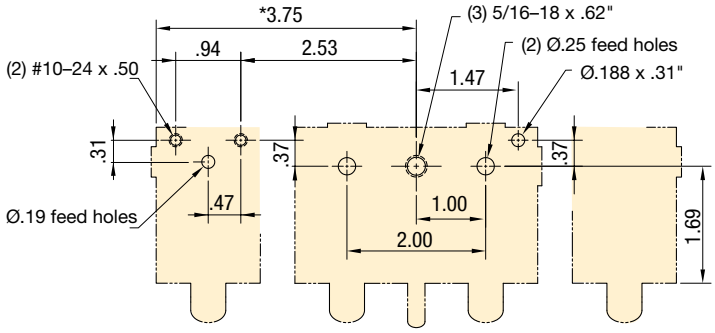


MCRC-21 with MCRA-11 **Receiver with air passage and with P.O check – Mtg. hole pattern**



Can mount air passage on either side.

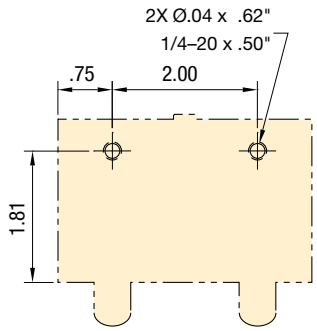
MCR-21 with MCRA-11 **Receiver with air passage and without P.O check – Mtg. hole pattern**



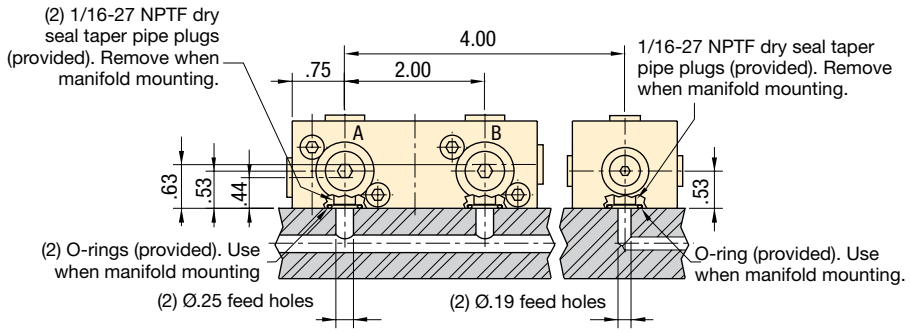
Can mount air passage on either side.

* Minimum from edge of tool plate

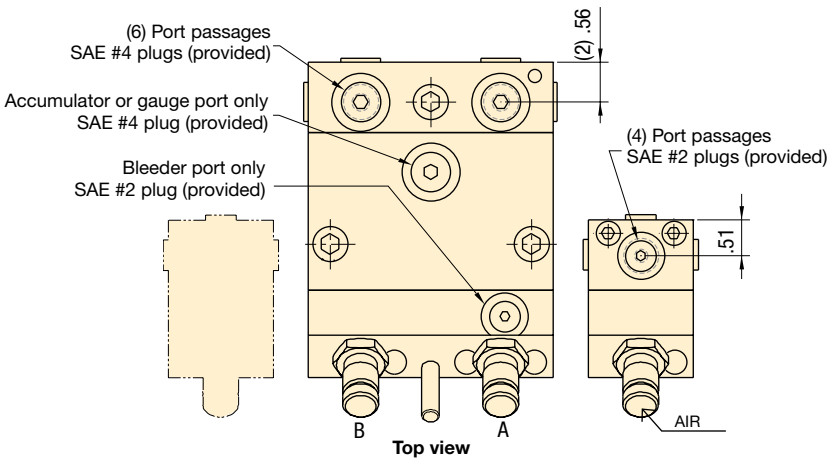
MCSB-21 **Storage Block – Mounting Hole Pattern**



Manifold and Port Dimensions



Rear view



Top view

Max. Flow: 4 GPM

Pressure: 0-5000 psi

(E) Acopladores manuales

(F) Manuel coupleur

(D) Manuelle kupplung

Options

FZ Series fittings 194

Hoses and couplers 192

Pilot operated check valves 153

Accumulators 162

Important

Do not couple or uncouple with the hydraulic nozzles under pressure. This can damage the couplers.

Do not exceed maximum flow and pressure.

Activator wand and booster

Shown: RA-1061, B-81

99_078

Contamination resistant closed hydraulic system

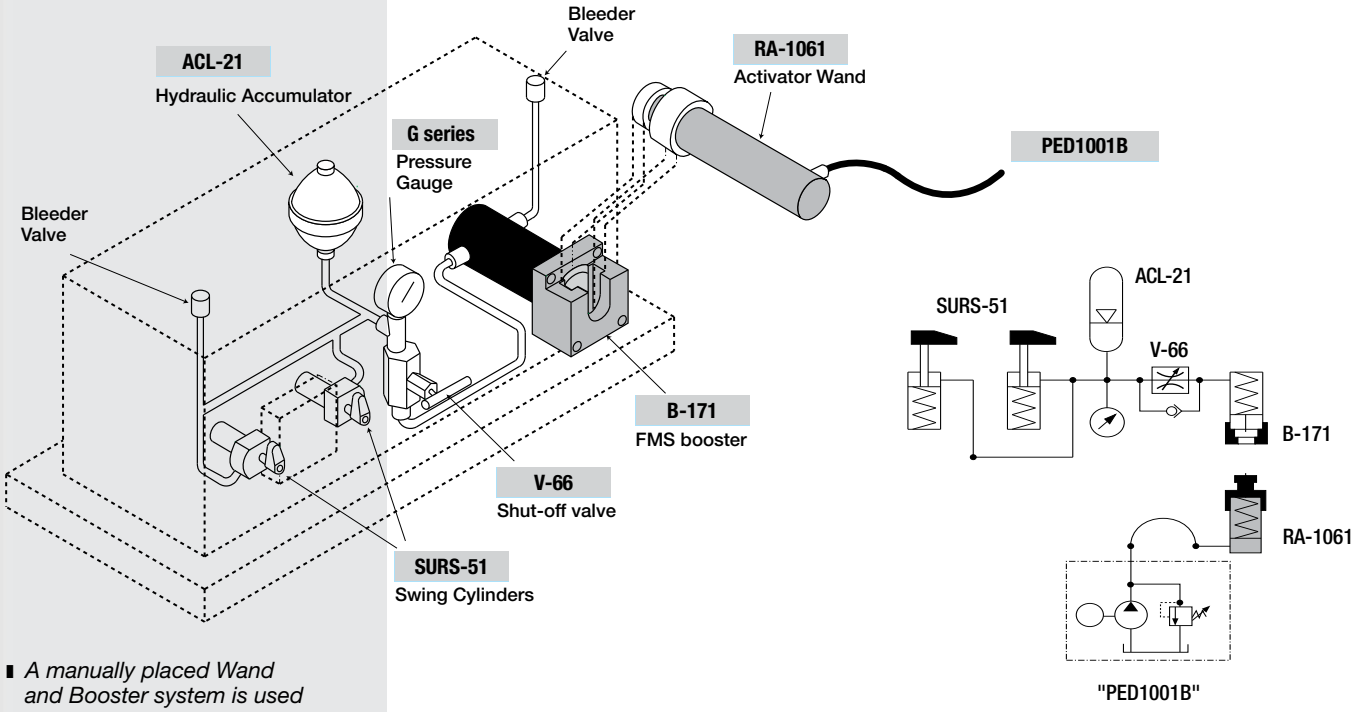
- No-leak palletized system, eliminates oil loss at connection point
- Closed design prevents machining chips and coolant from entering the hydraulic circuit
- Booster can be mounted in either horizontal or vertical position for flexible fixture design

B and RA series

Mechanical energy transfer system uses external cylinder to operate receiver booster.

Hydraulic system schematics

The Activator Wand RA-1061 is placed into the receiver booster B-81 or B-171. The mechanical transfer of force from the activator wand plunger to the booster piston provides oil flow to the system.



A manually placed Wand and Booster system is used to clamp the castings in this machining fixture.

Product selection

Pressure ratio	Oil flow ratio	Oil volume per stroke	Stroke	Model number	Effective area	Operating pressure	
		in³	in		in²	psi	lbs
▼ Receiver booster							
2:1	1.75:1	8.10	2.04	**B-81**	3.98	400-5000	12.7
2:1	1.75:1	17.10	4.30	**B-171**	3.98	400-5000	15.7
▼ Activator wand							
–	–	9.90	4.44	**RA-1061**	2.23	800-10,000	11.3

Ratio: 2:1

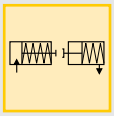
Stroke: 2.04-4.44 inch

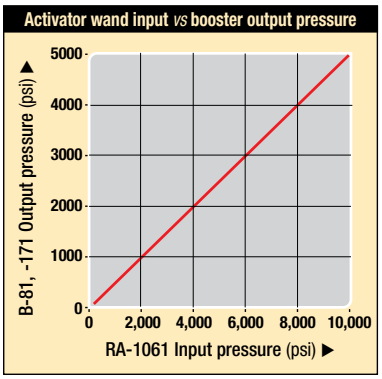
Pressure: 400-5000 psi

(E) **Multiplicadores**

(F) **Multiplicateur**

(D) **Betätigungszylinder und Druckverstärker**





Options

Fittings
194 ▶

Hoses and couplers
192 ▶

For 10,000 psi pumps, refer to the Enerpac Industrial Tools Catalog E327.

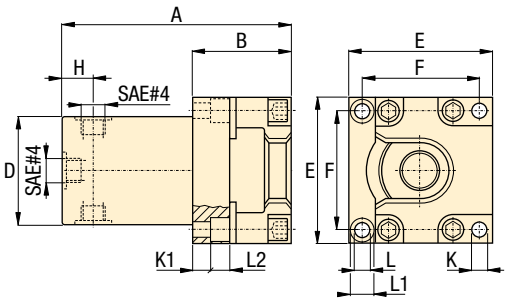
Existing fixtures with manual-connect single-acting circuits can be easily upgraded into the wand and booster.

Important

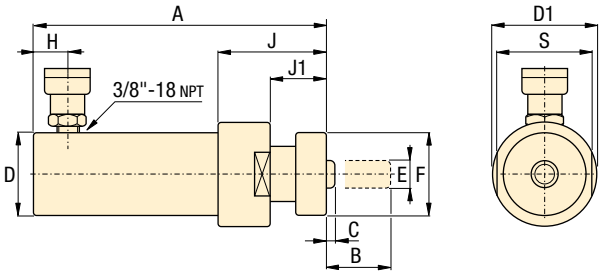
The activator wand has a 2 to 1 ratio of input pressure versus output force.

The booster output flow is 1.75 times the wand input flow.

B-81, -171



RA-1061



Product dimensions in inches [ ]

Model number	A	B	C	D ø	D1	E	F ø	H	J	J1	K	K1	L	L1	L2	S
▼ Receiver booster																
B-81	6.86	2.74	1.74	3.00	–	4.00	3.25	1.12	–	–	.41	2.26	.41	.62	.42	–
B-171	9.12	2.74	1.74	3.00	–	4.00	3.25	1.12	–	–	.41	2.26	.41	.62	.42	–
▼ Activator wand																
RA-1061	11.62	4.63	.19	2.25	3.00	.75	2.32	.75	3.02	1.53	–	–	–	–	–	2.75

Shown: WCA-62, WPA-62

For automated coupling of hydraulic circuits on palletized systems

- Sensing feedback of coupler position allows for fully automated applications
- Horizontal or vertical mounting for flexible installation on machine tools
- Available as 2 or 4 port model to provide a solution to various hydraulic circuit needs
- Adjustment stroke allows clearance for pallet indexing
- Coupler elements supplied with air blow-off nozzles to prevent damage from contamination
- Automatic coupler control box provides pre-programmed safety features to insure proper sequencing of automatic coupler and fixture operations

The automatic coupler system allows connection and disconnection of palletized hydraulic circuits. This system eliminates the direct intervention of an operator, allowing hands free, safe functioning of the process. Typical systems include one base station located at the load/unload station operating one or more pallet receivers.

ACCB-2 Control shown with ZW4020HJ-FHLT12U300 Pump.

A 4-way auto coupler is connected to the receiver, mounted on the side of a palletized fixture.

ACCB-2, Automatic coupler control box

175

- Provides automatic or manual control of your 2 or 4 port auto coupler station.
- Panel view informs when auto coupler is retracted or advanced and whether fixture is unclamped or clamped.
- Includes 2 pressure switches, 3 proximity switches.
- Pressure switches monitor clamping and unclamping system pressure.
- Proximity switches inform PLC when auto coupler is advanced or retracted and when pallet is in position for the auto coupling.
- Integrates with ZW4020HJ-FHLT12U300 and ZW5020HJ-FHLT12U300 pumps.

Product selection

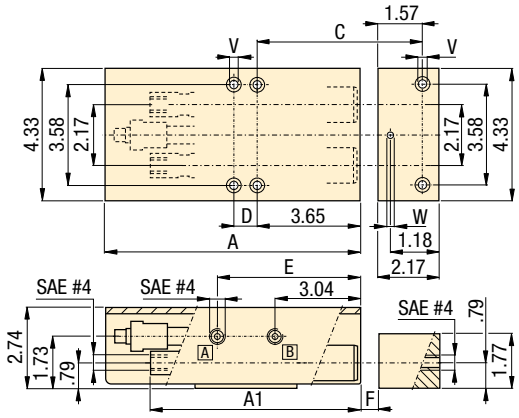
Station position	Model number[1]	Adjustable stroke	Oil capacity in³		Maximum oil flow [2]
		in	advance	retract	in³/min
▼ 2 port auto coupler					
Base	**WCA-62**	.20 - .59	.66	.66	60
Base	**WCA-82***	4.10 - 4.48	.66	.66	60
Pallet	**WPA-62**	–	–	–	–
▼ 4 port auto coupler					
Base	**WCA-64***	.20 - .59	.66	.66	60
Pallet	**WPA-64***	–	–	–	–

[1] For additional pallet clearance, WCA-82 long stroke model are available.
[2] Maximum oil flow of coupler elements is 4.3 GPM.
* This product is made to order. Please contact Enerpac for delivery information before specifying in your design.

Product specifications

Model number	Required radial alignment accuracy in	Operating pressure psi	Hydraulic nozzle model number (included)	Air blow-off fitting model No. (included)	Recommended alignment tool
▼ 2 port auto coupler					
WCA-62	± .02	580 - 5000	**CDF-6**	**FZ-2050**	**AT-1**
WCA-82	± .02	580 - 5000	**CDF-6**	**FZ-2050**	**AT-2**
WPA-62	± .02	580 - 5000	**CDM-6**	**FZ-2050**	**AT-1**
▼ 4 port auto coupler					
WCA-64	± .02	580 - 5000	**CDF-6**	**FZ-2050**	**AT-1**
WPA-64	± .02	580 - 5000	**CDM-6**	**FZ-2050**	**AT-1**

WCA-62, -82 **WPA-62**

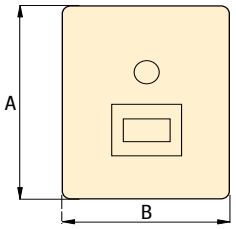


Model number	Voltage / Current
▼Automatic Coupler Control Box	
ACCB-2	115 VAC / 10 A

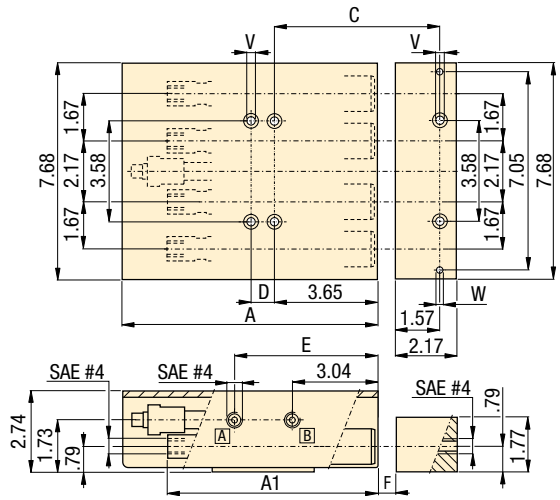
Note: Enclosure rating NEMA 12.

ACCB-2

Operator Station



WCA-64 **WPA-64**



Product dimensions in inches [⌲⌖]

Model number	A	A1	B	C	D	E	F max.	V [1] for mounting bolts thread x length	W [2]	lbs
▼ 2 port auto couplers										
WCA-62	8.86	7.48	–	5.42	.83	5.09	.394-.413	.312-18UN x 3.00	–	16.8
WCA-82*	15.67	14.03	–	9.36	3.94	8.20	3.70	.312-18UN x 3.00	–	28.8
WPA-62	–	–	–	–	–	–	–	.375-16UN x 2.00	.23	4.0
▼ 4 port auto couplers										
WCA-64*	8.86	7.48	–	5.42	.83	5.09	.394-.413	.312-18UN x 3.00	–	29.1
WPA-64*	–	–	–	–	–	–	–	.375-16UN x 2.00	.23	6.6
▼ Automatic coupler control box [3]										
ACCB-2	13.78	–	11.81	–	–	–	–	–	–	30.0

[1] Mounting bolts are not included. [2] Drill dowel pin holes after installing WPA.
* This product is made to order. Please contact Enerpac for delivery information before specifying in your design.

www.enerpacwh.com

Connection: 2-4 ports

Stroke: .20-4.48 inch

Pressure: 580-5000 psi

(E) Acopladores automáticos

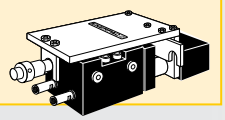
(F) Coupleurs automatiques

(D) Automatische Kupplungen

Options

High pressure filters
193

AT series alignment tool
Use the AT series alignment tool to adjust the position of the pallet station in relation to the base station.



Hoses and couplers
192

Important

Use high pressure filters on pallet station outlet ports, to avoid contamination of pallet mounted valves and cylinders.

To guarantee leakage free connections, accurate positioning of the pallet and base stations is crucial. Carefully read the instruction manual included with the product.

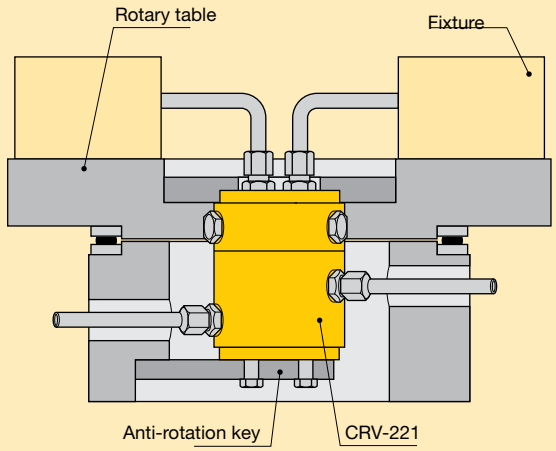
Do not couple or uncouple with the hydraulic nozzles under pressure. This could damage the internal coupler seals.

Do not exceed maximum flow and pressure.

Rotary couplers *Application & selection*

Shown: CRV-221, CR-111

Rotary couplers are specially designed unions to transfer pressurized fluid from a stationary supply line to a rotating device. Used for workholding or clamping device such as fixtures installed on rotating index tables.

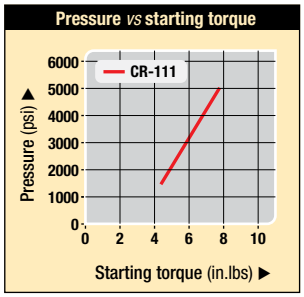


In this application eight CRV-221 rotary couplers are installed to power the individual presses of an eight station rotary press table.

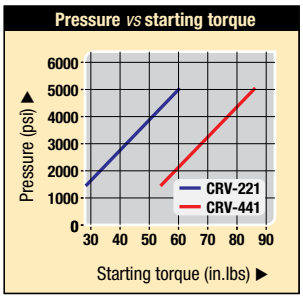
Permanent hydraulic connection on indexing and rotating work stations

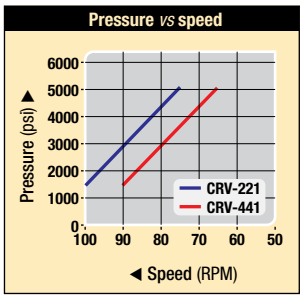
- High rotation per minute
- Low starting torque
- Internal oil bearings for increased lifetime
- Manifold mounting adaptors available to reduce fixture plumbing

Starting torque and speed diagrams



Max. operating speed = 30 RPM.





Oil loss CRV-221 = 1.22 in³/h, CRV-441 = 2.44 in³/h

Product selection

No. of radial passages	Model number [1]	Operating pressure range	Maximum speed		Starting torque	
			RPM		in.lbs	
		psi	1500 psi	5000 psi	1500 psi	5000 psi
1	**CR-111**	1500-5000	30	30	4.5	8
2	**CRV-221**	1500-5000	100	75	27	60
4	**CRV-441**	1500-5000	90	65	53	182

[1] Before selecting, note the starting torque and speed diagrams above.

Manifold mounting adaptor

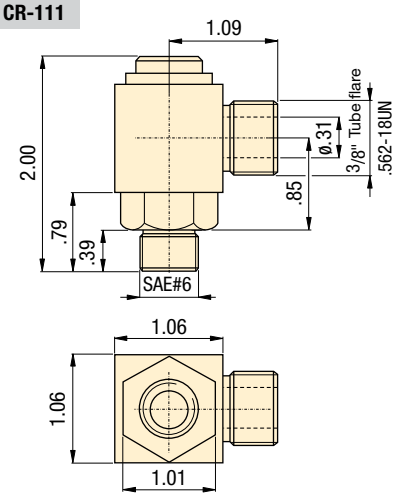
Mounting adaptor AMP-2, AMP-4
Mounts onto end of two and four passage rotary unions. Allows O-ring mounting directly to fixture.

Product selection

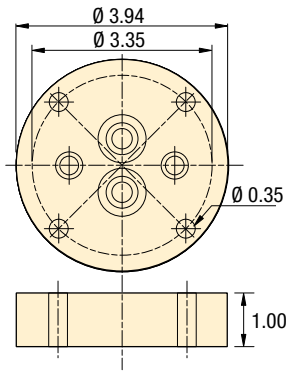
Number of radial passages	Model number	Operating pressure range	Used with
		psi	
2	**AMP-2**	1500-5000	CRV-221
4	**AMP-4**	1500-5000	CRV-441

Product dimensions in inches [⌲⌖]

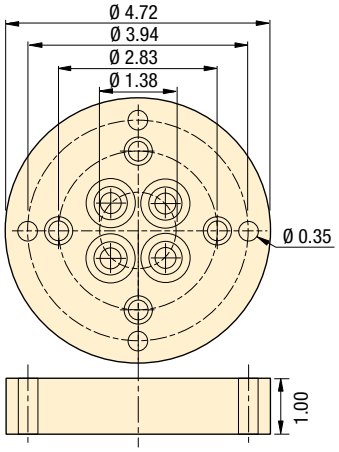
CR-111



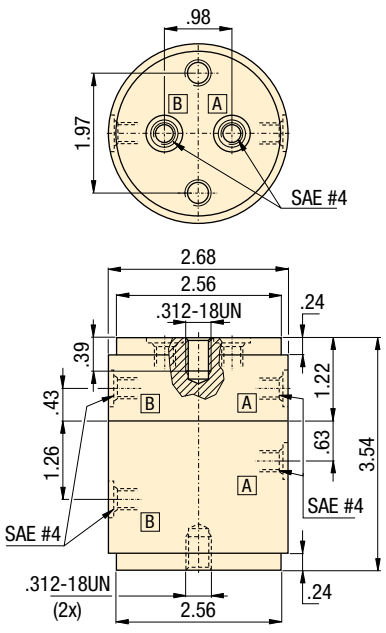
AMP-2



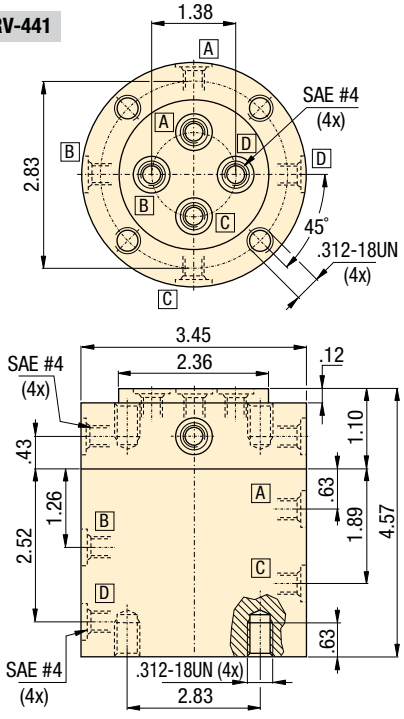
AMP-4



CRV-221



CRV-441



Passages: 1-4 lines

Speed: 30-100 RPM max.

Pressure: 1500-5000 psi

(E) Acoplamientos giratorios

(F) Joints tournants

(D) Drehdurchführungen

Options

Fittings 194 ▸

Couplers 192 ▸

Hoses and couplers 192 ▸

Important

Before selecting, note the pressure versus starting torque diagrams.

Rotary couplers must be mounted in the center of rotation of the installation.

Anti-rotation keys should be utilized.

For proper application, clamp force, pressures and timing, consult Enerpac for support.

Oil/oil intensifiers

Shown: PID-401

99_055

High flow units intensify low inlet oil pressure to high outlet pressure

- Internal bypass valving enables high output flow rates
- Wide range of intensification ratios allows for adapting to various operating pressure requirements
- Compact and self-contained design allows for ease of installation
- Includes dump valve eliminating the need for an external pilot check valve
- Select fit of all internal components provides long operating life

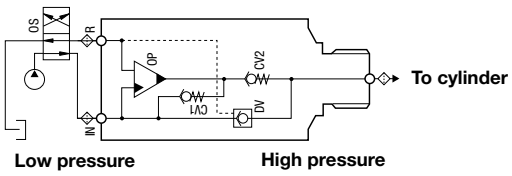
PID series

When hydraulic pressure from an existing power source is limited, Enerpac oil-to-oil intensifiers serve to increase output pressure to satisfy the required application.

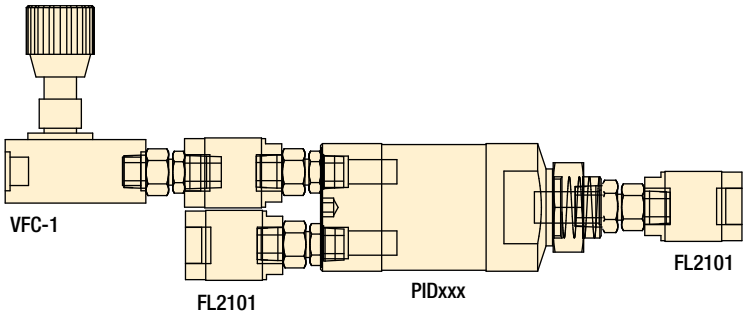
Intensifier principle

- When oil is supplied to the inlet (IN) port it flows freely past the check valves (CV) and the dump valve to the cylinder and advances it.
- As the inlet pressure increases the oscillating pump (OP) automatically increases the outlet pressure by the chosen intensification.
- Once the maximum pressure is reached, the pump frequency lowers and balances at the maximum pressure.
- Free flow from the cylinder to tank occurs when the directional control valve is switched to supply the R-port.
- 10 micron filtration is required on all ports in the circuit to ensure trouble free operation. Filters and flow control included.

PID Series



PID-xxxF intensifier



PID-Series intensifier utilizes low pressure machine hydraulics to power clamping cylinders.

Product selection

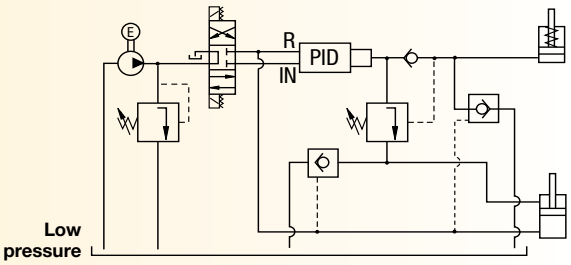
Maximum pressure psi	Pressure intensification ratio	Maximum input flow in³/min	Maximum output flow in³/min	Model number with dump valve	Inlet pressure range psi	lbs
10,000	1 : 3.2	610	150	**PID-321F**	300 - 1560	2.6
10,000	1 : 4.0	580	120	**PID-401F**	300 - 1250	2.6
10,000	1 : 5.0	550	95	**PID-501F**	300 - 1000	2.6
10,000	1 : 6.6	530	75	**PID-661F**	300 - 750	2.6

* Operating pressures above 5000 psi require high pressure fittings or intensifier models with BSPP ports. Contact Enerpac for details.

System set-up information:

With dump valve (PID models)

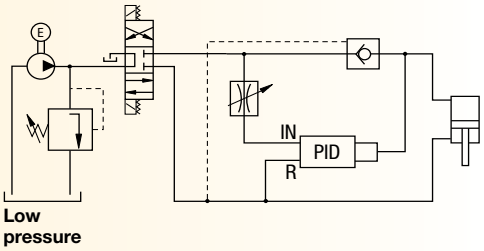
The intensifier with the dump valve is used to achieve high pressure on the advance side of a double-acting cylinder.

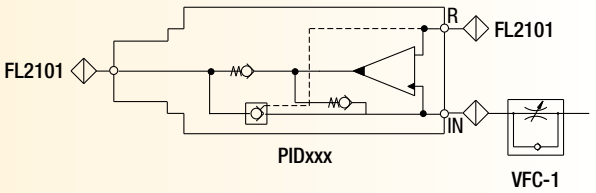


With external dump valve

In a system where the pump's oil flow is higher than the maximum inlet oil flow of the intensifier, an external check valve and flow control valve reduces the pump's oil flow.

This application can be set up when machines are equipped with low pressure hydraulics but the pressure to clamp the workpiece must be higher.





Ratio: 1:3.2-1:6.6

Flow: 75-150 in³/min

Pressure: 960-10,000 psi

(E) **Multiplicadores**

(F) **Multiplicateur**

(D) **Öl-Öl Drucküberseter**

Options

FL-series, high-pressure filters
193

Directional valves
135

FZ-series fittings
194

Important

Do not exceed maximum allowable inlet pressure.

10 micron filtration is included to ensure trouble-free operation.

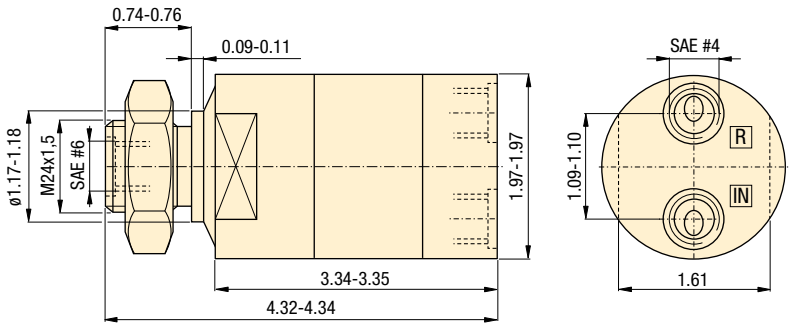
Applications above 5000 psi require high pressure fittings or intensifier models with BSPP ports. Contact Enerpac for details.

PID models with dump valve provide an economical means of relieving pressure from the system.

Can be panel mounted into machine (M24x1,5 thread).

Product dimensions in inches [⊳⊕]

PID series



Shown: SLS-2

SafeLink provides wireless communication between the fixture mounted SEND unit and the machine control interfaced RECEIVE unit.

A pressure switch is used on the fixture to monitor the circuit pressure. If the pressure switch on the fixture goes open, the RECEIVE unit communicates the changed status to the machine control through either 24 VDC, Modbus RTU RS485 or Ethernet IP protocol or Modbus TCP/IP.

The machine control would interrupt the machining process. The SEND unit can also be used with limit switch based position sensing clamps to verify clamped or unclamped status for robotically loaded systems.

WIRELESS communication between a fixture circuit and the machine control

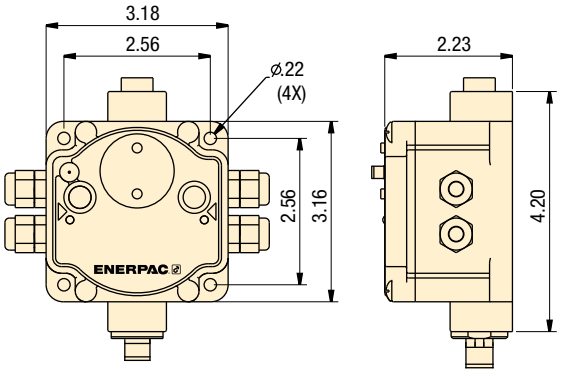
- Fixture mounted “SEND” unit uses radio communication to monitor pressure and/or clamp position
- 2.4 GHz Frequency Band for global acceptance
- “Frequency Hopping” used to for signal stability, even in busy production environments
- “SEND” units are easily reassigned to a different “RECEIVE” unit so fixtures can be moved between machines
- No limit to the number of systems used in a production area
- “SEND” units are internally powered by a replaceable 3.6 VDC Lithium battery – provides up to 3-year battery life
- “SEND” units are sealed to IP-67 for protection from contamination and coolant
- LED lights for visual status indication
- LCD Display window for set-up and status display

Model Number	Description
SLS-1	“SEND” Unit with Internal Antenna
SLS-2	“SEND” Unit with External Antenna
SLS-3	“SEND” Unit with External Antenna, 3 Inputs
SLR-1	“RECEIVE” Unit with External Antenna
SLR-2	“RECEIVE” Unit with External Antenna, 3 Inputs
SLS-2AC	.2m Antenna Cable
SLEM-1	Expansion Module for SLR
SLEB-1	Ethernet Bridge for SLR-1
SLSC-1	Power and Communication Splitter Cable for SLEB-1
SLDB-1	DIN Rail Mounting Bracket

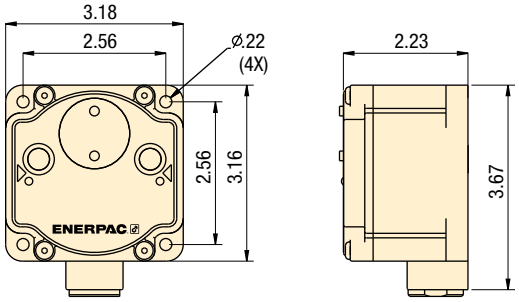
Product specifications

IP Rating	Radio Frequency	Transmit Power	Input Power for RECEIVE Unit	Outputs	FCC Rating	Receiver Commun-ication Protocols	Additional Outputs available from Receiver
IP 67	2.4 GHz	21 dBm conducted	+10 VDC to +30 VDC	+24 VDC	FCC Part 15, Subpart C, 15.247	Modbus RTU RS485 Ethernet IP Modbus TCP/IP	24 VDC Max from Receiver: 6
Dust tight, immersion up to 1 meter	Global Standard		Supplied by machine control	NMOS Sinking			

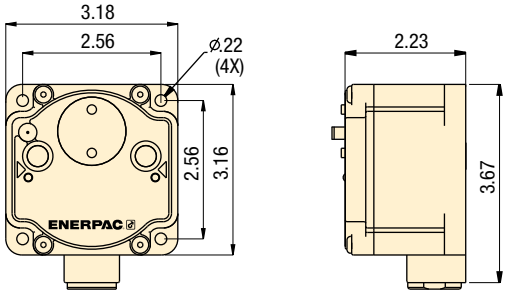
SLR-1 / SLR-2 RECEIVE UNIT



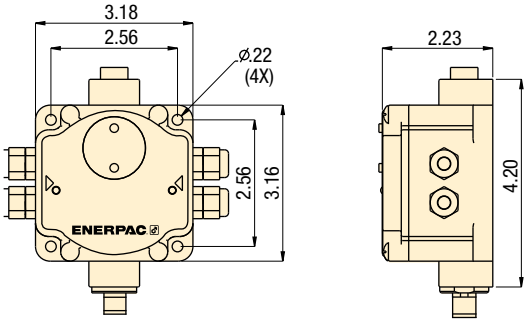
SLS-1 SEND UNIT



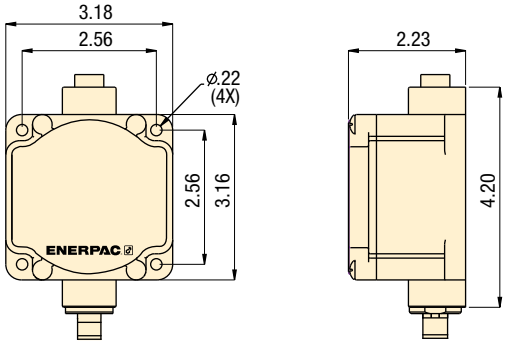
SLS-2 /SLS-3 SEND UNIT



SLEM-1 EXPANSION MODULE



SLEB-1 ETHERNET BRIDGE



Radio Frequency: 2.4 GHz

IP Rating: 67

Communication protocols:
Modbus RTU RS485
Ethernet TCP IP

(E) Monitoreo Inalámbrico

(F) Contrôle sans fil

(D) Drahtlose Überwachung

Important

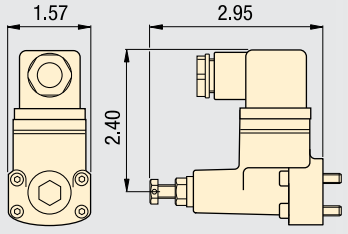
A Pressure Switch is required to monitor the pressure in the fixture circuit. For a convenient manifold mount model, use the PSCK-8 or PSCK-9 from Enerpac.

Manifold Mount Pressure Switch

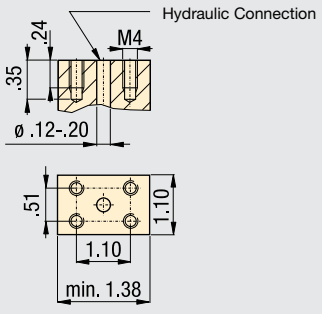
IP Rating: 65 (Dust and Water Jet)

PSCK–8: Range 1450–5000 psi (100-345 bar)

PSCK–9: Range 290–3045 psi (20-210 bar)



Mounting Dimensions



SafeLink *Systems using 24 VDC output*

Shown: SLS-1

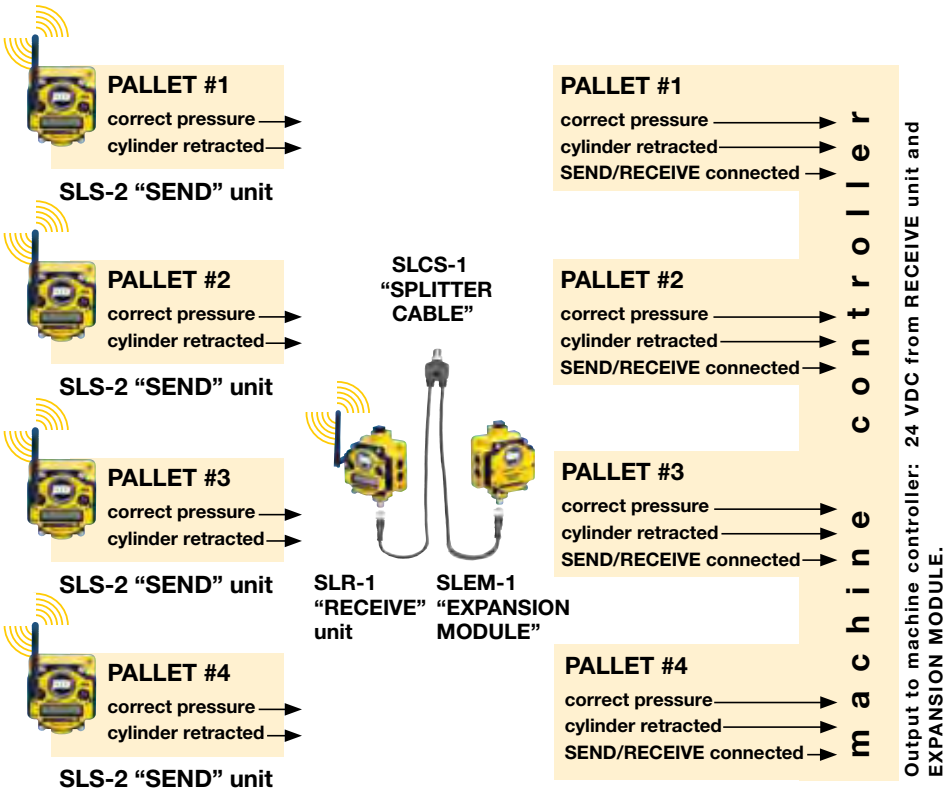
SafeLink can provide a discrete 24VDC output signal for systems of up to 4 fixtures. Each SEND unit can provide up to three outputs to the RECEIVE unit. The RECEIVE unit has 6 terminal stations , which are assigned to SEND units in groups of 3. So each RECEIVE unit can be paired with 2 SEND units when using the 24VDC output. For extra capacity, an EXPANSION MODULE provides an additional terminal strip, adding 2 more sets of three terminal stations.

SLCS-1 Splitter Cable

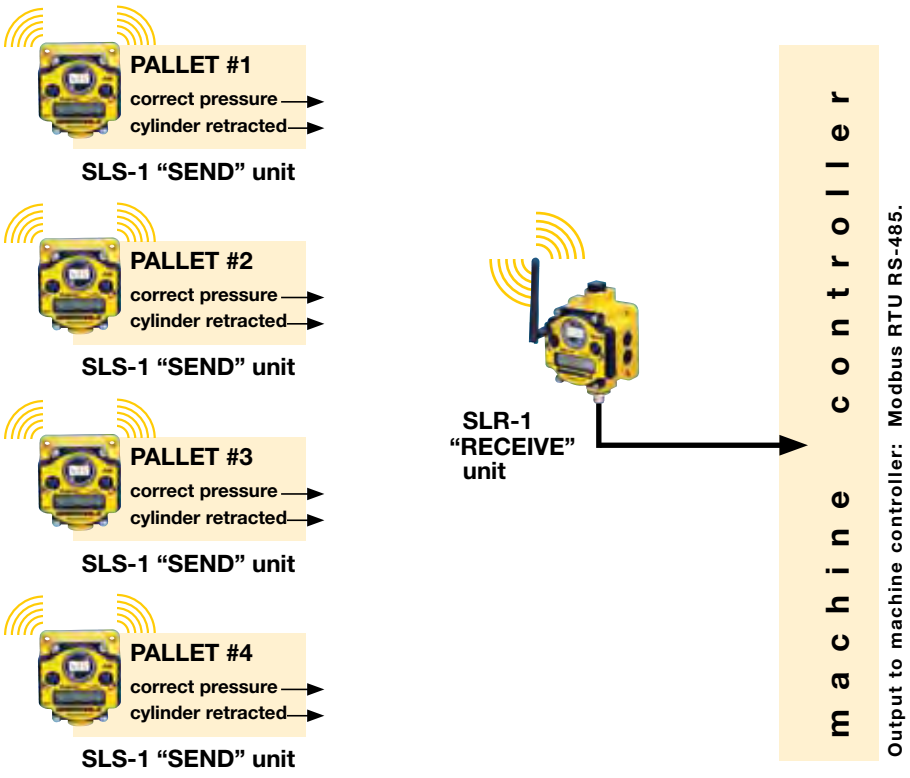
The **SLSC-1 Splitter Cable** is used with the **SLEM-1** Expansion Module and the **SLEB-1** Ethernet Bridge to connect to the **SLR-1** RECEIVE unit and the machine control circuit.

Basic System with I/O Machine Interface

Larger System with I/O Machine Interface



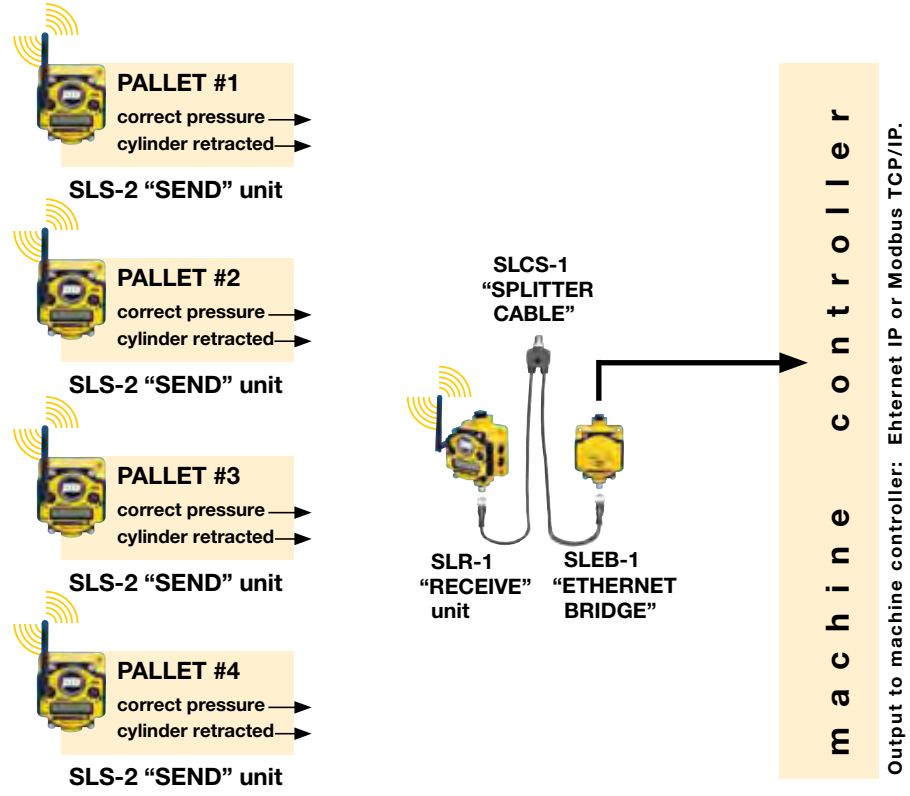
Larger System with Modbus RTU Machine Interface



Shown: SLR-1

SafeLink RECEIVE units can supply the outputs by using the standard Modbus RTU RS-485 protocol. This output uses the 5 pin connector on the RECEIVE unit. If Ethernet protocol is preferred, an ETHERNET BRIDGE is available to convert the Modbus RTU R-485 to ETHERNET IP or Modbus TCP/IP.

Larger System with Ethernet IP Machine Interface



Shown: SLEB-1

The SLEB-1 Ethernet Bridge is used with the SLR-1 Receiver when Ethernet connection is available in the machine control. Use of the SLEB-1 will allow the monitoring of more fixtures in a large pallet pool system.

SafeLink *FAQ*

Shown: SLR-1

SafeLink provides wireless communication between the fixture mounted SEND unit and the machine control interfaced RECEIVE unit. If the pressure switch on the fixture goes open, the RECEIVE unit communicates the changed status to the machine control through either 24 VDC Modbus RTU RS485 or Ethernet TCP IP protocol. The machine control would interrupt the machining process. The SEND unit can also be used with limit switch based position sensing clamps to verify clamped or unclamped status for robotically loaded systems.

▶ WHAT IS SAFELINK?

SafeLink is a wireless way to communicate between a palletized fixture and a machine control.

▶ WHY USE SAFELINK?

SafeLink can monitor the fixture pressure and clamp position in real time- even when parts are being machined. The system can also be used to verify that the operator has properly pressurized the fixture before it is sent in to be machined. If there is a pressure deficiency, the signal between the Send and Receive units is interrupted, and the machine control can respond before expensive damage occurs.

▶ HOW DOES SAFELINK WORK?

SafeLink uses 2.4 GHz radios to allow the SEND unit on the fixture to communicate with the RECEIVE unit that is interfaced with the machine control. The RECEIVE unit provides both 24 VDC outputs and a standard Modbus RTU RS485 communication protocol. An optional Ethernet Bridge will convert this to an Ethernet TCP IP protocol. The machine control must be set up to respond to this protocol to initiate a Feed Hold command, turn on a warning light, or even activate a Machine Stop command.

A pressure switch for pressure monitoring or a limit switch for position sensing is used with the SEND unit. If the pressure or position is lost, the switch goes open and the signal to the RECEIVE unit is interrupted.

▶ WHAT POWERS THE SEND UNIT?

The SEND unit uses a 3.6 VDC size D Lithium battery that is supplied with the unit.

Projected battery life is 3 years.

▶ WHAT POWERS THE RECEIVE UNIT?

The receive unit requires 24 VDC power, usually from the power supply in the machine control.

▶ WILL THE MACHINE FAULT IF THE PALLET IS IN THE LOADING STATION AND THE CLAMPS ARE UNCLAMPED?

The Receive unit is just an input source for the machine control. The machine control must be able to identify which fixture is in the machine being run and which one is in the loading station. When in the loading station, the machine control must be able to ignore the signal loss when the clamps are unclamped to remove the completed parts.

▶ HOW MANY FIXTURES CAN BE MONITORED BY ONE RECEIVE UNIT?

By using either Modbus RTU RS485 or Ethernet TCP IP, up to 56 SLS-1 or SLS-2 Send Units on fixtures can be monitored by a single SLR-1Receive Unit.

▶ IS INSTALLATION AVAILABLE FROM ENERPAC?

Enerpac has partnered with a CNC control specialist that can quote custom installation services. Contact your Enerpac Territory Manager for details.

SafeLink pallet monitoring system

For customers who require custom installation of the ENERPAC SafeLink pallet monitoring system, please provide the following information for each machine tool to be evaluated:

Company: _____ City, State, Zip: _____

Contact: _____ Contact phone (ext): _____

Address: _____ Contact email: _____

BUDGET

Budget for custom installation of SafeLink system on this machine tool:

$500	$1000	$2500	$5000+

MACHINE INFORMATION

MACHINE MAKE	
MACHINE MODEL	
MACHINE SERIAL NUMBER	
MACHINE TYPE	
SINGLE BED HORIZONTAL MACHINING CENTER	
PALLET POOL CELL WITH HORIZONTAL MACHINING CENTERS	
NUMBER OF MACHINES IN CELL	
SINGLE BED VERTICAL MACHINING CENTER	
TWO PALLET VERTICAL MACHINING CENTER	
SLIDE BY	
VERTICAL TURRET LATHE (VTL)	
OTHER/DESCRIBE	
NUMBER OF FIXTURES ASSOCIATED WITH THIS MACHINE	
TOTAL NUMBER OF CIRCUITS IN FIXTURE GROUP	

MACHINE CONTROL INFORMATION

MACHINE CONTROL/MAKE				
MACHINE CONTROL/MODEL NUMBER				
MACHINE CONTROL/SERIAL NUMBER				
MACHINE CONTROL INTERFACE AVAILABLE	MODBUS	ETHERNET	DEVICENET	RELAY
	SERIAL RS-232	OTHER/DESCRIBE		
MACHINE CONTROL IP ADDRESS				
ACTION IF FAULT IS DETECTED	FEEDHOLD		ACTIVATE A LIGHT	
	MACHINE STOP		OTHER/DESCRIBE	

CONTACT ENERPAC: INFO@ENERPAC.COM • PHONE 414-747-8315 • FAX 414-769-9247

ENERPAC

System

System Components

From the simplest to the most complex hydraulic system, Enerpac's system components help you complete your design. Gauges, pressure switches, couplers and hoses are simple but necessary items for any hydraulic system, and Enerpac can provide the full range.

Technical support

- Safety instructions
- Basic hydraulic information
- Advanced hydraulic technology
- FMS (Flexible Machining Systems) technology
- Conversion charts and hydraulic symbols

197 ▶

components

	▼ series	▼ page	
Pressure switches	IC, PB PSCK	188	
Digital pressure gauges	DG	189	
Pressure gauges	G	190	
Gauge accessories	GA, GS NV, FM	191	
Manifolds, couplers, hoses, tubing	A, AH/R HLS, H, T	192	
High pressure filters, hydraulic oil	FL, HF	193	
High pressure fittings	BFZ, FZ	194-196	

Shown: PSCK-8, IC-51

Enerpac remote mounted pressure switches monitor the hydraulic system to determine any change of pressure. The signal can then be used to control the pump, or other peripheral devices.

IC-series

The IC-series electrical pressure switches provide pressure readings for monitoring and/or control of hydraulic system pressure in workholding systems.

Integrated in your hydraulic system, the pressure switch can be used to automate your clamping cycles.

Reliable electrical control of hydraulic power

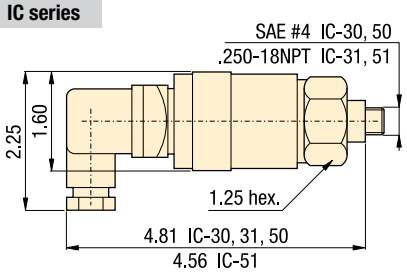
- Compact design minimizes space requirements on fixture
- Switch is easily adjustable to meet system requirements

Pressure: 500-7500 psi

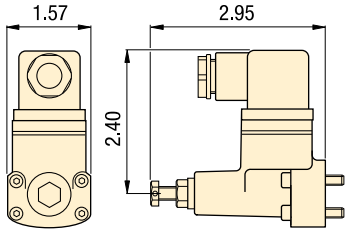
Accuracy: 2%

(E) **Presostatos**
(F) **Pressostats**
(D) **Druckschalter**

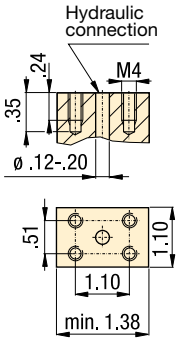
IC series



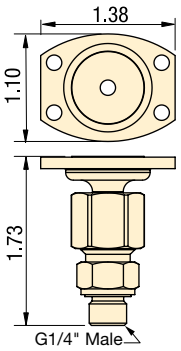
PSCK-8, 9



mounting dimensions



PB-4



Options

Fittings 194

Gauges 190

Important

Do not exceed the maximum pressure.

Product selection

Adjustable pressure range	Electrical specifications	Model number	Deadband	Switch point repeatability	Oil port	
psi	at 50/60 Hz		psi	% of range		lb
▼ **Electrical pressure switches**						
500-3500	125 VAC @ 5 A	**IC-30**	100 - 500	+ /-2	SAE #4	1.0
500-3500	125 VAC @ 5 A	**IC-31**	100 - 500	+ /-2	.250-18 NPT	1.0
3000-7500	125 VAC @ 5 A	**IC-50**	250 - 800	+ /-2	SAE #4	1.0
3000-7500	125 VAC @ 5 A	**IC-51**	250 - 800	+ /-2	.250-18 NPT	1.0
1450-5000	115 VAC @ 2 A	**PSCK-8**	250 - 800	+ /-2	Manifold mount	0.8
290-3045	115 VAC @ 2 A	**PSCK-9**	250 - 800	+ /-2	Manifold mount	0.8
–	–	**PB-4**	–	–	G ¼"	.25

Pressure: 0-20,000 psi

Accuracy: ± 0.25%

Voltage: 3 VDC (battery)

(E) **Manómetros digitales**

(F) **Manomètres digitaux**

(D) **Digitale Manometer**

Options

Fittings

194

Gauge adaptors

190

Important

Do not exceed the maximum pressure.

Gauges can be easily installed into the hydraulic system using GA-3 gauge adaptor.

191

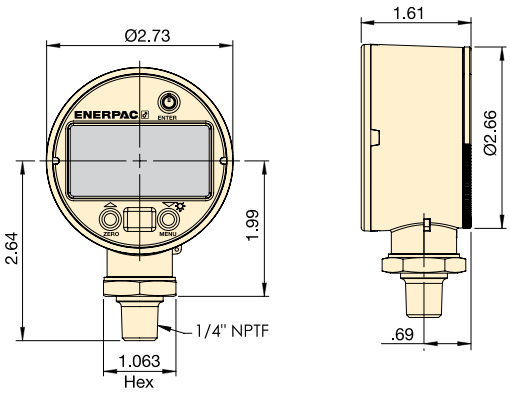
Protective cover included

Fits over face of gauge for protection in harsh environments.

Easy and precise pressure monitoring

DGR-2

- Rated for system pressure up to 20,000 psi
- Displays in multiple units: psi, bar, mPA, kg/cm² (user selectable)
- Zero reset – ensures that gauge reads actual system pressure
- Batteries included, condition indicator on readout
- IP65 rated case design
- Shut off selectable – menu driven
- UL listed, CE and RoHS compliant



Shown: DGR-2

Enerpac digital pressure gauges offer greater accuracy and are easier to read than conventional dial gauges, greatly enhancing your ability to monitor and control hydraulic system pressure.

DGR-2 Remote Operation

Battery operated for additional flexibility. Includes maximum and minimum pressure capture.

Back-lit Readout

Back-lit readout allows easy reading in less than ideal lighting.

Product selection

Pressure rating		Model	Pressure rating		Pressure rating		Pressure rating		
psi			bar		MPa		Kg/cm²		
Range	Resolution		Range	Resolution	Range	Resolution	Range	Resolution	lbs
0-20,000	1	**DGR-2**	0-1380	0.07	0-140	0.01	0-1400	0.07	0.5

Pressure gauges and accessories *Application & selection*

Shown: GS-2, G-2512L, GS-3

Enerpac gauges provide a safe and inexpensive monitoring system for your hydraulic circuit

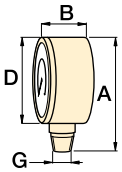
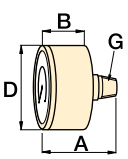
Highly reliable and accurate pressure sensing

- ± 1.5% accuracy of full scale
- All pressure sensing parts sealed and dampened by glycerine for long life
- Includes safety blow-out disk and pressure equalizing membrane to prevent overpressurization
- Copper alloy, coiled safety Bourdon tube for 1000 psi and higher
- Dual psi and bar scale readings, 2.5 inch gauge face

Gauge accessories for easy installation

- Needle valves providing positive shut-off
- 303 stainless steel stem (NV-251)
- Snubber valves to control pressure surges between gauge and hydraulic system
- Gauge adaptors – male end screws into pump or cylinder, female port accepts hose or coupler, the third port is for gauge connection
- FM-25NG for panel mounting of 2.50 inch diameter gauges

Product selection

Pressure gauge mounting style	Pressure range psi	Pressure range bar	Model number	PSI graduation Major psi	PSI graduation Minor psi	Bar graduation Major bar	Bar graduation Minor bar	A in	B in	D in	G
▼ Pressure gauge – Lower mount											
	0-100	0-7	**G-2509L**	10	2	1	0,01	3.31	1.46	2.50	1/4" NPT
	0-160	0-11	**G-2510L**	10	2	1	0,02	3.31	1.46	2.50	1/4" NPT
	0-200	0-14	**G-2511L**	50	5	1	0,02	3.31	1.46	2.50	1/4" NPT
	0-300	0-20	**G-2512L**	50	5	5	0,05	3.31	1.46	2.50	1/4" NPT
	0-600	0-40	**G-2513L**	100	10	10	1	3.31	1.46	2.50	1/4" NPT
	0-1000	0-70	**G-2514L**	100	20	10	1	3.31	1.46	2.50	1/4" NPT
	0-2000	0-140	**G-2515L**	500	50	10	2	3.31	1.46	2.50	1/4" NPT
	0-3000	0-200	**G-2516L**	500	50	50	5	3.31	1.46	2.50	1/4" NPT
	0-6000	0-400	**G-2517L**	1000	100	100	10	3.31	1.46	2.50	1/4" NPT
	0-10,000	0-700	**G-2535L**	2000	200	100	10	3.31	1.46	2.50	1/4" NPT
	0-1000	0-70	**G-2514SL**	100	20	10	1	3.66	1.23	2.50	SAE#4
	0-3000	0-200	**G-2516SL**	500	50	50	5	3.66	1.23	2.50	SAE#4
	0-6000	0-400	**G-2517SL**	1000	100	100	10	3.66	1.23	2.50	SAE#4
	0-10,000	0-700	**G-2535SL**	2000	200	100	10	3.66	1.23	2.50	SAE#4
▼ Pressure gauge – Rear mount											
	0-1000	0-70	**G-2531R**	100	20	10	1	2.48	1.46	2.50	1/4" NPT
	0-6000	0-400	**G-2534R**	1000	100	100	10	2.48	1.46	2.50	1/4" NPT
	0-10,000	0-700	**G-2537R**	2000	200	100	10	2.48	1.46	2.50	1/4" NPT
	0-1000	0-70	**G-2531SR**	100	20	10	1	2.46	1.23	2.50	SAE #4
	0-3000	0-200	**G-2533SR**	500	50	50	5	2.46	1.23	2.50	SAE #4
	0-6000	0-400	**G-2534SR**	1000	100	100	10	2.46	1.23	2.50	SAE #4
	0-10,000	0-700	**G-2537SR**	2000	200	100	10	2.46	1.23	2.50	SAE #4
	0-1000	0-70	**1531R**	100	20	10	1	1.99	0.98	1.50	1/8" NPT
	0-3000	0-200	**1533R**	500	100	50	10	1.99	0.98	1.50	1/8" NPT
	0-6000	0-400	**1534R**	1000	100	100	10	1.99	0.98	1.50	1/8" NPT
	0-10,000	0-700	**1537R**	2000	200	100	10	1.99	0.98	1.50	1/8" NPT

Pressure: 0-10,000 psi

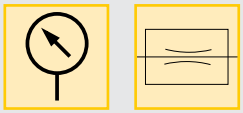
Accuracy: 1.5% /full scale

Gauge face: ø 2.5 inch

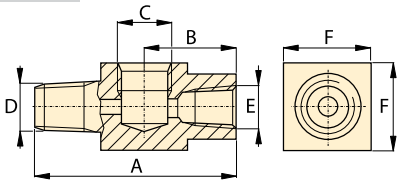
(E) Manómetros

(F) Manomètres

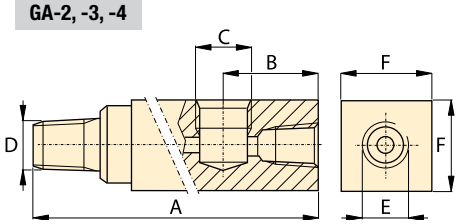
(D) Manometer



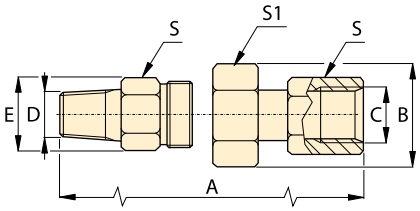
GA-1



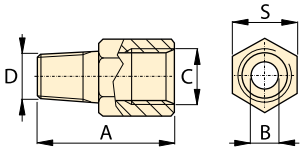
GA-2, -3, -4



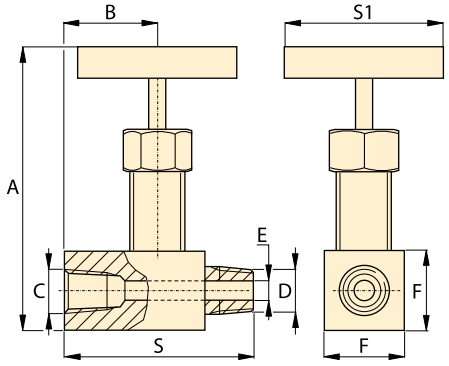
GA-918



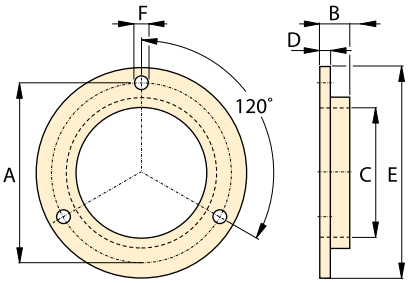
GS-2, -3



NV-251, V-91



FM-25NG



Options

Hoses and couplers 192

Digital gauges 189

Pressure switches 188

V-10 Auto Damper® valve 157

Important

Do not exceed maximum pressure.

Gauge snubbers or needle valves are recommended for high cycle applications.

Do not keep gauges under permanent pressure. The use of shut-off valves is recommended.

For basic system set-up information, refer to our "Yellow Pages" section. 202

Product dimensions in inches [ ]

Gauge port NPT	Max. pressure psi	Model number	Dimensions A	B	C	D	E	F	S	S1
▼ Gauge adaptors										
1/2"	10,000	**GA-1**	2.81	1.24	1/2"NPT	3/8"NPT	3/8"NPT	1.25	–	–
1/2"	10,000	**GA-2**	6.10	1.38	1/2"NPT	3/8"NPT	3/8"NPT	1.25	–	–
1/4"	10,000	**GA-3**	5.25	1.38	1/4"NPT	3/8"NPT	3/8"NPT	1.25	–	–
1/2"	10,000	**GA-4**	4.38	1.38	1/2"NPT	1/4"NPT	3/8"NPT	1.25	–	–
▼ Swivel gauge adaptor										
1/2"	10,000	**GA-918**	2.25	1.72	1/2"NPT	1/2"NPT	1.30	–	1.13	1.50
▼ Gauge shut-off valves										
1/4"	10,000	**NV-251**	2.25	1.14	1/4"NPT	1/4"NPT	.17	.75	2.25	2.50
1/2"	10,000	**V-91**	3.50	1.25	1/2"NPT	1/2"NPT	.19	1.25	2.50	2.50
▼ Gauge snubber valves										
1/4"	5000	**GS-2**	1.63	.018	1/4"NPT	SAE #4	–	–	.75	–
1/4"	5000	**GS-3**	1.63	.018	1/4"NPT	G1/4"	–	–	.75	–
▼ Flange mounting for panel mounting of G series gauges										
–	–	**FM-25NG**	2.95	.17	2.51	.07	3.35	.14	–	–

Manifolds, couplers, hoses, tubing

Shown: HLS, HF, AH, AR, FL, T, A-series

Use genuine Enerpac manifolds, couplers, hoses and tubings to connect your workholding cylinders or fixtures to the hydraulic power source.

A series, Manifolds

For multiple hydraulic line connections at one central location directing oil to or from a pressure source.

AH/AR series, Couplers

Quick disconnect low leakage couplers for easy connection of hydraulic circuits.

HLS series, Hoses

High pressure hydraulic hoses, featuring a heavy-duty protective plastic coating.

T-series, Tubing

High pressure steel tubing, available in 5 ft. lengths.

Options

Fittings
194

Manifolds

- Easy to connect
- Mounting holes on all models

Couplers

- Spee-D-Coupler® design allows cylinder to be connected and disconnected in seconds
- For more safety: couplers cannot be connected or disconnected while under hydraulic pressure

Hydraulic hoses and tubings

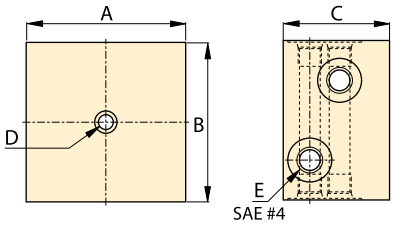
- Heavy-duty coating for abrasion resistance
- Resistant against mineral based hydraulic oil as well as water glycols
- High pressure steel tubing for permanent installations

Important

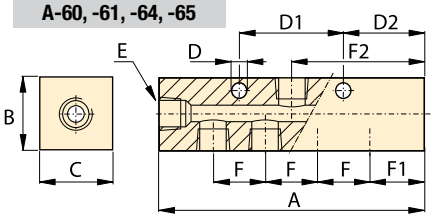
Do not exceed the maximum pressure.

Inspect hoses and tubing frequently and replace as required.

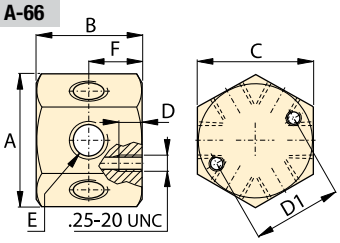
A-63



A-60, -61, -64, -65



A-66



Manifolds dimensions in inches [⊳⊕]

Number of ports	Model number	A	B	C	D	D1	D2	E	F	F1	F2	lbs
2 x 4	**A-63**	3.00	3.00	2.00	.25	–	–	SAE #4	–	–	–	2.0
5	**A-60**	3.50	1.25	1.25	.28	1.50	1.00	SAE #4	1.50	1.00	1.75	1.0
7	**A-61**	6.50	1.25	1.25	.28	1.50	1.25	SAE #4	1.00	1.25	3.25	1.4
7	**A-64**	7.00	1.25	1.25	.25	3.00	1.25	.375-18 NPT	1.50	1.25	3.50	3.3
7	**A-65**	14.5	1.25	1.25	.25	8.00	1.25	.375-18 NPT	4.00	1.25	7.25	6.1
6	**A-66**	2.30	1.63	2.00	.52	1.50	–	.375-18 NPT	–	–	–	1.8

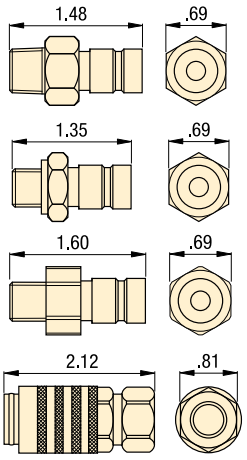
Couplers

AH-650
Male coupler half
.250-18 NPT

AH-652
Male coupler half
G1/4" BSPP

AH-654
Male coupler half
SAE #4 .437-20 UNF

AR-650
Female coupler half
.250-18 NPT



Hoses

Length ft	Model number	Internal diameter in	Maximum pressure psi
▼ 1/4", 37° flare			
1	**HLS-512**	.19	5000
2	**HLS-524**	.19	5000
3	**HLS-536**	.19	5000
4	**HLS-548**	.19	5000
5	**HLS-560**	.19	5000
10	**HLS-5120**	.19	5000
▼ 3/8" NPT			
3	**H-9203**	.25	10,000
6	**H-9206**	.25	10,000
10	**H-9210**	.25	10,000

Tubing

Length ft	Model number	Internal diameter in	External diameter in	Max. pressure psi
5	**T-2560**	.152	.25	5000

High-pressure filters

- Keep your hydraulic system clean
- Pleated stainless steel wire mesh screen construction provides large filter area in a compact size
- Rated for full system pressure up to 5000 psi
- Bi-directional design allows filtration of oil in either flow direction
- Two piece body construction for easy replacement of filter elements
- High flow rates are obtainable with a minimum pressure drop
- Threaded port connections on each end simplify installation

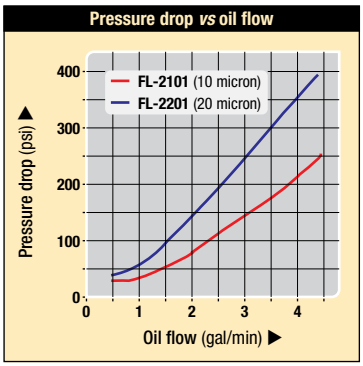
Hydraulic oil

- Ensures effective lubricity
- Protects essential parts

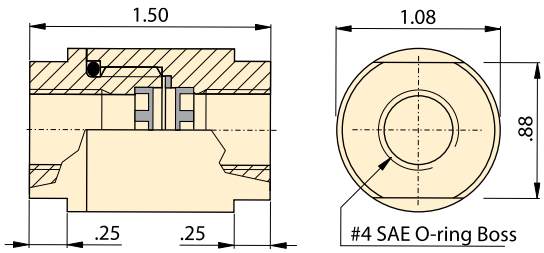
Filtration

20 micron filter provides the longest service life before element replacement

10 micron filter recommended for more sensitive hydraulic components



FL series



High in line pressure filters

Model number	Filtration micron		Filter element set	
	Nominal	Absolute		lbs
FL-2101	10	25	**FL-2101K**	.4
FL-2201	20	40	**FL-2201K**	.4

Hydraulic oil

Contents Gal	Model number	Specifications genuine Enerpac hydraulic oil	
.25	**HF-100**	0 °F	<12,000 S.U.S
1	**HF-101**	100 °F	150/165 S.U.S
5	**HF-102**	210 °F	42/45 S.U.S
55	**HF-104**	Flash, C.O.C.	400°F
		Pour point	-25°F
		Aniline point	210/220 °F

Note: Viscosity index: 100 min

www.enerpacwh.com

E Mangueras, Filtros Acoplamientos, Aceite

F Flexibles, Filtres Raccords, Huile

D Schläuche, Filter Kupplungen, Öl

High-pressure filters

Compact in line high pressure filters prevent chips and debris that have entered the hydraulic fluid system from damaging hydraulic system components.

Hydraulic oil

Use only genuine Enerpac hydraulic oil to guarantee optimal performance and long life of your hydraulic equipment.

Options

Fittings

194

Important

Do not exceed the maximum pressure.

Hydraulic power is distributed by manifolds and transported by hoses and tubing.

High Pressure Fittings *Selection & dimensions*

Shown: FZ-2052, FZ-2054, FZ-2023

99-036

Fitting are used to connect all cylinders, components, power sources, tubes, gauges and hoses in a hydraulic system. Enerpac fittings provide flexible, safe and leak-free connections.

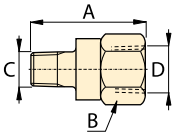
Multiple hydraulic line connections are easily installed with Enerpac fittings and manifolds.

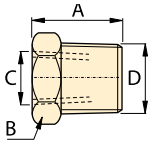
99-119

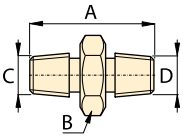
Proper connection for hydraulic components

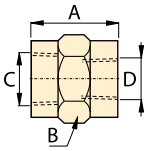
- Male and female NPT, SAE, BSPP threaded fittings in common sizes allow easy connection of all components.
- BFZ and FZ-1000 models are 10,000 psi maximum pressure
- FZ-2000 models are 5000 psi maximum pressure

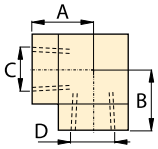
Product selection

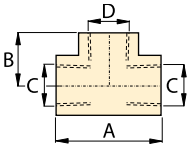


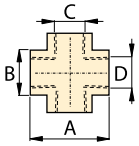








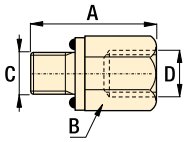


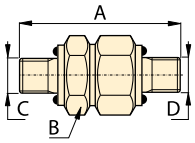


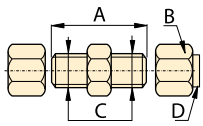
From	To	Max. pressure psi	Model number	Dimensions in inches A	B	C	D
▼ Adapters							
Female	**Male**						
1/4" NPT	1/8" NPT	10,000	**FZ-1642**	1.21	3/4"	1/8"-27 NPT	1/4"-18 NPT
3/8" NPT	1/4" NPT	10,000	**FZ-1055**	1.44	7/8"	1/4"-18 NPT	3/8"-18 NPT
1/2" NPT	1/4" NPT	10,000	**FZ-1633**	1.69	1-1/8"	1/4"-18 NPT	1/2"-14 NPT
1/2" NPT	3/8" NPT	10,000	**FZ-1634**	1.69	1-1/8"	3/8"-18 NPT	1/2"-14 NPT
▼ Reducers							
Female	**Male**						
1/4" NPT	3/8" NPT	10,000	**FZ-1630**	.86	3/4"	3/8"-18 NPT	1/4"-18 NPT
1/4" NPT	1/2" NPT	10,000	**FZ-1661**	1.11	7/8"	1/2"-14 NPT	1/4"-18 NPT
SAE #6	SAE #8	5000	**FZ-2029**	1.38	1-1/16"	9/16"-18	3/4"-16
▼ NPT Male Nipples							
1/4" NPT	1/4" NPT	10,000	**FZ-1608**	1.45	5/8"	1/4"-18 NPT	1/4"-18 NPT
3/8" NPT	3/8" NPT	10,000	**FZ-1617**	1.45	3/4"	3/8"-18 NPT	3/8"-18 NPT
3/8" NPT	3/8" NPT	10,000	**FZ-1619**	2.00	3/4"	3/8"-18 NPT	3/8"-18 NPT
3/8" NPT	G1/4"	10,000	**BFZ-305**	1.42	3/4"	3/8"-18 NPT	G1/4"-19
▼ NPT Female Connectors							
1/4" NPT	1/4" NPT	10,000	**FZ-1605**	1.13	3/4"	1/4"-18 NPT	1/4"-18 NPT
3/8 NPT	1/4" NPT	10,000	**FZ-1615**	1.13	7/8"	3/8"-18 NPT	1/4"-18 NPT
3/8" NPT	3/8" NPT	10,000	**FZ-1614**	1.13	7/8"	3/8"-18 NPT	3/8"-18 NPT
1/2" NPT	3/8" NPT	10,000	**FZ-1625**	1.50	1-1/8"	1/2"-14 NPT	3/8"-18 NPT
▼ NPT Elbows							
1/4" NPT	1/4" NPT	10,000	**FZ-1638**	.88	3/4"	1/4"-18 NPT	1/4"-18 NPT
3/8" NPT	3/8" NPT	10,000	**FZ-1610**	1.02	7/8"	3/8"-18 NPT	3/8"-18 NPT
▼ NPT Tee							
1/4" NPT	1/4" NPT	10,000	**FZ-1637**	1.76	3/4"	1/4"-18 NPT	1/4"-18 NPT
3/8" NPT	3/8" NPT	10,000	**FZ-1612**	2.04	7/8"	3/8"-18 NPT	3/8"-18 NPT
▼ NPT Cross							
3/8" NPT	3/8" NPT	10,000	**FZ-1613**	2.04	7/8"	3/8"-18 NPT	3/8"-18 NPT

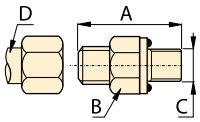
Product selection

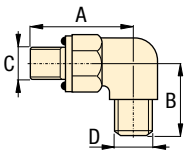
From	To	Max. pressure psi	Model number	Dimensions in inches A	B	C	D
▼ Adapters							
Male	**Female**						
1/8" NPT	SAE #4	5000	FZ-2075	1.21	11/16"	1/8"-27 NPT	1/4"-18 NPT
1/4" NPT	SAE #4	5000	FZ-2042	1.31	11/16"	1/4"-18 NPT	7/16"-20
1/4" NPT	G1/4"	10,000	BFZ-16411	1.38	3/4"	1/4"-18 NPT	G1/4"
SAE #4	1/8" NPT	5000	FZ-2008	1.00	9/16"	7/16"-20	1/8"-27 NPT
SAE #4	1/4" NPT	5000	FZ-2007	1.16	3/4"	7/16"-20	1/4"-18 NPT
SAE #2	SAE #4	5000	FZ-2022	1.03	11/16"	5/16"-24	7/16"-20
SAE #6	1/4" NPT	5000	FZ-2056	1.16	3/4"	9/16"-18	1/4"-18 NPT
SAE #8	1/4" NPT	5000	FZ-2067	1.13	7/8"	3/4"-16	1/4"-18 NPT
SAE #8	3/8" NPT	5000	FZ-2069	1.28	7/8"	3/4"-16	3/8"-18 NPT
G 1/8"	1/8" NPT	5000	FZ-2055	.97	5/8"	G 1/8"-28	1/8"-27 NPT
G 1/8"	1/4" NPT	5000	FZ-2060	1.28	3/4"	G 1/8"-28	1/4"-18 NPT
G 1/8"	#4 SAE	5000	FZ-2066	1.00	11/16"	G 1/8"-28	7/16"-20
G 1/4"	1/4" NPT	5000	FZ-2023	1.28	3/4"	G 1/4"-19	1/4"-18 NPT
G 1/4"	#4 SAE	5000	FZ-2065	1.11	3/4"	G 1/4"-19	7/16"-20
▼ Straight union							
SAE #4	SAE #4	5000	FZ-2005	1.27	9/16"	7/16"-20	7/16"-20
SAE #6	SAE #6	5000	FZ-2028	1.41	11/16"	9/16"-18	9/16"-18
SAE #8	SAE #8	5000	FZ-2040	1.56	7/8"	3/4"-16	3/4"-16
▼ Straight union to tube ends							
ø.25	ø.25	5000	FZ-2033*	1.38	1/2"	7/16"-20	ø.25
ø.25	ø.25	5000	FZ-2013**	2.03	1/2"	7/16"-20	ø.25
▼ Adaptors to tube end							
Male	**Tube size**						
1/8" NPT	ø.25	5000	R-1054*	1.22	1/2"	1/8"-27 NPT	ø.25
1/4" NPT	ø.25	5000	FZ-2020*	1.42	9/16"	1/4"-18 NPT	ø.25
1/4" NPT	ø.375	5000	FZ-2072*	1.43	5/8"	1/4"-18 NPT	ø.375
1/4" NPT	ø.25	5000	FZ-2012**	1.32	9/16"	1/4"-18 NPT	ø.25
3/8" NPT	ø.25	5000	FZ-2061*	1.44	3/4"	3/8"-18 NPT	ø.25
3/8" NPT	ø.375	5000	FZ-2068*	1.44	3/4"	3/8"-18 NPT	ø.375
SAE #2	ø.25	5000	FZ-2025*	1.02	9/16"	5/16"-24	ø.25
SAE #4	ø.25	5000	FZ-2019*	1.23	9/16"	7/16"-20	ø.25
SAE #4	ø.25	5000	FZ-2001**	1.13	9/16"	7/16"-20	ø.25
SAE #6	ø.25	5000	FZ-2059*	1.28	11/16"	9/16"-18	ø.25
SAE #8	ø.25	5000	FZ-2039*	1.38	7/8"	3/4"-16	ø.25
SAE #8	ø.375	5000	FZ-2070*	1.38	7/8"	3/4"-16	ø.375
G1/8"	ø.25	5000	FZ-2053*	1.18	14 mm	G1/8"-28	ø.25
G1/4"	ø.25	5000	FZ-2054*	1.37	19 mm	G1/4"-19	ø.25
G1/4"	ø.375	5000	FZ-2064*	1.38	19 mm	G1/4"-19	ø.375
▼ Elbow to tube end							
Male	**Tube size**						
1/8" NPT	ø.25	5000	FZ-2074*	0.78	7/16"	1/8"-27 NPT	ø.25
1/4" NPT	ø.25	5000	FZ-2073*	1.09	9/16"	1/4"-18 NPT	ø.25
1/4" NPT	ø.25	5000	FZ-2076**	1.09	9/16"	1/4"-18 NPT	ø.25
1/4" NPT	ø.375	5000	FZ-2081*	1.09	9/16"	1/4"-18 NPT	ø.375
3/8" NPT	ø.25	5000	FZ-2082*	1.22	3/4"	3/8"-18 NPT	ø.25
3/8" NPT	ø.375	5000	FZ-2083*	1.22	3/4"	3/8"-18 NPT	ø.375
SAE #2	ø.25	5000	FZ-2024*	0.92	7/16"	5/16"-24	ø.25
SAE #4	ø.25	5000	FZ-2035*	1.03	9/16"	7/16"-20	ø.25
SAE #4	ø.25	5000	FZ-2002**	1.03	9/16"	7/16"-20	ø.25
SAE #8	ø.375	5000	FZ-2071*	1.45	7/8"	3/4"-16	ø.375
G1/8"	ø.25	5000	FZ-2051*	1.03	14mm	G1/8"-28	ø.25
G1/4"	ø.25	5000	FZ-2052*	1.25	19mm	G1/4"-19	ø.25
ø.25	ø.25	5000	FZ-2014**	0.89	9/16"	ø.25	ø.25











*Flared
**Flareless

Pressure: 0-10,000 psi

Threads: NPT, SAE, BSPP

For tubing: .25 in/.375 in/8mm

(E) Acoplamientos

(F) Raccords

(D) Verschraubungen

Options

Gauges
190

Manifolds, couplers, hoses, tubing
192

Important

Do not exceed the maximum pressure.

Use fittings and tubing in high cycle applications and areas having excessive heat or weld splatter.

To seal NPT threads use anaerobic thread sealers or Teflon paste. Apply Teflon tape one thread from the end of the fitting, to prevent it from winding up in the hydraulic system.

High presure hydraulic fittings allow connection of many components with minimum effort.

Pressure: 0-5000 psi

Threads: NPT, SAE, BSPP

For tubing: .25 in/.375 in/8mm

E Acoplamientos

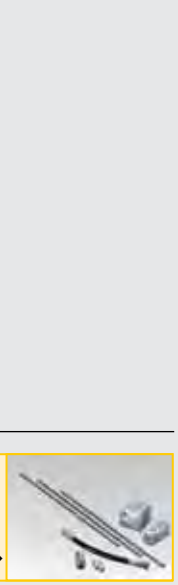
F Raccords

D Verschraubungen

Options

Manifolds, couplers, hoses, tubing

192 ▶



Important

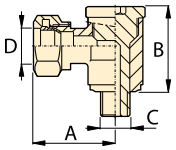
Do not exceed maximum pressure.

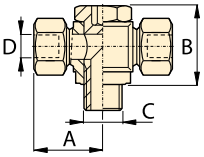
Use fittings and tubing in high cycle applications and areas having excessive heat or weld splatter.

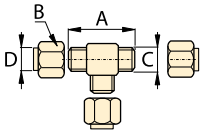
High pressure fittings enable the design of hydraulic systems to meet a variety of applications.

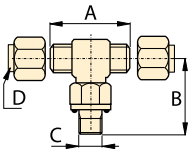
99-060

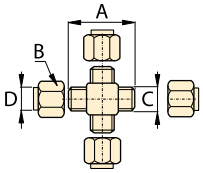
Product selection

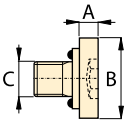


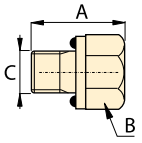


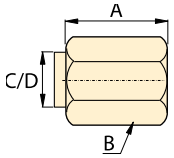


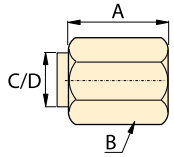












From	To	Max. pressure psi	Model number	Dimensions in inches A	B	C	D
▼ Swivel banjo BSPP to tube							
Male	**Tube size**						
G1/4"	ø 8mm	10,000	**BFZ-307****	1.14	19mm	G1/4"-19	ø 8mm
▼ Swivel T-banjo BSPP to tube							
Male	**Tube size**						
G 1/4"	ø 8mm	10,000	**BFZ-309****	1.14	19mm	G 1/4"-19	ø 8mm
▼ Union tee							
ø.25	ø.25	5000	**FZ-2021***	1.78	9/16"	7/16"-20	ø.25
ø.25	ø.25	5000	**FZ-2015****	1.78	9/16"	7/16"-20	ø.25
▼ Branch tee							
Male	**Tube size**						
SAE #4	ø.25	5000	**FZ-2036***	1.78	9/16"	7/16"-20	ø.25
SAE #4	ø.25	5000	**FZ-2004****	1.78	9/16"	7/16"-20	ø.25
▼ Union cross							
ø.25	ø.25	5000	**FZ-2034***	1.78	9/16"	7/16"-20	ø.25
ø.25	ø.25	5000	**FZ-2016****	1.78	9/16"	7/16"-20	ø.25
▼ SAE Plug							
SAE #4		5000	**FZ-2006**	.11	.56	7/16"-20	
SAE #6		5000	**FZ-2003**	.19	.69	9/16"-18	
▼ SAE Hex Plug							
SAE #8		5000	**FZ-2041**	.80	7/8"	3/4"-16	
▼ Nut and Sleeve for Tubing							
ø.25		5000	**FZ-2037***	.62	9/16"	37°	ø.25
▼ Cap for Tubing							
ø.25		5000	**FZ-2038***	.62	9/16"	37°	ø.25
ø.25		5000	**FZ-2017****	.60	9/16"	ø.25	ø.25
ø.375		5000	**FZ-2011***	.73	11/16"	37°	ø.375

*Flared

**Flareless

Enerpac "Yellow Pages"
stand for
Hydraulic Information!

If selecting hydraulic equipment is not your daily routine, then you will appreciate these pages. The "Yellow Pages" are designed to help you work with hydraulics. They will help you better understand the basics of hydraulic system set-ups and the most commonly used hydraulic techniques. By making an educated selection of equipment, you will receive greater benefits from your hydraulic system.

Take the time to go through these "Yellow Pages" and you will benefit even more from Enerpac hydraulic workholding.

Index	▼ page
Safety instructions	198 - 199
Basic hydraulics	200 - 201
Basic system set-up	202 - 205
Clamping technology	206 - 209
Cutting tool technology	210 - 212
Conversion factors and hydraulic symbols	213 - 219
Valving technology	220 - 223
Flexible machining systems	224 - 225
Converting from mechanical clamping to hydraulic clamping	226 - 228

ENERPAC WARRANTY STATEMENT

www.enerpac.com

Visit our website for the complete Enerpac Global Warranty or call your Enerpac representative or Enerpac Authorized Service Center.

Enerpac is certified for several quality standards. These standards require compliance with standards for management, administration, product development and manufacturing.

ISO 9001 REGISTERED

Enerpac worked hard to earn the quality rating ISO 9001, in its ongoing pursuit of excellence.

UL approved
All electrical components used on Enerpac products carry the UL rating when possible.

Canadian Standards Association
Where specified, Enerpac electric pump assemblies meet the design, assembly and test requirements of the Canadian Standards Association.

Product Design Criteria
All hydraulic components are designed and tested to be safe for use at maximum 350 bar/5,000 psi pressure unless otherwise specifically noted.

EMC Directive 89/336/EEC
Where specified, Enerpac electric power pumps meet the requirements for Electromagnetic Compatibility per EMC Directive 89/336/EEC.

CE Marking & Conformity
Enerpac provides a Declaration of Conformity and CE marking for products that conform with the European Community Directives.

Hydraulic clamping can increase your machine shop's efficiency by reducing setup time. Power clamping can also maximize output by reducing employee lost time due to the injuries that can occur with manual clamping.

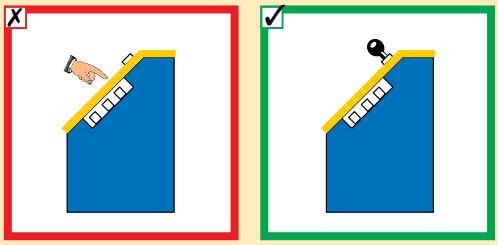
Although hydraulic operation moves the control of the clamping fixture to an area of greater safety, operators must still be alert to several common sense practices. And to that end we offer some DOs and DON'Ts, simple common sense points which apply to all Enerpac hydraulic products.

The line drawings and application photos of Enerpac products throughout this catalog are used to portray how some of our customers have used hydraulics in industry. In designing similar systems, care must be taken to select the proper componentvs that provide safe operation and fit your needs.

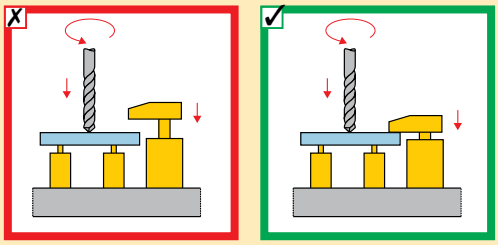
Check to see if all safety measures have been taken to avoid the risk of injury and property damage from your application or system.

Enerpac can not be held responsible for damage or injury, caused by unsafe use, maintenance or application of its products. Please contact the Enerpac office or a representative for guidance when you are in doubt as to the proper safety precautions to be taken in designing and setting up your particular system.

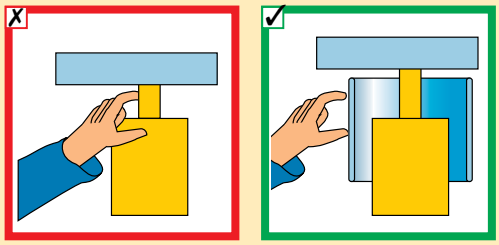
In addition to these tips, every Enerpac product comes with instructions spelling out specific safety information. Please read them carefully.



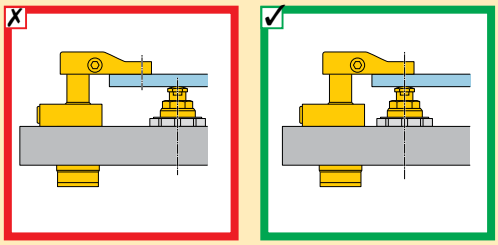
Prevent inadvertent activation of the control units of power operated clamping systems.



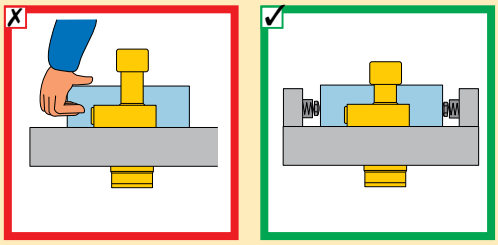
Clamping devices must be activated before main spindle can be started.



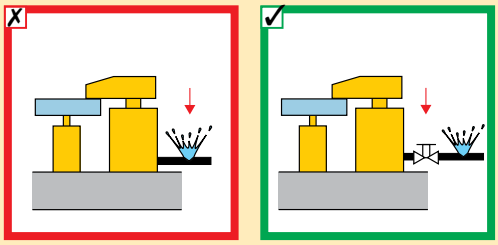
Maintain a safe distance from clamping elements and workpiece to avoid personal injury.



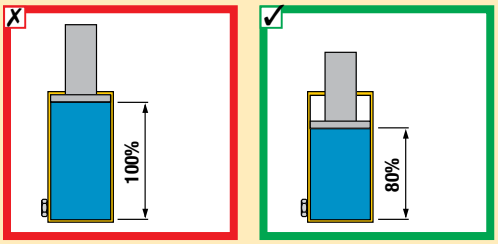
Do not apply off-center load. Clamping force must be directly over the support point.



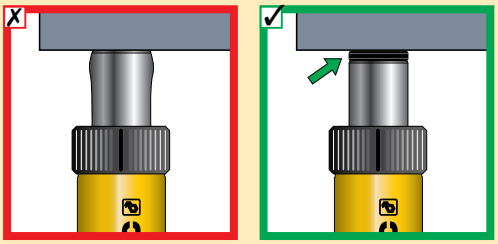
Use mechanical devices and not fingers to hold part until the hydraulics are activated.



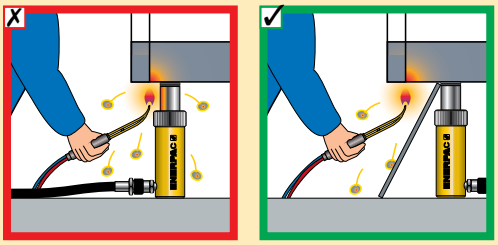
Use check valves to maintain hydraulic pressure to clamping devices in the event of a hydraulic line failure.



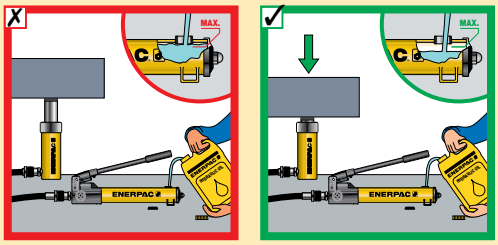
Do not operate cylinders beyond limits of rated stroke or pressure. Use only 80% of usable stroke.



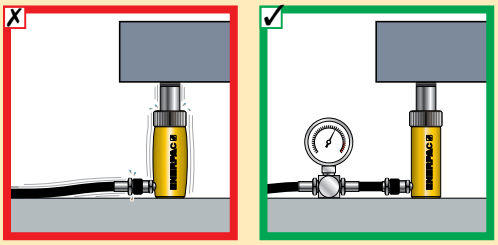
Use saddles or buttons to prevent mushrooming of plungers. Saddles distribute load evenly on the plunger.



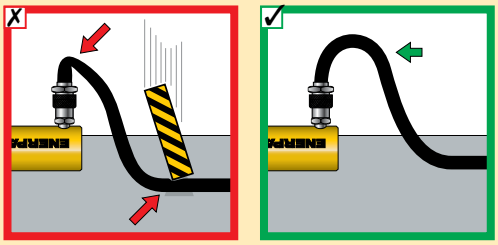
Keep hydraulic equipment away from open fire and temperatures above 150 °F / 65 °C.



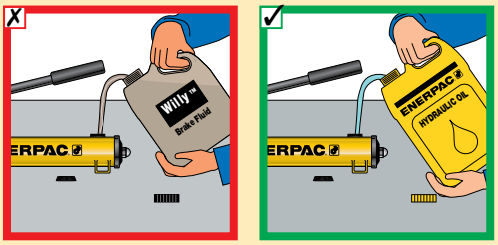
Fill pump only to recommended level. Fill only when connected cylinders are fully retracted.



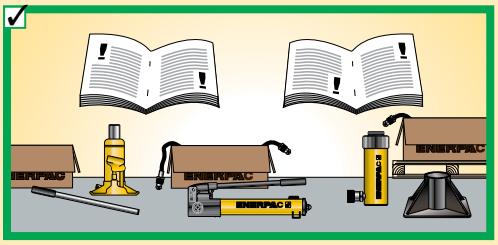
Do not override the factory setting of pressure relief valves. Always use a gauge to check system pressure.



Do not kink hoses. Bending radius must be at least 4.5 inch (115 mm). Do not drive over or drop heavy objects on hoses. Use high pressure tubing in high cycle applications.



Always use genuine Enerpac hydraulic oil.



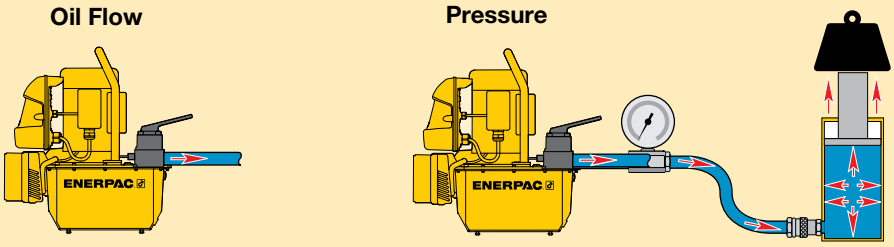
Always read instructions and safety warnings that come with your Enerpac hydraulic equipment.

Oil Flow

A hydraulic pump produces flow. Flow is the amount of fluid coming out of the pump.

Pressure

Pressure occurs when there is resistance to flow.



Pascal's Law

Pressure applied at any point upon a confined liquid is transmitted undiminished in all directions (Fig.1). This means that when more than one hydraulic cylinder is being used, each cylinder will pull or push at its own rate, depending on the force required to move the load at that point (Fig. 2).

Cylinders with the lightest load will move first and cylinders with the heaviest load will move last (Load A), if the cylinders have the same capacity.

To have all cylinders operate uniformly so that the load is being pulled or pushed at the same rate at each point, control valves (see Valve section) must be added to the system (Load B).

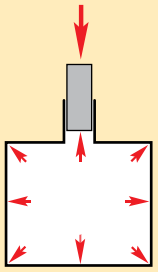


Figure 1

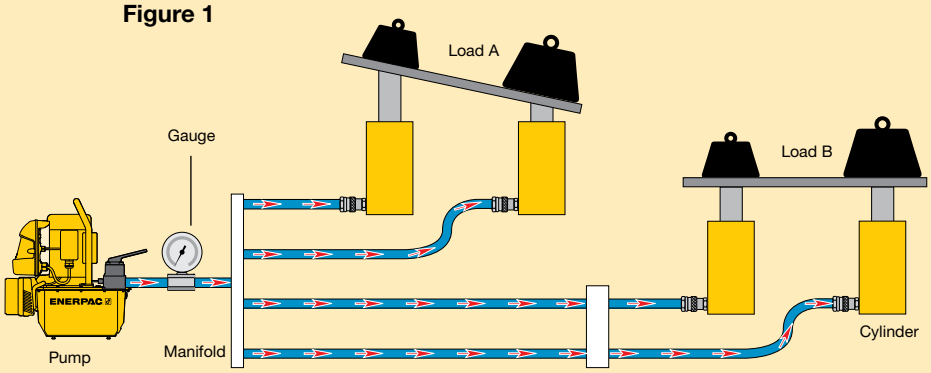
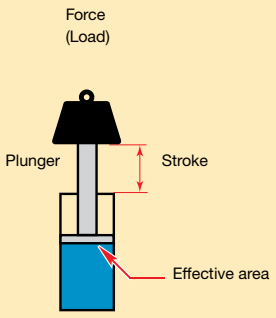


Figure 2

Force

The amount of force a hydraulic cylinder can generate is equal to the hydraulic pressure times the "effective area" of the cylinder (see cylinder selection charts).

Use the formula **F = P x A** to determine either force, pressure or effective area if two of the variables are known.

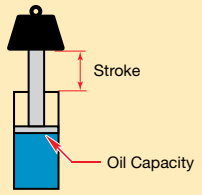


Force	=	Hydraulic Working Pressure	X	Cylinder Effective Area
F	=	P	X	A

Cylinder Oil Capacity

The volume of oil required for a cylinder (cylinder oil capacity) is equal to the effective area of the cylinder times the stroke.

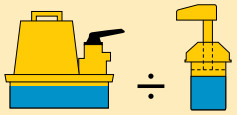
Cylinder Oil Capacity in³ (cm³) = **Cylinder Effective Area** in² (cm²) x **Cylinder Stroke** in (cm)



Usable Oil Capacity

The amount of hydraulic oil in the pump's reservoir which can be used to activate one or more cylinders.

Pump Usable Oil Capacity in³ (cm³) ÷ **Cylinder Oil Capacity** in³ (cm³) = **Total Number of Cylinders**



Cylinder Speed

Pressure applied at any point Cylinder speed is determined by dividing the pump flow rate by the cylinder effective area.

Cylinder Clamp Speed in/min (mm/sec) = **Pump Flow Rate** in³/min (cm³/min) / **Cylinder Effective Area** in² (cm²) x $\frac{10}{60}$

Seals

Various seal types are used in our hydraulic equipment: O-rings, U-cups, Quad-rings and T-rings for static and dynamic applications such as rod-seal, piston-seal and wipers. Buna-N (nitrile rubber) and Polyurethane basic compounds are most frequently used - they offer the best performance and durability for most applications.

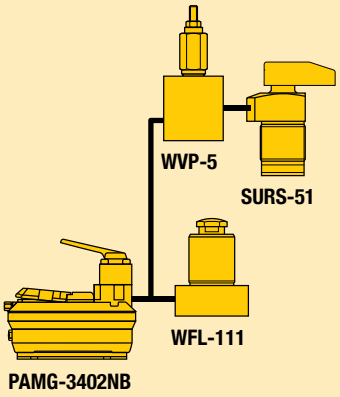
Heat is a crucial factor in seal life. Maximum temperature for good seal life is 150°F (65°C). This is also the maximum temperature of Enerpac hydraulic oil. Above 150°F, the use of Viton and high temperature oil is necessary. Viton has a maximum temperature which is much higher than nitrate or polyurethane. Viton is however an extremely quick wearing material. In many cases Viton seals will have a short working life due to abrasive wear.

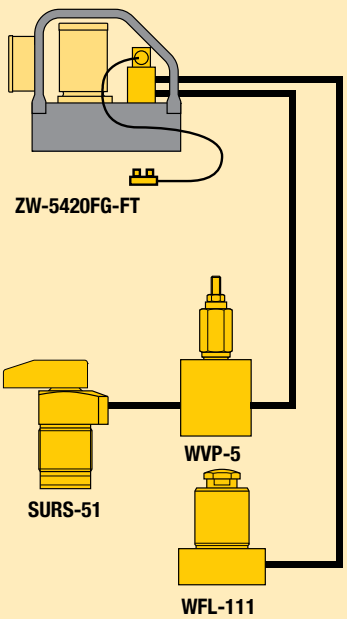
Not all machine tool coolants are compatible with standard Enerpac seals. While most are, there are coolants that can harden or soften seals, which may result in free entry of contamination into the hydraulic cylinder. Using a high water based coolant may cause severe corrosive damage. This will often occur on fixtures where coolant has been allowed to pool for an extended period of time and evaporation has allowed it to concentrate. Drain and clean fixtures after use.

Often Viton seals are an immediate cure for coolant attack on standard Enerpac seals. When using Viton seals in cylinders, seals in the power source must also be replaced by Viton because inevitably some coolant will enter the hydraulic system. Consult the coolant manufacturer to verify compatibility with any seal material. Cutting fluid suppliers will provide an application book on the compatibility of their fluids. If problems arise after previous successful use, or if problems persist, contact Enerpac.

Basic system set-up *The four essential steps*

Building the right workholding system for a specific production tooling requirement is best achieved by observing the following basic steps – three steps deal with equipment selection, one with system connection.





Step 1

Selecting the type of cylinders, determined by shape and size of workpiece and the machining process involved, is the critical factor in any workholding system. For that reason, Enerpac offers an exceptionally broad range of production tooling cylinders – in terms of type, stroke and force rating.

Positioning and push cylinders are designed to position the workpiece and to push-clamp it securely in that position.

Down-holding cylinders are designed to clamp the positioned workpiece firmly to the fixture or worktable. The range of Enerpac swing cylinders and edge-clamps meet virtually any down-holding requirement.

Pull cylinders are used where the workpiece shape or fixture dictates clamping by pull forces, this type of cylinder with hydraulic or spring return can be selected to match particular needs.

Work support cylinders are designed to maintain the workpiece accurately on the prescribed plane throughout the machining operation. These support cylinders preclude both vibration and distortion problems.

Step 2

Select cylinder force and stroke, and choose single- or double-acting operation. The choice of force and stroke is largely dependent on size and shape of the workpiece and machining operation involved. Another factor to be considered is working space or clearance around the job, fixture or worktable.

Where a machining operation requires positive hydraulic return action, double-acting cylinders should be specified. Where spring-return action is sufficient, single-acting cylinders or a combination of the two can be used.

Step 3

Select the power source. The power source for an automatic workholding system can accurately be matched to the requirements. Enerpac pumps span a wide range of sizes and capacities – in compressed air or electric-driven configurations.

Step 4

Connect the system. Getting your workholding system together for operation means connecting the pump to the various control valves and cylinders through a circuit of hoses and/or piping, fittings, gauges and other accessories.

For example, two swing cylinders and work support cylinders working in sequence, powered by an electric-drive hydraulic pump unit would require the following components:

1. ZW Workholding pump
2. GA Gauge adaptor
3. G Pressure gauge
4. H Hoses
5. FZ Fittings
6. SU Swing cylinders
7. WFL Work aupport cylinders
8. WVP-5 Sequence valve

Select all these components from their respective catalog sections.

Swing cylinders and work supports

The combined use of clamping cylinders and work supports in fixturing has become indispensable.

Swing cylinders have become important clamping components for fixturing applications where unrestricted loading and unloading of the workpiece is required. Enerpac offers the most complete, comprehensively featured and compact swing cylinder line.

Work supports are widely used to support critical workpiece areas to prevent them from bending and/or vibrating during the machining process. This minimizes the deflection of the workpiece, improving its quality and assuring a high degree of repeatability.

The combination of swing cylinders and work supports provides substantial time savings and quality improvements in the machine tool industry.

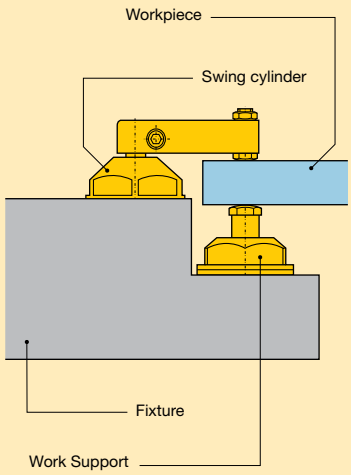


Figure 1
The combined use of clamping cylinders and work supports.

Support forces

When designing a fixture, several products features of swing cylinders and work supports have to be considered. The determination of the necessary support force and the size of the work support is very critical. In principle the work support has to overcome two forces:

- clamping forces
- machining forces (including forces that may be generated by vibrations)

Clamping forces

In practice, as a rule of thumb, the clamping force applied to the work support should not exceed 50% of its capacity at a given operating pressure. For many applications this is sufficient to absorb additional forces like machining forces. This 2 to 1 safety factor may need to be increased to 4 to 1 if extreme vibration or an interrupted cut is used.

The pressure/force diagrams, provided in the product selection pages of this catalog, allow for quick selection of the right combination of swing cylinder and work support.

The recommended ratio between clamping force and support force can be achieved by selecting the right sizes of the clamping components and/or by operating the swing cylinder and the work support with different operating pressures, e.g. the work support will be operated at maximum pressure while the swing cylinder operates at a reduced pressure.

www.enerpac.com

Download the **Swing Clamp Selection Tool.**

The size of the swing cylinder that can be used depends on the required force and length of the clamping arm.

With this tool you can determine, based on above mentioned input and type of clamp, which size of clamp can be used.

Point of contact

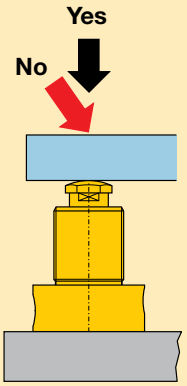


Figure 2
The direction of the clamping force must be axial at the centerline of the work support's plunger for best results in clamping and repeatability of quality.

Side loading of the work support must be avoided in order to ensure reliable and safe function (Figure 2).

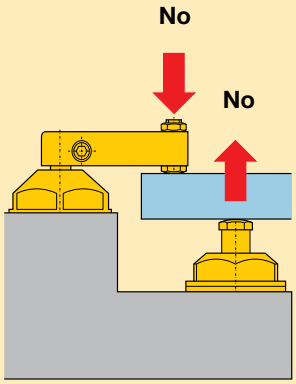


Figure 3
An off-set load will cause bending of the workpiece and uncontrolled deflection (Figure 3).

Hydraulic requirements

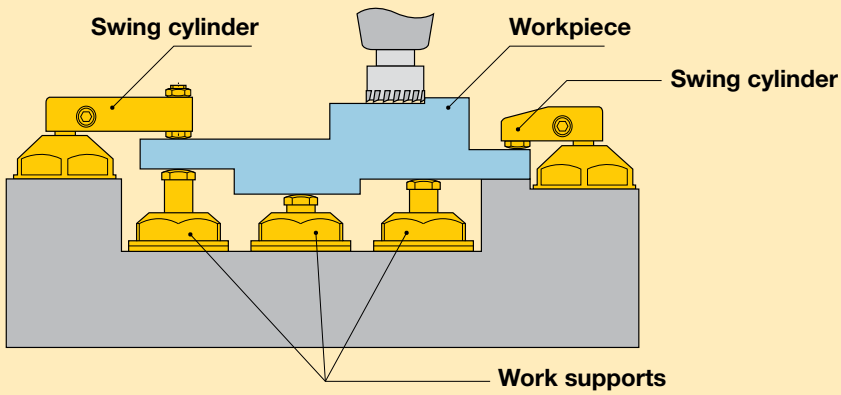


Figure 4
Swing cylinders and hydraulically advancing work supports are very sensitive regarding the oil flow rate applied.

To ensure safe and reliable function of these elements the maximum oil flow rate indicated in the catalog pages and in the instruction literature must not be exceeded. If there is the risk of high oil flow rates it is recommended to use flow control valves to adjust the flow rate.

During the clamping sequence it must be ensured that work supports will be operated only after the workpiece is firmly positioned and held against locators and datums. However, if the cylinder is clamping directly over the work support, the work support should be brought to full pressure before the cylinders clamp. This can be done by using a sequence valve.

Hydraulic requirements (continued)

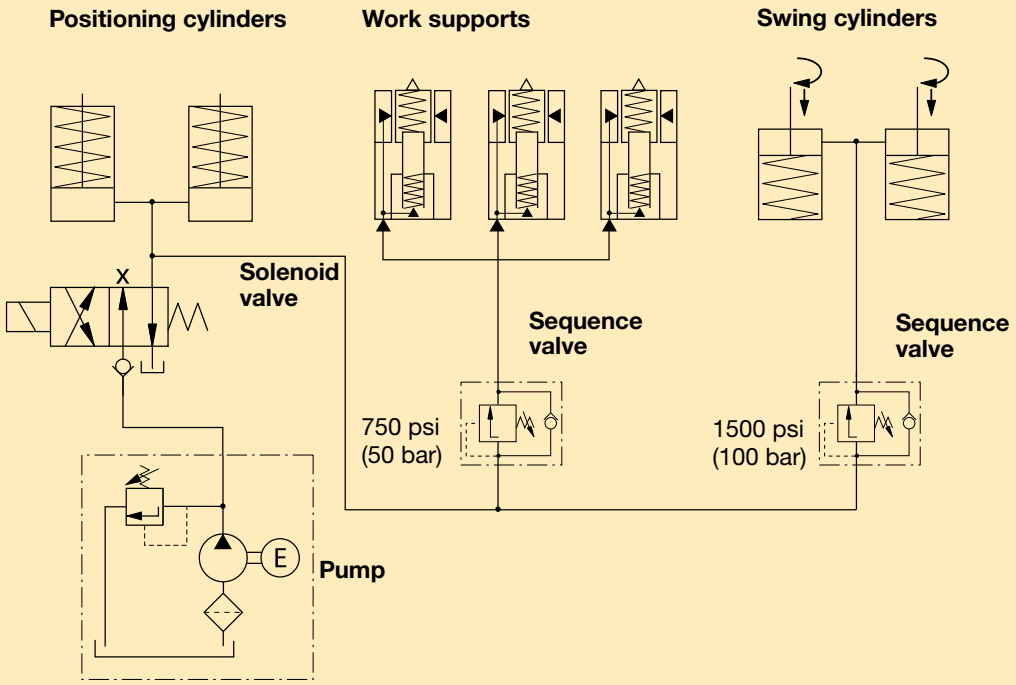


Figure 5
For overhanging areas of the workpiece which have to be supported, the recommended sequence should be as follows (Figure 5):

1. Positioning of the workpiece
2. Actuate work supports
3. Clamp the overhanging area against work support.

The hydraulic sequence can be controlled either by independently controlled hydraulic circuits (Figure 6) or by sequence valves (Figure 7).

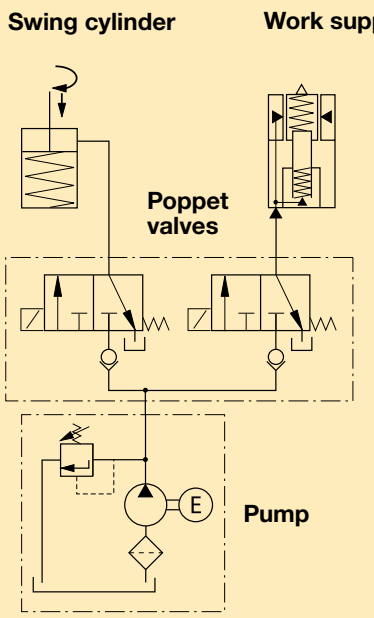


Figure 6

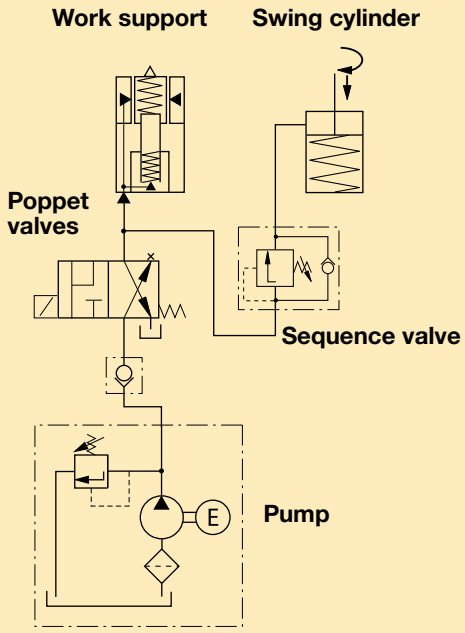


Figure 7

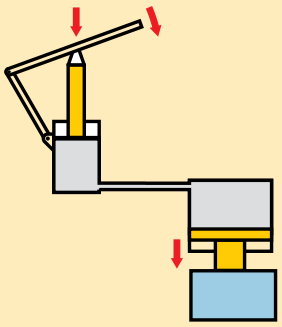


Figure 1
Operating principle of a hydraulic clamping device

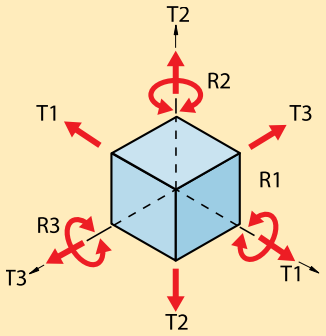


Figure 2
Three-dimensional body

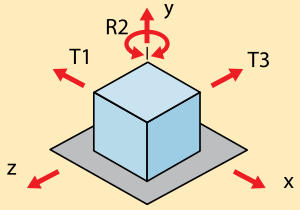


Figure 3a
Three degrees of freedom

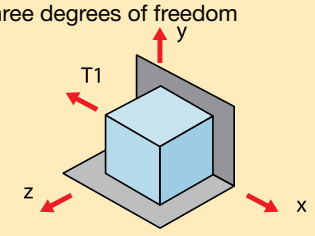


Figure 3b
One degree of freedom

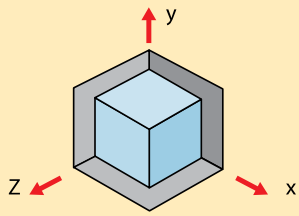


Figure 3c
Zero degree of freedom

1 Basic principles

1.1 A simple hydraulic clamping mechanism (Figure 1).

1.2 Terms and definitions

1.2.1 Clamping Plunger
A device that applies clamping force to the workpiece.

1.2.2 Workpiece
The part or material that is to be held in place.

1.2.3 Pressure Piston
A device used to apply pressure to a hydraulic medium.

1.2.4 Hydraulic Medium
A fluid used to transmit the pressure created by applying a force to the pressure piston

1.3 Hydraulic clamping process

The hydraulic clamping process consists of properly applying the forces created by a hydraulic clamping system to secure a workpiece. A hydraulic clamping system consists of the components illustrated in Figure 1, which shows the basic arrangement and operating principle of the use of hydraulic media.

Any such process using hydraulic fluids for clamping purposes may be referred to as a hydraulic clamping system. The operating pressure provided by hydraulic fluids in clamping systems can reach a maximum of 5000 psi (350 bar), allowing the application of considerable clamping forces even when using compact clamping cylinders.

When properly designed and controlled, the hydraulic clamping mechanism will prevent the workpiece from moving (sliding, twisting, etc.) when machining or other forces are applied, yet will not cause an unexpected permanent distortion to occur in the workpiece.

2 Assembly of hydraulic clamping devices

2.1 Locating, clamping, and supporting workpieces

2.1.1 Locating a Body

The term “locating” refers to the process of positioning the workpiece inside the clamping device, and holding it in position for the necessary machining. Only workpieces that are correctly held can be consistently machined within specified tolerances.

2.1.2 Limiting the degrees of freedom

The process of locating and holding a workpiece may be referred to as “limiting the degrees of freedom.” Any motion of a workpiece in any possible direction is considered to represent one degree of freedom.

A three-dimensional workpiece therefore possesses six degrees of freedom, as shown in Figure 2. These six degrees of freedom consist of the translational motions “T” in x, y, and z direction, and the rotational motions “R” turning about the x, y, and z axes.

The degrees of freedom that a given workpiece or body possesses may be reduced by introducing reference planes that pass through any two axes.

For example, the plane in Figure 3a limits movement to travel in x and z directions and rotation about the y-axis. By defining this fixed plane, the workpiece can thus be limited or constrained to three degrees of freedom.

Another two degrees of freedom may be constrained by introducing a second reference plane, as shown in Figure 3b. This reference plane limits movement to translational motion in the x direction.

Constraining the last degree of freedom can be accomplished by defining a third reference plane as shown in Figure 3c.

2.1.3 Locating a workpiece

The process of locating and holding a necessarily require the elimination of movement in all six degrees of freedom, the following three locating techniques are used in actual practice.

Figure 4a: Semi-constrained Workpiece. The workpiece is held in one plane only (elimination of three degrees of freedom).

Figure 4b: Constrained Workpiece. The workpiece is held by two planes (elimination of five degrees of freedom).

Figure 4c: Fully-constrained Workpiece. The workpiece is held by three planes (elimination of six degrees of freedom).

2.1.4 Avoiding over-location

a. Workpiece with locating planes
b. Incorrectly located workpiece
c. Correctly located workpiece

Over-location of the workpiece occurs when there is more than one locating plane or point for any given degree of freedom.

To prevent bending the b-c rib while machining the piece, a third reference plane (3) is introduced. Placing a workpiece (6) inside the clamping device (4) causes over-location. Since the distance between the locating planes (1) and (3) is constant in this device, the dimension c differs between individual workpieces. This over-location therefore gives rise to machining error.

Figure 5c: Shows how to locate a workpiece correctly. To avoid tilting the workpiece, the torque “M” transferred from the workpiece (5) to the body to be machined (6) must be balanced by an appropriate counter-torque. This counter-torque is created by the clamping force “F.”

Over-location may also occur if a workpiece (Figure 5) is limited by too many locating points. The introduction of more than three locating points along the bearing surface, or more than two points in the guide plane, or more than one point in the supporting plane may lead to undesirable workpiece motion, and thus adversely affect the precision of the resulting product. Any additional support points must be adjustable.

If the workpiece to be machined must be supported to avoid deflection, then all other bearing points must be defined as variables and must be determined in relationship to the workpiece being machined.

The location process is subject to a number of design guidelines, but exceptions are possible.

- Always arrange the location points according to the pre-machined condition of the workpiece. Previously machined points have priority as desirable locating points.
- The locating points on the locating plane should be as far away from each other as possible.
- Arrange the clamping points such that the defined position is retained during clamping.
- The locating points should be in line with the clamping points to shorten the force vectors inside the workpiece. Three, two, or even one clamping point may be used to clamp a workpiece against the locating plane.
- Precision surfaces should not be held on a continuous surface, so that an “infinite” number of contact points can be avoided.

3 Clamping

The term “clamping” refers to the secure fastening of an already positioned workpiece in a clamping device for machining purposes. Locating and clamping may be viewed as a combined operation.

Clamping is invariably associated with force transmission through the device. The force vector should, as far as possible, describe a straight line from the application point of the clamping force through the workpiece to the bearing points.

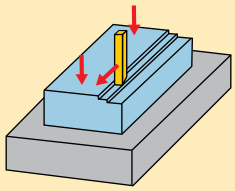


Figure 4a
Semi-constrained Workpiece

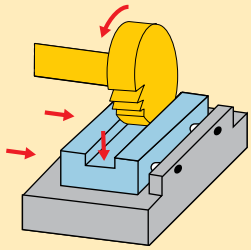


Figure 4b
Constrained Workpiece

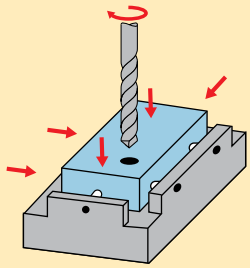


Figure 4c
Fully-constrained Workpiece

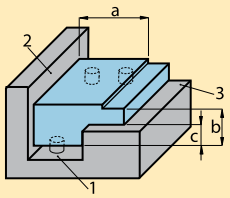


Figure 5a
Workpiece with locating planes

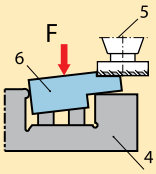


Figure 5b
Inorrectly located workpiece

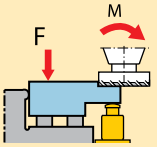


Figure 5c
Correctly located workpiece

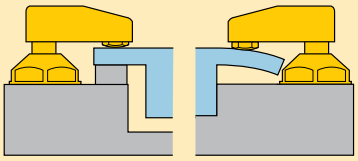


Figure 6
Design guidelines for clamping

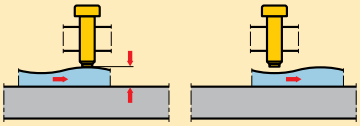


Figure 7
Mechanical clamping

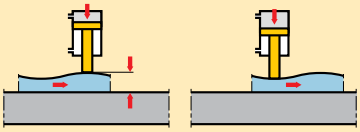


Figure 8
Hydraulic clamping

As with clamping, locating is subject to a number of design guidelines, although exceptions are possible:

- Keep the clamping force vector away from the critical tolerance zones on the workpiece.
- Workpiece deformation and marking due to clamping forces should be avoided or minimized.
- The clamping points on the workpiece should be selected so that the piece can be machined without reclamping or, if this is not feasible, with a minimum of reclamping.
- The required clamping forces should be approximated by rough estimations.
- The clamping dimensions of the workpiece may change due to thermal expansion and vibration resulting from machining.
- The workpiece should only be exposed to a clamping force if it is appropriately supported by a solid bearing point, as illustrated in Figure 6.

The dimensions of clamped workpieces may change due to vibrations and the effects of thermal expansion. Two types of clamping may compensate for these changes.

- Mechanical Clamping
- Hydraulic Clamping

The illustration in Figure 7 (mechanical clamping) demonstrates that tension is relieved as the dimensions of the workpiece in the clamping area change.

In hydraulic clamping, the clamping elements gripping the workpiece adjust to changes while maintaining a constant clamping force. This is illustrated in Figure 8, where the workpiece is elongated due to temperature increases during machining.

Mechanical clamping is accomplished by using the following mechanical clamping elements:

- Clamping Bars
- Clamping Springs
- Clamping Nuts
- Clamping Bolts (Figure 7)

Hydraulic clamping is achieved by:

- Elastometric media
- Clamping with air (pneumatic clamping)
- Clamping with liquids (hydraulic clamping)

Mechanical clamping elements are usually used for simple clamping devices. However, mechanical clamping elements may be converted to hydraulic ones by inserting cylinders between the clamping element and the workpiece. In addition, mechanical elements may also be combined with hydraulic clamping elements.

Clamping may be subject to errors that cause deformation of the clamped workpiece. Since such deformations must not affect the function of the workpiece, all conceivable locating and supporting techniques, as well as the best possible directed transmission of the clamping force through the workpiece, should be considered.

It is recommended that clamping forces be estimated to prevent excessively high clamping forces and possible deformation of the workpiece. Deformation of the workpiece may also be avoided by selecting a suitable shape (for example, a sphere) for the clamping points and the locating points.

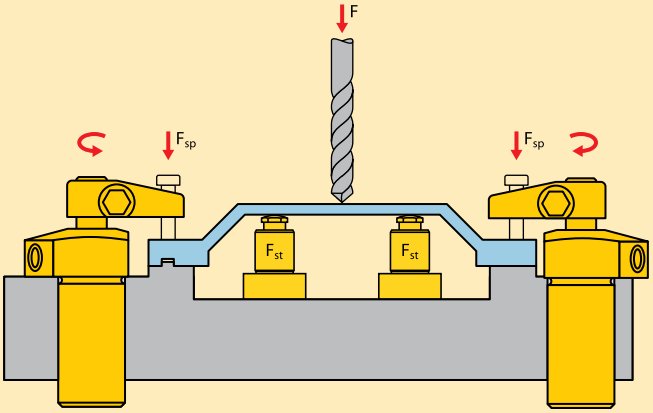


Figure 9
Supported workpieces.

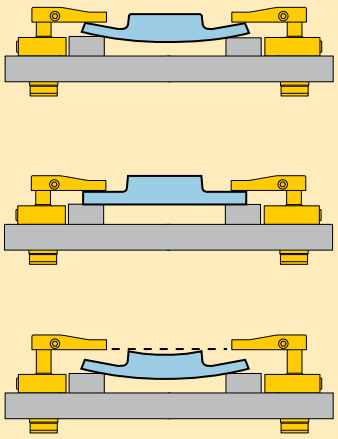


Figure 10a
Deformation caused by conventional clamping

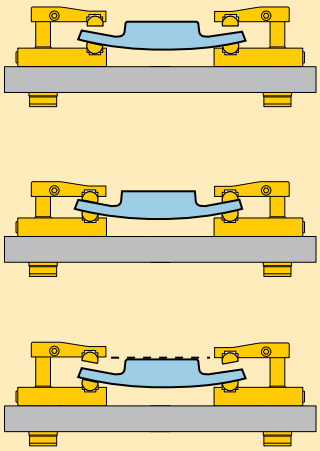


Figure 10b
Eliminate deformation using spherical ball supports

4 Supporting the workpiece

4.1 Supported workpiece

The workpiece requires support to ensure functional force transmission between the tool, the workpiece, and the clamping device, and/or to protect the workpiece from deformation (such as deflection at points with a thin cross-section) due to machining forces, gravitational forces, and clamping forces. Workpiece support also acts to eliminate the resulting machining errors (Figure 9).

In addition, surface quality may be improved and the service life of the tool prolonged with the use of an optimum supporting mechanism. The three-dimensional position of a workpiece, however, should not be defined by its support. It is preceded sequentially by the locating process and also has a lower priority.

4.2 Supporting options for bent workpieces

a. Unclamped workpiece
b. Clamped workpiece
c. Machined workpiece

A workpiece is considered to be supported even if it must be supported by frequently mobile and variable elements surpassing the theoretical maximum number of locating points. An example of this would be an unstable workpiece that easily vibrates.

When a deformed workpiece must be held and clamped in all three planes without altering its shape, it is possible to use a technique involving self-adjusting spherical surfaces. In this case the bearing surfaces, the close-tolerance bolts, the limit stops, and the vertically adjustable supporting and clamping elements must be equipped with spherical surfaces.

The illustrations in Figure 10 illustrate two different clamping methods. It shows deformation of a workpiece caused by conventional clamping (Figure 10a). As a result of this deformation, the surface area of the workpiece exhibits a greater degree of deformation when unclamped.

This deformation, which is convex in shape, may be attributed to the fact that the workpiece assumes its original, deformed shape (c), as soon as the clamping pressure is released.

The clamping points illustrated in Figure 10b are spherically shaped, and can therefore largely adapt to the workpiece curvatures (b). The machined surface is therefore flat, and the workpiece is only exposed to possible internal stresses that may be released by machining.

4.3 Determination of the clamping force

It is important to ensure that a workpiece that is clamped inside a device is not moved from its position by the clamping force and the subsequent action of the cutting force. This risk of movement may be minimized by applying the clamping force to the solid bearing surfaces of the device (Figure 11).

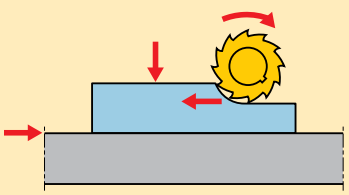
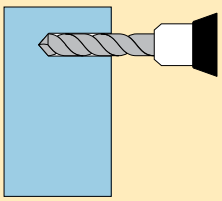
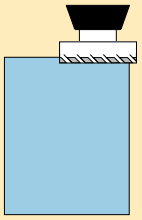


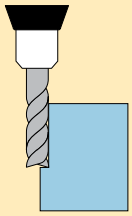
Figure 11
Approximation of the clamping force



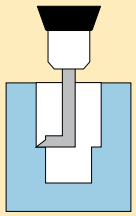
Drilling



Face milling



End mill



Boring

Introduction

This introduction will help you use information provided by tool manufacturers in the application of their tools. Estimating cutting forces being transferred into the workpiece is just one tool to use in a competitive workholding environment.

The information presented here is only to be a guideline and not the final decision. Use this information with a cutting tool brochure you get from your cutting tool supplier as an aid in determining your cutting forces. Much of the calculations presented here are readily available from many sources. Your cutting supplier may even have a slide chart you can obtain to do equations for you.

The operations described here include boring, drilling, end milling and face milling.

Drilling involves using a multi-fluted tool with a helix spiral. The tool is driven in as it is rotated to create a round hole.

End Milling uses a multi-fluted rotary tool with or without removable (inserts) teeth to remove material along the edge of the workpiece. The cut is usually very shallow and the depth is many times the thickness of the cut.

Face Milling involves a very shallow depth, but a very wide cut. Cutters can range up 12 inches (300 mm) or more in diameter and can have many replaceable teeth (inserts).

These examples are only a very small sample of operations that can use hydraulic workholding.

Cutting force determinations

These cutting force examples involve face milling. The largest use of hydraulic workholding is by far for some sort of milling operations.

1 Imperial system

Cutting Force (Pounds) = Spindle Horsepower x 26400 (Horsepower to foot pounds per minute at 80% efficiency)/ Cutting Speed (In tool surface feet per minute) Spindle Horsepower = Unit Power (Horsepower per cubic inches of material removed per minute) x Material removal rate (Cubic Inches per Minute)

Material removal rate (Cubic inches per minute) = Width of the cut (Inches) x Depth of the Cut (Inches) x Feed per cutter tooth (Inches) x Number of cutter teeth x Spindle RPM

Example
An 8-inch diameter cutter with 10 teeth (inserts) is machining low silicon aluminum at 3000 SFM (surface feet per minute).

First, you must convert surface feet/ minute into tool RPM/Solving
Tool RPM= SFM

Diameter (Inch) x .2618 = 1432 Tool RPM

Now you can determine your material removal rate. An independent tool catalog lists a feed per tooth of 0.008" maximum at 3000 SFM at cut depth of 0.1".

This gives 8" (diameter cutter) x 0.100" (cut depth) x 0.008" (feed per tooth) x 10 (number of teeth) x 1432 (spindle RPM)= 91.6 cubic inches per minute material removal rate.

Next, spindle horsepower is found using unit HP from the table Spindle Horsepower = 91.6 x 0.4 (Unit Horsepower for Aluminum with a dull tool) = 36.6 HP.

Note this Horsepower is for fixture design and not for machine tool horsepower requirements.

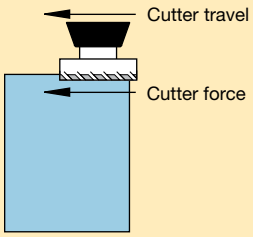
For example a true 40 HP machine can remove aluminum well over 200 cubic inches per minute.

Using the original formula:

36.6 hp x 26,400/3000 SFM = 322 lbs. 3000 SFM of force being transmitted into the work.

Force is transmitted in the same direction as the cutter movement. In other words, if the cutter moves right to left in the diagram below, the cutter force is transmitted from right to left.

Using a safety factor of 2 for rigid clamping gives 644 pounds in line parallel to the line force and 483 pounds using an elastic medium such as hydraulics with a safety factor of 1.5. Note this force does not take into account any sort of friction factors if you plan on relying on friction force between a swing cylinder and the workpiece.



For example:
The coefficient of friction for lubricated aluminum is .12 (flooded with coolant) this same 483 pounds of force becomes 483/.12 = 4025 pounds. This uses clamp force only and does not take into account any direct forces that may be developed by the cylinders that located the workpiece against fixed locators.

$$\text{Cutting Force}^{[1]} = \frac{\text{Spindle Hp x 26406}^{[2]}}{\text{Cutting Speed}^{[3]}}$$

[1] Cutting force in Pounds

[2] Spindle Horsepower to foot-pounds at 80% efficiency

[3] Cutting tool surface feet per minute

$$\text{MRR}^{[1]} = \text{W x D x F x N x RPM}^{[2]}$$

[1] Material Removal Rate (in^3/min)

[2] W = Width of cut (in)
D = Depth of cut (in)
F = Feed per tooth (in)
N = Number of cutter teeth
RPM = Spindle speed

$$\text{Tool RPM} = \frac{\text{SFM}^{[1]}}{\text{Diameter x 0.2618}}$$

[1] SFM = Surface Feet per Minute

Unit Power for dull tools [imperial system]

Material	Hardness	Unit Power hp/in^3/min		
		Turning	Drilling	Milling
		HSS & Carbide Tools	HSS Drills	HSS & Carbide Tools
STEELS	85-200 Bhn	1.4	1.3	1.4
Plain carbon	35-40 Rc	1.7	1.7	1.9
Alloy steels	40-50 Rc	1.9	2.1	2.2
Tool steels	50-55 Rc	2.5	2.6	2.6
	55-58 Rc	4.2	3.2	3.2
CAST IRONS	110-190 Bhn	0.9	1.2	0.8
Gray, ductile	190-320 Bhn	1.7	2.0	1.4
and malleable				
STAINLESS STEELS	135-275 Bhn	1.6	1.4	1.7
	30-45 Rc	1.7	1.5	1.9
TITANIUM	250-375 Bhn	1.5	1.4	1.4
NICKEL ALLOYS	80-360 Bhn	2.5	2.2	2.4
ALUMINUM ALLOYS	30-150 Bhn	0.3	0.2	0.4
MAGNESIUM ALLOYS	40-90 Bhn	0.3	0.2	0.2
COPPER ALLOYS	10-80 Rb	0.8	0.6	0.8
	80-100 Rb	1.2	1.0	1.2

Cutting technology

$$\text{Cutting Force}^{[1]} = \frac{\text{Spindle kW} \times 48000^{[2]}}{\text{Cutting Speed}^{[3]}}$$

[1] Cutting force (N)

[2] Spindle power (kW) required at 80% efficiency

[3] Cutting tool surface speed (m/min)

$$\text{MRR}^{[1]} = \frac{\text{W} \times \text{D} \times \text{F} \times \text{N} \times \text{RPM}^{[2]}}{1000}$$

[1] Material Removal Rate (cm^3/min)

[2] W = Width of cut (mm)
D = Depth of cut (mm)
F = Feed per tooth (mm)
N = Number of teeth
RPM = Spindle speed

$$\text{Tool RPM} = \frac{\text{MPM} \times 1000^{[1]}}{\pi \times \text{Tool diameter}^{[2]}}$$

[1] MPM = Surface speed m/min

[2] Tool diameter in millimeters

Metric System
Cutting Force (Newtons) = Spindle Power (kW) x 48000 (80% efficiency) / Cutting Speed (Meters per minute).

Spindle Power = Unit Power (kilowatts per cubic centimeters of material remove per minute) x Material removal rate (cubic centimeters per minute).

Material removal rate (Cubic centimeters per minute) = Width of cut (mm) x depth of cut (mm) x feed per tooth (mm) x number of teeth x spindle RPM/1000.

Example:
A 200 mm cutter with 10 teeth is machining low silicon aluminum at 1000 MPM (meters per minute).

Solving Tool RPM = MPM x 1000 Diameter (mm) x p (= 1592 Tool RPM)

The same tool catalog lists a feed per tooth of 0.2 mm at 1000 MPM and a cutting depth of 2.5 mm. This gives an 200 mm cutter x 2.5 mm depth x 0.2 mm feed x 10 teeth x 1592 Tool RPM/1000 = 1592 cm^3/min.

Spindle power = 1592 x 0.018 = 28.7 kW
This too is power from a fixture design standpoint; the actual operation will use less power than indicated here.

Using the original formula transposed is: Cutting Force 1378 (Newtons) = 28.7 (kW) x 48000 (80% efficiency) / 1000 (MPM cutting speed).

Multiply by a safety factor of 2 for rigid clamping and by 1.5 for elastic clamping (hydraulic).

This calculation does not take into account coefficients of friction when using clamp cylinders. For example, if the aluminum has a coefficient of .12 (flooded with coolant), the clamping force becomes 1378/.12 = 11483 Newtons of force. This calculation does not take into account forces being generated by the fixture positioning cylinders.

Use these numbers and set up your hydraulic system to run at about 50 to 75% of its rated pressure. This leaves some reserve for a later date when the process is optimized and you need more holding/ clampforce for higher speeds and feeds. If you design to the maximum now, you have nothing in reserve.

Unit Power for dull tools [metric system]

Material	Hardness	TURNING P1 HSS AND CARBIDE TOOLS feed .12 - .50 mm/r	DRILLING P HSS DRILLS feed .05 - .20 mm/r	MILLING P d HSS AND CARBIDE TOOLS feed .12 - .30 mm/r
STEELS, WROUGHT				
AND CAST	85-200 Bhn	0.064	0.059	0.064
Plain Carbon	35-40 Rc	.077	.077	.086
Alloy Steels	40-50 Rc	.086	.096	.100
Tool Steels	50-55 Rc	.114	.118	.118
	55-58 Rc	.191	.146	.146
CAST IRONS	110-190 Bhn	.41	.055	.036
Gray, ductile and malleable	190-320 Bhn	.077	.091	.064
STAINLESS STEELS,				
WROUGHT AND CAST	135-275 Bhn	.073	.064	.077
Ferritic, austenitic and				
martensitic 30-45 Rc	.077	.068	.086	
TITANIUM	250-375 Bhn	.068	.064	.064
NICKEL ALLOYS	80-360 Bhn	.114	.100	.109
ALUMINUM ALLOYS	30-150	.014	.009	.018
MAGNESIUM ALLOYS	40-90	.009	.009	.009
COPPER ALLOYS	10-80 R_B	.036	.027	.036
	80-100 R_B	.055	.046	.055

Key to measurements

All capacities and measurements in the catalog are expressed in uniform values. The conversion chart provides helpful information for their translation into equivalent systems.

Pressure:

1 psi	= .069 bar
1 bar	= 14.50 psi
	= 10 N/cm^2
1 MPa	= 145 psi

Volume:

1 in^3	= 16.387 cm^3
1 cm^3	= .061 in^3
1 liter	= 61.02 in^3
	= .264 gal
1 US gal	= 3,785 cm^3
	= 3.785 l
	= 231 in^3

Weight:

1 pound (lb)	= .4536 kg
1 kg	= 2.205 lbs
1 metric ton	= 2205 lbs
	= 1000 kg
1 ton (short)	= 2000 lbs
	= 907.18 kg

Other measurements:

1 in	= 25.4 mm
1 mm	= .039 in
1 in^2	= 6.452 cm^2
1 cm^2	= .155 in^2
1 hp	= .746 kW
1 kW	= 1.340 hp
1 Nm	= .738 Ft.lbs
1 Ft.lbs	= 1.356 Nm
1 kN	= 224.82 lbs
1 lb	= 4.448 N

Temperature:

To Convert °C to °F:
T °F = (T °C x 1.8) + 32
To Convert °F to °C:
T °C = (T °F – 32) ÷ 1.8

Imperial to metric

Inches	Decimal	Millimeters
1/16	.0625	1.59
1/8	.125	3.18
3/16	.187	4.76
1/4	.250	6.35
5/16	.312	7.94
3/8	.375	9.53
7/16	.437	11.11
1/2	.500	12.70
9/16	.562	14.29
5/8	.625	15.88
11/16	.687	17.46
3/4	.750	19.05
13/16	.812	20.64
7/8	.875	22.23
15/16	.937	23.81
1	1.000	25.40

Metric to imperial

Millimeters	Inches
1	.039
2	.078
3	.118
4	.157
5	.197
6	.236
7	.275
8	.315
9	.354
10	.394
11	.433
12	.472
13	.512

Millimeters	Inches
14	.551
15	.591
16	.630
17	.670
18	.709
19	.748
20	.787
21	.827
22	.866
23	.906
24	.945
25	.983

Best practices in hydraulic system design

The following information consists of recommendations, advice and general rules regarding the design of hydraulic workholding systems. These tips apply to just about any system, and are a good starting point if you have questions about what products to use and how to apply them properly.

General design

Double-acting cylinders should always be used in applications where cycle time is critical. While the cylinders are designed with strong return springs, they may not consistently overcome the effects of long runs of tubing, orifices, and other restrictions. Double-acting cylinders help eliminate these effects.

Many hydraulic pumps are rated for substantial flow rates (10 gpm or more) that are far beyond the requirements of a hydraulic workholding system. While these pumps can be used, it is not recommended in general practice. Workholding cylinders are typically very small in comparison to the types of cylinders that these pumps were designed to operate. You will spend a great deal of time and money reducing the flow through the use of valving and still may not have an ideal system. Consider a separate hydraulic pump rated for less flow whenever possible.

Spool valves are very common and inexpensive, but also have their share of issues regarding use in hydraulic workholding systems. Spool valves are designed for use at much higher flow rates than those typically seen in workholding circuits. In fact the acceptable internal leakage in these valves is typically equal to the total amount of flow required for a small workholding circuit. And, the leakage will result in improper function and possible damage to many pumps designed for workholding systems.

Breather vents on cylinders are often overlooked. When you put oil into a single-acting cylinder and it begins to advance, the opposite side of the cylinder is filled with air. This air has to go somewhere. The breather vent provides this path. In turn, when the cylinder is retracting, and oil is leaving the cylinder, a vacuum is created and air needs to re-fill that opposite side of the cylinder. If the breather vent is located in an area that is subject to contamination from coolant, and chips, these items will also get pulled into the cylinder. Make sure the breather vent is plumbed to a clean location at all times.

Swing cylinders

The swing cylinders turn on a mechanical concept of a ball or a pin riding in a hardened groove. Trying to turn this too fast with a large heavy arm will result in enormous pressure on the ball or the pin, causing damage and eventually failure. A large arm also increases the amount of side load introduced into the cylinder. As the length of the arm increases, the allowable clamp load has to decrease accordingly. Follow the one-second rule: it should take at least one full second for the clamp arm to rotate and engage the part. Anything faster can result in damage.

Work supports

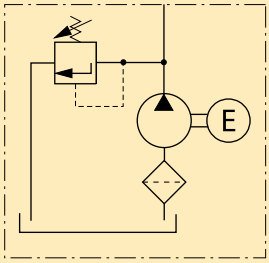
Work supports are rated based upon a somewhat constant load. Sharp vibrations from an interrupted cut or a large impact load (such as dropping a part on the fixture) will cause the work support to slip. Because of the design, once the work support has been subjected to a high impact load, it may no longer function. Be aware of this fact and limit impact loading wherever possible.

Manifold mounting

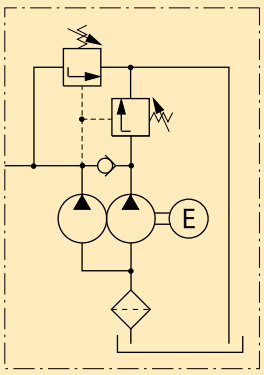
Manifold mounting of cylinders significantly decreases the amount of space required on a fixture. It also makes installation and service much simpler. Be sure to clean and de-burr all passages in the fixture manifold. Burrs can break loose over time and be ingested into the hydraulic cylinders, causing severe damage. If you have a long line of cylinders all in the same manifold, route the passages from the center out and use large diameters for the main feed line. The use of small passages everywhere in the manifold will cause drastic back-pressures on single- acting circuits.

Be sure to include a passage for the breather vents where necessary. This passage should be routed to a large open area, not an enclosed cavity. Eventually, an enclosed cavity may fill up with chips and coolant and begin to work into the cylinders.

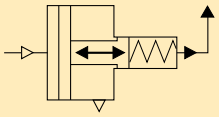
Power sources



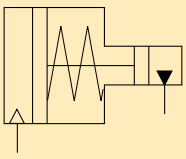
Single-stage electric pump
Example
ZW4010NB-S



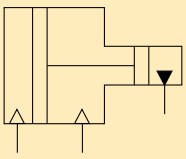
Two-stage electric pump
Example
ZW5020NG



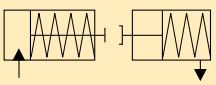
Reciprocating air pump
Example
PA-136



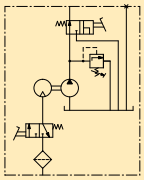
Single-acting booster
Example
B-3006



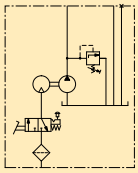
Double-acting booster
Example
AHB-34



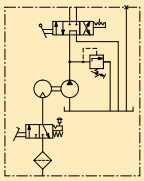
Activator wand and booster
Example
B-171
RA-1061



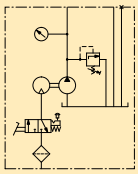
Turbo air pump
Example
PATG-3102NB



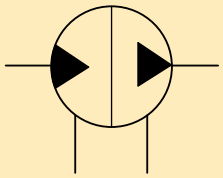
Turbo air pump
Example
PASG-3002SB



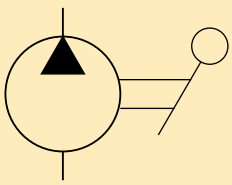
Turbo air pump
Example
PAMG-3402NB



Turbo air pump
Example
PACG-3002NB



Hydraulic intensifier
Example
PID-321

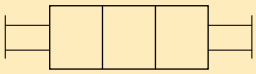


Hand pump
Example
P-142

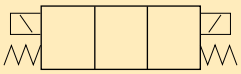
Valves

2-position manual

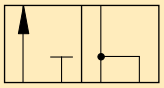
2-position solenoid



3-position manual

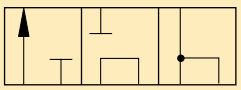


3-position solenoid



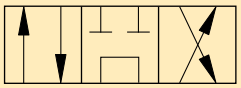
3-way, 2-position, Normally open

Series	Example
V	**VM-2**



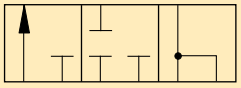
3-way, 3-position, Tandem center

Series	Example
V	**VM-3, VC-3**
VE	**VEF-15000D**



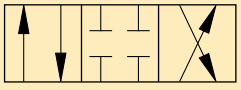
4-way, 3-position, Tandem center

Series	Example
V	**VM-4, VC-4**
VE	**VEC-15000D**



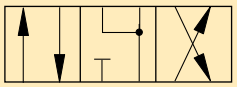
3-way, 3-position, Closed center

Series	Example
V	**VC-15**
VE	**VEG-15000A**



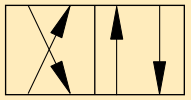
4-way, 3-position, Closed center

Series	Example
V	**VC-20**
VE	**VEB-15000A**



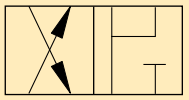
4-way, 3-position, Float center

Series	Example
VE	**VED-15000A**
VMM	**VMMD-001**



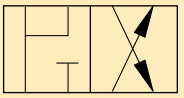
4-way, 2-position, Crossover offset

Series	Example
VE	**VEE-15000A**



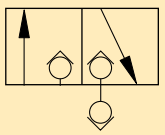
4-way, 2-position, Normally open

Series	Example
VSS/VAS	**VSS-1410D**



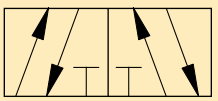
4-way, 2-position, Normally closed

Series	Example
VST/VAT	**VST-1410D**



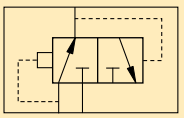
3-way, 2-position, Normally closed

Series	Example
VP	**VP-31**



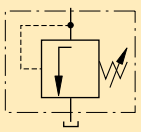
4-way, 2-position, Air valve

Series	Example
VA	**VA-42**
	VAS-42



Rapid air exhaust valve

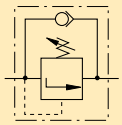
Series	Example
VR	**VR-3**



Pressure relief valve

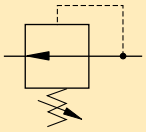
Series	Example
V	**V-152**

Valves



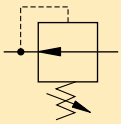
Sequence valve

Series	Example
MVP	**MVPM-5**
WVP	**WVP-5**



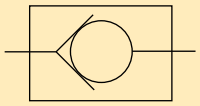
Pressure limiting valve

Series	Example
PLV	**PLV-40013B**



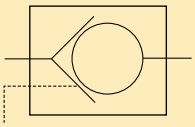
Pressure reducing valve

Series	Example
PRV	**PRV-3**



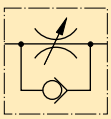
Check valve

Series	Example
V	**V-17**



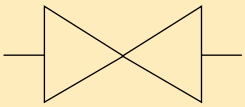
Check valve, Pilot operated

Series	Example
MV	**MV-72**
V	**V-72**



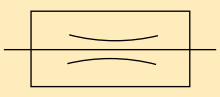
Flow control valve, Free flow check

Series	Example
VFC	**VFC-1**



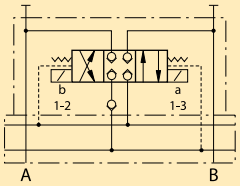
Shut-off valve

Series	Example
V	**V-12**



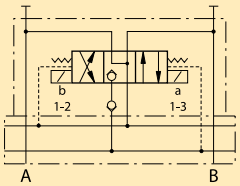
Auto-damper valve

Series	Example
GS, V	**GS-2, V-10**



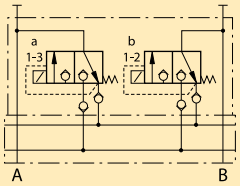
4-way, 3-position, Closed center

Example
VP-11, -12



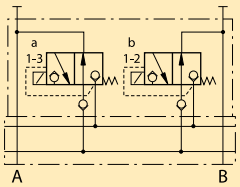
4-way, 3-position, Float center

Example
VP-21, -22



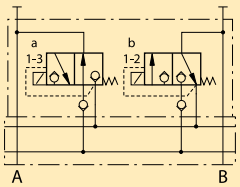
3-way, 2-position, Normally closed

Example
VP-31, -32



3-way, 2-position, Normally open

Example
VP-41, -42

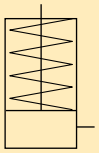


3-way, 2-position,
one port normally open and
one port normally closed

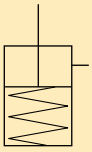
Example
VP-51, -52

Hydraulic symbols *Most common system elements*

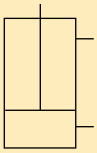
Cylinders



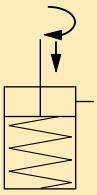
Single-acting cylinder, Push
Example
CSB-18252
CST-5131
CSM-18131



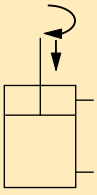
Single-acting cylinder, Pull
Example
PLSS-51
PTSS-51
PUSS-51



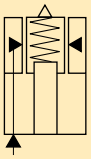
Double-acting cylinder
Example
CDB-18252
RD-96
CDT-18131



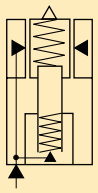
Single-acting swing cylinder
Example
SLRS-92
STRS-92
SURS-92



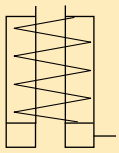
Double-acting swing cylinder
Example
SLRD-92
STRD-92
SURD-92



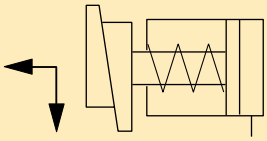
Spring advance work support
Example
WSL-111



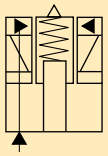
Fluid advance work support
Example
WFL-111



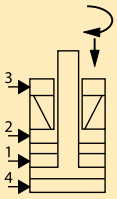
Single-acting hollow plunger cylinder
Example
CY-21295
HCS-80
RWH-202



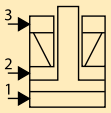
Pull down clamp
Example
ECH-202



Collet-Lok® work support
Example
WPFS-200
WPTS-200

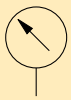


Collet-Lok® swing cylinder
Example
WPFR-100
WPTR-100

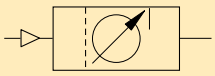


Collet-Lock® push cylinder
Example
WPFS-100
WPTS-100

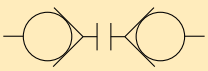
System components



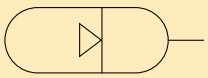
Pressure gauges
Example
DGR-1
G-2534R



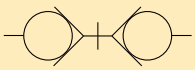
Air regulator
Example
RFL-102



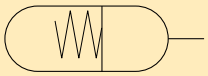
Hydraulic couplers, Uncoupled
Example
AH-650
AH-652
AH-654



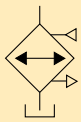
Accumulator, Gas charged
Example
ACL-201
WA-502



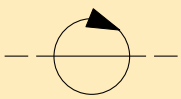
Hydraulic couplers, Coupled
Example
AH-650
AH-652
AH-654



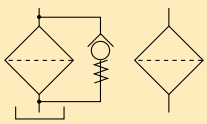
Accumulator, Spring loaded
Example
ACM-1



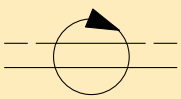
Heat exchanger
Example
ZHE-1



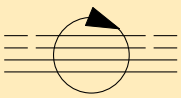
Rotary coupler, Single passage
Example
CR-111



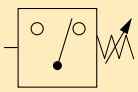
Return line filter,
high pressure filter, in line
Example
PFK-25
FL-2101



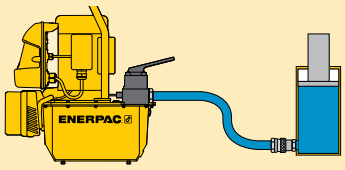
Rotary coupler, Double passage
Example
CRV-221



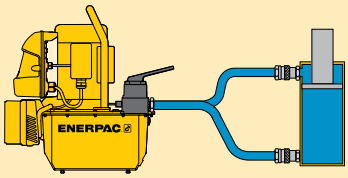
Rotary coupler, Four passage
Example
CRV-441



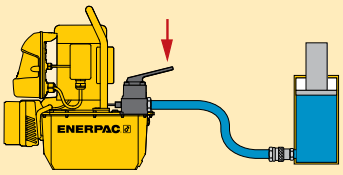
Pressure switch
Example
IC-50



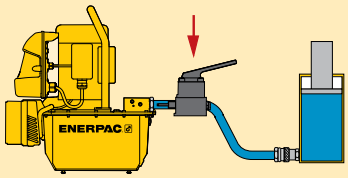
3-way valve used with single-acting cylinder



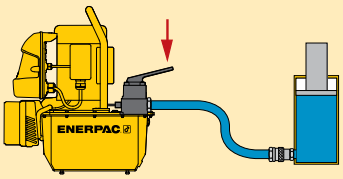
4-way valve used with double-acting cylinder



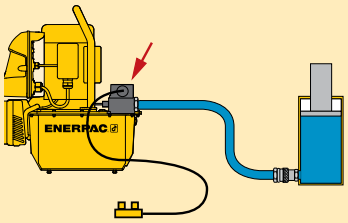
Valves can be **pump mounted**



Valves can be **remote mounted**



Valves can be **manually operated**



Valves can be **solenoid operated**

Valve types and functions

Hydraulic valves can be divided into 3 groups:

1. Directional Control
2. Pressure Control
3. Flow Control

1 Directional control valves

Ways – the (oil) ports on a valve

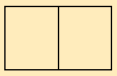
A 3-way valve has 3 ports: pressure (P), tank (T), and cylinder (A).

A 4-way valve has 4 ports: pressure (P), tank (T), advance (A) and retract (B).

Single-acting cylinders require at least a 3-way valve, and can, under certain instances, be operated with a 4-way valve.

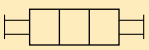
Double-acting cylinders require a 4-way valve, providing control of the flow to each cylinder port.

Positions – the number of control points a valve can provide

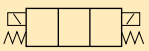


A 2-position valve has the ability to control only the advance or retraction of the cylinder. To be able to control the cylinder with a hold position, the valve requires a third position.

Operation – the way to shift the valve into position



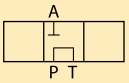
The valve position can be **manually operated** with the use of the handle.



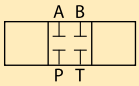
The valve position can be **solenoid operated** using power supply.

Center configuration

The center position of a valve is the position at which there is no movement required of the hydraulic component, whether a tool or cylinder.

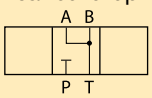


The most common is the **Tandem Center.** This configuration provides for no movement of the cylinder and the unloading of the pump. This provides for minimum heat build-up.



The next most common is the **Closed Center** configuration, which is used mostly for independent control of multi-cylinder applications. This configuration again provides for no movement of the cylinder, but also dead-heads the pump, isolating it from the circuit.

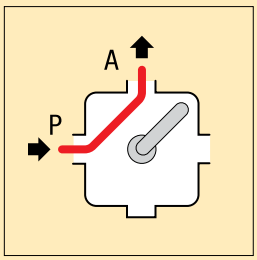
The use of this type of valve requires some means of unloading the pump to prevent heat build-up.



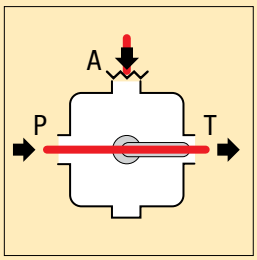
Another commonly used valve configuration is **Float Center.** This type of valve allows the cylinder ports to drain pressure back to tank. Used with a pallet mounted pilot operated check, it allows the hydraulics to be disconnected from the pallet.

Advance, hold and retract
The direction of the oil flow can be controlled depending on valve type, valve positions and port functions.

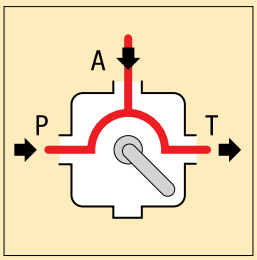
Single-acting cylinder
Controlled by a 3-way, 3-position valve.



Advance
The oil flows from the pump pressure port P to the cylinder port A: the cylinder plunger will extend.

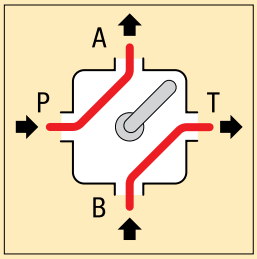


Hold (tandem center)
The oil flows from the pump pressure port P to the tank T. The cylinder port A is closed: the cylinder plunger will maintain its position.

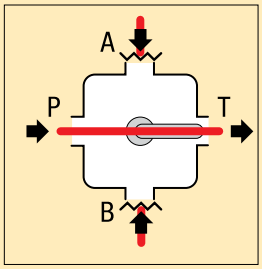


Retract
The oil flows from the pump and cylinder port A to the tank T: the cylinder plunger will retract.

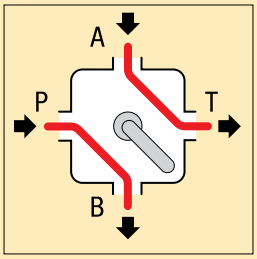
Double-acting cylinder
Controlled by a 4-way, 3-position valve.



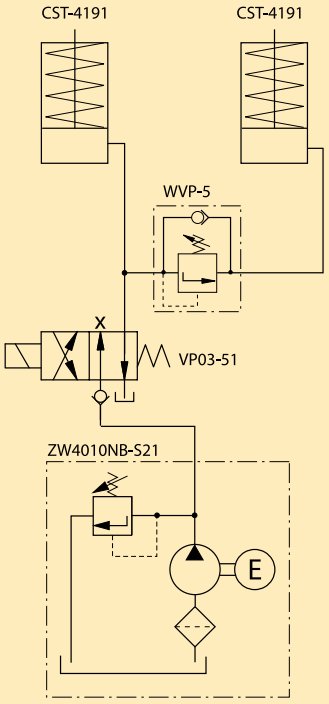
Advance
The oil flows from the pump pressure port P to the cylinder port A and from cylinder port B to tank T.

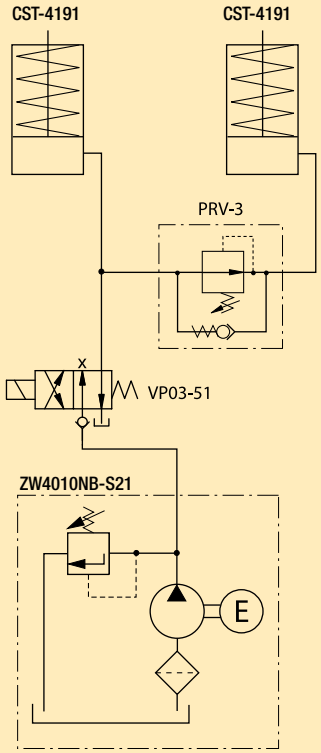


Hold (tandem center)
The oil flows from the pump pressure port P to the tank T. The cylinder ports A and B are closed: the cylinder plunger will maintain its position.



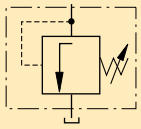
Retract
The oil flows from the pump pressure port P to cylinder port B and from cylinder port A to tank T: the cylinder plunger will retract.





2 Pressure control

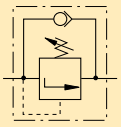
Relief valve



The most common type of pressure control valve is the pressure relief valve. This valve is used to limit the maximum pressure in the hydraulic circuit. This valve should always be included in any hydraulic system to limit the circuit to a maximum safe pressure. When used in a system, design considerations should be made since the valve does not act instantly. As the pressure approaches the set point the valve will at first only permit a very small amount of oil to pass. It is only when the valve opens farther that the full flow will pass through the valve.

From a practical standpoint, don't set the relief valve with a hand pump and then use it with a power pump and vice versa. The point of operation will vary. Also because of this action, when used in application with a pressure switch, the pressure setting on the pressure switch should be set at least 500 psi (35 bar) lower than the point at which the relief valve opens. This will prevent rapid cycling of the motor on the pump because of the slight pressure loss thorough the relief valve. If the pressure settings must be closer than that the pressure switch should be monitoring the system pressure and a check valve should be added between the pump and the system. This will permit the pressure to bleed down on the pump through the relief and yet the check holds the pressure in the system, which is monitored by the pressure switch.

Sequence valve

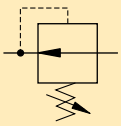


This valve controls the order in which various branches of the hydraulic circuit operate. It sequences the order of the actions. In practice, one part of the circuit will reach a preset pressure at which point the sequence valve will open and permit oil to flow to the secondary part of the circuit. When the flow to the secondary part of the circuit begins, the pressure in the first part of the circuit will remain at the set point permitting for example a work support to stay at its rated pressure as the swing cylinder clamps.

Enerpac sequence valves have a free flow return check meaning that there is no sequence action when the circuit is unclamping. There is however a small bias spring that will open at about 30 psi (2 bar). This will ensure a positive seal when the valve must provide sequence action in the forward direction. When multiple sequence valves are used they should be used in parallel and not in series. If used in series, these 30 psi (2 bar) bias springs will restrict the flow in an accumulative effect.

For example, if three valves are used, there would be about 3 x 30 psi = 90 psi (6 bar) of backpressure on components after the sequence valve in the system. While on a 5000 psi (350 bar) system this pressure may not seem like much, it is enough to prevent a single-acting swing from unclamping all the way or possibly cause a work support to not fully release and not properly readjust for the next part.

Pressure reducing valve

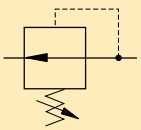


As the name implies, this valve will reduce the pressure to a lower value for a secondary part of the circuit. This is useful, for example, when you must reduce the capacity of a swing cylinder that might be clamping over a work support. The pressure reducing valve will automatically make-up pressure loss after the valve by permitting a very small amount of oil to the secondary circuit.

This pressure difference from when the valve first closes to the point it re-opens for pressure make-up is referred as the "deadband" of the valve. For example, on the Enerpac pressure reducing valve, this deadband is about 5% of the system pressure. If your system pressure is 3000 psi (210 bar) and the reduced pressure is 2000 psi (140 bar), the pressure in the secondary part of the circuit would need to drop 5% of the system pressure, [3000 x .05 = 150 psi (10 bar)] before the valve would open.

In this case the secondary part of the circuit would drop to 1850 psi (127.5 bar), before the valve would open and permit oil to flow to the secondary part of the circuit to return the pressure to 2000 psi (140 bar). This valve provides this function in only one direction with free flow in the reverse direction to allow cylinders to unclamp or work supports to unlock.

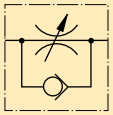
Pressure limiting valve



This valve, like the pressure-reducing valve, will limit the pressure in a secondary part of the circuit to a preset lower setting than the system pressure. This valve functions differently in that once the valve closes, the secondary part of the circuit will not receive any make-up oil for any pressure loss. The system pressure must drop to zero pressure before the valve will open and permit oil to flow to the secondary part of the circuit. There is no pressure make-up capability with a pressure-limiting valve.

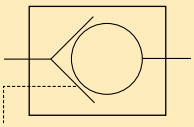
3 Flow control

Flow control valves

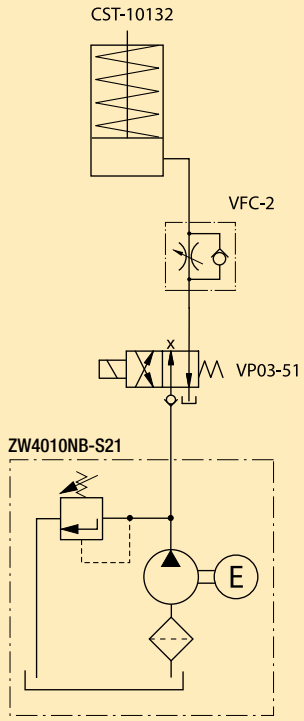


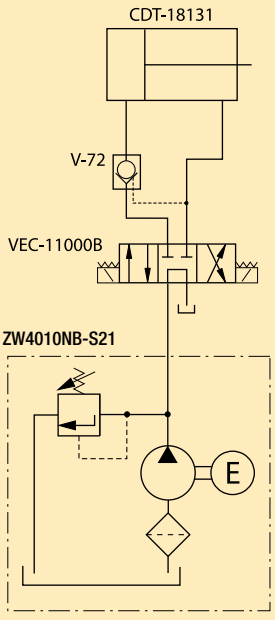
Flow controls permit the change of speed of a hydraulic component through the use of an adjustable orifice. Unlike a regular flow control that provides the same flow restriction in both directions, these flow controls provide a free flow reverse check. This allows restricted flow in one direction and unrestricted flow in the other. This is a very important feature when using a flow control to regulate the speed of a single-acting swing cylinder or work support. The cylinder requires the clamping speed be regulated to a safe value through the use of a flow control to prevent damage to the cylinder. When unclamping, the spring in the cylinder will develop only a small amount of pressure. To ensure rapid unclamp time, back pressure, or resistance, must be minimized. Free flow reverse checks allow you to minimize this resistance.

Pilot operated check valves

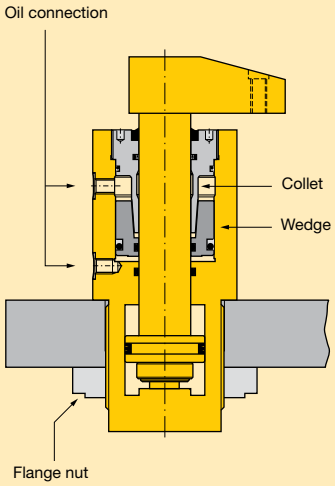


A check valve only permits the flow of oil in one direction. The pilot operated check valve works the same as a regular check valve but also has an additional port for a pressure signal. Pressure to this extra port will mechanically open the check valve to permit the oil to flow in both directions. The pilot operated check is useful in holding pressure over a period of time in a remote part of a circuit, but allowing the pressure to be released using a pressure signal to the extra port on the valve. Usually this pressure is much lower than the system pressure you are holding back. Enerpac pilot operated check valves only require 15% of the system pressure you are clamping with to open the check valve, permitting the oil to return from the fixture and unclamp the part.





Flexible machining systems



One of the most important aspects of machining cycle times is the speed and precision of the workpiece positioning, clamping and release.

The speed of these actions is greatly improved through the use of hydraulic workholding components, leading to increased efficiencies and cost savings.

Use of palletized fixtures
Being able to load many parts onto palletized fixtures also greatly increases the productivity and efficiency of the machining cycle. The use of palletized fixtures poses several problems however. The clamping cylinders must be repeatedly connected and disconnected from the hydraulic power source to make use of the flexibility of the pallets.

With conventional hydraulic cylinders, this also requires the use of load holding valves and accumulators to maintain pressure. With proper maintenance, this system of hydraulic workholding is very effective. This type of clamping is also very susceptible to contamination, and additional care must be taken to maintain the filtration and preventive maintenance schedules required.

Fixture for machining exhaust manifolds.

Enerpac's exclusive Collet-Lok® technology
There is another solution to palletized clamping. Enerpac's exclusive Collet-Lok® technology eliminates the need for live hydraulics to be maintained on the pallet during the machining cycle. Once the part is hydraulically clamped in position for machining, the cylinders are mechanically locked in place. This mechanical lock replaces the accumulators, load holding valves and other requirements of live hydraulic palletized circuits. Once the machining cycle is complete, the mechanical lock is released, and the cylinders can be retracted to allow for the next piece to be loaded.

Enerpac offers swing cylinders, work supports and push cylinders with Collet-Lok® technology incorporated. Used in conjunction with an automatic coupler, pressure switches and proximity sensors, this technology can provide a totally automated and accurate clamping cycle.

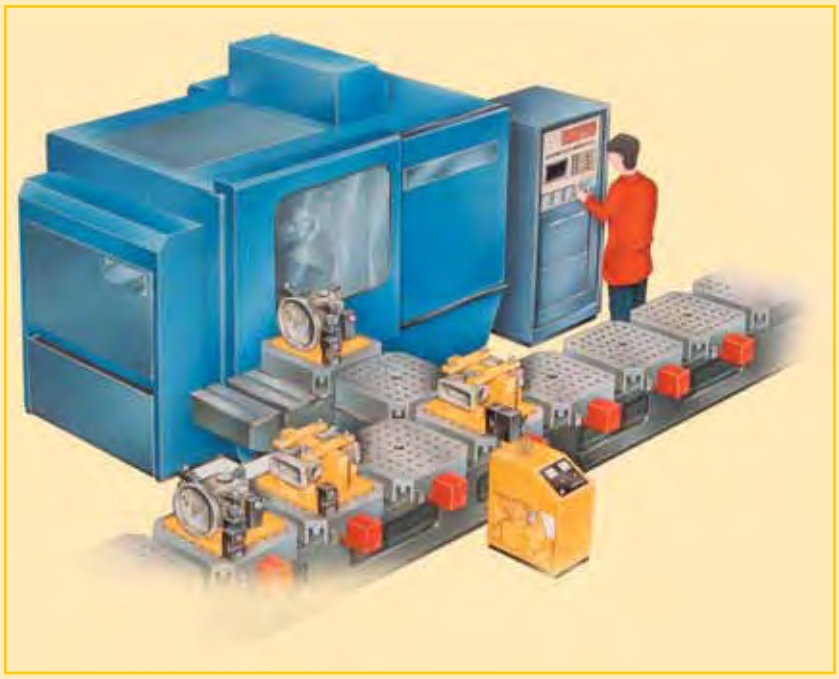
On the next page is an example of how this technology works. The Collet-Lok® swing cylinder has four ports.

Port #1 is first pressurized to apply the appropriate clamping force. Once this pressure is reached, a sequence valve opens, sending pressure to Port #2, which mechanically locks a wedge into place. This wedge locks the plunger in place, preventing movement, and maintaining the clamping force on the workpiece. The pressure should now be removed and machining can be performed at any time. This lock can be maintained for minutes, hours, even days, without the need for hydraulic pressure.

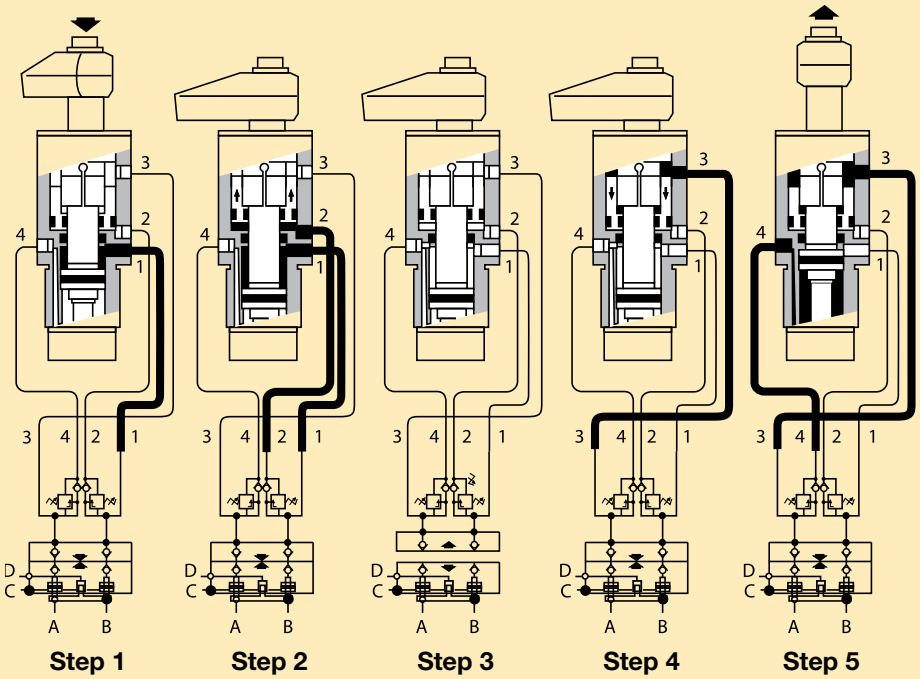
Once the machining cycle is complete, and the workpiece needs to be changed, the lock can be very easily removed. Pressure should be applied to Port #3 to unlock the wedge system. Once the wedge is unlocked, and the plunger is free, pressure can be applied to Port #4 to allow the plunger to retract. With this complete, the machined workpiece can be removed and a new piece can be loaded into the fixture to continue the process.

This system is the ultimate in system automation and positive control in clamping technology. For more information, be sure to consult Enerpac to receive additional literature and installation instructions.

Palletized machining



Hydraulic Clamping and Hydraulic Mechanical Locking



Step 1
2-way Auto coupler connects external power source with pallet part and the Collet-Lok® cylinder is activated for hydraulic clamping.

Step 2
After reaching maximum clamping pressure the sequence valve is opened and actuates the internal wedge hydraulically.

Step 3
The wedge system secures the plunger position mechanically and the hydraulic pressure is taken off, then the auto coupler retracts. The product on the pallet is now securely clamped, without being connected to a power source.

Step 4
After being in the center of the machine the pallet returns to the loading and unloading position and the auto coupler is connected again to release the wedge.

Step 5
The hydraulic plunger is now retracted and the pallet is free for unloading and loading.

WPTR-100 Collet-Lok® swing cylinder

1 = 90° Rotation + Clamp
2 = Lock
3 = Unlock
4 = Unclamp + 90° Rotation

WCA-62, WPA-62 Auto coupler

A = Pressure line from pump to swing cylinder
B = Pressure line from pump to swing cylinder
C = Auto coupler advance
D = Auto coupler retract

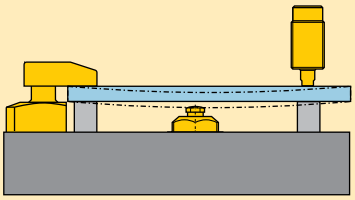


Figure 1
Simple hydraulic fixture with minimal workpiece deflection

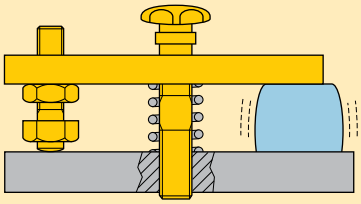


Figure 2
Simple mechanical fixture with larger workpiece deflection

Mechanical clamping versus hydraulic clamping

Many factors should be taken into account when deciding whether to use mechanical or hydraulic workholding products for clamping your parts. In general, hydraulic clamping should be used in high volume applications, or when critical tolerances need to be held. Mechanical clamping products can be used in shorter production runs, or on rougher procedures where surface finishes and tight tolerances are optional.

For example, using hydraulic workholding products will allow you to maintain within a 1% accuracy on your clamping force. This is through the use of digital pressure switches, electric powered pumps and hydraulic clamping and support cylinders. This type of accuracy may be necessary when machining a surface requiring tight tolerances, less than .001 inch (0,025 mm). The slightest variation in clamping force could result in part movement or deflection greater than the required overall tolerance (Figure 1). In situations like this, the investment in hydraulic clamping is undeniable.

Mechanical clamping products are sufficient when tight tolerances are not required, or when the part is a large casting for example, and no amount of clamping force will distort the part. A typical operator, for example, can tighten a stud over a clamp to a specific torque value with possibly only 10% accuracy using a manual wrench. This could result in significant differences in part height and position on a fixture (Figure 2). However with a rough casting where the required finish is not critical, this may be acceptable. And, for the cost of mechanical clamping compared to hydraulic clamping, the choice is easy.

There are also situations where hydraulic clamping is not only not necessary for accuracy, but also, potentially dangerous. A perfect example of this is a die casting machine. Heat is an enemy of hydraulic components, and die casting obviously generates an enormous amount of heat. Mechanical clamping is an excellent and safe solution to the problem.

Production quantity runs should also be taken into account along with time savings and cost of materials when choosing between hydraulic and mechanical clamping.

Mechanical clamping is typically less expensive but more time consuming compared to hydraulic clamping.

See the examples below for ideal situations in which to use hydraulic or mechanical clamping:

Example 1

Production quantity:	60,000 pieces
Part material cost:	$25
Machine time cost:	$150 p/h
Hydraulic fixture and component cost:	$30,000
Parts per fixture:	4
Load/unload time:	20 seconds
Run time:	720 seconds

The run time and the load/unload time equate to 185 seconds of machine time per part. The machine costs money no matter whether you are actually cutting chips or waiting to cut chips while you are loading the parts. This is why you must take both the load and the run time into account.

This 185 seconds per part equates to being able to run 155 parts per 8 hour day, at an additional cost of $7.71 per part due to machine time cost of $150.00 per hour.

The hydraulic fixture cost of $30,000 divided over 60,000 parts equates to an additional $0.50 per part. All together, in this very simple example, you have added only $8.21 to the cost of the part. The $8.21 equates to only about a 33% increase in cost. Granted, there are more aspects which could be factored in, but you can see the minimal cost added by hydraulics in this example.

Assume that you were only running 3000 parts on a small run. The machine time is the same, but now, the hydraulic fixture and components adds an additional $10 to the cost of the part (30,000/3000 parts). This is a total of $17.71 additional cost, or a 71% increase. Hydraulic clamping is much too expensive for such a short run.

Example 2

Production quantity:	3000 pieces
Part material cost:	$25
Machine time cost:	$150 p/h
Mechanical fixture and component cost:	$5000
Parts per fixture:	4
Load/unload time:	240 seconds
Run time:	720 seconds

In this example, the production quantity is much lower, and mechanical clamping is being used. The same part is being machined, on the same machine process. The mechanical clamping fixture is much less expensive, only adding $1.67 to the cost of each part. However, the load/unload time has increased significantly since the operator has to manually clamp each part. The machine is now only able to produce 120 parts per 8 hour day. This adds $10 to the cost of each part in machine time cost. All together, $11.67 has been added to the cost of each part, a 47% increase. While this may seem significant, remember that the cost increase using hydraulic clamping was 71%. Mechanical clamping is a much better choice in the lower production runs, even though it may be slower.

Many factors must be taken into account to decide on either mechanical clamping or hydraulic clamping. For example, taking labor into account can significantly add to the cost of mechanical clamping, since it is a much slower process. These examples are very simple and do not include all of the variable details that could affect your decision. Be sure to account for every situation in making your choice.

Replacing mechanical clamping with hydraulic clamping

In order to properly replace a mechanical clamping set-up with hydraulic cylinders, the most important thing to understand is the amount of clamping force being applied to the part. Figure 3 is an example of a typical mechanical clamping set-up for either one part or two parts. In this situation, the operator tightens the nut on the clamping stud, which in turn applies a holding force to the work piece. In order to convert this set-up to hydraulic clamping, you will need to know some values from Figure 3.

T = Torque on the clamping stud (ft-lbs or N-m)

D = Thread diameter and pitch (for example, 3/8-16 or M8)

L_1 = Distance from center of clamping stud to contact point on the workpiece

L_2 = Distance from center of clamping stud to reaction point (or contact point on second workpiece)

You will also need to know whether the clamping stud and nut are lubricated or dry. This makes a difference in how much clamping force is generated.

The first thing to know is how tight that nut is being applied to the clamping stud. This is best measured using a torque wrench. Even though the operator may not use a torque wrench in the everyday use of the fixture, it is critical to be able to provide a torque reading when converting to hydraulic clamping.

It may be necessary to use a torque wrench on the part a few times in order to get a good consistent value to be used in calculating the clamping force.

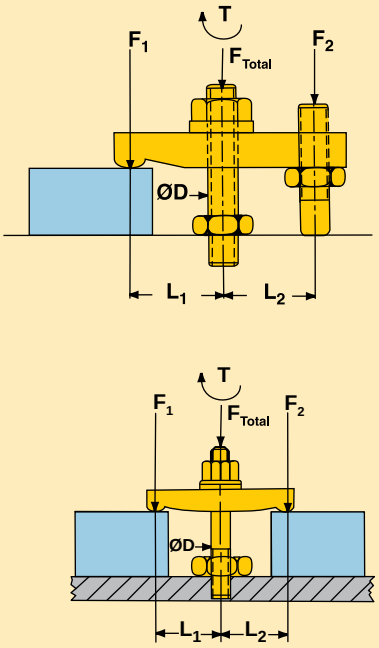


Figure 3
Typical mechanical clamping set-up

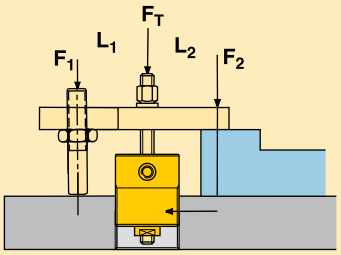


Figure 4
Center-hole cylinder used in hydraulic clamping set-up

Once you have determined the amount of torque being applied to the clamping stud, and you have measured the diameter of the stud, and the distances L_1 and L_2, the clamping forces can be calculated. It is important to understand that the amount of clamping force being put into the clamping stud is not the same amount of force being applied to the part. In this setup, much less force gets applied to the part. You can calculate the force applied to the stud using the table. The force applied to the part is based on the formula.

$$F_1 = L_2 / (L_1 + L_2) * F_T$$
$$F_2 = L_1 / (L_1 + L_2) * F_T$$

When $L_1 = L_2$ (when the clamping stud is exactly halfway between the clamping points), $F_1 = F_2 = \frac{1}{2} F_T$

SAE stud sizes

Dry Threads K = 0.20

Stud size	Torque (ft-lbs)	Applied load (lbs)
	4	1190
1/4" - 20	6	1790
	8	2380
	10	2980
	14	3250
5/16" - 18	16	3720
	18	4180
	20	4640
	24	4580
3/8" - 16	28	5350
	32	6110
	36	6880
	60	8470
1/2" - 13	65	9180
	70	9880
	75	10590
	125	13980
5/8" - 11	135	15100
	145	16220
	155	17340
	200	18390
3/4" - 10	225	20690
	250	22990
	275	25280
	350	27390
7/8" - 9	375	29340
	400	31300
	425	33260
	450	30740
1" - 8	550	37580
	650	44410
	750	51240

Lubricated Threads K = 0.15

Stud size	Torque (ft-lbs)	Applied load (lbs)
	4	1590
1/4" - 20	6	2380
	8	3180
	10	3970
	14	4330
5/16" - 18	16	4950
	18	5570
	20	6190
	24	6110
3/8" - 16	28	7130
	32	8150
	36	9170
	60	11290
1/2" - 13	65	12230
	70	13170
	75	14120
	125	18640
5/8" - 11	135	20130
	145	21620
	155	23120
	200	24520
3/4" - 10	225	27580
	250	30650
	275	33710
	350	36520
7/8" - 9	375	39130
	400	41730
	425	44340
	450	40990
1" - 8	550	50100
	650	59210
	750	68320

Note: Values in the charts above are based on theoretical values. The chart values are meant to be guidelines in determining equivalent hydraulic cylinders for an application, but are by no means exact.
Factors such as lubrication, material, plating and method or torque application can affect the actual clamping force. Please use proper engineering practices when designing a fixture.

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With an 80-year history of quality and innovation, the broadest line in the business, and more than 4,000 distributors and factory-trained service centers around the world, Enerpac leads the industry by setting new standards in design, strength, durability and local support. Strict quality programs, zero tolerance for defects, and ISO-9001 certification are your assurance of safe, trouble-free operation.

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02/2013

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