

Getting to know the assembly line

Hands-on exercise 1

[1 Assignment \(4p total\)](#)

[2 Description of Distribution Station](#)

[2.1 Operating the Stations \(Figure 1\)](#)

[2.2 How assembly line works](#)

[3 Detailed Description of Distribution Station](#)

[4 Description of Testing Station](#)

[5 Preliminary exercises](#)

[6 Exercises \(2p total\)](#)

[6.1 Exercise 1](#)

[6.2 Exercise 2](#)

1 Assignment (4p total)

Purpose of this assignment is to get students accustomed to controlling and monitoring our Festo modular production system as well as familiarize better with inner workings of distribution station and testing station.

As preliminary assignment read this document and prepare to answer preliminary questions. (2p).

During first part of hands-on exercise you can try to execute emergency stop and initialize the testing station. As you are doing this, pay attention to what the station does at initialization as you will need this knowledge for the final exercise questions.

During second part of the hands on exercise students will have to move workpiece from its starting position inside the magazine of distribution station through the testing station manually using the pneumatic switches. The position of workpiece and the state of assembly line stations will have to be deduced from available sensors.

Final questions are located at the bottom of this document. They have to be returned to MyCourses (2p).

2 Description of Distribution Station

2.1 Operating the Stations (Figure 1)

Station shuts down if **stop** button is pressed. If **emergency stop** button is pressed power is also cut off from the station.

The station can be restarted after emergency stop by first pulling the **emergency stop** button to its original position and then **quit** button has to be pressed for station to acknowledge the resetting of emergency stop.

Now the station is ready for ordinary restart. This is done by pressing the reset button. After button is pressed station moves to its initial position. Start button lights up indicating that station is ready to start by pressing this button.



Figure 1: *Stopping and starting the station. Emergency stopping and restarting the station.*

2.2 Overview of assembly line

Our assembly line consists of four different stations: distribution station, testing station, processing station and handling station.

Main task of **distribution station** is to supply other stations with material. This is done by taking appropriate amount of raw material from the container and moving it to the testing station. In this case plastic and metal workpieces serve as raw material. They are picked from magazine one at the time. There are three types of workpieces: black, metal and red.

Distributed workpieces are identified and separated at the **testing station**. This is accomplished with the help of four sensors. Capacitive sensor recognises if any workpiece is in place for testing. The optical sensor differentiates between black and red workpieces and inductive sensor between metal and plastic workpieces. The length of red and metal pieces is measured with mechanical sensor. After differentiation is done red and metal pieces are passed to processing station and black pieces are pushed out.

Processing station moves the workpieces under drill and locks them to this position while hole is drilled. Each workpiece is then moved under testing device that verifies that hole was made. Finally the workpieces are moved to wait for pickup from Handling station.

Handling station picks up the ready pieces form processing station and moves them to place assigned for ready workpieces.

3 Details of Distribution Station

Distribution station (Figure 1) is composed of following component: stack magazine module (figure 2), changer module (figure 3) and sensors and pneumatic actuators related to them. Details are shown in pictures below.

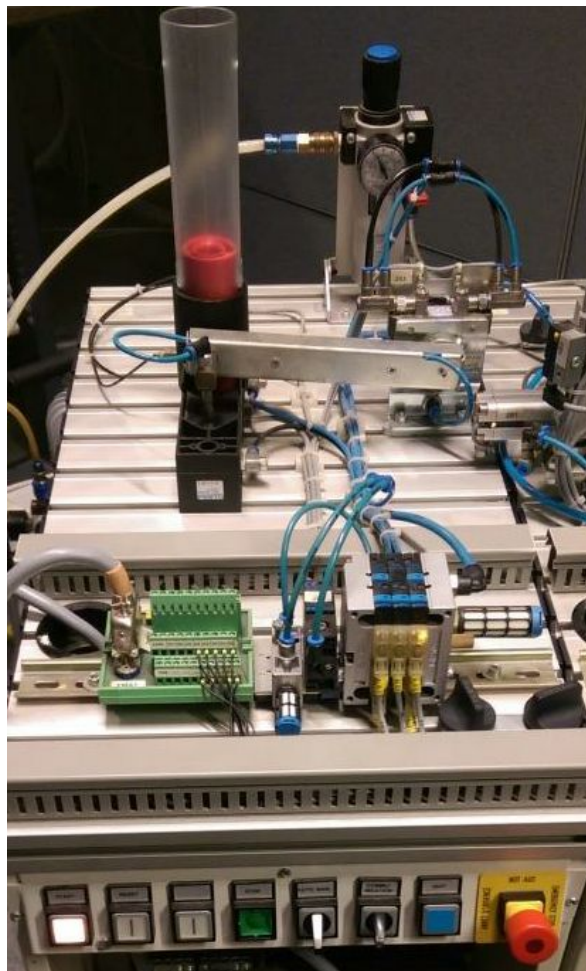


Figure 1: Overview of Distribution Station.

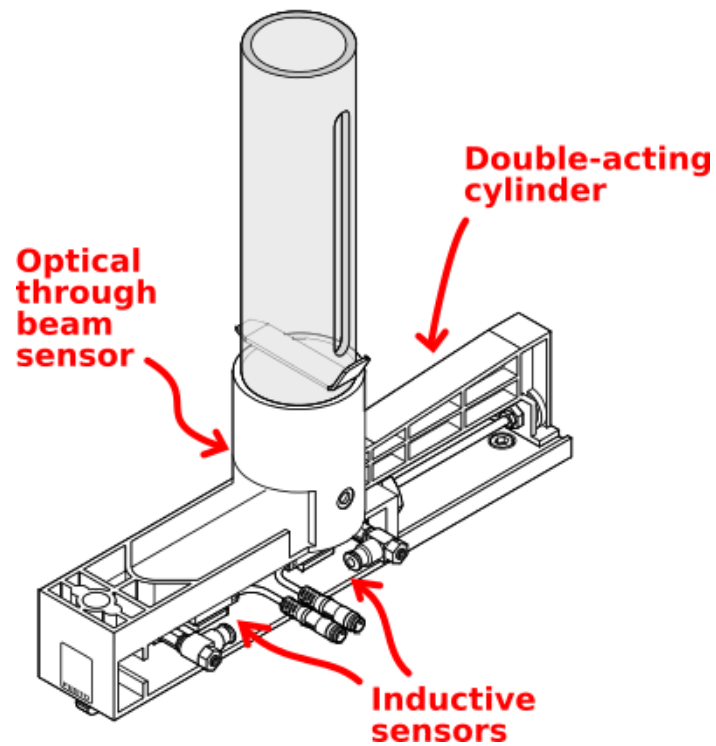


Figure 2: Stack Magazine module of distribution station. Inductive sensors identify the end positions of double-acting cylinder. Optical through beam sensor activates when magazine module is empty.

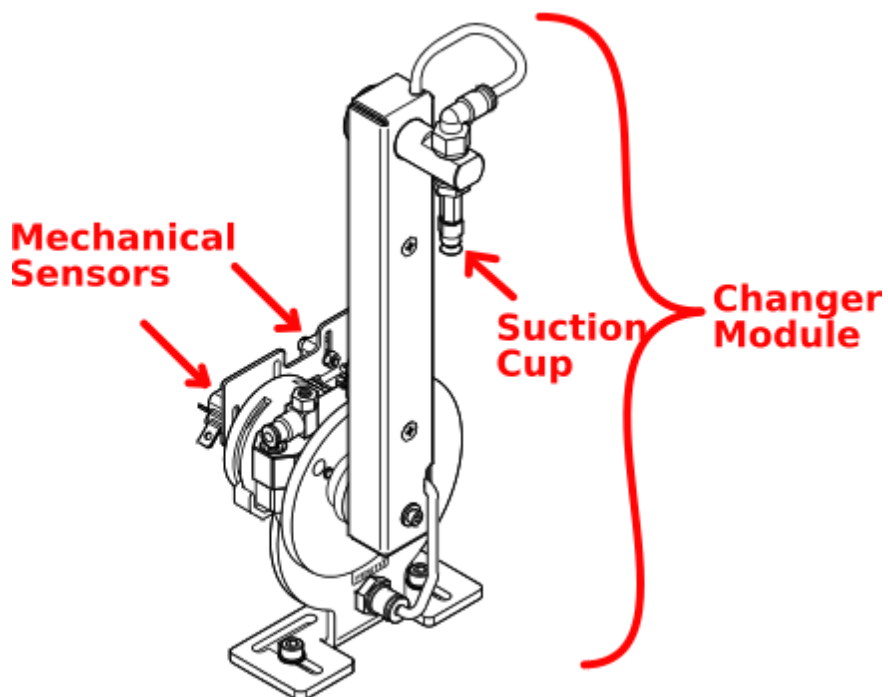


Figure 3: Changer module. Sensors recognize the two end positions of rotary drive. Suction cup contains a mechanical sensor that recognizes pressure changes.

I 6 - Magazine empty (Opt.)

I 6 - Workpiece picked up (Mec.)

I 3 - Rotary drive at testing station (ind.)

I 2 - Rotary drive at magazine (ind.)

I 1 - Cylinder extended (ind.)

I 0 - Cylinder retracted (ind.)

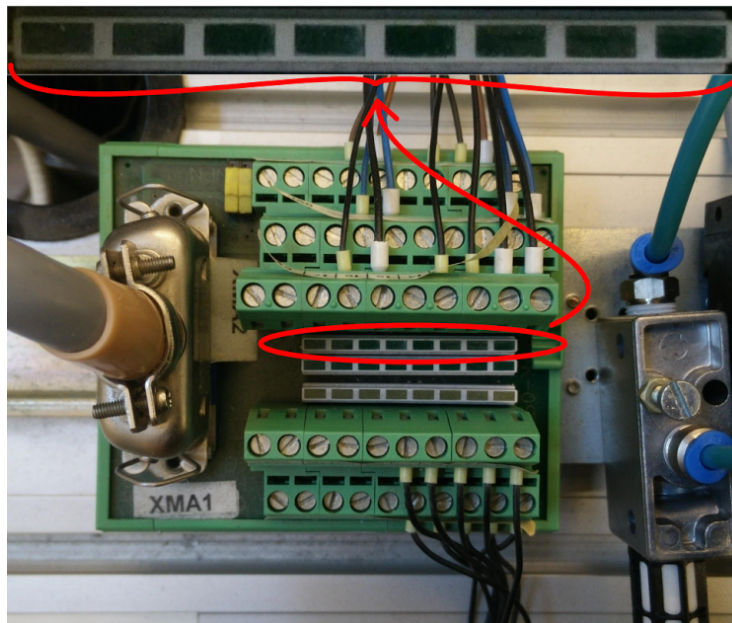


Figure 4: IO of Distribution station. Figure shows to what input sensor are connected to. (ind. = inductive sensor, Opt. = Optical through beam sensor, Mec. = mechanical sensor)

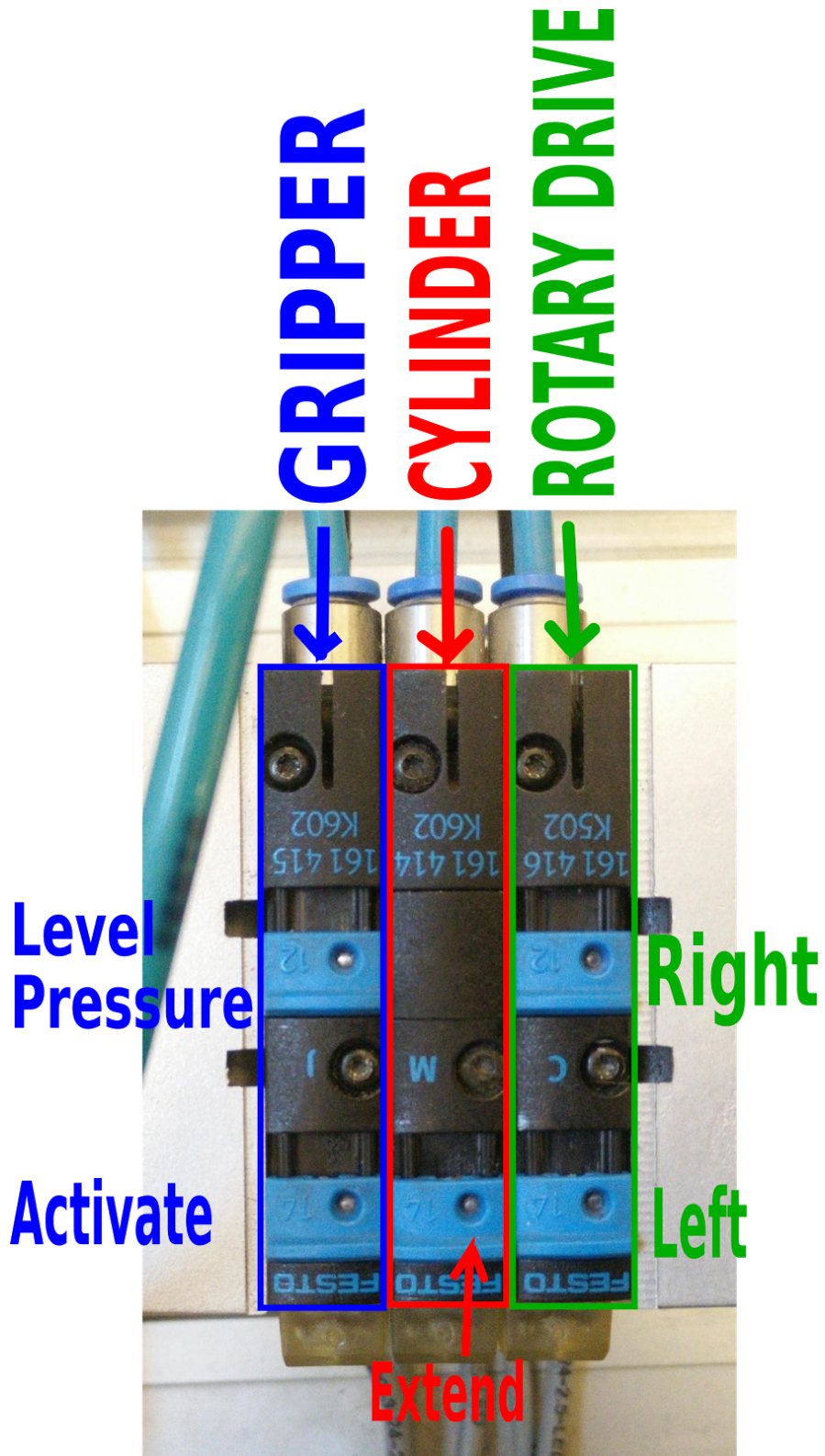


Figure 5: Manual pneumatic switches of Distribution station.

4 Description of Testing Station

Testing station is station responsible for verifying that correct pieces are passed to further stations in assembly line. Testing station handles following tasks: acquisition of information (test if workpiece is red, metal or black and measure height), comparing specified characteristics with reference values and resulting decision (reject black workpieces and pass red and metal workpieces to next station).

Sensors responsible of information acquisition are are capacitive sensor, optical sensor and inductive sensor. Capacitive senses all pieces and thus serves as availability check. This sensor is also the only one that can sense black workpiece and thus it is used with combination of other sensors to identify black pieces. Inductive sensor separates metal pieces from the rest and optical sensor is used to distinguish between red and black pieces. Black pieces are rejected and pushed away from assembly line with the help of ejecting piston of lifting module and a slide.

Lifting module handles lifting of pieces from sensing module to measuring module. Lifting module is made up of rodless lifting cylinder and ejecting cylinder. There is inductive sensor at the top position and end position of lifting module. These enable monitoring the two end positions of lifting module.

The height of red and black workpieces is also measured before passing them along. This happens at the Measuring module. It consist of analog height measuring sensor, lowering cylinder that moves analog height sensor on top of workpiece and inductive sensor that tells if measuring sensor is lowered into measuring position. After measurement is done workpieces are pushed to slide leading to next station. Gate at the end of the slide opens when next station is ready to take workpiece.

- IDENTIFYING SENSORS
- STATE TELLING SENSORS
- ACTUATORS

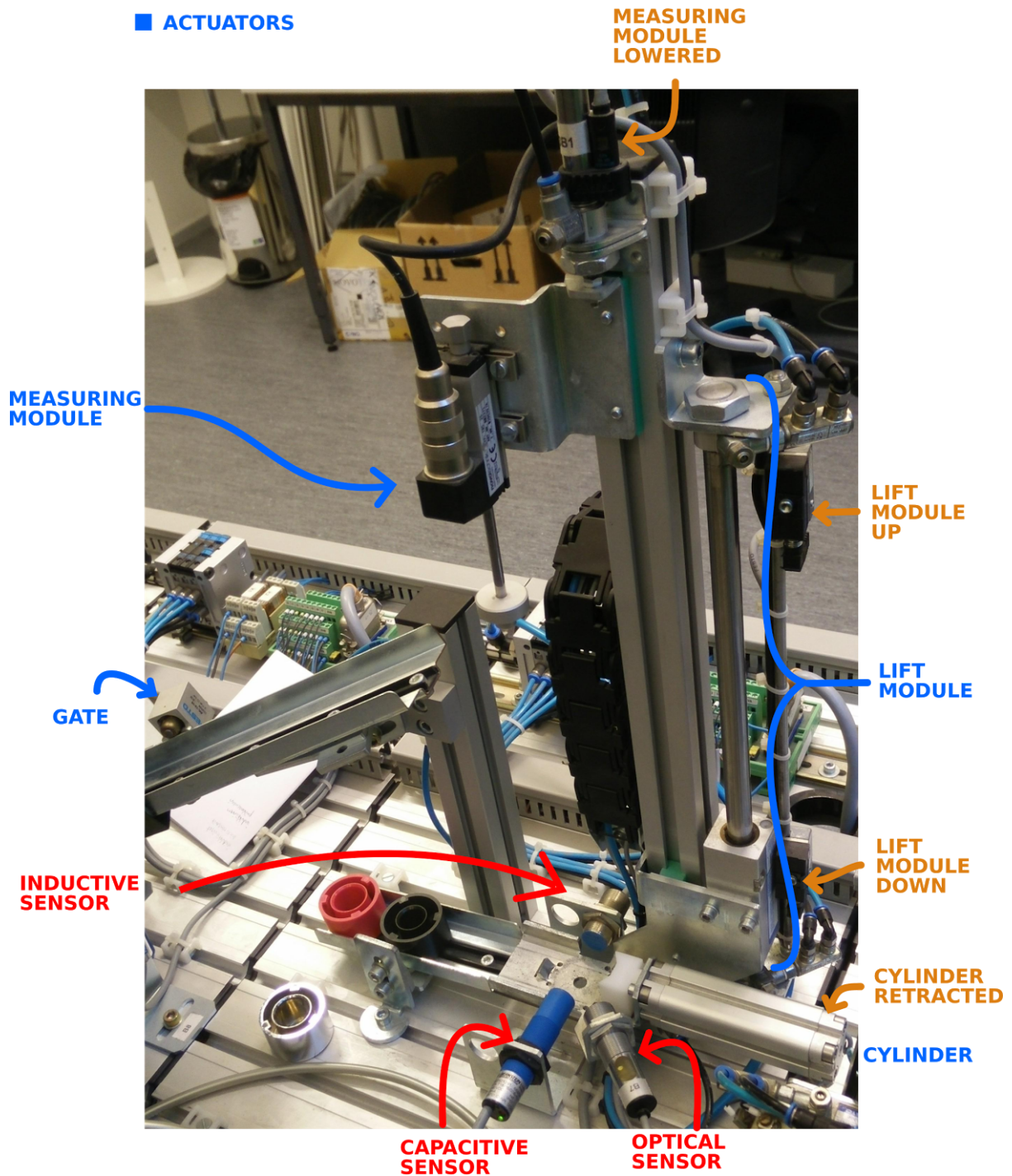


Figure 6: Sensors and actuators of testing station. Sensors marked with orange tell state of testing station. They are all inductive sensors. Measuring module has mechanical height sensor.

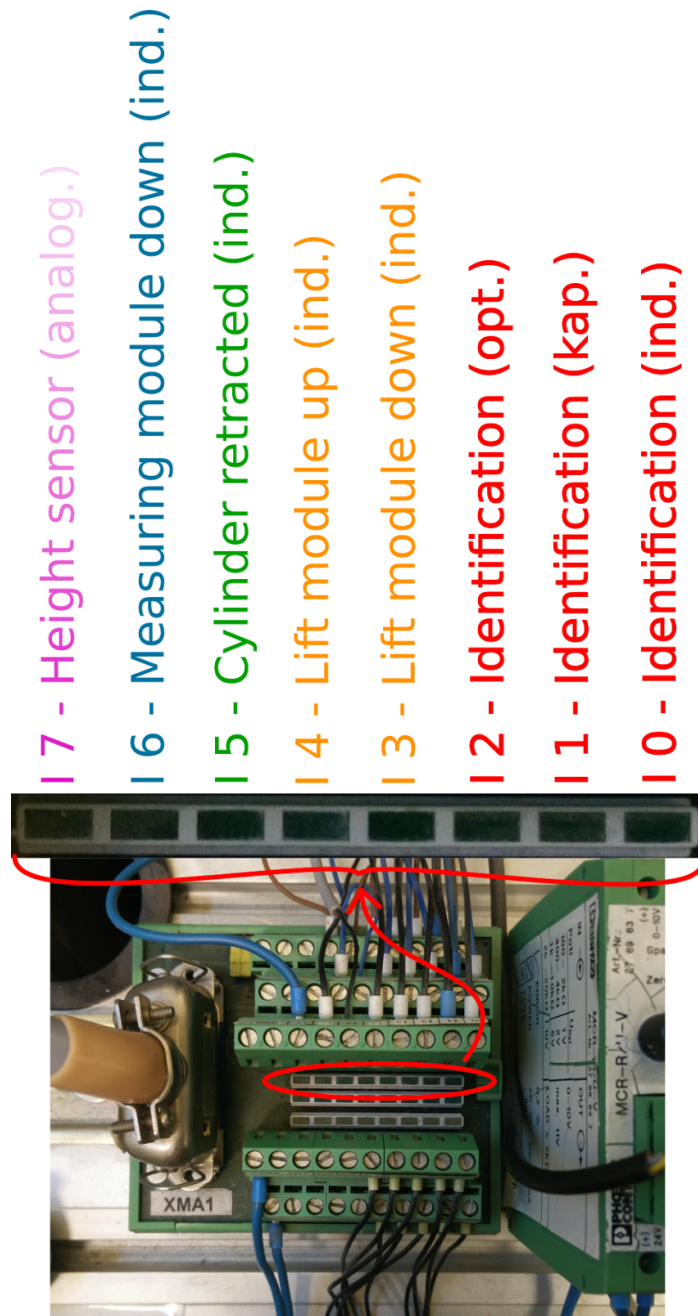


Figure 7: IO of testing station. Figure shows how sensors are connected to IO module. Height sensor (I7) is the only analog sensor of assembly line. Sensors I0-I2 are used to identify workpieces. I3-I6 are inductive sensors that tell state of testing station.

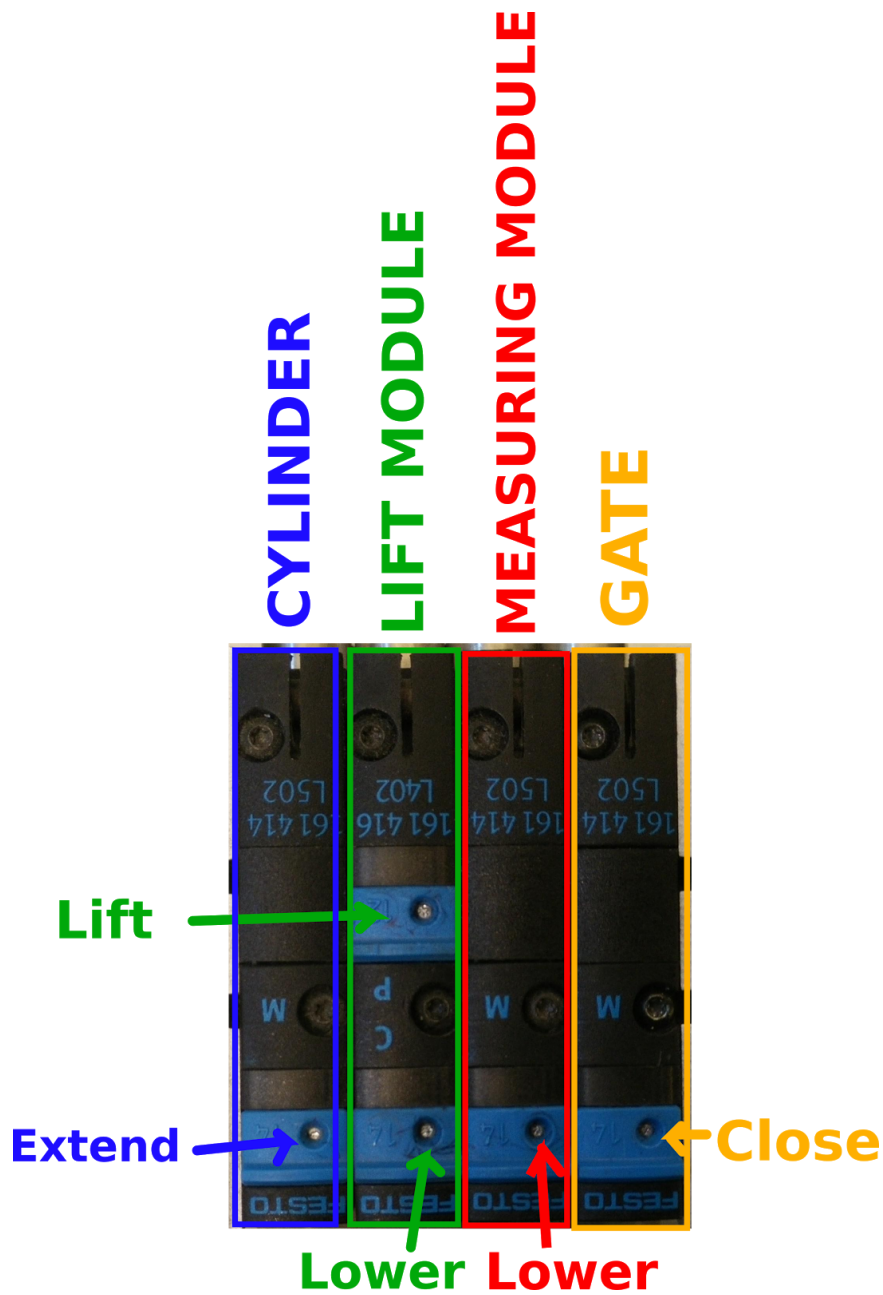


Figure 8: Pneumatic switches of testing station.

5 Preliminary exercises

Tell assistant at the beginning of hands-on exercise how to emergency stop testing station and how to start it up after the emergency stop is done. Show what sensors and actuators the testing station consists of.

6 Exercises (2p total)

Answer with one or 2 sentences.

1. What happens at the testing station when reset button is pressed and station was stopped beforehand. (1p)
2. Why is station initialized before starting it up after the emergency stop? (1p)