Mounting Configurations of 4-port Hydraulic Directional Control Valves

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As we are aware, a valve to be connected to a hydraulic system should be sized according to the maximum flow rate estimated for the system. Table 1 presents the size designations, port sizes, and nominal flow rates for different sizes of 4-port hydraulic directional control valves according to the DIN (NG part), NFPA, ISO, and CETOP standards. However, the dimensions given are indicative and the exact values may be ascertained from the data on manufacturer's catalogue.

Table 1 | The size designations, port sizes, and nominal flow rates for different sizes of directional control valves

Size representations				Port dia inch (mm)	Nominal flow gpm (lpm)
NG*	NFPA	ISO	CETOP		
NG 4	D02	02	2	0.177 (4.5)	5 (20)
NG 6	D03	03	3	0.295 (7.5)	10 (40)
NG 10	D05	05	5	0.44 (11)	20 (80)
NG 16	D07	07	7	0.69 (17.5)	30 (120)
NG 25	D08	08	8	0.984 (25)	60 (240)
NG 32	D10	10	10	1.25 (32)	100 (400)

[*As the author understands 'NG' stands for Nominal Size – Normale Größe (in the German language)]

A directional control valve or group of valves for a hydraulic system can be configured in many different ways according to the required installation convenience. According to the way the valve body and ports are organised, the valve or valve system can be of the following types: (1) line-mounted, (2) sub-plate mounted, and (3) manifold mounted.

Line-mounted Valves

In a line-mounted valve, the valve assembly includes the valve body and ports as an integral unit, as shown in Figure 1. The ports are threaded to fix fittings for fluid conductors. Therefore, the conductors can be directly connected to the valve.

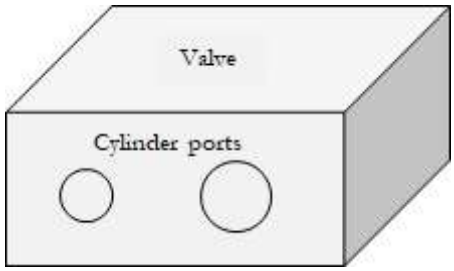

Figure 1 | A line-mounted valve

Line-mounted valves are lightweight and less expensive. However, they are prone to leakage. Further, it is not easy to assemble and disassemble a line-mounted valve, as all connections to the valve should be removed during the time when the valve is to be repaired or replaced. Line-mounted valves are suitable for mobile equipment and small-flow hydraulic systems.

Sub-plate Mounted Valves

In a sub-plate mounted valve, as shown in Figure 2, the valve and set of connection ports are distinct sections. All the ports are provided on a sub-plate. The sub-plate can be side ported or bottom ported. All conductor connections are made to the ports on the sub-plate.

The sub-plate serves as a convenient mounting pad for mounting one valve. It contains bores, mostly with a standard pattern, to pass a fluid medium and hence realise the control function of the associated valve. The valve with O-ring seals is mounted to the sub-plate using bolts. The seals are necessary to eliminate leaks. Many thread options such as NPT, SAE, metric, BSP etc., are offered by valve manufacturers. Sub-plates are manufactured as per a standard or custom-made. Aluminium, ductile iron or steel material can be used for the construction of a sub-plate depending on the system pressure. Aluminium can be used for pressures up to 210 bar and ductile iron can be used for pressures up to 350 bar.

It is not required to disconnect conductor connections when replacing a valve mounted on a sub-plate. This feature is convenient as the time required to replace the valve and cost can greatly be reduced. Some manufacturers offer wiring channels in the sub-plates. The sub-plates come with many different sizes, patterns, and locations for ports and mounting holes, and pressure ratings.

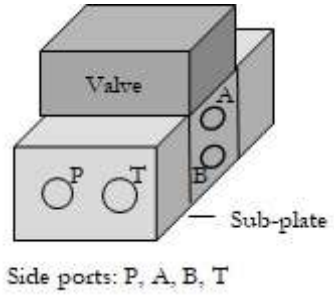

Figure 2 | A sub-plate mounted valve

Interface Layouts for Sub-plates

The sizes, locations, and pattern of ports and mounting holes on the mounting surface of a sub-plate should perfectly match with that of the associated four-port hydraulic directional control valve. Therefore, the parameters of mounting surfaces of valves and sub-plates are standardised as per NFPA T3.5.1 MR1, ISO 4401, CETOP, or NG part of DIN 24340 standard. These standards specify sizes, size designations, interface layouts, and locations of ports and mounting holes for different sizes of valves and sub-plates. A sub-plate mounted directional control valve conforming to a particular standard from any manufacturer is interchangeable with a valve of comparable size and conforming to the same standard from a different manufacturer. The probable difference can be whether the bolts have SAE or metric threads.

Interface Layout for a Sub-plate of Size 02 as per ISO 4401 [NFPA D02, CETOP 2, or NG 4]

The locations, and pattern of ports, and holes for mounting bolts and locating pins on the mounting surface of a sub-plate for size 02 as per ISO 4401 [NFPA D02, CETOP 2, or NG 4] are given in Figure 3.

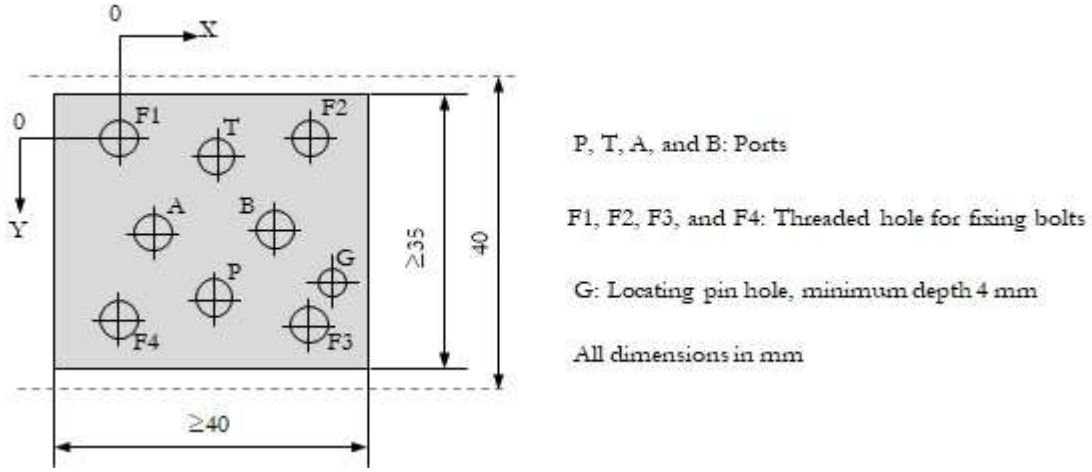

Figure 3 | Interface layout for a sub-plate of size 2 as per ISO 4401

Port Sizes and Locations, Size 02 Conforming to ISO 4401

The indicative sizes and locations of ports and other openings for fixing bolts and locating pin are given in Table 2.

Table 2 | Sizes and positions of ports, and holes for mounting bolts and locating pins for size 02, ISO 4401

Axis	P	A	T	B	F1	F2	F3	F4	G
	Φ 4.5 max	Φ 4.5 max	Φ 4.5 max	Φ 4.5 max	M5	M5	M5	M5	Φ 3.4
x	12	4.3	12	19.7	0	24	24	0	26.5
y	20.25	11.25	2.25	11.25	0	-0.75	23.25	22.5	17.75

Interface Layout for a Sub-plate of Size 03 as per ISO 4401 [NFPA D03, CETOP 3, or NG 6]

The locations, and pattern of ports, and holes for mounting bolts and locating pins on the mounting surface of a sub-plate for size 03 as per ISO 4401 [NFPA D03, CETOP 3, or NG 6] without pilot ports are given in Figure 4. The details of the sub-plate for size 03 are given in Figure 5.

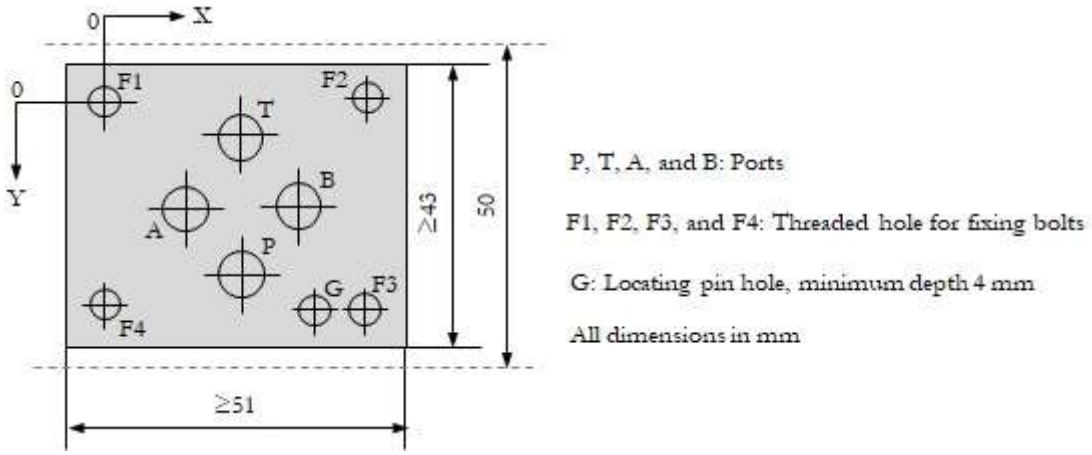

Figure 4 | Interface layout for a sub-plate of size 03 (without pilot ports) as per ISO 4401

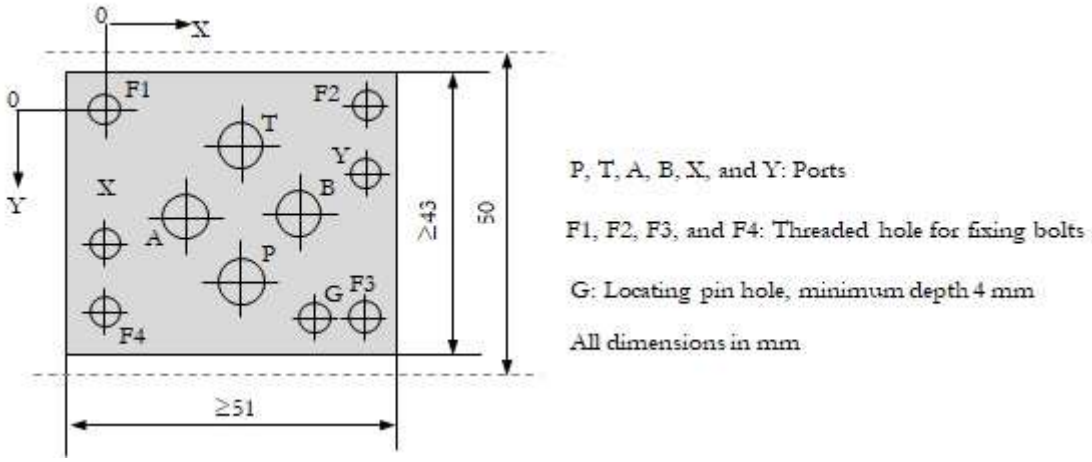

Figure 5 | Interface layouts for sub-plate for size 03 (with pilot ports) as per ISO 4401

Port Sizes and Locations, Size 03 Conforming to ISO 4401

The indicative sizes and locations of ports and other openings for fixing bolts and the locating pin are given in Table 3.

Table 3 | Sizes and positions of ports, and holes for mounting bolts and locating pins for size 03, ISO 4401

Axis	P	A	T	B	F1	F2	F3	F4	X	Y	G
	Φ 7.5 max	Φ 7.5 max	Φ 7.5 max	Φ 7.5 max	M5	M5	M5	M5	Φ 3.3 max	Φ 3.3 max	Φ 4.
x	21.5	12.7	21.5	30.2	0	40.5	40.5	0	0	40.5	33
y	25.9	15.5	5.1	15.5	0	-0.75	31.75	31	22	9	31.75

Interface Layout for a Sub-plate of Size 05 as per ISO 4401 [NFPA D05, CETOP 5, or NG 10]

The locations, and pattern of ports, and holes for mounting bolts and locating pins on the mounting surface of a sub-plate for size 05 as per ISO 4401 [NFPA D05, CETOP 5, or NG 10] without pilot ports are given in Figure 6. The details of the sub-plate for size 05 with pilot ports are given in Figure 7.

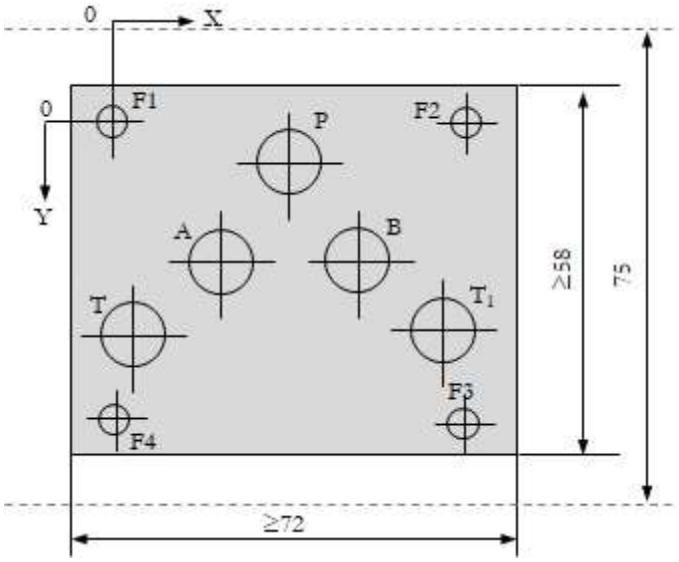

Figure 6 | Interface layout for a sub-plate of size 05 (without pilot ports) as per ISO 4401

Interface Layouts for Sub-plate of Size 05 (with pilot ports) as per ISO 4401

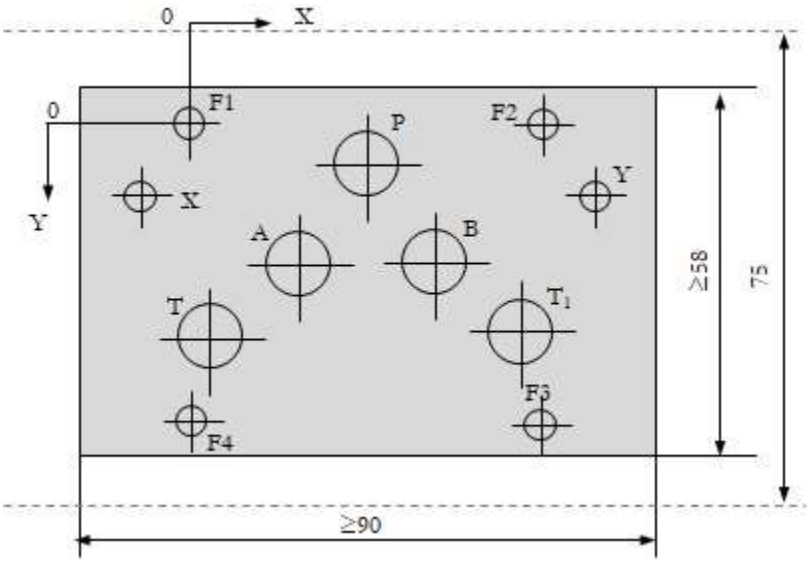

Figure 7 | Interface layouts for sub-plate for size 05 (with pilot ports) as per ISO 4401

Port Sizes and Locations, Size 05 Conforming to ISO 4401

The indicative sizes and locations of ports and other openings for fixing bolts are given in Table 4.

Table 4 | Sizes and positions of ports, and holes for mounting bolts and locating pins for size 05, ISO 4401

Axis	P	A	T	T_1	B	F1	F2	F3	F4	X	Y
	Φ 11.2 max	Φ 11.2 max	Φ 11.2 max	Φ 11.2 max	Φ 11.2 max	M6	M6	M6	M6	Φ 6.3 max	Φ 6.3 max
x	27	16.7	3.2	50.8	37.3	0	54	54	0	-8	62
y	6.3	21.4	32.5	32.5	21.4	0	0	46	46	11	11

Interface Layout for a Sub-plate of Size 07 as per ISO 4401 [NFPA D07, CETOP 7, or NG 16]

The locations, and pattern of ports, and holes for mounting bolts and locating pins on the mounting surface of a sub-plate for size 07 as per ISO 4401 [NFPA D07, CETOP 7, or NG 16] with pilot ports are given in Figure 8.

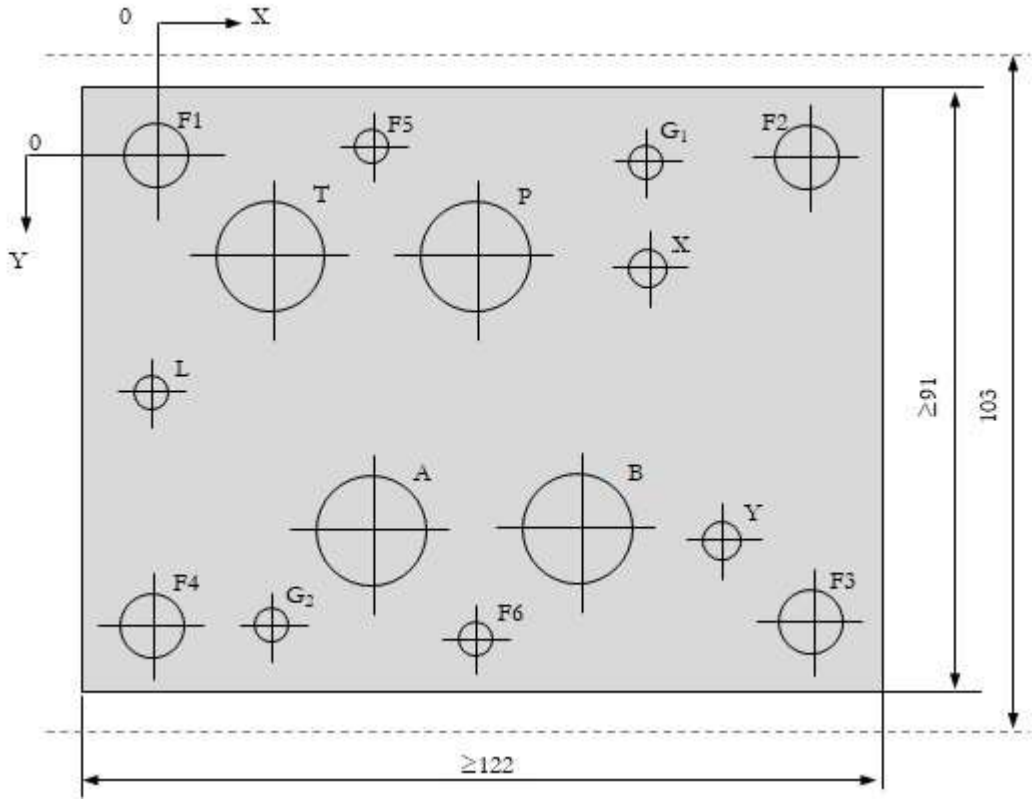

Figure 8 | Interface layout for a sub-plate of size 07 (without pilot ports) as per ISO 4401

Port Sizes and Locations, Size 07 Conforming to ISO 4401

The indicative sizes and locations of ports and other openings for fixing bolts and locating pins are given in Table 5.

Table 5 | Sizes and positions of ports, and holes for mounting bolts and locating pins for size 07, ISO 4401

Axis	P	A	T	B	L	X	Y	G1	G2	F1	F2	F3	F4	F5	F6
	Φ 17.5 max	Φ 17.5 max	Φ 17.5 max	Φ 17.5 max	Φ 6.3 max	Φ 6.3 max	Φ 6.3 max	Φ 4	Φ 4	M10	M10	M10	M10	M6	M6
x	50	34.1	18.3	65.9	0	76.6	88.1	76.6	18.3	0	101.6	101.6	0	34.1	50
y	14.3	55.6	14.3	55.6	34.9	15.9	57.2	0	69.9	0	0	69.9	69.9	-1.6	71.5

Interface Layout for a Sub-plate of Size 08 as per ISO 4401 [NFPA D08, CETOP 8, or NG 25]

The locations, and pattern of ports, and holes for mounting bolts and locating pins on the mounting surface of a sub-plate for size 08 as per ISO 4401 [NFPA D08, CETOP 8, or NG 25] with pilot ports are given in Figure 9.

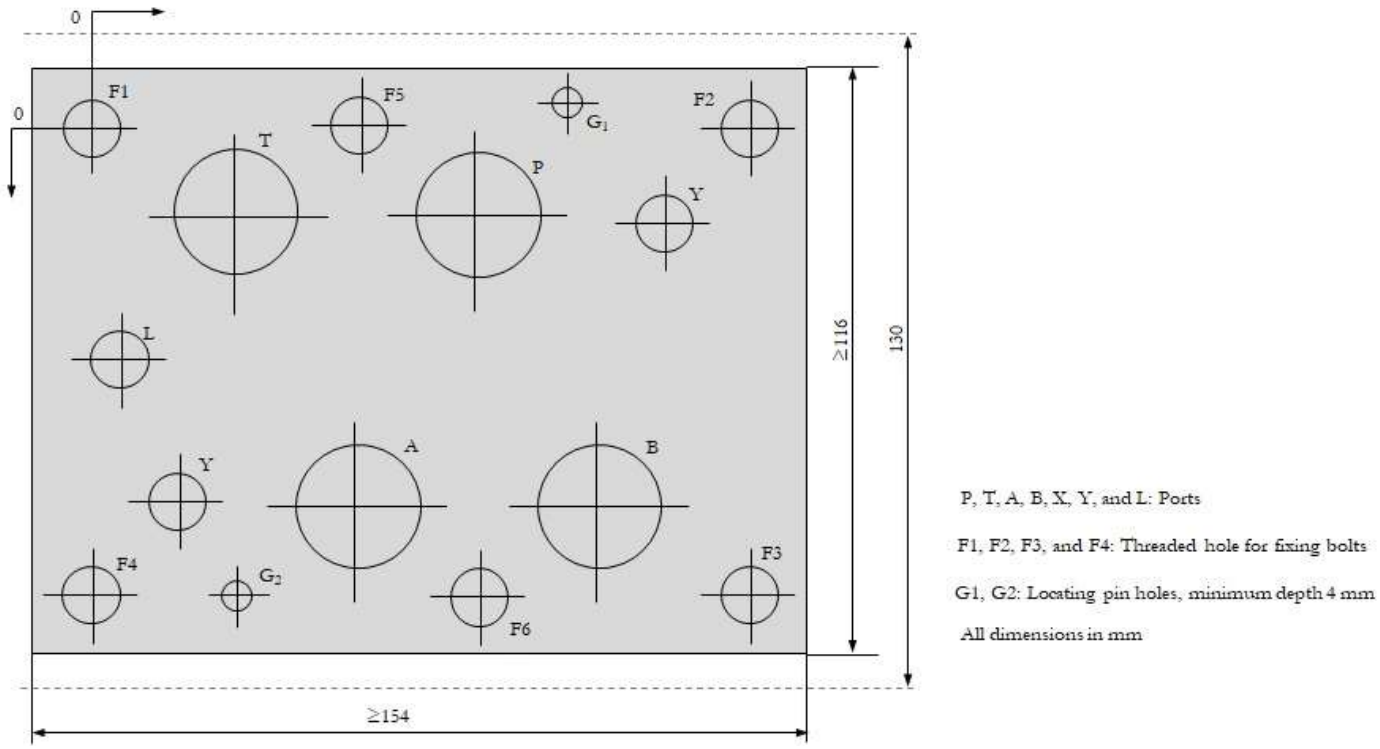

Figure 9 | Interface layout for a sub-plate of size 08 (without pilot ports) as per ISO 4401

Port Sizes and Locations, Size 08 Conforming to ISO 4401

The indicative sizes and locations of ports and other openings for fixing bolts and locating pins are given in Table 6.

Table 6 | Sizes and positions of ports, and holes for mounting bolts and locating pins for size 08, ISO 4401

Axis	P	A	T	B	L	X	Y	G1	G2	F1	F2	F3	F4	F5	F6
	Φ 25 max	Φ 25 max	Φ 25 max	Φ 25 max	Φ 11.2 max	Φ 11.2 max	Φ 11.2 max	Φ 7.5	Φ 7.5	M12	M12	M12	M12	M12	M12
x	77	53.2	29.4	100.8	5.6	17.5	112.7	94.5	29.4	0	130.2	130.2	0	53.2	77
y	17.5	74.6	17.5	74.6	46	73	19	-4.8	92.1	0	0	92.1	92.1	0	92.1

Interface Layout for a Sub-plate of Size 10 as per ISO 4401 [NFPA D10, CETOP 10, or NG 32]

The locations, and pattern of ports, and holes for mounting bolts and locating pins on the mounting surface of a sub-plate for size 10 as per ISO 4401 [NFPA D10, CETOP 10, or NG 32] without pilot ports are given in Figure 10.

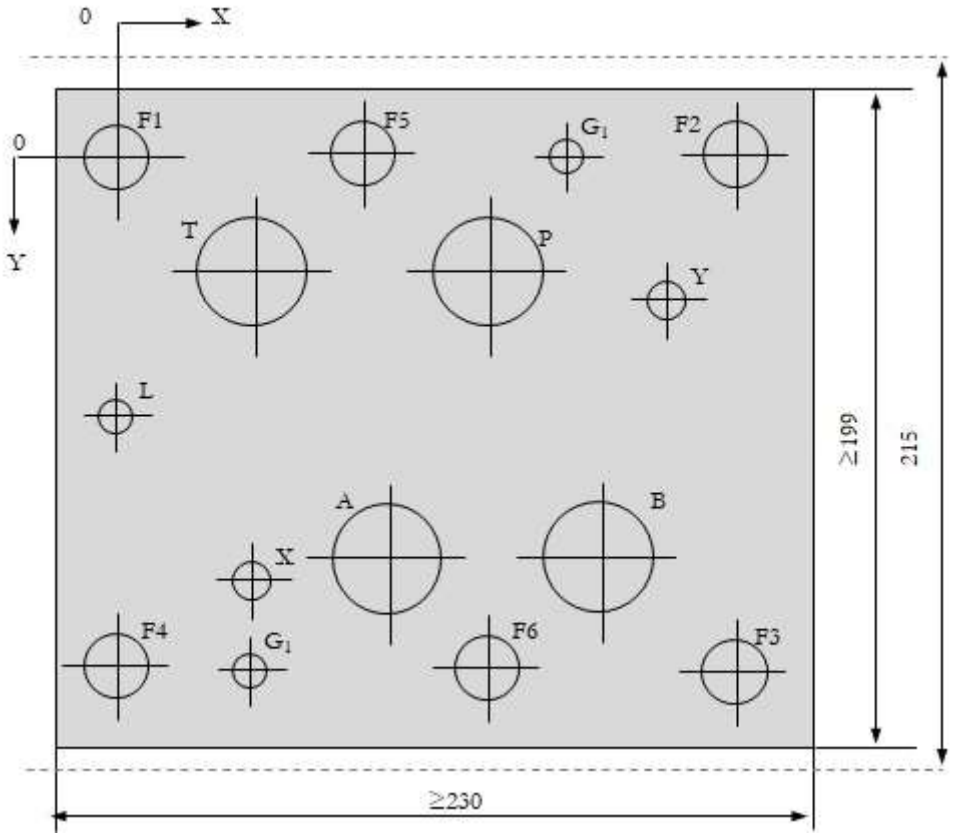

Figure 10 | Interface layout for a sub-plate of size 10 (without pilot ports) as per ISO 4401

Port Sizes and Locations, Size 10 Conforming to ISO 4401

The indicative sizes and locations of ports and other openings for fixing bolts and locating pins are given in Table 7.

Table 7 | Sizes and positions of ports, and holes for mounting bolts and locating pins for size 10, ISO 4401

Axis	P	A	T	B	L	X	Y	G1	G2	F1	F2	F3	F4	F5	F6
	Φ 32 max	Φ 32 max	Φ 32 max	Φ 32 max	Φ 11.2 max	Φ 11.2 max	Φ 11.2 max	Φ 7.5	Φ 7.5	M20	M20	M20	M20	M20	M20
x	114.3	82.5	41.3	147.6	0	41.3	168.3	138.6	41.3	0	190.5	190.5	0	76.2	114.3
y	35	123.8	35	123.8	79.4	130.2	44.5	0	158.8	0	0	158.8	158.8	0	158.8

Manifold Assembly

The flow in a complex hydraulic system with conventional pipe connections tends to be restricted. Further, the pipe connections can become potential leakage points. A hydraulic system with the manifold assembly enables the creation of hydraulic circuits without the use of pipes and fittings and helps to build a compact and leak-free system that is easier to maintain.

A single-piece bar manifold or stackable plate assembly in a hydraulic system provides a single place to mount several valves, with standard mounting patterns. These units also are available with wiring channels and plug-in valves for solenoid operation. The manifold in a hydraulic system is designed to distribute fluid throughout the system. The flow of the pressurized fluid is regulated by hydraulic valves installed within the manifold.

The bar manifold, as shown in Figure 11, supports all valves and contains all the passages for the entire hydraulic system.

A stackable modular plate assembly consists of two or more sub-plates connected to make a valve stack with an internal passage for a common pressure connection and an internal passage for a common tank connection. Each modular sub-plate unit supports only one valve and contains internal passages for the supported valve as well as flow-through provisions. It is normally connected to a series of similar modular blocks to make up a complete system.

Figure 11 | A bar manifold

There are two ways of manufacturing manifolds: That is: (1) A manifold can be made from a piece of steel, aluminium, or cast iron that can be drilled to provide the required flow passages. (2) A manifold can also be custom-made from several layers of steel sheets that have appropriate passages machined or milled through them. These sheets along with solid metal end plates are then stacked and the whole stack is brazed. With this laminar design, the internal passages can be formed in contoured shapes and as large as possible. Therefore, in a manifold, any flow rate can be accommodated with minimum pressure drop.

The advantages of manifold systems include reduced costs of assembly and installation, decreased pressure drop, bare minimum leak points, and easy component interchangeability.

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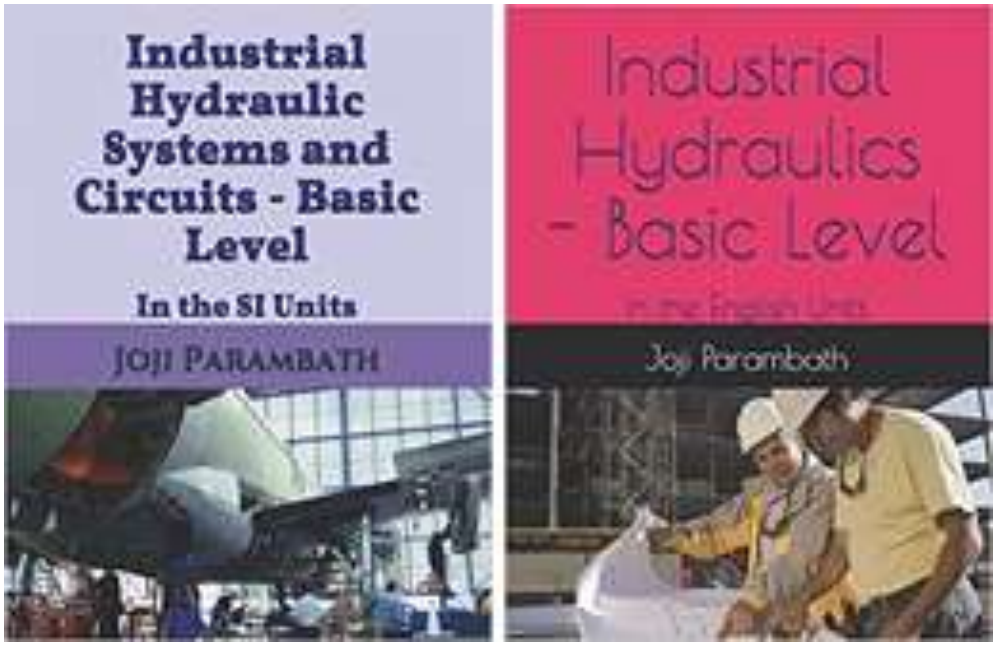
Dedication

This article is dedicated to all information seekers in the field of fluid power and readers of the books on 'Industrial Hydraulic Systems Industrial Hydraulic Systems and Circuits -Basic Level (In the SI Units)' and 'Industrial Hydraulics -Basic Level (In the English Units)' authored by Joji Parambath.



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