

LEVEL 4 ASSESSMENT SPECIFICATION

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Lecturer:	C. Williams	Internal Verifier:	R. Kadhim
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Submission method:	All written assessments, where practical and possible, must be submitted via Turnitin unless otherwise instructed by the Lecturer. (Please DO NOT put this assessment specification into Turnitin or it will match many similarities with other students' submissions.) Alternative submission method (if applicable): Late submission of the assessment will result in a late penalty mark. Penalties for late submission: Up to one-week late, maximum mark of 40%. Over one week late, 0%. Only the Extenuating Circumstances Panel may approve a change to submission dates.		
Academic honesty / referencing:	Academic honesty is required. In the main body of your submission you must give credit to authors on whose research and ideas your work is based. Append to your submission a reference list that indicates the books, articles, etc. that you have used, cited or quoted in order to complete this assessment.		

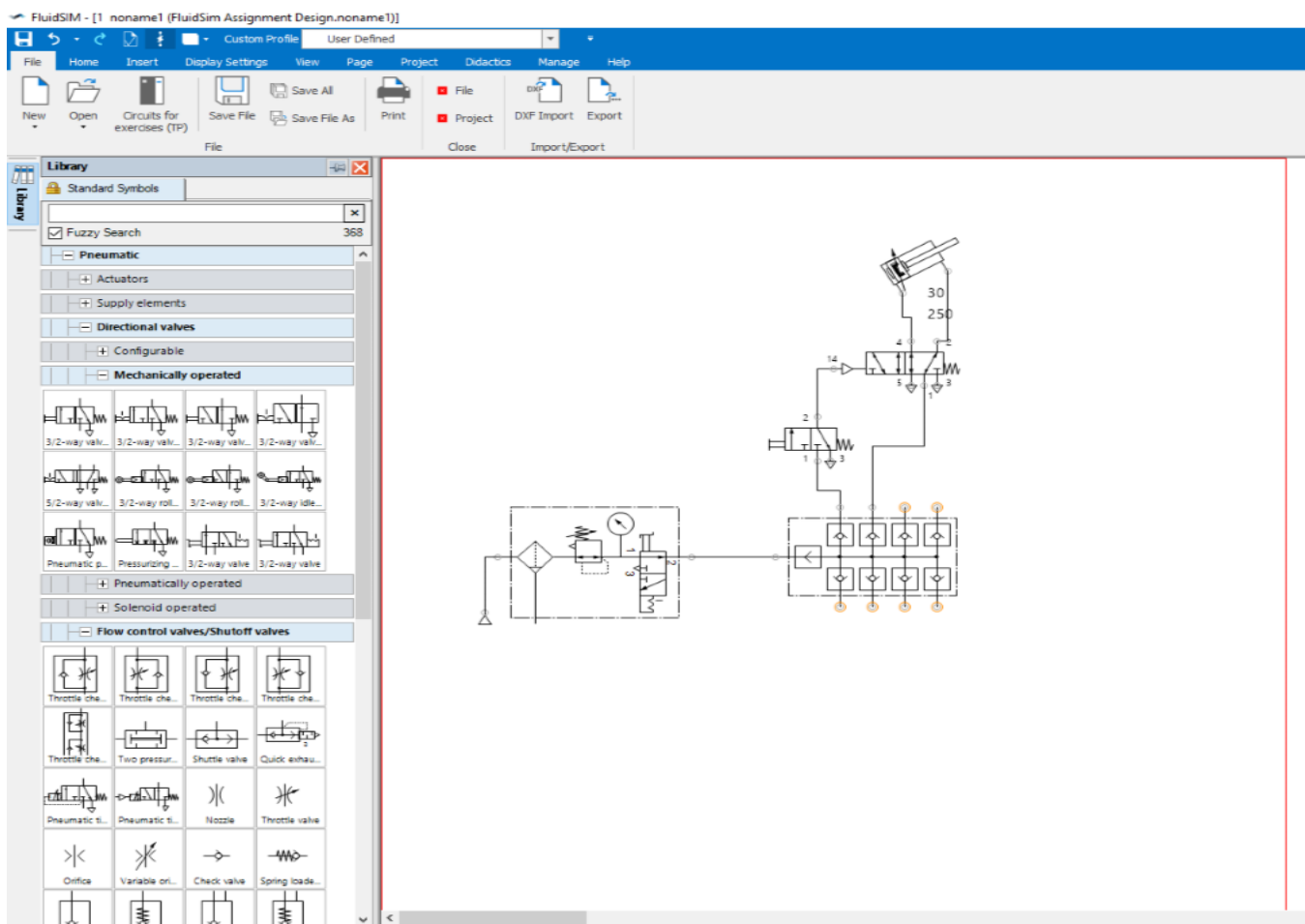
Table of Contents

Introduction	3
Circuit Design (Task 1)	3
Circuit Elements	3
Cylinder Calculation.....	7
Festo Cylinder Selection.....	8
Task 2.....	10
Design	10
System Function	10
System Locked.....	11
System Open – Pistons Extending.....	11
System Open – Pistons Returning.....	12
Circuit Time Delay	12
References.....	14

Introduction

This assignment will focus on the design and simulation of a pneumatic circuit, allowing me to apply my knowledge of pneumatic systems to develop and test a functional circuit. I will do this by using Fluidsim software, where I will set the system up with the correct operation and timing of individual cylinder actuation within the circuit. This will require me to take a thorough approach when creating my circuit simulations, all relevant calculations and my choice of cylinder selection. This assignment will allow me to express both my theoretical knowledge and practical skills in pneumatic system design and analysis.

Circuit Design (Task 1)



Circuit Elements

- **Compressed Air Supply** – This is the first component I added as this acts as the foundation to any pneumatics system, as it will provide all the components with the necessary pressurised air. Without a consistent air supply, the system simply would not work effectively. Research studies such as Jimenez. M state “double-acting pneumatic cylinders emphasise the necessity of

a stable compressed air source to ensure accurate actuator performance.” (Jiménez, Kurmyshev and Castañeda, 2020). When used in Fluidsim, this represents a real world compressor, ensuring all pneumatic valves and actuators can operate. By selecting this component, I am making sure that my pneumatic systems will be supplied with a consistent airflow ensuring system performance.



(MRC, 2025)

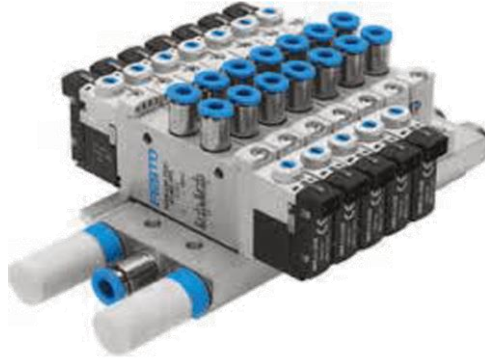
- **Start-up Valve** – A start-up valve will make sure that my pneumatic system has a smooth and controlled startup protecting in from any unnecessary damage caused by a sudden change in pressure. As stated by Gurvitz. R, “By including a soft start valve with the other primary air preparation devices, your pneumatic component will slow the air pressure integrated into the equipment. The valve will reduce the air cylinder speed and prevent them from slamming into the original position.” (Gurvitz, 2022). This means the system will be protect from any sudden air surges that could result in excessive wear of components. This is a very important part of a system as it acts as a protection device for all the elements, enhancing the systems reliability and longevity.



(RS Components, 2020c)

- **Manifold** – The manifold will distribute the pressurised air from a single source to multiple outputs (Festo, 2025c). In my system design, the manifold enables the air to be distributed through eight separate outputs, ensuring equal and efficient air distribution to all components connected. This gets rid of the need for multiple individual air supplies, not only reducing the

complexity of the design but also cutting down on the probability of component failure due to less elements being needed. Lastly, a correct sized manifold will eliminate any system pressure drops, allowing for optimal operation.



(Sun Source, 2025)

- **3/2 Way Valve with Pushbuttons** – The 3/2 way valve is made up of three ports (air inlet, outlet, and exhaust) and two positions, making it great for controlling single-acting cylinders (Festo, 2025). Due to the inclusion of a pushbutton actuator, it can be used for manual control of the system allowing the operator to start/stop airflow when needed. This component is vital for allowing operator control over system functions, particularly for applications where manual intervention is needed. Also, if a spring return mechanism is used, the valve will automatically reset when the button is released, providing extra safety and ease of use.



(Pustjens, 2023)

- **5/2 Way Valve, Pneumatically Operated** – A 5/2 valve is designed to control the functions of a double-acting cylinder. It has five ports (two for cylinder control, two for exhaust, and one for air supply) and two switching positions (Festo, 2025b). Instead of this component being manually operated, it switches positions based off the air signals rather than human input. This allows for automated control, making it very effective for sequential operations. It will direct

air follow to either side of the cylinder, allowing for extension and retracting of the piston, making it an integral part in automated systems.



(RS Components, 2020a)

- **Double Acting Cylinder** – A double-acting cylinder is a vital actuator in a pneumatics system, as it requires compressed air for both extension and retraction. This provides precise control of any movement, allowing it to be more versatile than a single-acting cylinder. The 5/2 way valve is generally used to alternate the airflow between the two ports, giving efficient and reliable extension and retraction of the piston. (Festo, 2025a)



(RS Components, 2020b)

Cylinder Calculation

In this section, I am going to be calculating the minimum piston diameter using formulas I have found using didactics on FluidSim and online from my research.

Calculating the Piston-Rod Diameter:

$$F_B = \mu_B \times m_m \times g \times \cos(\theta) \approx 0.19 \times 100 \times 9.81 \times \cos(30) \approx 161.42N$$

$$F_C = \mu_C \times m_m \times g \times \cos(\theta) \approx 0.13 \times 100 \times 9.81 \times \cos(30) \approx 110.44N$$

$$F_g = mg \times \sin(\theta) = (100 \times 9.81) \times \sin(30) = 490.5N$$

$$F_t = 161.42 + 490.5 = 651.92N$$

Minimum Piston-Rod Diameter:

$$F_{Piston} = P(\text{Pressure}) \times A(\text{Piston Cross sectional area})$$

$$A = \frac{F_t}{p} = \frac{651.92}{0.7} = 931.31mm^2$$

$$A = \frac{\pi \times D^2(\text{Piston Diameter}^2)}{4}$$

$$D = \sqrt{\frac{4 \times A}{\pi}} = \sqrt{\frac{4 \times 931.31}{\pi}} = 34.44mm^2$$

Festo Cylinder Selection

Festo product compare_10_03_2025_10_15		
Property	Round cylinder	Round cylinder
Comparison	CRHD-32- -PPV-A-MS-S6	CRHD-40- -PPV-A-MQ-S6
Price	£0.00	£0.00
Suitable for use with food	See supplementary material information	See supplementary material information
Variants	Heat-resistant seals max. 120°C	Heat-resistant seals max. 120°C
Mode of operation	Double-acting	Double-acting
Material seals	FPM	FPM
LABS (PWIS) conformity	VDMA24364-B2-L	VDMA24364-B2-L
Theoretical force at 0.6 MPa (6 bar, 87 psi), return stroke	415 N	633 N
Corrosion resistance class CRC	3 - high corrosion stress	3 - high corrosion stress
Theoretical force at 0.6 MPa (6 bar, 87 psi), advance stroke	483 N	754 N
Material housing	High-alloy stainless steel	High-alloy stainless steel
Note on operating and pilot medium	Lubricated operation possible (in which case lubricated operation will always be required)	Lubricated operation possible (in which case lubricated operation will always be required)
Cushioning length	17 mm	19.5 mm
Cushioning	Pneumatic cushioning, adjustable at both ends	Pneumatic cushioning, adjustable at both ends
Position detection	Via proximity switch	Via proximity switch
Additional moving mass per 10 mm stroke	9 g	16 g
Moving mass for 0 mm stroke	106 g	198 g
Operating medium	Compressed air to ISO 8573-1:2010 [7:4:4]	Compressed air to ISO 8573-1:2010 [7:4:4]
Additional weight per 10 mm stroke	26 g	42 g
Basic weight for 0 mm stroke	640 g	1154 g
Pneumatic connection	G1/8	G1/8
Ambient temperature	-20 °C ... 120 °C	-20 °C ... 120 °C
Stroke	10 mm ... 500 mm	10 mm ... 500 mm
Piston diameter	32 mm	40 mm
Design	Piston Piston rod	Piston Piston rod
Operating pressure	1 bar ... 10 bar	1 bar ... 10 bar
Material cover	High-alloy stainless steel	High-alloy stainless steel
Mounting position	optional	optional
Material piston rod	High-alloy stainless steel	High-alloy stainless steel
Symbol	991235	991235

Product compare

- ☒ Different
- ☒ Identical
-  Download
-  Clear all and close



Round cylinder
CRHD-32- -PPV-A-MS-S6
195555



Round cylinder
CRHD-40- -PPV-A-MQ-S6
195544

Technical Data

Calculation Pressure in Both Cylinders:

CRHD-32- -PPV-A-MS-S6

$$A = \frac{\pi \times D^2(Piston\ Diameter^2)}{4} = \frac{\pi \times 32^2}{4} = 804.25mm^2$$

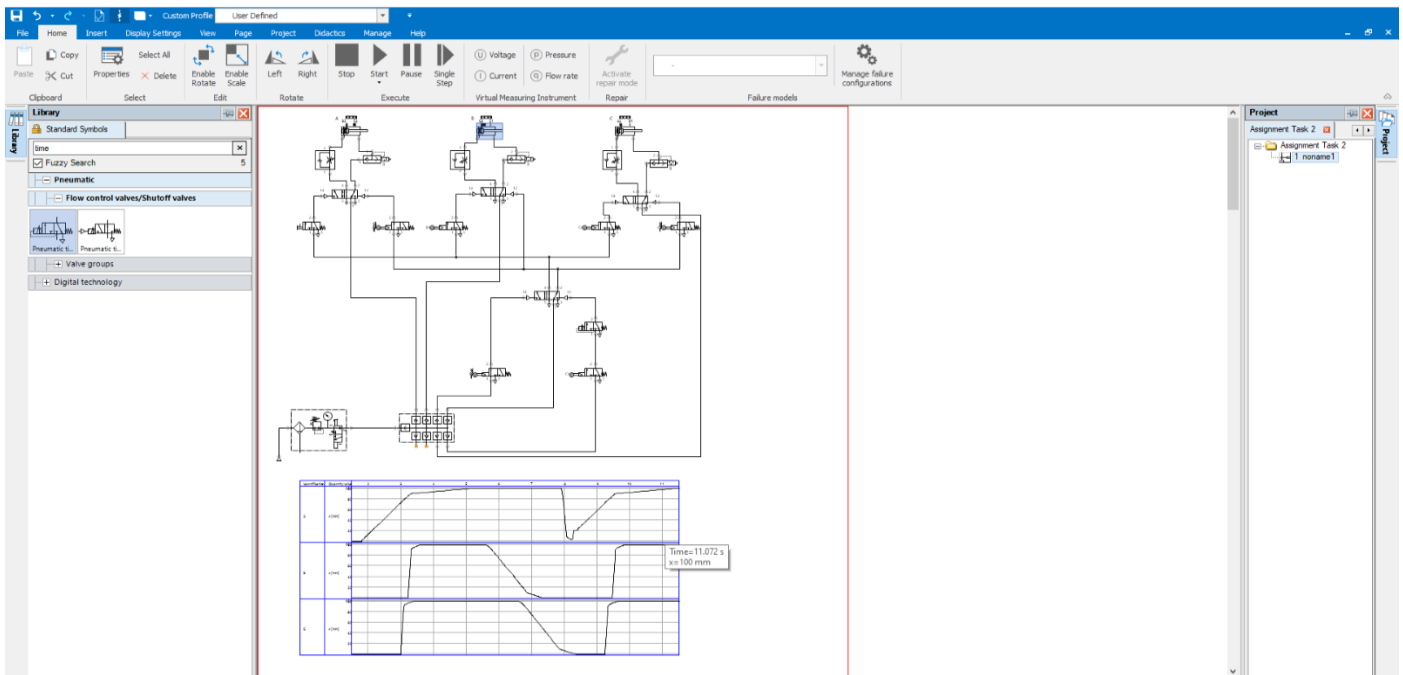
$$P(Pressure) = \frac{F_{Piston}}{A(Piston\ cross\ sectional\ area)} = \frac{483}{804.25} = 0.6MPa$$

$$A = \frac{\pi \times D^2(\text{Piston Diameter}^2)}{4} = \frac{\pi \times 40^2}{4} = 1256.64 \text{mm}^2$$

$$P(\text{Pressure}) = \frac{F_{\text{Piston}}}{A(\text{Piston cross sectional area})} = \frac{754}{1256.64} = 0.6 \text{MPa}$$

Task 2

Design



System Function

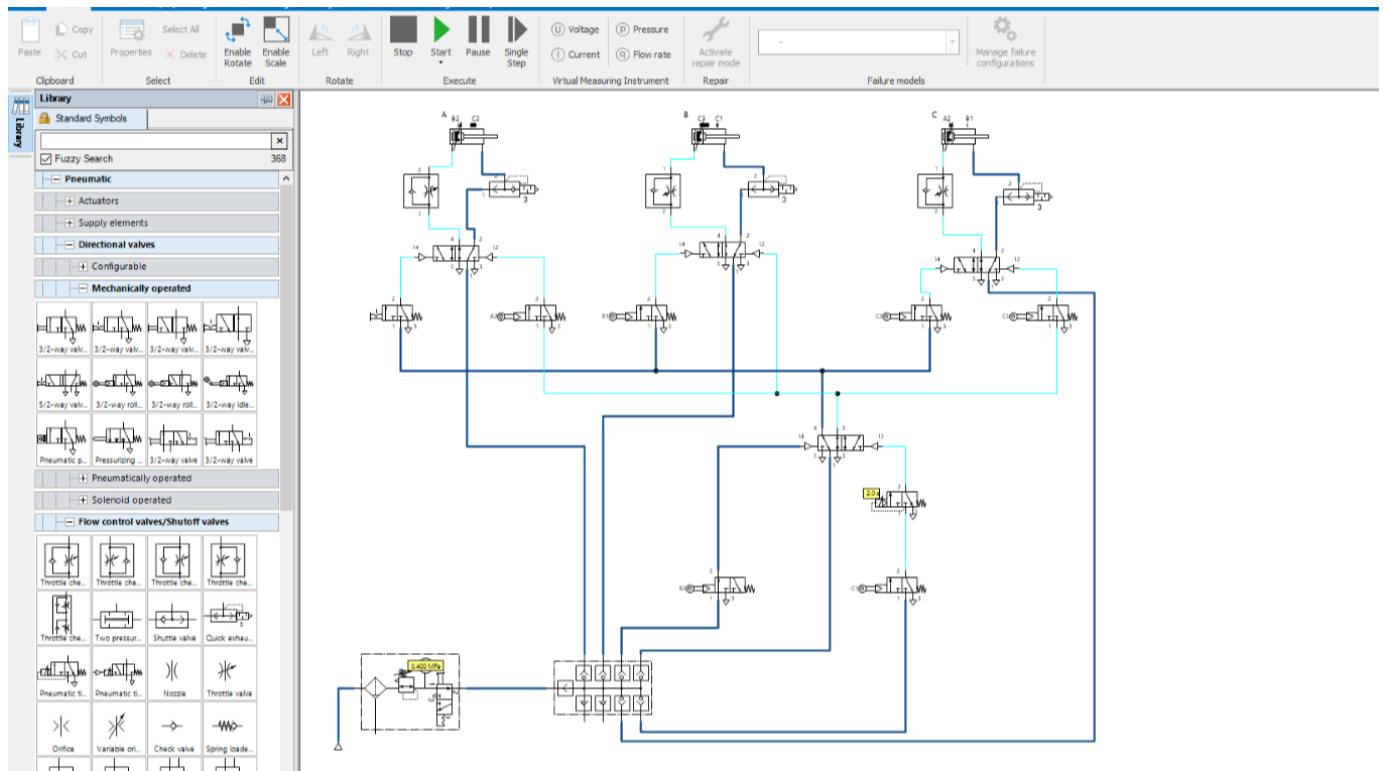
Before anything is activated the system will sit at rest. When at rest all cylinders (A, B, C) are retracted. When switched on, the compressor will feed the air to the start-up valve where the air will be released to the manifold with a slow but increasing pressure. For the system to be able to function, the 3/2 way valve with selection switch or striking button needs to be pressed. Once this is clicked, a signal will be sent to the 5/2 way valve, shifting it to allow the air to travel up towards cylinder A. Before the air can reach cylinder A, the air flows through a throttle check valve where the opening level is set to 1.2%. When the air has passed through the throttle check valve it will then reach cylinder A where it will take between 3 - 3.5 seconds to extend.

When cylinder A has fully extended, a sensor at the end of A's stroke will be triggered. This sensor will send a signal to the 5/2 way valve controlling cylinder B, will be shifted, allowing air to travel through cylinders B's throttle check valve which is set to an opening level of 7%. The air will then reach cylinder B, extending it rapidly. There is also a sensor at the end of cylinder B's stroke that will send a signal to cylinder C when activated. This will follow the same processes as the cylinder B as this will also extend rapidly.

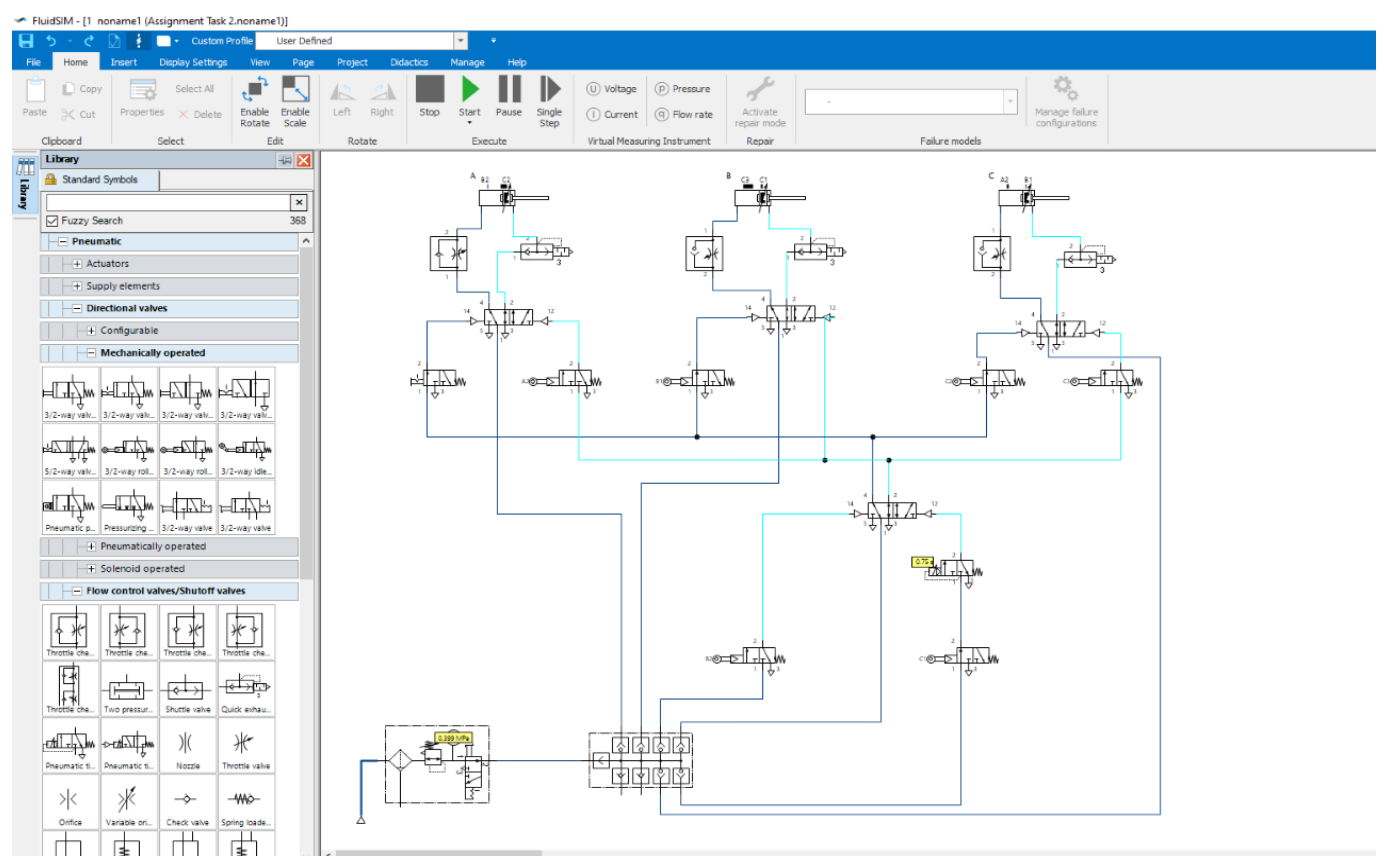
Once all cylinders have extended, the retraction process will start. Cylinder B will retract first, it does this as the 5/2 way valve will shift, allowing air to flow through the exhaust and into the front chamber of the piston. The piston in cylinder B will take 2 seconds to retract. There is a sensor at the start of cylinder B's stroke which will be activated, triggering cylinder C's retraction. This follows the same process as B and will also take 2 seconds to retract. Once cylinder B has retracted, the sensor will activate cylinder A's

retraction. Cylinder A will retract rapidly. Once the system has completed a full cycle, it will keep repeating the same processes over and over until the 3/2 way valve selection switched is pressed, locking the system. When this is pressed, the system will still complete its full cycle.

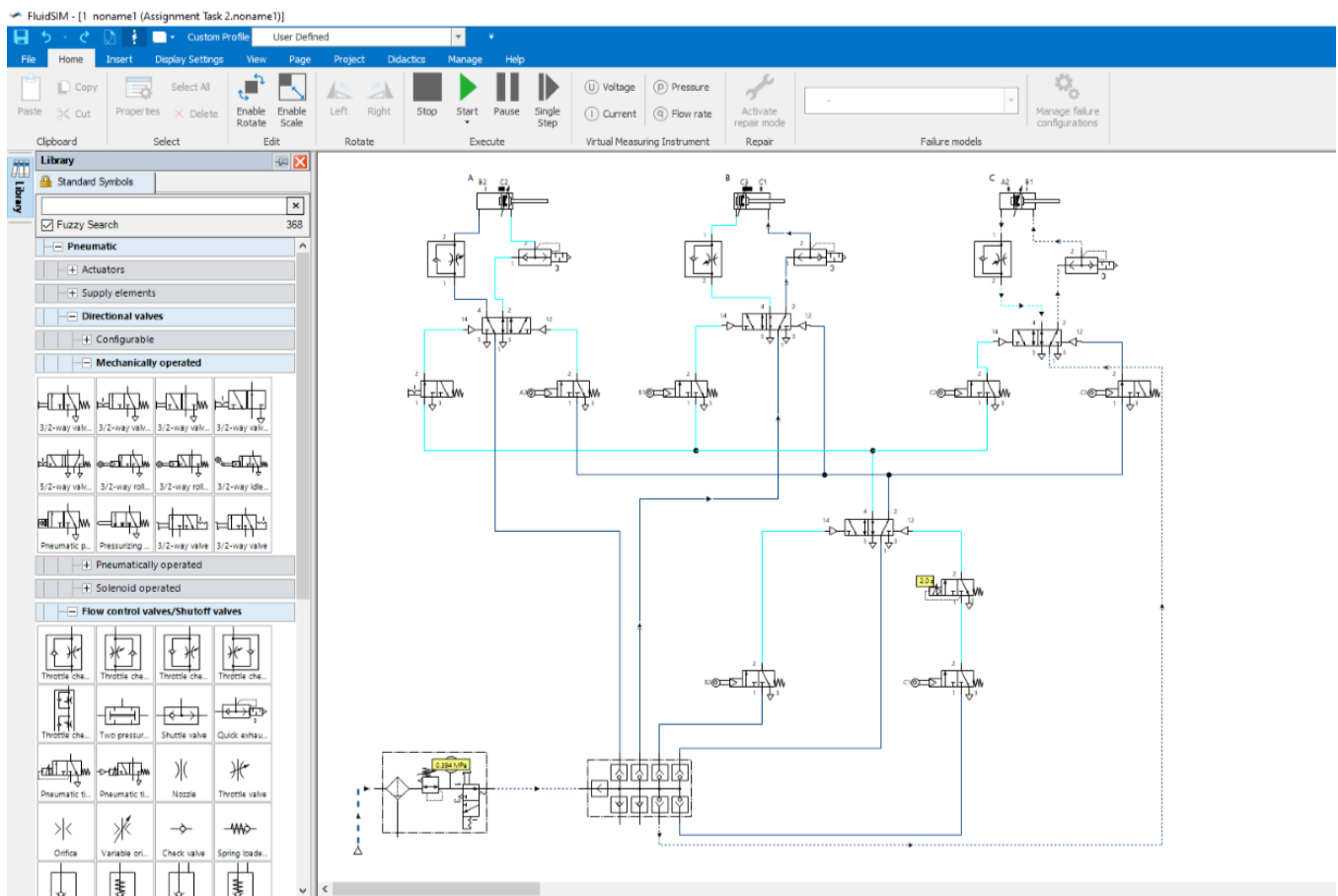
System Locked



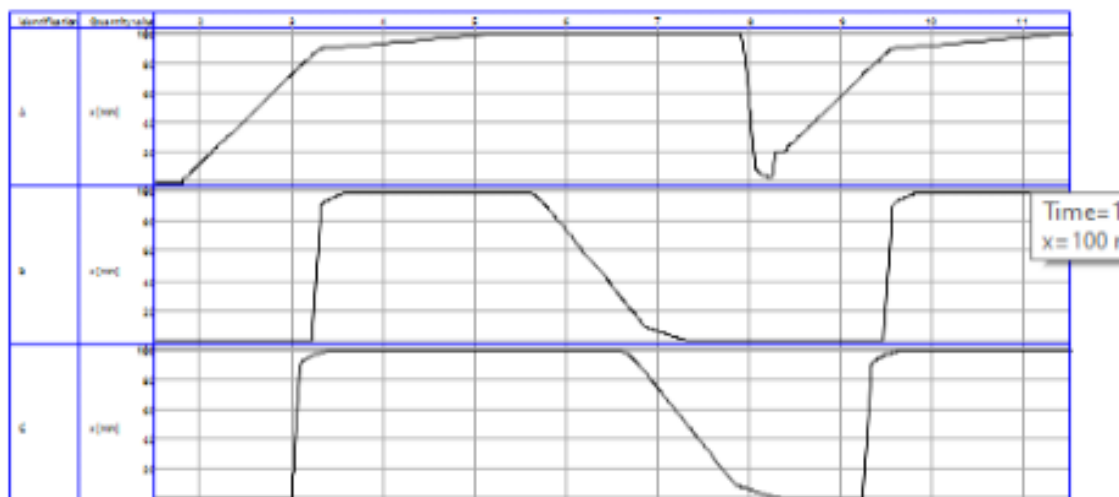
System Open – Pistons Extending



System Open – Pistons Returning



Circuit Time Delay



The above image is showing the time delay of each cylinder. The first box shows cylinder A, the second is cylinder B, and the bottom one is showing cylinder C. as can be seen, Cylinder A takes 3-3.5 seconds to extend, this is shown by the line diagonally extending to the top (gradually extending), whereas cylinder B and C extend rapidly, shown by the line on the graph being nearly vertical. Cylinder B and C don't start to extend until cylinder A is approximately 80% extended. When all cylinders have fully extended, there is a time delay of 2 seconds because the return process is started. When looking at the cylinders returning, it is

clear to see that B starts returning first, then C follows once B is approximately 90% returned. Both cylinders B and C take 1.5-2 seconds to return. Once cylinder C is almost fully returned, this triggers cylinder A to return Rapidly.

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