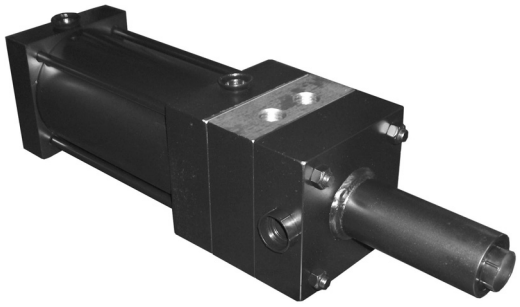
DESIGNING WITH BOOSTERS: AIR-TO-OIL and OIL-TO-OIL

The terms BOOSTER and INTENSIFIER are used interchangeably to describe these practical devices that typically multiply standard shop air into higher hydraulic pressure (air-to-oil), although hydraulic fluid may also be the input medium (oil-to-oil). INTENSIFIERS tend to describe those products that provide very high pressure ratios. BOOSTERS generally provide lower pressure ratings and higher volume.

There are two basic styles of BOOSTERS and INTENSIFIERS. They are the "single" and the "dual" pressure styles. The SINGLE pressure device increases the pressure in the entire non-obstructed circuit. The DUAL pressure device increases the pressure only in the portion of the circuit after the high pressure output port.

BOOSTER AND INTENSIFIER SELECTION

Proper selection of a booster or intensifier requires the following information:



1. The input air (fluid) pressure
2. The desired output pressure
3. The bore and stroke of the high pressure cylinder in the application
4. The desired output force from the high pressure cylinder
5. A sketch of the fluid power circuit (see page 48 for examples)
6. The type of line conductors and fitting connectors used in the circuit
7. How fast the system must operate (cycles per minute)
8. Booster or intensifier mounting style
9. General description of the application and environment (temperature, wash down, etc.)

SELECTION FORMULAS

Using the above information, calculate the required values:

$$\frac{\text{HIGH PRESS. CYL. FORCE}}{\text{HIGH PRESS. CYL. AREA}} = \text{OUTPUT PRESSURE}$$

$$\frac{\text{OUTPUT PRESSURE X 1.05}}{\text{INPUT PRESSURE X .8}} = \text{PRESSURE RATIO}$$

HIGH PRESSURE CYLINDER STROKE X HIGH PRESSURE CYLINDER AREA = HIGH PRESSURE CYLINDER VOLUME

$$\frac{\text{HIGH PRESS. CYL. VOLUME}}{\text{RAM ROD AREA X .95}} = \text{MINIMUM STROKE LENGTH}$$

MINIMUM STROKE LENGTH + .25 = EFFECTIVE STROKE LENGTH (ROUND UP TO NEAREST .25 INCH)

The .95 and 1.05 multipliers allow for friction and expansion in the hydraulic system. The .8 multiplier allows for normal variations in air line pressure. These values are general guidelines and must be adjusted accordingly.

BOOSTERS, INTENSIFIERS, AIR-OIL TANKS (Cont.)

SAMPLE CALCULATION: BOOSTER / INTENSIFIER SIZING

Assume a 2-1/2" dia. bore cylinder with 6" stroke. The cylinder must push 10,000 pounds for .250 inches. The cylinder must extend and retract on pressurized air or oil at 100 PSI.

What size intensifier is required?
What size air-oil tank?

$$\frac{\text{HIGH PRESS. CYL. FORCE}}{\text{HIGH PRESS. CYL. AREA}} = \text{OUTPUT PRESSURE} \qquad \frac{\text{10,000 POUNDS}}{2.5^2 \text{ X } .7854} = \text{2,037 PSIG}$$

$$\frac{\text{OUTPUT PRESSURE X 1.05}}{\text{INPUT PRESSURE X .8}} = \text{PRESSURE RATIO} \qquad \frac{\text{2,037 PSIG X 1.05)}}{\text{(100 PSIG X .8)}} = 26.74$$

HIGH PRESSURE CYLINDER STROKE X HIGH PRESSURE CYLINDER AREA = HIGH PRESSURE CYLINDER VOLUME
The high pressure cylinder stroke is .250 x .490 square inches = 1.23 cubic inches

$$\frac{\text{HIGH PRESS. CYL. VOLUME}}{\text{RAM ROD AREA X .95}} = \text{MINIMUM STOKE LENGTH} \qquad \frac{\text{1.23 Cubic Inch}}{\text{.31 (from Ratio Chart below) x .95}} = \text{4.17 Inches}$$

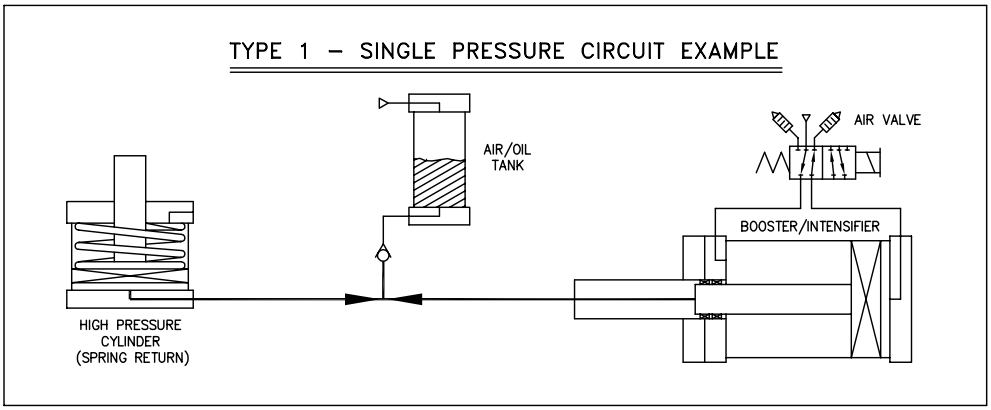
MINIMUM STROKE LENGTH + .25 = EFFECTIVE STROKE LENGTH (ROUND UP TO NEAREST .25 INCH)
The minimum stroke length 4.17 plus .25 = 4.42 inch effective stroke, rounding up to 4.5 inches total stroke

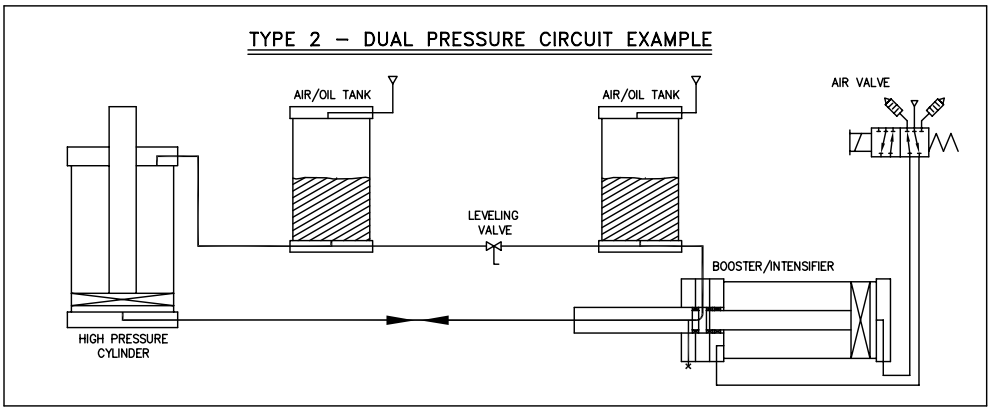
The following intensifiers can be used for this sample application. Choose among the three by the space available for the intensifier. Consult Lehigh for additional application assistance. (See page 48 for air-oil tank selection.)

3-1/4" dia. bore x 5/8" ram dia. x 4-1/2" stroke
4" dia. bore x 5/8" ram dia. x 4-1/2" stroke
6" dia. bore x 1" ram dia. x 2" stroke

RAM ROD DIA.	RAM ROD AREA (SQ. IN.)	PRESSURE RATIOS (BORE AREA / RAM AREA) BORE SIZE (BORE AREA)						
		3 1/4 (8.29 SQ. IN.)	4.0 (12.57 SQ. IN.)	5.0 (19.64 SQ. IN.)	6.0 (28.27 SQ. IN.)	8.0 (50.27 SQ. IN.)	10.0 (78.54 SQ. IN.)	12.0 (113.10 SQ. IN.)
5/8	.31	26.74	40.55	63.35	- - -	- - -	- - -	- - -
1	.79	10.49	15.91	24.86	35.78	63.63	- - -	- - -
1 3/8	1.49	5.56	8.44	13.18	18.97	33.75	52.71	- - -
1 3/4	2.41	3.44	5.22	8.15	11.73	20.86	32.59	46.93
2	3.14	2.64	4.00	6.25	9.00	16.00	25.01	36.02
2 1/2	4.91	- - -	- - -	- - -	5.76	10.24	15.99	23.03
3	7.06	- - -	- - -	- - -	- - -	- - -	11.12	16.02
3 1/2	9.62	- - -	- - -	- - -	- - -	- - -	- - -	11.76

BOOSTERS, INTENSIFIERS, AIR-OIL TANKS (Cont.)





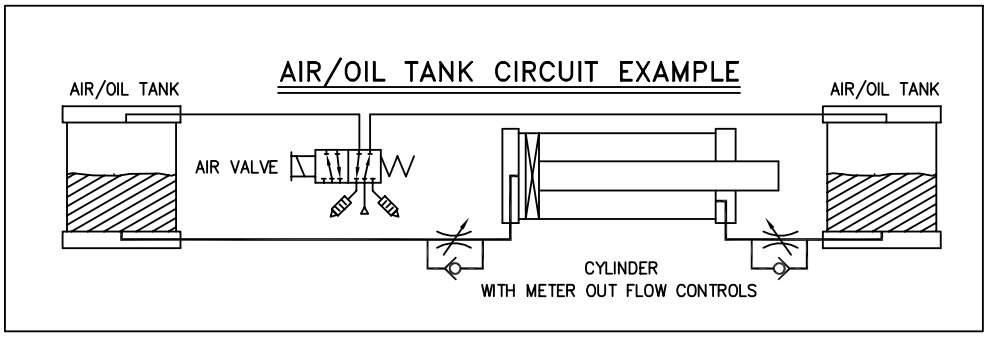
SAMPLE CALCULATION: AIR-OIL TANK SIZING

$$\frac{\text{BORE}^2 \text{ X } .7854 \text{ X STROKE X TANK FACTOR}^*}{\text{TANK VOLUME PER INCH}} = \text{MINIMUM TANK LENGTH} \qquad \frac{2.5^2 \text{ X } .7854 \text{ X } 6 \text{ X } 2.5}{8.3 \text{ (from chart on p. 50)}} = 8.87 \text{ INCHES}$$

(Use the bore diameter of the working cylinder for *BORE*^{2}. Use the stroke of the working cylinder for *STROKE*. The *TANK VOLUME PER INCH* is from the chart on p.50. The volume selected for the formula yields the minimum tank length for the associated tank bore.)

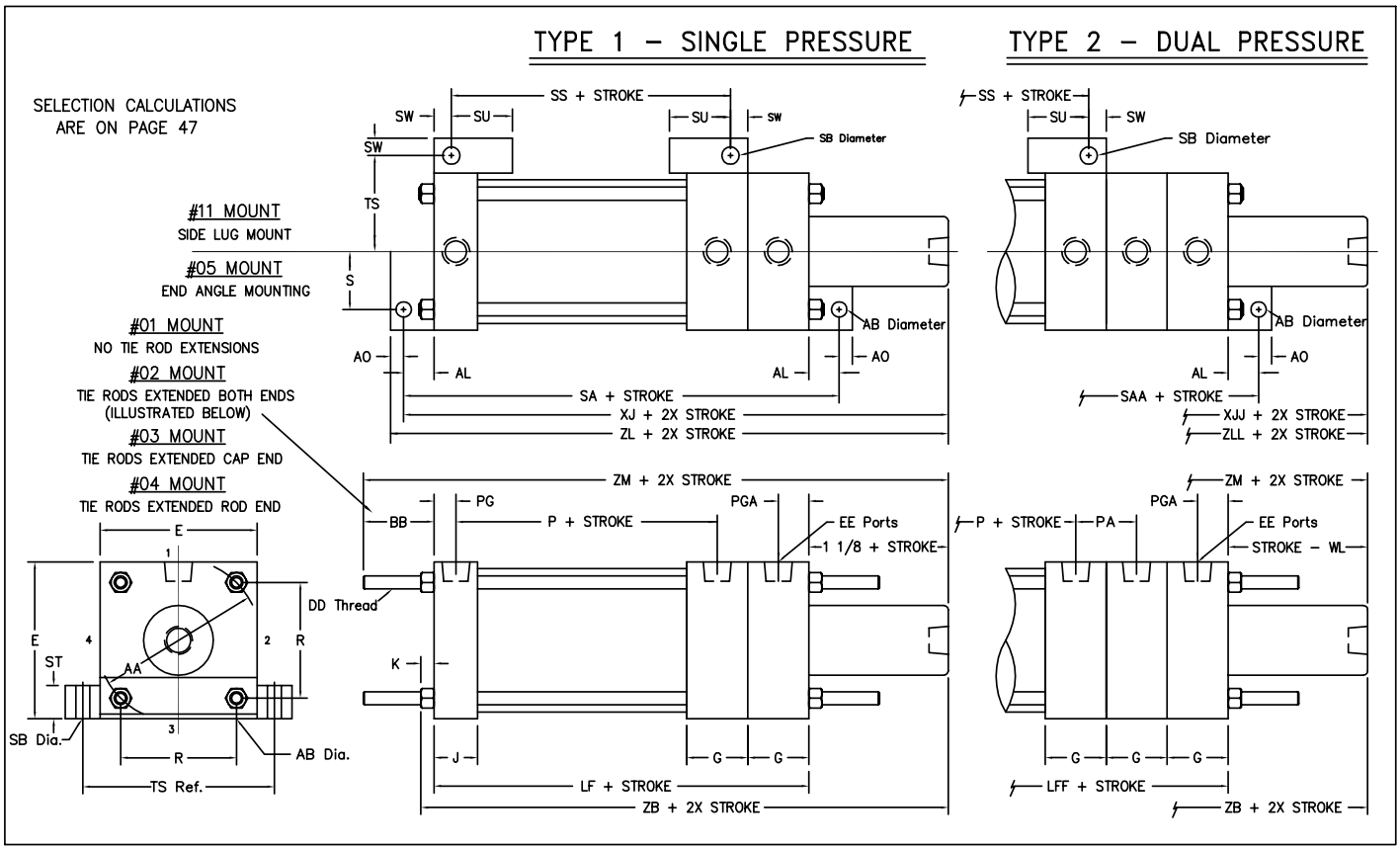
ROUND THE TANK LENGTH UPWARD TO THE NEAREST WHOLE INCH: 8.87 rounds to 9.0 inches long

*The "Tank Factor" varies with tank length, but is generally between 2 and 3 depending on the tank application.



Note: Sample circuits are for concept illustration purposes only. Additional safety devices, controls and lockouts are required for safe operation.

BOOSTERS, INTENSIFIERS, AIR-OIL TANKS (Cont.)



ENVELOPE AND MOUNTING DIMENSIONS

BORE	AA	AB	AL	AO	BB	DD	E	EE NPT	G	J	K	ADD STROKE LF	LFF	P	SA	SAA	SS
3 1/4	3.90	9/16	1 1/4	1/2	1 3/8	3/8-24	3 3/4	1/2	1 3/4	1 1/4	3/8	6	7 3/4	2 5/8	8 1/2	10 1/4	3 1/4
4	4.70	9/16	1 1/4	1/2	1 3/8	3/8-24	4 1/2	1/2	1 3/4	1 1/4	3/8	6	7 3/4	2 5/8	8 1/2	10 1/4	3 1/4
5	5.80	11/16	1 3/8	5/8	1 13/16	1/2-20	5 1/2	1/2	1 3/4	1 1/4	7/16	6 1/4	8	2 7/8	9	10 3/4	3 1/8
6	6.90	13/16	1 3/8	5/8	1 13/16	1/2-20	6 1/2	3/4	2	1 1/2	7/16	7	9	3 1/8	9 3/4	11 3/4	3 5/8
8	9.10	13/16	1 13/16	11/16	2 5/16	5/8-18	8 1/2	3/4	2	1 1/2	9/16	7 1/8	9 1/8	3 1/4	10 3/4	12 3/4	3 3/4
10	11.20	1 1/16	2 1/8	7/8	2 11/16	3/4-16	10 5/8	1	2 1/4	2	11/16	8 5/8	10 7/8	4 1/8	12 7/8	15 1/8	4 5/8
12	13.30	1 1/16	2 1/8	7/8	2 11/16	3/4-16	12 3/4	1	2 1/4	2	11/16	9 1/8	11 3/8	4 5/8	13 3/8	15 5/8	5 1/8

BORE	R	PA	PG	PGA	S	SB	ST	SU	SW	TS	STROKE MINUS WL	ADD 2X STROKE XJ	XJJ	ZB	ZL	ZLL	ZM
3 1/4	2.76	2 1/8	9/16	11/16	2 3/4	9/16	3/4	1 1/4	1/2	4 3/4	5/8	8 3/8	8	7 1/2	8 7/8	8 3/8	8 1/2
4	3.32	2 1/8	9/16	11/16	3 1/2	9/16	3/4	1 1/4	1/2	5 1/2	5/8	8 3/8	8 1/8	7 1/2	8 7/8	8 1/2	8 1/2
5	4.10	2 1/8	9/16	11/16	4 1/4	13/16	1	1 9/16	11/16	6 7/8	5/8	8 3/4	8 7/16	7 13/16	9 3/8	8 15/16	9 3/16
6	4.88	2 3/8	11/16	13/16	5 1/4	13/16	1	1 9/16	11/16	7 7/8	7/8	9 1/2	9 1/8	8 9/16	10 1/8	9 5/8	9 15/16
8	6.44	2 3/8	11/16	13/16	7 1/8	13/16	1	1 9/16	11/16	9 7/8	7/8	10 1/16	9 3/8	8 13/16	10 3/4	10	10 9/16
10	7.92	2 1/2	1	1	8 7/8	1 1/16	1 1/4	2	7/8	12 3/8	1 1/8	11 7/8	11 1/16	10 7/16	12 3/4	11 11/16	12 7/16
12	9.40	2 1/2	1	1	11	1 1/16	1 1/4	2	7/8	14 1/2	1 1/8	12 3/8	11 9/16	10 15/16	13 1/4	12 3/16	12 15/16

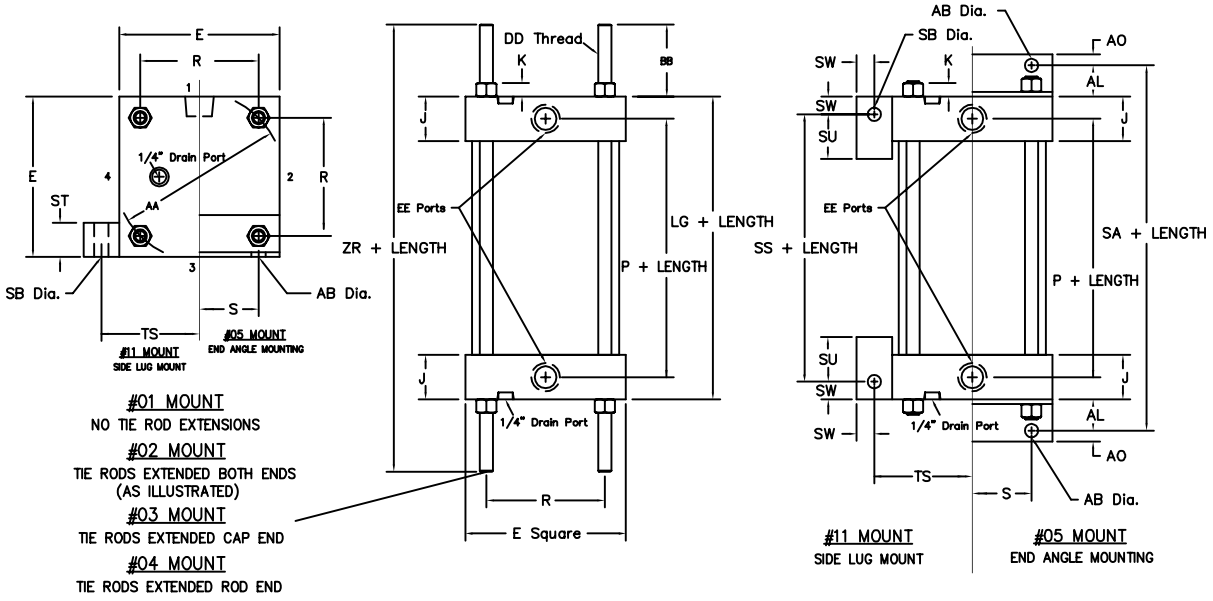
NPT PORTS FURNISHED UNLESS OTHERWISE SPECIFIED

BOOSTERS, INTENSIFIERS, AIR-OIL TANKS (Cont.)

AIR – OIL TANKS

TYPE 1 = TRANSLUCENT TUBE
TYPE 2 = OPAQUE TUBE & SIGHT TUBE

SELECTION CALCULATIONS ON PAGE 48



#01 MOUNT
NO TIE ROD EXTENSIONS

#02 MOUNT
TIE RODS EXTENDED BOTH ENDS (AS ILLUSTRATED)

#03 MOUNT
TIE RODS EXTENDED CAP END

#04 MOUNT
TIE RODS EXTENDED ROD END

MATERIALS OF CONSTRUCTION TYPICALLY ARE STEEL HEADS, TIE RODS AND MOUNTS, WITH TRANSLUCENT PLASTIC TUBES. OPTIONS INCLUDE METALLIC AND NON–METALLIC TUBES, SIGHT GLASSES, ADDITIONAL PORTS, ALL STAINLESS STEEL, COMPOSITE MATERIALS, GLASS TUBES, ETC. PLEASE CONSULT THE FACTORY FOR MATERIALS COMPATABILITY WITH BOTH THE STANDARD TANKS AND SPECIAL APPLICATIONS.

ENVELOPE AND MOUNTING DIMENSIONS

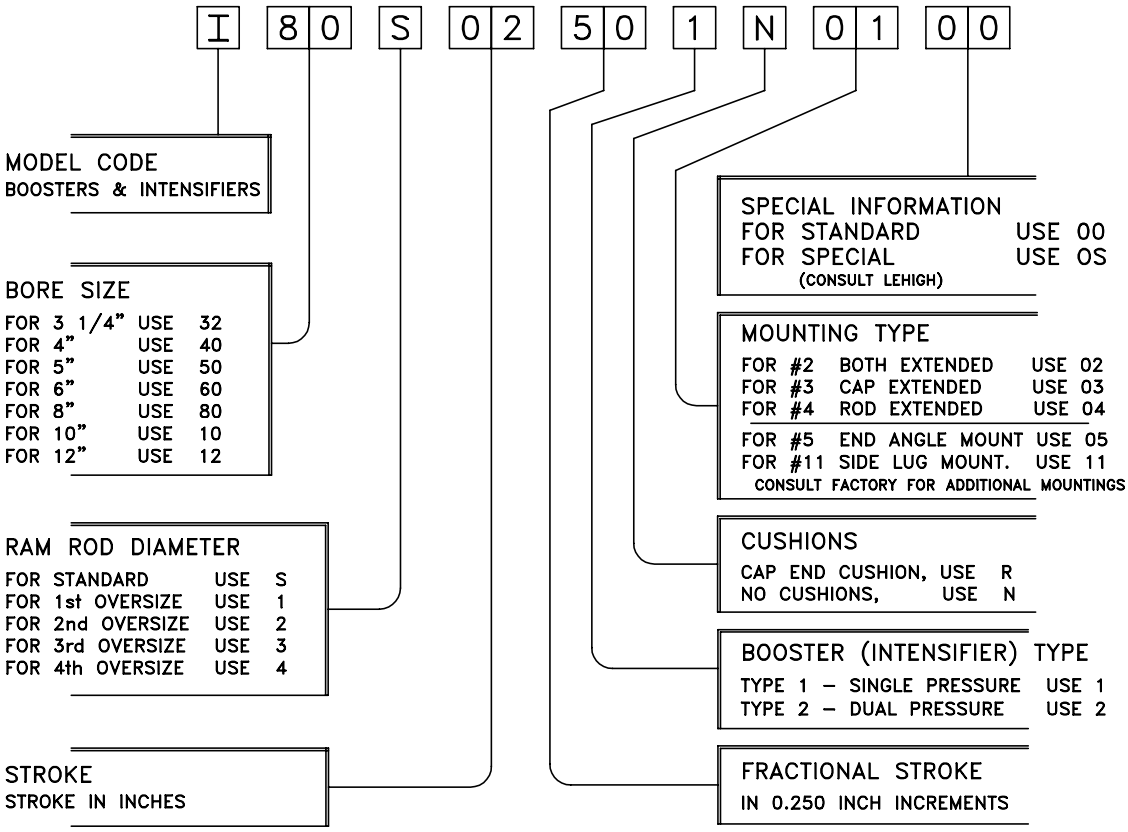
BORE	VOL. PER IN.	AA	AB	AL	AO	BB	DD	E	EE NPT	J	K	PG
3 1/4	8.29 CU. IN.	3.90	9/16	1 1/4	1/2	1 3/8	3/8-24	3 3/4	1/2	1 1/4	3/8	9/16
4	12.56 CU. IN.	4.70	9/16	1 1/4	1/2	1 3/8	3/8-24	4 1/2	1/2	1 1/4	3/8	9/16
5	19.63 CU. IN.	5.80	11/16	1 3/8	5/8	1 13/16	1/2-20	5 1/2	1/2	1 1/4	7/16	9/16
6	28.27 CU. IN.	6.90	13/16	1 3/8	5/8	1 13/16	1/2-20	6 1/2	3/4	1 1/2	7/16	11/16
8	50.26 CU. IN.	9.10	13/16	1 13/16	11/16	2 5/16	5/8-18	8 1/2	3/4	1 1/2	9/16	11/16

BORE	R	S	SB	ST	SU	SW	TS	ADD TANK LENGTH				
								LG	P	SA	SS	ZR
3 1/4	2.76	2 3/4	9/16	3/4	1 1/4	1/2	4 3/4	2 1/2	1 3/8	5	1 1/2	5 1/4
4	3.32	3 1/2	9/16	3/4	1 1/4	1/2	5 1/2	2 1/2	1 3/8	5	1 1/2	5 1/4
5	4.10	4 1/4	13/16	1	1 9/16	11/16	6 7/8	2 1/2	1 3/8	5 1/4	1 1/8	6 1/8
6	4.88	5 1/4	13/16	1	1 9/16	11/16	7 7/8	3	1 5/8	5 3/4	1 5/8	6 5/8
8	6.44	7 1/8	13/16	1	1 9/16	11/16	9 7/8	3	1 5/8	6 5/8	1 5/8	7 5/8

NPT PORTS FURNISHED UNLESS OTHERWISE SPECIFIED

ORDERING INFORMATION

BOOSTERS & INTENSIFIERS



AIR / OIL TANKS