HYDRAULICS AND PNEUMATICS

COURSE PRIMER 1

Component Equipment and Plant Symbols

4 Component, Equipment and Plant Symbols

Aims

At the end of this chapter you should be able to:

1 *Have an awareness of the relevant CETOp, International and British Standards relating to symbols used for pneumatic and hydraulic components, equipment and plant.*
2 *Recognise certain common symbols used in pneumatic and hydraulic circuit diagrams.*
3 *Understand component lettering and numbering identification systems.*
4 *Relate the use of lettering and number designations to component selection.*

4.1 Identification of graphical symbols used in pneumatics and hydraulics

During 1964 the Comite Europeen des Transmissions Oleohydrauliques et Pneumatiques (CETOP) published a proposed range of symbols for hydraulic and pneumatic equipment. These symbols were later adopted by the International Standards Organisation in its document ISO 1219 and this in turn subsequently formed the basis of the British Standard BS 2917 (1977) - Graphical symbols used on diagrams for fluid power systems and components.

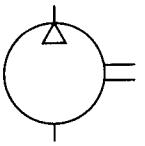
Appendix 4 lists some international fluid power standards together with relevant standardisation organisations.

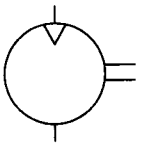
There are some differences between CETOP, ISO and BS symbols, but all are intended to be self explanatory. Also, it should be noted that sometimes manufacturers produce a piece of pneumatic or hydraulic equipment which cannot be exactly represented by existing symbols, in which case the manufacturer develops its own symbol. Thus companies such as Festo, IMI Norgren, Bosch, etc. may produce their own symbols for particular equipment and components.

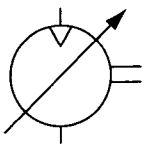
The following shows the more commonly applied BS 2917 symbols. A more detailed description of the symbols relating to fluid power generation, distribution, supply equipment, valves and actuation will be given in later chapters.

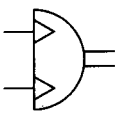
4.2 Energy conversion symbols

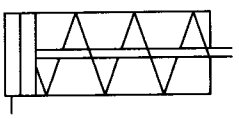
Note: For hydraulic components the part symbol ∇ will be filled in thus ▼ e.g. A hydraulic motor would be shown as 

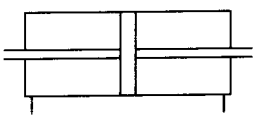

Compressor

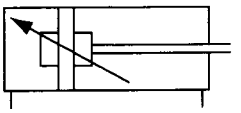

Pneumatic motor, constant, with one direction flow

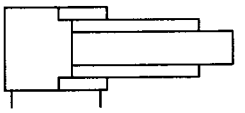

Pneumatic motor, adjustable, with one direction flow

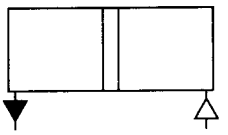

Pneumatic semi-rotary actuator, with limited angle of rotation (rotary cylinder), with two directions of rotation

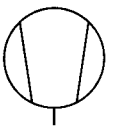

Single-acting cylinder, return stroke by spring

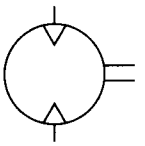

Double-acting cylinder with double-ended piston rod

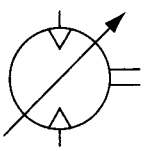

Double-acting cylinder with cushioning adjustable at both ends

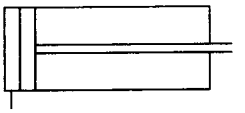

Double-acting telescopic cylinder

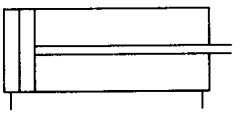

Pneumatic-hydraulic rodless actuator

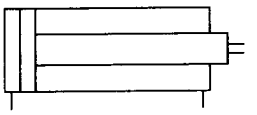

Vacuum pump

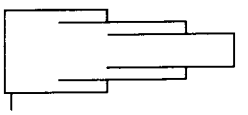

Pneumatic motor, constant, with two direction flow

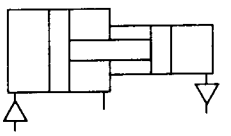

Pneumatic motor, adjustable, with two direction flow

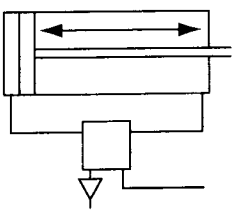

Single-acting cylinder, return stroke by external force


Double-acting cylinder


Differential cylinder

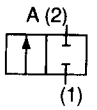

Single-acting telescopic cylinder


Pressure intensifier

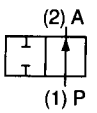

Pneumatic linear unit

4.3 Valve symbols

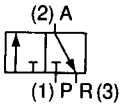
Directional control valves



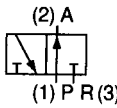
2/2-way valve, closed normal position



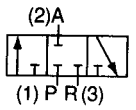
2/2-way valve, open normal position



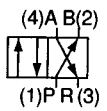
3/2-way valve, closed normal position



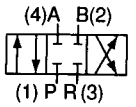
3/2-way valve, open normal position



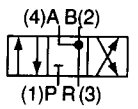
3/3-way valve, closed neutral position



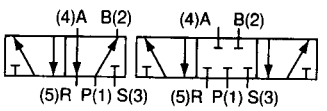
4/2-way valve



4/3-way valve, closed neutral position



4/3-way valve, neutral position, working lines vented



5/2-way valve

5/3-way valve, closed neutral position

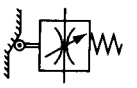
Direction control valve with intermediate switching positions and two final positions

Flow control valves

Throttle valve with constant restriction

Diaphragm valve with constant restriction

Throttle valve, adjustable, any type of operation



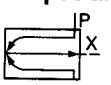
Throttle valve, adjustable, mechanical operation against return spring

Throttle valve, adjustable, manual operation

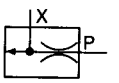
Gate valve

Gate valve (simplified)

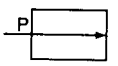
Special symbols*



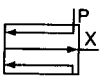
Reflex sensor



Back pressure nozzle

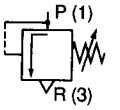


Nozzle, general, emitter nozzle for air gate

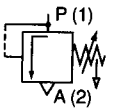


Collector nozzle, with air supply for air gate

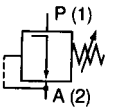
Pressure control valves



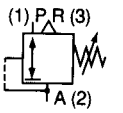
Pressure relief valve, adjustable



Sequence valve, adjustable, with pressure relief

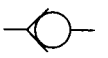


Pressure regulator, adjustable



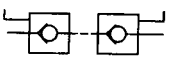
Relieving pressure regulator, adjustable

Non-return valves

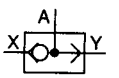


Check valve without spring

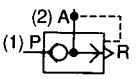
Check valve with spring



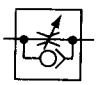
Pilot-controlled check valve



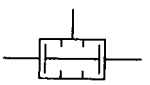
Shuttle valve



Quick exhaust valve

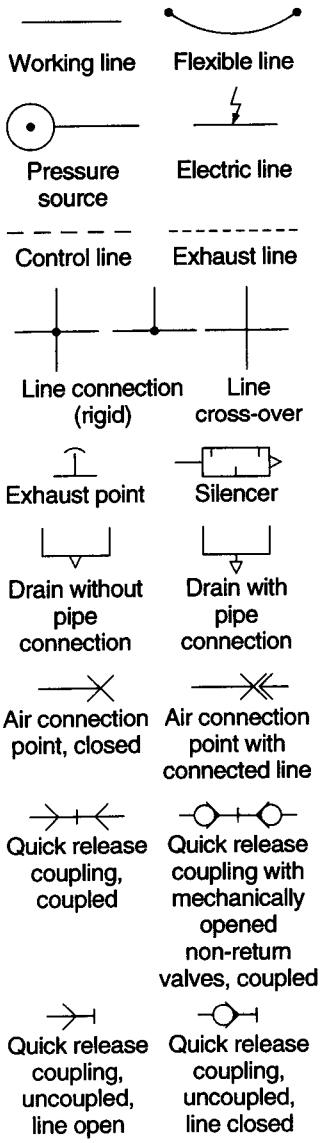


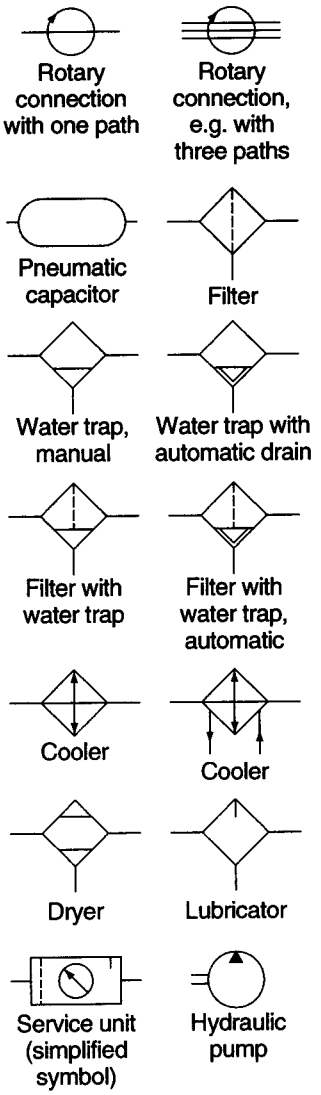
One-way flow control valve, adjustable



Two-pressure valve

4.4 Energy transmission symbols



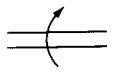


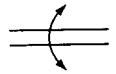
4.5 Control symbols

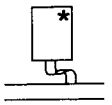
Mechanical components

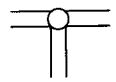

Detent

Over-centre device

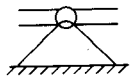

Shaft rotational movement in one direction


Shaft rotational movement in two directions

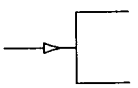

Locking device (*control method for releasing the locking device)

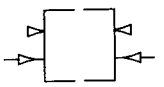

Hinge joint with extended lever

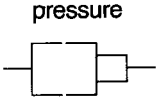

Hinge joint simple

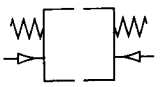

Hinge with fixed pivot

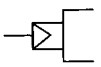
Pressure controls


Direct by application of pressure


Pressure centred


Differential pressure actuation


Spring centred


Indirect by application of pressure

Combined controls


By solenoid and pilot valve

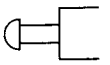

By solenoid or pilot valve


By solenoid or manual operation with return spring


General *explanatory symbol

Manual controls

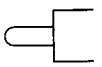

General


Button

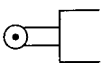

Lever

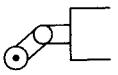

Pedal

Mechanical controls


Plunger


Spring

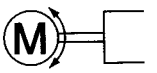

Roller


Roller with idle return

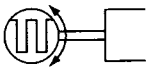
Electrical controls


Solenoid with one effective winding

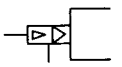

Solenoid, e.g. with two windings acting in opposition

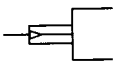


Electric motor with continuous rotary motion


Electric stepping motor

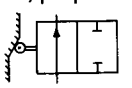
Special controls


By application of pressure through pressurised amplifier*


By application of pressure, type of control produces alternating behaviour*

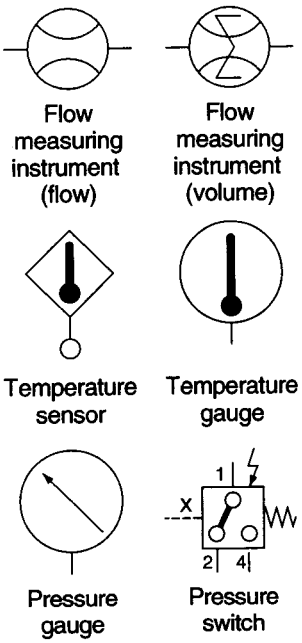
* = not standardised, proposal


Mechanical return


Actuated in starting position

4.6 Other symbols

Other devices

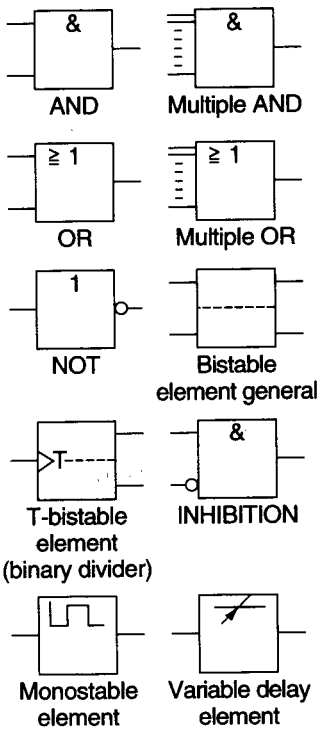


ISO STANDARD 5599/II

Designation of Connections

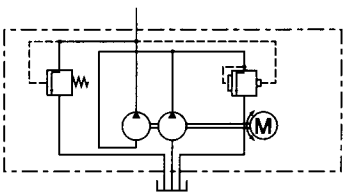
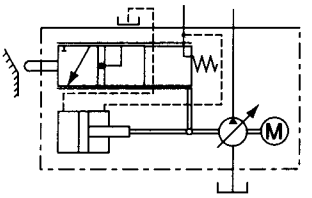
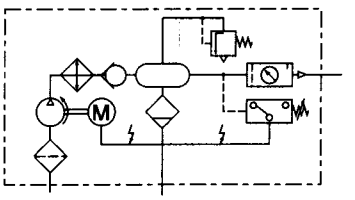
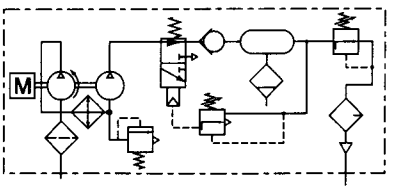
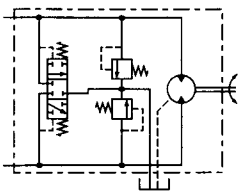
A, B, C (2, 4, 6)	working lines
P(1)	compressed air connection
R, S, T (3, 5, 7)	drain, exhaust points
L(9)	leakage line
Z,Y,X(12,14,16)	control lines

Logic Symbols

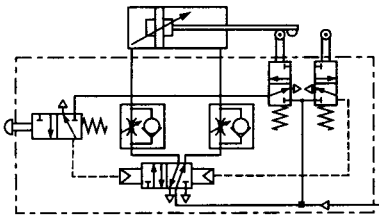
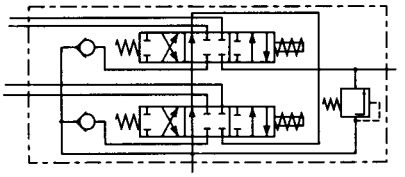


4.7 Examples of assemblies of equipment

In circuit diagrams, symbols normally represent equipment in the unoperated condition. However, any other condition can be represented, if clearly stated.

Description and interpretation of the examples	Symbol
Driven assemblies (pumps)	
A two-stage pump driven by an electric motor with a pressure relief valve in the second stage and a proportioning relief valve which maintains the pressure of the first stage at, for example, half the pressure of the second stage.	
A variable displacement pump driven by an electric motor, control being by a servo-motor with a differential cylinder and a tracer valve, with two throttling orifices and mechanical feedback.	
A single stage air compressor driven by an electric motor which is automatically switched on and off as the receiver pressure falls and rises.	
A two stage air compressing assembly driven by an internal combustion motor which idles or takes up the load with the switching over of a 3/2 directional control valve, depending on the receiver pressure.	
Driving assemblies (motors)	
A motor driven in either direction of rotation, with pressure relief valves and flushing valve.	

Examples of assemblies of equipment (continued)

Control and regulating assemblies	
A control unit by which the piston of a cylinder is automatically moved back and forth.	
A group of two 6/3 directional control valves which are connected to separate non-return valves and to a common pressure relief valve. When both directional control valves are in the neutral position, the flow is returned to the reservoir.	

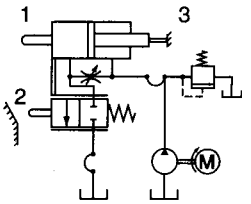
4.8 Examples of complete installations

In circuit diagrams, symbols normally represent equipment in the unoperated condition. However, any other condition can be represented, if clearly stated.

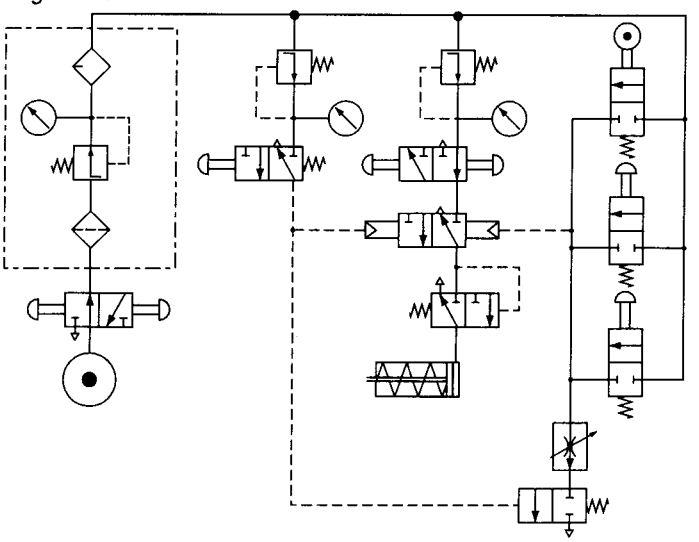
Installations

Copying control

Key
1 = Tool
2 = Template
3 = Machine frame

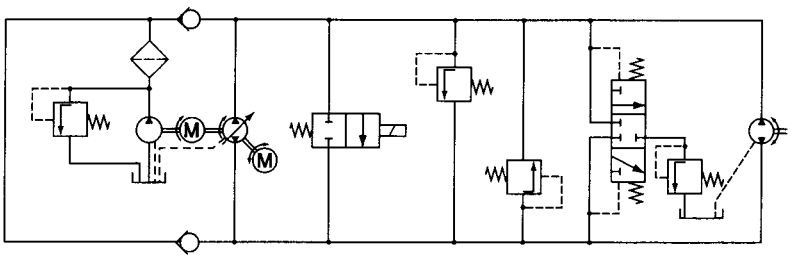


Clutch-operating control



Remote drives Transmissions

Reversible drive



4.9 Component identification

Valve symbol description

In general the symbols are similar for pneumatic and hydraulics but each control medium has specific characteristics that are unique.

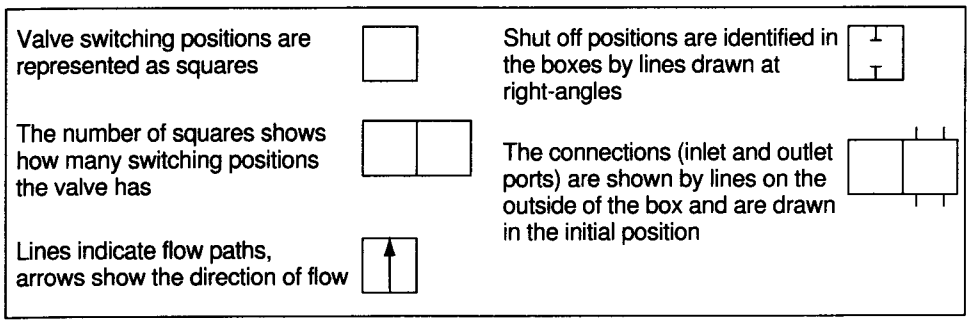


Figure 4.1 Directional control valves – symbol development

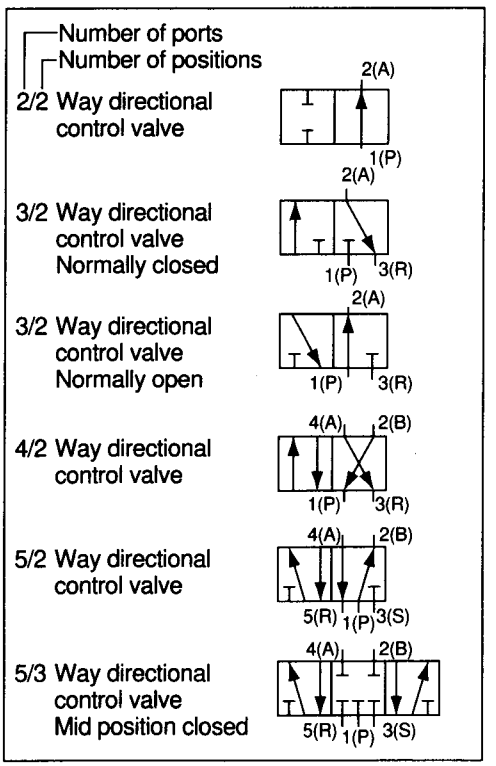


Figure 4.2 Directional control valves ports and positions (ways)

The directional control valve is represented by the number of controlled connections and the number of positions (Figure 4.1). Each position is shown as a separate square. The designation of the ports is important when interpreting the circuit symbols and the valve as fitted to the physical system. To ensure that the correct lines, connections and valves are physically in place, there must be a relationship between the circuit and the components used.

Therefore all symbols on the circuit must be designated and the components used should be labelled with the correct symbol and designations (Figure 4.2).

A numbering system is used to designate directional control valves and is in accordance with ISO 5599. Prior to this a lettering system was used. Both systems of designation are shown as follows:

Port or connection	ISO 5599 Numbering system	Lettering system
Pressure port	1	P
Exhaust port	3	R (3/2-way valve)
Exhaust ports	5, 3	R, S (5/2-way valve)
Signal outputs	2, 4	B, A
Pilot line opens flow 1 to 2	12	Z (single pilot 3/2-way valve)
Pilot line opens flow 1 to 2	12	Y (5/2-way valve)
Pilot line opens flow 1 to 4	14	Z (5/2-way valve)
Pilot line flow closed	10	Z, Y
Auxiliary pilot air	81, 91	Pz

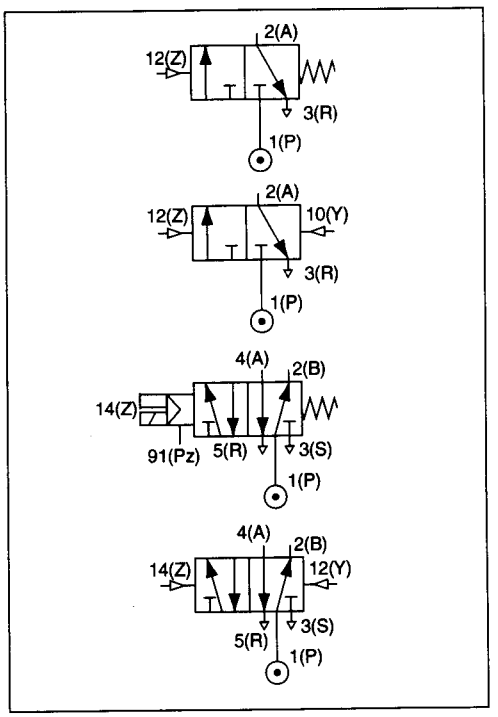


Figure 4.3 Examples of designations