Basic Pneumatic Circuitry

For control and automation

NORGREN

Contents

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Introduction

- **This module shows the methods of application of pneumatic valves and components for control and automation**

- **The methods of pure pneumatic sequential control are confined to simple examples**

- **The majority of modern systems are controlled electronically and is the subject of electro-pneumatic modules**

- **A message to pneumatic circuit designers:**

  - **Use proven and reliable design techniques**

  - **Produce circuits and documentation that are clear to read**

  - **Design for safety**

  - **Do not try to be too clever, the circuit will be difficult for others to read and maintain**
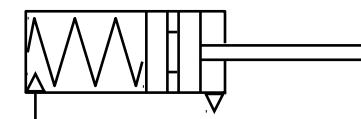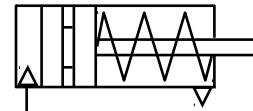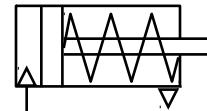
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Symbols

- **The standard for fluid power symbols is ISO 1219-1. This is a set of basic shapes and rules for the construction of fluid power symbols**

- **Cylinders can be drawn to show their extreme or intermediate positions of stroke and any length above their width**

- **Valves show all states in the one symbol. The prevailing state is shown with the port connections**

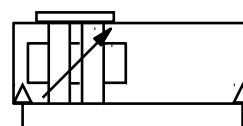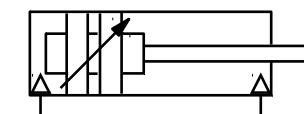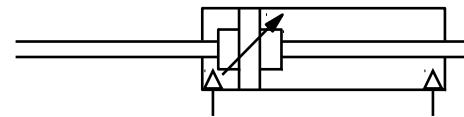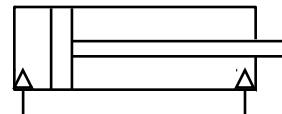- **Other components are single state symbols**

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Symbols single acting actuators

- **Single acting, sprung instroked**

- **Single acting, sprung outstroked**

- **Single acting, sprung instroked, magnetic**

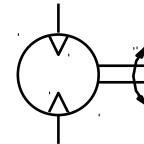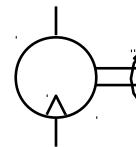- **Single acting, sprung outstroked, magnetic**

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Symbols double acting actuators

- **Double acting, non-cushioned**

- **Double acting, adjustable cushions**

- **Double acting, through rod, adjustable cushions**

- **Double acting, magnetic, adjustable cushions**

- **Double acting, rodless, magnetic, adjustable cushions**
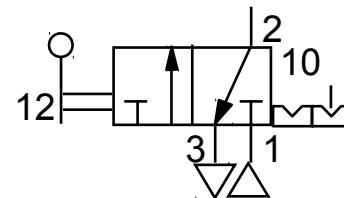
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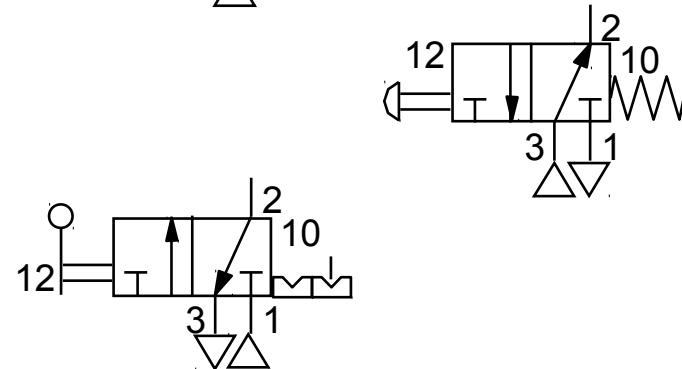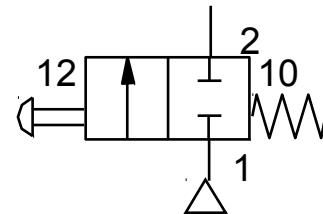
Symbols rotary actuators

- **Semi-rotary double acting**

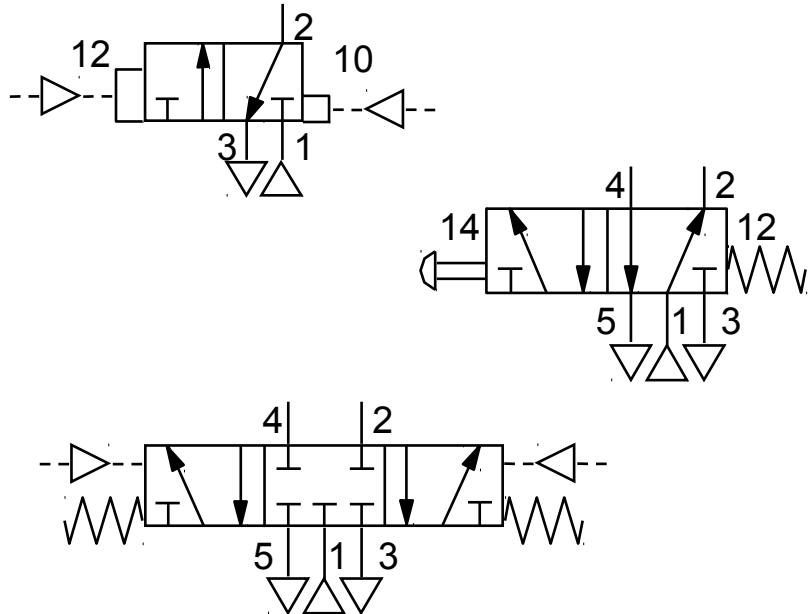- **Rotary motor single direction of rotation**

- **Rotary motor bi-directional**

Symbols valves

- **2/2 Valve push button / spring**

- **3/2 Valve push button / spring**

- **3/2 Valve detented lever operated**

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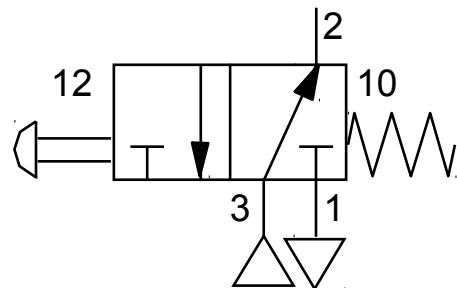
Symbols valves

- **3/2 Valve differential pressure operated**
- **5/2 Valve push button / spring**
- **5/3 Valve double pressure operated spring centre**

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Symbols valves

- **A valve function is known by a pair of numbers e.g. 3/2. This indicates the valve has 3 main ports and 2 states**

- **The valve symbol shows both of the states**

- **Port numbering is to CETOP RP68P and shows:**
  - **when the valve is operated at the 12 end port 1 is connected to port 2**
  - **when reset to the normal state at the 10 end port 1 is connected to nothing (0)**

Symbols valves

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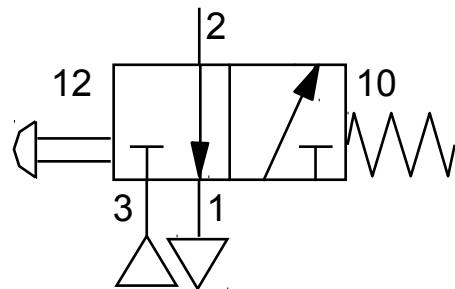- **The valve symbol shows both of the states**

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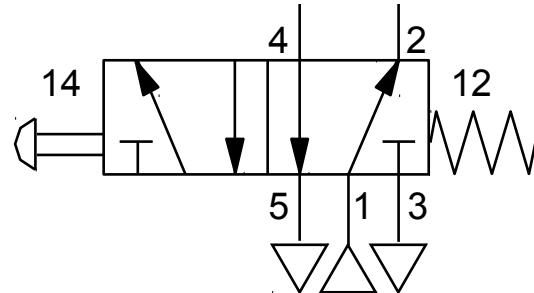
Symbols valves

- **This example is for a 5/2 valve**

- **This has 5 main ports and 2 states**

- **When the valve is operated at the 14 end port 1 is connected to port 4 (also port 2 is connected to port 3)**

- **When reset to the normal state at the 12 end port 1 is connected to port 2 (also port 4 is connected to port 5)**
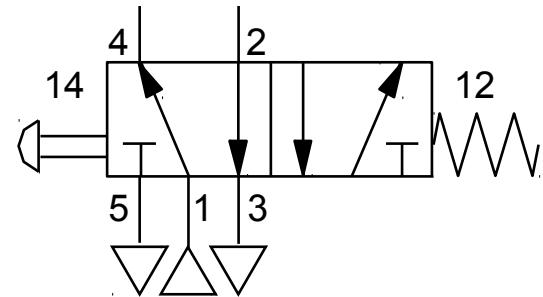
Symbols valves

- **This example is for a 5/2 valve**

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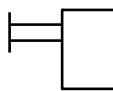- **When reset to the normal state at the 12 end port 1 is connected to port 2 (also port 4 is connected to port 5)**

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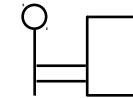
Symbols operators manual
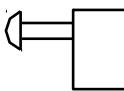
General manual
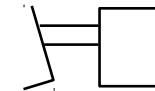
Push button

Pull button

Push/pull button

Lever

Pedal

Treadle

Rotary knob

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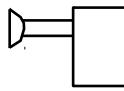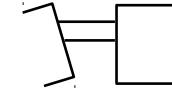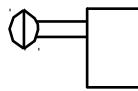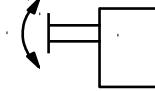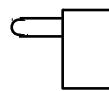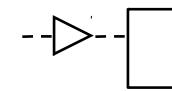
Symbols operators mechanical
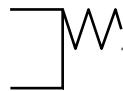
Plunger
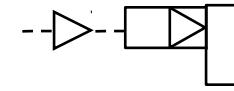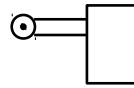
Spring normally as a return
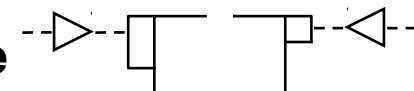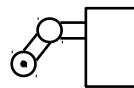
Roller
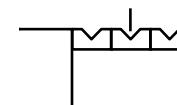
Uni-direction or one way trip

Pressure

Pilot pressure

Differential pressure
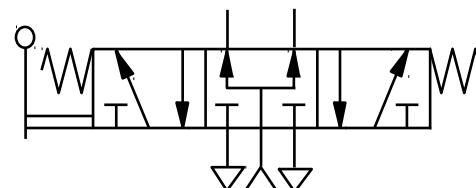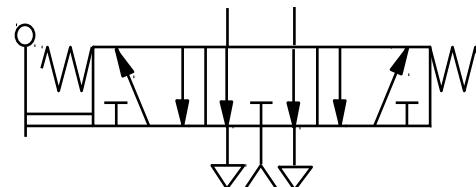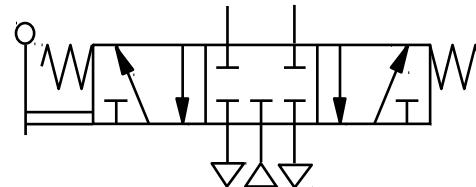
Detent in 3 positions

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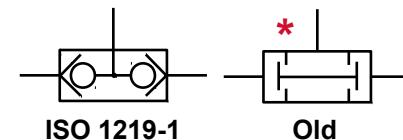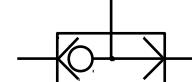
Symbols 5/3 valves

- All valves types shown in the normal position

- Type 1. All ports blocked

- Type 2. Outlets to exhaust

- Type 3. Supply to outlets

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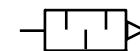
Symbols function components

- **Non-return valve**
- **Flow regulator uni-directional**
- **Flow regulator bi-directional**
- **Two pressure 'AND'**
- **Shuttle valve 'OR'**
- **Silencer**
- **Quick exhaust valve with silencer**
- **Pressure to electric switch adjustable**

ISO 1219-1   Old

* **Note:** Traditional symbol in extensive use (preferred)

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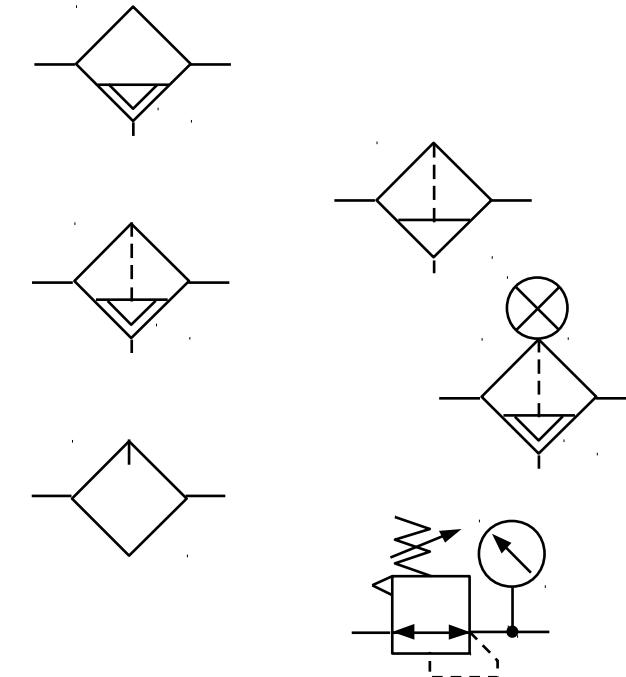
Symbols air line equipment

- **Water separator with automatic drain**
- **Filter with manual drain**
- **Filter with automatic drain**
- **Filter with automatic drain and service indicator**
- **Lubricator**
- **Pressure regulator with gauge**
- **F.R.L. filter, regulator, lubricator simplified symbol**

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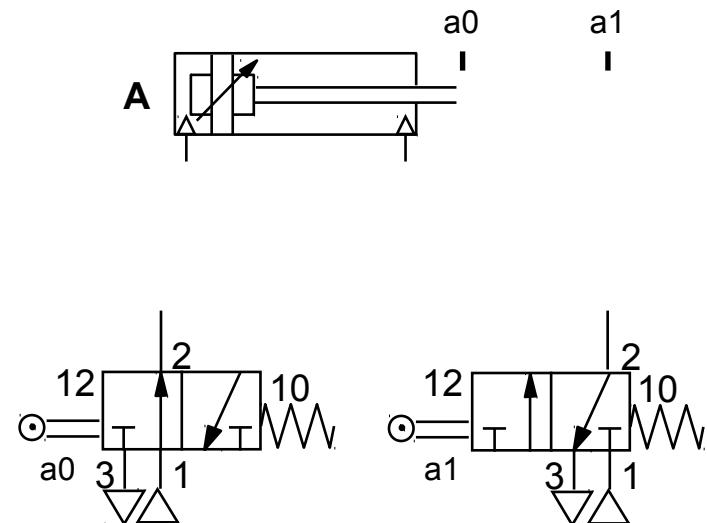
Circuit layout

- The standard for circuit diagrams is ISO 1219-2
- A4 format or A3 folded to A4 height for inclusion in a manual with other A4 documentation
- To be on several sheets if necessary with line identification code
- Minimum crossing lines
- Limit valves position of operation by actuators shown by a marker with reference code to symbol

- Circuits should be drawn with all actuators at the top of the page in order of sequential operation
- Other components to be drawn in sequential order from the bottom up and from left to right
- Circuit should show the system with pressure applied and ready to start

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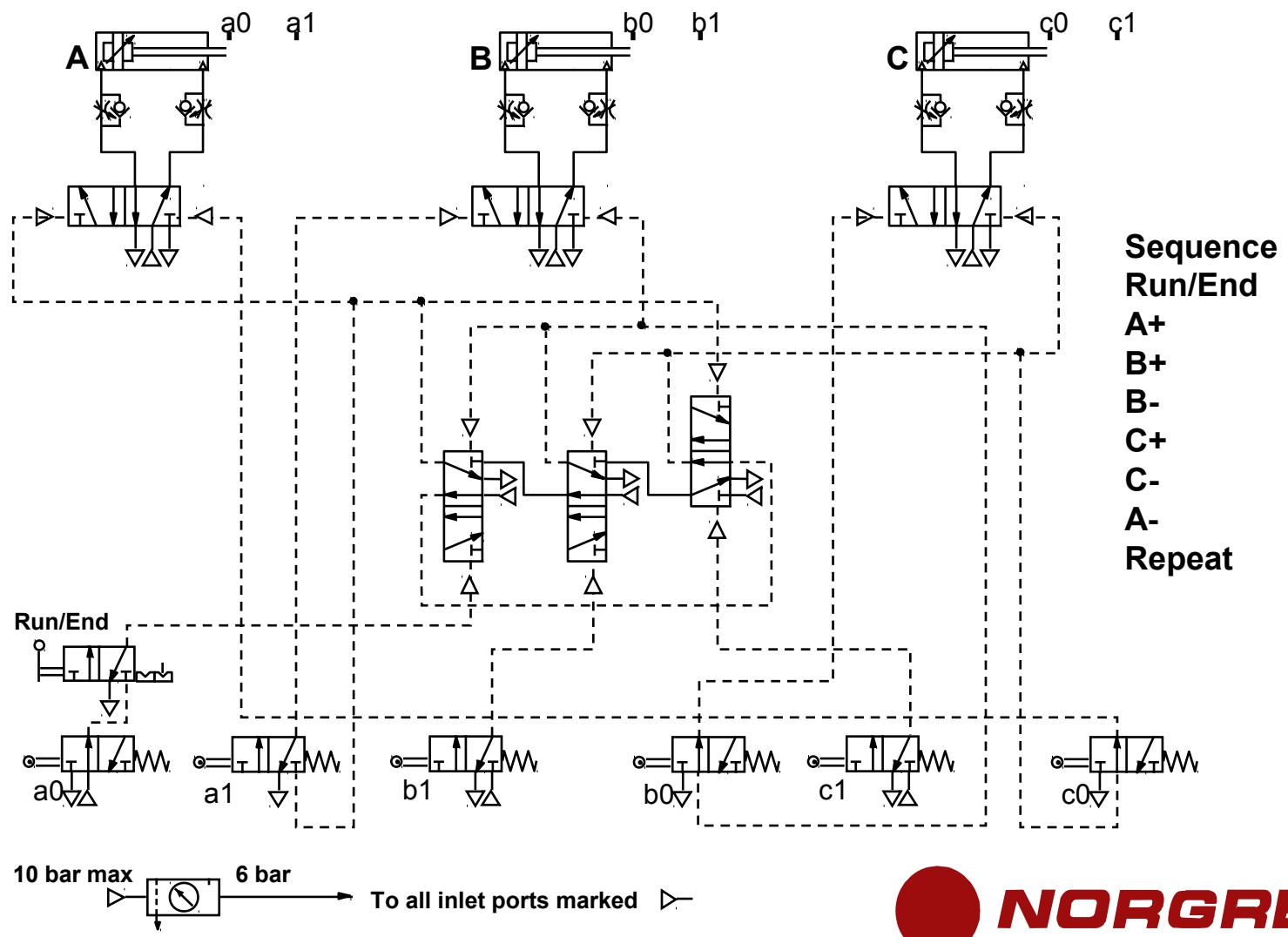
Component identification

- The ISO suggested component numbering system is suited for large circuits and those drawn on several pages

- For this presentation a simple code is used

- For cylinders: A,B,C etc.

- For associated feedback valves: alpha-numeric code 'a0' for proof of instroke, 'a1' for proof of outstroke

- For cylinder B: b0 and b1

- Note: the a0 valve symbol is drawn in the operated position because the actuator A is instroked

Example circuit

Sequence
Run/End
A+
B+
B-
C+
C-
A-
Repeat

Run/End

a0   a1   b1   b0   c1   c0

10 bar max   6 bar   To all inlet ports marked ▷—

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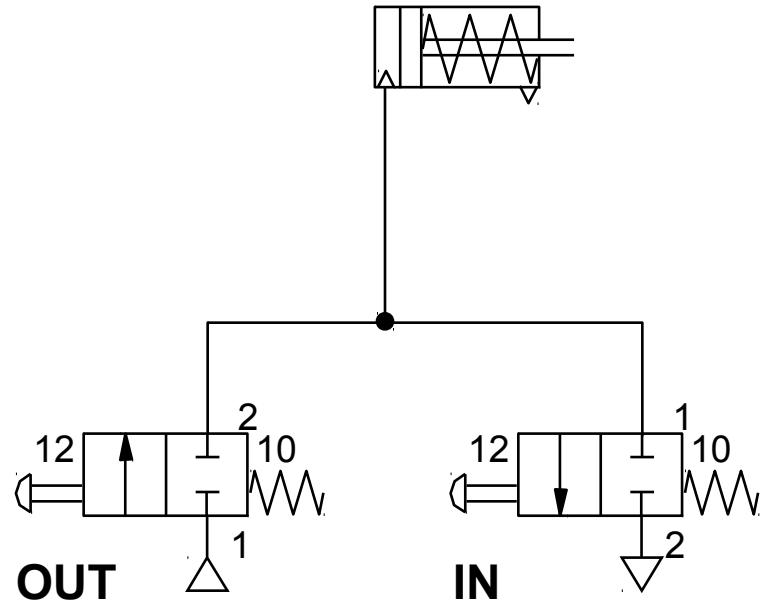
Actuator control 2/2 valve
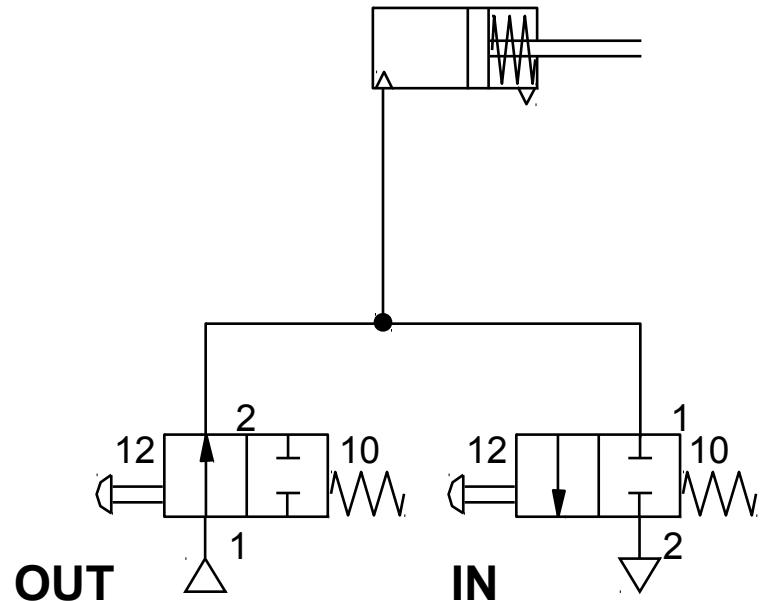
2/2 Valve actuator control

- **A pair of the most basic of all valve types the 2/2 can be used to control a single acting cylinder**

- **The normally closed position of the valve is produced by the spring**

- **The operated position is produced by the push button**

- **One valve admits air the other valve exhausts it**

OUT

IN
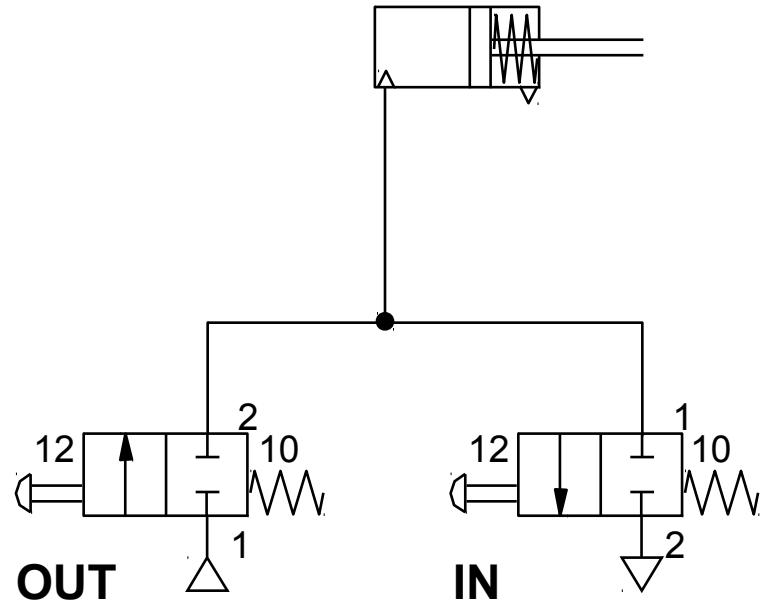
2/2 Valve actuator control

- The button marked OUT is pushed to operate the valve

- Air is connected to the cylinder and it outstrokes

- Air cannot escape to atmosphere through the valve marked IN as this is closed

- The air at atmospheric pressure in the front of the cylinder vents through the breather port
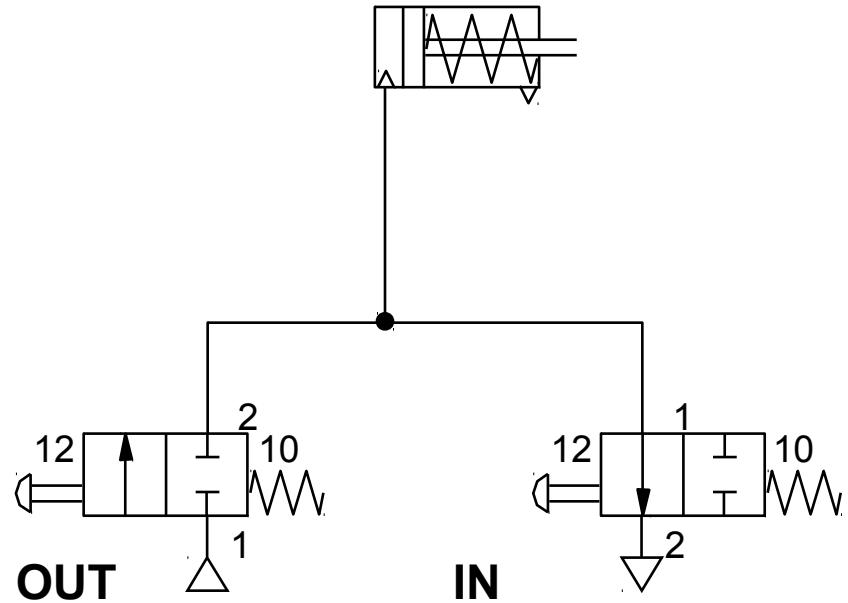
2/2 Valve actuator control

- The push button of the valve marked OUT is released and it returns to a normal closed position

- Air is now trapped in the system and provided there are no leaks the piston rod will stay in the outstroked position

- If the load increases beyond the force exerted by the air the piston rod will start to move in

OUT

IN

NORGREN
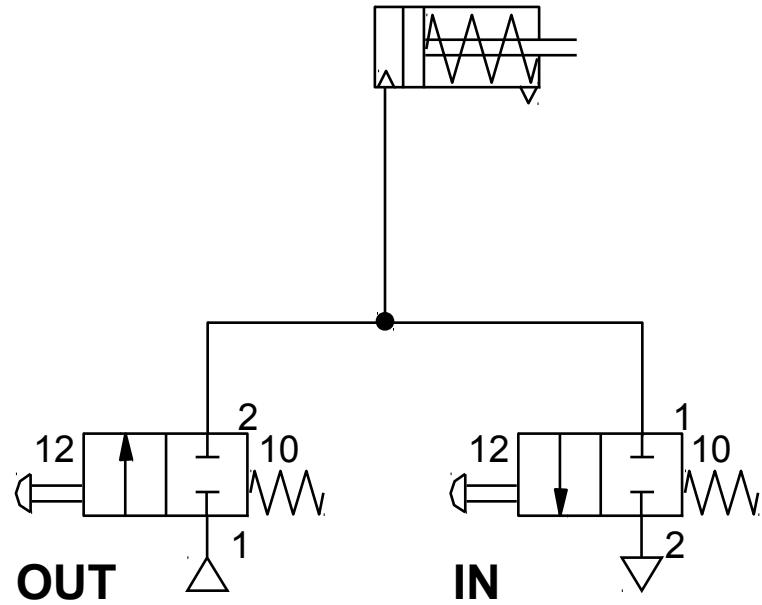
2/2 Valve actuator control

- The button marked IN is pushed to operate the valve

- Air escapes and the piston rod moves to the instroked position

- The push button must be held operated until the piston rod is fully in

- Atmospheric air will be drawn in to the front of the cylinder through the vent port
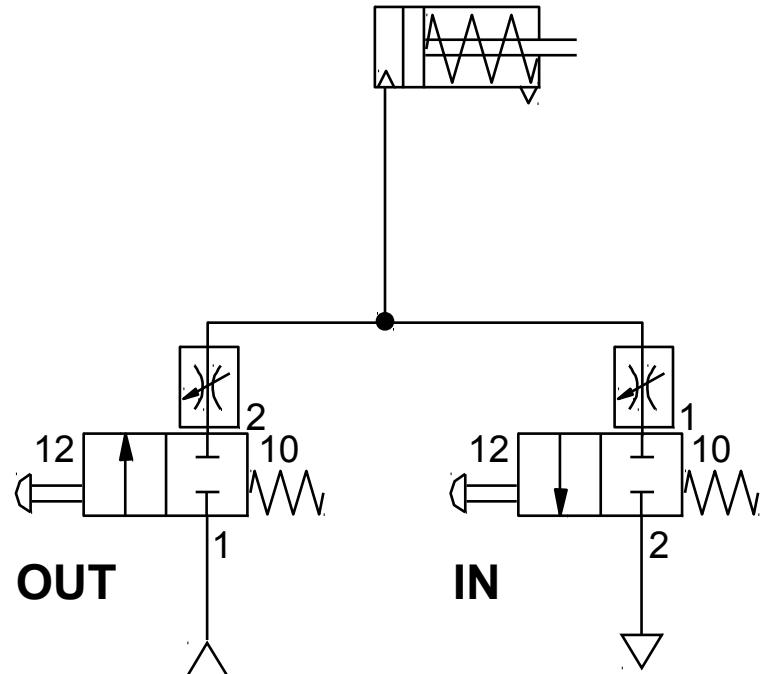
2/2 Valve actuator control

- **If the button marked IN is released the piston rod will remain in the instroked position**

- **Any leaks in the installation can cause the piston rod to creep**

OUT

IN

NORGREN
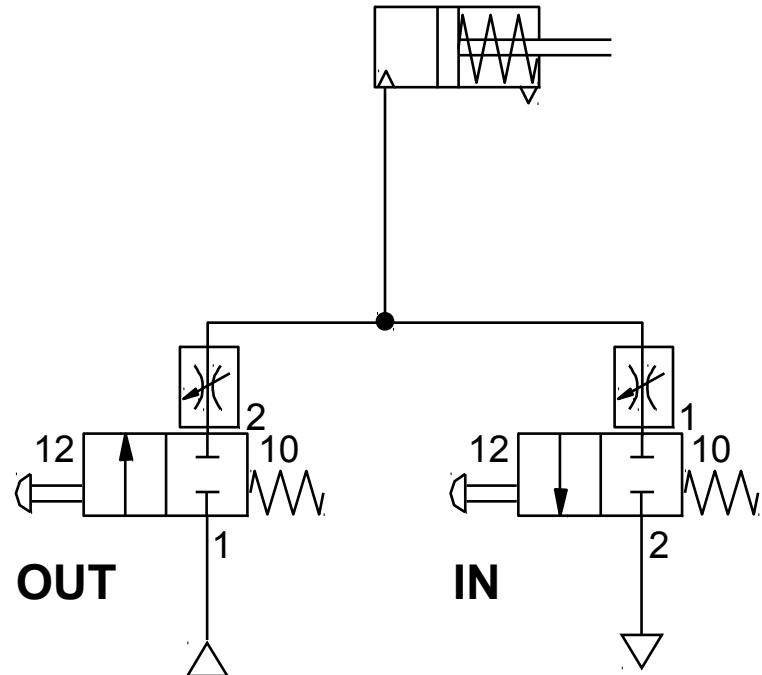
2/2 Valve actuator control

- To control the speed of the piston rod, flow restrictors are placed in the pipes <u>close</u> to each of the valves.

- Adjustment of the restrictors will slow down the flow rate thereby giving independent outstroke and instroke speed control

OUT   IN

NORGREN
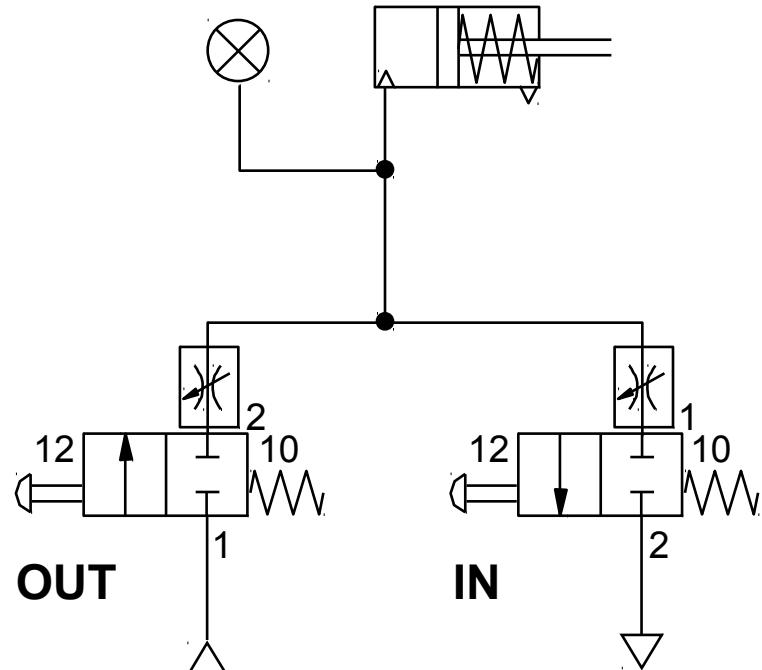
2/2 Valve actuator control

- **By repeated operation of either button during movement the piston rod can be moved in small steps for approximate positioning**

- **This will only be successful under slow speeds**

OUT   **IN**

2/2 Valve actuator control

- With any compressed air system that intentionally traps air, the potential hazard of this must be recognised

- Unintended release or application of pressure can give rise to unexpected movement of the piston rod

- A pressure indicator or gauge must be fitted to warn of the presence of pressure

OUT

IN

Actuator control 3/2 valve

3/2 valve actuator control

- **A 3 port valve provides the inlet and exhaust path and is the normal choice for the control of a single acting cylinder**

- **In the normal position produced by the spring, the valve is closed**

- **In the operated position produced by the push button the valve is open**

- **The push button must be held down for as long as the cylinder is outstroked**

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3/2 valve actuator control

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3/2 valve actuator control

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3/2 valve actuator control

- To generally slow the cylinder speed an adjustable bi-directional flow regulator or fixed restrictor can be used

- The flow regulator setting will be a compromise as the ideal outstroke speed may not produce the desired results for the instroke speed

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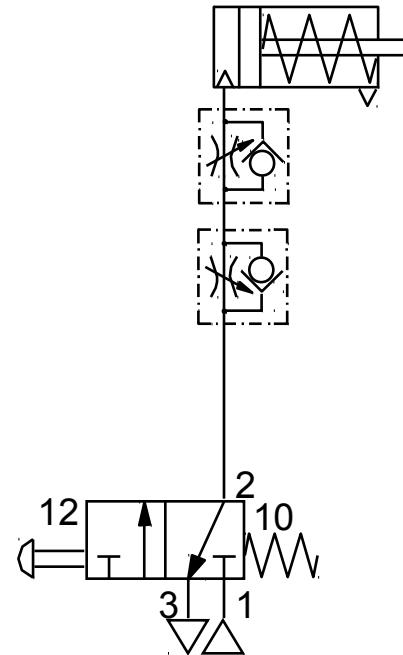
3/2 valve actuator control

- **To control the outstroke speed of a single acting cylinder without controlling the instroke speed, a uni-directional flow regulator is used**

- **The flow into the cylinder closes the non return valve and can only pass through the adjustable restrictor**

- **By adjusting the restrictor the outstroke speed of the cylinder can be set**

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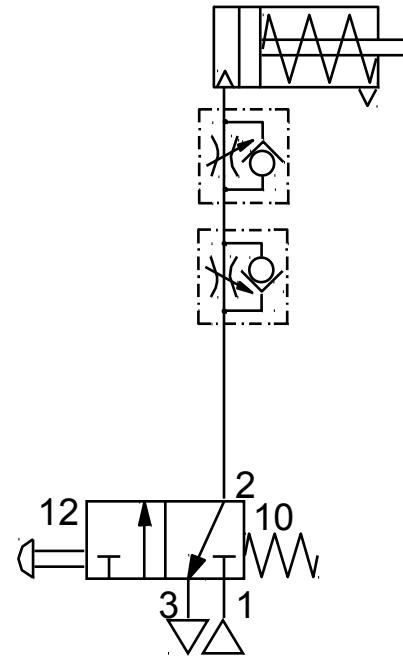
3/2 valve actuator control

- **For independent speed control in each direction two flow regulators are required**

- **Installed in opposite directions to each other**

- **Upper regulator controls the outstroke speed**

- **Lower regulator controls the instroking speed**
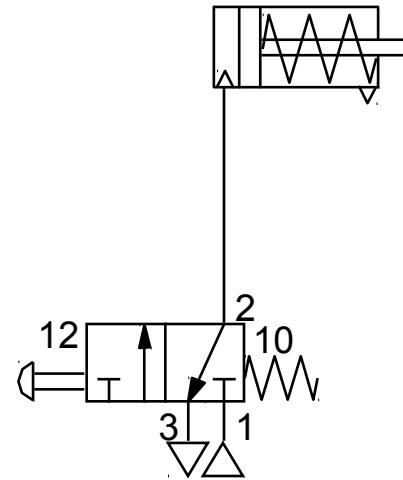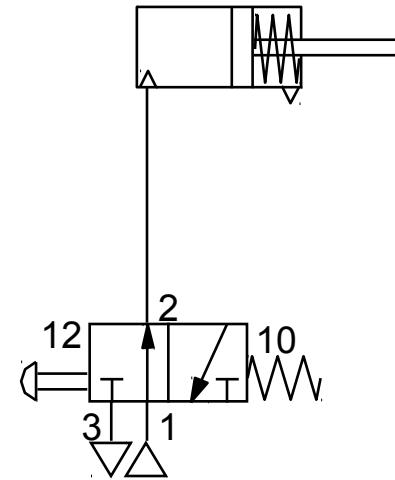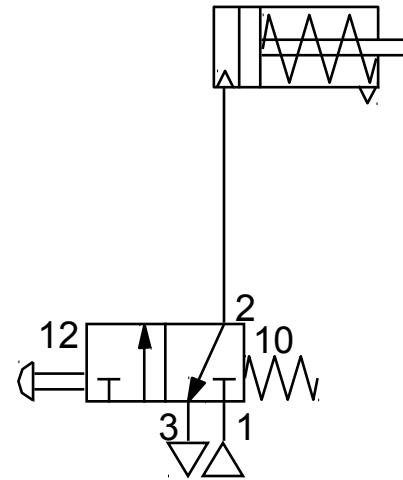
3/2 valve actuator control

- **A 3 port valve provides the inlet and exhaust path and is the normal choice for the control of a single acting cylinder**

- **In the normal position produced by the spring, the valve is closed**

- **In the operated position produced by the push button the valve is open**

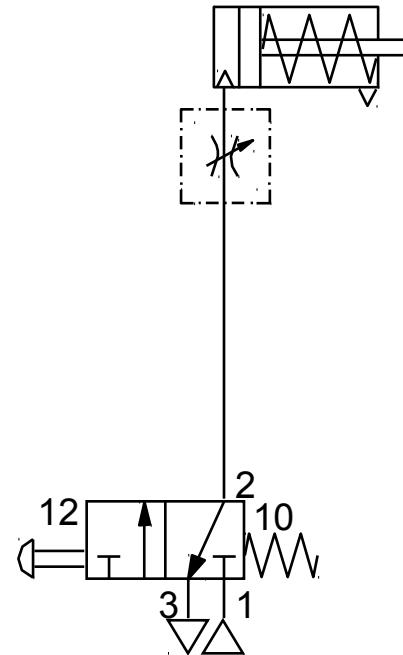- **The push button must be held down for as long as the cylinder is outstroked**

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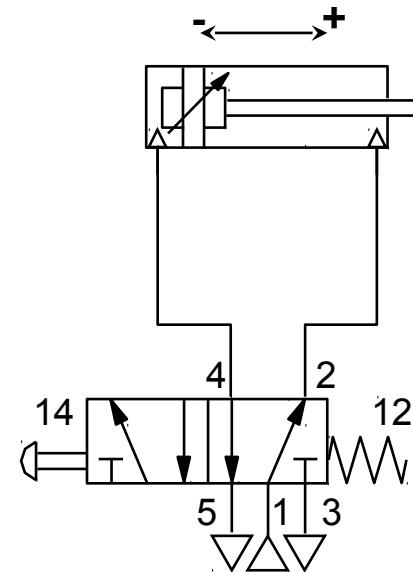
Actuator control 5/2 valve
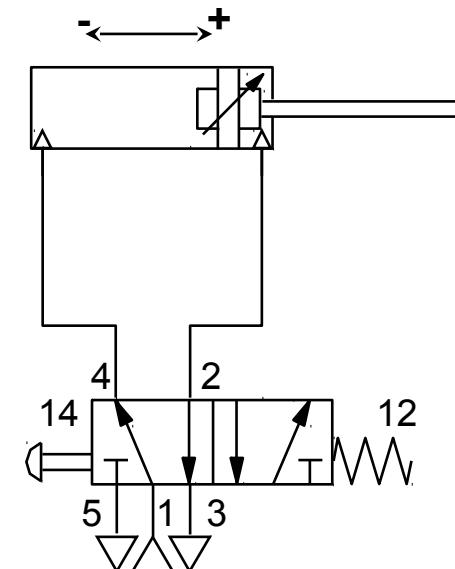
5/2 Valve actuator control
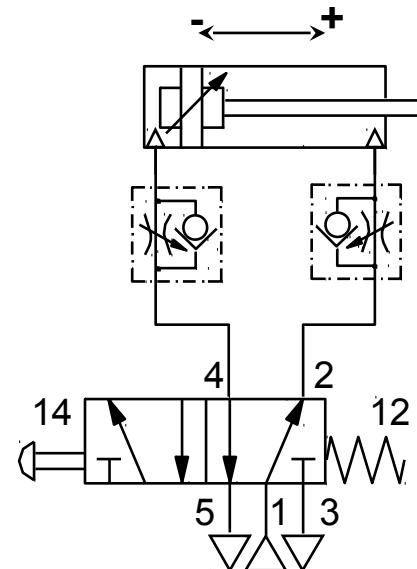
- For a double acting cylinder the power and exhaust paths are switched simultaneously

- When the button is pushed the supply at port 1 is connected to port 4 and the outlet port 2 connected to exhaust port 3. The cylinder moves plus

- When the button is released port 1 is connected to port 2 and port 4 connected to port 5. Cylinder minus

5/2 Valve actuator control

- **For a double acting cylinder the power and exhaust paths are switched simultaneously**

- **When the button is pushed the supply at port 1 is connected to port 4 and the outlet port 2 connected to exhaust port 3. The cylinder moves plus**

- **When the button is released port 1 is connected to port 2 and port 4 connected to port 5. Cylinder minus**

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5/2 Valve actuator control

- **Independent speed control of the plus and minus movements**

- **In most applications speed is controlled by restricting air out of a cylinder**

- **Full power is developed to drive the piston with speed controlled by restricting the back pressure**

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5/2 Valve actuator control

- **Independent speed control of the plus and minus movements**

- **In most applications speed is controlled by restricting air out of a cylinder**

- **Full power is developed to drive the piston with speed controlled by restricting the back pressure**

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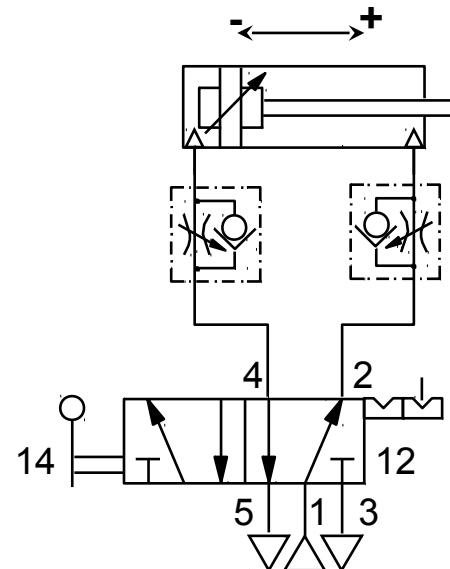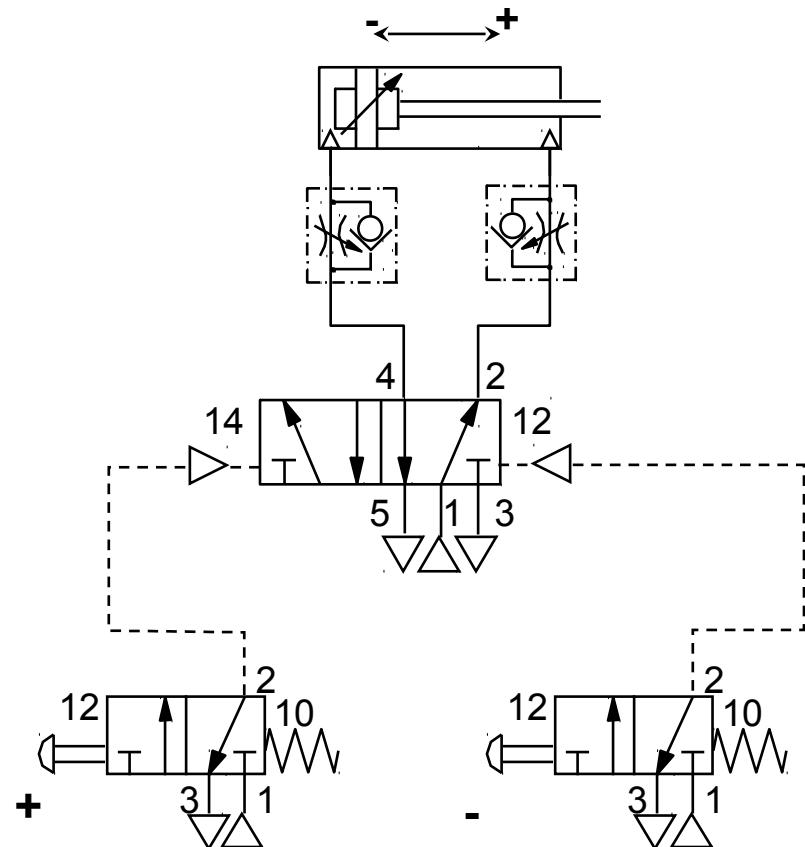
5/2 Valve actuator control

- **Valves with a spring return are mono-stable and need the operator to be held all the time that the cylinder is required in the plus position**

- **Bi-stable valves will stay in the position they were last set**

- **The lever valve example illustrated indicates a detent mechanism. The lever need not be held once the new position has been established**

NORGREN

Manual control

- **Remote manual control of a double acting cylinder**
- **Valve marked + will cause the cylinder to outstroke or move plus**
- **Valve marked - will cause the cylinder to instroke or move minus**
- **The 5/2 double pilot valve is bi-stable therefore the push button valves only need to be pulsed**

Manual control

- **Remote manual control of a double acting cylinder**

- **Valve marked + will cause the cylinder to outstroke or move plus**

- **Valve marked - will cause the cylinder to instroke or move minus**

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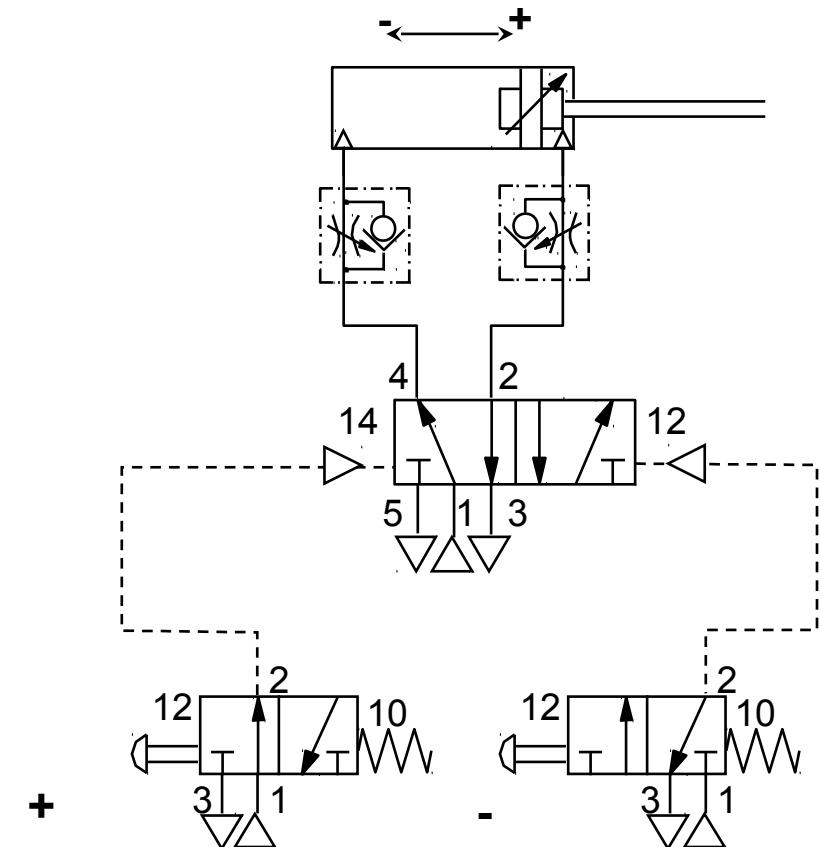
Manual control

- **Remote manual control of a double acting cylinder**

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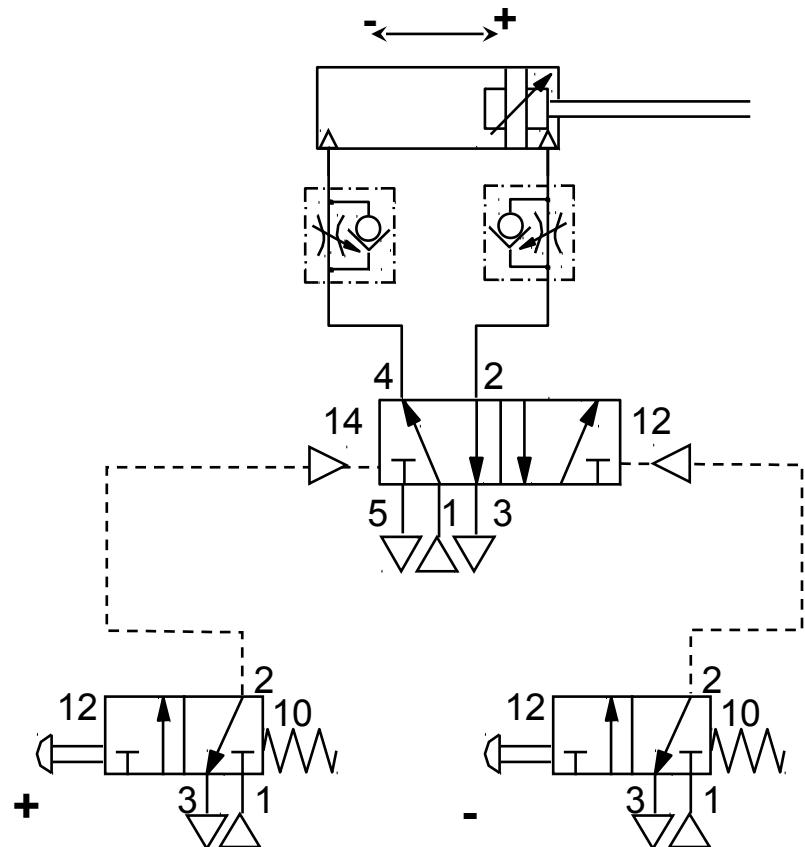

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Semi-automatic control

- **Manual remote start of a double acting cylinder with automatic return**

- **Cylinder identified as "A"**

- **Trip valve operated at the completion of the plus stroke identified as "a1"**

Fully-automatic control
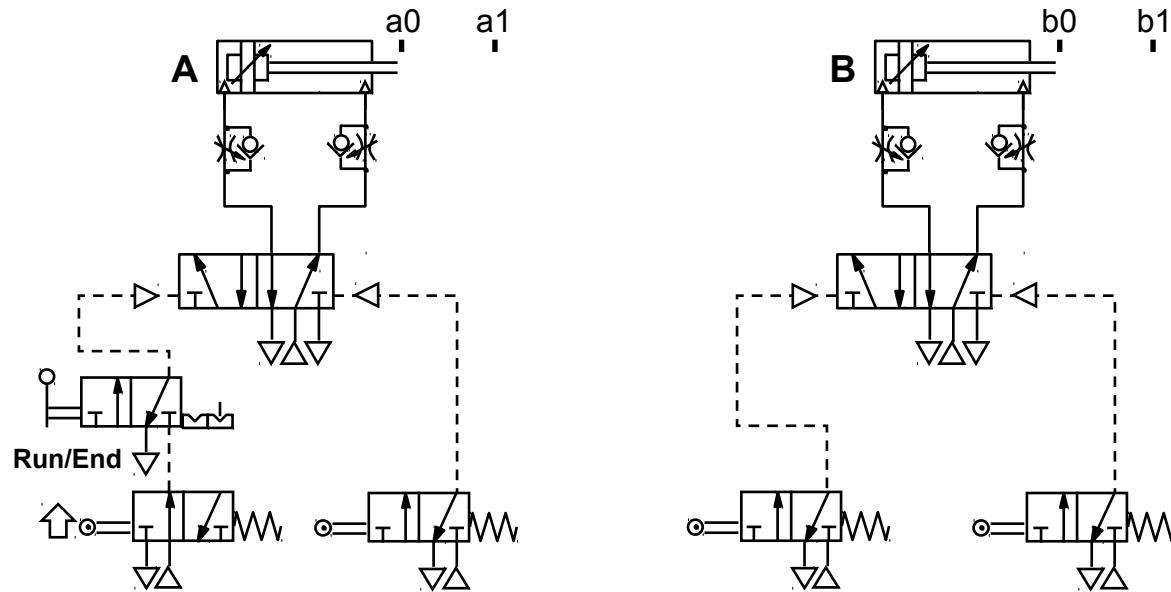
- **Continuous automatic cycling from roller operated trip valves**
- **Manual Run and End of the automatic cycling**
- **Cylinder will come to rest in the instroked position regardless of when the valve is put to End**
- **Tags for the roller feedback valves a0 and a1 show their relative positions**

Sequential control

Circuit building blocks
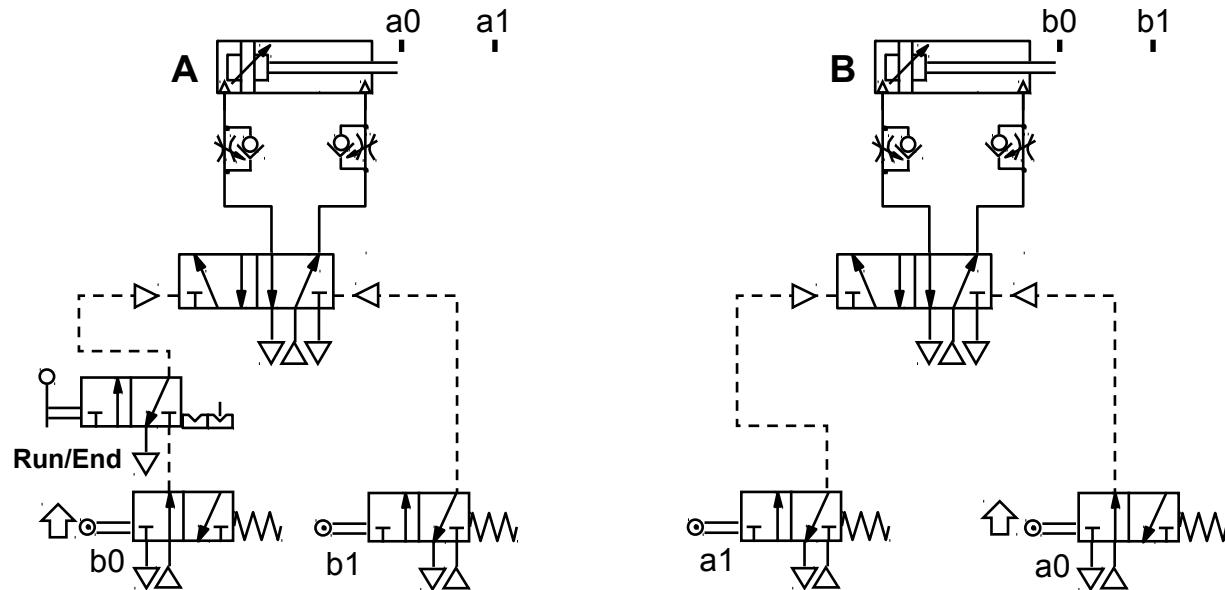
- **These circuits can be considered as building blocks for larger sequential circuits consisting of two or more cylinders**

- **Each actuator will have a power valve and two associated feedback valves. The first actuator to move also has a Run/End valve**

Repeat pattern sequence

- A repeat pattern sequence is one where the order of the movements in the first half of the sequence is repeated in the second half

- Each actuator may have one Out and In stroke only in the sequence

- There may be any number of actuators in the sequence

- The signal starting the first movement must pass through the Run/End valve

- Needs only the basic building blocks to solve

- Examples of repeat pattern sequences:

- A+ B+ C+ D+ A- B- C- D-

- A- B+ C- A+ B- C+

- C+ A+ B- C- A- B+

NORGREN
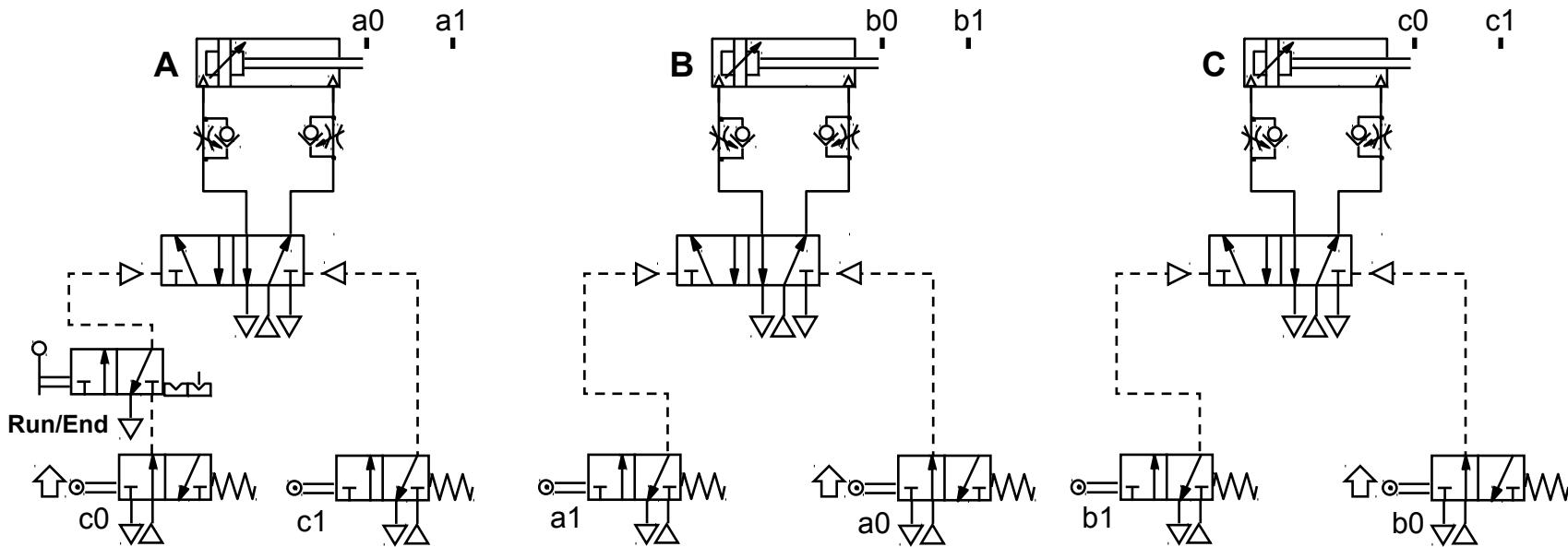
Repeat pattern sequence

- **The two cylinders A and B are to perform a simple repeat pattern sequence as follows: A+ B+ A- B-**

- **Apply the rule "The signal given by the completion of each movement will initiate the next movement"**

- **In this way the roller valves can be identified and labelled**
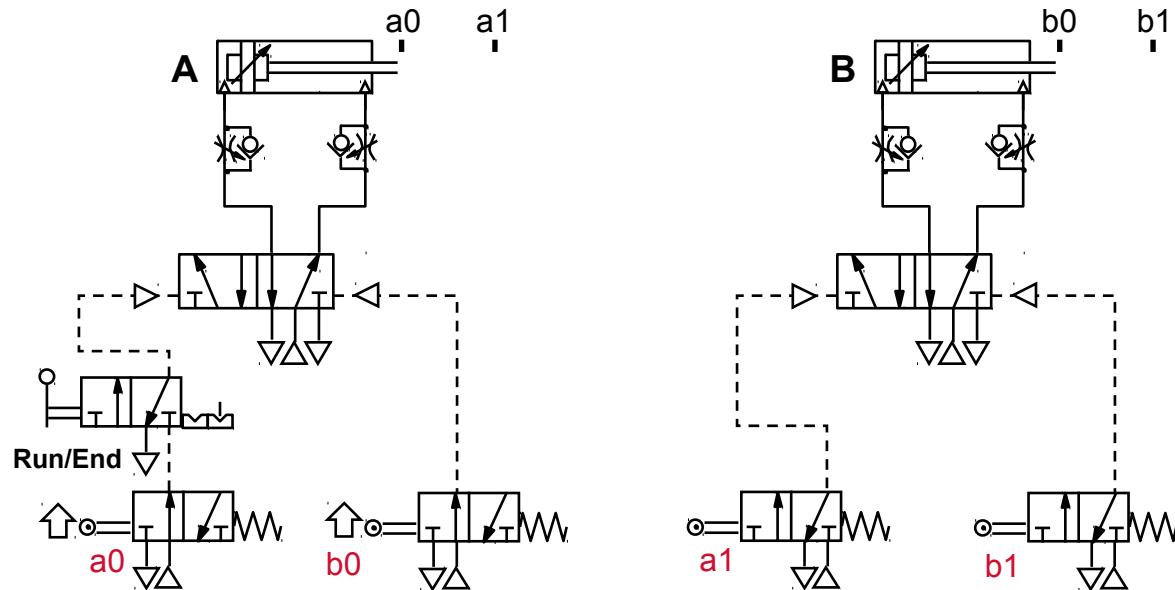
Repeat pattern sequence

- **For three cylinders A, B and C also to perform a simple repeat pattern sequence as follows: A+ B+ C+ A- B- C-**

- **Apply the rule "The signal given by the completion of each movement will initiate the next movement"**

NORGREN
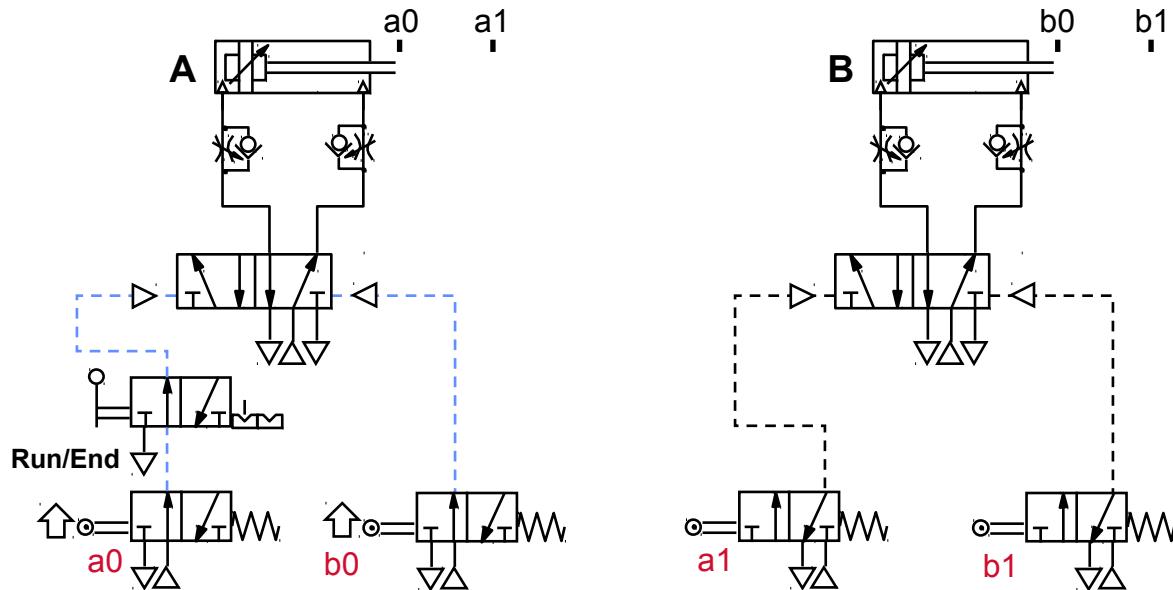
Non-repeat pattern sequence
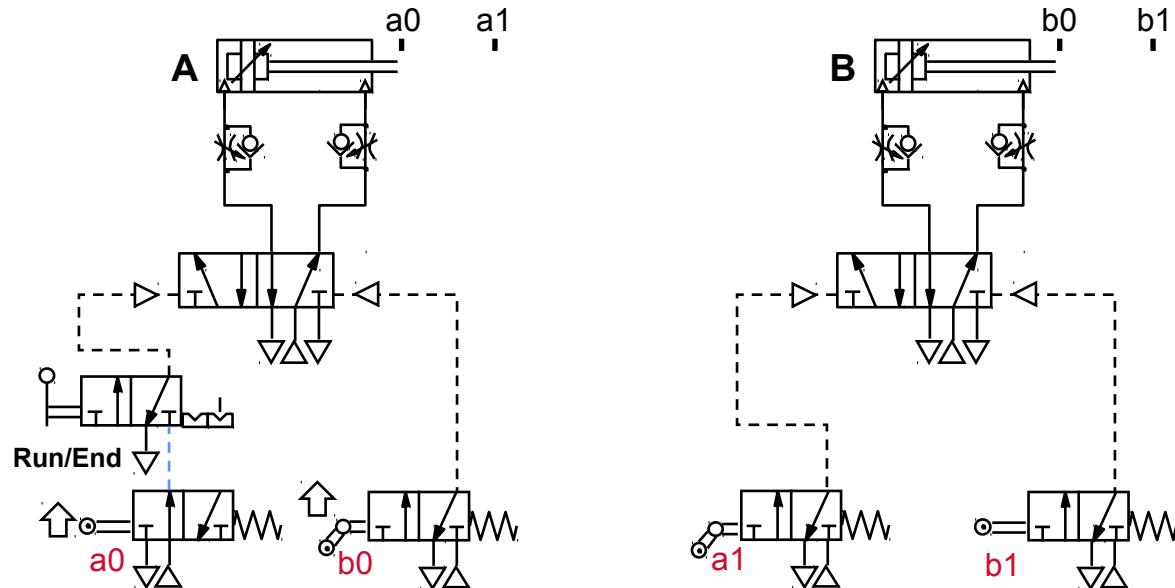
- **If the rule applied to a repeat pattern sequence is applied to any other sequence there will be opposed signals on one or more of the 5/2 valves preventing operation**

- **This circuit demonstrates the problem**

- **The sequence is A+ B+ B- A-**

Opposed signals

- **When the valve is set to Run, cylinder A will not move because the 5/2 valve has an opposed signal, it is still being signalled to hold position by the feedback valve b0**

- **If A was able to move + a similar problem will occur for the 5/2 valve of B once it was +**

- **The sequence is A+ B+ B- A-**

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Mechanical solution

- **The problem was caused by valves b0 and a1 being operated at the time the new opposing instruction is given**

- **If these two valves were "one way trip" types and over tripped at the last movement of stroke, only a pulse would be obtained instead of a continuous signal**

Sequence solution methods
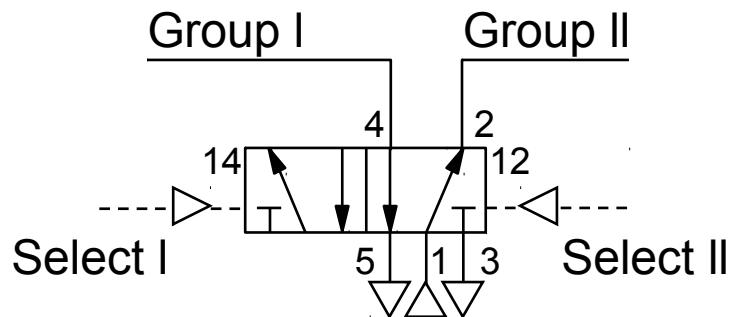
- The main solutions to solving sequences are:
  - Cascade (pneumatic)
  - Shift register (pneumatic)
  - Electro-pneumatic
  - PLC (Programmable logic controller)
- Cascade circuits provide a standard method of solving any sequence. It uses a minimum of additional logic hardware (one logic valve per group of sequential steps)

- Shift register circuits are similar to cascade but use one logic valve for every step
- Electro-pneumatic circuits use solenoid valves and electro-mechanical relays
- PLC. The standard solution for medium to complex sequential systems (except where electrical equipment cannot be used)
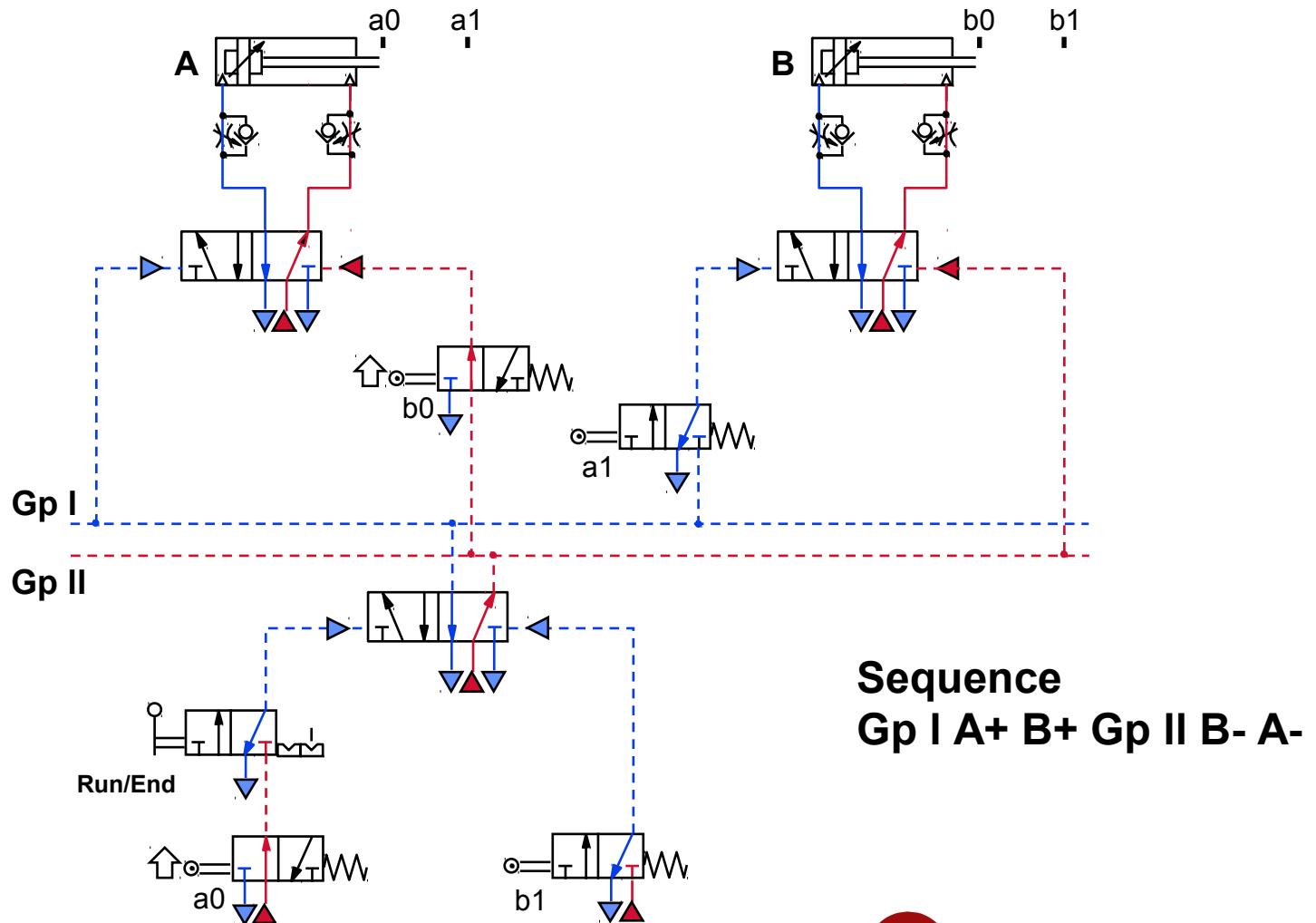
NORGREN

Cascade two group
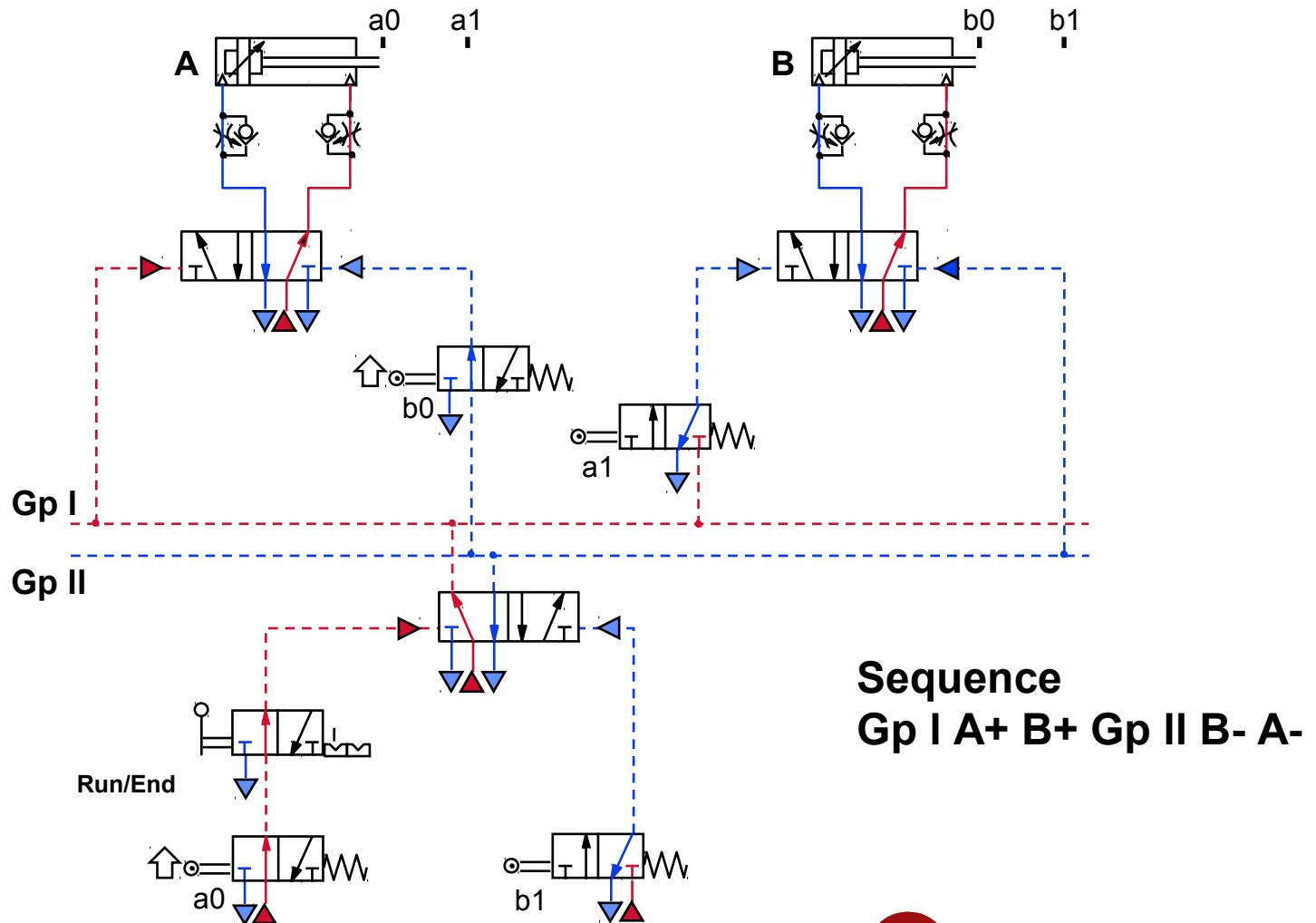
- The A+ B+ B- A- circuit is solved by the two group cascade method

- The sequence is divided at the point where B immediately returns

- The two parts are allocated groups I and II

- Gp I A+ B+ / Gp II B- A-

- Two signal supplies are provided from a 5/2 valve one is available only in group I the other is available only in group II

- Because only one group output is available at a time it is not possible to have opposed signals

- A standard 5/2 double pressure operated valve is the cascade valve
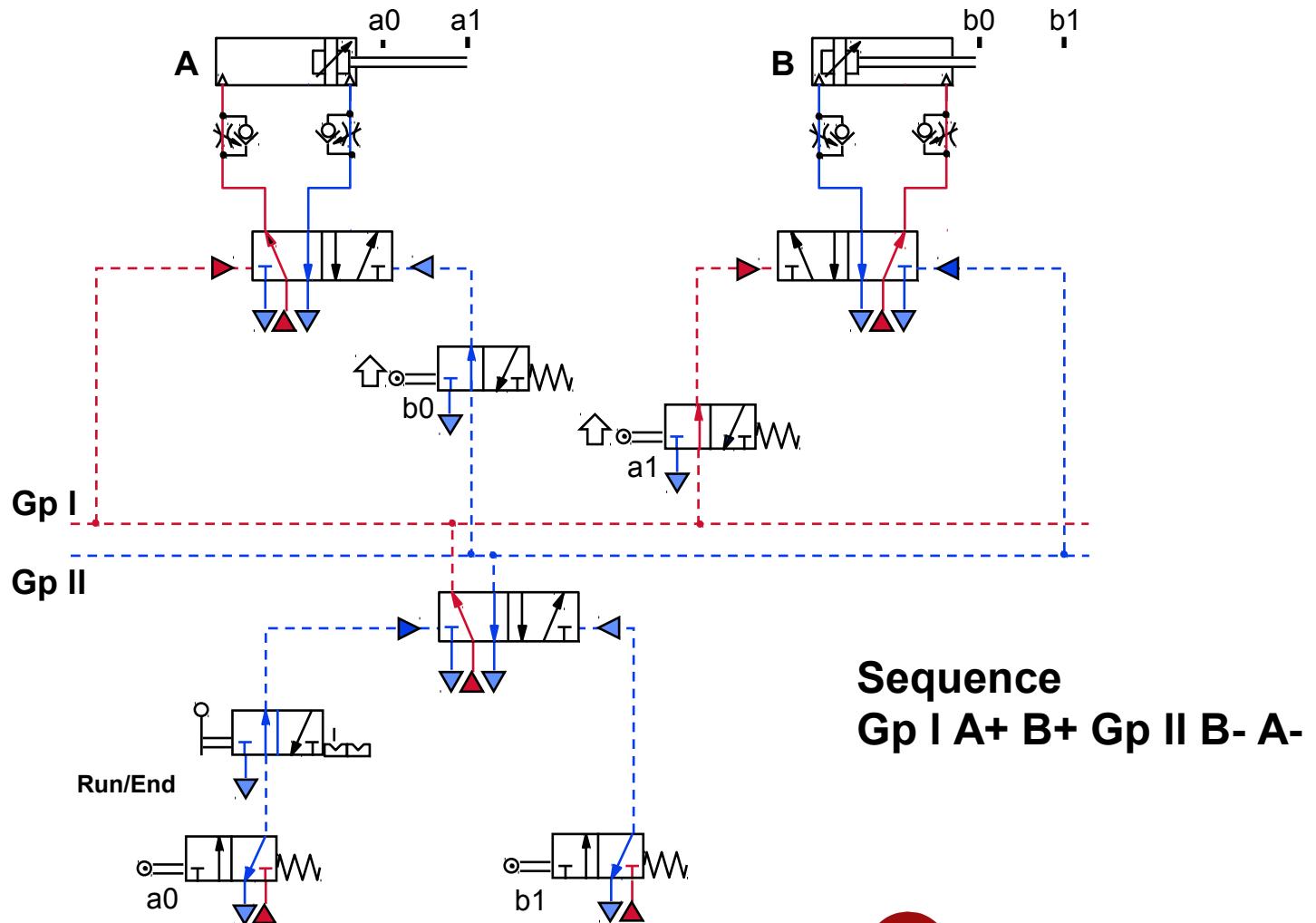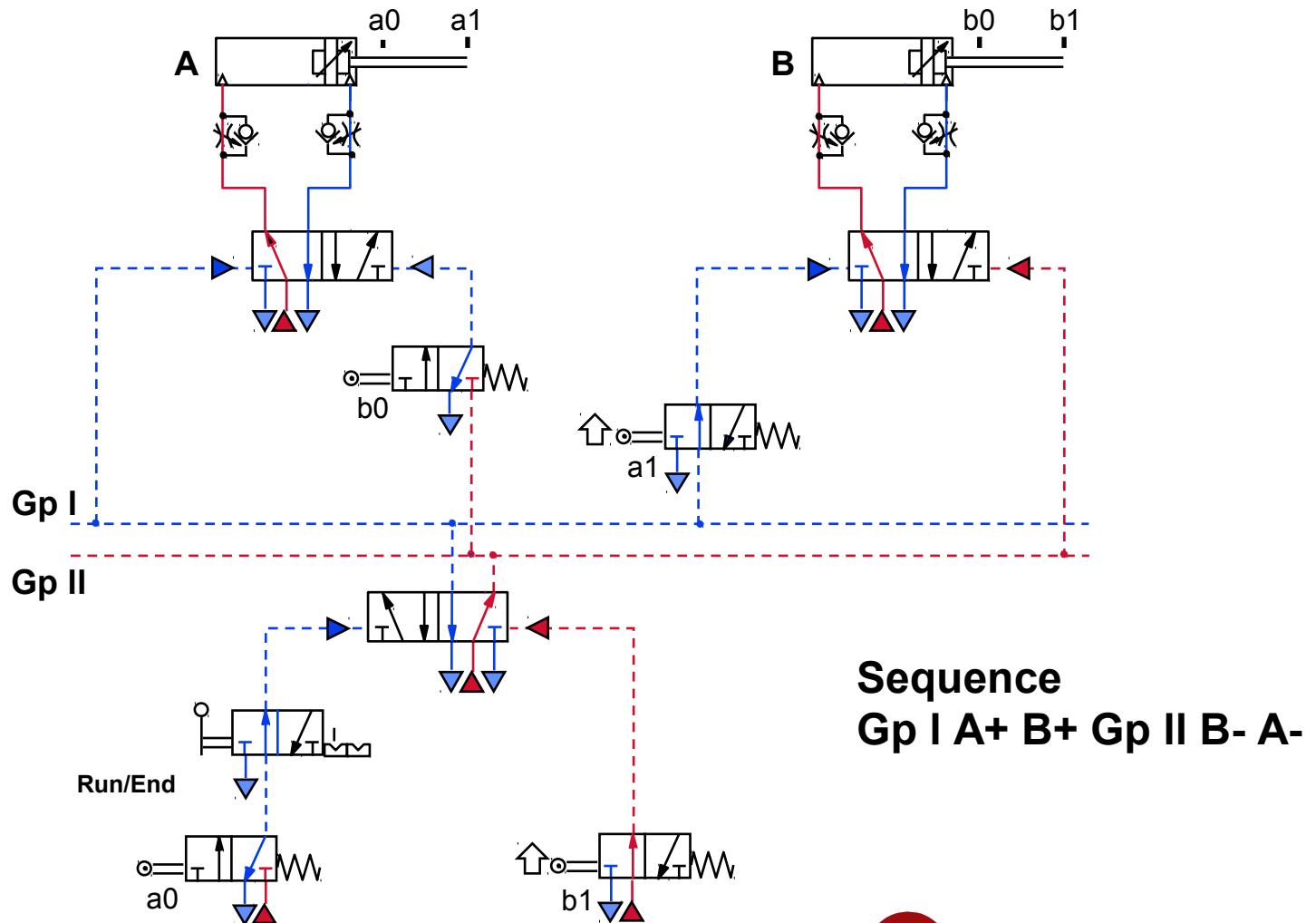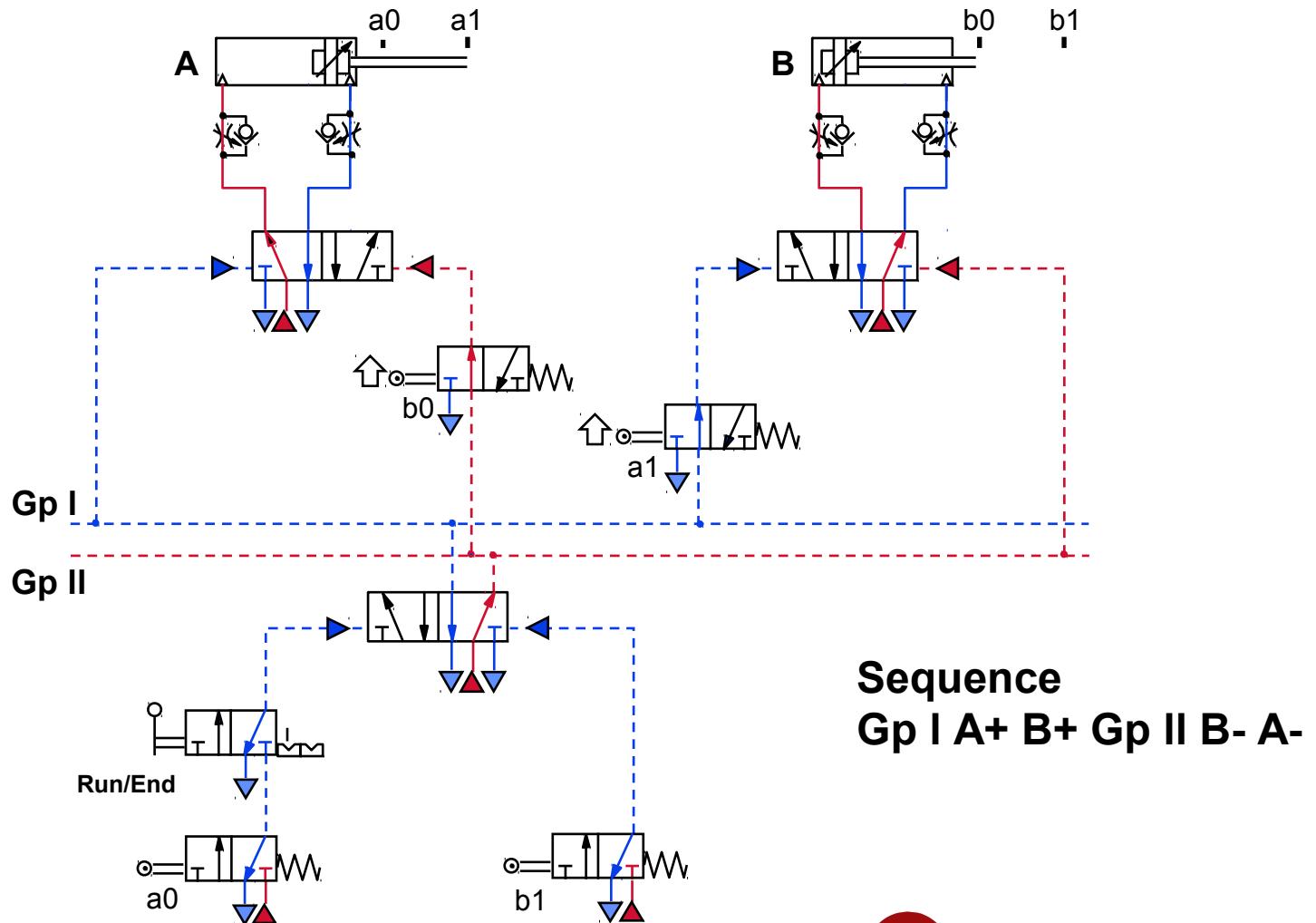
Group I   Group II

14   4   2   12

Select I   5   1   3   Select II

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Cascade (two group)

Sequence
Gp I A+ B+ Gp II B- A-

Cascade (two group)

Sequence
Gp I A+ B+ Gp II B- A-

Cascade (two group)

a0　a1

b0　b1

A

B

Gp I

Gp II

b0

a1

Run/End

a0

b1

Sequence
Gp I A+ B+ Gp II B- A-

NORGREN

Cascade (two group)

Sequence
Gp I A+ B+ Gp II B- A-

Cascade (two group)

Sequence
Gp I A+ B+ Gp II B- A-

Cascade (two group)

Sequence
Gp I A+ B+ Gp II B- A-

Gp I

Gp II

Run/End

a0

b1

A

B

a0   a1

b0   b1

b0

a1

NORGREN
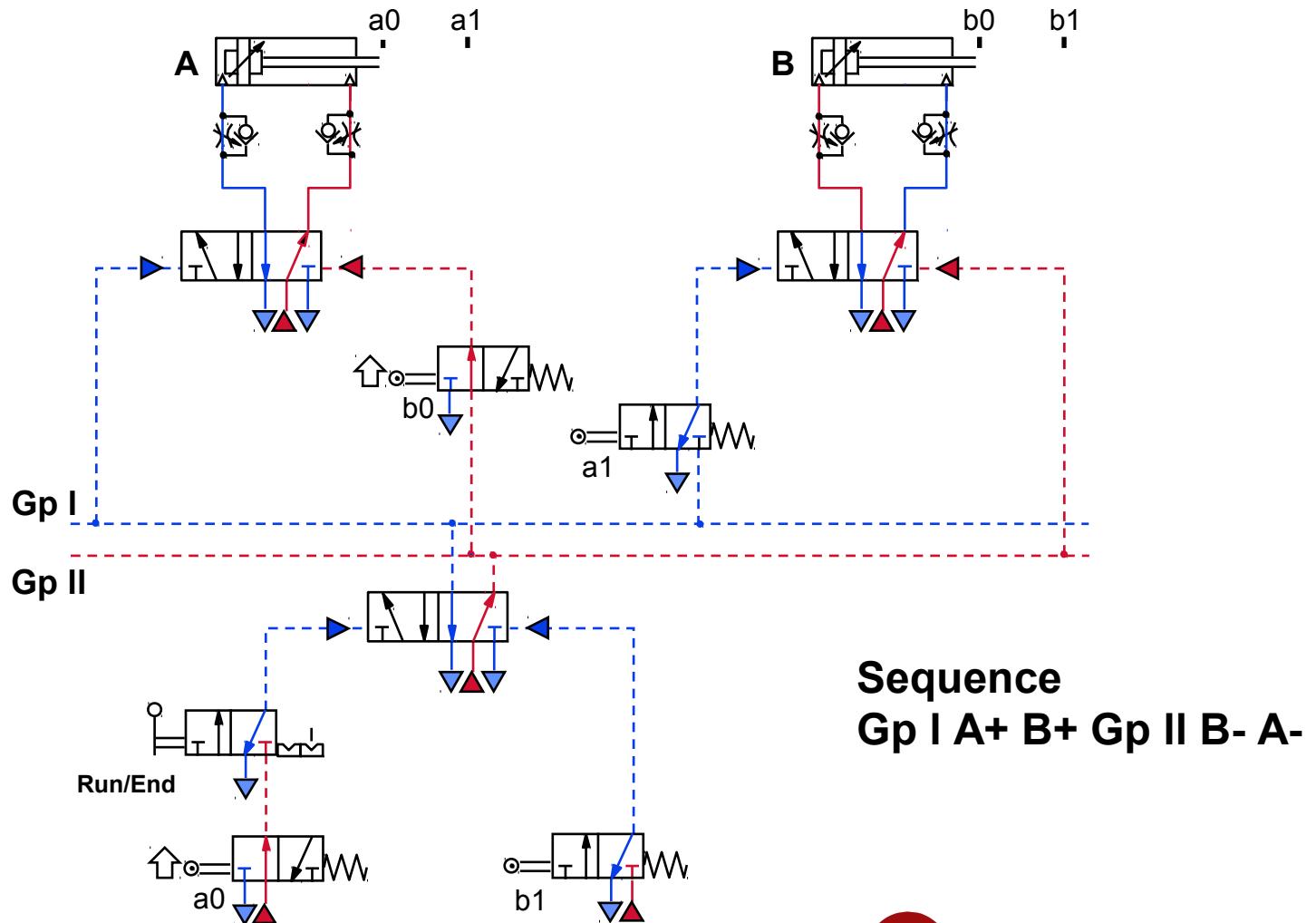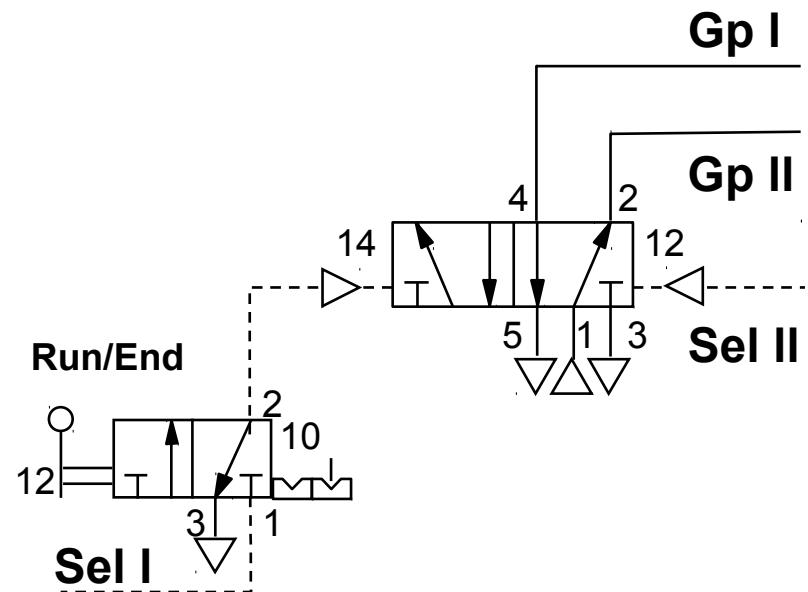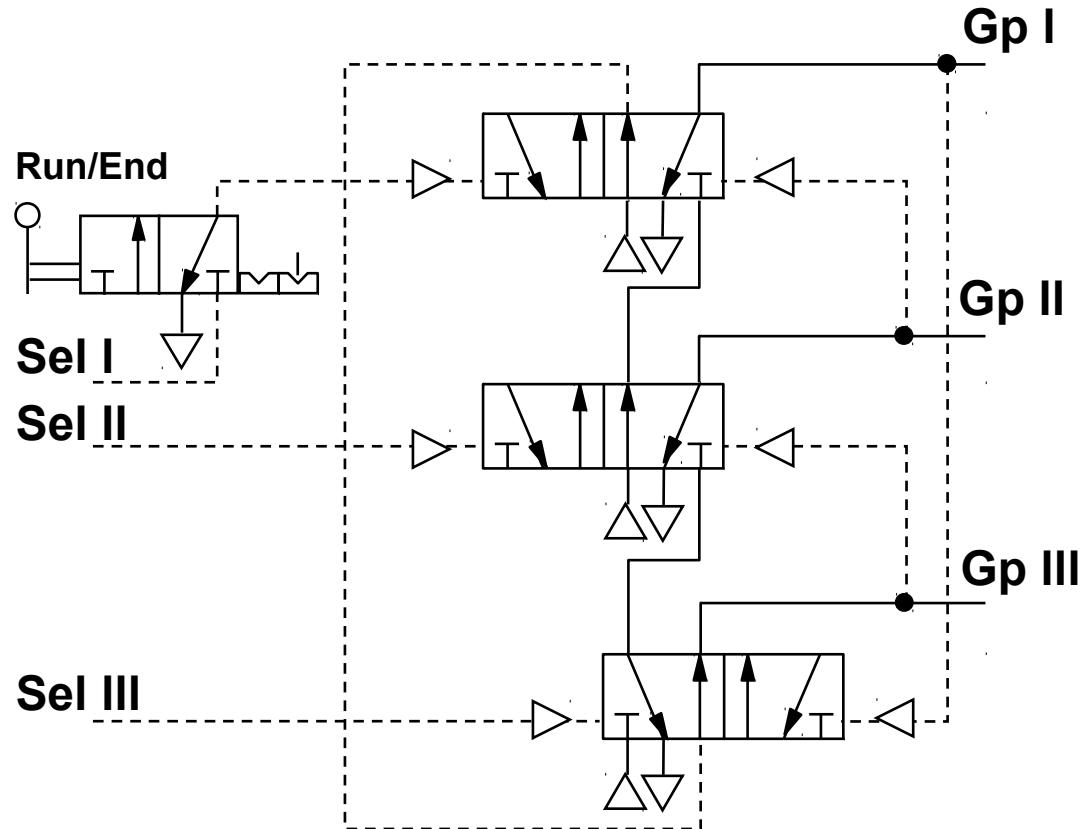
Cascade building blocks

- **A two group building block consists of a lever valve to run and end the sequence plus the 5/2 double pilot operated cascade valve**

- **For a two group system consisting of any number of cylinders this building block and the cylinder building blocks are all that is required to solve the sequence**

Gp I

Gp II

14   4   2   12

Run/End   5   1   3   Sel II

2   10

12

3   1

Sel I

NORGREN
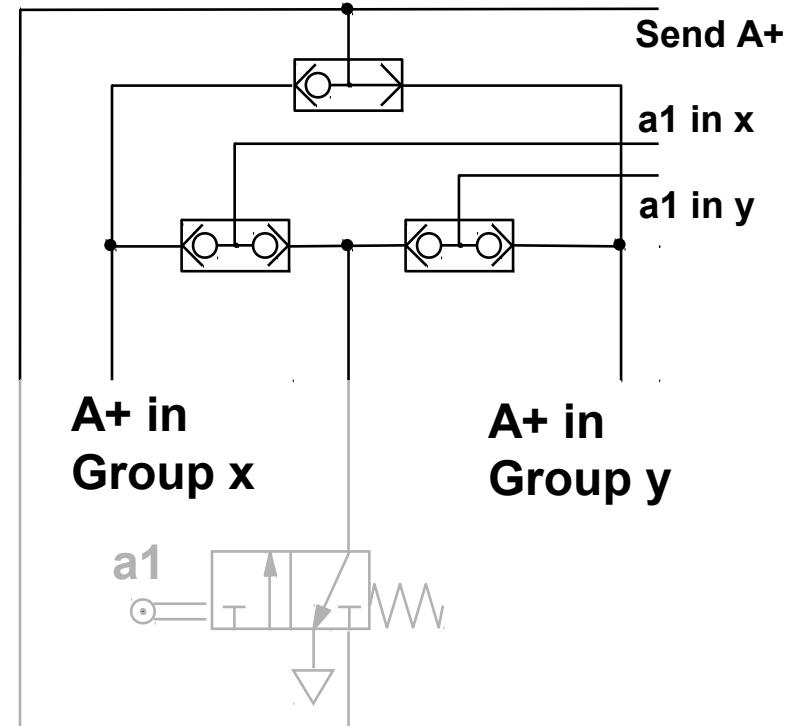
Cascade building blocks

- **This three group building block establishes an interconnecting pattern that can be extended to any number of groups**

Dual trip building blocks

- **When a sequence has a cylinder operating twice in one overall sequence a dual trip building block may be required for each of the two feedback valves**

- **The supply will be from different groups and the output go to different destinations**

- **Example is for feedback valve a1 of cylinder A when A is sent + both in Group x and Group y**

Send A+

a1 in x

a1 in y

A+ in Group x

A+ in Group y

a1

Note: can often be rationalised to less than these three components

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Cascade rules

- **Establish the correct sequence**

- **Divide the sequence in to groups. Always start a sequence with the Run/End valve selecting group I e.g. R/E | A+ B+ | B- C+ | C- A-**

- **Select the cylinder building blocks**

- **Select the cascade building block**

- **Select dual trip building blocks if required**

- **Interconnect the blocks as follows:**

- **The first function in each group is signalled directly by that group supply**

- **The last trip valve operated in each group is supplied with main supply air and selects the next group**

- **The remaining trip valves are supplied with air from their respective groups and initiate the next function**

- **The "run/end" valve will control the signal from the last trip valve to be operated**
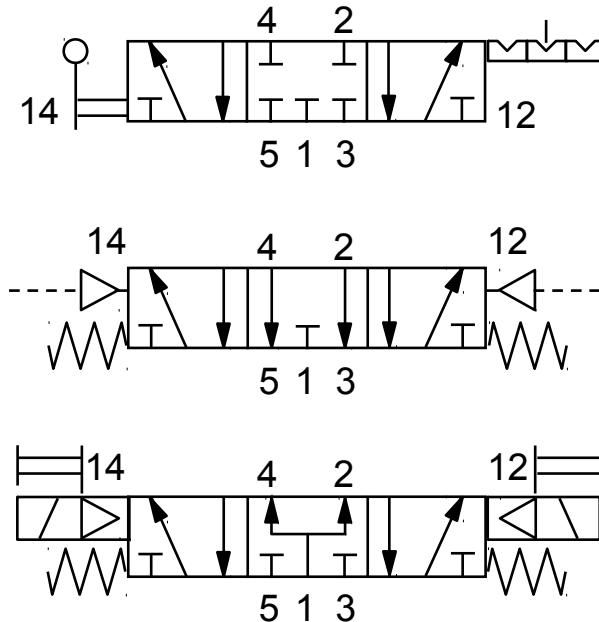
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Three position valves

5/3 Valve

- 5/3 valves have a third mid position

- The valve can be tri-stable e.g. a detented lever operator or mono-stable e.g. a double air or double solenoid with spring centre

- There are three common configurations for the mid position:
  - All ports blocked
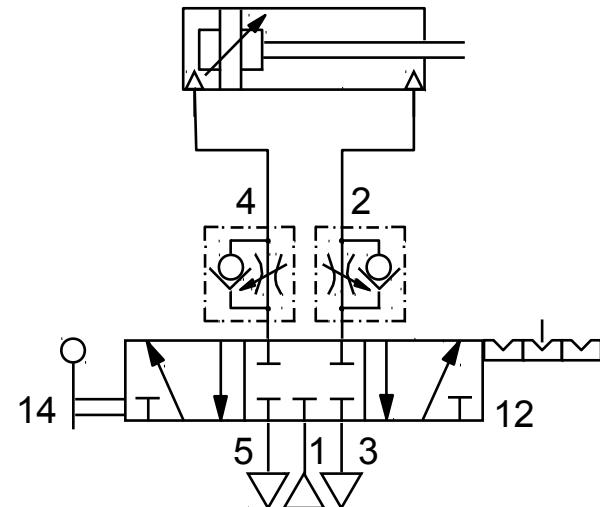 - Centre open exhaust
  - Centre open pressure

- The majority of applications are actuator positioning and safety

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5/3 Valve actuator control

- The valve illustrated has "all ports blocked" in the mid position
- Whenever the mid position is selected the pressure conditions in the cylinder will be frozen
- This can be used to stop the piston at part stroke in some positioning applications
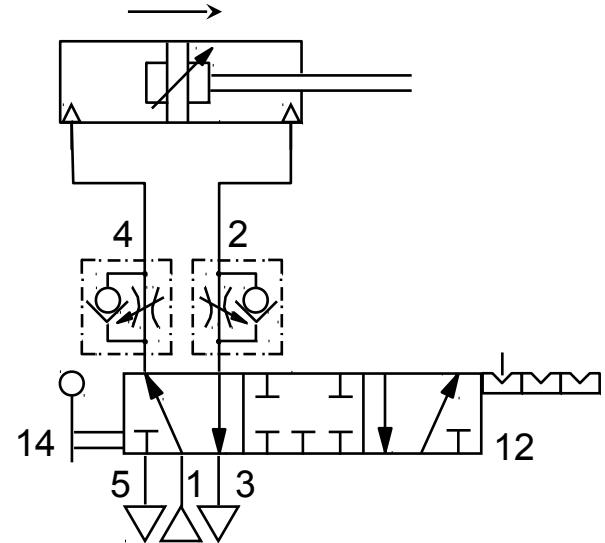- Flow regulators mounted close to the cylinder to minimise creep

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- **Flow regulators mounted close to the cylinder to minimise creep**

NORGREN

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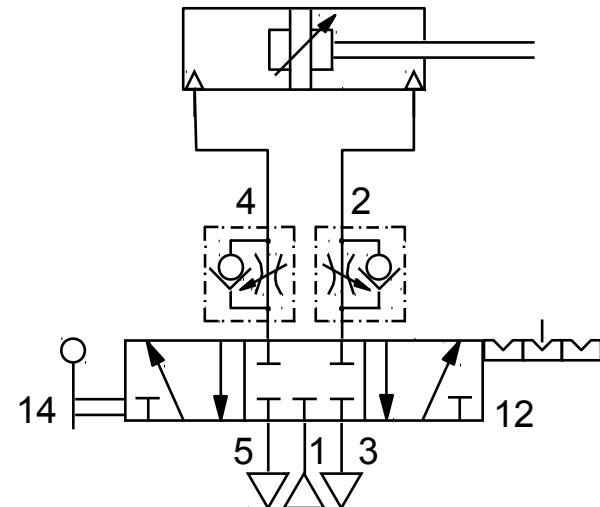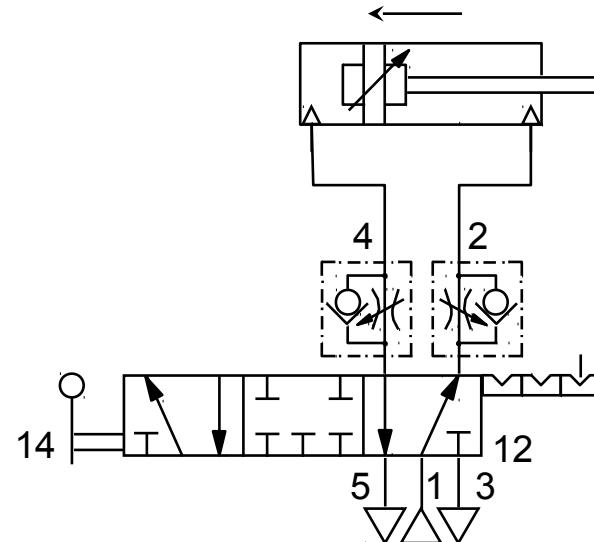- **Flow regulators mounted close to the cylinder to minimise creep**

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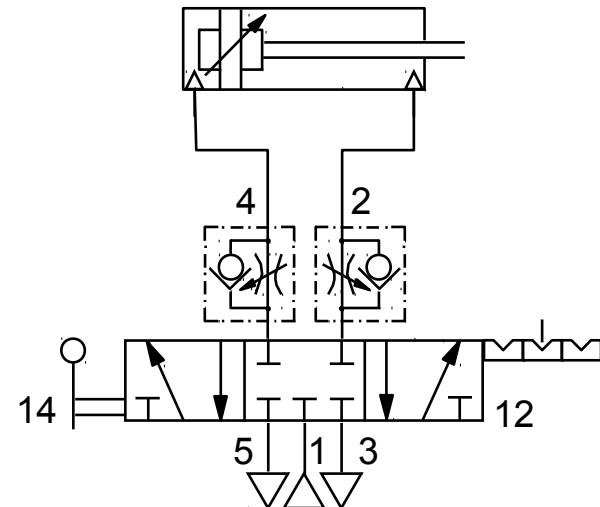- Flow regulators mounted close to the cylinder to minimise creep

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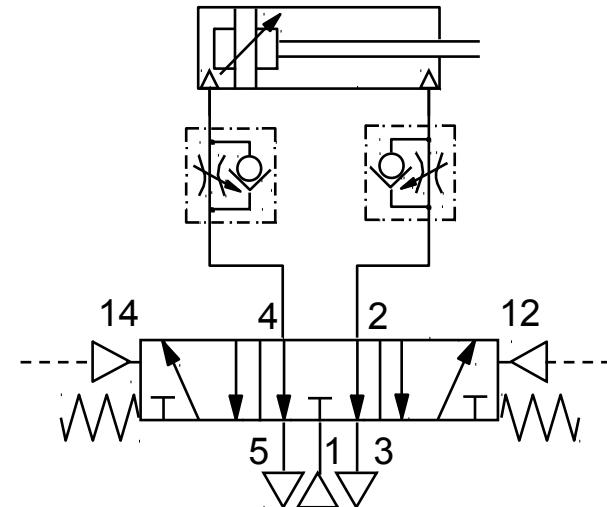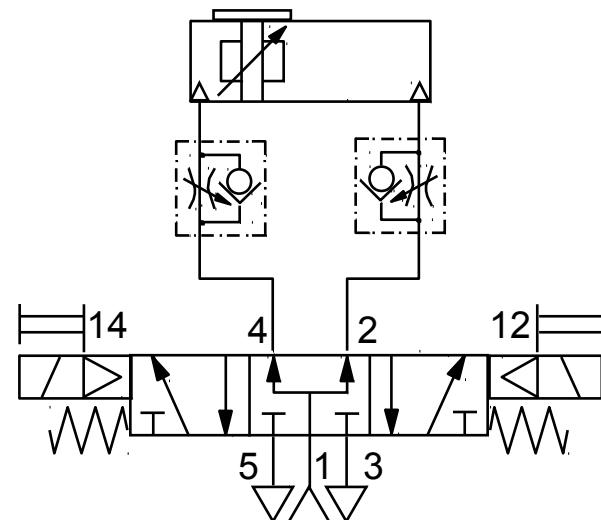- **Flow regulators mounted close to the cylinder to minimise creep**

5/3 Valve actuator control

- This version of a 5/3 valve is "centre open exhaust"
- The supply at port 1 is isolated and the cylinder has power exhausted when this centre position is selected
- The version illustrated shows a mono-stable version double pilot operated spring centre
- The cylinder will be pre-exhausted when changing from the mid position

5/3 Valve actuator control

- This version of a 5/3 valve is "centre open pressure"
- The supply at port 1 is connected to both sides of the cylinder and the exhaust ports isolated when this centre position is selected
- Can be used to balance pressures in positioning applications
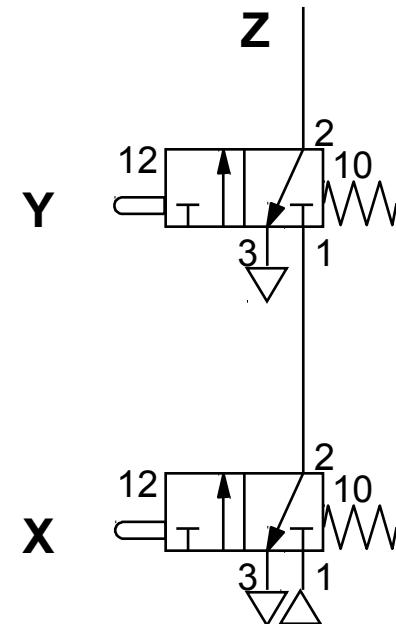- The version illustrated is mono-stable, double solenoid, spring centre

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Logic functions for poppet and spool valves

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Logic AND

- **To obtain the output Z both plungers X AND Y must be operated and held**

- **If X only is operated the air will be blocked at port 1 in valve Y**

- **If Y only is operated there will be no pressure available at port 1**

- **If either X or Y is released the output signal Z will be lost**
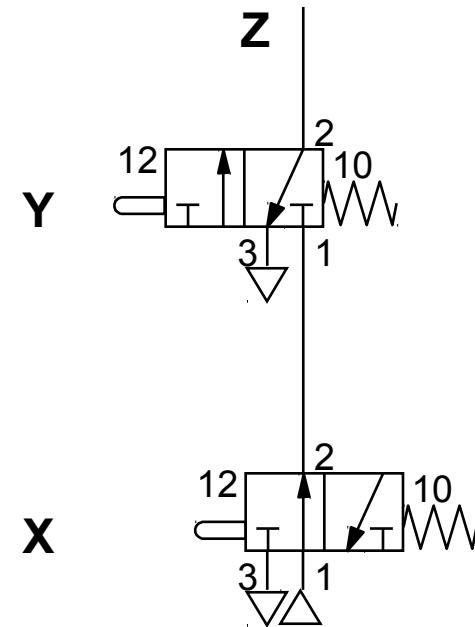

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Logic AND

- **To obtain the output Z both plungers X AND Y must be operated and held**

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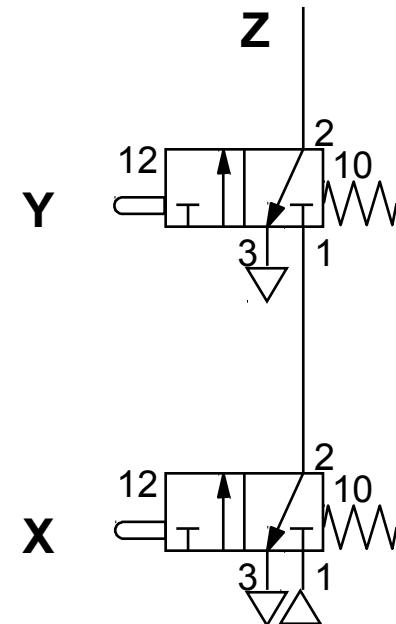- **If either X or Y is released the output signal Z will be lost**

Logic AND

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- **If Y only is operated there will be no pressure available at port 1**
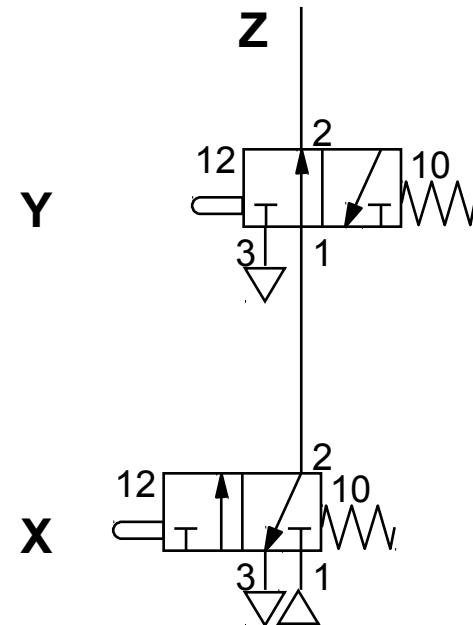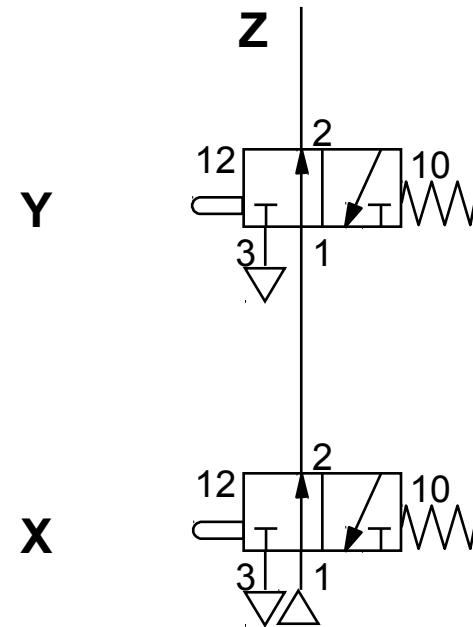- **If either X or Y is released the output signal Z will be lost**

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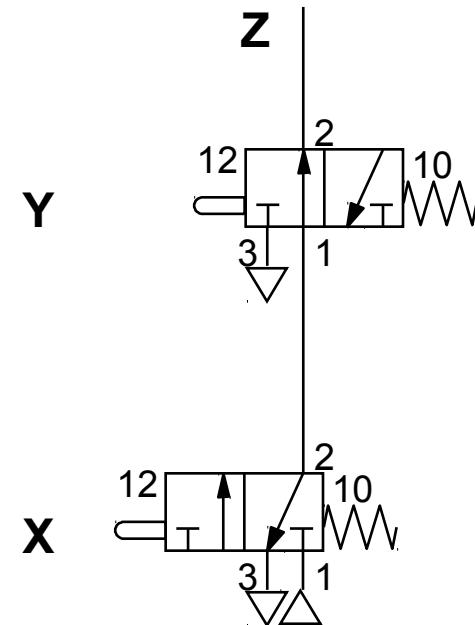

NORGREN

Logic AND

- **To obtain the output Z both plungers X AND Y must be operated and held**
- **If X only is operated the air will be blocked at port 1 in valve Y**
- **If Y only is operated there will be no pressure available at port 1**
- **If either X or Y is released the output signal Z will be lost**

Z

Y

12   2   10

3   1
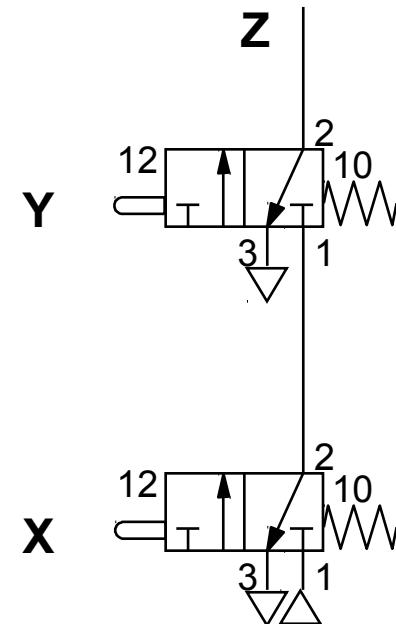
X

12   2   10

3   1

NORGREN

Logic AND

- **To obtain the output Z both plungers X AND Y must be operated and held**

- **If X only is operated the air will be blocked at port 1 in valve Y**

- **If Y only is operated there will be no pressure available at port 1**

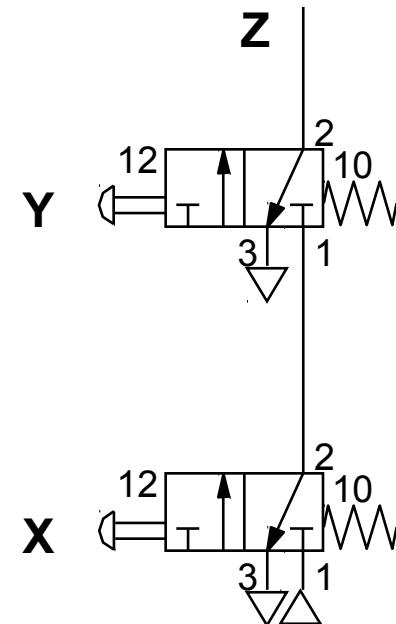- **If either X or Y is released the output signal Z will be lost**

Logic AND

- **To obtain the output Z both plungers X AND Y must be operated and held**
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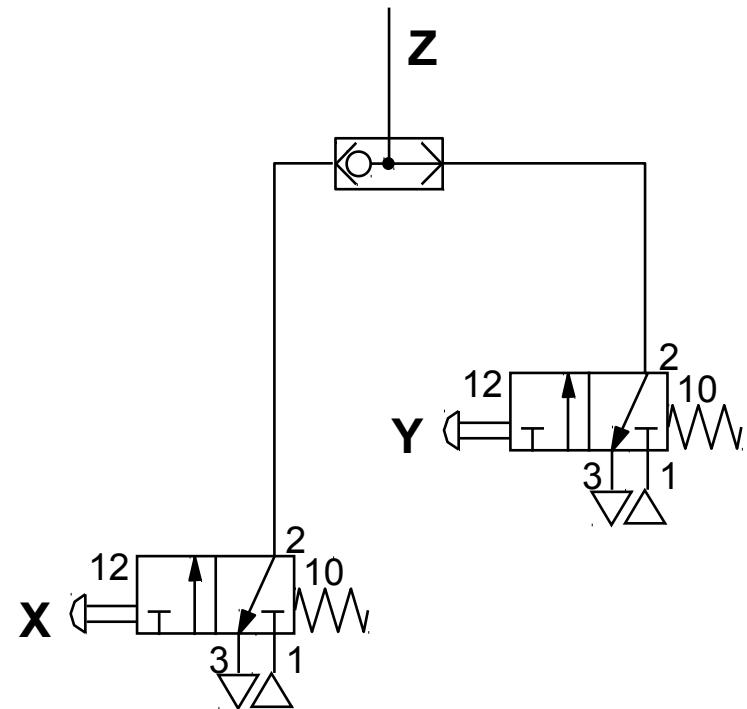- **If either X or Y is released the output signal Z will be lost**

Logic AND

- This method **must not** be used as a two handed safety control
- It is too easy to abuse. e.g. one of the buttons could be permanently fixed down and the system operated from the other button only
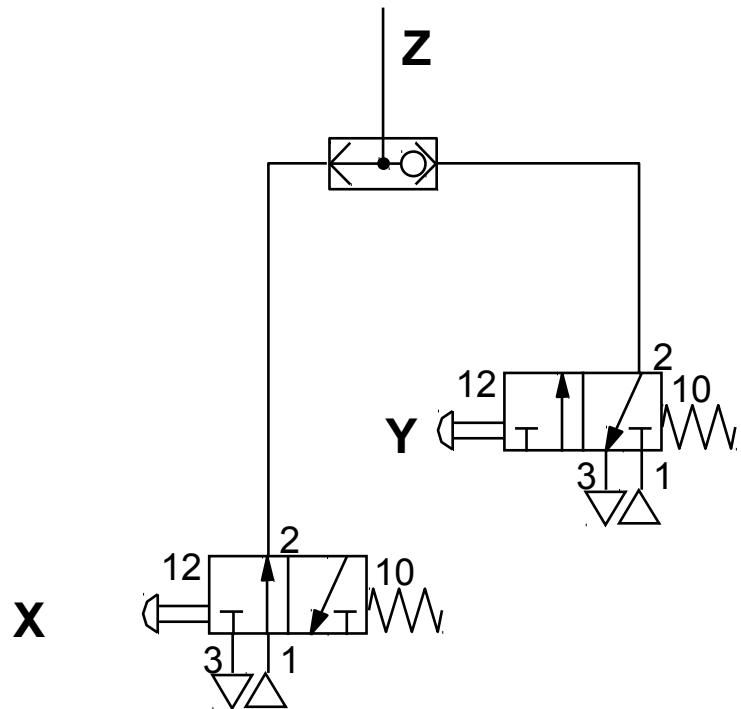- Use the purpose designed two handed safety control unit

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Logic OR

- **Use of an 'OR' function shuttle valve**

- **Source X and Y can be remote from each other and remote from the destination of Z**

- **When X or Y is operated the shuttle valve seal moves across to prevent the signal Z from being lost through the exhaust of the other valve**

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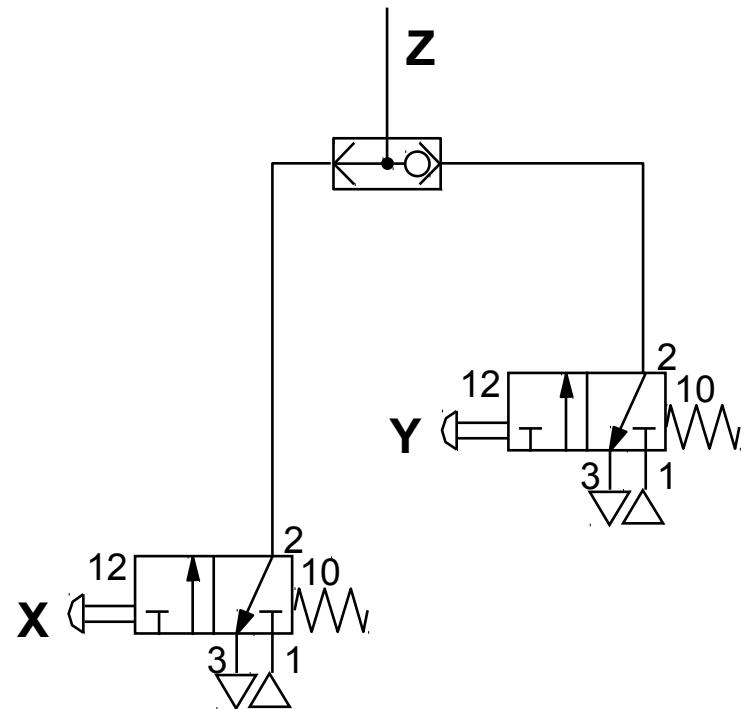
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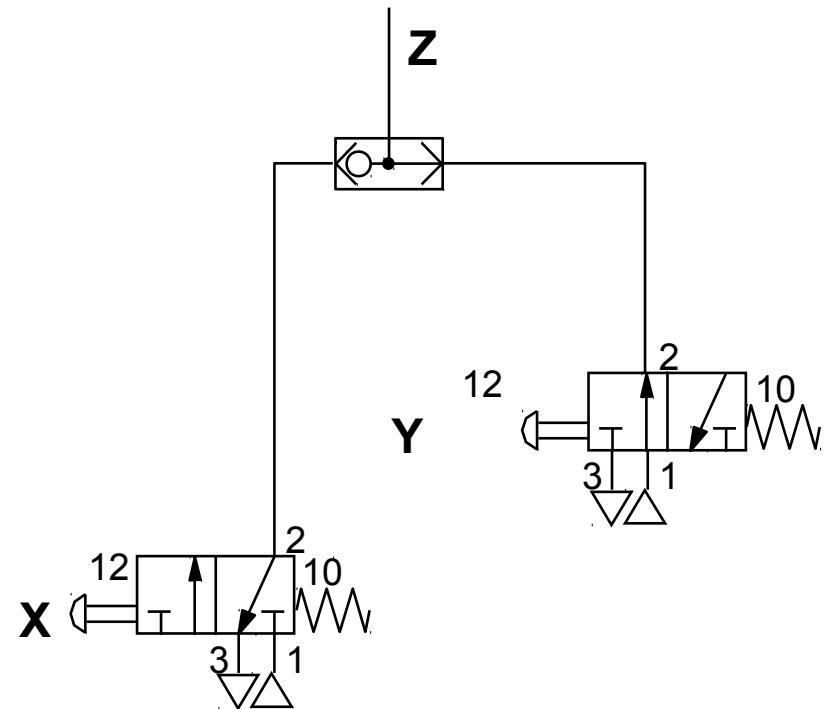
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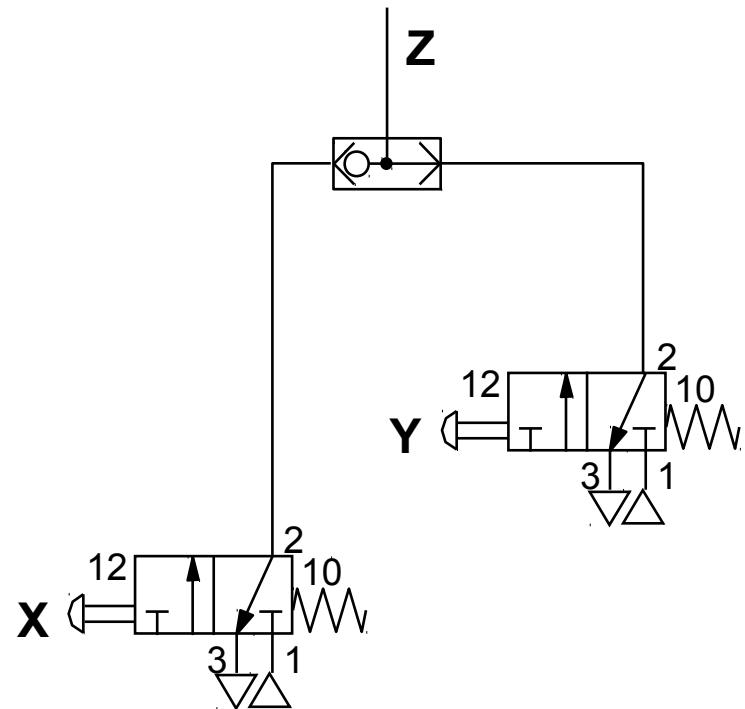
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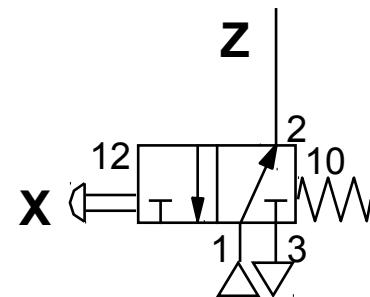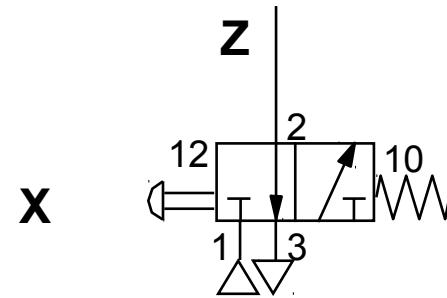
Logic NOT

- **A logic NOT applies to the state of the output when the operating signal is present (the output is simply an inversion of the operating signal)**
- **The valve shown is a normally open type (inlet port numbered 1)**
- **When the signal X is present there is NOT output Z**
- **When X is removed output Z is given**
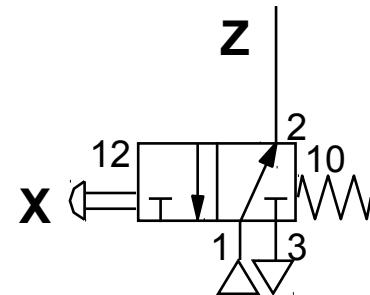
Z

12 | 2 | 10

X

1 | 3

NORGREN

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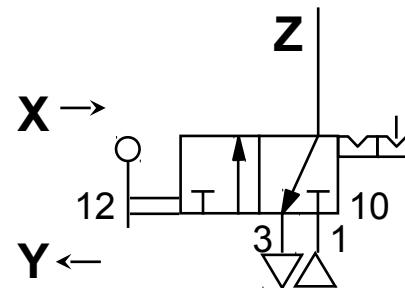
Z

2

12   10

X

1   3

NORGREN

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- **The valve shown is a normally open type (inlet port numbered 1)**

- **When the signal X is present there is NOT output Z**
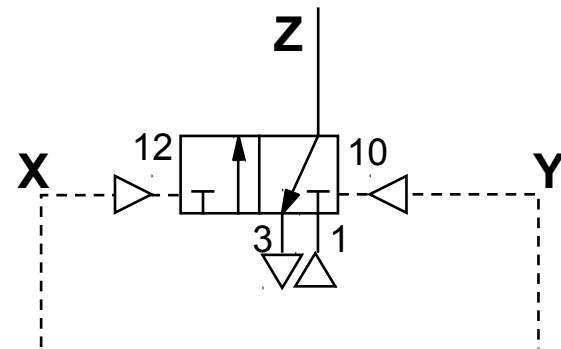
- **When X is removed output Z is given**

Logic MEMORY

- **A logic MEMORY allows the output signal state (ON or OFF) to be maintained after the input signal has been removed**

- **Any bi-stable valve is a logic MEMORY**

- **With this lever detented valve, once the lever has been moved X direction or Y direction it can be released and will stay in that position**
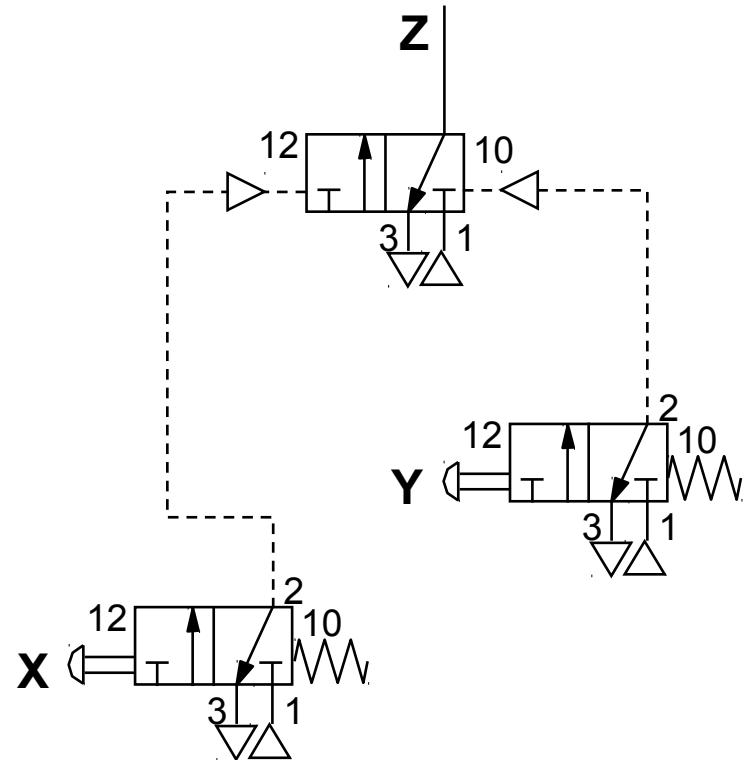
NORGREN

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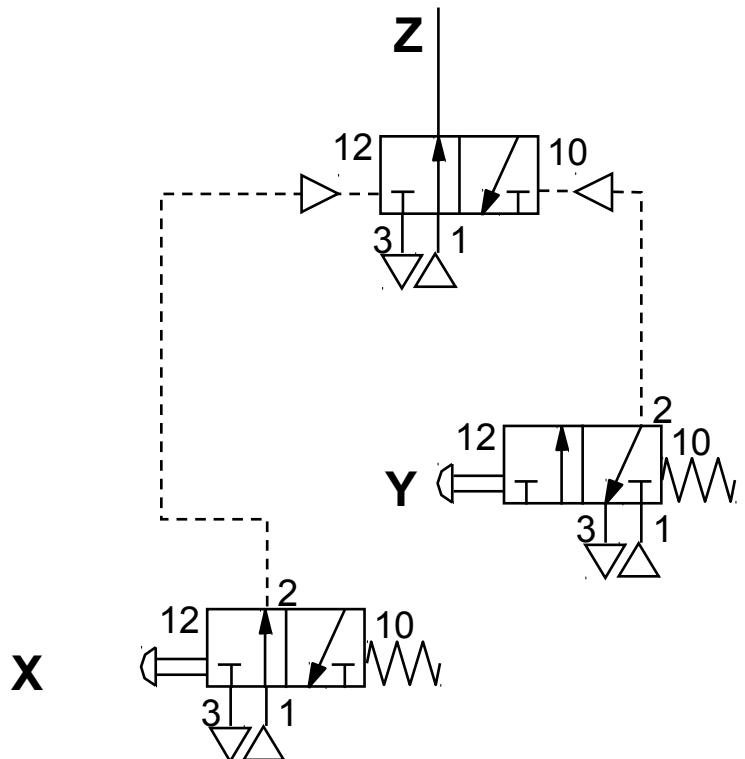
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- **A bi-stable double pilot valve can be set or reset simply by a pulse (push and release) on buttons X or Y**
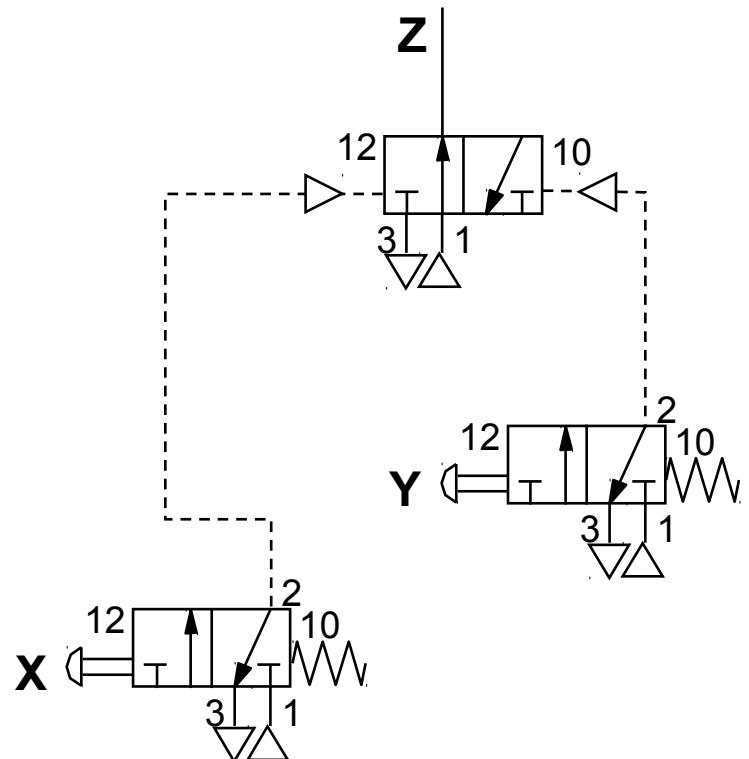
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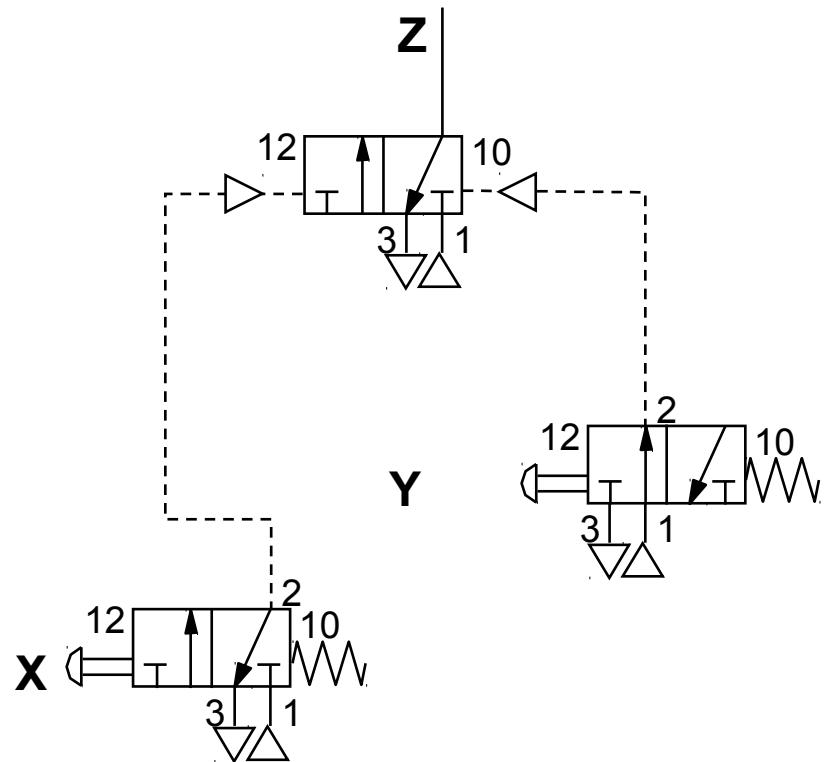- **A bi-stable double pilot valve can be set or reset simply by a pulse (push and release) on buttons X or Y**
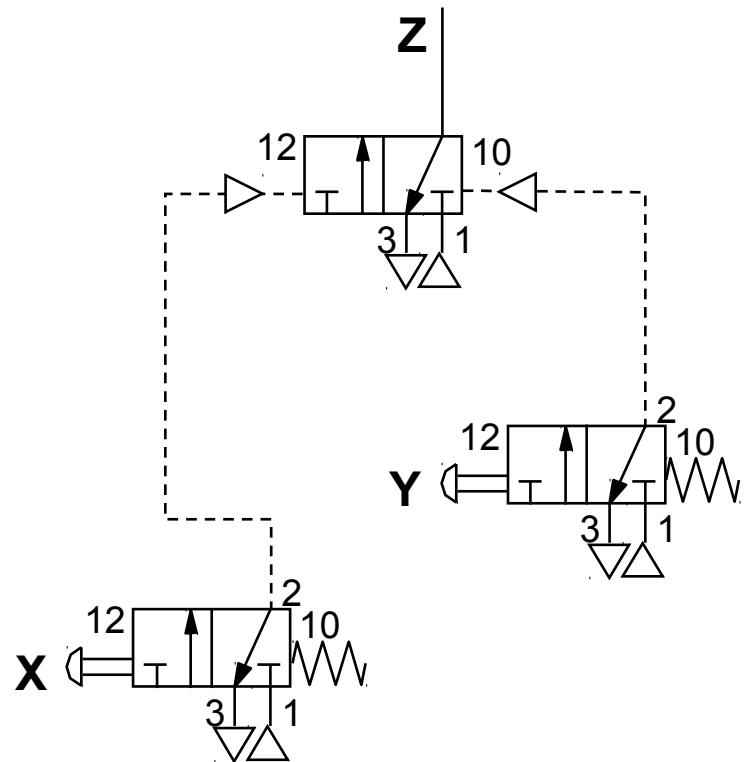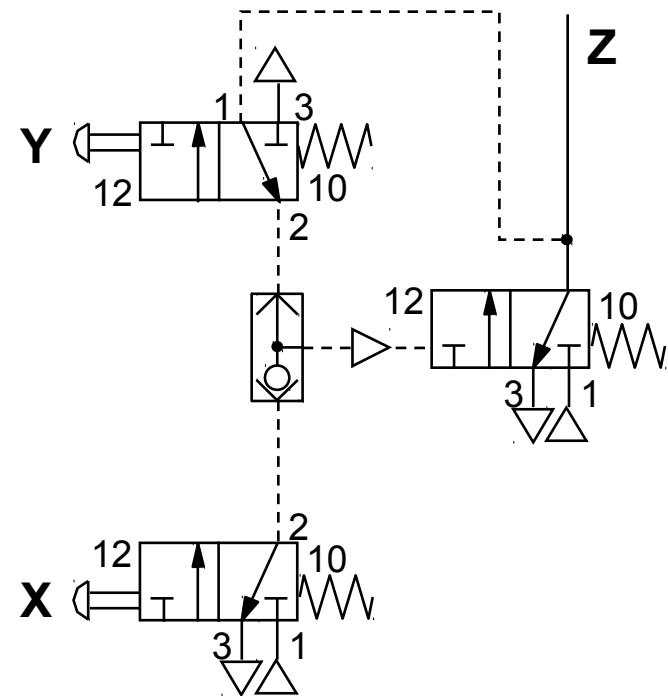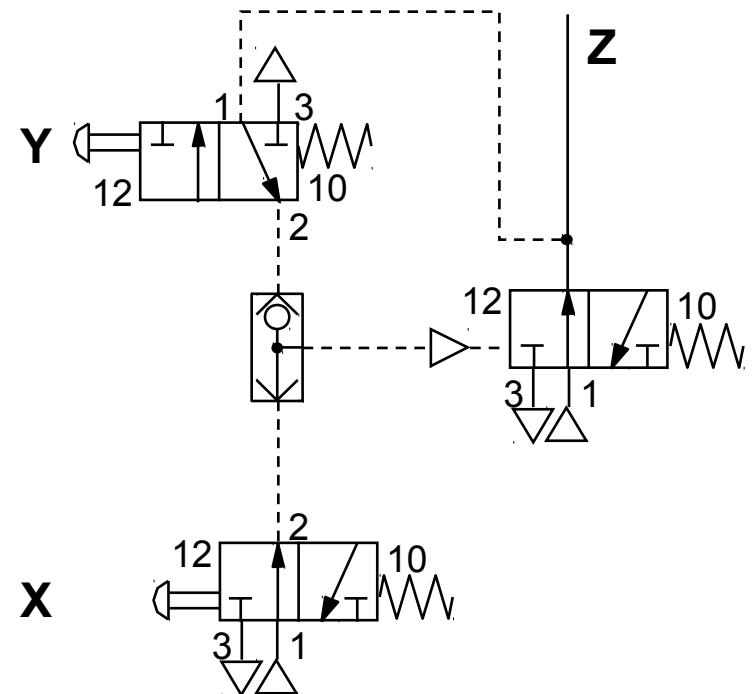
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Logic MEMORY (latch)

- **A popular memory circuit is the latch**

- **Will not re-make after pneumatic power failure**

- **A pulse on X operates the pilot / spring valve to give output Z**

- **A feedback from Z runs through the normally open valve Y to latch the operation of Z when X is released**

- **A pulse on Y breaks the latch and Z is exhausted**

NORGREN

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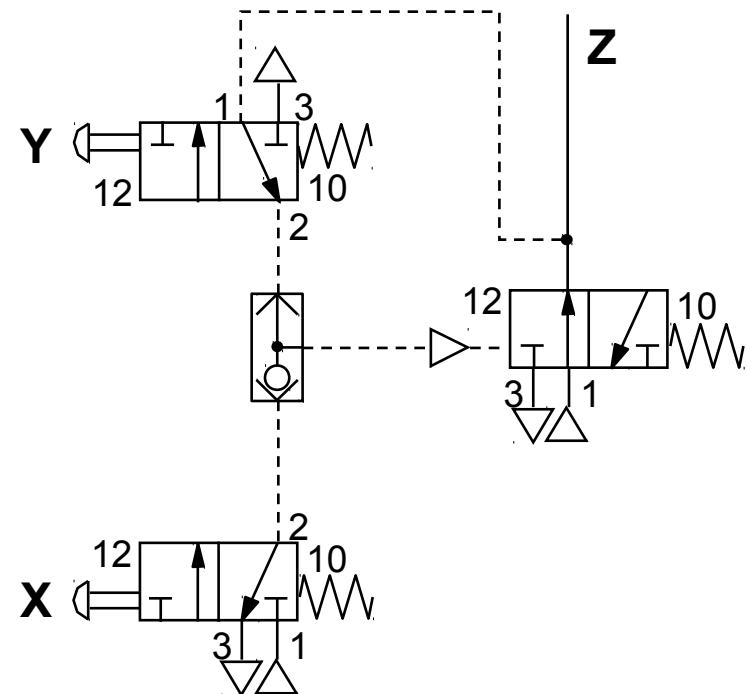- **A pulse on Y breaks the latch and Z is exhausted**

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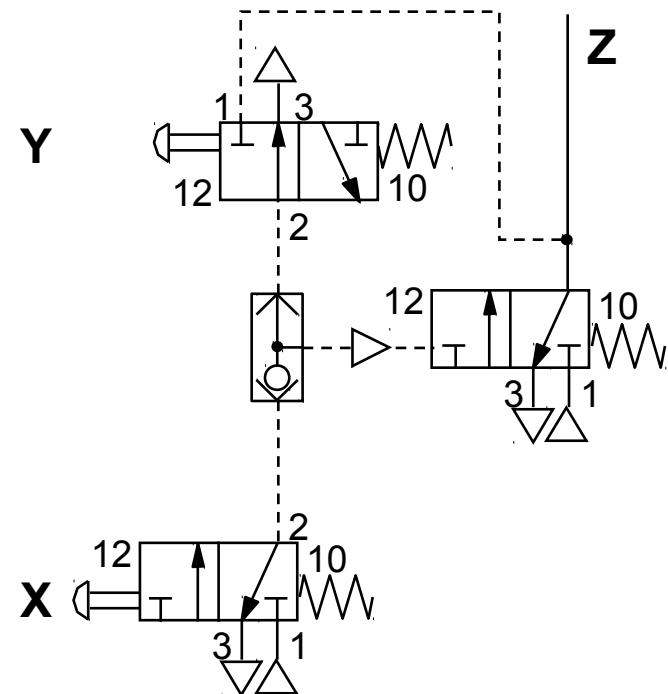- **A pulse on Y breaks the latch and Z is exhausted**

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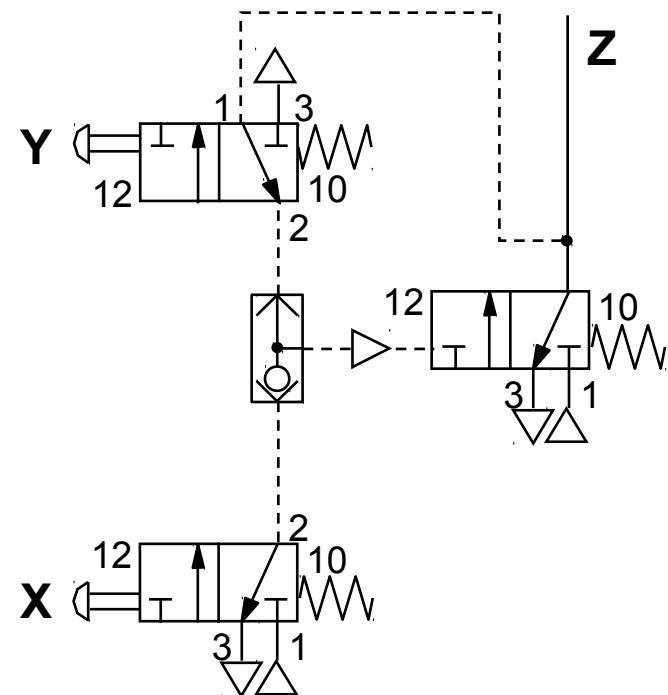- **A pulse on Y breaks the latch and Z is exhausted**

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Logic arrangements for fully balanced spool valves

NORGREN

Logic circuits (spool valves)

- **NO / NC**
- **Selection / Diversion**
- **Latch**
- **OR, AND, NOT**
- **Single pulse maker**
- **Slow pressure build**
- **Pre-select**

- **5/2 OR**
- **Single pulse control**
- **Air conservation**
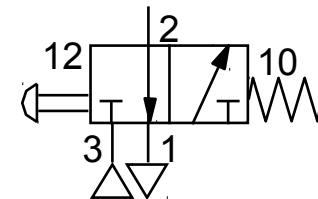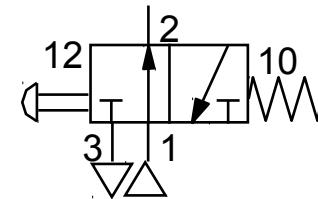- **Double flow**
- **Counting**

NORGREN

3/2 NO / NC

- **A fully balanced valve allows pressure on any pot or combination of ports**

- **A single valve can be used normally open or normally closed**

- **For normally open the supply pressure is connected to port 1**

- **For normally closed the supply pressure is connected to port 3**
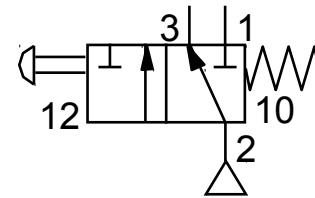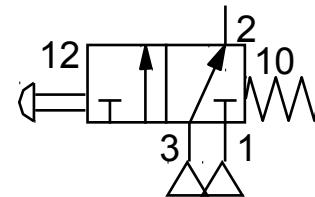

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3/2 Valve selection / diversion

- **Selection of one of two supplies connected to ports 1 and 3 can be different pressures**

- **Diversion of one supply to one of two outlets**

- **If it is required to exhaust the downstream air a 5/2 valve is required**
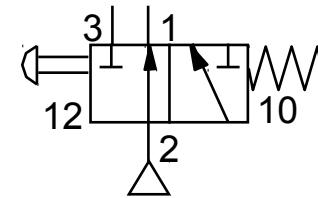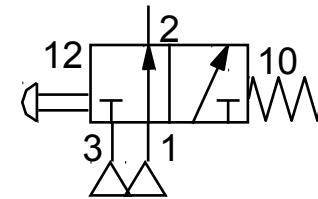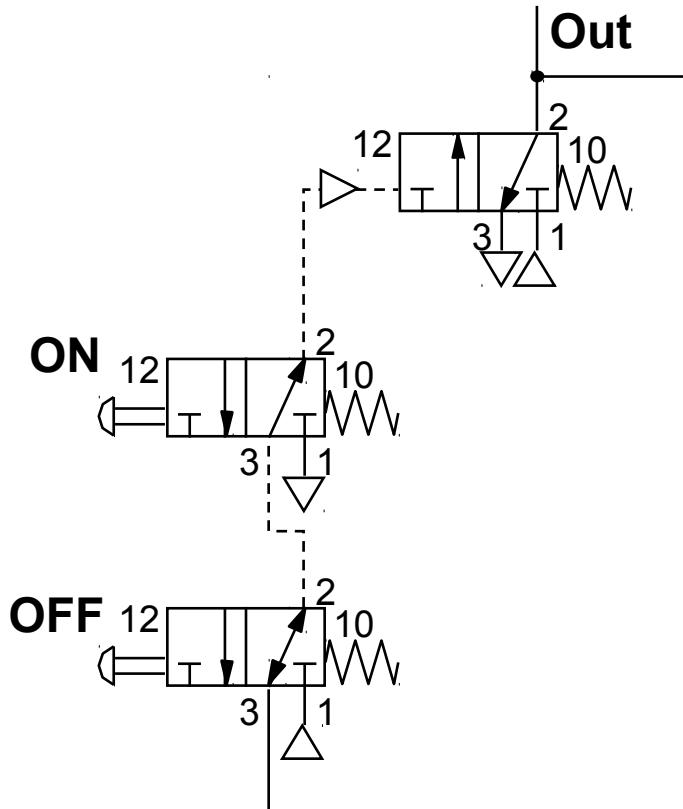

NORGREN

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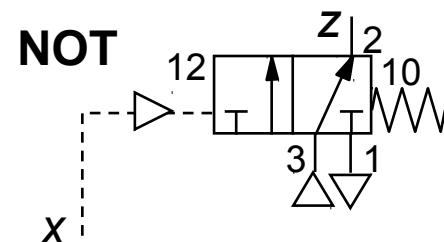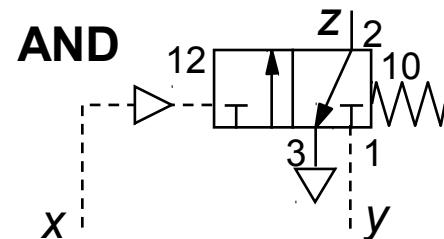- **If it is required to exhaust the downstream air a 5/2 valve is required**
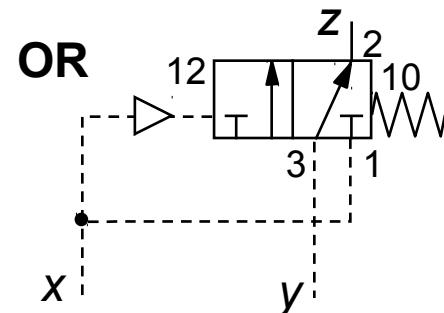
Latch with controls

- **In this version of a latch the push button valves are connected to perform 'OR' and 'NOT' functions**

- **The 'OFF' valve must be placed last in the signal chain so that if both valves are operated together the 'OFF' command will dominate over the 'ON' command**
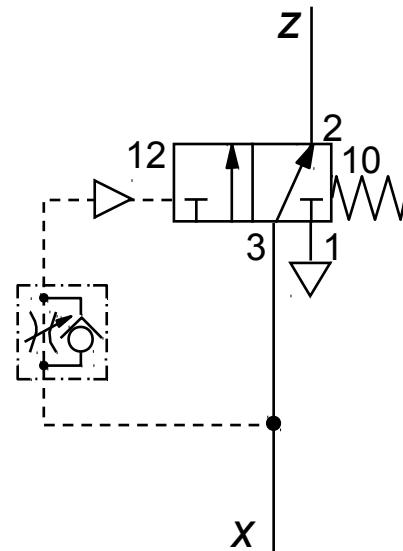
Out

ON

OFF

NORGREN

OR, AND, NOT

- **A single 3/2 pilot operated spring return valve can be use for any of these logic functions**
- *x* **OR** *y* **gives output** *z*
- *x* **AND** *y* **gives output** *z*
- *x* **gives NOT** *z*

OR
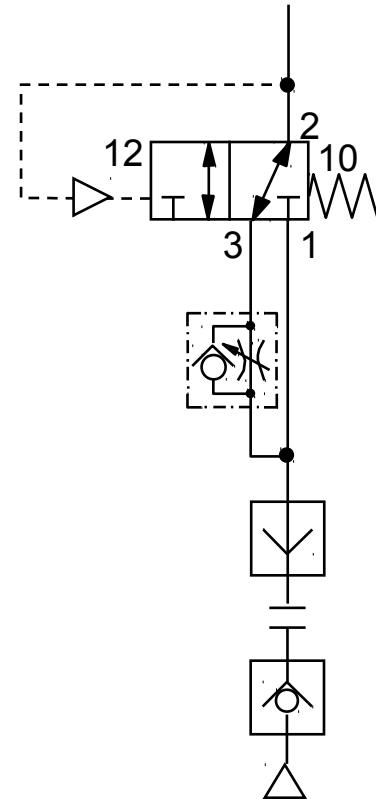
AND

NOT

NORGREN

Single pulse maker

- **Converts a prolonged signal *x* into a single pulse *z***

- **Signal z must be removed to allow the valve to reset then x can be applied again**

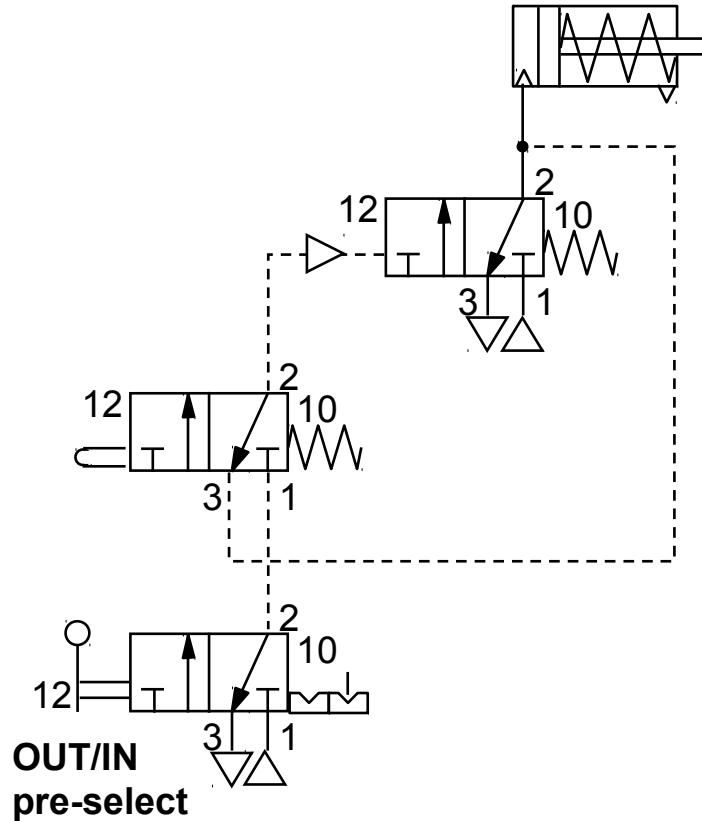- **The duration of the pulse can be adjusted with the flow regulator**

Slow initial pressure build up

- **Choose a 3/2 pilot spring valve with a relatively high operating force e.g. 3 to 4 bar**

- **When the quick connect coupling is made, the output at port 2 is controlled at the rate of the flow regulator setting**

- **When the pressure is high enough to operate the valve full flow will take over**
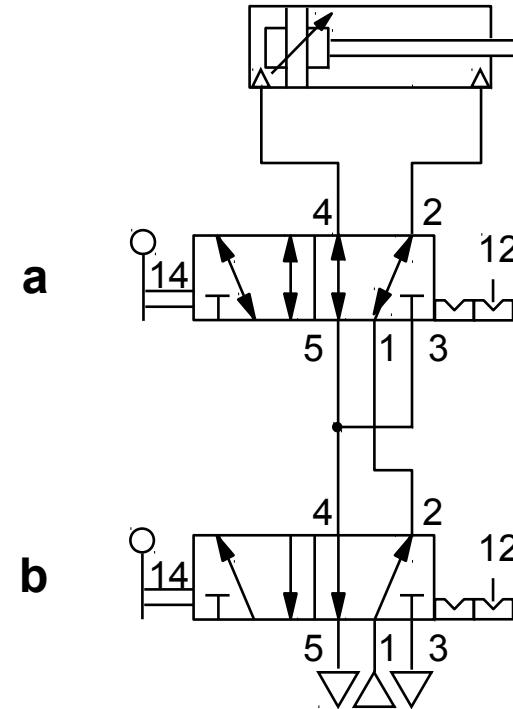
NORGREN

Pre-select

- **The lever valve can pre-select the movement of the cylinder OUT or IN**

- **The movement will occur the next time the plunger valve is operated**

- **The plunger valve can be released immediately and subsequently operated and released any number of times**
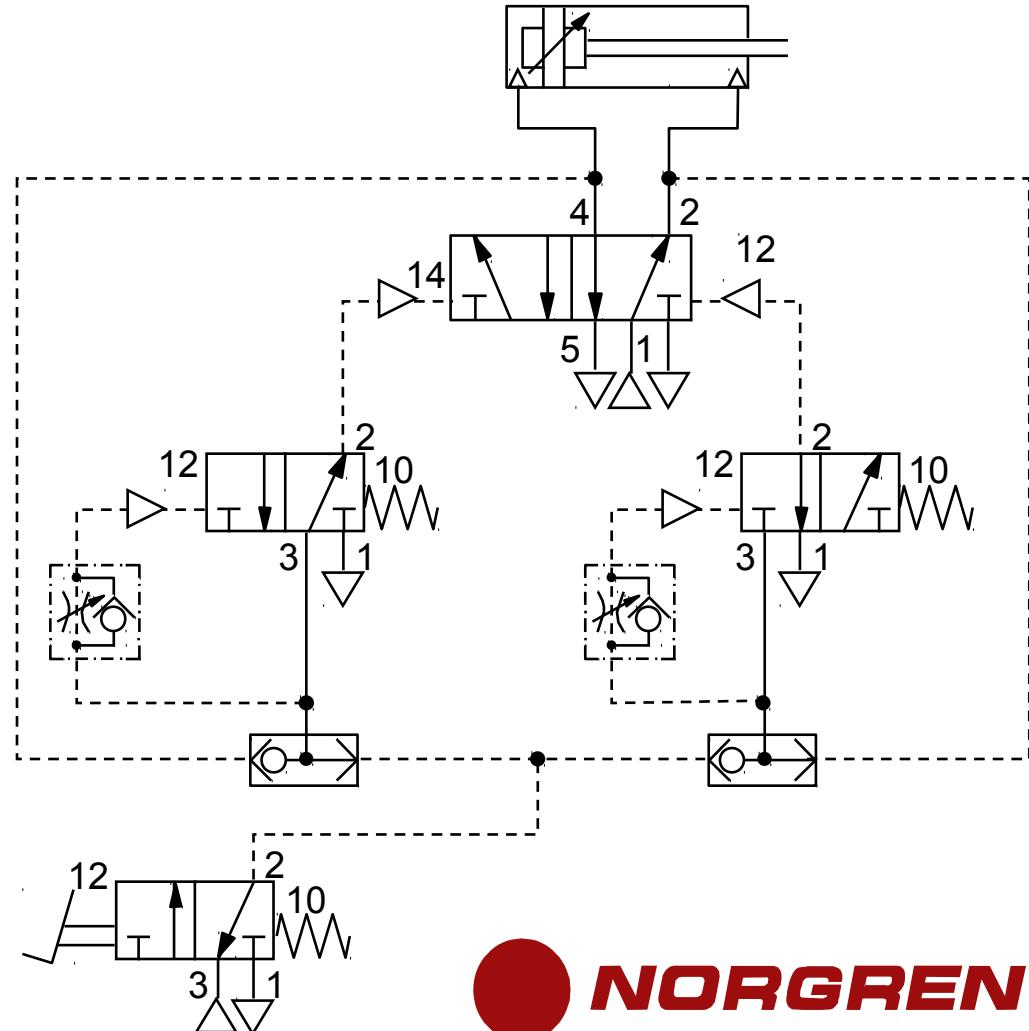
**OUT/IN
pre-select**

5/2 OR function

- **The valve at position 'a' is reversed connected and supplied from the valve conventionally connected at position 'b'**

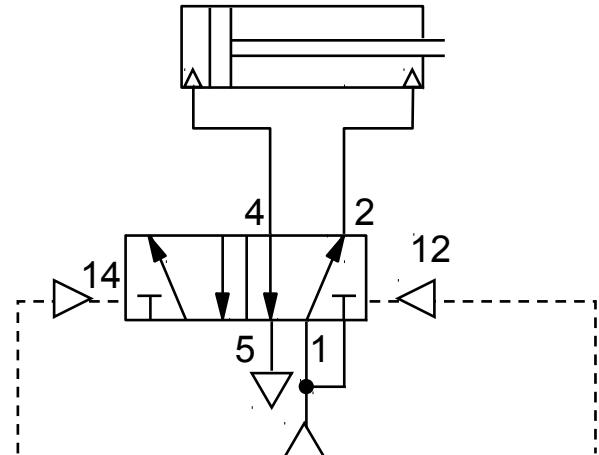- **The cylinder can be controlled from either position 'a' 'OR' position 'b'**

Single pulse control

- **Each time the foot operated valve is pressed the cylinder will single stroke + and - alternately**

- **First foot operation the cylinder moves out**

- **Second foot operation the cylinder moves in**

- **Third….. out and so on**

Air conservation

- **Power stroke in the instroke direction only**

- **Differential area of the piston gives an outstroke force when the pressure is balanced**

- **Air used to outstroke is equivalent to a cylinder with only the same bore as the rod diameter**

- **Assumes the cylinder is not loaded on the plus stroke and low friction**
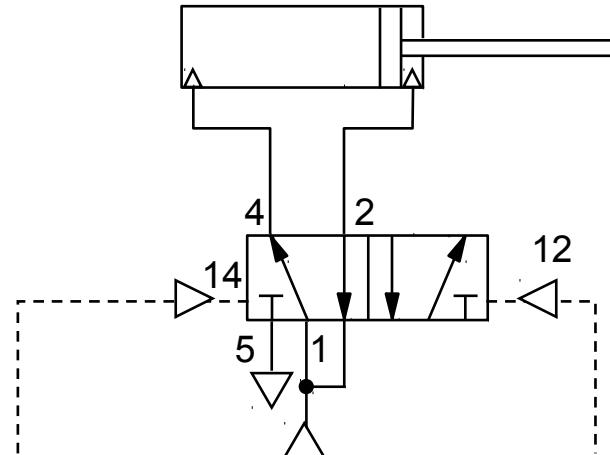
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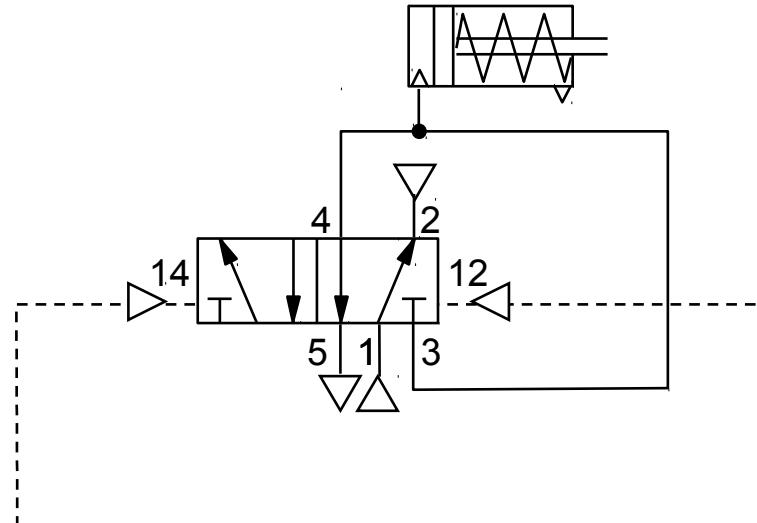- **Assumes the cylinder is not loaded on the plus stroke and low friction**

Double flow

- **Where a larger 3/2 valve is not available**
- **Two flow paths in a 5/2 valve each with a separate supply can be arranged to give double flow or supply separate devices**
- **Ensure the tube size to the cylinder is large enough to take the double flow**
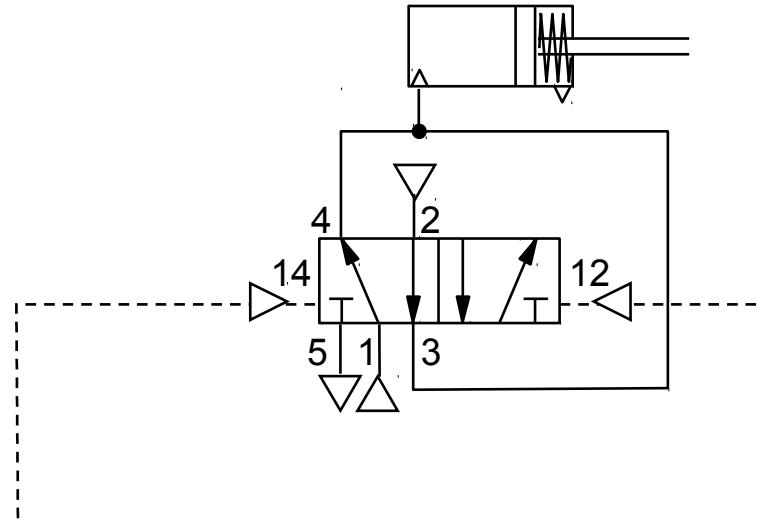
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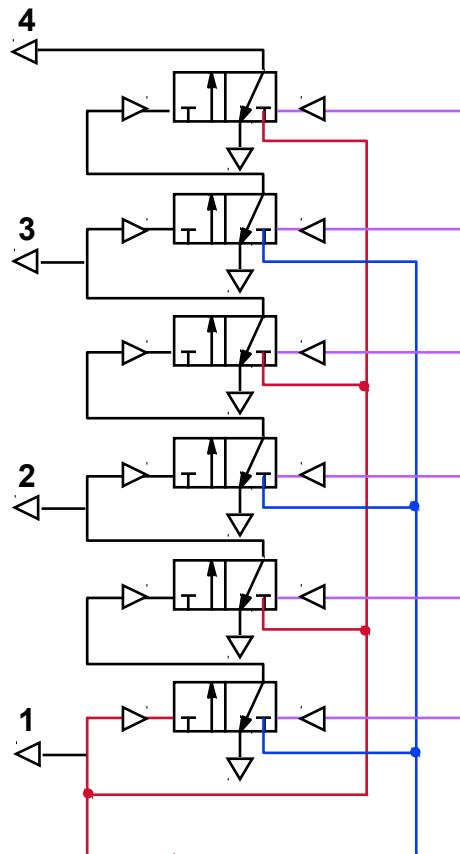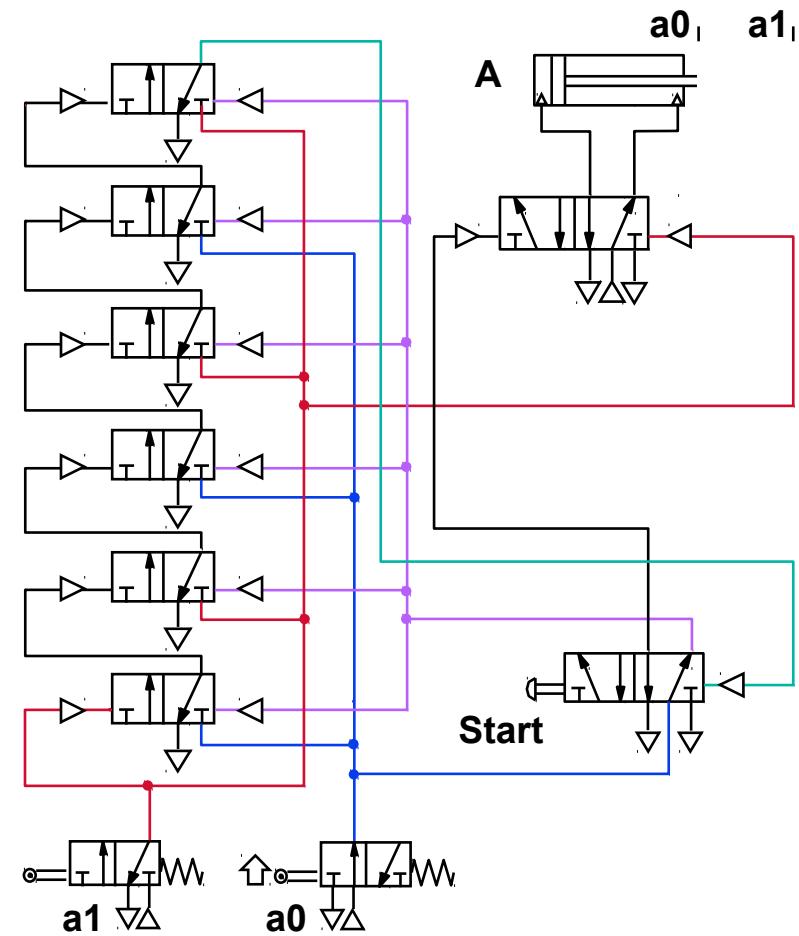- **Ensure the tube size to the cylinder is large enough to take the double flow**

NORGREN

Counting

- **Counting applications are best achieved with electro-mechanical or programmable electronic counters**

- **Pneumatic counting circuits use large numbers of logic valves and can be slow**

- **The counting chain shown will count to 4**

- **Red and blue are non-overlapping alternate pulses, purple is the reset line**

NORGREN

Counting application

- **The counting circuit is applied to count 4 strokes of a cylinder**

- **At rest all counting valves are held reset by the start valve**

- **Start outstrokes 'A'**

- **Alternate signals from 'a1' and 'a0' progresses operation of the counting valves up the chain**

- **On the 4th operation of 'a1' the green signal resets the start valve to stop the cylinder**
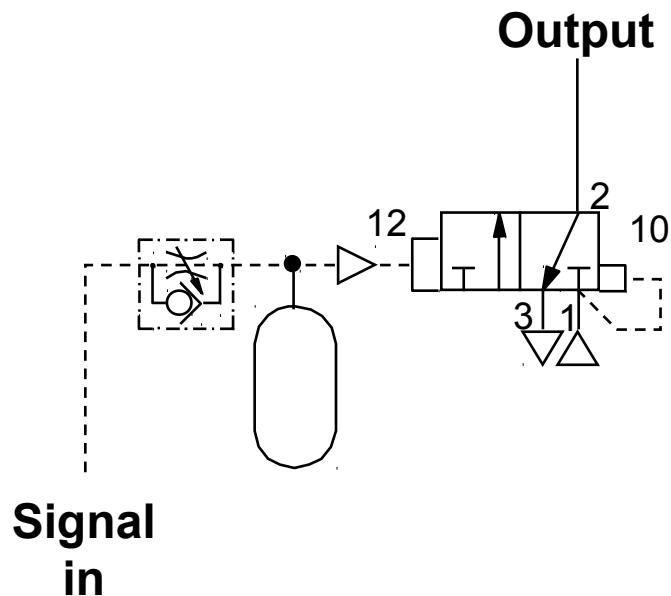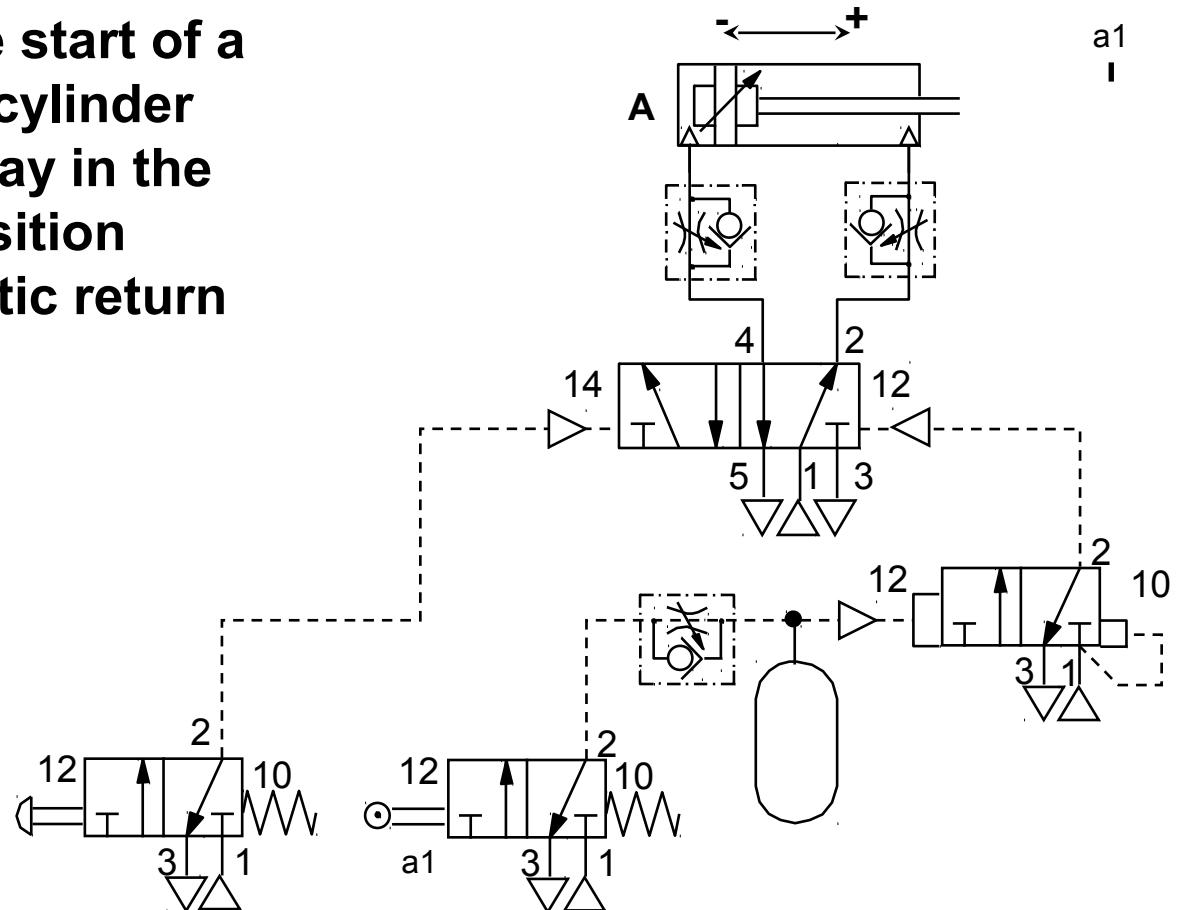
Feedback methods

Time delay

- **A signal is restricted to slow the rate of pressure build up on a pressure switch (3/2 differential pressure operated valve)**

- **When the pressure switch operates a strong un-restricted output is given**

- **A reservoir provides capacitance to allow less fine and sensitive settings on the flow regulator making it easy to adjust**
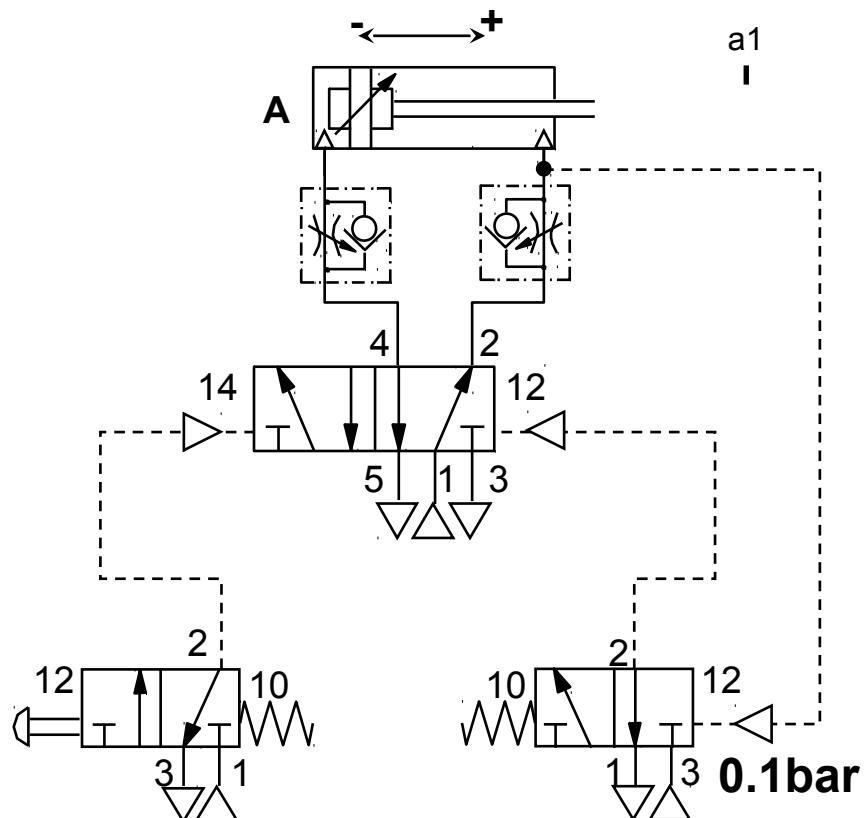
Output

12

2

10

3 1

Signal in

NORGREN

Time delay

- **Manual remote start of a double acting cylinder with a time delay in the outstroked position before automatic return**
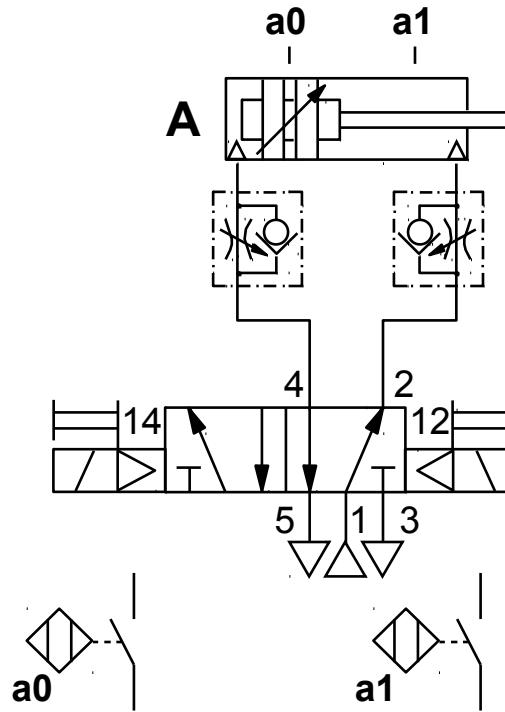
Pressure decay

- **Manual remote start of a double acting cylinder**
- **Uses a low pressure operated valve connected normally open**
- **When the back pressure in the front of the cylinder falls below 0.1 bar the return signal is given**
- **Connection taken between the cylinder and flow regulator**
- **Useful for pressing work pieces of variable size**

Electro-pneumatic

- The majority of systems use electrical/electronic control due to the high degree of sophistication and flexibility

- Solenoid valves are used to control cylinders

- Feedback signals are from reed switches, sensors and electrical limit switches

- Logic is hard wired or programmed in to a PLC (programmable logic controller)

- Circuit building block for each cylinder

End