Q5 Series Cylinders

Medium-Duty NFPA Interchangeable

HYDRO-LINE, INC.

An IMC Company

How to Order a Q5 Cylinder

Hydro-Line standard cylinders can be completely and accurately identified with a model number that encodes construction specifications. To develop the model number for ordering a cylinder, see the following example.

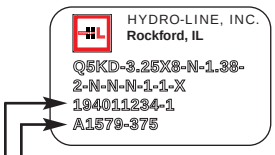
Feature	Description	Symbol
Rod Diameter	Specify in inches (2 position decimal)	—
Cushions	Noncushioned	**N**
	Cushioned both ends	B
	Cushioned head end	H
	Cushioned cap end	C
Stroke	Specify in inches (2 position decimal)	—
Bore	Specify in inches (2 position decimal)	—
Double Rod	Include ONLY for double-rod cylinder	**D**
Mounting Style	Side lugs, MS2	A
	Side tapped, MS4	B
	Cap fixed clevis, MP1	C
	Cap Mono clevis	CM
	Cap detachable clevis, MP2	DC
	Cap Mono detachable clevis, MP4	DCM
	Side end lugs, MS7	E
	Head rectangular flange, MF1	F
	Head square, ME5	G
	Head square flange, MF5	J
	No mount	**K**
	All tie rods extended, MX1	L
	Head end tie rods extended, MX3	M
	Cap end tie rods extended, MX2	N
	Cap square, ME6	P
	Cap rectangular flange, MF2	R
	Cap square flange, MF6	S
	Intermediate fixed trunnion, MT4	TT
	Head trunnion, MT1	U
	Cap trunnion, MT2	W
	Side end angles, MS1	Y
Model/Series	Air prelubricated to 200 psi	**Q5**
	Hydraulic to 400 psi	HQ5
	Air/oil tank (aluminum caps/fiberglass tube)	QT
Rod End Style	Male, large	1
	Male, large, extended	1X
	Male, small (standard)	**2**
	Male, small, extended	2X
	◆ Male modified	2M
	Female	4
	◆ Female modified	4M
	Plain end	5
	Male, full rod diameter	6
	Male, for rod end coupling	10
	Modified	M
Ports	NPTF	**N**
	NPTF, 1st size over standard	L
	SAE	S
Rod Seals	Nitrile lip type	**N**
	Nitrile ELF rounded lip type	L
	Polypak	P
	Urethane Ultra Seal	H
	Viton lip type	V
	Nitrile lip type with scraper	S
	Viton lip type with scraper	U
	Special	X
Piston Seals	Nitrile lip-type	**N**
	Nitrile ELF rounded lip type	L
	Low friction polypak (air/oil piston seals)	D
	Viton lip-type	V
	Magnetic piston (2 switches) Hall Effect	F
	Magnetic piston (1 switch) Hall Effect	G
	Magnetic piston (no switches) Hall Effect	H
	Magnetic piston (2 switches) Reed	M
	Magnetic piston (1 switch) Reed	O
	Magnetic piston (no switches) Reed	S
	Special	X
Port Locations	Head End	**1 thru 4**
	Special	X
	Cap End	**1 thru 5**
	Special	X
Special Modifications	Include ONLY if special modifications are required.	**X**
	Special Seals	
	Nonstd. mount	
	Oversize ports	
	Bronze bushings	
	Stainless steel rod	
	Stop tube	
	Nonrotating rod	
	Rod boots	
	Indicator switches	
	Studded rod	
	Port or cushion modifications	
	Double-end rod with different rod ends	
	Special paint/plating	
	Linear displacement transducer	
	Adjustable stroke	
	Spring extend/return	
	Hardened rod	

◆ Include drawing or description

Q5KD - 3.25 X 8 - N - 1.38
- 2 - N - N - N - 1 - 1 - X

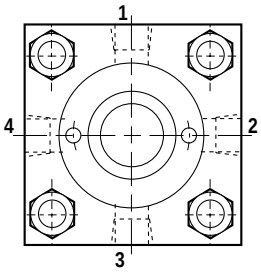
HOW TO ORDER

1. Quantity
2. Model Number
3. Special modifications if required
4. Operating temperature if below -40°F or above 200°F
5. Required ship date



Customer Number (if desired)
Hydro-Line Serial Number

National FLUID POWER Association MEMBER



PORT LOCATIONS

Port location 5 is on the center of the back face of the cap end.

Q5 Design Features

A Unitized Cartridge

Machined from gray iron for maximum bearing support and wear resistance. Open grain structure retains lubricant, increasing seal and rod life.

Standard removable retainer allows cartridge removal with hex wrench without loosening tie rods on 2½" bore and up. Full front plate used on 1½" and 2" bore.

B Piston and Rod Seals

Nitrile seal material provides long life and low friction in applications utilizing lubricated air as well as dry air and air free from oil.

C Double-Lipped Wiper

Carboxylated nitrile double-lipped wiper removes foreign materials from the exposed rod to extend rod seal life, while the back lip acts as a secondary seal.

D Hard Coat Anodized Aluminum Alloy Tubing

(60 Rc on I.D.) for

- Superior seal life
- excellent wear resistance

E NPTF Ports

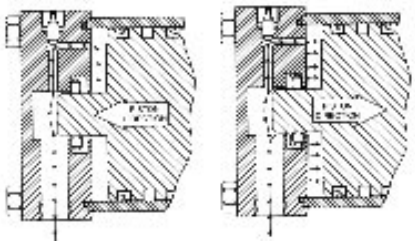
- 1 NPTF port size under NFPA specification is standard on Q5
- NFPA specification NPTF port size available at no extra charge
- NFPA specification SAE port standard on HQ5

F O-Ring Tube End Seals

- provide positive sealing
- are reusable

Fig. 3-1

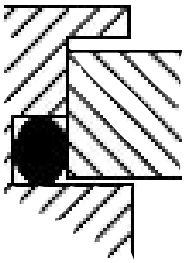
As the cylinder enters cushion, the new floating elastomeric cushion seal aligns itself on the cushion spear or collar. Sealing takes place on the spear or collar diameter and the back of the cushion seal pocket. Air trapped between the cushion and piston seal is metered out past the cushion adjustment needle to create the desired cushioning effect, dependent upon cylinder speed and load. As the cylinder comes out of cushion the cushion seal is unseated from the back of the pocket. Molded feet on the front face of the seal do not allow it to seal on the front of the pocket. Depressions molded into the outer diameter allow air to escape around the seal and work on the entire piston face for a quick break-away and stroke reversal. Due to this "self-checking" design, there is no need for ball checks.



INTO CUSHION OUT OF CUSHION

Fig. 3-2

O-ring tube end seals in nitrile material are pressure compensating and reusable.



G Cushion Seals

Self-centering, self-checking elastomeric cushion seal design on head and cap provides:

- optimum cushioning
- long life
- eliminates the need for ball checks
- ensures quick break-away and stroke reversal.

See **Fig. 3-1.**

H Adjustable Cushion

Captive and flush cushion needle design allows safe adjustment under pressure. Fine threads and special tip allow precise adjustment over a broad range of operation.

I Aluminum Head and Cap

- Machined from precision aluminum blocks
- Provides truly flat and parallel mounting surfaces
- Ensure correct alignment of tube and rod cartridge
- Anodized for abrasion and corrosion resistance

J Tie Rods

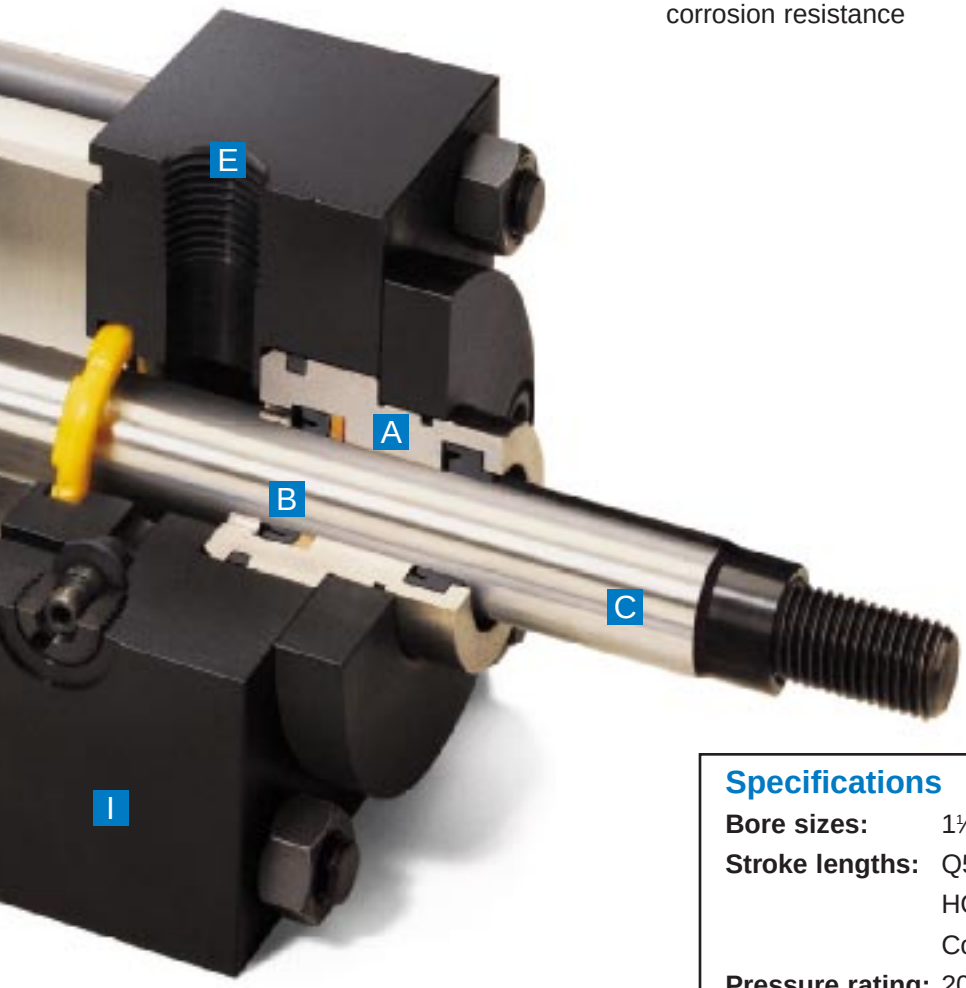
100,000 PSI minimum yield steel. Roll threaded for added strength.

K Pistons

- Precision machined from solid aluminum alloy.
- Magnetic ring for switch actuation optional.

L Consistent Cushioning

Close tolerance cap cushion spear and head cushion collar provide consistent cushioning performance. Floating head cushion collar reduces wear.



Specifications

Bore sizes:	1½" through 8"
Stroke lengths:	Q5 – 250 PSI
	HQ5 – 250 PSI hydraulic – noncushioned
	Consult factory for higher pressures.
Pressure rating:	200 psi air
Temperature:	-40°F to 200°F standard

NFPA interchangeable mountings

Q5: Pneumatic cylinders incorporate internally lubricated nitrile lip type piston and rod seals, which are permanently lubricated at assembly by filling the “v” groove with molybdenum disulfide grease.

HQ5: Hydraulic cylinders incorporate urethane “ultra” rod seals, nitrile lip-type piston seals and SAE ports.

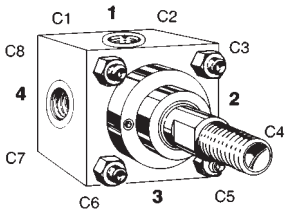
Table Of Contents

How to Order a Q5 Cylinder ....page 2
Q5 Design Features ....pages 3-4
Q5 Options .... page 5
Port and Cushion Adjustment Locations ....page 5
Port Sizes ....page 5
Rod Cartridge Retainers....page 5
Custom Cylinders ....page 6
Hydro-Line Application Data ....page 7
Q5 Mounting Dimensions ....page 8-10
QT Series Air/Oil Tanks....page 11
Cylinder Mounting Accessories ....page 12-13
Technical Data ....page 14
Low Profile Reed and Hall Effect Switches....page 15-17
Rod End Styles....page 18
Cylinder Dimensions....page 19
Oversized Rods ....page 19

Q5 Options

- Cushions
- Oversized rod
- Oversized NPTF and SAE ports
- Stainless steel rod
- Stop tube
- Rod scraper
- Bronze bushing
- High temperature seals
- Air/oil piston
- Double rod end
- Rod boots
- Nonrotating rod
- Electroless nickel plated
- Spring extend/return
- Piston with magnetic ring
- Rod end couplers
- Studded rod ends
- Hardened rods
- ELF rounded lip piston and rod seals

Port and Cushion Adjustment Locations



Standard port locations are at No. 1, with optional locations at No. 2, 3 or 4. Standard cushion adjustment location is above port location No. 2 in location C3, with optional locations at C1, C2 or c4 through C8.

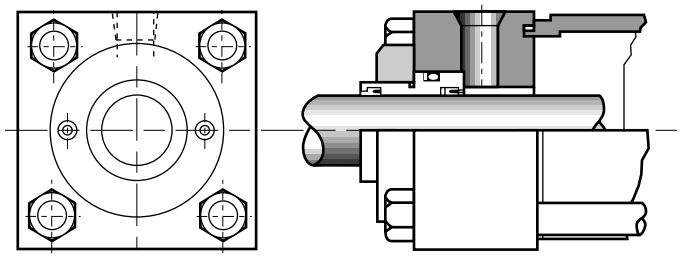
PORT SIZES

		Oversize	
Bore	**Standard**	**NPTF**	**SAE**
1½, 2, 2½	¼ NPTF	⅜ NPTF	#6
3¼, 4, 5	⅜ NPTF	½ NPTF	#10
6, 8	½ NPTF	¾ NPTF	#12

EXCEPTIONS:

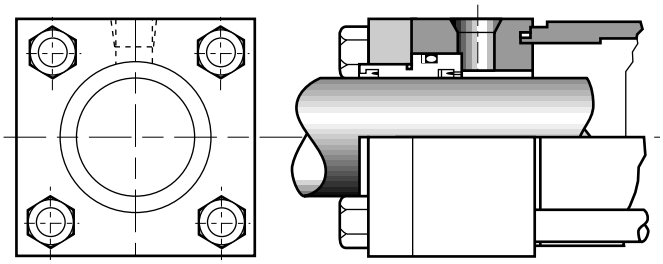
- Ports at No. 3 not available on **E** mount cap on 1½" through 3¼" bores.
- Ports at No. 3 on **B** mount head and cap not available on 1½" and 2" bores.
- Oversized NPTF and SAE ports at No. 3 on **B** mount head and cap not available on 3¼" bores.
- Head cushion not available on 1½" bore with 1" diameter rod.

Rod Cartridge Retainers Simplify Cartridge Removal



Cylinders with the following bore and rod combinations use circular retainers which permit removal of rod cartridge without disassembling cylinder:

2½" bore with ⅝" and 1" rods
3¼" bore with 1" and 1⅜" rods
4" bore with 1" and 1⅜" rods
5" bore with 1" and 1⅜" rods
6" bore with 1⅜" and 1¾" rods
8" bore with 1⅜" and 1¾" rods



Cylinders use this retainer construction on the following bore and rod combinations:

1½" bore with all rods
2" bore with all rods

Commitment to Quality

It is the policy of Hydro-Line, Inc. to design, produce and deliver defect-free products and provide superior services, the first time and every time, that consistently meet the needs of our customers. Our philosophy calls upon every employee to strive for excellence in customer satisfaction through continuous improvement.

Custom Cylinders

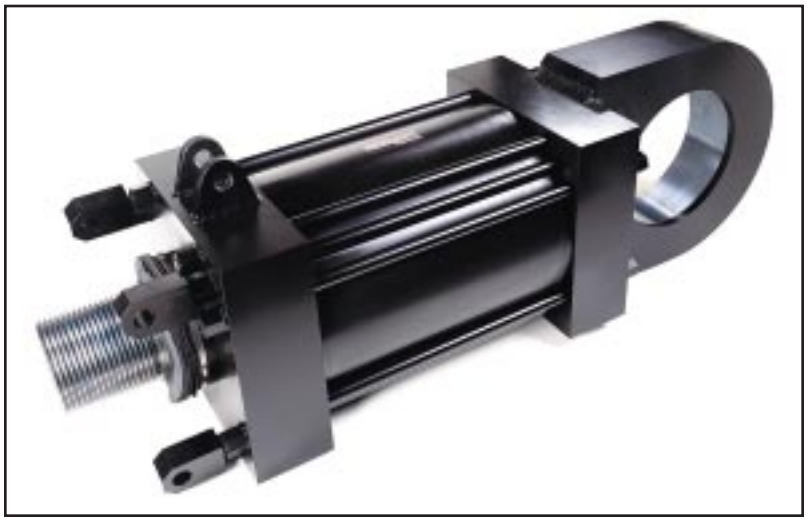
For Special Applications

Hydro-Line's full line of cylinder products and options fit most customers' application requirements, however, a special cylinder is often required to meet custom specifications. These custom cylinders are often needed to solve difficult application problems, upgrade existing equipment or are designed into new machinery.

Hydro-Line's Sales, Engineering and Manufacturing groups are cylinder specialists and have many years of experience in the interpretation of requirements, design and manufacture of custom cylinder products.

Our capabilities include:

- Bore diameters to 30"
- Stroke lengths to 300"
- Operating pressures to 10,000 psi or higher
- Operating mediums ranging from shop air to nitrogen, or from standard hydraulic fluid to special synthetic fluids
- Tie rod, threaded and bolted cylinder construction
- Finite element analysis
- Application simulation in our testing laboratories



= Solutions

Hydro-Line would appreciate an opportunity to submit a proposal to solve your application problem or fulfill your current cylinder requirements. Simply copy and complete the Application Data Sheet on page 8 and fax to your authorized Hydro-Line distributor.

Hydro-Line Application Data Sheet

Company Name: _____
Contact: _____
Phone Number: _____ Fax Number: _____

Distributor Name: _____
Contact: _____
Phone Number: _____ Fax Number: _____

Model Numbering System

QUANTITY

MODEL/SERIES MOUNT | BORE | STROKE | CUSHION | ROD DIA | ROD STY | SEALS PORTS | SEALS ROD | PORT LOC PSTN | PORT LOC H C | MODEL

DOUBLE END ROD STYLE | ADDITIONAL ROD LENGTH | NEEDLE LOCATION (C HEAD, C CAP) | KEYPLATE | 4-FLAT | BLEEDERS (HEAD CAP) | BRONZE BUSHING | DRAIN-BACK | IND. SWITCH (HEAD CAP) | MODEL PREFIX

Stop Tube Length | Trunnion XI Dimension | Stainless Steel Rod Type

Please fill in all available information above. Refer to the Hydro-Line Model Numbering System on Pages 2.

WHAT IS THE OPERATING ENVIRONMENT?

Fluid Media Operating Pressure

Air _____ Minimum _____ psi
Oil _____ Typical _____ psi
Other _____ Maximum _____ psi
Fluid Type _____

Temperature at Cylinder

Minimum _____ °F
Typical _____ °F
Maximum _____ °F

WHAT IS THE WORK BEING PERFORMED?

Load

Push _____ lbs.
Pull _____ lbs.

Rod Speed

Extend _____ in./sec.
Retract _____ in./sec.

Cycles per Minute

_____ (in and out)

WHAT IS THE MOUNTING?

Attitude

Vertical _____
Rod Up _____
Rod Down _____

Angle _____
Degrees From Vertical _____
Rod Up _____
Rod Down _____

Horizontal _____

Rod End Connection

Firmly Guided _____
Supported _____
Unsupported _____

Known Side Load

_____ lbs.

WHAT ENVIRONMENTAL CONDITIONS IS THE CYLINDER SUBJECTED TO?

Standard Factory _____ Corrosive Washdown _____ Chemical? _____ Outdoors _____ Other _____

WHAT IS THE PRESENT CYLINDER TYPE AND MODEL NUMBER?

WHAT IS THE PRESENT PROBLEM?

WHAT INDUSTRY IS THE CYLINDER USED IN?

WHAT TYPE OF MACHINE IS THE CYLINDER USED ON?

WHAT IS THE CYLINDER NAME THE APPLICATION?

APPLICATION SKETCH:

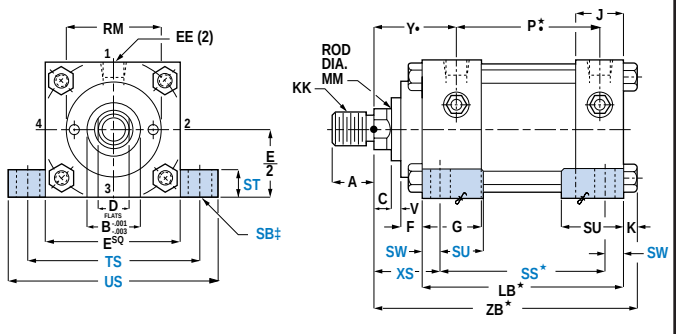
DESCRIPTION OF APPLICATION OR SPECIAL REQUIREMENT:

PREPARED BY:	DATE:	REVIEWED BY:	DATE:

CUSTOMER DRAWING NUMBER:	REVISION DATES:	HYDRO-LINE QUOTE NUMBER:

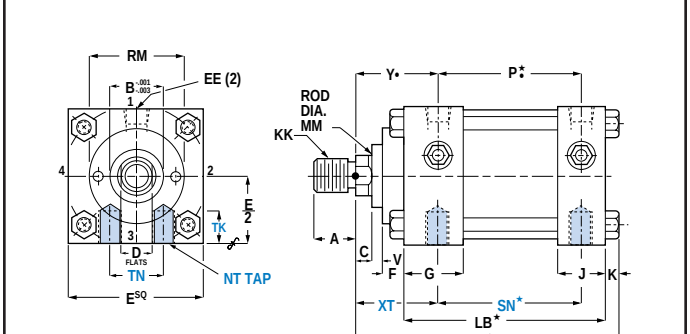
Q5 Mounting Dimensions

See Cylinder Dimensions on Page 18

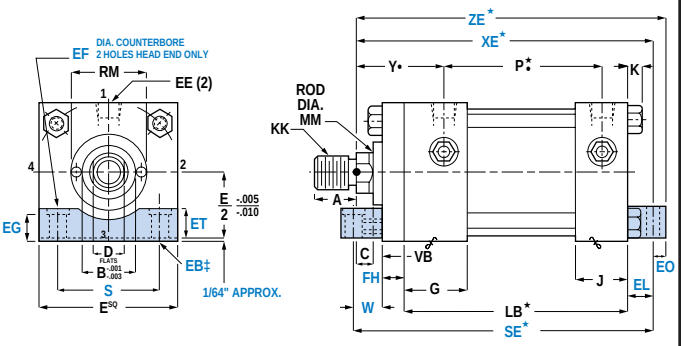


For double rod end cylinder (Mount **AD**), add 1/2" to mounting dimension **SS.**

Q5A – Side Lugs Mount (NFPA Style MS2)

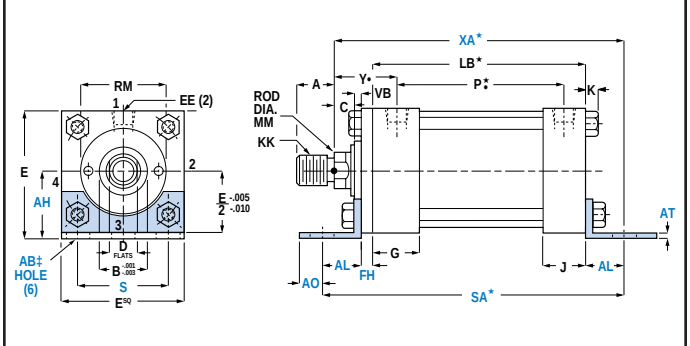


Q5B – Side Tapped Mount (NFPA Style MS4)



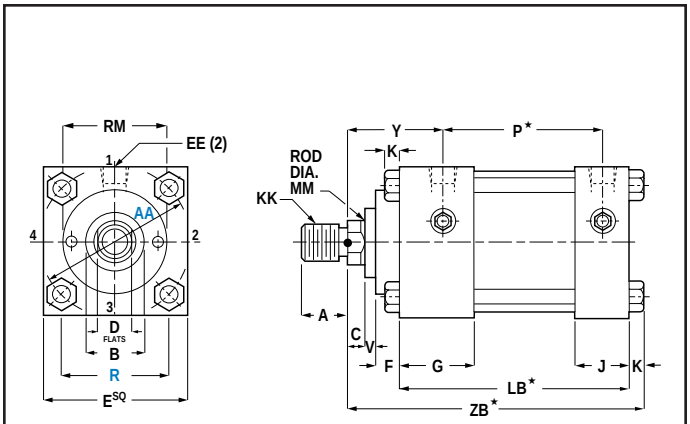
For double rod end cylinder (Mount **ED**), add 1/2" plus **FH** dimension to mounting dimensions **SE, ZE** and **XE.**
Note: Bottoms of heads and caps are mounting surfaces.
Lugs hold cylinders against mounting surface.
Note: 8" bore does not use full front plate.
Use **F** in place of **FH.** Use **V** in place of **VB.**

Q5E – Side End Lugs Mount (NFPA Style MS7)

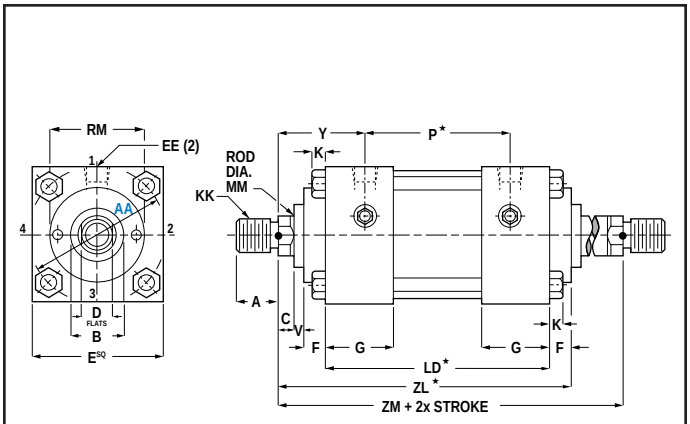


For double rod end cylinder (Mount **YD**), add 1/2" plus **FH** dimension to mounting dimensions **SA** and **XA.**
Note: 8" bore does not use full front plate. Use **F** in place of **FH.**
Use **V** in place of **VB. AL** measured from head.

Q5Y – Side End Angles Mount (NFPA Style MS1)



Q5K – No Mount

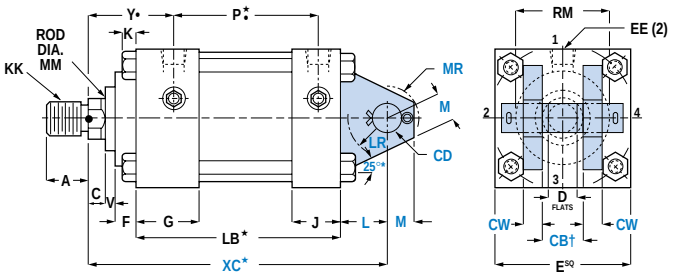


Add **D** for double end after the desired series and mounting style.
Example: **Q5KD.**

Q5D – Double Rod

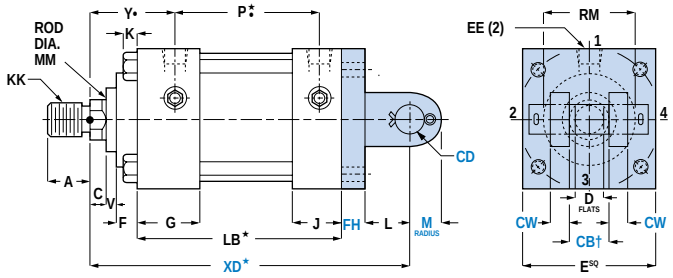
Q5 Mounting Dimensions

See Cylinder Dimensions on Page 16



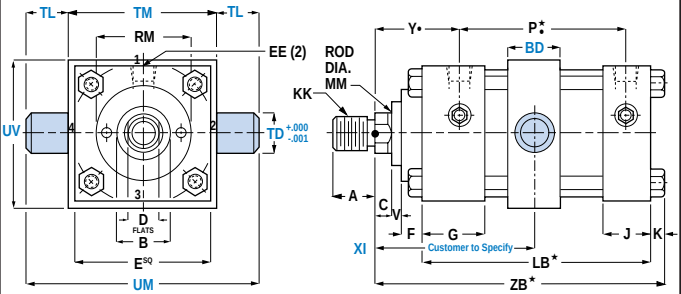
† Maximum width of mating part.
1" bore has single eye, **CB** wide.
* 28° on 1" bore only.

Q5C – Cap Clevis Mount (NFPA Style MP1`) **(1½"-6" Bores)**

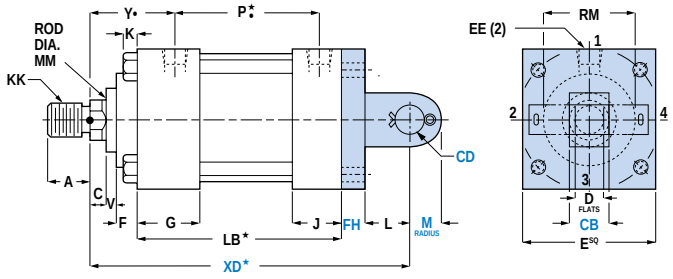


† Maximum width of mating part.

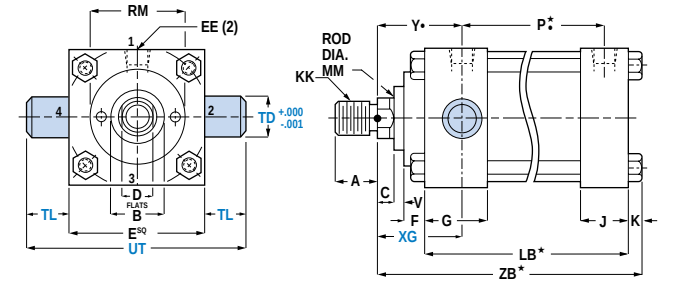
Q5DC – Cap Detachable Clevis Mount (NFPA Style MP2)



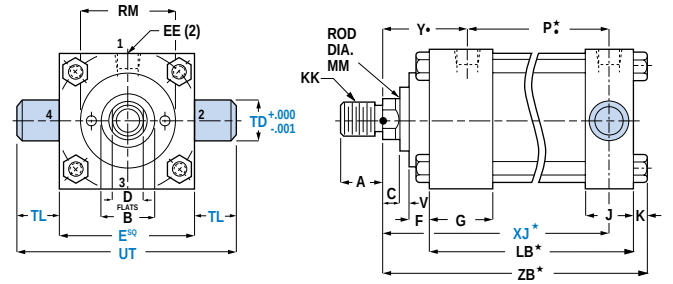
Q5TT – Intermediate Fixed Trunnion Mount (NFPA Style MT4)



Q5DCM – Cap Detachable Mono Clevis Mount (NFPA Style MP4) **(1½"-6" Bores)**



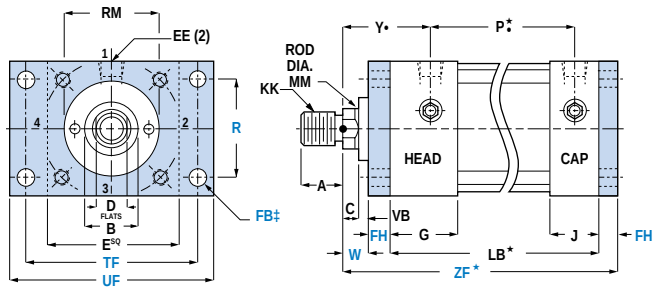
Q5U – Head Trunnion Mount (NFPA Style MT1)



Q5W – Cap Trunnion Mount (NFPA Style MT2)

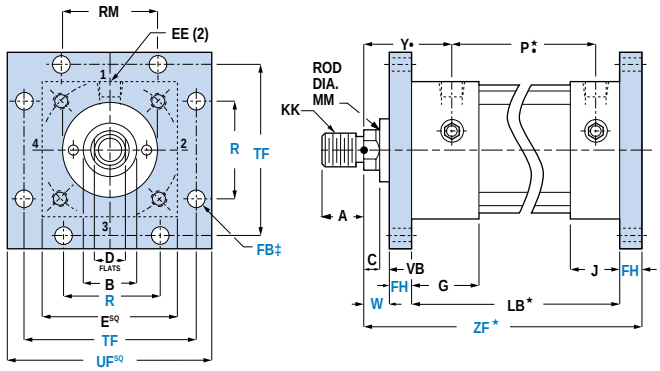
Q5 Mounting Dimensions

See Cylinder Dimensions on Page 16



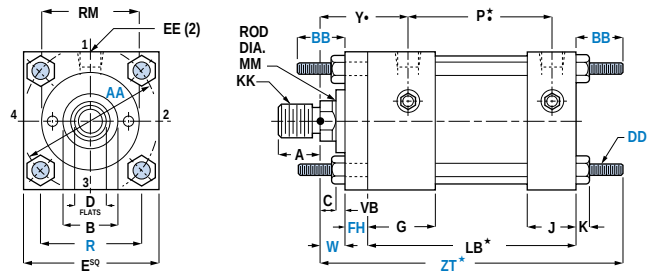
Note: Tie rod nuts will extend past the head or cap.
K thickness on the end opposite flange mounting.

Q5F – Head Rectangular Flange Mount (NFPA Style MF1)
Q5R – Cap Rectangular Flange Mount (NFPA Style MF2) (1½"-6" Bores)



Note: Tie rod nuts will extend past the head or cap.
K thickness on the end opposite flange mounting.

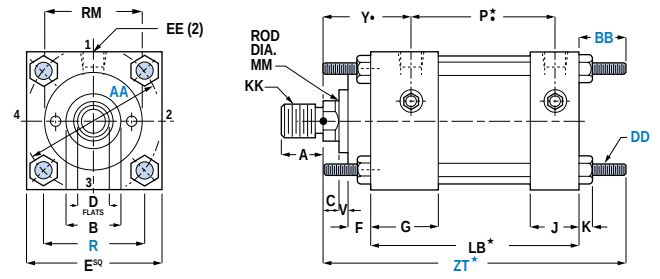
Q5J – Head Square Flange Mount (NFPA Style MF5)
Q5S – Cap Square Flange Mount (NFPA Style MF6) (1½"-6" Bores)



(MX1) L – Both tie rods extended
(MX2) N – Cap end tie rods extended)
(MX3) M – Head end tie rods extended

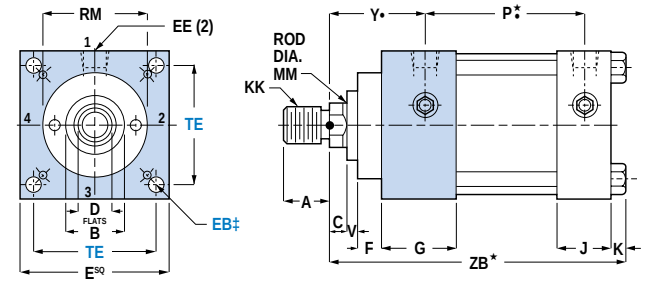
Mounting style **N** has a standard circular retainer on the head end on 2½" through 6" bores. Use **RM** dimension and **F** instead of **FH** and

Q5L, M, N – Tie Rods Extended Mount
(NFPA Style MX1, MX2, MX3) (1½"-6" Bores)

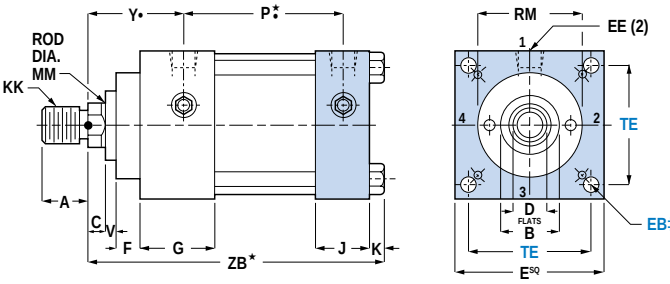


(MX1) L – Both tie rods extended
(MX2) N – Cap end tie rods extended)
(MX3) M – Head end tie rods extended

Q5L, M, N – Tie Rods Extended Mount
(NFPA Style MX1, MX2, MX3) (8" Bores)



Q5G – Head Square Mount (NFPA Style ME3) (8" Bores only)



Q5P – Cap Square Mount (NFPA Style ME4) (8" Bores only)

QT Series Air/Oil Tanks

Pressures to 200 psi maximum

Air/oil systems combine the speed and low cost of air operation with the smooth, even actuator control of oil from a standard air line source (see **Fig. 9-1**).

- Anodized aluminum caps are lightweight and corrosion resistant.
- O-ring tube-end seals provide positive sealing.
- Translucent filament-wound fiberglass tubing has a high strength-to-weight ratio and a dent resistance much higher than brass or aluminum.
- Translucent tube property also provides visual oil-level indication without the need for separate costly, easily damaged sight glasses.
- Unique Hydro-Line designed oil baffle system eliminates whirlpooling and oil forming.
- End angles provide mounting flexibility.

Sizing the Air/Oil Tank

1. Determine the volume of fluid displaced by the work cylinder by multiplying stroke by piston area (see **Table 9-1**).
2. Refer to **Table 9-2** to find the bore and length equal to or greater than this volume. In general, longer tanks of smaller bore size are most economical.
3. Suggested minimum internal length is 6".
4. Tank should be sized so that the oil level does not change more than 6" per second.
5. Selection should be based on economics, envelope dimensions and port size in high speed applications.
6. Air/oil tanks should be mounted vertically at the highest point in the system to allow self-bleeding of the tank.

Table 9-1

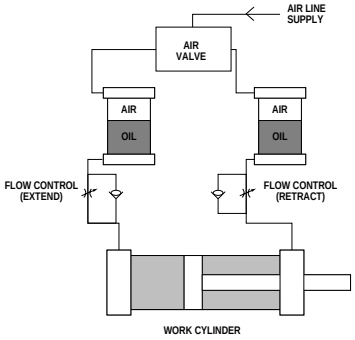
Work Cylinder Piston Area	
Cyl. Bore (inch)	Piston Area (sq. inch)
1½	1.77
2	3.14
2½	4.91
3¼	8.30
4	12.57
5	19.64
6	28.27
8	50.27

Work Cylinder Seal Selection

1. Specify nitrile lip-type piston seals and urethane ultra-seal rod seals in air/oil two tank circuits.
2. Specify air/oil piston seals and urethane ultra-seal rod seals in one tank circuits with oil on the head end of the work cylinder.
3. Specify air/oil piston seals and nitrile lip type rod seals in one tank circuits with oil on the cap end of the work cylinder.

Table 9-2 **Maximum Useable Capacities – cubic inches**

Tank Bore (inches)	Tank Length (inches)															
	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	22
2	9.2	12.3	15.1	17.7	20.5	23.1	26.2	29.1	31.8	34.5	37.4	39.9	43.1	46.2	48.7	54.1
3¼	24.4	32.6	39.9	46.8	54.1	60.9	69.2	76.9	84.1	91.3	98.8	106	114	122	129	143
5	57.3	76.5	93.8	110	127	143	163	181	198	215	232	250	268	286	304	337
8	146	195	239	280	324	365	414	461	504	547	592	637	684	729	774	858



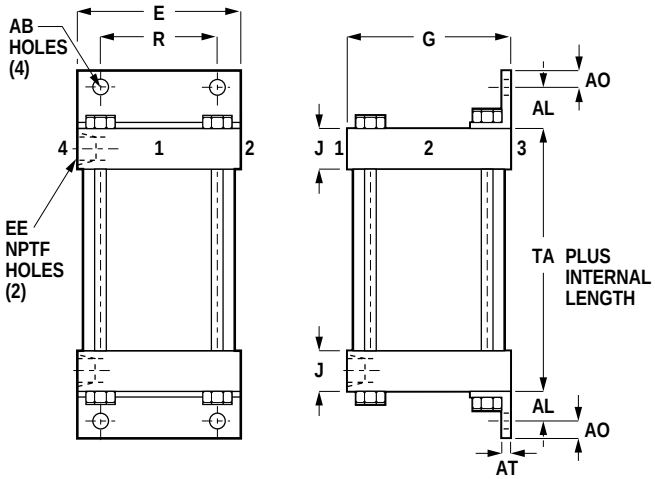


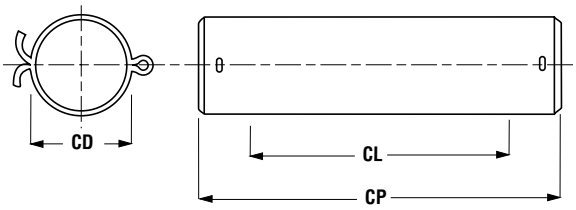
Table 9-3

Bore Size	AB	AL	AO	AT	E	EE	J	R	TA	G	H
2	7/16	1	3/8	1/8	2½	¼	1	1.75	2	2 11/16	¼
3¼	7/16	1¼	½	1/8	3¾	3/8	1¼	2.76	2½	3⅞	3/8
5	9/16	1⅜	⅝	3/16	5½	3/8	1¼	4.10	2½	5⅝	3/8
8	11/16	1 13/16	11/16	¼	8½	½	1½	6.44	3	8⅝	3/8

NOTE: Standard port location is position 4. Port positions 1 through 3 optional.
NOTE: Oversized NPTF and SAE ports optional (see page 5).

Cylinder Mounting Accessories

Pivot Pin

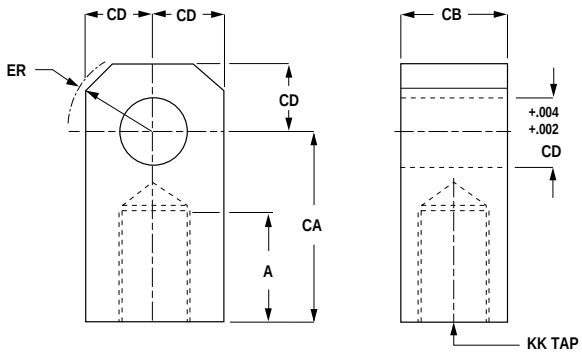


Part No.	CD	CL	CP
C-9003-3	½	1¾	2⅜
C-9004-3	¾	2½	3⅛
C-90065-3	1	3	3¾
C-9008-3	1⅜	4	4¾
C-9010-3	1¾	5	6 1/32

1. Pivot pins are furnished with clevis mounted cylinders.
2. Pivot pins must be ordered as a separate item if to be used with female eye, female clevis, NFPA eye bracket and NFPA clevis bracket.

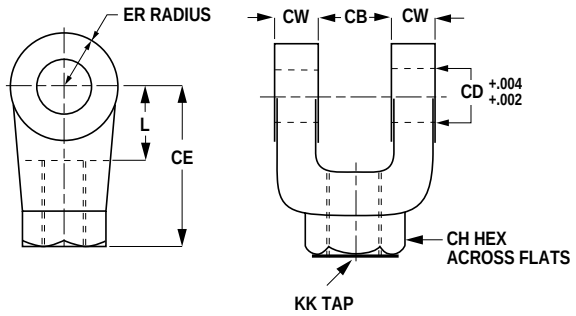
NOTE: CL = (2 x CW) + CB

Female Eye



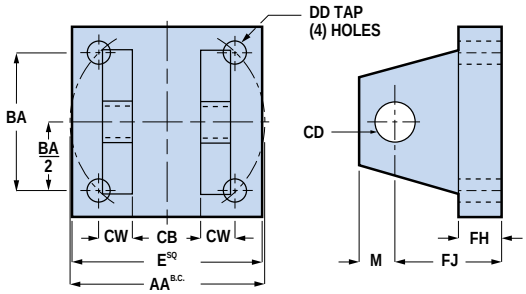
Part No.	A	CA	CB	CD	ER	KK
C-9303	¾	1½	¾	½	⅝	7/16-20
C-9304	1⅛	2 1/16	1¼	¾	⅞	¾-16
C-93065	1⅝	2 13/16	1½	1	1 3/16	1-14
C-9308	2	3 7/16	2	1⅜	1 9/16	1¼-12
C-9310	2¼	4	2½	1¾	2	1½-12

Female Clevis



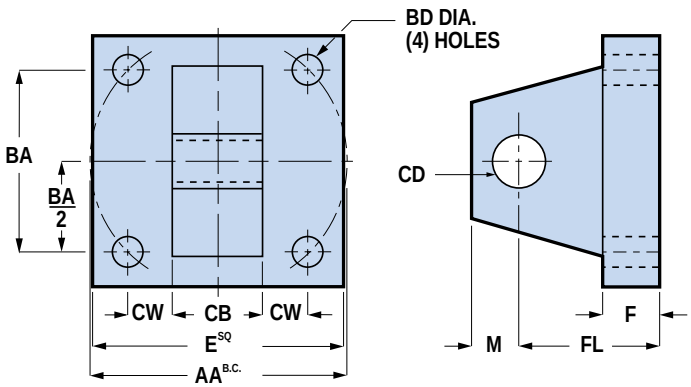
Part No.	CB	CD	CE	CH	CW	ER	KK	L
C-134-05	¾	½	1½	⅞	½	½	7/16-20	¾
C-134-08	1¼	¾	2⅜	1⅜	⅝	¾	¾-16	1¼
C-134-11	1½	1	3⅛	1⅝	¾	1	1-14	1½
C-134-14	2	1⅜	4⅛	2	1	1⅜	1¼-12	2⅛
C-134-16	2½	1¾	4½	2⅜	1¼	1¾	1½-12	2¼

NFPA Clevis Bracket



Part No.	AA	BA	CB	CD	CW	DD	E	FH	FJ	M
Q-133-03	2.3	1.62	¾	½	½	⅜-24	2½	⅜	1⅛	⅝
Q-133-05	3.6	2.56	1¼	¾	⅝	½-20	3¾	⅝	1⅞	⅞
Q-133-065	4.6	3.25	1½	1	¾	⅝-18	4½	¾	2¼	1
Q-133-08	5.4	3.81	2	1⅜	1	⅝-18	5	⅞	3	1⅜
Q-133-10	7.0	4.93	2½	1¾	1¼	⅞-14	6½	⅞	3⅛	1¾

NFPA Eye Bracket

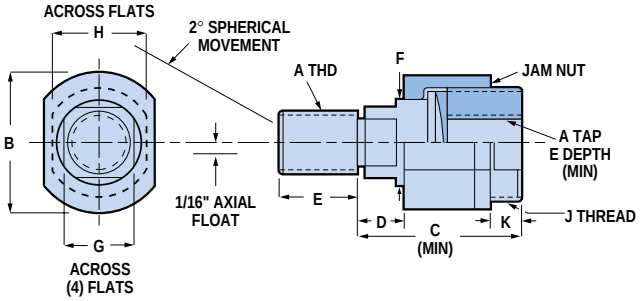


Part No.	AA	BA	BD	CB	CD	E	F	FL	M
Q-8903	2.3	1.62	13/32	3/4	1/2	2 1/2	3/8	1 1/8	5/8
Q-8904	3.6	2.56	17/32	1 1/4	3/4	3 3/4	5/8	1 7/8	7/8
C-89065	4.6	3.25	21/32	1 1/2	1	4 1/2	3/4*	2 3/8*	1
C-8908	5.4	3.81	21/32	2	1 3/8	5	7/8	3	1 3/8
C-8910	7.0	4.93	29/32	2 1/2	1 3/4	6 1/2	1 1/8*	3 3/8*	1 3/4

*Dimensions **F** and **FL** reflect revised NFPA standards.

Self-Aligning Coupler

- Increases cylinder life by reducing component wear caused by misalignment.
- Allows greater tolerance between cylinder centerline and mating component
- Prevents binding and erratic movement produced by misalignment.

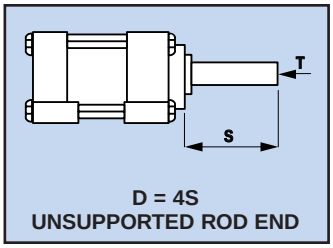


Part No.	A	B	C	D	E	F	G	H	J	K	Max. Pull at Yield
AC-2-05	7/16-20	1 1/4	2	1/2	3/4	5/8	1/2	13/16	1-14	5/16	8,320
AC-2-08	3/4-16	1 11/16	2 5/16	1/2	1 1/8	31/32	13/16	1 1/8	1 3/8-12	1/2	35,000
AC-2-11	1-14	2 3/8	2 29/32	1/2	1 5/8	1 11/32	1 5/32	1 5/8	1 7/8-12	11/16	64,500
AC-2-14	1 1/4-12	2 5/8	3 19/32	3/4	2	1 23/32	1 7/16	2	2 1/4-12	27/32	82,550
AC-2-16	1 1/2-12	3	4 5/32	7/8	2 1/4	1 31/32	1 3/4	2 3/8	2 5/8-12	29/32	128,340

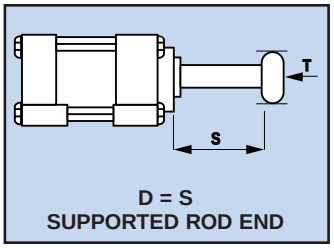
Rod End Accessories Guide

O.D. THD.	Female Clevis	NFPA Eye Bracket	Pivot Pin	NFPA Female Eye	NFPA Clevis Bracket	Bore (Std. Rod Dia. with #2 Rod End Style)
7/16-20	C-134-05	Q-8903	C-9003-3	C-9303	Q-133-03	1 1/2, 2, 2 1/2
3/4-16	C-134-08	Q-8904	C-9004-3	C-9304	Q-133-05	3 1/4, 4, 5
1-14	C-134-11	Q-89065	C-90065-3	C-93065	Q-133-065	6, 8

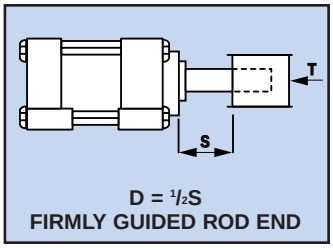
Hydro-Line Technical Data
Rod Size and Stop Tube Selection



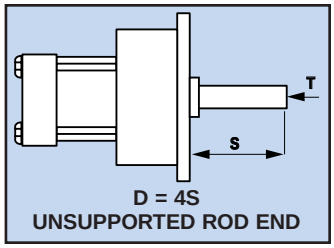
D = 4S
UNSUPPORTED ROD END



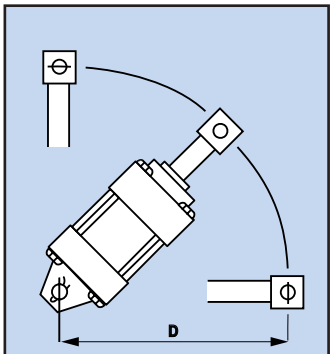
D = S
SUPPORTED ROD END



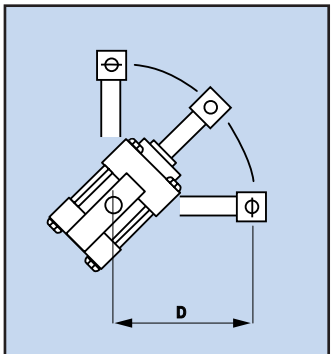
D = ½S
FIRMLY GUIDED ROD END



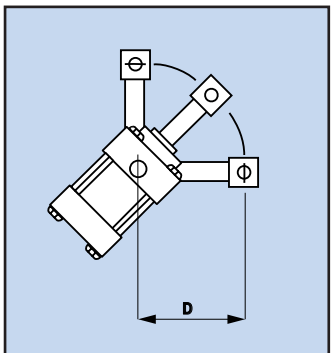
D = 4S
UNSUPPORTED ROD END



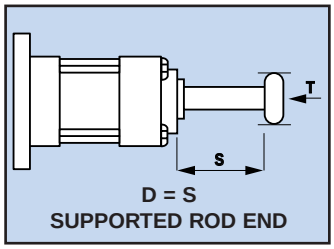
CAP CLEVIS
OR TRUNNION



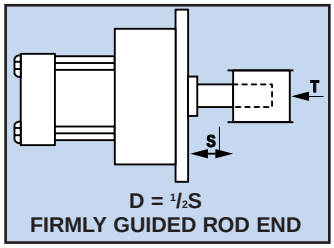
INTERMEDIATE
TRUNNION



HEAD
TRUNNION



D = S
SUPPORTED ROD END

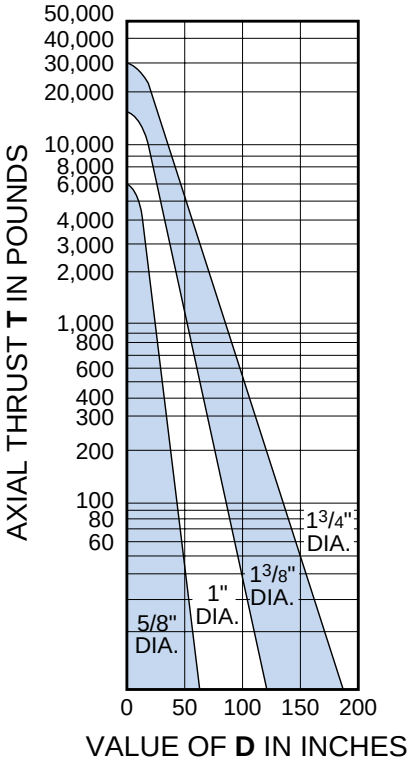


D = ½S
FIRMLY GUIDED ROD END

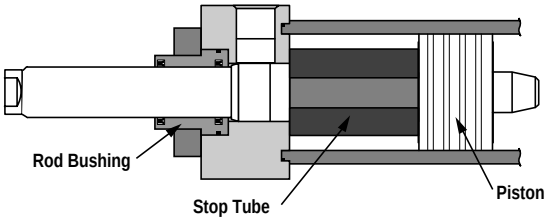
Rod Size Selection

Standard rod sizes are normally suitable for all applications except for long stroke or high thrust applications. Proper selection of minimum rod size may be determined by the following steps:

1. With knowledge of bore size and stroke, thrust may be determined. Refer to graph in next column.
2. Select from illustrations above the type of mounting to be used and determine the length of **D** with the piston rod in the fully extended position.
3. Find the value of **D** at the bottom of the graph and follow its line vertically until it intercepts the horizontal line representing the maximum push thrust that will be applied to your cylinder. The intersection of these two lines will fall within a stripe representing the minimum recommended piston rod diameter for your application.



Stop Tubes



Stop tubes are located between the piston and the rod shoulder on the head end of the cylinder. Bearing loading is reduced by separating the piston and the rod bushing. Bearing wear and tendency to buckle is reduced.

To determine if a stop tube is required and the length of stop tube needed, use the following procedure:

Determine the value of **D** with the piston rod in the fully extended position. If the value of **D** is under 40", no stop tube is needed. If **D** is greater than 40", one inch of stop tube is recommended for each 10" or fraction thereof beyond 40".

Special note: When specifying stroke and stop tube lengths, please include net working stroke plus stop tube length.

Cushions

Cushions are recommended when piston speed is in excess of 20-25 feet per minute. Cushions decelerate the piston and rod assembly at the end of the stroke, lessening the noise and shock and increasing cylinder life. Heavy loads that are attached to piston and rod assembly should be stopped by external means such as shock absorbers, springs, decelerating valves, etc.

Low Profile Reed and Hall Effect Switches

Hydro-Line Low Profile Reed and Hall effect switches are available for all bore size Q5, A5 and E-Line Series cylinders. These switches are activated by a magnetic band fitted around the cylinder position. Signals from these switches are used as input to programmable controllers, sequencers, relays, and in some cases, to drive valve solenoids.

Benefits

- Low profile design is considerably smaller than conventional switches, saving space and providing additional mounting flexibility. (See mounting dimensions.)
- Low profile bracket attaches securely to one tie rod and is easily adjusted over the entire piston travel.
- Several switches may be mounted to control or initiate any sequence or function.
- LED indicator provides convenient means for positioning and troubleshooting circuits.
- Optional quick-connect versions allow electrical disconnection without changing the adjustment of the switch on the cylinder.

Low Profile Switch Selection

Use the requirements in the chart at the right to determine which switch fits the application. By using the process of elimination, you should be able to choose the proper switch. See the specifications for each switch to confirm your choice.

	Part No.			
	C-463 & C-463-1	C-464 & C-464-1	C-462 & C-462-1	C-461 & C-461-1
Requirements	**Hall (Sink)**	**Hall (Source)**	**DC Reed**	**AC Reed**
AC				X
DC	X	X	X	
Mechanical Switch			X	X
Solid State Switch (zero bounce)	X	X		
Input for Programmable Controller	X	X	X	X
Coil Direct		X		
Longest Life	X	X		

NOTE: Transient protection should be used with most any switch wired direct to coil.

Low Profile Hall Effect Switches

Hydro-Line Low Profile Hall Effect Switches are solid-state devices designed specifically to provide an input signal to various types of programmable controllers or logic systems. Since Hall Effect Switches are solid-state, there are no moving parts to wear out. Due to this, the switches offer an infinite number of trouble-free operations. Hall Effect Switches operate on DC current only.

	Part No.	
	C-463 & C-463-1	C-464 & C-464-1
Operating Principle	Hall Effect	
Actuated By	Piston Magnet	
Input Voltage	4.5 to 24 VDC	
Output Type	Sinking (NPN)	Sourcing (PNP)
Current Rating	20 mA. Max.	100 mA. Max.
Voltage Drop	.5 VDC Max.	
Switch Burden	10 mA. Max.	
Environmental	NEMA 1, 2, 3, 4, 12, 13, IEC IP67	
Operating Temperature	32° to 176°F	
Switch Color	Yellow	Red

Hall Effect Working Principle

Hydro-Line Low Profile Hall Effect Switches contain a Hall generator (or semi-conductor) which has a current flowing through it (**Fig. 13-1**). Voltage at the edges of the Hall generator equals 0. When influenced by a magnet, negatively charged electrons "pile up" on one edge of the Hall generator and positive charges on the other, creating a Hall Voltage (V≠0, **Fig. 13-2**). This voltage provides the input to the controlling system.

Fig. 13-1

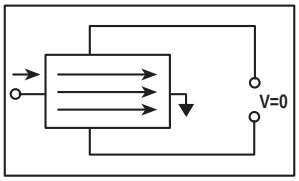
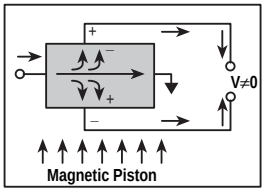


Fig. 13-2



Sink vs. Source

Hall Effect Switches are available in either a Sink or Source model. The Sink Output connects the load (controller or logic system) to ground (**Fig. 13-3**). The Source Output connects the load (controller or logic system) to positive (**Fig. 13-4**). These two outputs are supplied because different logic systems require either current sinking or current sourcing inputs.

Fig. 13-3

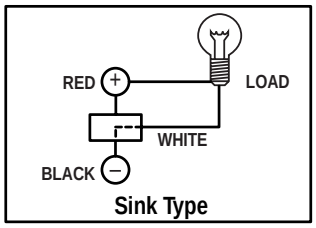
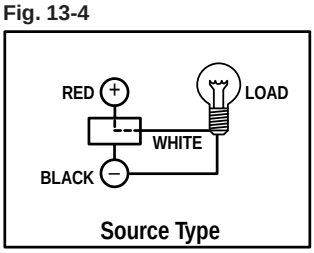
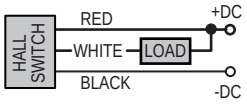


Fig. 13-4

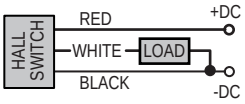


Low Profile Hall Effect Switch Wiring Schematics

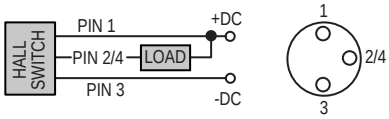
Part No. C-463



Part No. C-464

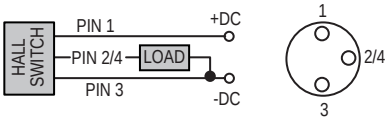


Part No. C-463-1



Hall Effect - Sink - NPN

Part No. C-464-1



Hall Effect - Source - PNP

NOTE: LED has been omitted from the schematics for clarity.

Low Profile Reed Switches

Hydro-Line Low Profile Reed Switches are available in either an AC or DC model. They are ideal for use as inputs for many types of sequencers and programmable controllers. In some cases they can be used to drive some relays or valve solenoids. However, electrical transients (inrush currents or line spikes) associated with inductive or capacitive loads can damage and shorten the life of the switch.

	Part No.	
	C-461 & C-461-1	C-462 & C-462-1
Operating Principle	Magnetic Reed	
Actuated By	Piston Magnet	
Input Voltage	110 to 120 VAC	4.5 to 24 VDC
Current Rating	Inter. limited to 25 mA	200 mA. Switched
Contact Resistance	1.5 Ohm Max.	90 mOhm Max.
Output Type	Contact Closure	
Environmental	NEMA 1, 2, 3, 4, 12, 13, IEC IP67	
Operating Temperature	32° to 176°F	
Switch Color	Green	White

Reed Working Principle

Hydro-Line Low Profile Reed Switches contain hermetically sealed reeds (mechanical contacts) which are open in their normal state (**Fig. 13-5**). When the piston with an axial magnetic band moves within proximity of the switch, magnetism is induced into the reeds. Since magnetic poles attract each other, the ends of the reeds are drawn together making electrical contact (**Fig. 13-6**). As the piston (with the magnet) moves away, the reeds assume their original open position.

Fig. 13-5

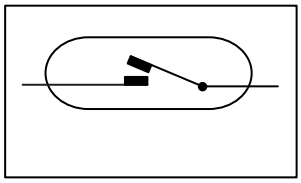
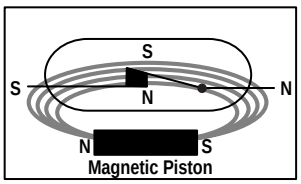
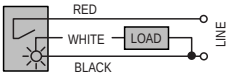


Fig. 13-6

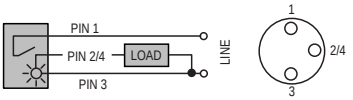


Low Profile Reed Switch Wiring Schematics

Part No. C-461

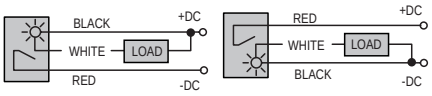


Part No. C-461-1

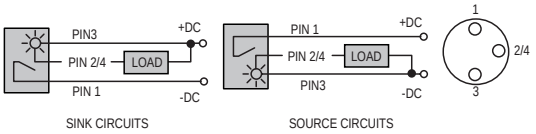


Reed – AC

Part No. C-462



Part No. C-462-1



Reed – DC

NOTE: Bi-polar LED emits a green light in the sinking circuit and a red light in the sourcing circuit.

Switch Mounting Brackets

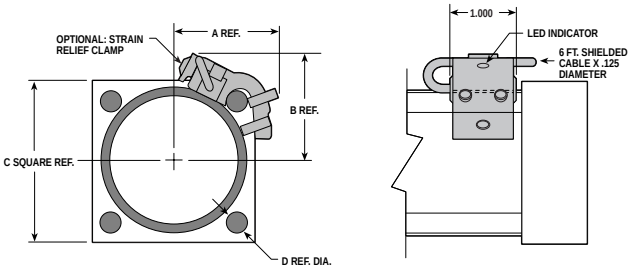
Two different size brackets are required to cover eight bore sizes.

The extruded aluminum brackets mount securely to a single tie rod and do not allow the switch to pull away from the cylinder barrel.

Optional strain relief clamps may be used to protect the switch cable from damage at the switch due to flexing.

Switch Part No.	Cylinder Bore	Switch Bracket Part No.	Strain Relief Clamp Part No.
C-461, C-461-1 C-462, C-462-1	1½, 2, 2½, 3¼ & 4	C-465-1	C-466
C-463, C-463-1 C-464, C-464-1	5, 6 & 8	C-465-2	

Mounting Dimensions



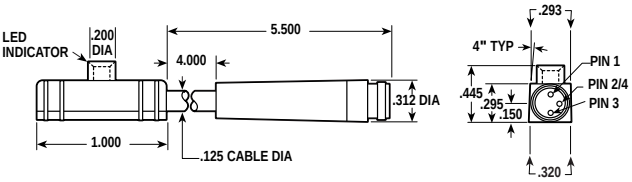
Bore Size	Letter Dimension			
	A	B	C	D
1½"	1.375	1.500	2.000	.250
2"	1.500	1.750	2.500	.312
2½"	1.750	1.875	3.000	.312
3¼"	2.000	2.187	3.750	.375
4"	2.375	2.500	4.500	.375
5"	3.000	3.125	5.500	.500
6"	3.375	3.375	6.500	.500
8"	4.000	4.125	8.500	.625

Quick Connect Option

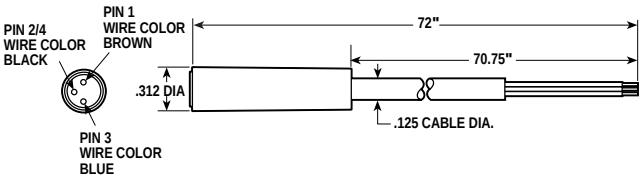
All Low Profile Reed and Hall Effect Switches are available with quick connect cable option, shown by a (-1) after the standard switch part number (i.e. C-463-1).

NOTE: Quick connect switches do not include mating cable assembly. Order Part No. C-468.

Dimensions – Quick Connect

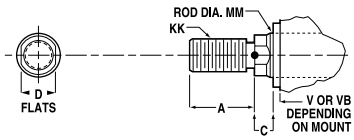
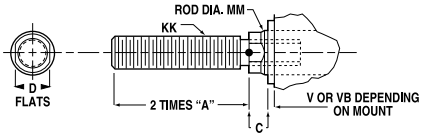
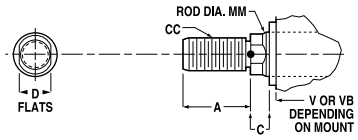
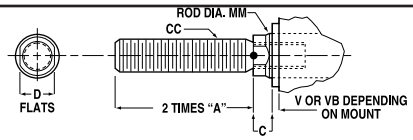
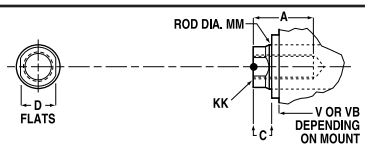
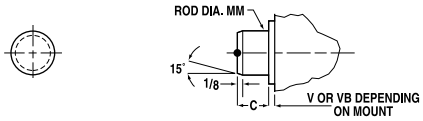
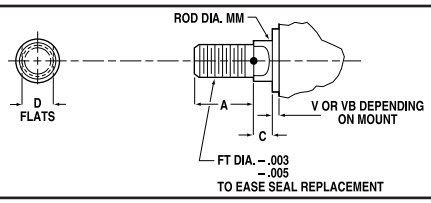
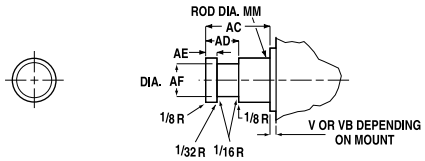


Quick Connector Cable Assembly – Part No. C468



Rod End Styles

Choose from eight

Rod End Style No.	Dimensions
2 STD ★	
2X	
1	
1X	
4 STD ★★	
5	
6	
10	

★ Male Rod End Style No. 2 is standard and will be furnished unless otherwise specified.

★★ Rod End Style No. 4 will be furnished when female thread is required unless otherwise specified.

NOTE: All Hydro-Line mounting accessories are designed to fit Nos. 2 and 2X Rod End Styles only.

NOTE: Rods larger than 5/8" diameter are turned down below **MM** diameter to ease seal replacement. A 1/8" long taper begins 1/16" from pilot face and leads to the turned down diameter, except on Rod Style Nos. 5 and 6.

FIVE YEAR LIMITED WARRANTY

Five Years

Hydro-Line Products are warranted for a period of five years from date of shipment from our plant to be free from defects in workmanship and material under correct use, normal operating conditions and proper applications. This warranty does not extend to goods damaged, or subjected to accident, abuse, or misuse after shipment from our factory, nor to goods altered or repaired by anyone other than authorized Hydro-Line representatives.

Disclaimers

This five year limited warranty is the only warranty extended by Hydro-Line in connection with any sale by Hydro-Line. **THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE,** notwithstanding disclosure to Hydro-Line of the product's intended use. An affirmation of fact or promise made on behalf of Hydro-Line shall not be deemed to create an express warranty that the goods shall conform to the affirmation of promise; any description of the goods is for the sole purpose of identifying them and shall not be deemed to create an express warranty that the goods shall conform to such description; any sample or model is for illustrative purposes only and shall not be deemed to create an express warranty that the goods shall conform to the sample or model; and no affirmation or promise, or description, or sample or model, shall be deemed part of the basis of the bargain.

Exclusive Remedy

Hydro-Line's obligation upon breach of warranty shall be limited to replacing or repairing at our option, free of charge, but not including installation, dismantling, reassembling or any other charge, the particular product or part which inspection discloses to have been defective at time of shipment. Inspection may be at the place of installation and use, or at our plant if returned to us at our expense including lowest transportation cost, is requested. Written notice of such defect shall be given by customer to Hydro-Line within 30 days after such defect(s) appear. Written permission for any warranty claim return must be first obtained from authorized Hydro-Line representatives. **All returns must be accompanied with a complete written explanation of claimed defects and the circumstances of operational failure.** Replacement of cylinders or parts thereof repaired under this warranty shall be warranted under the terms of this warranty for the remainder of the term of the original warranty or for a period of six months after such repair or replacement, whichever is longer. Upon expiration of the warranty, all of Hydro-Line's obligations hereunder shall terminate.

IN NO EVENT SHALL HYDRO-LINE HAVE ANY LIABILITY FOR PAYMENT OF ANY CONSEQUENTIAL, INCIDENTAL, INDIRECT, SPECIAL OR TORT DAMAGES OF ANY KIND INCLUDING, BUT NOT LIMITED TO, ANY LOSS OF PROFITS, TO THE EXTENT EXCLUSION IS PERMITTED BY LAW.

This warranty states our entire and exclusive liability and buyer's exclusive remedy for any claim of damages in connection with the sale or furnishing of Hydro-Line's products or parts, their design, suitability for use, installations or operation, or for any claimed defects therein. **Goods not manufactured by Hydro-Line are furnished subject only to the Manufacturer's warranties, if any, and without warranties, express or implied, by Hydro-Line.**

Cylinder Dimensions

BORE	1 1/2	2	2 1/2	3 1/4	4	5	6	8
A	3/4	3/4	3/4	1 1/8	1 1/8	1 1/8	1 5/8	1 5/8
AA	2.02	2.6	3.1	3.9	4.7	5.8	6.9	9.1
AB‡	7/16	7/16	7/16	9/16	9/16	11/16	13/16	13/16
AC	1 1/8	1 1/8	1 1/8	1 1/2	1 1/2	1 1/2	1 3/4	1 3/4
AD	5/8	5/8	5/8	15/16	15/16	15/16	1 1/16	1 1/16
AE	1/4	1/4	1/4	3/8	3/8	3/8	3/8	3/8
AF	3/8	3/8	3/8	11/16	11/16	11/16	7/8	7/8
AH	1 3/16	1 7/16	1 5/8	1 15/16	2 1/4	2 3/4	3 1/4	4 1/4
AL	1	1	1	1 1/4	1 1/4	1 3/8	1 3/8	1 13/16
AO	3/8	3/8	3/8	1/2	1/2	5/8	5/8	11/16
AT	1/8	1/8	1/8	1/8	1/8	3/16	1/4	1/4
B -.001 -.003	1 1/8	1 1/8	1 1/8	1 1/2	1 1/2	1 1/2	2	2
BB	1	1 1/8	1 1/8	1 3/8	1 3/8	1 13/16	1 13/16	2 5/16
BD	1 1/4	1 1/2	1 1/2	1 3/4	1 3/4	2	2	2 1/2
C	3/8	3/8	3/8	1/2	1/2	1/2	5/8	5/8
CB	3/4	3/4	3/4	1 1/4	1 1/4	1 1/4	1 1/2	1 1/2
CC	1/2-20	1/2-20	1/2-20	7/8-14	7/8-14	7/8-14	1 1/4-12	1 1/4-12
CD	1/2	1/2	1/2	3/4	3/4	3/4	1	1
CW	1/2	1/2	1/2	5/8	5/8	5/8	3/4	3/4
D	17/32	17/32	17/32	7/8	7/8	7/8	1 1/8	1 1/8
DD	1/4-28	5/16-24	5/16-24	3/8-24	3/8-24	1/2-20	1/2-20	5/8-18
E	2	2 1/2	3	3 3/4	4 1/2	5 1/2	6 1/2	8 1/2
EB‡	5/16	3/8	3/8	7/16	7/16	9/16	9/16	11/16
EE (NPT)	1/4	1/4	1/4	3/8	3/8	3/8	1/2	1/2
EE (SAE)	6	6	6	10	10	10	12	12
EF	1/2	1/2	1/2	–	–	7/8	7/8	–
EG	7/16	15/32	5/8	–	–	1 1/4	1 1/4	–
EL	3/4	15/16	1 1/16	7/8	1	1 1/16	1	1 1/8
EO	1/4	5/16	5/16	3/8	3/8	1/2	1/2	5/8
ET	9/16	3/4	7/8	1	1 1/4	1 1/2	1 5/8	2
F	▲	▲	11/32	1/2	1/2	1/2	19/32	19/32
FB‡	5/16	3/8	3/8	7/16	7/16	9/16	9/16	–
FH	3/8	3/8	3/8	5/8	5/8	5/8	3/4	1
FT	5/8-18	5/8-18	5/8-18	1-14	1-14	1-14	1 3/8-12	1 3/8-12
G	1 1/2	1 1/2	1 1/2	1 3/4	1 3/4	1 3/4	2	2
J	1	1	1	1 1/4	1 1/4	1 1/4	1 1/2	1 1/2
K	1/4	5/16	5/16	3/8	3/8	7/16	7/16	9/16
KK	7/16-20	7/16-20	7/16-20	3/4-16	3/4-16	3/4-16	1-14	1-14
L	3/4	3/4	3/4	1 1/4	1 1/4	1 1/4	1 1/2	1 1/2
LB★	3 5/8	3 5/8	3 3/4	4 1/4	4 1/4	4 1/2	5	5 1/8
LD★	4 1/8	4 1/8	4 1/4	4 3/4	4 3/4	5	5 1/2	5 5/8
LR	9/16	1 1/16	1 1/16	1 1/4	1 7/8	1 15/16	2 1/16	2 11/16
M	5/8	5/8	5/8	7/8	7/8	7/8	1 1/4	1
MM	5/8	5/8	5/8	1	1	1	1 3/8	1 3/8
MR	9/16	1 1/16	1 1/16	1 1/8	1 3/4	1 7/8	2 1/8	2 3/4
NT	1/4-20	5/16-18	3/8-16	1/2-13	1/2-13	5/8-11	3/4-10	3/4-10

BORE	1 1/2	2	2 1/2	3 1/4	4	5	6	8
P★	2 9/32	2 13/32	2 27/64	2 43/64	2 43/64	2 59/64	3 5/32	3 9/32
R	1.43	1.84	2.19	2.76	3.32	4.10	4.88	6.44
RM	§	§	2 3/8	2 5/8	2 5/8	2 5/8	3 1/4	3 1/4
S	1.43	1.84	2.19	2.76	3.32	4.10	4.88	6.44
SA★	6	6	6 1/8	7 3/8	7 3/8	7 7/8	8 1/2	8 3/4
SB‡	13/32	13/32	13/32	17/32	17/32	25/32	25/32	25/32
SE★	5 1/2	5 7/8	6 1/4	6 5/8	6 7/8	7 1/4	7 3/4	7 7/8
SJ	5/8	5/8	5/8	3/4	3/4	9/16	13/16	13/16
SN★	2 1/4	2 1/4	2 3/8	2 5/8	2 5/8	2 7/8	3 1/8	3 1/4
SS★	2 7/8	2 7/8	3	3 1/4	3 1/4	3 3/8	3 5/8	3 3/4
ST	1/2	1/2	1/2	3/4	3/4	1	1	1
SU	1 1/8	1 1/8	1 1/8	1 1/4	1 1/4	1 1/16	1 5/16	1 5/16
SW	3/8	3/8	3/8	1/2	1/2	11/16	11/16	11/16
TD	1	1	1	1	1	1	1 3/8	1 3/8
TE	–	–	–	–	–	–	–	7.57
TF	2 3/4	3 3/8	3 7/8	4 11/16	5 7/16	6 5/8	7 5/8	7.57
TK	3/8	1/2	5/8	3/4	3/4	1	1 1/8	1 1/8
TL	1	1	1	1	1	1	1 3/8	1 3/8
TM	2 1/2	3	3 1/2	4 1/2	5 1/4	6 1/4	7 5/8	9 3/4
TN	5/8	7/8	1 1/4	1 1/2	2 1/16	2 11/16	3 1/4	4 1/2
TS	2 3/4	3 1/4	3 3/4	4 3/4	5 1/2	6 7/8	7 7/8	9 7/8
UF	3 3/8	4 1/8	4 5/8	5 1/2	6 1/4	7 5/8	8 5/8	–
UM	4 1/2	5	5 1/2	6 1/2	7 1/4	8 1/4	10 3/8	12 1/2
US	3 1/2	4	4 1/2	5 3/4	6 1/2	8 1/4	9 1/4	11 1/4
UT	4	4 1/2	5	5 3/4	6 1/2	7 1/2	9 1/4	11 1/4
UV	2 1/2	3	3 1/2	4 1/4	5	6	7	9 1/2
V	▲	▲	9/32	3/8	3/8	3/8	13/32	13/32
VB▲	1/4	1/4	1/4	1/4	1/4	1/4	1/4	–
W	5/8	5/8	5/8	3/4	3/4	3/4	7/8	–
XA★	5 5/8	5 5/8	5 3/4	6 7/8	6 7/8	7 1/4	8	8 9/16
XC★	5 3/8	5 3/8	5 1/2	6 7/8	6 7/8	7 1/8	8 1/8	–
XD★	5 3/4	5 3/4	5 7/8	7 1/2	7 1/2	7 3/4	8 7/8	9
XE★	5 3/8	5 9/16	5 13/16	6 1/2	6 5/8	6 15/16	7 5/8	7 7/8
XG	1 3/4	1 3/4	1 3/4	2 1/4	2 1/4	2 1/4	2 5/8	2 5/8
XI	CUSTOMER TO SPECIFY							
XJ★	4 1/8	4 1/8	4 1/4	5	5	5 1/4	5 7/8	6
XS	1 3/8	1 3/8	1 3/8	1 7/8	1 7/8	2 1/16	2 5/16	2 5/16
XT	1 15/16	1 15/16	1 15/16	2 7/16	2 7/16	2 7/16	2 13/16	2 13/16
Y	1 31/32	1 55/64	1 55/64	2 25/64	2 25/64	2 25/64	2 25/32	2 25/32
ZB★	4 7/8	4 15/16	5 1/16	6	6	6 5/16	7 1/16	7 5/16
ZE★	5 5/8	5 7/8	6 1/8	6 7/8	7	7 7/16	8 1/8	8 1/2
ZF★	5	5	5 1/8	6 1/4	6 1/4	6 1/2	7 3/8	–
ZJ★	–	–	–	–	–	–	–	6 3/4
ZL★	5 1/2	5 1/2	5 19/32	6 5/8	6 5/8	6 7/8	7 23/32	7 27/32
ZM	6 1/8	6 1/8	6 1/4	7 1/2	7 1/2	7 3/4	8 3/4	8 7/8
ZT★	5 5/8	5 3/4	5 7/8	7	7	7 11/16	8 7/16	9 1/16
PISTON THICKNESS	1 1/8	1 1/8	1 1/4	1 1/4	1 1/4	1 1/2	1 1/2	1 5/8

Oversize Rods affect dimensions in grey-shaded areas. See chart below.

Oversize Rod Information

The dimensions listed are those which change when oversize rods are used.

BORE	1 1/2	2	2 1/2	3 1/4	4	5	6	8
MM	1•#§■	1§	1	1 3/8	1 3/8	1 3/8	1 3/4	1 3/4
KK	3/4-16	3/4-16	3/4-16	1-14	1-14	1-14	1 1/4-12	1 1/4-12
CC	7/8-14	7/8-14	7/8-14	1 1/4-12	1 1/4-12	1 1/4-12	1 1/2-12	1 1/2-12
FT	1-14	1-14	1-14	1 3/8-12	1 3/8-12	1 3/8-12	1 3/4-12	1 3/4-12
A	1 1/8	1 1/8	1 1/8	1 5/8	1 5/8	1 5/8	2	2
AC	1 5/8	1 5/8	1 5/8	1 3/4	1 3/4	1 3/4	2	2
AD	15/16	15/16	15/16	1 1/16	1 1/16	1 1/16	1 5/16	1 5/16
AE	3/8	3/8	3/8	3/8	3/8	3/8	1/2	1/2
AF	11/16	11/16	11/16	7/8	7/8	7/8	1 1/8	1 1/8
B -.001 -.003	1 1/2	1 1/2	1 1/2	2	2	2	2 3/8	2 3/8
C	1/2	1/2	1/2	5/8	5/8	5/8	3/4	3/4
D	7/8	7/8	7/8	1 1/8	1 1/8	1 1/8	1 1/2	1 1/2
F	▲	▲	11/32	19/32	19/32	19/32	19/32	19/32
P•	2 3/16	–	–	–	–	–	–	–
RM	§	§	2 31/64	3 1/4	3 1/4	3 1/4	3 7/8	3 7/8
V	▲	▲	17/32	13/32	13/32	13/32	17/32	17/32
VB	1/2	1/2	1/2	3/8	3/8	3/8	3/8	–

BORE	1 1/2	2	2 1/2	3 1/4	4	5	6	8
W	1	1	1	1	1	1	1 1/8	–
XA★	6	6	6 1/8	7 1/8	7 1/8	7 1/2	8 1/4	8 13/16
XC★	5 3/4	5 3/4	5 7/8	7 1/8	7 1/8	7 7/8	8 3/8	–
XD★	6 1/8	6 1/8	6 1/4	7 3/4	7 3/4	8	9 1/8	9 1/4
XE★	5 3/4	5 15/16	6 3/16	6 3/4	6 7/8	7 3/16	7 7/8	8 1/8
XG	–	2 1/8	2 1/8	2 1/2	2 1/2	2 1/2	2 7/8	2 7/8
XJ★	4 1/2	4 1/2	4 5/8	5 1/4	5 1/4	5 1/2	6 1/8	6 1/4
XS	1 3/4	1 3/4	1 3/4	2 1/8	2 1/8	2 5/16	2 9/16	2 9/16
XT	2 5/16	2 5/16	2 5/16	2 11/16	2 11/16	2 11/16	3 1/16	3 1/16
Y	2 7/16	1 47/64	1 47/64	2 41/61	2 41/61	2 41/61	3 1/32	3 1/32
ZB★	5 1/4	5 5/16	5 7/16	6 1/4	6 1/4	6 9/16	7 5/16	7 9/16
ZE★	6	6 1/4	6 1/2	7 1/8	7 1/4	7 11/16	8 3/8	8 3/4
ZF★	5 3/8	5 3/8	5 1/2	6 1/2	6 1/2	6 3/4	7 5/8	–
ZJ★	–	–	–	–	–	–	–	7
ZL★	5 7/8	5 7/8	5 31/32	6 31/32	6 31/32	7 1/32	7 31/32	8 3/32
ZM	6 7/8	6 7/8	7	8	8	8 1/4	9 1/4	9 3/8
ZT★	6	6 1/8	6 1/4	7 1/4	7 1/4	7 15/16	8 11/16	9 5/16

‡ Use screws 1/16" smaller than mounting holes.
• Cushion not available on head end.
Mount **B** not available in this bore and rod combination.

★ Add stroke to all dimensions with an asterisk.
▲ If no dimension given, use **FH** dimension in place of **F** and **VB** in place of **V.**
NOTE: NPTF ports standard on Q5; SAE ports standard on HQ5

§ This bore size and rod combination uses a full front retaining plate.
■ Mount **U** not available in this bore and rod combination.
Dimensions shown in blue are mounting dimensions.

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