

# STUDENT FEEDBACK FORM

**Student:** Tomas Griffiths

**Assessment:** Pneumatics and Hydraulics 2

**Course:** HNC Instrumentation Engineering

This section details the *extent* to which the assessment criteria are demonstrated by you, which in turn determines your mark. The marks available for each category of skill are shown. Lecturers will use the space provided to comment on the achievement of the task(s), including those areas in which you have performed well and areas that would benefit from development/improvement.

| Generic Assessment Criteria                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Marks available | Marks awarded |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|---------------|
| <b>1. Engagement with Literature Skills</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                 |               |
| Engagement with a wide range of independently sourced literature from internet and books.<br>Selection of relevant and credible sources.<br><br>Harvard referencing system applied to a good standard – well done for incorporating this since the previous assignment.                                                                                                                                                                                                                                                                                                                                                                      | 20              | 14            |
| <b>2. Knowledge and Understanding Skills</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                 |               |
| Competent knowledge of the basic underlying concepts of fluid power device construction and operation.<br><br>Exhibits very good understanding and is able to explain gathered knowledge well.<br><br>Good use of sectional component images and well explained circuit diagrams.<br><br>Used figures are referred to in the writing.<br><br>Calculations are mostly correct and a good level of understanding is demonstrated, one small error as highlighted in the marking has resulted in a couple of incorrect results.<br><br>Good interpretation of circuits and how the pressures and various operations relate to circuit behaviour | 50              | 33            |
| <b>3. Cognitive and Intellectual Skills</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                 |               |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 0               |               |
| <b>4. Practical Application Skills</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                 |               |
| Able to interpret requirements of system design, build effective solutions and problem solve.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 20              | 14            |
| <b>5. Transferable Skills for Life and Professional Practice</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                 |               |
| Work is accurate, coherent, fluent, well-structured and organised.<br><br>Work is relevantly linked to current employment and legislation.<br><br>Report presentation has improved since previous assignment – well done, but there is more to improve on.                                                                                                                                                                                                                                                                                                                                                                                   | 10              | 6             |

**Assessment Mark** (Assessment marks are subject to ratification at the Exam Board. These comments and marks are to give feedback on module work and are for guidance only until they are confirmed. )

**Late Submission Penalties (tick if appropriate)**

Up to 1 week late (40% Max)

Over 1 week late (0%)

**67 %**

# Tomas Griffiths Assignment 2

*by* Tomas Griffiths

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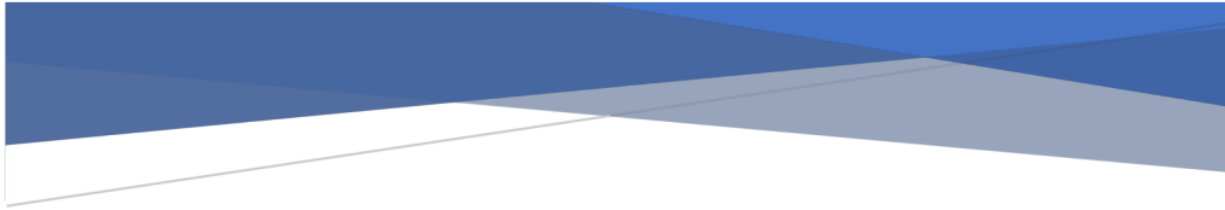
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**Word count:** 3131

**Character count:** 16104



*67% overall grade*

# PNEUMATICS & HYDRAULICS ACTUATORS AND DESIGN

HNC Instrumentation Engineering

Pneumatics and Hydraulics

PCEE4010

Tomas Griffiths

*\* 'Assignment 2' on the cover page would be useful \**

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## Introduction

This assignment will give an insight of the key aspects of pneumatics and hydraulics actuators along with the designing of systems. The assignment will cover the construction of linear and rotary actuators, speed calculations and system design. This will be done through calculations, research and design work.

## Task 1 – Actuator Construction and Operation

Produce a report explaining the construction and operation of the following types of actuators:

- Linear
- Rotary

Linear actuators are used to turn electric, pneumatic, and hydraulic energy into a push-and-pull motion or linear movement that has a control signal that can be manual or by an automatic control system. One type of linear actuator that can be used for a hydraulic application is a double acting linear actuator. If an application needs to move in two directions and need to have full control, it's best to have a double acting linear hydraulic actuator. (VComp Inc, 2017). An example of where a hydraulic double acting linear actuator is used, is at a refinery which has an FCCU, where hydraulic actuated valves are used to finely control the level of catalyst within 2 vessels, the valve is typically controlled automatically but in certain cases can be put into manual and controlled via the local hydraulic skid. Most equipment found in food and beverage factories require a straight motion to move the products around and use linear actuated valves to control the flow of raw materials and finished products. (JR., 2021). As seen in figure 1 the double acting actuator works by applying hydraulic fluid at pressure onto either the extend side, retract side or both lines if a certain position of the rod is needed. This can be done quickly, if required, or very gradually with precise control. The faster and predictable retraction of double acting cylinders makes them the better choice for applications that need repeatable accuracy. Double acting actuators typically use 2-, 3-, 4- or 5-way valves to allow the operator to change the position of the actuator to suite. (Enerpac, 2021). When compared to a single acting actuator, because the double acting actuator has a retract line this allows more control of the piston and rod during retraction and ensures it always returns back to its original starting position whereas a single acting actuator with spring return may become less effective over time and not fully retract back to its original position. Due to the surface area of the piston being smaller because of the rod taking up room on the retract side of the actuator, it will be slightly slower at retracting when compared to extending. The downfall to using a double acting actuator is that the piston seal as seen in figure 1 could potentially fail losing control and accuracy of the actuator.

True

Good example

How precise can the movement be?

What can be done to balance the cylinder?

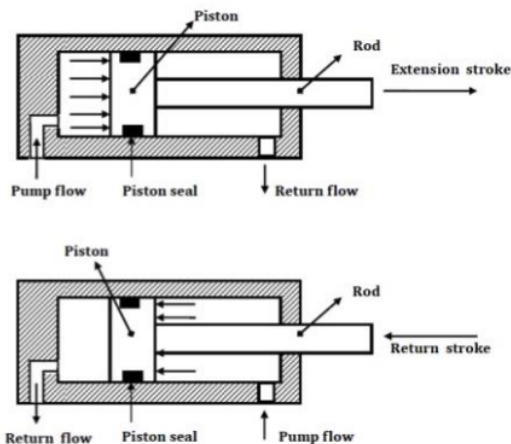
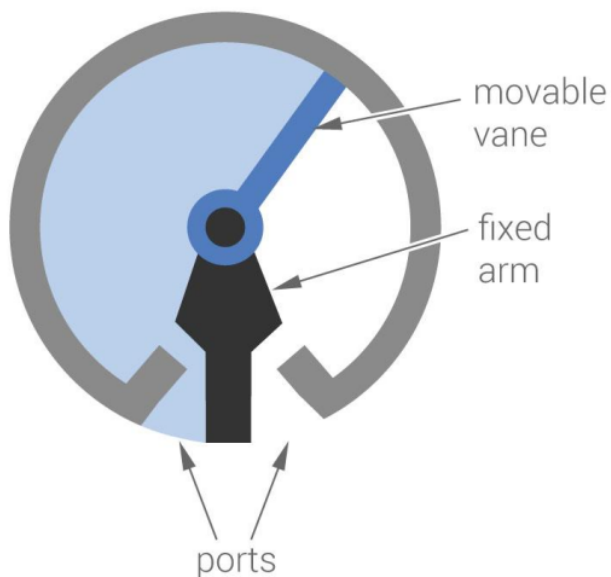


Figure 1 - Shows a double acting actuator (VComp Inc, 2017)

Clear diagram with correct figure labelling and in-text referencing.  
Page 3 of 23

Rotary actuators are used for rotary actuation for equipment such as a machinery hydraulic ram. Rotary actuators are essentially the hydraulic or pneumatic versions of electric motors. For its compact size a hydraulic rotary actuator gives more power and torque than a pneumatic rotary actuator. One type of a rotary actuator is a hydraulic or pneumatic rotary vane actuator which uses one or two vanes attached to a hub within either a wedge-shaped housing or a circular housing that can move between 90 degrees and 280 degrees. (Thomas.Net, 2019). Figure 2 shows a simple version of a single vane rotary actuator. As seen in figure 2, hydraulic fluid or pneumatic air would be directed by either a 2-,3-,4- or 5-way valve into either one of the ports depending on what direction is wanted by the operator and the vane arm would move a ram to the point needed. When the direction of the ram is needed to be changed then pressure would be relieved from one input port and more pressure would be sent onto the other port.

*Detailed construction and operation*



*Good simplified diagram to illustrate the theory, an image of the physical device would be good also.*

*Figure 2 - Shows a simple diagram of a hydraulic vane rotary actuator (Parikh, 2019)*

## Task 2 – Actuator Calculations

A double acting hydraulic cylinder has a bore diameter  $D$ . The rod diameter is 50mm and the stroke length is  $S$ . The rod must produce a pushing force of 30kN. The flow rate available in both directions is  $Q$ .

Calculate:

$$D = 120\text{mm} = 0.12\text{m}$$

$$RD = 50\text{mm} = 0.05\text{m}$$

$$S = 110\text{mm} = 0.11\text{m}$$

$$Q = 12\text{dm}^3/\text{min} \quad (1\text{dm}^3 = 1\text{Ltr} = 1\text{Kg})$$

$$\text{Pushing Force} = 30\text{kN}$$

- a) The system pressure needed.

$$P = \frac{F}{A}$$

$$\frac{30 \times 10^3}{\left(\frac{\pi \times 0.12^2}{4}\right)} = 2.65 \times 10^6$$

$$= 2.65\text{MPa} \quad \square$$

- b) The force with which it pulls given the same pressure.

$$F = P \times A$$

$$F = 2.65 \times 10^6 \times \left(\frac{\pi \times 0.12^2}{4} - \frac{\pi \times 0.05^2}{4}\right)$$

$$F = 24.77 \times 10^3$$

$$F = 24.77\text{kN}$$

$\square$

c) The time taken to extend fully.

$$Speed = \frac{Distance}{Time}$$

$$110mm = 0.11m$$

$$120mm = 0.12m$$

$$\begin{aligned} Volume &= \frac{\pi \times 0.12^2}{4} \times 0.11 \\ &= 1.244 \times 10^{-3} \\ &= 1.244 \text{Ltrs or } dm^3 \end{aligned}$$

$$\begin{aligned} \frac{Q}{V} &= \frac{12dm^3/min}{1.244dm^3/min} \\ &= 9.646 \end{aligned}$$

$$\begin{aligned} \frac{V}{Q} &= \frac{1.244}{12} \\ &= 0.1036 \times 60 \\ &= 6.22 \text{ seconds} \end{aligned}$$

□

d) The velocity on the outward stroke.

$$\begin{aligned} Speed &= \frac{Distance}{Time} \\ &= \frac{0.11}{6.22} \\ &= 0.0177m/s \end{aligned}$$

□

e) The time taken to retract fully.

$$\begin{aligned} \text{Volume} &= \frac{\pi \times 0.12^2}{4} \times 0.11 \\ &= 1.244 \times 10^{-3} \\ &= 1.244 \text{Ltrs or } dm^3 \end{aligned}$$

$$\begin{aligned} \text{Area} &= \frac{\pi \times 0.05^2}{4} \\ &= 1.963 \times 10^{-3} \\ &= 0.00196m^2 \end{aligned}$$

*You have not accounted for the rod volume. You have taken rod AREA away from cylinder volume. You should have noticed that your volumes, times and velocities for extension and retraction are incredibly similar. There would be a significant difference due to the change in oil volume required to fill both sides of the cylinder.*

$$\begin{aligned} \text{Volume} - \text{Area} &= 1.244 - 0.00196 \\ &= 1.242 \text{Ltrs} \end{aligned}$$

*6.22 seconds is correct for extension, It should be 5.14s for retraction.*

$$\begin{aligned} \frac{\text{Volume}}{\text{Flow Rate}} &= \frac{1.242}{12} \\ &= 0.1035 \times 60 \\ &= 6.21 \text{ seconds} \end{aligned}$$

f) The velocity on the inward stroke.

$$\begin{aligned} \text{Speed} &= \frac{\text{Distance}}{\text{Time}} \\ &= \frac{0.11}{6.21} \\ &= 0.0177m/s \end{aligned}$$

g) The power transmitted on the outstroke.

$$Power = \frac{Work}{Time}$$

$$Work = Force \times Distance$$

$$= 30kN \times 0.11$$

$$= 3300J$$

$$Power = \frac{Work}{Time}$$

$$= \frac{3300}{6.22}$$

$$= 530.54 \text{ Watts}$$

□

*Majority of calculation results are correct*

### Task 3 – Circuit Analysis

Figure 3 shows the circuit diagram of an electro-pneumatic system:

Produce a report explaining the full operation of the system include reference to each component. As part of the report include an explanation of the construction and operation of a relay.

*System supply pressure: 10bar*

*PS1 switching pressure: 9bar*

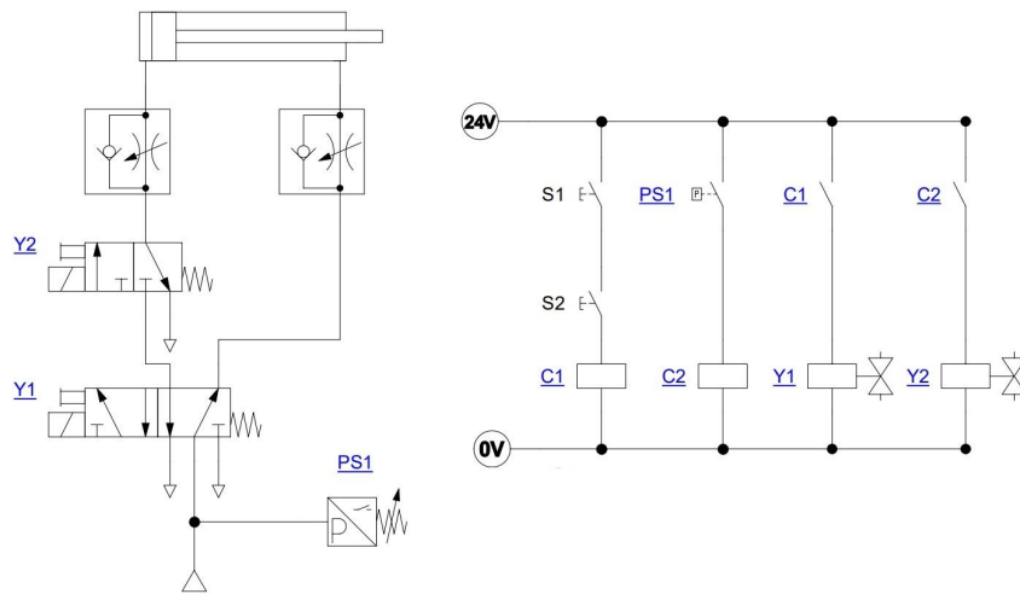


Figure 3 - Shows the electro-pneumatic system circuit diagram

Figure 3 Shows the electro-pneumatic system and circuit diagram. The components found within the electro-pneumatic system are a double acting actuator connected to a flow restriction that has non-return valves built in on the extend and retract of the actuator. The flow restrictions are to prevent a massive surge of pressure rushing into the actuator causing it to open too quick and damage the cylinder. The extend line of the actuator has a 3/2-way valve with a solenoid, push button and spring return feature. Both the extend and retract lines of the actuator ultimate connect up to a 5/2-way valve again with a solenoid, push button and spring return feature. The 10bar supply pressure/source is found at the bottom of the drawing with a pressure switch that switches at 9bar just above the source outlet.

*Good description of overall system construction*

On the 24V circuit diagram moving from left to right the first set of electrical components are S1 and S2 which are Normally-Open push buttons. Below them is C1 which is a Coil that once energised closes the Normally-Open contact C1. Moving onto the next line, a Normally-Open pressure switch PS1 can be found, this closes when a 9bar pressure from the pressure switch PS1 has been achieved. The next component on that line is C2 which is a coil that once energised closes the Normally-Open

contact C2. The next line contains Normally-Open contact C1 and Solenoid Operated Valve Y1. The final line contains Normally-Open contact C2 and Solenoid Operated Valve Y2.

The operation of the circuit starts off with the compressor being started up so that a constant air supply is to be maintained. This will give a constant 10bar air supply to the system. The pneumatic circuit starts off with the actuator having air on the retract side meaning that the cylinder rod is not extended. Once the lines have been pressured up and the circuit has built up to a pressure of 9bar, the pressure switch (PS1) will close its contact and energise the coil C2 closing the Normally-Open contact C2. Upon Normally-Open contact C2 closing Solenoid Operated Valve Y2 will energise and move the position of the 3/2-way valve so that when an air supply is put onto the inlet of the valve the actuator will extend fully (this will only happen if the 5/2-way valve is in the correct position). For this system to work the operator needs to use both hands to close the Normally-Open contacts S1 and S2, this is designed this way so that it acts as a safety feature so that if the operator had to release their hands then the actuator will automatically retract. So, when the manual Normally-Open push button contacts S1 and S2 are closed, this will energise the coil C1 closing the Normally-Open contact C1. Upon Normally-Open contact C1 closing Solenoid Operated Valve Y1 will energise and move the position of the 5/2-way valve applying air through the 3/2-way valve and onto the extend of the actuator. If the operator at any point releases either S1 or S2 then Normally-Open contact C1 will open, causing Y1 to lose its power, which in return will make the 5/2-way valve switch back to its original position blocking off the air to the actuator extend line. If a leak within the system occurs and the system pressure drops below 9bar then the pressure switch contact PS1 will open causing Normally-Open contact C2 to open dropping off power on Y2 which will cause the 3/2-way valve to revert back to its original position and not allow the air to be applied on the extend line of the actuator.

*Two hand operation identified along with potential hazard*

*Clear description of operation*

A relay is used in many electrical circuits. Many industries such as the oil and gas industry use relays as part of their control system. Before PLC's were made, relay banks were used to carry out the same job as a PLC would. In an electrical circuit a relay is used where it is not possible to have a direct electrical connection between the control circuit and the electrical components. A relay is a type of electrical switch turned on and off by an electromagnet. When a current is passed through the coil, an electromagnetic field is set up. The field attracts an iron armature, whose other end pushes the contacts together, completing the circuit. When the current is switched off, the contacts open again, switching the circuit off. (Bitesize Author, 2020).

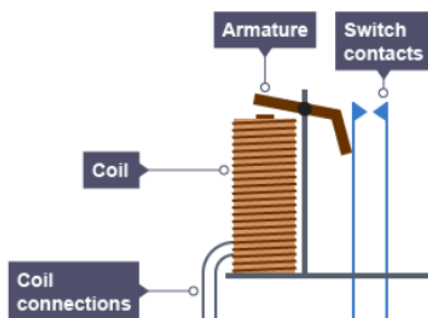


Figure 4 - Shows a diagram of a relay (Bitesize Author, 2020)

*A concise explanation of a relay accompanied by a clear diagram.*

## Task 4 – Circuit Design

Your employer has tasked you with designing two fluid power circuits to meet the following requirements for use within a production facility. Produce the electro-pneumatic and hydraulic circuit diagrams using Automation Studio and provide a detailed account of each system's operation.

- A) At the end of a conveyor section, boxes are to be detected then lifted by a pneumatic cylinder, then pushed onto a second conveyor by a second cylinder. On this installation it is vital that the second cylinder should not return until the first one has fully retracted.

Using figure 5 to explain the electro-pneumatic system and circuit diagram, the components found within the electro-pneumatic system are 2 single acting actuators with spring return, both of these actuators have limit switches (SW1, SW2, SW3, SW4) that switch contacts within the circuit diagram (C1, C2). Both of these actuators are connected to their own individual 3/2-way valves that carry out the action for both individual actuators. On both of the 3/2-way valves are pneumatic pilots and solenoids used to change the direction of the valve upon command.

On the 24V circuit diagram moving from left to right the first set of electrical components are Normally-Open manual push button C1 and coil C1 that when energised closes Normally-Open contact C1. Moving onto the next line, Normally-Open contact C1 can be found, this closes when the coil C1 has been energised, when closed this applies a voltage onto the solenoid S1 switching the 3/2-way valve for cylinder 1. The next line contains Normally-Open limit switch contact SW1 which operates when the cylinder 1 rod hit its limit switch contact, when the contact has been made this will apply power onto coil C2 causing Normally-Open contact C2 to close. The next line contains Normally-Open contact C2 which when closed gives power to solenoid S3 switching the 3/2-way valve for cylinder 2. On the next line is Normally-Open limit switch contact SW2 which operates when the cylinder 2 rod hit its limit switch contact, when the contact has been made this will apply power onto solenoid S2 switching the 3/2-way valve for cylinder 1. The final line in the circuit diagram contains Normally-Closed limit switch contact SW4 which operates when the cylinder 1 rod retracts fully and hits its limit switch contact, when the contact has been made this will apply power onto solenoid S4 switching the 3/2-way valve for cylinder 2 so that it returns to its original position.

*Detailed descriptions of circuit operation*

The static position of the system can be seen below in figure 5, this is before the operator has utilised the push button contact C1.

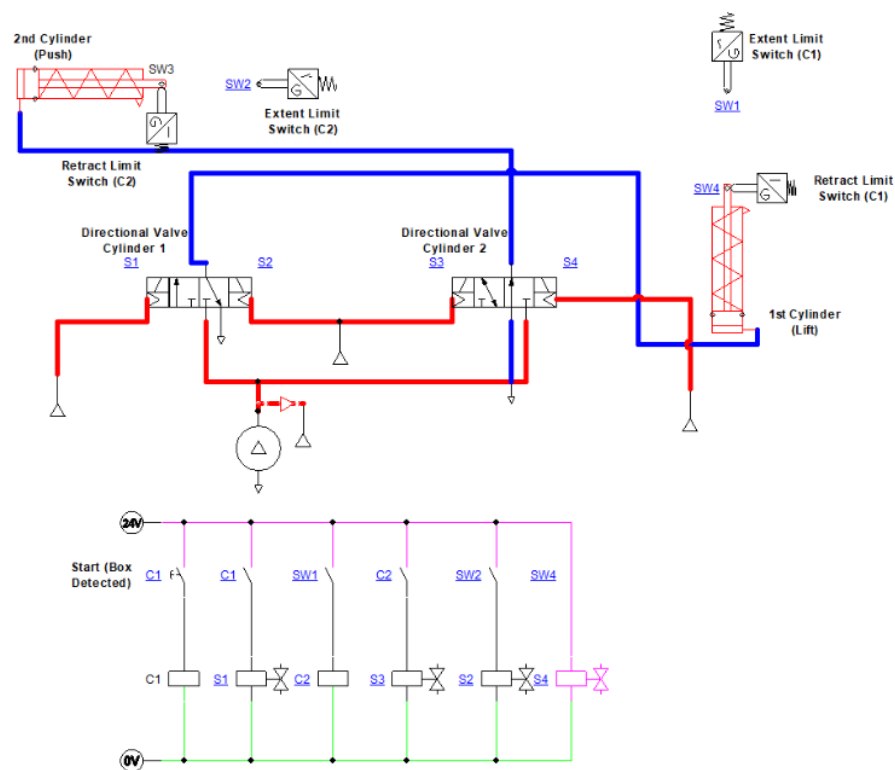


Figure 5 - Shows the conveyor circuit static

The operation of this circuit begins when the operator presses the push button C1. This will apply voltage onto the coil C1 closing the Normally-Open contact C1. Once C1 contact is closed this will energise the solenoid S1 causing the 3/2-way directional control valve for cylinder 1 to change allowing air onto the actuator. This can be seen in figure 6. Once the air has entered the actuator and caused cylinder 1 to fully extend this causes limit switch SW1 to cause the Normally-Open contact SW1 to close allowing voltage onto coil C2. This then closes the Normally-Open contact C2 applying voltage onto the Solenoid S3.

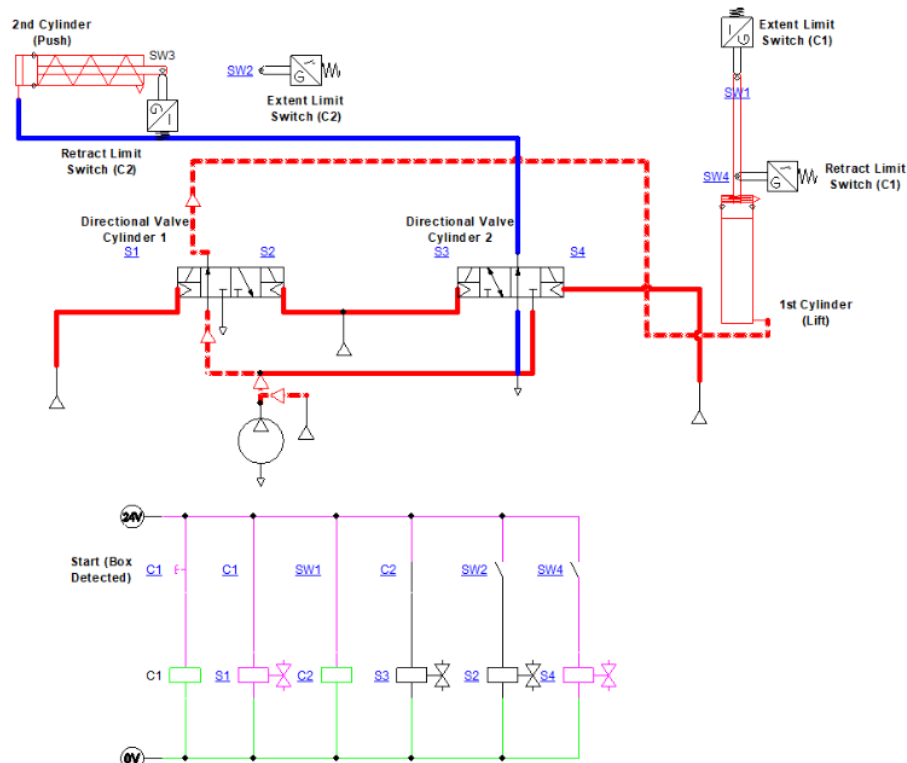


Figure 6 - Shows the 1st cylinder in operation

Various stages of operation clearly shown

Once solenoid S3 has been energised, this switches the position of the 3/2-way valve for cylinder 2 applying air onto its actuator. This can be seen in figure 7. Once the air has entered the actuator and caused cylinder 2 to fully extend this causes limit switch SW2 to cause the Normally-Open contact SW2 to close allowing voltage onto solenoid S2. This will switch the position of the 3/2-way valve for cylinder 1 blocking off air to its actuator.

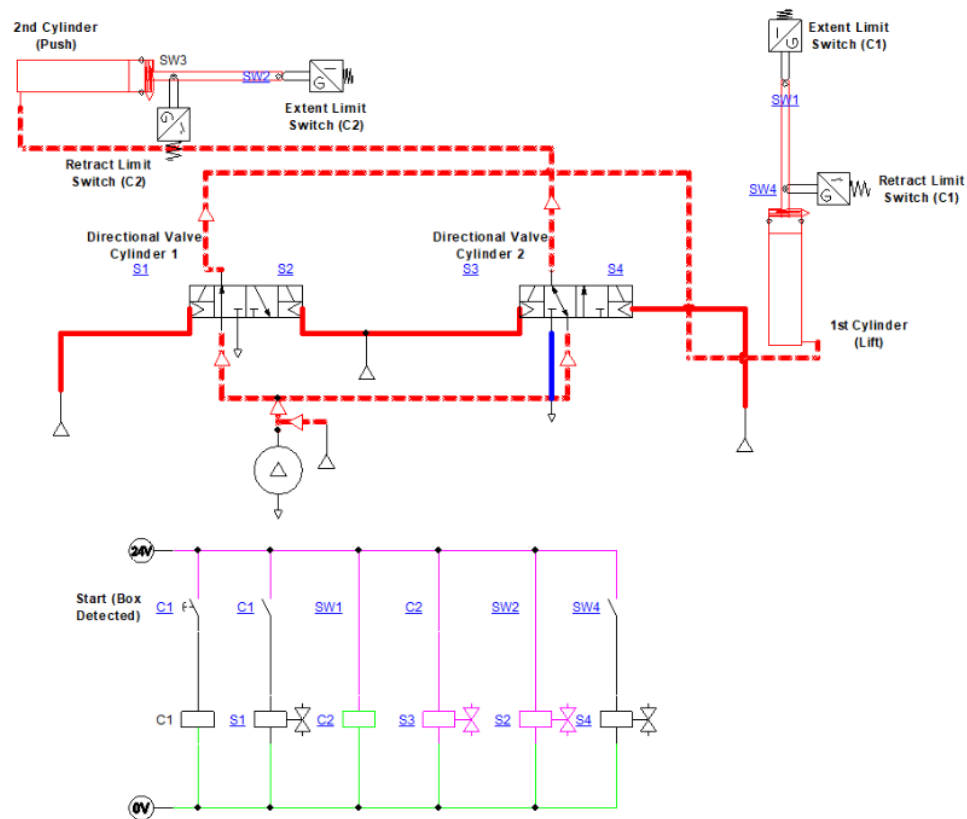


Figure 7 - Shows both the 1<sup>st</sup> and 2<sup>nd</sup> cylinders in operation

Once the air has fully vented off from cylinder 1 as shown in figure 8, this hits limit switch SW4 causing the Normally-Closed contact SW4 to close applying voltage onto solenoid S4. SW4 is there to ensure that cylinder 2 will not retract before cylinder 1 has hit the switch limit.

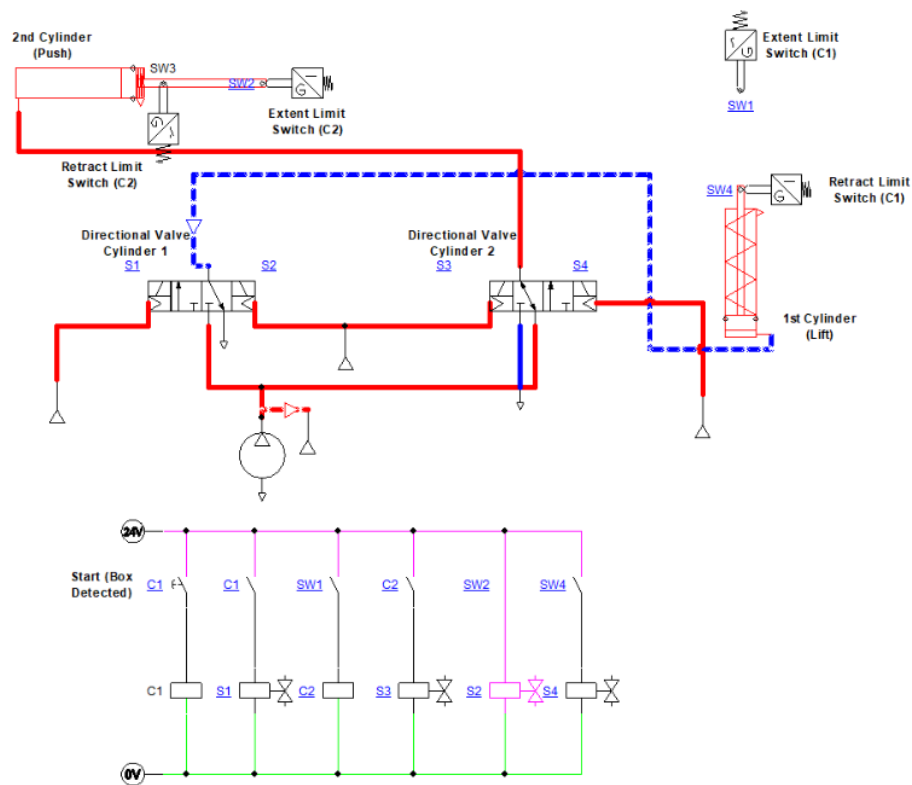


Figure 8 - Shows the 1st cylinder retracting after lifting

Once the solenoid has been energised this will switch the 3/2-way valve position for cylinder 2 blocking off air to its actuator which will cause the cylinder to retract. Once the 2<sup>nd</sup> cylinder has fully retracted the operation has been completed until the operator presses the Normally-Open push button C1 again.

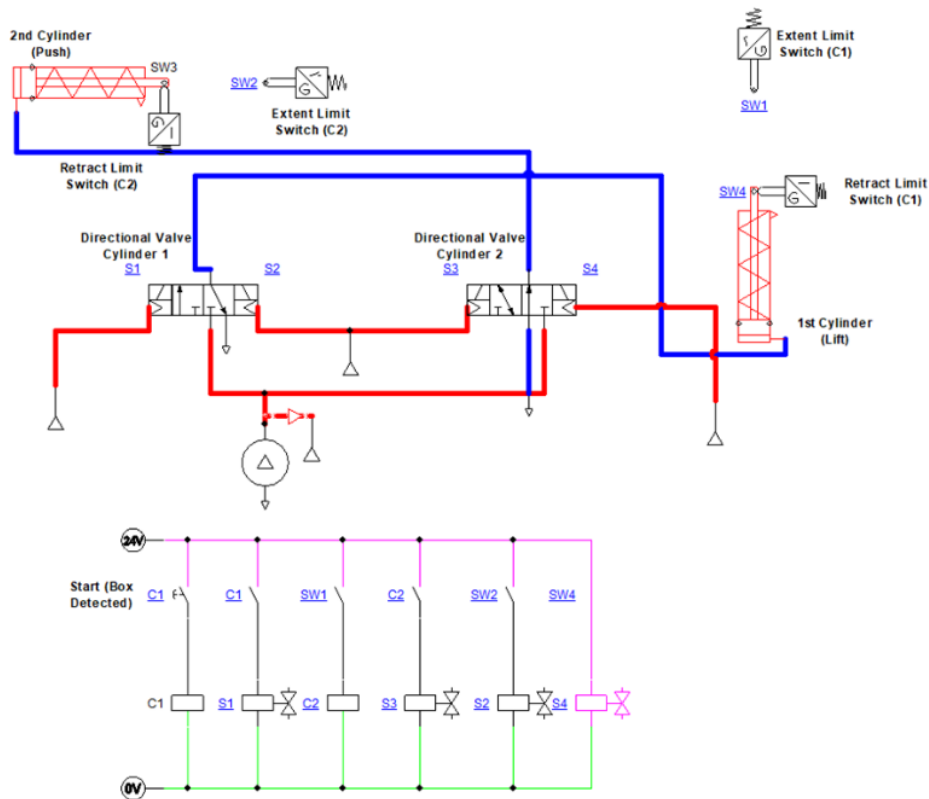


Figure 9 - Shows the conveyor system after completing its task

- B) A set of three hydraulic cylinders are used in sequential operation to clamp a steel plate in position. After clamping, a pair of cylinders fold the steel plate into the required shape.

Figure 10 shows the clamp and folding system in a static position. Once the 3/2-way valve moves position then the operation will begin.

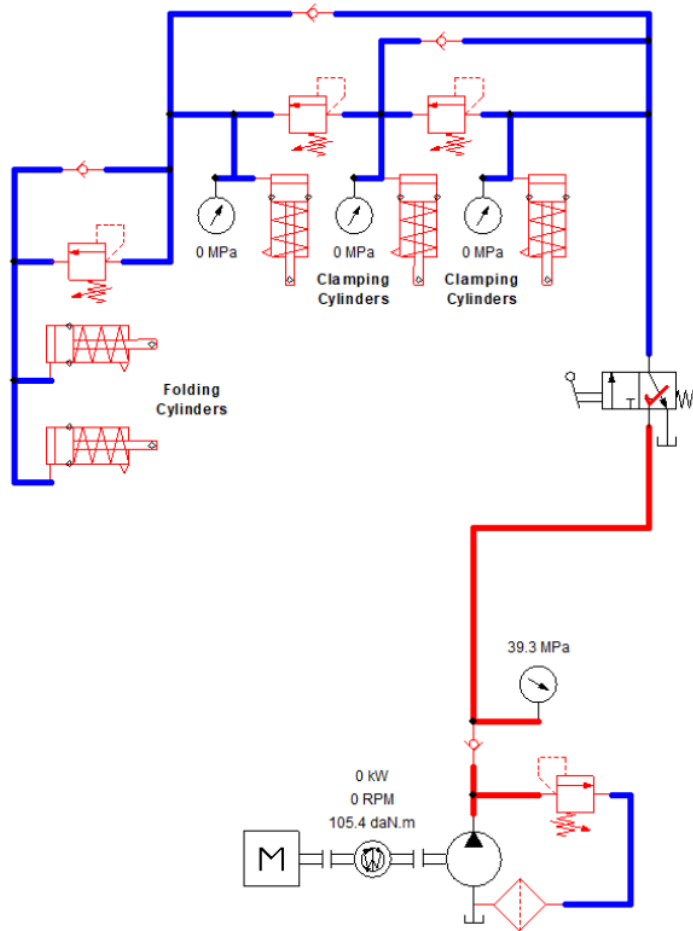


Figure 10 - Shows the clamping and folding circuit static

Once the 3/2-way valve has moved its position to allow hydraulic fluid into the system the sequence of operation begins. As seen in figure 11, the pressure of the hydraulic fluid fully extends the 1<sup>st</sup> clamping cylinder in sequence. Non-return valves can be seen fitted into the line to stop the hydraulic fluid from extending any of the other actuators as this will ruin the sequence of operation.

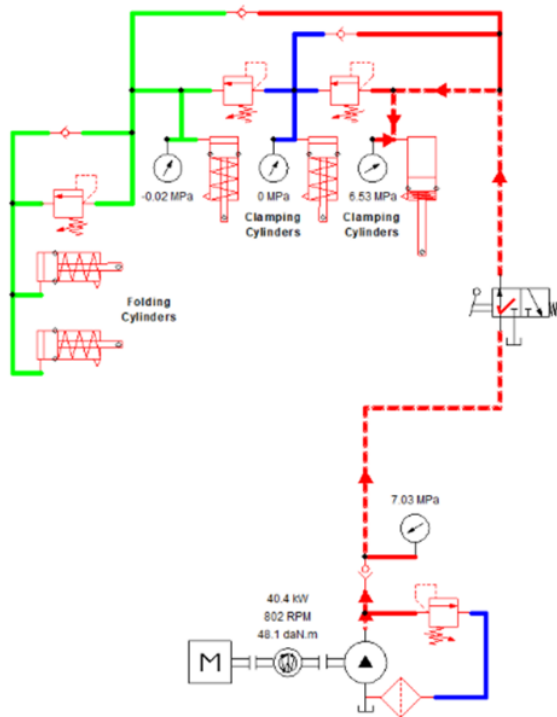


Figure 11 - Shows the 1<sup>st</sup> clamping cylinder in operation

Once the system pressure has built up enough, the variable pressure relief valve lifts allowing hydraulic fluid into the 2<sup>nd</sup> cylinder. This can be seen in figure 12. Each relief valve has been set to a specific relief pressure so that the actuators extend at certain pressures.

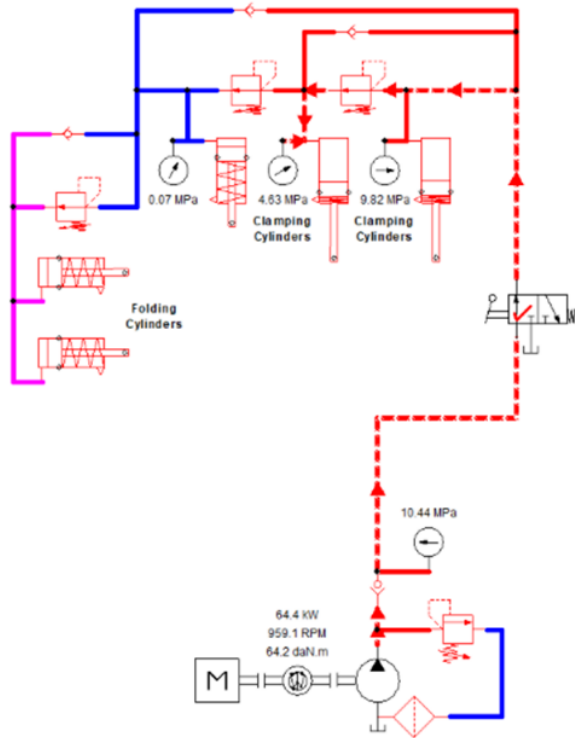


Figure 12 - Shows the 2nd clamping cylinder in operation

Again, once enough pressure has built up within the system, the hydraulic fluid will pass through the variable pressure relief valve and extend the 3<sup>rd</sup> clamping cylinder. This can be seen in figure 13.

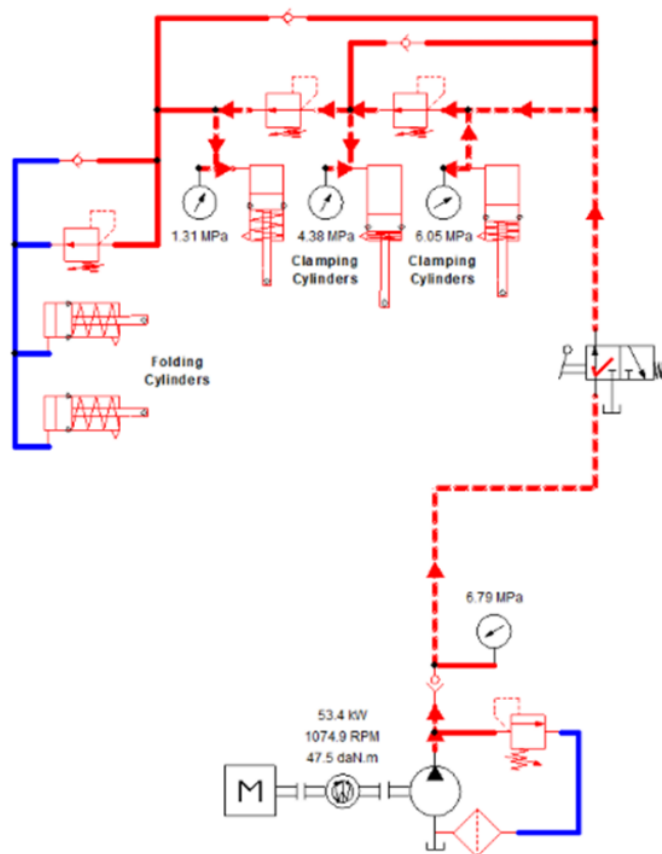


Figure 13 - Shows the 3rd clamping cylinder in operation

Finally once the 3<sup>rd</sup> cylinder has fully extended and enough pressure has built up within the system, the final variable pressure relief valve will allow the hydraulic fluid into both the folding cylinder. Both these cylinders extend at the same time which can be seen in figure 14.

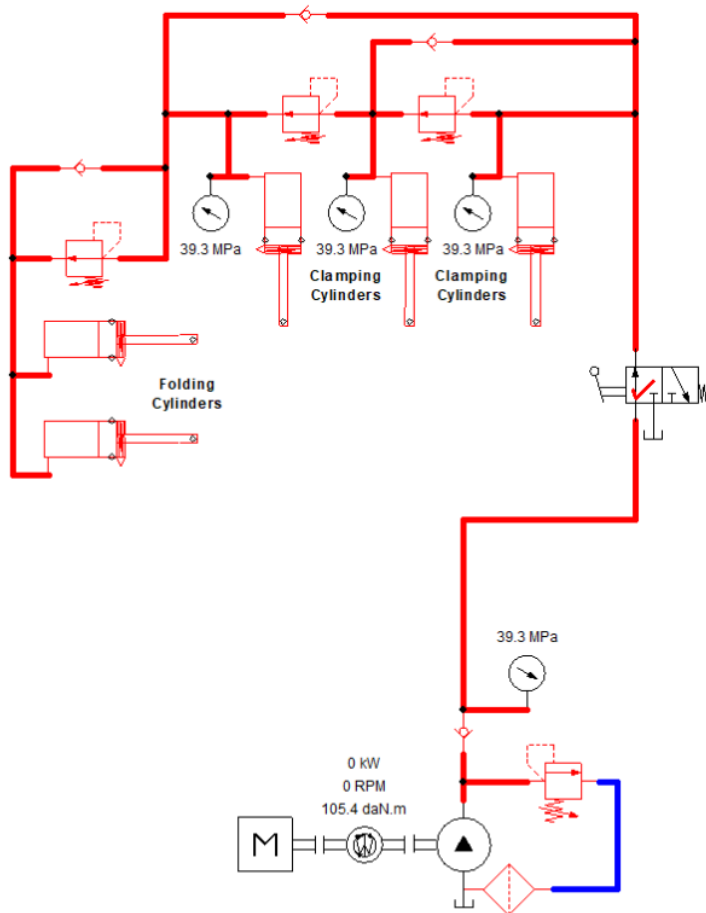


Figure 14 - Shows the folding cylinders fully extended

*A useful view of the circuit under maximum operating pressure.*

Once the folding operation has been completed and the hydraulic fluid is allowed to drain back to the tank via the 3/2-way control valve, all cylinders retract at the same time. This is done by having non-return valves fitted into the line so that it only allows hydraulic fluid to return to the tank and not pressure up the system straight away ruining the cylinder sequencing operation. This can be seen in figure 15.

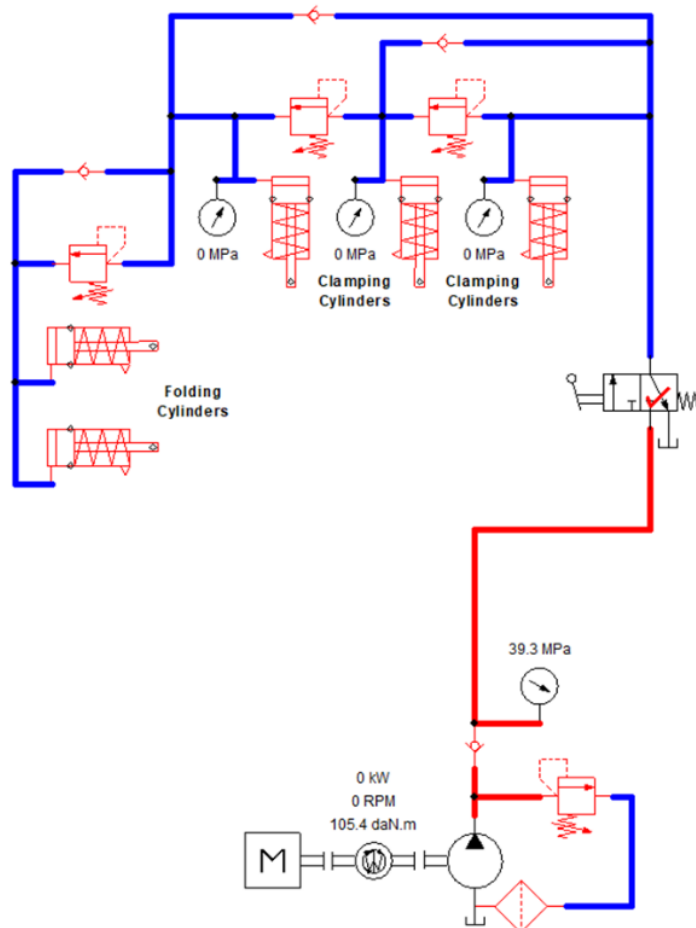


Figure 15 - Shows the system after the clamp and folding operation has taken place and the system is drained back to tank

(Correct operation of both circuits observed in simulation lab - JM)

Well populated reference list that links to the main body.

## References

Bitesize Author, 2020. *BBC Bitesize*. [Online]

Available at: <https://www.bbc.co.uk/bitesize/guides/zcgkp39/revision/6>

[Accessed 19 05 2022].

Enerpac, 2021. *Enerpac*. [Online]

Available at: <https://blog.enerpac.com/single-acting-vs-double-acting-hydraulic-cylinders/#:~:text=In%20a%20double%20acting%20hydraulic,very%20gradually%20with%20precise%20control>

[Accessed 20 05 2022].

JR., G. W., 2021. *Control Engineering*. [Online]

Available at: <https://www.controleng.com/articles/actuators-explained-types-of-actuators-application-choice-maintenance/>

[Accessed 18 05 2022].

Parikh, D., 2019. *Engineering Clicks*. [Online]

Available at: <https://www.engineeringclicks.com/hydraulic-actuators/>

[Accessed 20 05 2022].

Parr, A., 1998. Rotary Actuators. In: B. Ltd, ed. *Hydraulics and Pneumatics A technician's and engineers guide*. Oxford: Elsevier Butterworth-Heinemann, p. 244.

Thomas.Net, 2019. *Thomas.Net.com*. [Online]

Available at: <https://www.thomasnet.com/articles/machinery-tools-supplies/rotary-actuators/#:~:text=All%20About%20Rotary%20Actuators%20-%20Types%2C%20Applications%2C%20and,applications.%206%20More%20from%20Machinery%2C%20Tools%20%26%20Supplies?adlt=strict&toWww=1&redig>

[Accessed 20 05 2022].

Turner, I. C., 1996. Actuators. In: H. H. PLC, ed. *Engineering Applications of Pneumatics and Hydraulics*. London: Arnold, p. 165.

VComp Inc, 2017. *VComp Inc*. [Online]

Available at: <https://medium.com/@vcompmississaug/what-are-single-acting-double-acting-hydraulic-cylinders-817d6e6f30a8>

[Accessed 20 05 2022].

# Tomas Griffiths Assignment 2

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## GRADEMARK REPORT

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FINAL GRADE

GENERAL COMMENTS

Instructor

67 / 100

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PAGE 1

**Text Comment.** 67% overall grade

**Text Comment.** \* 'Assignment 2' on the cover page would be useful \*

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PAGE 2

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PAGE 3

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PAGE 4

**Text Comment.** True

**Text Comment.** Good example

**Text Comment.** How precise can the movement be?

**Text Comment.** What can be done to balance the cylinder?

**Text Comment.** Clear diagram with correct figure labelling and in-text referencing.

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PAGE 5

**Text Comment.** Detailed construction and operation

**Text Comment.** Good simplified diagram to illustrate the theory, an image of the physical device would be good also.

**Text Comment.** □

**Text Comment.** □

**Text Comment.** □

**Text Comment.** □

**Text Comment.** You have not accounted for the rod volume. You have taken rod AREA away from cylinder volume. You should have noticed that your volumes, times and velocities for extension and retraction are incredibly similar. There would be a significant difference due to the change in oil volume required to fill both sides of the cylinder.

**Text Comment.** 6.22 seconds is correct for extension, It should be 5.14s for retraction.

**Text Comment.** □

**Text Comment.** Majority of calculation results are correct

**Text Comment.** Good description of overall system construction

**Text Comment.** Two hand operation identified along with potential hazard

**Text Comment.** Clear description of operation

**Text Comment.** A concise explanation of a relay accompanied by a clear diagram.

**Text Comment.** Detailed descriptions of circuit operation

**Text Comment.** Various stages of operation clearly shown

**Text Comment.** A useful view of the circuit under maximum operating pressure.

**Text Comment.** (Correct operation of both circuits observed in simulation lab - JM)

**Text Comment.** Well populated reference list that links to the main body.