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Department of Mechatronics

Report

Vacation Training II

Name of Firm	**:**	**Jendamark Automation**
Period of Vacation Training	**:**	**Second**
Branch of Study	**:**	**Nelson Mandela University**
Year of Study	**:**	**Third**
Vacation Training Start Date	**:**	**26 June 2023**
Vacation Training End Date	**:**	**21 July 2023**

Compiled by
Surname: Flanegan
Student ID: s220324085

Port Elizabeth

26 July 2023

VACATION TRAINING CERTIFICATE

STUDENT'S NAME: Kyle Flanegan

FIELD OF STUDY: Engineering

PERIOD OF TRAINING (first/second): Second

EMPLOYER'S NAME AND ADDRESS: Jendamark Automation
76A York Road, North End, Gqeberha, South Africa

DATE STARTED SERVICE: 26 June 2023

DATE LEFT SERVICE: 21 July 2023

DATES OF INTERRUPTIONS: N/A

TYPE OF WORK DONE: Kyle spent time with our programmers on the floor where he picked up experience in PLC setup, basic programming and faultfinding. He gained an insight of how this all comes together.

GENERAL CONDUCT: Kyle has a real interest for the industry. He is timely and does his work with detial. Kyle's logic thinking is good. He took on the tasks given to him with ambition and showd that he has the ability to perform well.

REMARKS: Kyle has the drive to perform really well in this industy. His interest and passion for this type of work is clear and I feel that he has what it takes.

Name of Supervisor: Rudi Bellingan

Company Designation: Controls Supervisor

Email & Tel: rudib@jendamartk.co.za

Qualifications: NDip

Professional Affiliations:

Relation to student: none

DATE: 9/10/23

Rudi Bellingan
EMPLOYER'S SIGNATURE
Certifying that they have read and agree with the contents of the students vacation training report.

JENDAMARK AUTOMATION
76a YORK ROAD, NORTH END
PORT ELIZABETH, 6000
TEL: 041 391 4700 FAX: 041 391 4703
EMAIL: info@jendamark.co.za

OFFICIAL STAMP OF INSTITUTION

NOTE: This page must be completed and included in the final Vacation Training report.

VACATION TRAINING REPORT MARKING SCHEME

STUDENT'S SURNAME & INITIALS: Flanegan K STUDENT No. s220324085

YEAR OF STUDY: Third (2023)

PERIOD OF TRAINING COMPLETED (fist/second): Second

ASPECT	√	COMMENT
GENERAL		
Physical Appearance:		
Bound	√	
A4, Larger drawings folded to A4	√	
Drawings with CAD or sketch software	√	
Language, style, Grammar:		
English	√	
Style reflects technical document	√	
Third person	√	
Short sentences and paragraphs	√	
Clear and unambiguous	√	
Tables	√	
Drawings & Figures	√	
FRONT MATTER	√	
Cover	√	
First page: Vac. Work certif.	√	
Stamped	√	
Second Page: Mark schedule	√	
Summary	√	
What was done	√	
What was fond out	√	
Significance	√	
Table of Contents	√	
Summary	√	
Nomenclature	√	
Introduction	√	
Central chapters	√	
Discussion and Conclusion	√	
Reference	√	
Appendices	√	

ASPECT	√	COMMENT
List of figures	√	
Page numbers	√	
List of Tables	√	
Page numbers	√	
Nomenclature and Abbreviations	√	
CENTRAL CHAPTERS	√	
Introduction	√	
Name and historical background of institution	√	
Present size and location	√	
Divisions or departments	√	
Available transport and services	√	
Summary of work/project/investigation	√	
Reason why project was undertaken and its importance	√	
Descriptive part	√	
Technical	√	
Detailed description of the projects	√	
Apparatus used	√	
Non-technical	√	
Organization Management	√	
Lay-out planning	√	
Production methods	√	
Handling of Materials	√	
Quality Control	√	
Purchasing	√	
Sales	√	
Maintenance	√	
Discussion of Results, Conclusion, Recommendations	√	
Reference	√	
Appendices	√	

REMARKS:

……

……

……

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MARKED BY: …… DATE ……..

NOTE:

1) The first three lines of this page must be completed, and the page included in the final Vacation Training Report.
2) All students submitting the vacation training reports must complete the VACATION TRAINING REPORT MARKING SCHEME as a self-evaluation.
3) All vacation training reports must be submitted via Moodle, and the Turnitin similarity report should be attached in the appendix.
4) The maximum allowable similarity must be less than 15%.

Summary

During the vacation training period, the student worked in the Controls Department at Jendamark from June 26, 2023, to July 21, 2023. The initial two weeks were dedicated to observing the commissioning and testing of a catalytic converter production line for a client based in Mexico. This involved witnessing various forms of testing and maintenance procedures.

Subsequently, the student split their time equally between the office and the factory, where they focused on PLC programming using Siemens and Allan Bradley systems. In particular, the student worked with TIA Portal to program the interlocks for the material transfer station in the catalytic converter production line.

Throughout the training period, the student gained valuable hands-on experience and insights into the practical aspects of control engineering. Working alongside professionals in the field taught them about the intricacies of PLC programming and its application in industrial settings. The exposure to different PLC systems and their practical implementation provided a well-rounded learning experience for the student.

Overall, the vacation training at Jendamark proved to be an enriching experience for the student, allowing them to acquire valuable skills and knowledge in the controls department of an engineering company. The opportunity to observe commissioning, testing, and PLC programming in action contributed significantly to their professional development in the field of control engineering.

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Nomenclature and Abbreviations

PLC	Programmable Logic Controller
G.B.D.	Gap Bulk Density
TIA	Totally Integrated Automation
HR	Human Relations

Introduction

During the semester break from June 26th to July 21st, 2023, the student completed vacation training at Jendamark Automation. This four-week program involved various projects within the Controls Department, including commissioning and testing a catalytic converter production line and PLC programming using Siemens and Allan Bradley systems.

Historical Background

South Africa has a diverse and evolving industry sector, which has undergone significant transformations over the years. Following the apartheid era, the country experienced economic changes, including the expansion of various industries. This period coincided with the rise of automation and robotics in global manufacturing. Jendamark Automation started around this time, as automation solutions grew internationally.

Jendamark specializes in automation and industrial robotics. The company's success can be attributed to its ability to adapt to evolving technologies and industry demands. They provide customized automation solutions for various sectors, including automotive, aerospace, and consumer goods. Through strategic partnerships and a commitment to excellence, Jendamark has contributed significantly to the enhancement of manufacturing processes in South Africa [1].

Size and Location

The global head office of Jendamark Automation has it's situated at 76A York Road, North End, Gqeberha, South Africa, and has satellite offices in Pretoria and East London. The company has additional manufacturing sites in Germany and India and a sales office in the USA. Jendamark has grown into an internationally respected brand by producing world-class production solutions. The growth of the company has increased the number of employees.

Divisions or Departments

The reception and main offices are upstairs at the front of the main building, furthest from the machine shop, where the noise levels are minimal. The offices accommodate the project management, HR, purchasing, and sales departments, with the control systems offices downstairs with an entrance to the factory. The canteens and board rooms are also located amongst the main offices.

The main factory, on the ground floor, has many divisions for the different stages of manufacturing - the machine shop, assembly and testing stations, commissioning and installation stations, and various other areas used for specific operations. The latest addition to the Jendamark factory is the design warehouse with an assembly department and offices upstairs for the design and electrical team.

Transport and Services

The company owns a range of vehicles for different purposes such as ‘bakkies’ for general use, small trucks to transport larger materials and equipment, and forklifts to move packaging pallets and other materials within the warehouse.

Jendamark has a health and safety service that supplies steel tips for employees’ boots and first aid in case of emergencies. An optional medical aid service is also offered to all employees.

Summary of Work Done

During the semester break from June 26th to July 21st, 2023, the student completed vacation training at Jendamark Automation, specifically in the Controls Department. Throughout the four weeks, the student observed and participated in various projects under the guidance and supervision of employees and project supervisors.

The primary project focused on the commissioning and testing of a catalytic converter production line for an international client based in Mexico. The student gained valuable insights into testing and maintenance procedures involved in the production line.

Additionally, the student had the opportunity to work in the office with full access to the factory, where they gained practical experience in PLC programming. They utilized Siemens and Allan Bradley systems and worked on programming the interlocks for the material transfer station in the catalytic converter production line using TIA Portal.

The vacation training at Jendamark Automation offered the student exposure to real-world engineering scenarios and extensive learning experience in the field of controls engineering.

Descriptive Part

Technical:

Catalytic Converter Production Line

A catalytic converter production line was commissioned for a client to operate systematically and efficiently to ensure the manufacturing of high-quality cat cells. A cat cell includes a monolith and a mat which is compressed inside a can. This line was mainly observed; the communication and programming of robots and PLCs was very interesting and useful to learn.

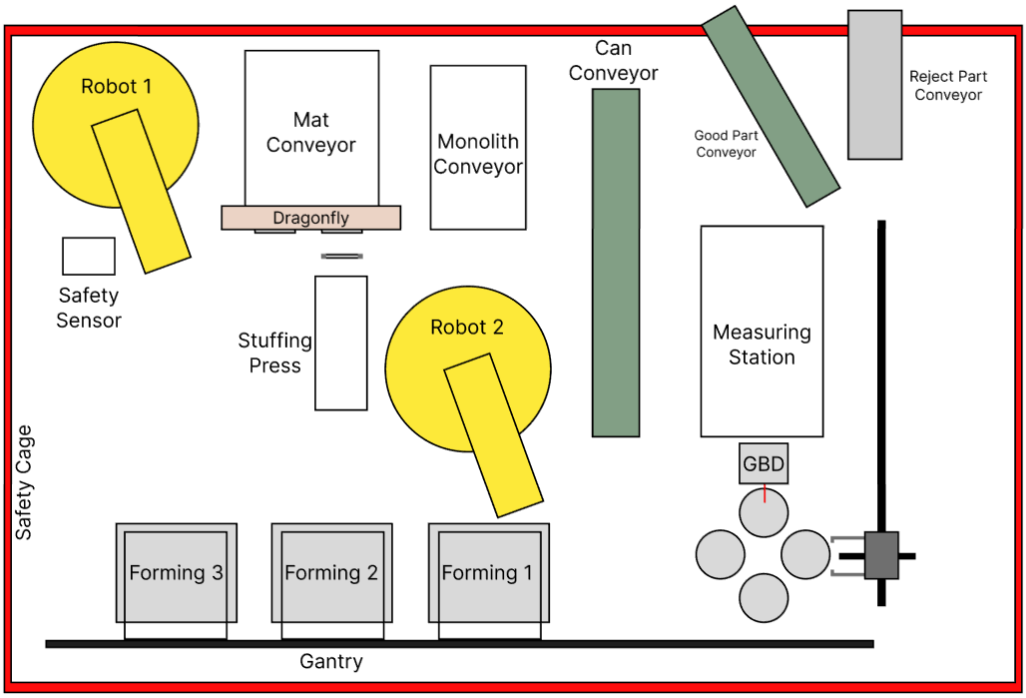


Figure 1: Basic schematic of Cat Cell Line

Safety measures are of utmost importance, and the entire production line is enclosed within a safety cage. Access to the line is limited to three gates, ensuring controlled entry and exit for personnel. During production, no one is allowed inside the safety cage, and a floor sensor is in place to halt production if anyone passes by.

The production line is equipped with two FANUC robots, specifically the R-2000ic 125L model, which play a crucial role in transporting the cat cells throughout the production process.

The process begins with a conveyor system that moves a mat into position, where it lies across a thin platform. Robot 1 retrieves a monolith from another conveyor and places it on top of the mat, preparing it for wrapping. Pressure is then applied to the monolith, and a cylindrical clamp securely wraps the mat around the monolith. The wrapped monolith is then fed into the dragonfly wheel, which has two circular openings for the catalytic converter cells. The wheel rotates 180 degrees to align the monolith with the can.

Meanwhile, Robot 2 has already positioned a can, obtained from another conveyor, onto a grip, which is aligned with the wrapped monolith. A stuffing press pushes the can through the dragonfly wheel, effectively sealing the monolith and mat within the can.

Operational sequence diagram for cat cell once sealed with mat and monolith inside:

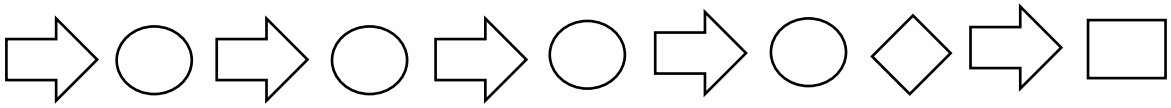


Figure 2: Cat Cell Operational Sequence Diagram

1. Robot 2 places the cat cell in Forming 2, where the cell is lowered into a cylindrical press.
2. The Forming 2 press seals and tightens the cat cell.
3. An overhead gantry on a single-axis line transports the cell from Forming 2 to Forming 1.
4. The forming 1 press forms fillets on each end of the cat cell can.
5. Gantry moves the cat cell to the laser measuring station.
6. Laser uses G.B.D. to measure the can diameter.
7. A clamp mounted on a two-axis rail transports the cell to a measuring station.
8. The cell undergoes meticulous measurement to verify its quality and compliance.
9. The system decides if the cell passes the measuring process.
10. Clamp transports the cell to either the good part conveyor or the reject part conveyor.
11. An operator will perform the final inspection by checking the laser marking.

Throughout the entire process, the catalytic converter production line combines precise robotic operations, efficient material handling, and quality control measures to ensure the production of reliable and high-performing catalytic converters.

SIEMENS PLC Programming

Description:

Another project that was worked on was SIEMENS PLC programming for the mat transfer station in the catalytic converter production line. The mat transfer station was responsible for efficiently and safely handling and transferring the mats for the catalytic converter cell. This station consisted of two cartridges, each containing two vertical stacks of mats, with two cylinders and one drive mechanism controlling the movements.

The fundamental working principle of the mat transfer station started with the drive, which would move horizontally and stop above a cartridge containing a mat. The vertical cylinder lowered a plate with two needles at the bottom, controlled by an additional cylinder. Once the plate touches the mat, it is forced upwards, initializing the needle cylinders. Subsequently, the needles advanced to prick and secure the mat in place. The vertical cylinder then retracted the plate to the top, and the drive moved to the designated scale (home) position, preparing the mat for drop-off. At this point, the vertical cylinder advanced again, causing the needles to retract, and the mat was released onto the conveyor.

The primary purpose of the mat transfer station was to efficiently pick up a mat from the cartridge and deposit it onto a conveyor, facilitating its transport to the monolith wrapping position.

Objective:

1. Add all inputs and outputs to a tag table for interlocks.
2. To program the interlocks for the mat transfer station, ensuring safe and precise movements of its components.
3. To implement a logical sequence in the TIA Portal Software, controlling the station's actions and adhering to strict safety protocols.

Apparatus used for this task:

1. Laptop: Used as the programming interface to access the TIA Portal Software.
2. TIA Portal Software: The programming tool employed to create and implement the necessary PLC logic.

Conclusion:

A lot was learned while programming in TIA portal, knowledge that will be beneficial for varsity and future engineering work. By applying SIEMENS PLC programming techniques, the student contributed to the overall functionality and safety of the catalytic converter production line at Jendamark Automation. This experience provided valuable insights into control engineering and demonstrated the importance of considering the little things when PLC programming.

Allen Bradley PLC Programming

Allen-Bradley PLC programming is another widely used programming platform in the industrial industry, developed by Rockwell Automation. It offers a range of PLCs designed to control and automate various industrial processes. Jendamark control systems engineers work with Allen Bradley PLC's as well as Siemens, which makes them versatile with production line designs.

The use of Allen Bradley or Siemens depends entirely on the company standard. Some industries and companies may have long-standing partnerships with Rockwell Automation, making Allen-Bradley PLCs a natural choice due to familiarity and trust in the brand's products and services, and will specify that in their design requirements. The controls department will work with Allen Bradley PLC's and software to program the production line to satisfy the client's needs.

The programming of logic sequences and networks in Allen Bradley was observed by the student. One of the previous cat cell lines that Jendamark manufactured, named Flexican 2, was run using Allen Bradley PLC's as that was the client's requirement. The programming of interlocks and networks for this line were observed and compared to a Siemens production line. It was noted that the Allen Bradley software was much more understandable and user-friendly. As a beginner PLC programmer, it is recommended to learn using Allen Bradley.

Non-technical:

Organization and Management

Employees are individually responsible for maintaining clean and organized workspaces. Strict regulations are set in place to monitor the use and storage of tools and equipment, with clear labelling to keep everything organized. This is vital for tracking thousands of small parts and ensuring high productivity.

The management of parts is closely monitored with two sections: a "General Store" accessible to authorized personnel who must sign for valuable components and a separate “Store” for nuts and bolts which is more accessible with no signing necessary.

The factory maintains an efficient workflow with labelled sections and set deadlines for product completion. Supervisors oversee departments to ensure employees meet their responsibilities. All employees have access to the factory floor to help out and witness the commissioning of production lines.

Lay-out and Planning

The office and factory layout in Jendamark is well thought out. The main offices including reception, accounts, and human resources are strategically placed away from the noisy machine shop. The factory floor has offices for each department with supervisors, promoting accessibility to employees.

The factory is designed for efficient material flow, with designated separate drop-off and pickup areas to manage product movement smoothly. An exclusive entrance is reserved for office personnel with fingerprint recognition for attendance tracking.

Factory supervisors have offices within the factory space, located between their respective departments, ensuring authority and effective supervision.

Raw materials are stored in a newly bought warehouse next to the drop-off entrance. The process begins in the machine shop, where metal is cut and shaped. Welding, painting, and sealing follow if required. Final assembly occurs in the design building, wiring, pneumatics, etc. Projects are programmed, tested, commissioned, and prepared for shipping to their destination for installation.

Production Methods

Design

The design department is responsible for creating a product or assembly line based on the customer’s needs. An entire electrical and mechanical design for the product or line is created, simulated, and tested. Once the design is approved, the purchasing department will order the necessary materials for the assembly.

Mechanical

Mechanical processes such as CNC milling and machining, manual milling and machining, 3D rendering, finishing, and painting of parts take place in the machine shop. Any product or part that is required in a design and cannot be ordered is made in the machine shop.

Electrical

Wiring and pneumatics are installed in the assembly department, located in the design building. Employees are given diagrams and instructions which they use to install all the necessary components.

Controls

The controls department is responsible for all the PLC programming using Allen Bradley or Siemens. They work together to meet the customer's design requirements for their production line.

Handling of Materials

Numerous safety regulations are implemented for the proper handling of materials, including the use of gloves, glasses, masks, and safety shoes. It is compulsory to wear safety shoes, to ensure the well-being of everyone on the factory floor. These requirements are diligently enforced by the on-site safety officer.

Every employee bears responsibility for the materials they have acknowledged and are using for their designated projects. They are held accountable in case of any missing items.

The company has two forklifts, which are used daily to facilitate the movement of heavy materials and components within the factory.

Quality Control

Each project undergoes comprehensive testing throughout the manufacturing process. Initially, mechanical design is tested for proper functioning and secure fastening. The electrical department conducts tests to verify correct wiring. Machines are powered on for further assessments of electrical performance. Employees are individually responsible for signing off on their work and ensuring completion of all quality control checks.

After the final stage, including programming, the commissioning of the production line is conducted to validate the entire line's functionality. This includes a dry run (without parts) and subsequent testing with parts. Further testing and commissioning occur when the line is set up at the client's facility.

Purchasing

The store manager oversees all procurement activities, including the purchase of raw materials, consumables, and various other items. However, these purchases can only be made if there is sufficient evidence demonstrating their necessity for a specific project. When supplies begin to run low in any department, employees are required to notify their supervisors, who inform the store manager.

Upon arrival at the factory, all stock undergoes a thorough inspection to verify its accuracy and ensure that none of the inventory is damaged. The items are kept in the general store. The employee responsible for the project conducts a thorough check to ensure that all the required components are present. After confirming the completeness of the supplies, they sign off on the items received.

Sales

The sales department handles all clients and sales for the company. Jendamark has many long-term clients who need additional production lines or upgrades on their existing lines. The company sales have been consistent for many years, due to their good reputation.

Maintenance

Factory and Equipment:

The factory floor undergoes constant maintenance including sweeping, filling drill holes in the ground, and repainting in sections to maintain a neat and safe environment. Machinery undergoes a comprehensive service every five years, and any old or damaged equipment is replaced.

Products:

Jendamark offers maintenance on all products that they design and manufacture for their clients. They also have a servicing department that performs repairs and upgrades to installed production lines.

Discussion of the Results

Organization and Management

Jendamark's approach to organization and management is commendable. Employees take ownership of their workspaces, adhering to strict regulations for tool and equipment usage. Careful organization is crucial, given the vast inventory of small parts. Part management, with controlled access to the "General Store" and more relaxed access to the "Store," is effective. Supervisors oversee departments, maintaining a collaborative work environment.

Lay-out and Planning

Jendamark's layout and planning is effective as separating noisy areas from offices improves working conditions. The designated drop-off and pickup areas help material flow. The use of fingerprint recognition for attendance tracking enhances security.

Production Methods

The design department's approach to product creation and testing before ordering parts for assembly is effective as it avoids the risk of ordering unnecessary materials.

The machine shop's capability to produce custom parts adds flexibility to the manufacturing process, ensuring that all components meet design requirements.

The assembly department's use of diagrams and instructions for component installation ensures that components are correctly installed.

The controls department's skills in PLC programming using both Allen Bradley and Siemens allow for a wider customer base as company standards vary between the two different software.

Handling of Materials

Jendamark's commitment to safety, including mandatory safety shoes etc. prioritizes employee well-being. Accountability for materials promotes responsible handling. The use of forklifts is very effective as it aids in material movement within the factory.

Quality Control

The company’s quality control measures throughout the manufacturing process demonstrate a commitment to delivering high-quality products. Employee quality control checks are efficient as each part used in the production line is tested and quality is assured.

Purchasing

The store manager's thorough control and inspection of incoming and outgoing stock contribute to efficient inventory management. The requirement of providing evidence of the necessity of purchases helps save costs and control part usage in the factory.

Sales

The company's sales department worked hard over the years to ensure consistent sales and a good reputation among long-term clients.

Maintenance

Regular maintenance of the factory floor, machinery, and equipment ensures a safe and efficient working environment. Providing maintenance services and support to clients demonstrates a commitment to customer satisfaction.

Conclusion

Jendamark has an efficient factory workflow with several commissioning sections designated for continuous testing of production lines. The company has very strict safety protocols to ensure the well-being of its employees. The offices for the various departments are strategically located to ensure efficiency in the company. Their organization, management, and production methods are well-suited for delivering high-quality products. Quality control measures are strong, and purchasing processes are efficient. The company's dedication to maintaining long-term client relationships through sales and servicing contributes to its continued success.

Recommendations:

- Continue to support and train employees to maintain a skilled workforce.
- Explore opportunities for further automation to enhance productivity.
- Continue to monitor and update safety rules to keep everyone safe.
- Explore eco-friendly practices to align with environmental concerns and industry trends.

References

[1] "Jendamark Automation (Pty) Ltd," Jendamark Automation (Pty) Ltd, [Online]. Available: https://www.jendamark.co.za/our-company/. [Accessed 26 June 2023].

[2] "Jendamark Automation," [Online]. Available: https://www.jendamark.co.za/. [Accessed 27 June 2023].

[3] SIEMENS, "Programming guideline en - Siemens," SIEMENS, [Online]. Available: https://cache.industry.siemens.com/dl/files/040/90885040/att_861867/v1/81318674_Programming_guideline_DOCU_v14_en.pdf. [Accessed 1 July 2023].

Appendices

Appendix A: Factory Floor Plan

Appendix B: FANUC Robot used in Cat Cell Line

R-2000*i*C/210L

Max. load capacity at wrist: 210 kg

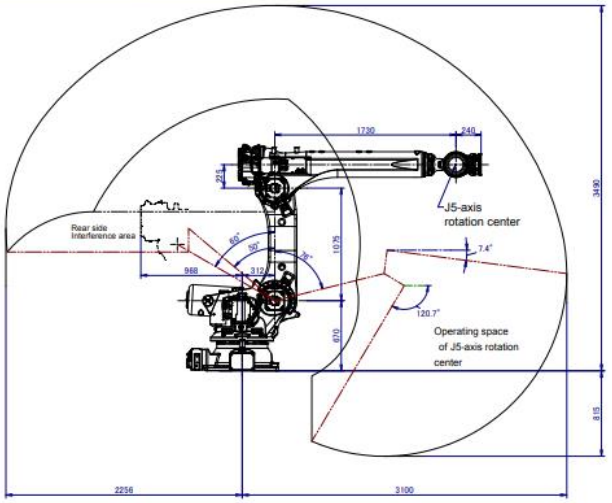
Max. reach: 3100 mm

FANUC

Robot								Motion range (°)						Maximum speed (°/s)										Protection	
Series	Version	Type	Max. load capacity at wrist [kg]	Reach [mm]	Controlled axes	Repeatability [mm]	Mechanical weight [kg]	J1	J2	J3	J4	J5	J6	J1	J2	J3	J4	J5	J6	J4 Moment/ Inertia	J5 Moment/ Inertia	J6 Moment/ Inertia	Average Power consumption [kW]	Body standard/optional	Wrist & J3 arm standard/optional
R-2000	*i*C	210L	210	3100	6	± 0.05**	1350	370	136	301	720	250	720	105	90	85	120	120	200	1700/ 320	1700/ 320	900/ 230	2.5	IP54 / IP56	IP67

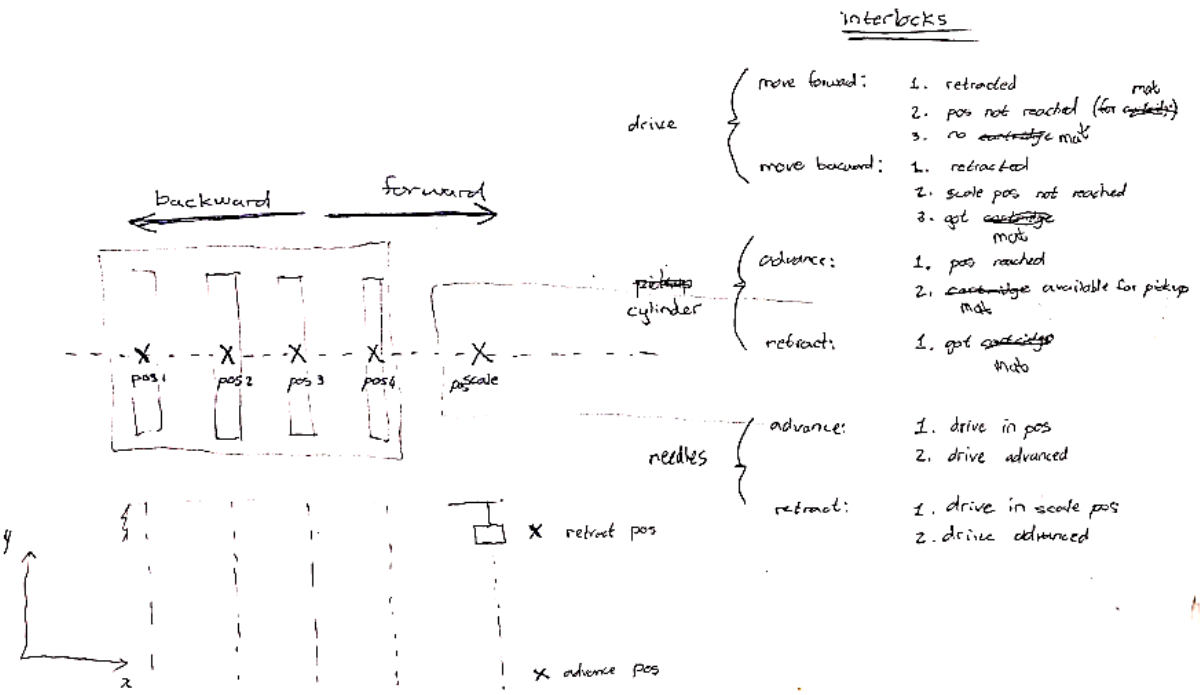
● standard ○ on request – not available [ ] with hardware and/or software option *1) depending on rail specification ** Based on ISO9283

R-2000*i*C/210L Long arm

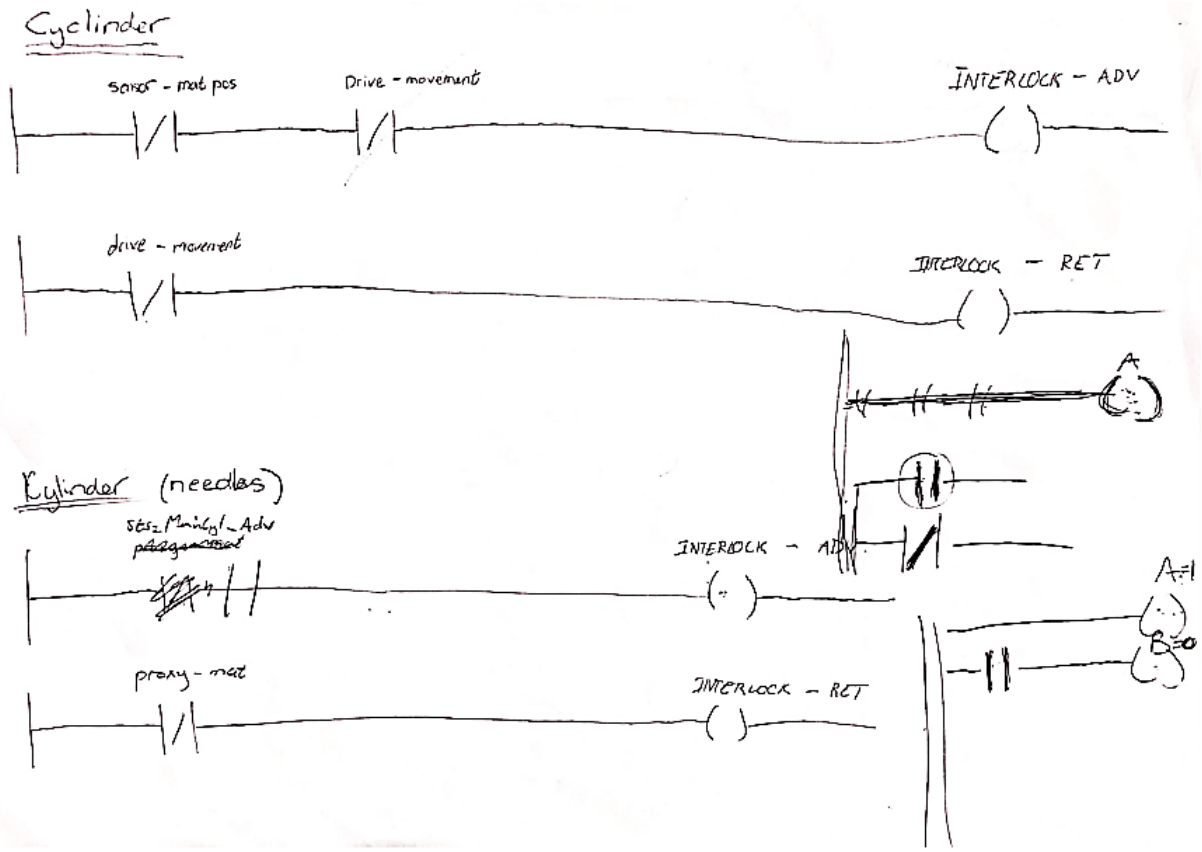


Appendix C: PLC Programming Interlocking Calculations

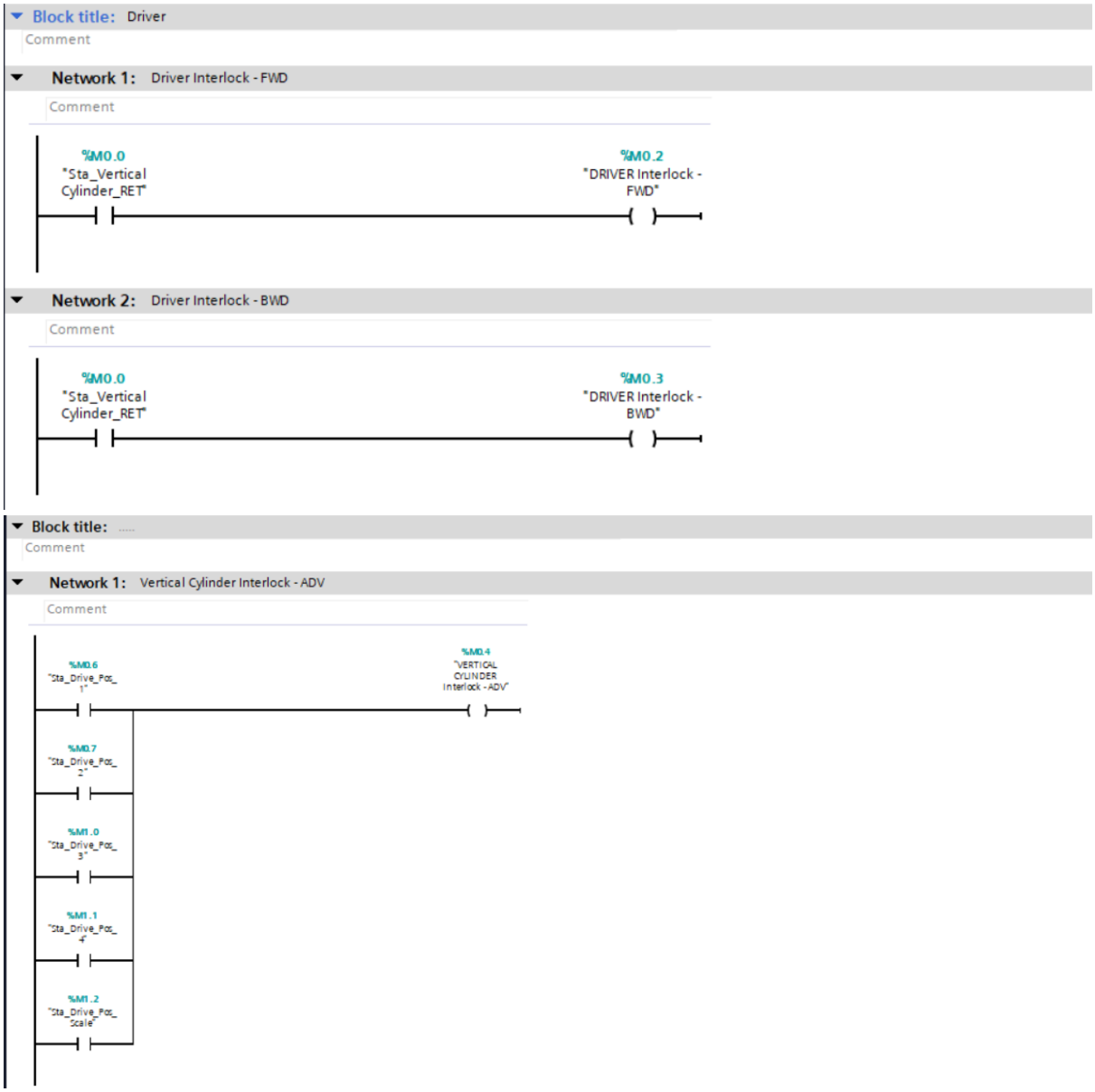
1. Station to be programmed



2. Rough interlocking calculations

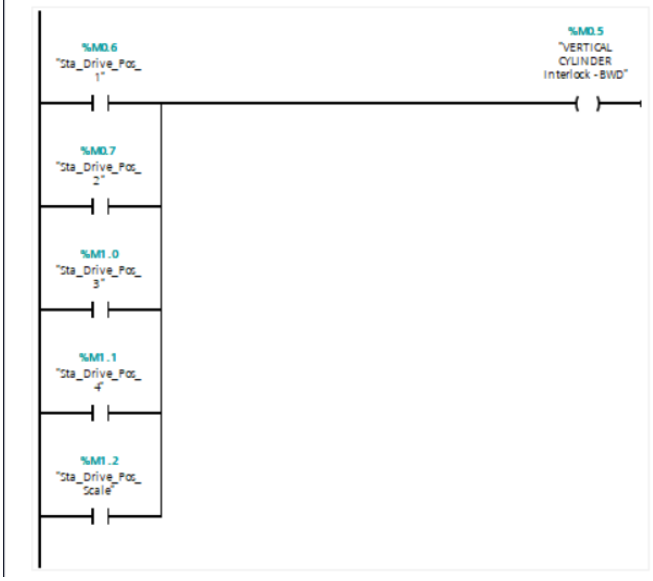


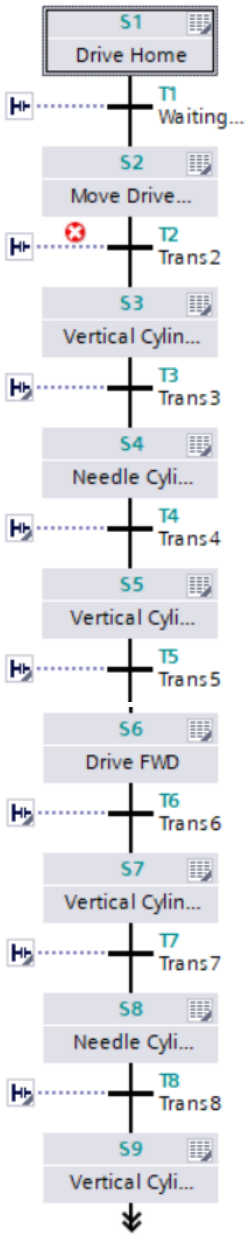
Appendix D: Programming in TIA Portal: Interlocks



Network 2: Vertical Cylinder Interlock - BWD

Comment




S1
Drive Home
T1
Waiting...
S2
Move Drive...
T2
Trans2
S3
Vertical Cylin...
T3
Trans3
S4
Needle Cyli...
T4
Trans4
S5
Vertical Cyli...
T5
Trans5
S6
Drive FWD
T6
Trans6
S7
Vertical Cylin...
T7
Trans7
S8
Needle Cyli...
T8
Trans8
S9
Vertical Cyli...

Tag Table

		Name	Data type	Address	Retain	Acces...	Writa...	Visibl...
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2		Sta_VerticalCylinder_ADV	Bool	%M0.1	☐	☑	☑	☑
3		DRIVER Interlock - FWD	Bool	%M0.2	☐	☑	☑	☑
4		DRIVER Interlock - BWD	Bool	%M0.3	☐	☑	☑	☑
5		VERTICAL CYLINDER Interlock - ...	Bool	%M0.4	☐	☑	☑	☑
6		VERTICAL CYLINDER Interlock - ...	Bool	%M0.5	☐	☑	☑	☑
7		Sta_Drive_Pos_1	Bool	%M0.6	☐	☑	☑	☑
8		Sta_Drive_Pos_2	Bool	%M0.7	☐	☑	☑	☑
9		Sta_Drive_Pos_3	Bool	%M1.0	☐	☑	☑	☑
10		Sta_Drive_Pos_4	Bool	%M1.1	☐	☑	☑	☑
11		Sta_Drive_Pos_Scale	Bool	%M1.2	☐	☑	☑	☑
12		Sta_Mat_Pos	Bool	%M1.3	☐	☑	☑	☑
13		<Add new>			☐	☑	☑	☑