

PFLF Series *POSITION FEEDBACK* **Aluminum Cylinders** **1.50" to 8.00" Bore**

PFLF Series Cylinders

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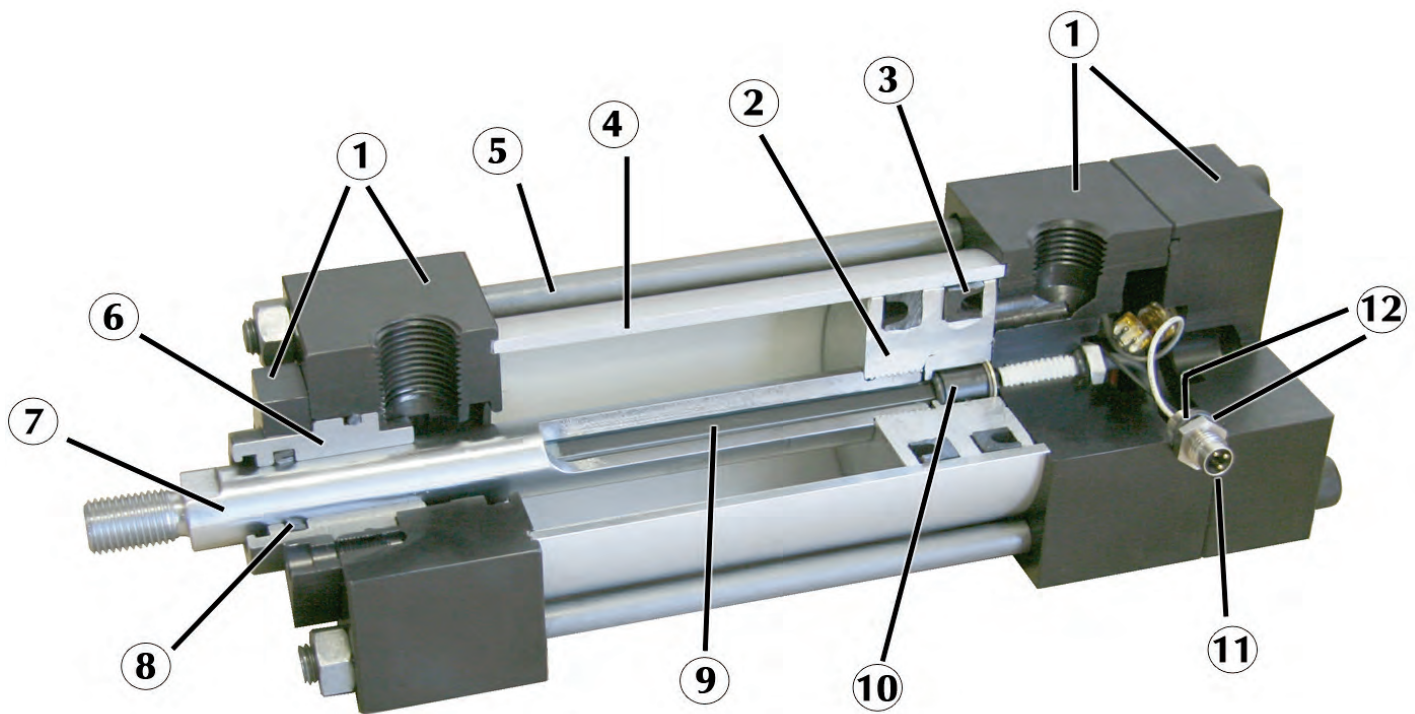
PCS Position Control System

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**95% OF OUR CYLINDERS SHIP IN 2-3 DAYS!
ONE DAY RUSH SERVICE AVAILABLE ON ALL CATALOGED CYLINDER MODELS!**

POSITION FEEDBACK LOW FRICTION (PFLF) CYLINDER



- ① **HEAD, CAP & RETAINER** – Precision machined from high strength 6061-T6 aluminum alloy. Black anodized for corrosion resistance.
- ② **PISTON** – Precision machined from high strength aluminum alloy for light weight and extended cycle life.
- ③ **PISTON SEALS** – Seals are low friction and packed with special low friction non-migrating Teflon® based grease for permanent lubrication. Lip seals are pressure activated and wear compensating.
- ④ **CYLINDER TUBE** – Precision machined from 6063-T832 high tensile aluminum alloy and hard coat to 60 Rc for wear resistance and extended cycle life.
- ⑤ **TIE RODS** – Prestressed tie rod construction eliminates axial loading of cylinder tube and maintains compression on tube end seals.
- ⑥ **BEARING** – Precision machined from graphite filled cast iron and Teflon® coated to reduce friction and extend cycle life. Design allows increased lubrication in effective bearing area.
- ⑦ **PISTON ROD** – Precision machined from high yield, polished and chrome plated steel.
- ⑧ **ROD SEAL** – Seals are low friction and packed with special low friction non-migrating Teflon® based grease for permanent lubrication. Lip seals are pressure activated and wear compensating. **(Rod wiper is omitted unless requested - see options note on performance).**
- ⑨ **LINEAR RESISTIVE TRANSDUCER (LRT) PROBE** – The LRT probe is an anodized aluminum probe with Delrin® threaded flange, o-ring and back-up washer. The probe has infinite resolution, nonlinearity of ± 1 percent of full stroke and a rated life of 10 million cycles. Typical probe input is 10 VDC, input impedance required is 1 Mohm with a temperature rating of 0 ° to +200 °F.
- ⑩ **LINEAR RESISTIVE TRANSDUCER (LRT) WIPER** – The LRT wiper is completely assembled precision molded assembly with a rated life of 1000 linear miles.
- ⑪ **(3) PIN CONNECTOR** - This connector is supplied on all PFLF cylinders. The connector has a universal 8mm (3) pin DIN male connection.
- ⑫ **O-RINGS** - To provide a positive seal to prevent any contaminants or liquids from entering cylinder cavity and affecting cylinder performance.

Features of the PFLF Cylinder

- Continuous Position Sensing
- Highly Accurate: Infinite resolution, linearity of ± 1 percent of full stroke, $\pm .001$ " mechanical repeatability
- Strokes up to 24"
- Easily Repairable
- Electronic Controllers available for dual set point and scalable analog output applications.
- Closed Loop Pneumatic Control Systems (PCS) available for 1.50" thru 4.00" bores.
- Permanently Lubricated Seals
- Quick Connect (IP67) Standard on all models.

PFLF - How to Order
 PFLF - How it works
 PFLF Dimensions
 Component Repair Kits
 PCS - Pneumatic Control System
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HOW TO ORDER: POSITION FEEDBACK LOW FRICTION (PFLF)

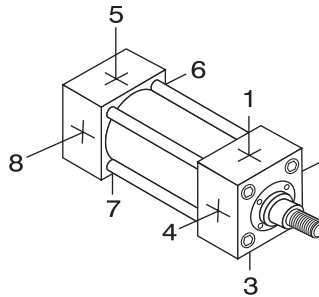
PFLF - **MS4** - **4.00** x **10** - **KK3** - **MPR**

SERIES		NFPA MOUNTS		BORE		STROKE		CYLINDER OPTIONS	
PFLF	ANODIZED ALUMINUM	MX0	NO MOUNT (1.50"- 8.00" Bore)	1.50	2.00	2"-24"(1.50" - 2.50") 3"-24"(3.25" - 8.00")		B*	.25" URETHANE BUMPER BOTH ENDS
		MP1	REAR PIVOT CLEVIS (1.50"- 8.00" Bore)	2.50	3.25			BC*	.25" URETHANE BUMPER CAP ONLY
		MP2	REAR PIVOT CLEVIS (1.50"- 6.00" Bore)	4.00	5.00			BH*	.25" URETHANE BUMPER HEAD ONLY
		MP4	REAR PIVOT EYE (1.50"- 4.00" Bore)	6.00	8.00			A =	EXTENDED PISTON ROD THREAD - SPECIFY (Example: A = 2")
		MT1	FRONT TRUNNION (1.50"- 8.00" Bore)					C =	EXTENDED PISTON ROD - SPECIFY (Example: C = 1.5")
		MT2	REAR TRUNNION (1.50"- 8.00" Bore)					EN	ELECTROLESS NICKEL PLATED
		MT4	INTERMEDIATE TRUNNION (1.50"- 8.00" Bore)					KK2	LARGE MALE ROD THREAD
		MX3	EXTENDED TIE-RODS (HEAD) (1.50"- 8.00" Bore)					KK3	FEMALE ROD THREAD
		MF1	FRONT FLANGE (1.50"- 6.00" Bore)					KK4	FULL DIAMETER MALE ROD THREAD
		MF2	REAR FLANGE (1.50"- 6.00" Bore)					MPR	MAGNETIC PISTON FOR REED SWITCHES
		ME3	FRONT MOUNTING HOLES (8.00" Bore)					MPH	MAGNETIC PISTON FOR HALL SWITCHES
		MS1	FRONT & REAR END FOOT (1.50"- 8.00" Bore)					OP	OPTIONAL PORT LOCATION - SPECIFY (Example: Ports @ 3 & 7)
		MS2	SIDE LUG (1.50"- 4.00" Bore Standard 5.00"- 8.00" Consult Factory)					XX	SPECIAL VARIATIONS (SPECIFY)
		MS4	BOTTOM TAPPED HOLES (1.50"- 8.00" Bore)					*URETHANE BUMPERS ADD .25" PER END OF CYLINDER	

OPTIONS AVAILABLE BUT NOT RECOMMENDED (WILL AFFECT CYLINDER PERFORMANCE)	
H	HEAD CUSHION
MS	METALLIC ROD SCRAPER
RW	ROD WIPER

STANDARD PORT POSITIONS AND FEEDBACK CABLE CONNECTOR POSITIONS

- Ports - Positions 1 and 5
- Cushion Adjustment - Positions 2 and 6
- Specify Non-Standard Positions When Ordering



PFLF MOUNTS

MX0 1.50"-8.00" Bores Page 237	MS4 1.50"-8.00" Bores Page 238	MP1 1.50"-8.00" Bores Page 238	MP2 1.50"-6.00" Bores Page 239	MP4 1.50"-4.00" Bores Page 239
MT1 1.50"-8.00" Bores Page 239	MT2 1.50"-8.00" Bores Page 240	MT4 1.50"-8.00" Bores Page 240	MF1 1.50"-6.00" Bores Page 241	MF2 1.50"- 6.00" Bores Page 241
MX3 1.50"-8.00" Bores Page 242	MS1 1.50"-8.00" Bores Page 242	MS2 1.50"-4.00" Bores Consult factory for larger size. Page 243	ME3 8.00" Bore Page 243	

POSITION FEEDBACK LOW FRICTION (PFLF) CYLINDER: HOW IT WORKS

PFLF - How to Order

PFLF - How it works

PFLF Dimensions

Component Repair Kits

PCS - Pneumatic Control System

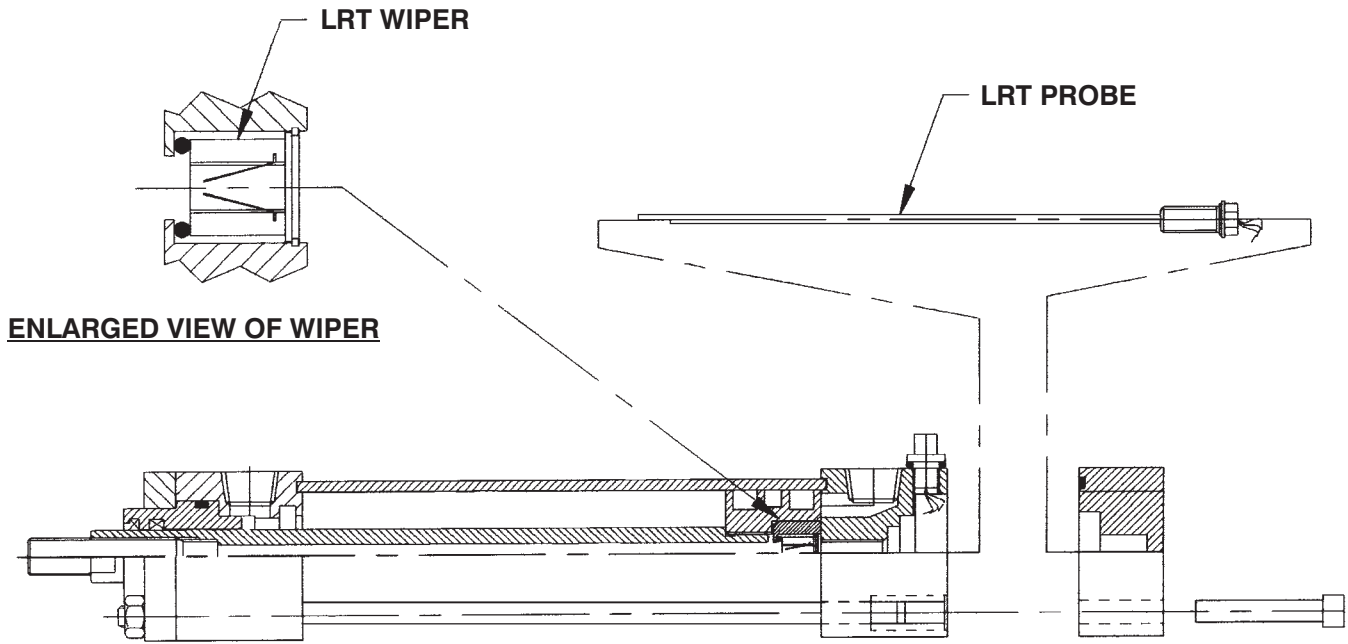
PCS Dimensions

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The Position Feedback Cylinder

contains a Linear Resistive Transducer (LRT) or potentiometer mounted in the cylinder rear head. The LRT probe, which has a resistive element on one side and a collector strip on the other, is inside the cylinder rod. A wiper assembly is installed in the piston. As the piston moves, an electrical circuit is created between the resistive element and collector strip. The resulting voltage is directed externally via wiring. The output voltage is proportional to the wiper position on the resistive element, which allows the cylinder position to be determined.

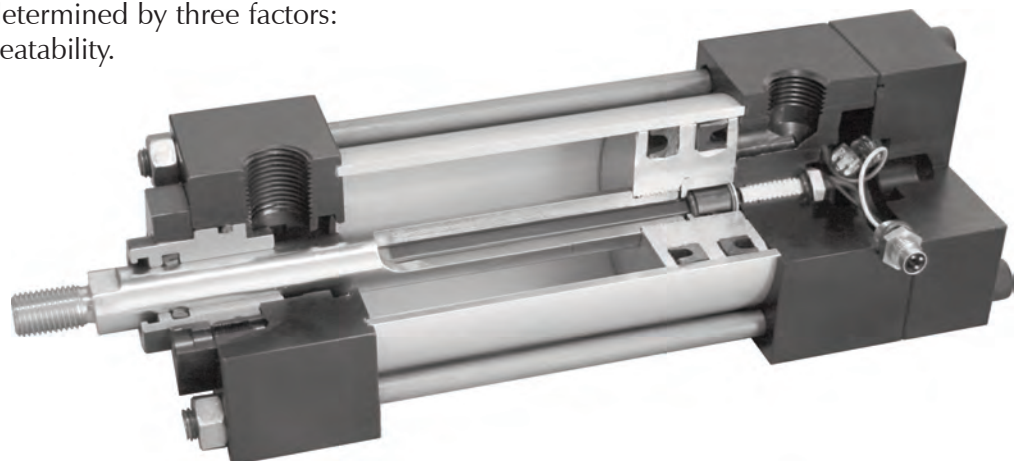
For example, in a 12-inch stroke cylinder, if the output voltage is 0 VDC when fully retracted and 10 VDC when fully extended, voltage readings of 2.5 and 5.833 VDC would indicate cylinder extensions of 3 inches and 7 inches.

The accuracy of an LRT is determined by three factors: resolution, linearity and repeatability.

Resolution refers to the smallest change that can be detected on the LRT. The LRT has infinite resolution, and can be divided into as many parts as the electronics allow. For example, with a 12-bit, 4096-part controller, the stroke could be divided into 4096 equal parts. When 10 VDC is placed on a 10" cylinder, the smallest detectable increment would be $10 \text{ VDC} \div 4096 = 2.4 \text{ millivolts}$ or $0.0024''$. Resolution is stroke sensitive, i.e., the longer the stroke, the less resolution.

Linearity refers to the maximum deviation of the output voltage to a straight line. The LRT's linearity is ± 1 percent of stroke.

Repeatability is the ability of the LRT to provide the same output voltage relative to a unique cylinder position each time the cylinder is cycled. Mechanical repeatability of the TRD Position Feedback Cylinder is $\pm 0.001''$.



POSITION FEEDBACK LOW FRICTION CYLINDER: DIMENSIONS

About Rod End Styles

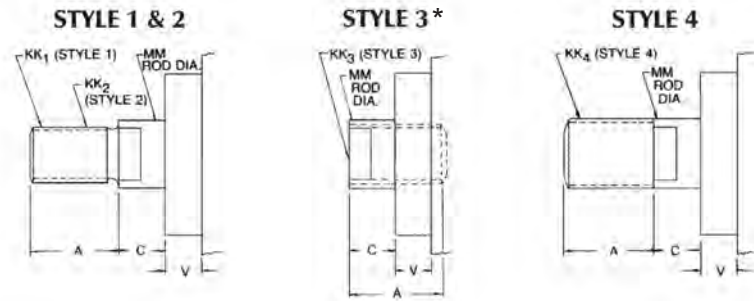
Style 1 Male Rod End is STANDARD

Other NFPA Styles can be specified (See Chart).

Need a rod end not listed? NO PROBLEM! Each Piston Rod is made to order and does not delay shipment. Coarse (UNC) threads, Metric threads or just plain rod ends are common. Thread lengths are also made to order (Specify: "A"=Length).

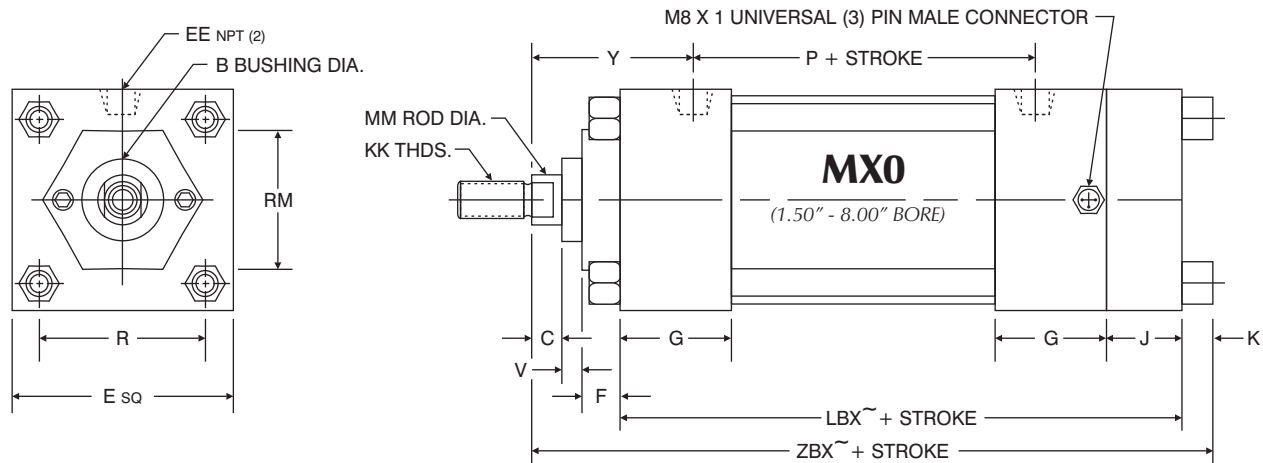
NEED SOMETHING NOT LISTED? Just send us a sketch. In most cases, quotes are turned around in one day!

PISTON ROD END STYLES



BORE	MM ROD DIAMETER	STANDARD		OPTIONAL						C	V
		Style 1 - Male	Style 2 - Male	Style 3 - Female	Style 4 - Male	KK1	A	KK2	A		
1.50, 2.00, 2.50	0.625	0.438-20	0.750	0.500-20	0.750	0.438-20	0.750	0.625-18	0.750	0.375	0.250
3.25, 4.00, 5.00	1.000	0.750-16	1.125	0.875-14	1.125	0.750-16	1.125	1.000-14	1.125	0.500	0.250
6.00 & 8.00	1.375	1.000-14	1.625	1.250-12	1.625	1.000-14	1.625	1.375-12	1.625	0.625	0.375

* KK (Style 3 - Female) will have a recessed plug due to thru hole in rod.

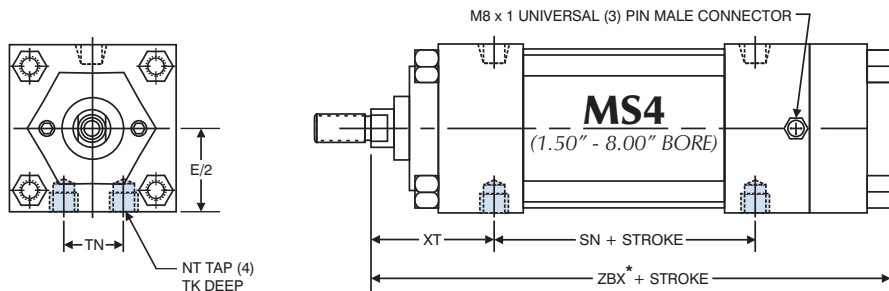


'MX0' PFLF CYLINDER DIMENSIONS - STANDARD ROD ONLY																			
BORE	ROD DIAMETER	A	B	C	E	EE	F	G	J	K	KK	LBX~	MM	P	R	RM	V	Y	ZBX~
1.50	0.625	0.750	1.125	0.375	2.000	0.375	0.375	1.500	1.000	0.250	0.438-20	5.125	0.625	2.375	1.430	2.000 SQ.	0.250	1.875	6.375~
2.00	0.625	0.750	1.125	0.375	2.500	0.375	0.375	1.500	1.000	0.313	0.438-20	5.125	0.625	2.375	1.840	1.750 Hex	0.250	1.875	6.438~
2.50	0.625	0.750	1.125	0.375	3.000	0.375	0.375	1.500	1.000	0.313	0.438-20	5.250	0.625	2.500	2.190	1.750 Hex	0.250	1.875	6.563~
3.25	1.000	1.125	1.500	0.500	3.750	0.500	0.625	1.750	1.250	0.375	0.750-16	6.000	1.000	2.750	2.760	2.750*	0.250	2.375	7.750~
4.00	1.000	1.125	1.500	0.500	4.500	0.500	0.625	1.750	1.250	0.375	0.750-16	6.000	1.000	2.750	3.320	2.750*	0.250	2.375	7.750~
5.00	1.000	1.125	1.500	0.500	5.500	0.500	0.625	1.750	1.250	0.500	0.750-16	6.250	1.000	3.000	4.100	2.750*	0.250	2.375	8.125~
6.00	1.375	1.625	2.000	0.625	6.500	0.750	0.625	2.000	1.500	0.500	1.000-14	7.000	1.375	3.250	4.880	3.500*	0.375	2.750	9.125~
8.00	1.375	1.625	2.000	0.625	8.500	0.750	0.625	2.000	1.500	0.625	1.000-14	7.125	1.375	3.375	6.440	3.500*	0.375	2.750	9.375~

* RM dimension is round retainer diameter
~ NON NFPA Dimensions

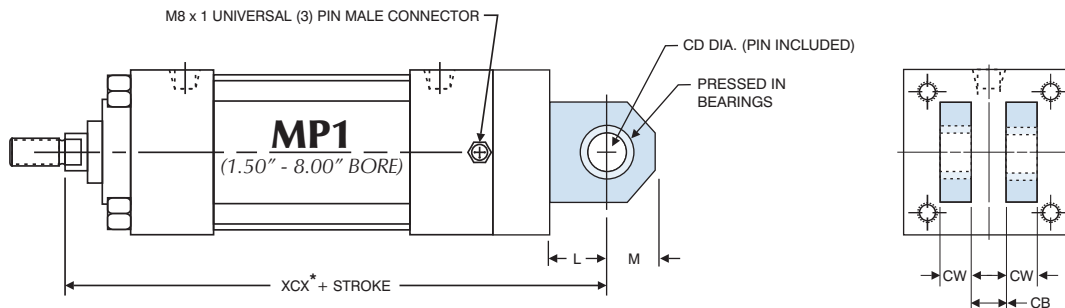
POSITION FEEDBACK LOW FRICTION CYLINDER: DIMENSIONS

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'MS4' PFLF CYLINDER DIMENSIONS - STANDARD ROD ONLY								
BORE	ROD DIAMETER	E/2	NT	TK	TN	XT	ADD STROKE	
							SN	ZBX*
1.50	0.625 Standard	1.000	0.250-20	0.375	0.625	1.938	2.250	6.375
2.00	0.625 Standard	1.250	0.313-18	0.500	0.875	1.938	2.250	6.438
2.50	0.625 Standard	1.500	0.375-16	0.625	1.250	1.938	2.375	6.563
3.25	1.000 Standard	1.875	0.500-13	0.750	1.500	2.438	2.625	7.750
4.00	1.000 Standard	2.250	0.500-13	0.750	2.063	2.438	2.625	7.750
5.00	1.000 Standard	2.750	0.625-11	1.000	2.688	2.438	2.875	8.125
6.00	1.375 Standard	3.250	0.750-10	1.125	3.250	2.813	3.125	9.125
8.00	1.375 Standard	4.250	0.750-10	1.125	4.500	2.813	3.250	9.375

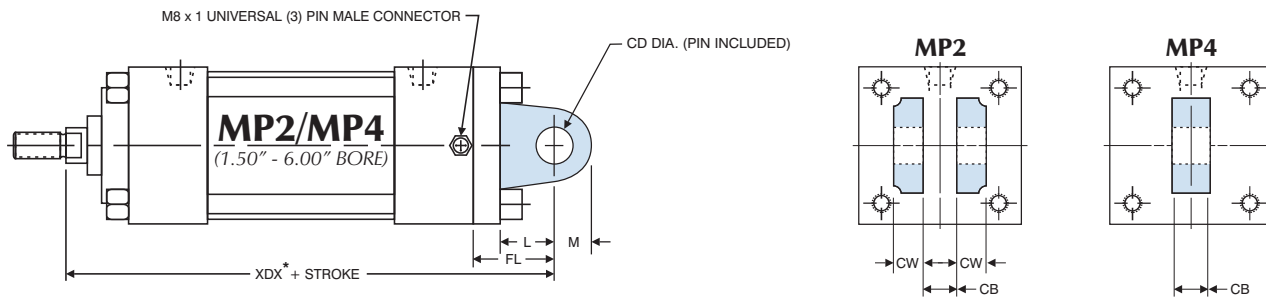
NOTE: All cylinder dimensions not shown are standard 'MX0' cylinder dimensions.
 * NON NFPA Dimensions



'MP1' PFLF CYLINDER DIMENSIONS - STANDARD ROD ONLY							
BORE	ROD DIAMETER	CB	CD	CW	L	M	ADD STROKE
							XCX*
1.50	0.625 Standard	0.750	0.500	0.500	0.750	0.625	6.875
2.00	0.625 Standard	0.750	0.500	0.500	0.750	0.625	6.875
2.50	0.625 Standard	0.750	0.500	0.500	0.750	0.625	7.000
3.25	1.000 Standard	1.250	0.750	0.625	1.250	0.875	8.625
4.00	1.000 Standard	1.250	0.750	0.625	1.250	0.875	8.625
5.00	1.000 Standard	1.250	0.750	0.625	1.250	0.875	8.875
6.00	1.375 Standard	1.500	1.000	0.750	1.500	1.000	10.125
8.00	1.375 Standard	1.500	1.000	0.750	1.500	1.000	10.250

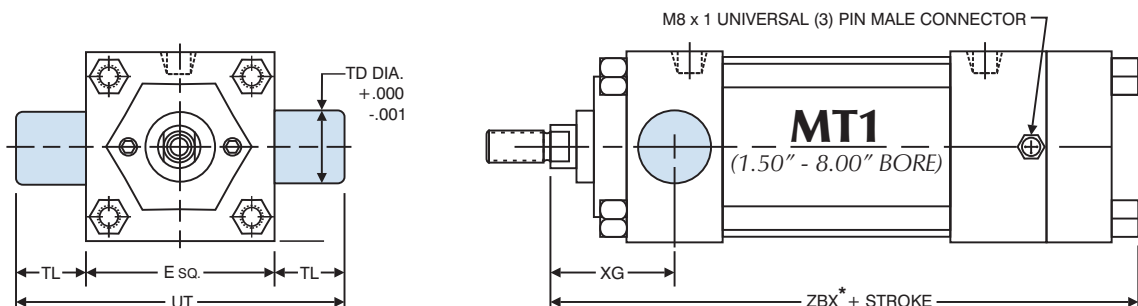
NOTE: All cylinder dimensions not shown are standard 'MX0' cylinder dimensions.
 1.50" & 2.00" bore MP1 extruded mounts are thru tie rod construction.
 2.50" bore and larger the rear MP1 cap is bolted on.
 * NON NFPA Dimensions

POSITION FEEDBACK LOW FRICTION CYLINDER: DIMENSIONS



'MP2' & 'MP4' CAST PFLF CYLINDER DIMENSIONS - STANDARD ROD ONLY								
BORE	ROD DIAMETER	CB	CD	CW	L	M	FL	ADD STROKE
								XDX*
1.50	0.625 Standard	0.750	0.500	0.500	0.750	0.625	1.125	6.250
2.00	0.625 Standard	0.750	0.500	0.500	0.750	0.625	1.125	6.250
2.50	0.625 Standard	0.750	0.500	0.500	0.750	0.625	1.125	6.375
3.25	1.000 Standard	1.250	0.750	0.625	1.250	0.875	1.875	8.000
4.00	1.000 Standard	1.250	0.750	0.625	1.250	0.875	1.875	8.000
5.00	1.000 Standard	1.250	0.750	0.625	1.250	0.875	1.875	8.250
6.00	1.375 Standard	1.500	1.000	0.750	1.500	1.000	2.250	9.375

NOTE: All cylinder dimensions not shown are standard 'MX0' cylinder dimensions.
 MP4 CAST MOUNT not available for 5.00" & 6.00" bores.
 Special WELDED MOUNTS are available. Consult factory for more information.
 * NON NFPA Dimensions

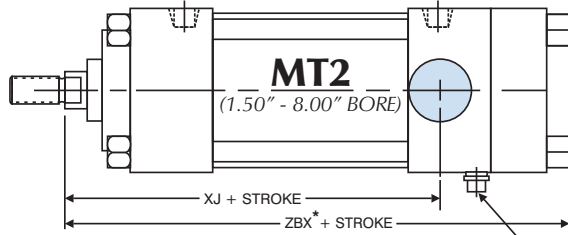
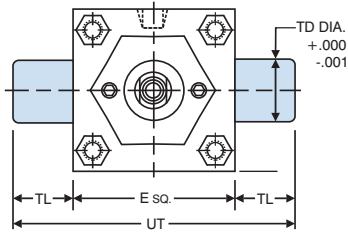


'MT1' PFLF CYLINDER DIMENSIONS - STANDARD ROD ONLY							
BORE	ROD DIAMETER	E	TD	TL	UT	XG	ADD STROKE
							ZBX*
1.50	0.625 Standard	2.000	1.000	1.000	4.000	1.750	6.375
2.00	0.625 Standard	2.500	1.000	1.000	4.500	1.750	6.438
2.50	0.625 Standard	3.000	1.000	1.000	5.000	1.750	6.563
3.25	1.000 Standard	3.750	1.000	1.000	5.750	2.250	7.750
4.00	1.000 Standard	4.500	1.000	1.000	6.500	2.250	7.750
5.00	1.000 Standard	5.500	1.000	1.000	7.500	2.250	8.125
6.00	1.375 Standard	6.500	1.375	1.375	9.250	2.625	9.125
8.00	1.375 Standard	8.500	1.375	1.375	11.250	2.625	9.375

NOTE: All cylinder dimensions not shown are standard 'MX0' cylinder dimensions.
 * NON NFPA Dimensions

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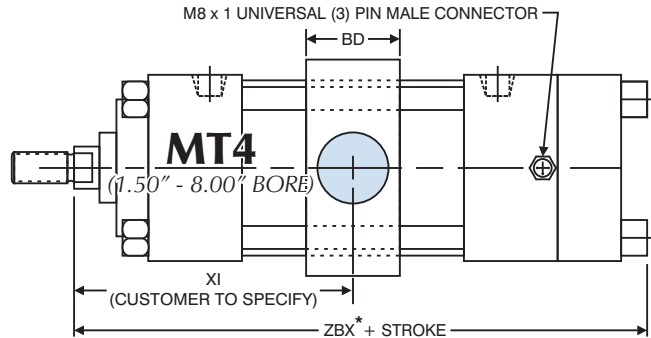
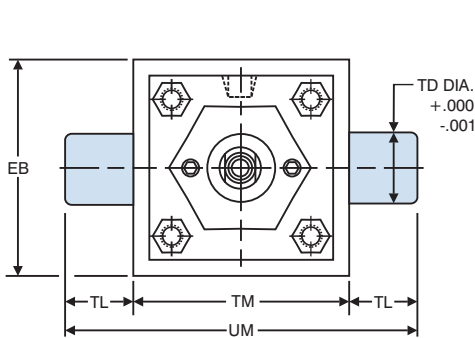
POSITION FEEDBACK LOW FRICTION CYLINDER: DIMENSIONS



M8 x 1 UNIVERSAL (3) PIN MALE CONNECTOR LOCATED 90° TO TRUNNION (POSITION 7)

'MT2' PFLF CYLINDER DIMENSIONS - STANDARD ROD ONLY							
BORE	ROD DIAMETER	E	TD	TL	UT	XJ	ADD STROKE
							ZBX*
1.50	0.625 Standard	2.000	1.000	1.000	4.000	4.125	6.375
2.00	0.625 Standard	2.500	1.000	1.000	4.500	4.125	6.438
2.50	0.625 Standard	3.000	1.000	1.000	5.000	4.250	6.563
3.25	1.000 Standard	3.750	1.000	1.000	5.750	5.000	7.750
4.00	1.000 Standard	4.500	1.000	1.000	6.500	5.000	7.750
5.00	1.000 Standard	5.500	1.000	1.000	7.500	5.250	8.125
6.00	1.375 Standard	6.500	1.375	1.375	9.250	5.875	9.125
8.00	1.375 Standard	8.500	1.375	1.375	11.250	6.000	9.375

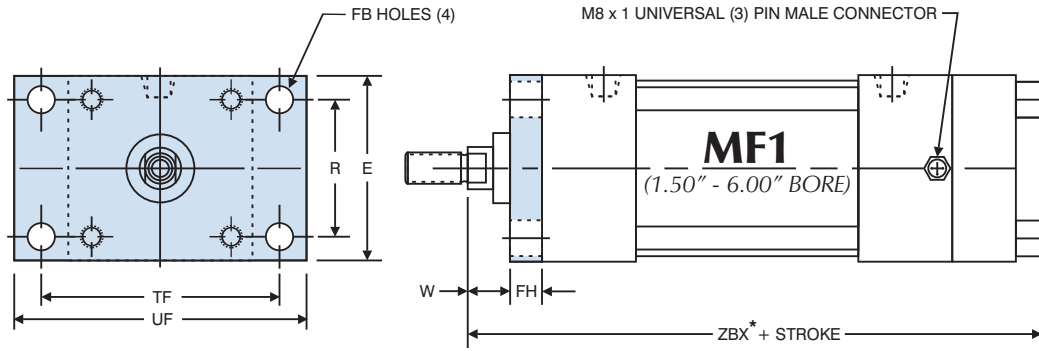
NOTE: All cylinder dimensions not shown are standard 'MX0' cylinder dimensions.
* NON NFPA Dimensions



'MT4' PFLF CYLINDER DIMENSIONS - STANDARD ROD ONLY									
BORE	ROD DIAMETER	BD	EB	TD	TL	TM	UM	XI	ADD STROKE
									ZBX*
1.50	0.625 Standard	1.250	2.500	1.000	1.000	2.500	4.500	CUSTOMER TO SPECIFY	6.375
2.00	0.625 Standard	1.500	3.000	1.000	1.000	3.000	5.000		6.438
2.50	0.625 Standard	1.500	3.500	1.000	1.000	3.500	5.500		6.563
3.25	1.000 Standard	2.000	4.250	1.000	1.000	4.500	6.500		7.750
4.00	1.000 Standard	2.000	5.000	1.000	1.000	5.250	7.250		7.750
5.00	1.000 Standard	2.000	6.000	1.000	1.000	6.250	8.250		8.125
6.00	1.375 Standard	2.000	7.000	1.375	1.375	7.625	10.375		9.125
8.00	1.375 Standard	2.500	9.500	1.375	1.375	9.750	12.500		9.375

NOTE: All cylinder dimensions not shown are standard 'MX0' cylinder dimensions.
* NON NFPA Dimensions

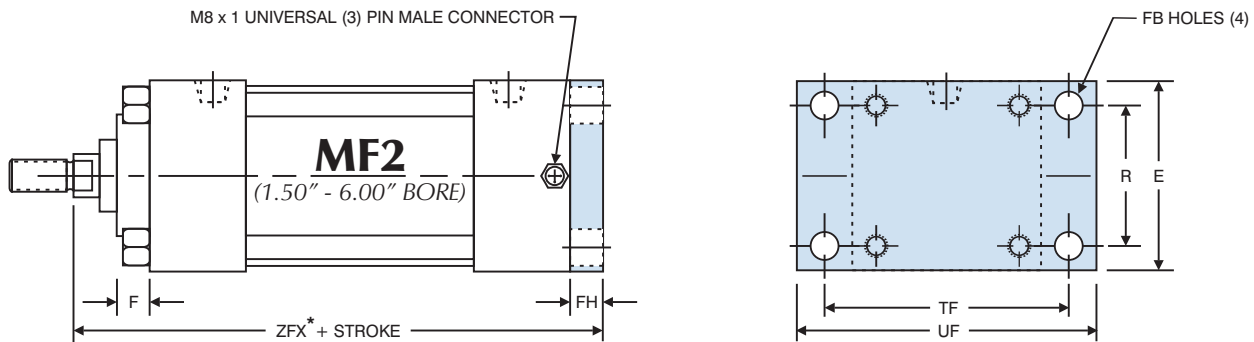
POSITION FEEDBACK LOW FRICTION CYLINDER: DIMENSIONS



'MF1' PFLF CYLINDER DIMENSIONS - STANDARD ROD ONLY									
BORE	ROD DIAMETER	E	FB	FH	R	TF	UF	W	ADD STROKE
									ZBX*
1.50	0.625 Standard	2.000	0.313	0.375	1.430	2.750	3.375	0.625	6.375
2.00	0.625 Standard	2.500	0.375	0.375	1.840	3.375	4.125	0.625	6.438
2.50	0.625 Standard	3.000	0.375	0.375	2.190	3.875	4.625	0.625	6.563
3.25	1.000 Standard	3.750	0.438	0.625	2.760	4.688	5.500	0.750	7.750
4.00	1.000 Standard	4.500	0.438	0.625	3.320	5.438	6.250	0.750	7.750
5.00	1.000 Standard	5.500	0.563	0.625	4.100	6.625	7.625	0.750	8.125
6.00	1.375 Standard	6.500	0.563	0.750	4.880	7.625	8.625	0.875	9.125

NOTE: All cylinder dimensions not shown are standard 'MX0' cylinder dimensions.

* NON NFPA Dimensions

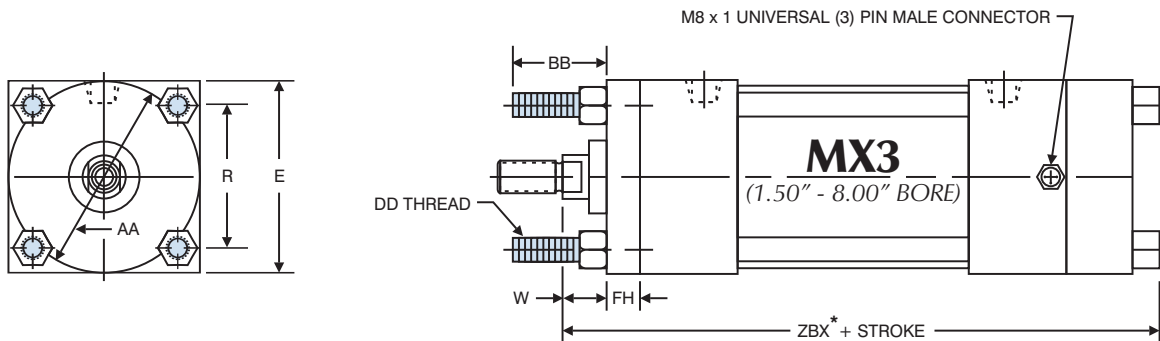


'MF2' PFLF CYLINDER DIMENSIONS - STANDARD ROD ONLY									
BORE	ROD DIAMETER	E	FB	FH	R	TF	UF	F	ADD STROKE
									ZFX*
1.50	0.625 Standard	2.000	0.313	0.375	1.430	2.750	3.375	0.375	5.500
2.00	0.625 Standard	2.500	0.375	0.375	1.840	3.375	4.125	0.375	5.500
2.50	0.625 Standard	3.000	0.375	0.375	2.190	3.875	4.625	0.375	5.625
3.25	1.000 Standard	3.750	0.438	0.625	2.760	4.688	5.500	0.625	6.750
4.00	1.000 Standard	4.500	0.438	0.625	3.320	5.438	6.250	0.625	6.750
5.00	1.000 Standard	5.500	0.563	0.625	4.100	6.625	7.625	0.625	7.000
6.00	1.375 Standard	6.500	0.563	0.750	4.880	7.625	8.625	0.625	7.875

NOTE: All cylinder dimensions not shown are standard 'MX0' cylinder dimensions.

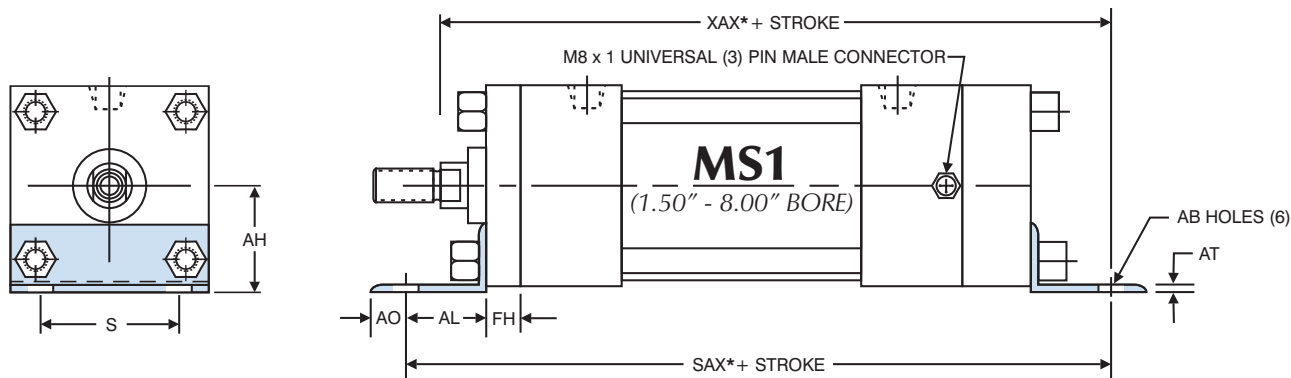
* NON NFPA Dimensions

POSITION FEEDBACK LOW FRICTION CYLINDER: DIMENSIONS



'MX3' PFLF CYLINDER DIMENSIONS - STANDARD ROD ONLY										
BORE	ROD DIAMETER	E	FH	R	AA	BB	DD	W	ADD STROKE	
									ZBX*	
1.50	0.625 Standard	2.000	0.375	1.430	2.020	1.000	0.250-28	0.625	6.375	
2.00	0.625 Standard	2.500	0.375	1.840	2.600	1.125	0.313-24	0.625	6.438	
2.50	0.625 Standard	3.000	0.375	2.190	3.100	1.125	0.313-24	0.625	6.563	
3.25	1.000 Standard	3.750	0.625	2.760	3.900	1.375	0.375-24	0.750	7.750	
4.00	1.000 Standard	4.500	0.625	3.320	4.700	1.375	0.375-24	0.750	7.750	
5.00	1.000 Standard	5.500	0.625	4.100	5.800	1.813	0.500-20	0.750	8.125	
6.00	1.375 Standard	6.500	0.750	4.880	6.900	1.813	0.500-20	0.875	9.125	
8.00	1.375 Standard	8.500	0.625**	6.440	9.100	2.313**	0.625-18	1.625	9.375	

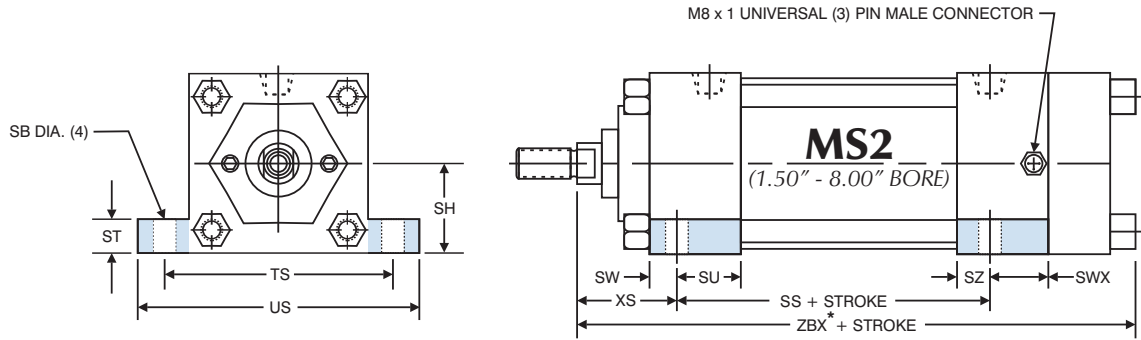
NOTE: All cylinder dimensions not shown are standard 'MX0' cylinder dimensions.
 * NON NFPA Dimensions
 ** 8.00" Bore has round retainer, not a full square retainer as smaller bores.
 "BB" dimension is from head.



'MS1' PFLF CYLINDER DIMENSIONS - STANDARD ROD ONLY										
BORE	ROD DIAMETER	AB	AH	AL	AO	AT	FH	S	ADD STROKE	
									SAX*	XAX*
1.50	0.625 Standard	0.438	1.188	1.000	0.375	0.125	0.375	1.250	7.500	7.125
2.00	0.625 Standard	0.438	1.438	1.000	0.375	0.125	0.375	1.750	7.500	7.125
2.50	0.625 Standard	0.438	1.625	1.000	0.375	0.125	0.375	2.250	7.625	7.250
3.25	1.000 Standard	0.563	1.938	1.250	0.500	0.125	0.625	2.750	9.125	8.625
4.00	1.000 Standard	0.563	2.250	1.250	0.500	0.125	0.625	3.500	9.125	8.625
5.00	1.000 Standard	0.688	2.750	1.375	0.625	0.188	0.625	4.250	9.625	9.000
6.00	1.375 Standard	0.813	3.250	1.375	0.625	0.188	0.750	5.250	10.500	10.000
8.00	1.375 Standard	0.813	4.250	1.813	0.688	0.250	0.625**	7.125	10.750	10.563

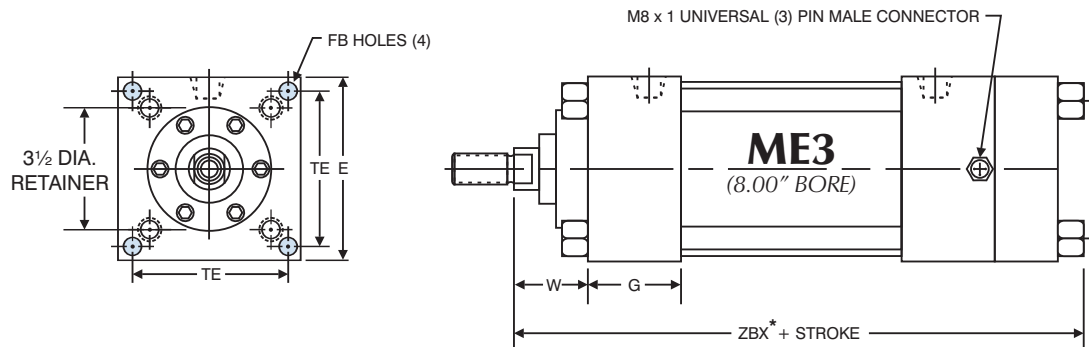
NOTE: All cylinder dimensions not shown are standard 'MX0' cylinder dimensions.
 ** 8.00" bore cylinders have round retainer, bracket bolted to head.
 * NON NFPA Dimensions

POSITION FEEDBACK LOW FRICTION CYLINDER: DIMENSIONS



'MS2' PFLF CYLINDER DIMENSIONS - STANDARD ROD ONLY													
BORE	ROD DIAMETER	SB	SH	ST	SU	SW	SZ	TS	US	XS	SWX*	ADD STROKE	
												SS	ZBX*
1.50	0.625 Standard	0.438	1.000	0.500	1.125	0.375	0.625	2.750	3.500	1.375	0.875	2.875	6.375
2.00	0.625 Standard	0.438	1.250	0.500	1.125	0.375	0.625	3.250	4.000	1.375	0.875	2.875	6.438
2.50	0.625 Standard	0.438	1.500	0.500	1.125	0.375	0.625	3.750	4.500	1.375	0.875	3.000	6.563
3.25	1.000 Standard	0.563	1.875	0.750	1.250	0.500	0.750	4.750	5.750	1.875	1.000	3.250	7.750
4.00	1.000 Standard	0.563	2.250	0.750	1.250	0.500	0.750	5.500	6.500	1.875	1.000	3.250	7.750
5.00	1.000 Standard	0.813	2.750	1.000	1.063	0.688	0.563	6.875	8.250	2.063	1.188	3.125	8.125
6.00	1.375 Standard	0.813	3.250	1.000	1.313	0.688	0.813	7.875	9.250	2.313	1.188	3.625	9.125
8.00	1.375 Standard	0.813	4.250	1.000	1.313	0.688	0.813	9.875	11.250	2.313	1.188	3.750	9.375

NOTE: All cylinder dimensions not shown are standard 'MX0' cylinder dimensions.
1.50" - 4.00" Standard, consult factory for 5.00" - 8.00"
 * NON NFPA Dimensions



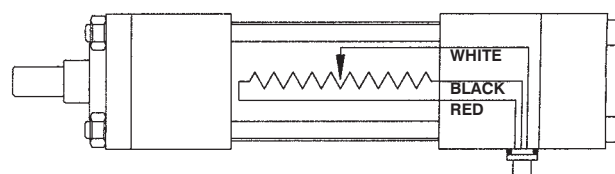
'ME3' PFLF CYLINDER DIMENSIONS - STANDARD ROD ONLY							
BORE	ROD DIAMETER	E	TE	W	G	FB	ADD STROKE
							ZBX*
8.00	1.375 Standard	8.500	7.570	1.625	2.000	0.688	9.375

NOTE: All cylinder dimensions not shown are standard 'MX0' cylinder dimensions.
 * NON NFPA Dimensions

POSITION FEEDBACK LOW FRICTION CYLINDER: SPECIFICATIONS

<p>Repeatability:</p> <p>Nonlinearity:</p> <p>Resolution:</p> <p>Signal Input:</p> <p>Input Impedance Required:</p> <p>Signal output:</p>	<p>±.001" Cylinder Only</p> <p>Refer to specifications in the following sections for positioning or measuring repeatability. Power supply ripple and A/D error will reduce repeatability when PFLF is utilized with industrial control systems.</p> <p>± 1% of full stroke</p> <p>Infinite</p> <p>10 VDC typical</p> <p>1 MOhm</p> <p>> 0 to slightly less than FS signal input (The internal electrical stroke is slightly larger than the mechanical stroke of the cylinder)</p>
<p>Rated Life of Probe:</p> <p>Rated Life of Wiper:</p> <p>Pressure Rating:</p> <p>Temperature Rating: (Cylinder & Probe)</p> <p>Maximum Speed:</p> <p>Interface:</p> <p>NEMA:</p>	<p>10 million cycles</p> <p>1000 linear miles</p> <p>150 psi</p> <p>0° to 200°F</p> <p>25 in./sec.</p> <p>8mm DIN connector</p> <p>6 (IP67)</p>

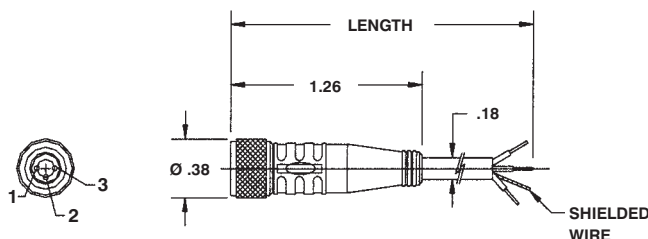
WIRE DESCRIPTION	PROBE/ PLUG WIRE COLORS	PLUG PIN NUMBERS	QUICK CONNECT CABLE/ WIRE COLORS
INPUT (+)	RED	3	BLUE
GROUND (-)	BLACK	2	BLACK
OUTPUT	WHITE	1	BROWN



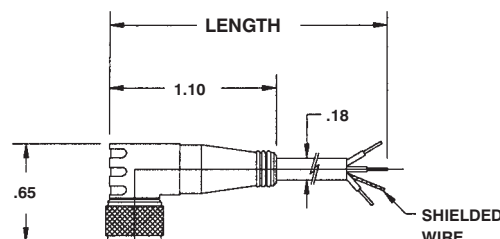
STROKE = 0, OUTPUT VOLTAGE = 0 VOLTS
STROKE = FULL, OUTPUT VOLTAGE = 10 VOLTS



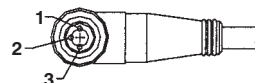
Straight-Models C4-S (2m), C4X-S (5m)



Right Angle-Models C5 (2m), C5X (5m)



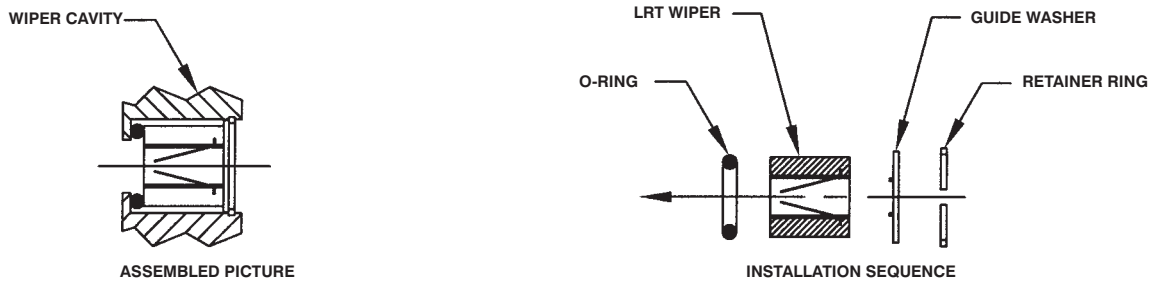
CONDUCTOR COLORS:
1 - BROWN
2 - BLACK
3 - BLUE



Note: All models have a M8 x 1 female thread.

Cable: 24 A.W.G. PVC insulated, fine stranded copper conductors, with Gray PVC jacket with stripped and tinned ends.

POSITION FEEDBACK LOW FRICTION CYLINDER: COMPONENTS/REPAIR KITS



LRT WIPER REPLACEMENT KIT

PART NO.	DESCRIPTION	REMARKS
PFLF-WK	POSITION FEEDBACK WIPER KIT	KIT TO CONSIST OF THE FOLLOWING: (1) O-RING, (1) LTR WIPER, (1) GUIDE WASHER, (1) RETAINING RING, (3) WIRE CONNECTORS & WIPER/PROBE INSTALLATION INSTRUCTION SHEET

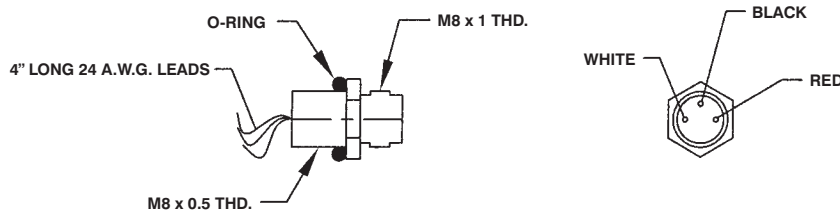


PROBE WIRE COLORS:
 RED = SUPPLY (+)
 BLACK = GROUND (-)
 WHITE = OUTPUT

LRT PROBE REPLACEMENT KIT

PART NO.	DESCRIPTION	REMARKS
PFLF-PRK-STROKE	POSITION FEEDBACK PROBE REPLACEMENT KIT	KIT TO CONSIST OF THE FOLLOWING: (1) LRT PROBE WITH O-RING & BACK-UP WASHER, (3) WIRE CONNECTORS & WIPER/PROBE INSTALLATION INSTRUCTION SHEET

Replacement LRT probe ordering example: 8.00" stroke PFLF cylinder, replacement probe would be PART NO. PFLF-PRK-8. Fractional stroke length cylinders use the next whole number. Example: 8.50" stroke replacement probe would be PFLF-PRK-9.



(3) PIN CONNECTOR REPLACEMENT KIT

PART NO.	DESCRIPTION	REMARKS
PFLF-CK	POSITION FEEDBACK CONNECTOR KIT	KIT TO CONSIST OF THE FOLLOWING: (1) 3 PIN CONNECTOR WITH O-RING & (3) WIRE CONNECTORS

PFLF BASIC CYLINDER SEAL KITS

BORE	PART NO.
1.50	PFLF-SK-625-150
2.00	PFLF-SK-625-200

BORE	PART NO.
2.50	PFLF-SK-625-250
3.25	PFLF-SK-100-325

BORE	PART NO.
4.00	PFLF-SK-100-400
5.00	PFLF-SK-100-500

BORE	PART NO.
6.00	PFLF-SK-137-600
8.00	PFLF-SK-137-800

Replacement PFLF cylinder seal kit to consist of the following:

(2) low friction piston seals, (2) tube end seals, (1) rod seal, (1) bushing o-ring, and (1) container of low friction grease

Note: basic seal kit **DOES NOT** include wiper, probe, or connector kits

PNEUMATIC CONTROL SYSTEM (MODEL PCS): HOW IT WORKS



The TRD Pneumatic Control System (Model PCS) is designed to control any 1.50" thru 4.00" bore pneumatic TRD position feedback actuator. The system is a closed-loop electronic controller with pneumatic valves that can accurately position the actuator rod and hold it in position with a high degree of accuracy and force. The system accomplishes the long term goal of using pneumatic technology to accurately stop and hold the rod at any desired position.

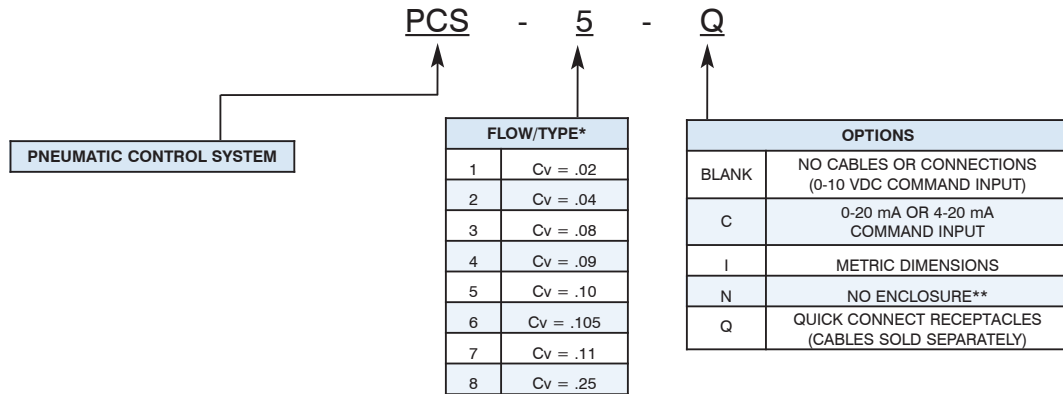
The standard PCS accepts a 0 to 10 VDC analog command signal. The command signal is used as a reference to move to and hold a specific position. Order Option C if a 0 to 20 mA or a 4 to 20 mA analog command signal is required. For example, if the application has a stroke of 10 inches (i.e., the electrical zero and span is set for a 10 inch stroke), then a 1 volt change in the command voltage is equal to a 1 inch movement. Similarly, a change in command signal of 0.005 of a volt equals a position change of 0.005 of an inch for the same 10 inch stroke application. If the application has a stroke of 5 inches, a change of 1 volt in the command signal represents a 0.500" movement.

The system utilizes the feedback from the actuator to close the control loop. The control loop compares the system's command signal (the 0-10 VDC, 0-20 mA, or 4-20 mA input command signal) to the feedback signal from the actuator. The difference between the command and feedback is referred to as the error term. When the error term is zero, all valves close, trapping air on both sides of the actuator piston. (The error term is considered to be zero when it is within the deadband range. The deadband range is an adjustable range that determines the final repeatability of the system. The Application Sizing chart located later in this section shows recommended deadband ranges for given application parameters.) This holds the rod at its commanded position. If some force or weight attempts to move the rod out of the commanded position, the system will react by increasing the restoring force eventually to full supply pressure, if necessary. Likewise, if the command signal changes, the system will respond to make the feedback equal the command signal.

There are four adjustments on the PCS system, adjustable via four trim pots. They include the Zero, Span, Decel, and Deadband adjustment. The Zero and Span adjustments allow you to set the zero and full scale position of the actuator to match the input (command) signal. The Decel and Deadband adjustments are used to optimize the performance of the system based on application parameters. These adjustments are described in detail in the Operating Manual, which is included with each system.

The actual accuracy/repeatability of the movements will depend on many factors, including signal noise, load, velocity, supply pressure, supply voltage, and application friction. Refer to the Application Sizing charts found later in this section for detailed information regarding sizing and suggestions for your application.

PNEUMATIC CONTROL SYSTEM (PCS): HOW TO ORDER

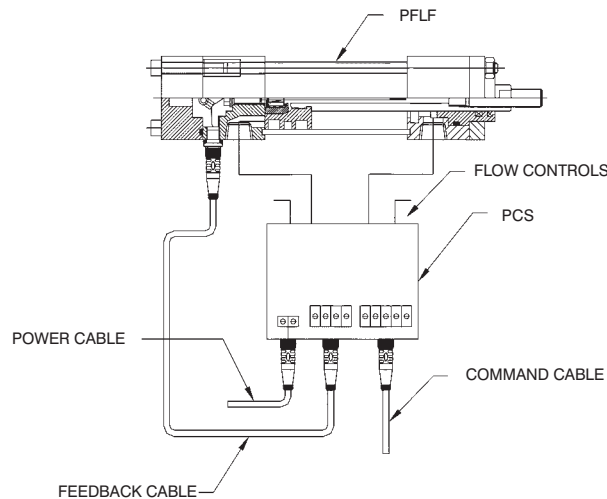


* The Cv values are approximated. The velocities for the different systems are shown in the sizing recommendations chart.
 ** Allows mounting of control valves close to the actuator and the electronics/PC board in a remote location. This would be beneficial in applications that would otherwise require long air lines which could reduce system accuracy or in applications that would place the electronics/PC board in an area that exceeds the 100°F operational temperature range.

ACCESSORY CABLES*

PART NUMBER	DESCRIPTION
PCS-CBL-PWR	2 meter Power Cable for Quick Connect Option
PCS-CBL-PWR-X	5 meter Power Cable for Quick Connect Option
PCS-CBL-CMD	2 meter Command Signal Cable for Quick Connect Option
PCS-CBL-CMD-X	5 meter Command Signal Cable for Quick Connect Option
PCS-CBL-FBK	2 meter Feedback Cable for Quick Connect Option
PCS-CBL-FBK-X	5 meter Feedback Cable for Quick Connect Option

* One Power, Command and Feedback cable required if Option Q is purchased. (3 CABLES TOTAL REQ'D)



System Block Diagram, shown with Option Q

PNEUMATIC CONTROL SYSTEM (PCS): SPECIFICATIONS

DESCRIPTION	SPECIFICATION
Zero Adjustment	50% of Total Full Scale Output between both adjustments
Span Adjustment	
DECEL Adjustment	Approximately 0.5 to 13.5 volts
Deadband Adjustment	Approximately 0.005 to 0.500 volts
@ Position	Discrete signal that Sinks to Ground when Within Deadband zone. 10mA Maximum
Current Position	0 to 10 VDC signal, 1M ohm input impedance required for input device
Operation at Power Loss	All valves close at power loss
Input Supply Voltage	23.5 to 24.5 VDC, 1 amp
Operating Pressure	70 to 80 max. psig
Air Requirement	Regulated and Filtered to 5 microns
Operational Temperature Range	0 to 100°F (Electronics/PC Board)
Reverse Polarity Protected	
Overvoltage Protected	

APPLICATION SIZING AND "RULES OF THUMB"

PFLF CYLINDER/PCS VALVE SYSTEM MATCHING AND SIZING RECOMMENDATIONS									
BORE SIZE	PCS MODEL	STROKE RANGE	MAXIMUM PAYLOAD	AVERAGE VELOCITY	MAXIMUM EXTERNAL FRICTION	ZERO FRICTION DEADBAND**	1/2 MAXIMUM FRICTION DEADBAND	MAXIMUM FRICTION DEADBAND	MINIMUM STEP***
PFLF-1.50"	PCS-1	2.00" to 3.00"	2 lbs.	2.50 in/sec	zero	±25mV	N/A	N/A	0.040"
PFLF-1.50"	PCS-2	4.00" to 24.00"	50 lbs.	5.50 in/sec	10 lbs.	±20mV	±40mV	±80mV	2 X Deadband
PFLF-2.00"	PCS-2	2.00" to 3.00"	4 lbs.	2.75 in/sec	zero	±50mV	N/A	N/A	0.020"
PFLF-2.00"	PCS-3	4.00" to 24.00"	90 lbs.	6.50 in/sec	20 lbs.	±15mV	±30mV	±60mV	2 X Deadband
PFLF-2.50"	PCS-4	3.00" to 4.00"	120 lbs.	2.00 in/sec	35 lbs.	±90mV	N/A	N/A	2 X Deadband
PFLF-2.50"	PCS-5	5.00" to 24.00"	150 lbs.	2.50 in/sec	35 lbs.	±40mV	±60mV	±60mV	2 X Deadband
PFLF-3.25"	PCS-6	3.00" to 4.00"	235 lbs.	2.00 in/sec	60 lbs.	±80mV	N/A	N/A	2 X Deadband
PFLF-3.25"	PCS-7	5.00" to 24.00"	235 lbs.	2.00 in/sec	60 lbs.	±40mV	±40mV	±60mV	2 X Deadband
PFLF-4.00"	PCS-7	3.00" to 4.00"	360 lbs.	2.00 in/sec	90 lbs.	±80mV	N/A	N/A	2 X Deadband
PFLF-4.00"	PCS-8	5.00" to 24.00"	360 lbs.	2.00 in/sec	90 lbs.	±40mV	±40mV	±60mV	2 X Deadband

- 1) If your application requires lower velocities or payloads, you may be able to reduce the minimum recommended deadband setting, or if your deadband requirements can accommodate a large range, you may be able to increase your payload higher than the recommended values.
- 2) **Note: the following formula can be used to convert the deadband voltage to displacement: $w=0.1(V) \times t$, where w is the deadband width, V is deadband voltage listed above and t is full scale travel of the actuator. For example: if the deadband is set for 20mv (0.02 of a volt) for a 6 inch stroke cylinder, $w=0.1 (0.02) \times 6 = \pm 0.012$ of an inch.
- 3) ***Minimum step is stroke dependent.

RECOMMENDED TUBING SIZES

BORE	I.D.	O.D.
1.50" Bore	0.125	0.250"
2.00" Bore	0.187	0.250"
2.50" Bore	0.187	0.250"
3.25" Bore	0.312	0.375"
4.00" Bore	0.312	0.375"

PNEUMATIC CONTROL SYSTEM (PCS): APPLICATION SIZING AND “RULES OF THUMB” (CONTINUED)

Assumptions used for Sizing Values recommendations:

- Values shown in sizing table are with no overshoot. If overshoot is acceptable for your application, the deadband may be less than specified. However, be sure your system cannot go unstable.
- The PFLF cylinder is a very low friction cylinder with a standard rod diameter and NO rod wiper. The use of a rod wiper or oversized rod diameters will have adverse effects on positioning capabilities.
- 80 psi air supply.
- Minimum of 23.5 VDC provided to the PCS.
- Clean Command Signal for Main Control (<5mV noise/ripple).
- Leak free system (The system will actually perform well with some system leakage, however, the best performance is with no leakage).
- Short (<18 inches), hard air lines (nylon) between the valves and the actuator.
- No backlash in the system.
- Horizontally guided load. The system can handle vertical or inclined loads and still meet the minimum deadband specified above, however, the velocity may be effected by up to 40%.

Typical “Rules of Thumb”:

- Deviation from the recommended parameters, such as air pressure, power supply voltage, external friction, etc., will negatively effect system performance. However, the system may still perform adequately for your application.
- Applications with loads less than 10% of actuator capacity and strokes greater than 4 inches will yield better repeatability than the minimum deadband shown in the sizing table.
- Reducing actuator velocity by use of Flow Controls may enable the deadband to be adjusted tighter for a given application. The Flow Controls must be inserted into the exhaust ports of the valve manifold, NOT in the actuator.
- Oversizing the actuator for a given application typically yields better repeatability.
- Generically, following are relative influences on velocity:
 - As Mass increases, Velocity decreases (up to 20%)
 - As Friction increases, Velocity decreases (up to 20%)
 - As Pressure decreases, Velocity decreases (up to 20%)
- Increased Friction decreases repeatability. Maximum external friction should not exceed 20% of the maximum rated payload. Any external friction in the application will degrade system performance. Ensure the system is aligned properly to any guiding systems. Misalignment will cause external application friction.
- A borderline solution can be effective through any/all of the following:
 - sacrificing performance in one area for another,
 - limiting velocity with external flow controls,
 - employing a small central portion of a longer probe,
 - using a larger bore cylinder.
- The PCS system is not suited for applications where accurate velocity control is needed by controlling the rate of command signal change. Flow controls can be used if lower velocities are required.



Do not allow the PCS valves to stay on for prolonged time periods unless the valves are well ventilated, as they may overheat potentially causing damage to the valves.

PNEUMATIC CONTROL SYSTEM (PCS): APPLICATION EXAMPLE

PFLF Example

Let's say we have just finished the installation procedure for a PFLF Cylinder with 10 inches of stroke, and are using a 0-10 VDC input command signal. There is a retracted hard stop at 1.5 inches of cylinder stroke and an extended hard stop at the 9.0 inches of cylinder stroke.

Therefore:

- After adjusting the Span setting, 10 volts is equivalent to 9.0 inches of cylinder rod extension.
- After adjusting the Zero setting, 1.5 inches of cylinder rod extension will equal 0 volts.

Therefore, 0 to 10 volts covers the 7.5 inches (9.0" - 1.5") range of motion.

Using the following formula:

The command signal can be translated into actuator displacement with the following formula:

$$CS = d * R / t + Z$$

where:

CS	=	the command signal required to achieve a desired position
d	=	the displacement the desired position is from the zero position
R	=	the full range of the command signal
t	=	full scale travel of the actuator
z	=	the command signal for the zero position

To command the PFLF to go to a position that is 2.0 inches extended from the retracted hard stop, the command signal would be calculated as follows:

$$CS = 2 \times 10 / 7.5 + 0 = 2.667 \text{ VDC Command Input Signal}$$

If a 4-20 mA signal is used, the command input signal would be calculated as follows:

$$CS = 2 \times 16 / 7.5 + 4 = 8.267 \text{ mA Command Input Signal}$$

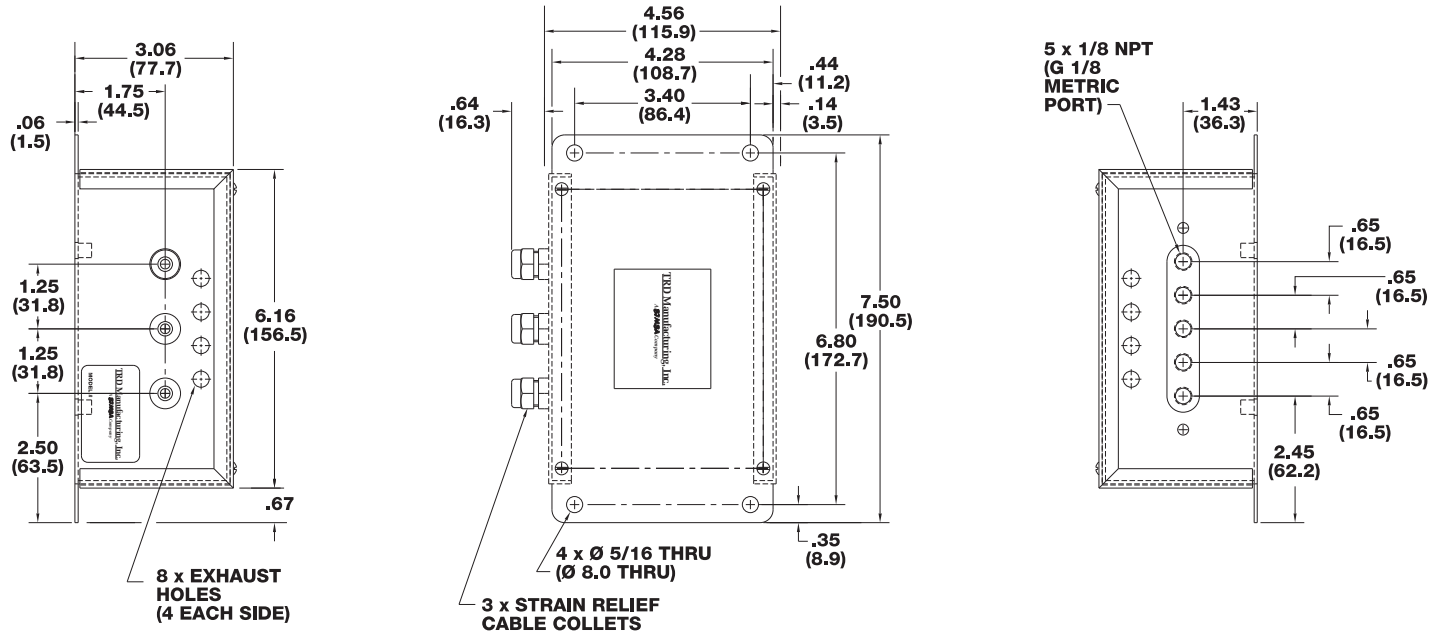
Note: The positional repeatability of the system will be determined by the Deadband adjustment. If the deadband was adjusted to $\pm 20\text{mV}$ in this example, the system would position to the 2 inch position within $\pm 0.015''$ ($w=0.1$ (V) * t).

PNEUMATIC CONTROL SYSTEM (PCS): DIMENSIONS

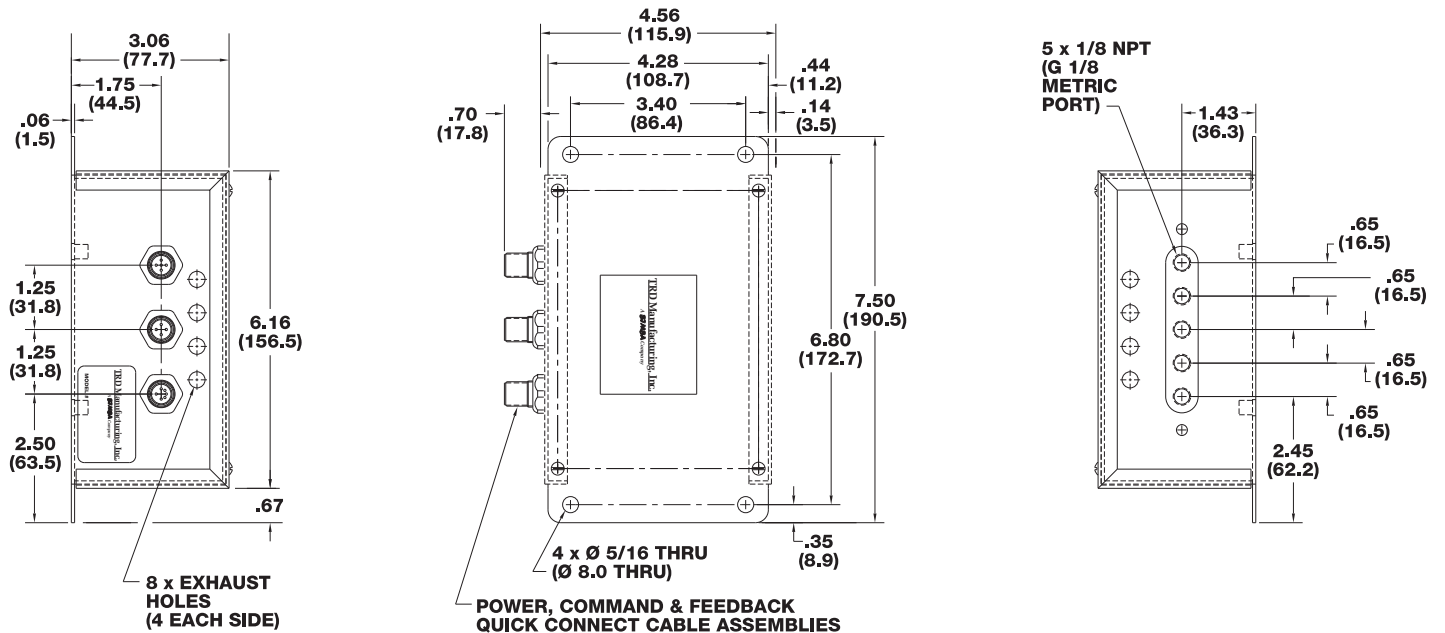
PCS1 THRU PCS3

Shown in inches (millimeters)

ENCLOSURE



OPTION Q (Quick Connect Receptacle)

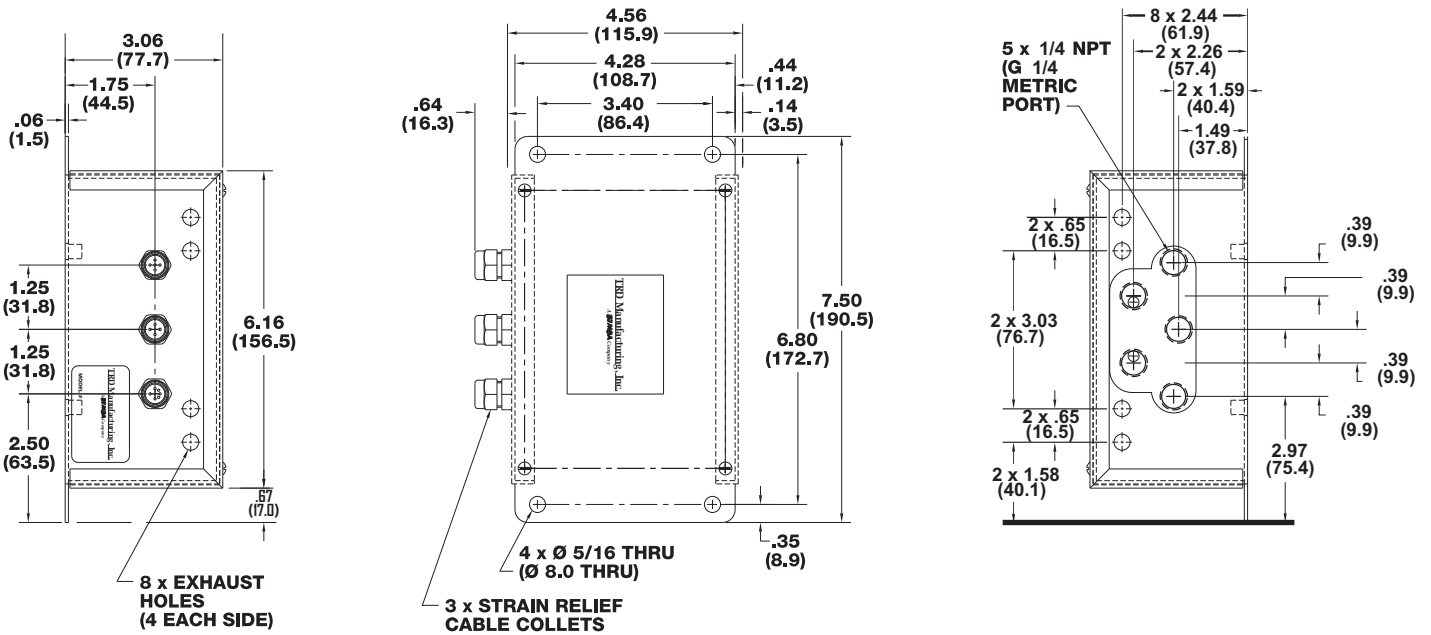


PNEUMATIC CONTROL SYSTEM (PCS): DIMENSIONS

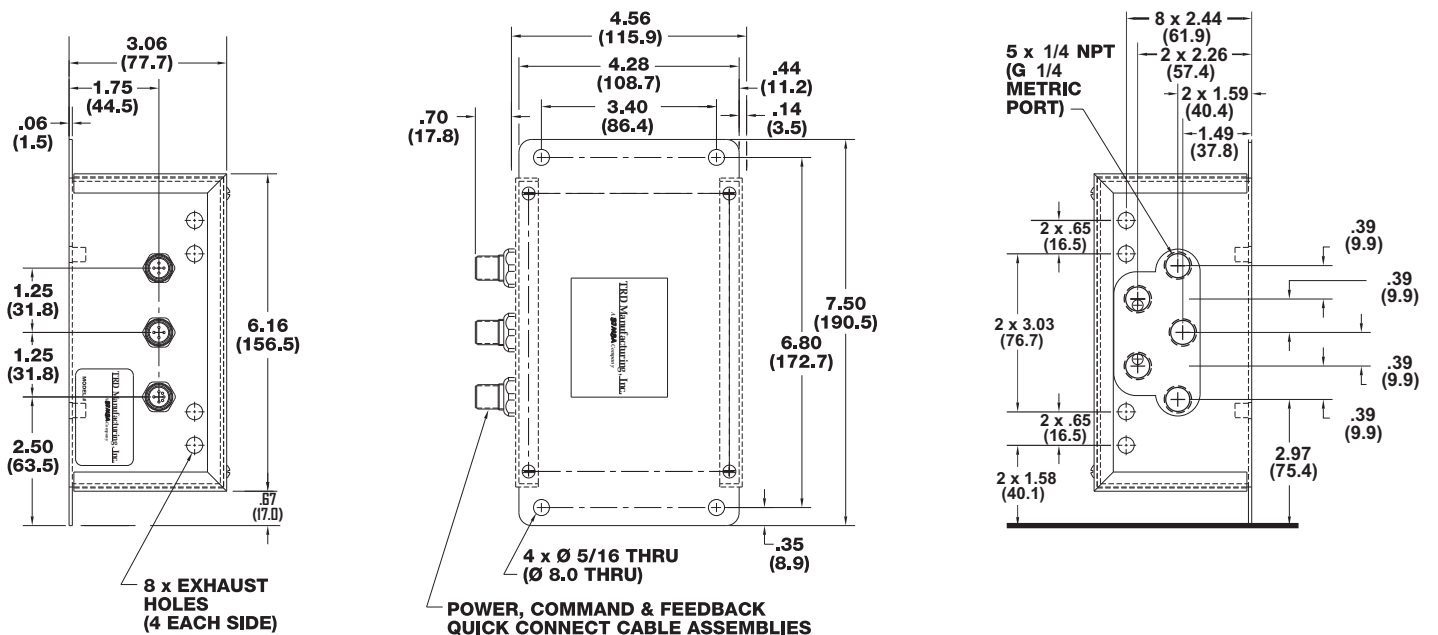
PCS4 THRU PCS8

Shown in inches (millimeters)

ENCLOSURE



OPTION Q (Quick Connect Receptacle)

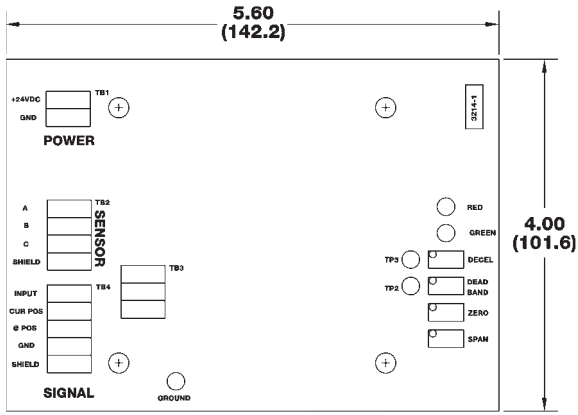


PNEUMATIC CONTROL SYSTEM (PCS): DIMENSIONS

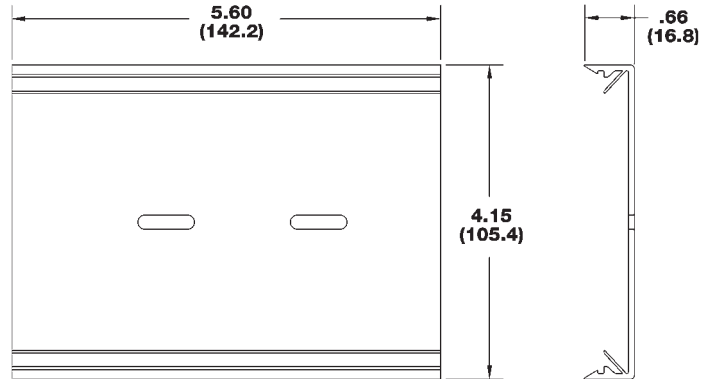
Shown in inches (millimeters)

OPTION N (No Enclosure)

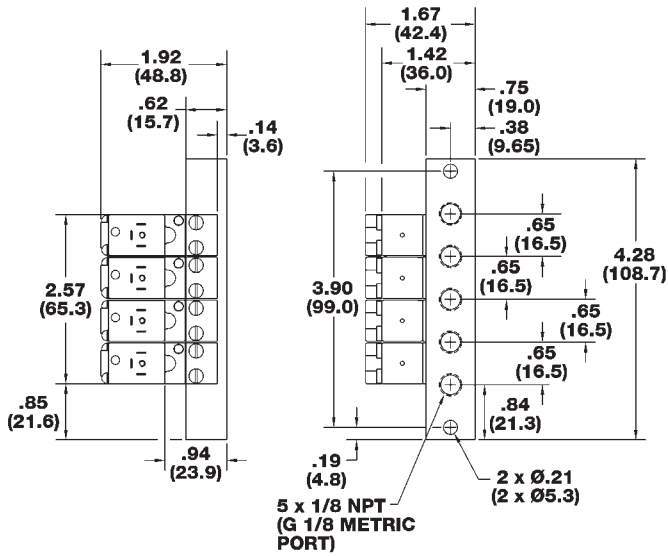
PC BOARD



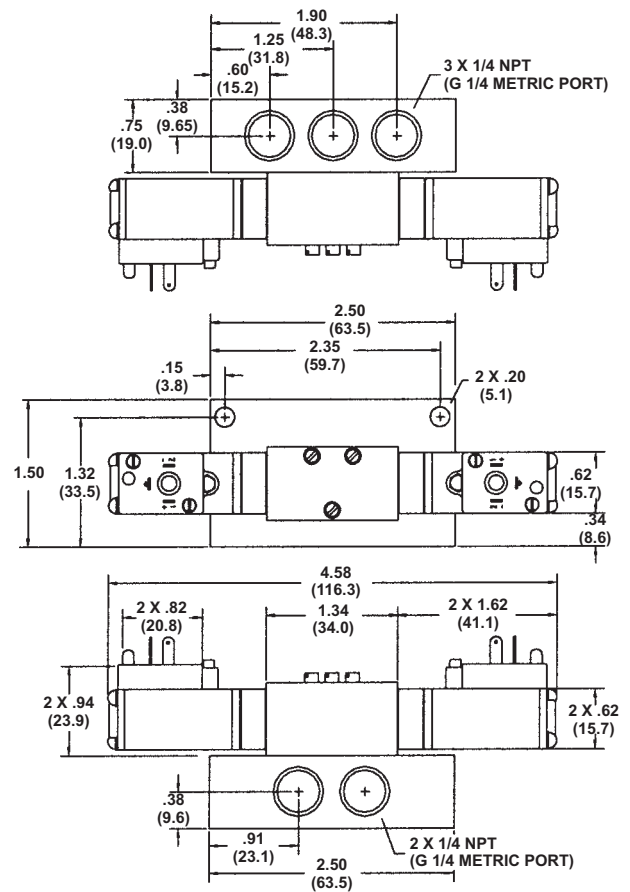
SNAP TRACK



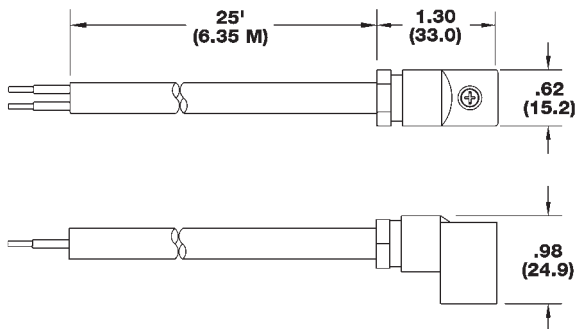
VALVE/MANIFOLD PCS1 THRU PCS3



VALVE/MANIFOLD PCS4 THRU PCS8



VALVE CABLE



PNEUMATIC CONTROL SYSTEM (PCS): ACCESSORIES

PFLF - How to Order

PFLF - How it works

PFLF Dimensions

Component Repair Kits

PCS - Pneumatic Control System

PCS Dimensions

Options Page 168

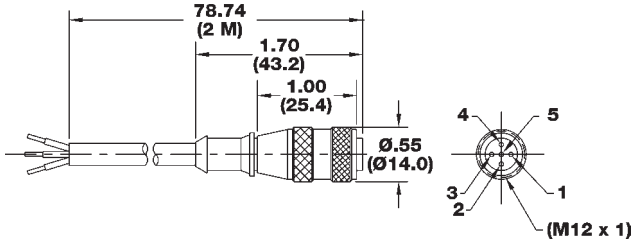
Accessories Page 206

Switches Page 220

Technical Data Page 256

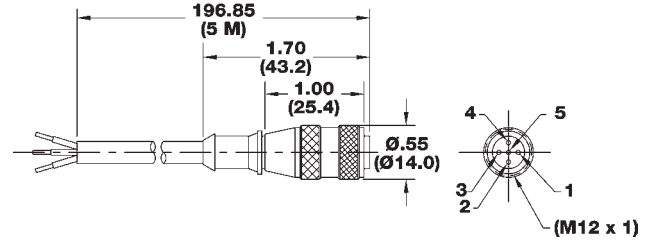
PCS-CBL-PWR

SPECIFICATIONS
5 CONDUCTORS OF 22 AWG LEADS RATED TO 250 V AT 4 AMPS SHIELDED



PCS-CBL-PWR-X

SPECIFICATIONS
5 CONDUCTORS OF 22 AWG LEADS RATED TO 250 V AT 4 AMPS SHIELDED



PCS-CBL-PWR WIRE COLOR CODES

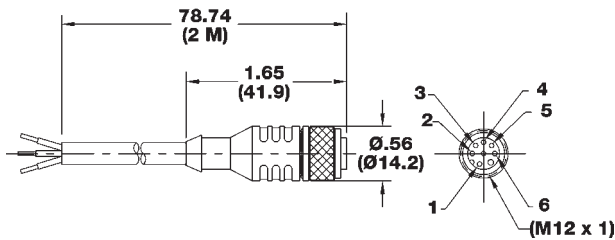
COLOR	PIN	DESCRIPTION
BROWN	1	POSITIVE
WHITE	2	N/C
BLUE	3	NEGATIVE
BLACK	4	N/C

PCS-CBL-CMD WIRE COLOR CODES

COLOR	PIN	DESCRIPTION
BROWN	1	INPUT
WHITE	2	@ POSITION
BLUE	3	GROUND
BLACK	4	CURRENT POSITION
GREEN/YELLOW	5	N/C
PINK	6	N/C

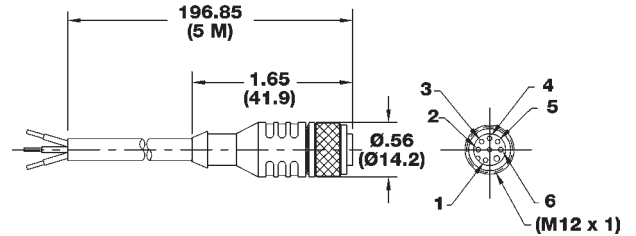
PCS-CBL-CMD

SPECIFICATIONS
6 CONDUCTORS OF 24 AWG LEADS RATED TO EITHER 30 VAC OR 36 VDC AT 4 AMPS SHIELDED



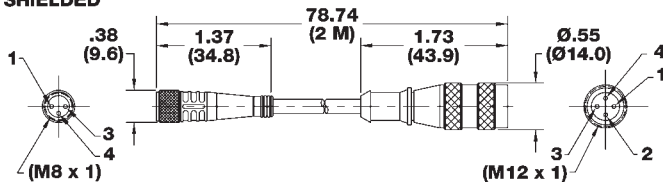
PCS-CBL-CMD-X

SPECIFICATIONS
6 CONDUCTORS OF 24 AWG LEADS RATED TO EITHER 30 VAC OR 36 VDC AT 4 AMPS SHIELDED



PCS-CBL-FBK

SPECIFICATIONS
3 CONDUCTORS OF 24 AWG LEADS RATED TO 120 V AT 4 AMPS SHIELDED



PCS-CBL-FBK-X

SPECIFICATIONS
3 CONDUCTORS OF 24 AWG LEADS RATED TO 120 V AT 4 AMPS SHIELDED

