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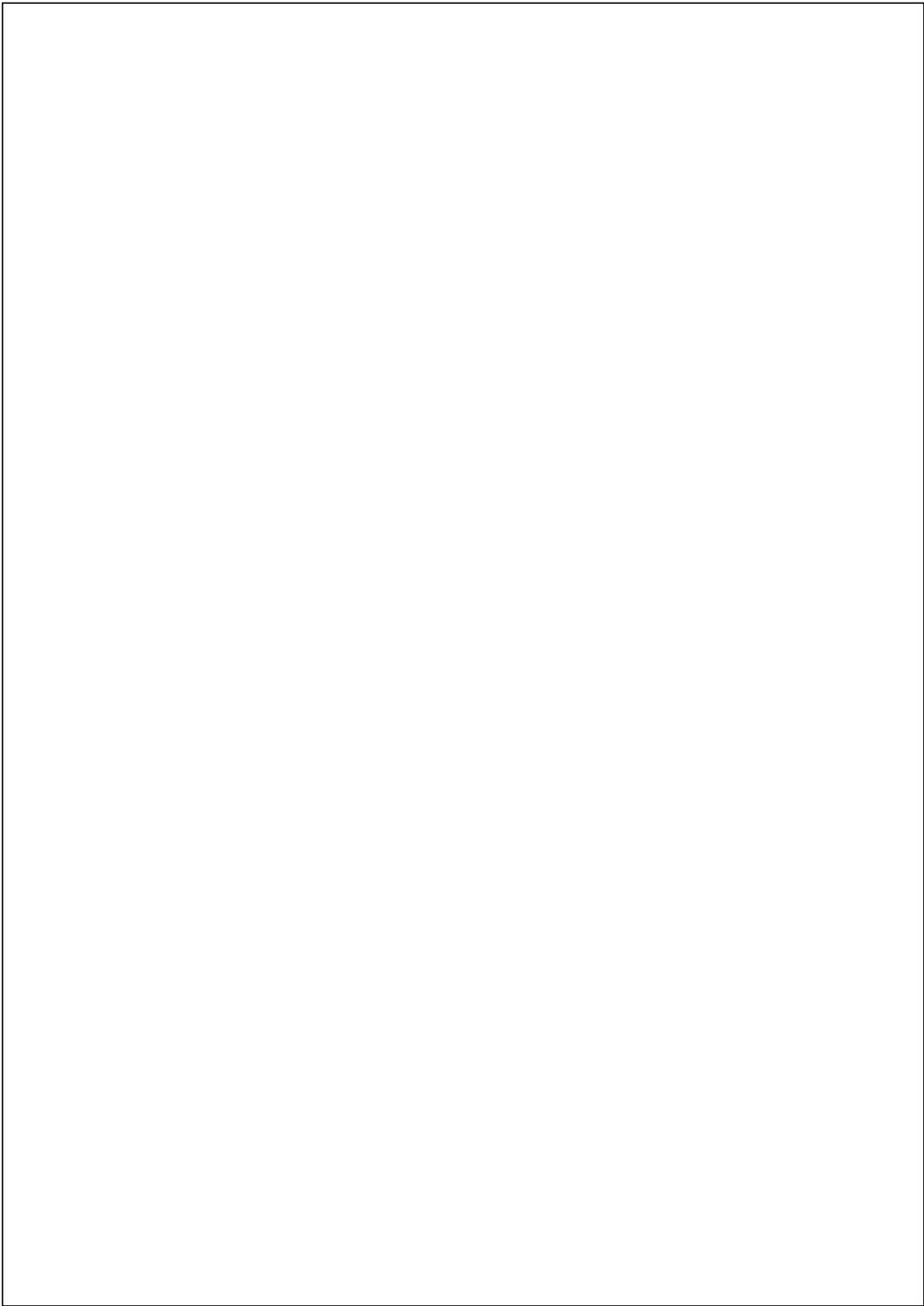


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Good extensive and detailed list of figures

Introduction

The project Aims to address the restoration and enhancement of the rotating turntable present within the lab at the college. The system contains a rotary indexing table, which has automated drilling and tapping workstations placed on each side. The system uses multiple substations which perform different machining operations on an object which are loaded and unloaded using robotic arms which are controlled by a separate system. *Good points*

There are three main workstations which comprise the system.

- Rotary index table (turntable)
- Drilling and tapping units for machining operations *Good points*
- Loading and unloading Robotic arms (external)

The drilling and tapping units utilise a DC motor to operate the spindle of the machine, whilst the Y axis movement is controlled via pneumatic bank. The turntable is controlled using a motor with a gearbox for precise movement which is controlled by a PLC and Driver. *Good points covered*

Issue statement

The main engineering problems that require addressing is the outdated methods of control for all the subsystems, the inability to alter the control systems compromises the function of the entire rig, stopping the flow of objects from system one to three, along with this the objects will not receive the required machining operations. As the central operating system, the turntables functionality is paramount for the operation of the entire system. *Good and informative*

Project aims and objectives

The project aim is to understand and identify the issues involved in the current system installed, these could include malfunction devices or outdated hardware and software. When The issues have been identified, repair and optimisation will need to be carried out to rectify the issues present to restore functionality.

Objectives

The sequential objectives of this project are as follows:

1. Comprehensive of fault diagnosis covering mechanical and electrical functions.
2. Implement repair and maintenance of the system if faults arise.
3. Ensure systems control operations are functioning as intended and implement new control unit and reprogram manual and automation sequencing.
4. Perform tests of drilling, tapping and turntable operations, when each system is verified to function as intended. Then the entire system will be tested with automatic sequencing to ensure the device interact as intended.

Each sub objective will result in complete functionality returning to the turntable system which will allow the complete three system operation to return to full operational capacity.

Good work

Background research

Programmable logic controller (PLC)

This section of the report will contain the background research to help understand the processes that could be used to accomplish our desired outcomes. The method of control that was used in the project was Programmable logic controller (PLC). A PLC is a industrial controller which I heavily used in the automation and control of electrical systems in the manufacturing, industrial systems and machinery.

These controllers are specifically designed to be rugged and deal with heavy industrial environments, the device can monitor inputs, make logic-based decisions based upon these outputs, the make the necessary outputs for the automation of machinery.



(Parmley Graham, n.d.)

The CPU of the device utilizes the information stored within the memory to make logic-based decisions. I/O modules will be connected to the relevant devices internal to the machine, for example the inputs will receive information from sensors and switches, based upon these inputs' logic operations will be determined and sent through the Output terminal to actuators for example motors.

A Programming software is required to allow control procedures to be implemented by software such as TIA Portal for siemens systems or Studio 5000 for Allen Bradley. There is several coding methods used in PLC systems, the first being simple ladder logic. (Schneider electronics, 2022)

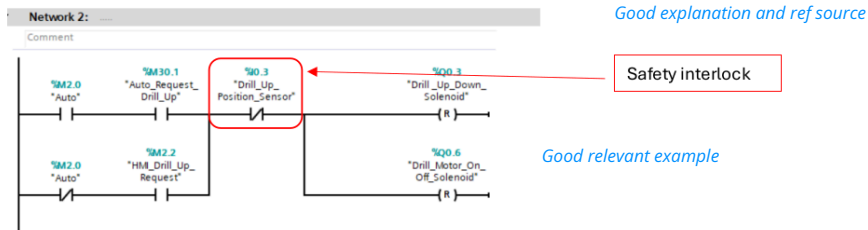


Figure 1 Ladder logic example

This system allows the control of basic processes; this could be that when a command is requested certain safety conditions would have to be met to allow the actuation of a motor. Along with this the choice between automatic and manual operation.

The next format for PLC programming is the "FBD" Design method, this system can be used for more advanced operations such as arithmetic calculations, an example of a timer function block is given below.

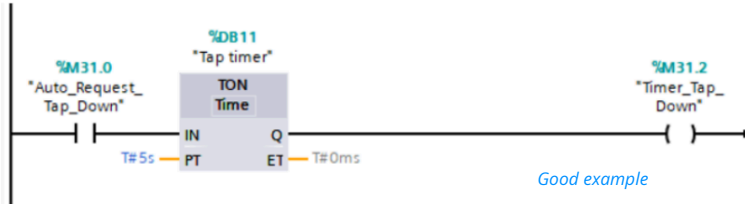


Figure 2 FBD Example

From the example it can be seen the process is built into the block instead of heavy amount of coding to perform an action, it simplifies and speeds up design procedures.

The final coding language is "SCL", this coding format is far closer to the traditional C programming design, where operations are written in lines of code. An example of SCL is given below.

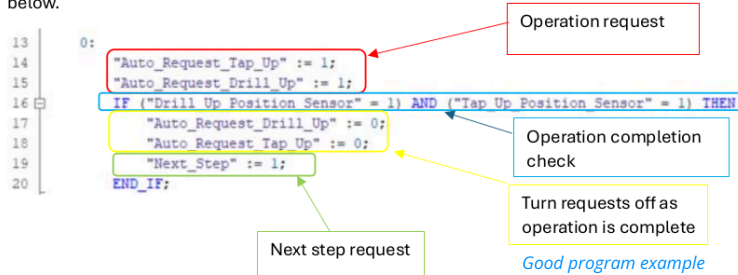


Figure 3 SCL Example and explanation

This format is primarily used in automatic sequencing of operations, First a request of series of requests is made, which reverts back to the main program to check for safety interlocks before movement, the system then checks to see if the step has been complete through the use of sensors, finally when the sensors are actuated the request is stopped and the program moves to the next step. This will continue until all steps in the case statement are complete. (Aghajani, n.d.)

Excellent work here

Motor Driver

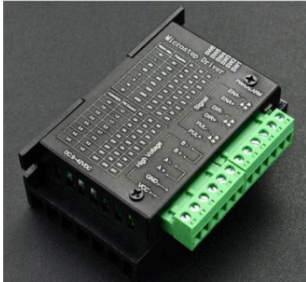
A driver is used in industrial operations as an interfacing device between the controller for example a PLC or microcontroller and a mechanical actuator for example in this case an electrical motor.

The device will take a low power control signal and then supply a high-power signal to the device. Depending on the device used will determine the driver's ability to precisely control speed, position and torque control. A lot of modern drivers can vary the pulses per revolution (P/R) which allows the engineer to vary the accuracy.

Good points

Another feature provided by the device is protection operations, providing over-current, open-voltage and thermal shut-down to prevent damage for both the actuator or solenoid as well as the control system. (Robocraze, n.d.)

This is a good feature of modern drivers



(ThePIHut, n.d.)

Good citations

Figure 4 Motor Driver

Pneumatic bank

A pneumatic bank also known as a pneumatic manifold with solenoid valves is commonly used in automation systems, this bank holds multiple pneumatic valves in one singular unit which can be expanded upon if the system requires it, giving a modular solenoid solution. It will deliver pneumatic pressure to solenoids which in this project will be the Y-axis control for the robotic drill and tap, the PLC will issue a signal to set and reset the valve within the bank. (Peterson, 2022). The pressure is delivered from an external air compressor.

Very good features researched relevant to this project



(Omega, n.d.)

Figure 5 Solenoid bank

Specification

Project description and outcomes

The project's focus is primarily the restoration and function of the rotating turntable, allowing the complete rig to return to operation. This turntable is essential in the operation of the system as it performs critical machining and sequencing operations for the entire Rig.

The scope of the function includes the diagnosing of mechanical, electrical and control faults and when found the replacing or repairing of the components to achieve this goal.

The anticipated outcome of this project is the complete functional restoration which includes automatic sequencing with manual control, along with this the technical adjustments will be documented to ensure ease of maintenance and troubleshooting for the future.

Project objectives

The first objective is to fully understand the motor, gearbox and driver components to ensure understanding of mechanical functions for example the pulses per revolution, along with this ensure no mechanical issues are present like gearbox teeth missing etc. The electrical system will be inspected to see if the system can be adjusted to meet the requirements of the circuit, The controller will need to be updated in terms of software and perhaps full controller replacement may be necessary, along with this all terminations and connections will need to be inspected and adjusted if required. Due to the time since its last function the driver may need replacing, along with that adjustments to the driver may be required based on motor replacements.

Upon completion of the system alterations and restoration a testing procedure will begin to ensure the system performs to the specification and requirements outlined, upon completion of the testing documentation will be completed to document the programming, electrical schematic and operating guides can be constructed to ensure future maintenance if required can be carried out with ease.

Time and budget

The project does have pre agreed upon time and budgeting constraints. The budgeting constraint is a total of £1,826.

- ▶ PLC and TIA Portal software - £400
- ▶ Laptop with Minimum 16GB RAM - £750
- ▶ Pneumatic cylinders and bank - £350
- ▶ Proximity sensors - £60
- ▶ DM556 V3.0 Driver - £36.48
- ▶ High torque CNC stepper motor - £31.33
- ▶ Turn table – £200

Figure 6 Price allocation

The project will be scheduled for completion by 18/4/2025. A Gantt chart will be constructed to ensure that the project stays on track to the timescale.

Health and Safety requirements

The health and safety requirements of this project is of paramount importance. The systems mechanical features must have safety interlocks for system and operator protections, magnetic sensors will be placed on the doors and interlocks will be input into the code, to stop any movement when operators have access to the internals of the system or two clashing mechanical operations taking place at the same time. *Good point about purpose of interlock*

All operations will have relevant risk assessments for each operation to identify hazards present for example electrical shock, trapping and pneumatic failures, these will be mitigated using guarding systems, necessary PPE, emergency stops and safe systems of operations.

Environmental protection and sustainability

When carrying out the construction of this project, environmental factors will be considered, first the motor will have an enable function which will allow power to be removed when not being utilised, stopping un-wanted power usage and heat being used when not required. More software will be utilised as this will reduce overall power consumption of the circuit; another benefit is that software systems have a lower rate of replacement than mechanical devices such as relays which is a more sustainable method of control. In the current circuit all components that can be reused will be and only necessary changes will be made again to increase the sustainability of the circuit. *Good arguments*

Planning

For monitoring project progression in relation to the timescale a Gantt chart was constructed, this chart allocates time to certain milestones in the project from start to finish, below the estimated time a real time indicator will be placed to compare the values to see if the project is on schedule.

- Planning will first be carried out to determine the optimal way to approach the different aspects in the project.
- Research will then be planned out on several solutions to achieve the outcomes of the project.
- When the research has been conducted in depth the materials and components can be gathered to complete the project.
- An overall design can then be constructed for both mechanical and electrical functions.
- A plan can be created for the software side of the project, to understand what is needed for the control and how to implement it.
- A design can then be constructed to perform all tasks required for the system and outlined in the planning phase on an external system to ensure safety for the engineer and system itself.
- This phase will incorporate the integration of any components that are needed for replacements.
- When the software has been verified as functioning it can be implemented into the main system.

- When all systems have been integrated into the rig testing can begin testing the overall functionality of the circuit and if it performs each task as required.

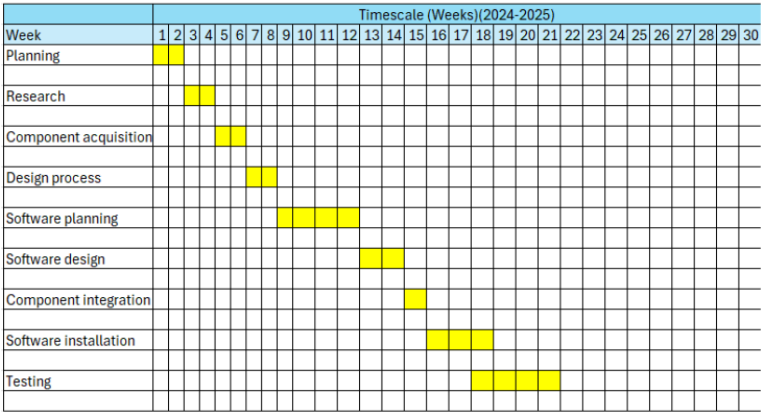


Figure 7 Project timescale Gantt chart *Good project plan*

Solutions

When considering the method of control of the turn table, three potential solutions were constructed, the positives and negatives of each method were looked at and a final solution was decided on.

Solution one – Mitsubishi Melsec

The first potential method of control was the use of the Mitsubishi Melsec FX1S-30MR-DS PLC that is currently already installed within the panel.



Figure 8 Mitsubishi Melsec FX1S-30MR-DS Picture

Positives

- This method of control offers a cost-effective means of controlling the I/O of the system
- PLC Controllers operate on a simple I/O layout which offers an easy method of wiring and troubleshooting of the physical design
- This controller although limited due to age will be capable of controlling the system as there is limited I/O and no requirement for fast changing variables.
- Wide range of support due to the device being a large company allowing easy means of replacement should the PLC fail in the future.
- The PLC is already wired into the system meaning no installation is required.
- No cost for physical device as it already presents within the college.
- Better environmental benefits through software control than hardwired controls

Negatives

- This device is an older model therefore there are alternative controllers with faster processing speeds like the Siemens 1214C.
- This method has a very limited means of expansion should there be need of further control required.
- Programming software GX Works has a large learning curve which will present issues to the engineer if they are not familiar with the software.

*A good solution forth system
Ref source should be used here*

Solution two – Industrial Relay and Timer Bank

The second solution considered for the control of the system was a hard-wired approach using industrial relays and timer banks.



Figure 9 Industrial Relays and timer banks

Positives

- Due to this design being a hard-wired method of control there will be no programming required for the system.
- Can be easy to understand electrically for trained personnel.
- The control method is relatively cheap due to there being no advanced methods of control like PLC's or Microcontrollers.
- This system is suitable for basic systems where there are no requirements for advanced operations for example repetitive operations.

Negatives

- This method offers very limited means of expandability, scalability and flexibility as minor adjustments require rewiring of the physical components.
- This method needs large control panels for even moderately complex systems as the control systems have large footprints.
- Can be very difficult to troubleshoot due to the large number of components and wires present within the circuit. On top of this hard-wired logic can be difficult to visualize to find the root cause of the issues.
- The system offers no diagnostic feedback or remote monitoring systems which can cause issues should a fault arise.
- Unsuitable for integration into modern larger systems and robotics as there are far more efficient methods of control.
- The system can become unreliable over time due to the mechanical wear of the components which could lead to difficult to find faults.
- This system is not environmentally sustainable as hard-wired systems typically have far larger power requirements.

Good arguments and supporting image

Ref source should also be included

Solution three

The final solution that was considered is the use of a Siemens S7-1214C PLC. This method offers a compact and modular solution for control. This system is capable of being integrated into larger systems with use of the Profinet communication and offers a visual HMI for the operator and engineer.



Figure 10 Siemens S7-1214C

Positives

- High processing capabilities for logic and sequencing for real-time automation tasks.
- Has integrated I/O both digital and analogue and can be further expanded using modules if expansion is required.
- Easy integration into larger control networks through expansion network banks.
- TIA portal offers a very user-friendly programming environment with diagnostic feedback.
- The devices and software are currently in the college and are used in both systems connected to the project which will allow for further integration in the future.

- The system is environmentally friendly as the control is done using one PLC and not high level of hardware components.

Negatives

- The control system has a high upfront cost for the PLC and HMI units.
- The software required for the system to work is very expensive.
- The learning curve for understanding the software can be very steep to get the full scope of the software's capabilities.

The large amount of the negatives discussed for this solution is negligent as all the components and software are currently present and can be utilised in the college. *Good arguments for this solution*

Solution comparison table

A comparison table was then constructed to visualize each factor and draw conclusions on which method of control is the most suitable for the projects system.

Factor	Siemens 1214C	Mitsubishi Melsec	Relay and timer bank	<i>Good evaluation table</i>
Flexibility	Highly flexible with motion control, several configurable coding systems	Moderate flexibility with ladder logic and limited memory storage	Very limited, any logic adjustments will require rewiring	
Physical size	Din Rail mounted with potential modular expansion	Din rail mounted but limited expansion potential	Large footprint for basic systems	
Scalability	Can be scaled using modular expansion, HMI's and network systems	Limited scalability due to lack of I/O adjustment	No scalability as the logic can only be adjusted through rewiring of system	
Maintenance	Easy maintenance through diagnostic tools, status tracking and online monitoring	Moderate maintenance as system has limited fault diagnostic methods	Very poor, requires fault finding through large wiring circuits and components	
Cost	PLC - £344 HMI - £200 Total - £544	PLC - £300	Dependant on size Relay - £15 Timer - £50	
Integration	Can be integrated into modern industrial systems	Limited integration due to outdated hardware and software	Cannot be integrated into larger circuits	
Program familiarity	High levels of program familiarity	GX software would be a new software entirely	No experience but basic wiring concepts so low learning curve	
Suitability	Highest level of suitability for the project	Could potentially be utilised	Would be largely unsuitable	
Environmental impact	Software based controller so it limits required hardware	Software based controller so it limits required hardware	High amount of physical components leading	

	lowering overall power usage	lowering overall power usage	to a high-power requirement. Also, replacement of components will be required and high levels of wire usage leading to a large environmental impact
--	------------------------------	------------------------------	---

Figure 11 Solution comparison table

Chosen solution justification

The chosen solution is the Siemens S7-1214C. This method of control was chosen due to its high level of processing power, the level of scalability and its ability to integrate with other systems that use robotics and pneumatic banks if required. Another crucial factor is that both the hardware and software are currently within the college, both systems on each side of the rotating table are controlled using a Siemens PLC so future development is possible. The software will not be as large of a learning curve through previous experience developing systems using TIA Portal, this will allow progression to take place at a faster rate with a reduced potential for issues arising from mistakes.

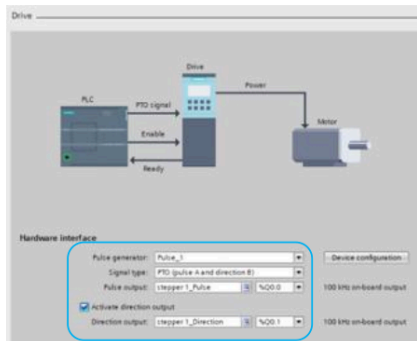
The Mitsubishi MELSEC although already wired to the Rig and is cost effective, its ability to control the system is very limited in comparison to the 1214C. The system would require unnecessary software adaptation with the requirement to learn the software whilst developing the program. The program has very limited scalability should more operation be added to the system and integration into the communication network with two other PLCs for the press and intake wouldn't be possible.

The Relay and timer bank solution was deemed not suitable due to its lack of flexibility, lack of diagnostic assistance and its lack of ability to support the complexity of the automation sequence required for the system. *Good arguments put forward for the justification*

Final solution and implementation

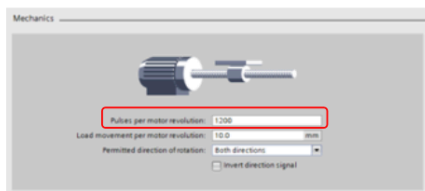
The final solution will be to replace the current Mitsubishi MELSEC with a more modern and easily integrated Siemens S7-1214C. The main challenge of implementing this solution is first discovering the wiring layout of the rig and matching it up to the I/O for the Siemens.

The first step in implementation was to understand the mechanical design of the rig, the pulses per revolution needed to be understood to properly and accurately move the turn table to each station, to figure this out a motor system was constructed external to the mechatronics rig. A motion control block was then constructed in the Siemens 1214C to declare the pulses per/rev and the I/O for forward and reverse of the motor along with the speed. The MC block is shown below.



Good identification of parameters

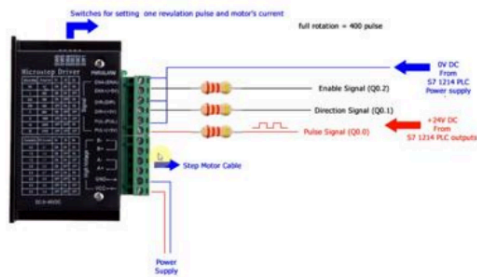
Figure 12 MC Drive control



Parameters identified

Figure 13 MC Pulse per revolution declaration

The PLC was then connected to a DM556 Driver which has optional dip switches to adjust the on-board accuracy changing the PPR. A diagram of the connections is shown below.



This is very good technical development

Figure 14 DM556 Wiring diagram

Once the system was wired up correctly basic manual functions were added to see if the test motor would run at different speeds accurately. A 90-degree, 180-degree and 270-degree range of motion. A mark was then placed on the zero quadrant and a visual test took place. Once it was verified that this operation was being carried out accurately the program could be implemented into the project rig.

The I/O was then mapped across from the Mitsubishi to the Siemens PLC, The IO mapping tables are shown below.

Input	1214C	Melsec
Drill up sensor	I0.3	X0
Drill down sensor	I0.4	X1
Tap Up Sensor	I0.5	X2
Tap Down sensor	I0.6	X3
Table Index	I0.7	X4
Cap sensor	I1.0	X17

Good work here

Figure 15 Input mapping

Outputs	1214C	Melsec
Index	Q0.0	Y0
Index direction	Q0.1	Y1
Drill up/down	Q0.3	Y2
Tap up/down	Q0.5	Y3
Index table lock	Q0.4	Y4
Drill motor on	Q0.6	Y5
Tap Motor on	Q0.7	Y6
Tap Motor reverse	Q1.0	Y7

Good work with mapping io

Figure 16 Output Mapping

Now that the I/O mapping has been tabulated the PLC can be rewired, the image given in the appendix shows the new PLC wired into the rig. Now that the PLC has been integrated into the new circuit the manual code can be created using Ladder and FBD formats, these are shown below.

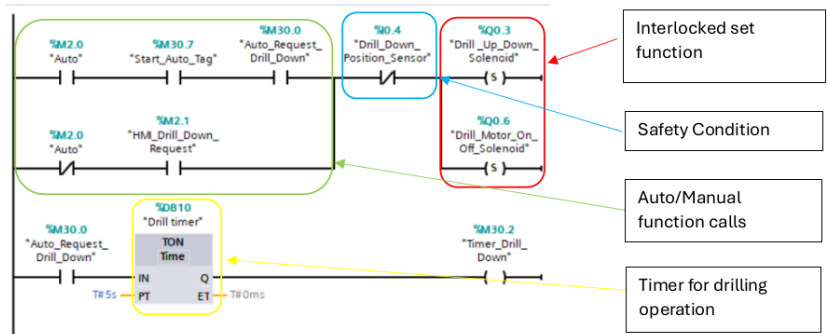


Figure 17 Ladder Logic example

This is excellent work. The timer is a great

Another important function to explain is the motion control FBD which takes the motion control function in to account to measure revolutions moved.

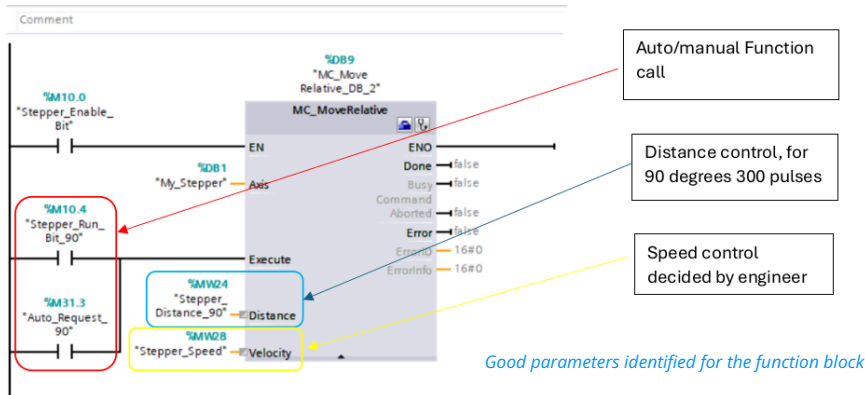


Figure 18 Motion control FBD

All other Ladder logic and FBD rungs operate on a very similar layout to the two covered above, auto functions have been placed in these rungs in preparation for automatic sequencing.

A HMI Was constructed to enable testing of the manual features of the system to confirm the I/O match up with the relevant controlled component. The HMI is given below.

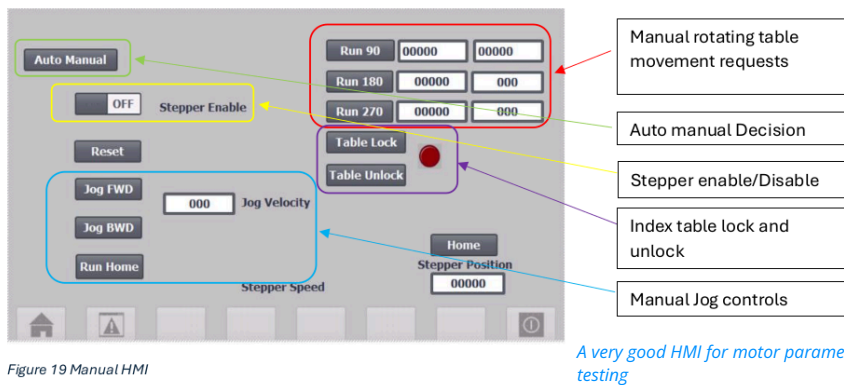


Figure 19 Manual HMI

A very good HMI for motor parameter testing

From this page all manual commands can be tested for functionality, this screen has been designed to be locked away for engineer use only. All manual controls can be seen in the appendix of the report. *Good point as this function allows any speed or distance to be set and tested*

Once all manual controls were verified to function as intended the automatic sequencing can be constructed. The design was to have a maximum of two counters on the turntable at any given time, the sequence would have a total of 14 steps which would operate in a cycle performing all machining tasks then being unload into the press. The sequence is given below.

```

1 IF ("FirstScan" = 1) OR ("Auto" = 0) OR ("Reset_Sequence" = 1) THEN
2   "Step" := 0; //reset all values to zero
3   "Next_Step" := 0; //this includes the step number
4   "Auto_Request_Drill_Down" := 0;
5   "Auto_Request_Drill_Up" := 0;
6   "Auto_Request_Tap_Down" := 0;
7   "Auto_Request_Tap_Up" := 0;
8   "Auto_Request_90" := 0;
9 END_IF;

```

Figure 20 SCL Automation first scan

When the auto mode sequence is actuated, the program will call for all requests to be zero to ensure there are no clashing requests from previous operations, when this verified to be true it will move into the sequence.

```

13 0:
14   "Auto_Request_Tap_Up" := 1;
15   "Auto_Request_Drill_Up" := 1;
16 IF ("Drill_Up_Position_Sensor" = 1) AND ("Tap_Up_Position_Sensor" = 1) THEN
17   "Auto_Request_Drill_Up" := 0;
18   "Auto_Request_Tap_Up" := 0;
19   "Next_Step" := 1;
20 END_IF;

```

Auto request placed

Condition check

Parameters of sequence are identified

Request removal when conditions are met

Figure 21 Drill up and Tap up control

This code is to ensure that all machining operations are in the up position before any turntable movement can begin. When all safety requirements have been completed the table can begin to move.

```

22 1:
23   // IF "Index_Table_Ref_Position_Sensor" = 1 THEN
24     "Auto_Request_90" := 1;
25   // END_IF;
26 IF "MC_MoveRelative_DB_2".Done = 1 THEN
27   "Auto_Request_90" := 0;
28   "Next_Step" := 2;
29 END_IF;

```

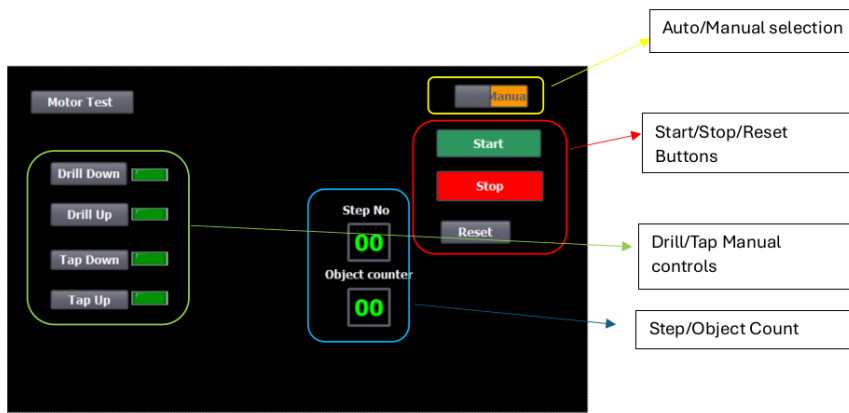
Figure 22 90-degree movement request

This sequence operates on a very similar layout to the previous auto step where a request is placed, a check to see if a condition has been met, then a request removal before moving on to the next step.

The remaining steps of the Automatic sequencing can be found in the appendix in a SCL format.

A screen was constructed to accommodate the functions required for the automatic sequencing; this screen is designed to be used by an operator.

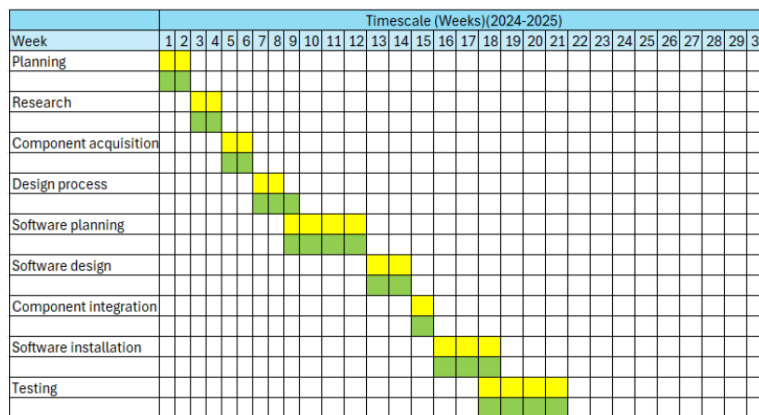
Good explanation



Good HMI design with manual and auto options

Time management

A Gantt chart was kept up to date for the entire process giving feedback on project development and keeping of track of targets against time. The Gantt chart is shown below.



As seen from the Gantt chart all project milestones were achieved within their allocated timescales, and the project was finished by the predetermined date of completion.

Now that all implementation steps have been completed the testing of the circuit can begin to verify that the circuit operates as intended. *Good plan with comparator timeline*

Testing

The testing covers all manual and automatic functions involved in the project, below are tables that contain what conditions should be met at each step, if the step has passed or failed the steps and the reference to the evidence in the appendix of the report.

Stop, Start, Auto/Manual and Reset function test

Test No	Start	Stop	Step count	Auto / Man	Reset	Pass / Fail	Ref.No
1	on	off	3	auto	off	P	Fig 26
2	on	off	0	auto	on	P	Fig 27
3	off	on	0	man	off	P	Fig 28
4	on	off	0	man	off	P	Fig 29

Sequence test (Manual)

Good table of results

Test No	Motor -300	Motor 600	Motor 900	Home	Position	Table lock	Pass / Fail	Ref .No
1	on	off	off	off	-300	on	P	Fig 30
2	off	on	off	off	300	on	P	Fig 31
3	off	off	on	off	1200	on	P	Fig 32
4	off	off	off	off	1200	on	P	Fig 33
5	on	off	off	off	1500	on	P	Fig 34
6	off	off	off	on	0	on	P	Fig 35

Good table of results

ON / OFF Enable test

Test No	Enable	Motor functions	Pass / Fail	Ref. No
1	on	on	P	Fig 36
2	off	off	P	Fig 37

Good test results

Auto Sequence test

Step No	Table position	Drill position	Tap position	Counter	Step display	Pass / Fail	Ref.No
0	0	up	up	1	0	P	Fig 38

1	-300	up	up	1	1	P	Fig 39
2	-300	down	up	1	2	P	Fig 40
3	-300	up	up	1	3	P	Fig 41
4	300	up	up	1	4	P	Fig 42
5	300	up	up	1	5	P	Fig 43
6	300	up	down	1	6	P	Fig 44
7	300	up	up	2	7	P	Fig 45
8	0	up	up	2	8	P	Fig 46
9	0	down	up	2	9	P	Fig 47
10	0	up	up	2	10	P	Fig 48
11	600	up	up	2	11	P	Fig 49
12	600	up	up	2	12	P	Fig 50
13	600	up	down	1	13	P	Fig 51
14	600	up	up	0	14	P	Fig 52

Good extensive test results

Conclusions and recommendations

The Project has successfully achieved its primary objectives which was to restore the functionality and reintegrating the rotating turntable, automatic drilling and tapping operations into the overall system. The table is now fully functional indexing workpieces into relevant machining stations operating in conjunction with pneumatic actuators, DC motors for machining tools and robotic loading and unloading arms. To achieve this thorough research, adhering to specifications, component analysis, correct methods of implementation and detailed testing systems were necessary. *Good point covered*

A detailed review of three separate solutions were considered and constructed and analysis into comparative factors was conducted to determine the ideal solution for the system, the final decision being the use of a Siemens S7-1214C PLC. A major factor is the familiarity with the software and both hardware and licensing already being present within the college, giving a cost-effective and time efficient resolution to the project.

All system adjustments were carried out practically leading to a rewire of the PLC system, Software control was developed using the TIA portal and testing was carried out to ensure that the system developed met the requirements of the specification and integration into the rig.

The system was tested against the performance, reliability and safety, diagnostic features were used providing real-time feedback and fault detection, allowing for fast maintenance.

The project met the requirements for timelines and budget requirements with no breaches of time constraints or expenses.

To conclude the project was successful demonstrating the requirement of system integration and planning using both technical and user requirement criteria. The project showed high levels of engineering practices using methodical design along with all adherences to working in a safe environment.

Good conclusion

Recommendations

There are several recommendations for the project moving into the future that could be implemented.

The first recommendation would be to integrate E-stops to the circuit, although there are a lot of safety features built into the code of the system, further mechanical e-stop buttons could be built into the external of the rig.

Good recommendation

Another recommendation would be to enhance energy efficiency with greater monitoring of machine idle conditions; this could be accomplished using encoders on the motors or inductive sensors for better turntable feedback.

Good recommendation and this is possible from the control function blocks

A third recommendation would be to incorporate a “get” and “put” function to the PLC where it would take information from the intake section and put information to the output section, this would further increase section integration of the machine creating a more integrated design.

Good future recommendation

A final recommendation would be to change the gearbox currently on the rotating table, with greater amounts of “teeth” on the motor it could increase accuracy and the amount of error whilst working at high speeds.

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Good number of ref sources

Appendix

Addresses (INPUTS)	
Cylinder Position	Input Address
DRILL UP Position	X0
DRILL DOWN Position	X1
TAP UP Position	X2
TAP DOWN Position	X3
INDEX TABLE REF/Position	X4
SPARE	X5
SPARE	X6
SPARE	X7
PUSH BUTTON	X10
PUSH BUTTON	X11
PUSH BUTTON	X12
TOGGLE SWITCH	X13
TOGGLE SWITCH	X14
SPARE	X15
SPARE	X16
CAPACITIVE SENSOR	X17

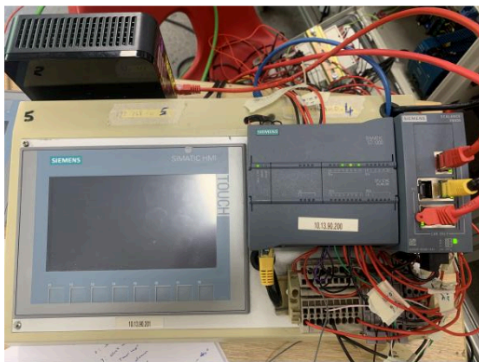
Good io data acquired

Figure 23 Mitsubishi Inputs

Addresses (OUTPUTS)	
Action	Output Address
INDEX	Y0
INDEX Direction	Y1
DRILL Down/Up	Y2
TAP Down/Up	Y3
INDEX Table Lock Cylinder	Y4
DRILL MOTOR On	Y5 R
TAP MOTOR On	Y6 R
TAP MOTOR Reverse	Y7 R

Good data acquired

Figure 24 Mitsubishi Outputs



Good image

Figure 25 Siemens PLC Wiring

	Name	Address	Display format	Monitor value	Modify value	
1	"Stepper_Home_..."	%I0.0	Bool	☐ FALSE	TRUE	
2	"Stepper_back_Li..."	%I0.1	Bool	☐ FALSE		
3	"Stepper_front_Li..."	%I0.2	Bool	☐ FALSE		
4	"Drill_Up_Positio..."	%I0.3	Bool	☒ TRUE		
5	"Drill_Down_Posit..."	%I0.4	Bool	☐ FALSE		
6	"Tap_Up_Position..."	%I0.5	Bool	☒ TRUE		
7	"Tap_Down_Posit..."	%I0.6	Bool	☐ FALSE		
8	"Index_Table_Ref..."	%I0.7	Bool	☐ FALSE		
9	"Capacitive_Sens..."	%I1.0	Bool	☐ FALSE		
10	"Stepper_Pulse"	%Q0.0	Bool	☐ FALSE		
11	"Stepper_Direction	%Q0.1	Bool	☐ FALSE		
12	"Drill_Up_Down_..."	%Q0.3	Bool	☐ FALSE		
13	"Table_Lock_Sole..."	%Q0.4	Bool	☐ FALSE		
14	"Tap_Up_Down_S..."	%Q0.5	Bool	☐ FALSE		
15	"Drill_Motor_On_..."	%Q0.6	Bool	☐ FALSE		
16	"Tap_Motor_On_..."	%Q0.7	Bool	☐ FALSE		
17	"Tap_Motor_Reve..."	%Q1.0	Bool	☐ FALSE		
18	"Seq_Run"	%M0.5	Bool	☒ TRUE		
19	"Start Sw"	%M0.3	Bool	☐ FALSE		
20	"Reset_Step_Sequ..."	%M1.5	Bool	☐ FALSE		
21	"Stop Sw"	%M0.4	Bool	☐ FALSE		

Figure 26 Manual/Auto test one

	Name	Address	Display format	Monitor value	Modify value	
1	"Stepper_Home_..."	%I0.0	Bool	☐ FALSE	TRUE	
2	"Stepper_back_Li..."	%I0.1	Bool	☐ FALSE		
3	"Stepper_front_Li..."	%I0.2	Bool	☐ FALSE		
4	"Drill_Up_Positio..."	%I0.3	Bool	☒ TRUE		
5	"Drill_Down_Posit..."	%I0.4	Bool	☐ FALSE		
6	"Tap_Up_Position..."	%I0.5	Bool	☒ TRUE		
7	"Tap_Down_Posit..."	%I0.6	Bool	☐ FALSE		
8	"Index_Table_Ref..."	%I0.7	Bool	☒ TRUE		
9	"Capacitive_Sens..."	%I1.0	Bool	☒ TRUE		
10	"Stepper_Pulse"	%Q0.0	Bool	☐ FALSE		
11	"Stepper_Direction	%Q0.1	Bool	☐ FALSE		
12	"Drill_Up_Down_..."	%Q0.3	Bool	☐ FALSE		
13	"Table_Lock_Sole..."	%Q0.4	Bool	☐ FALSE		
14	"Tap_Up_Down_S..."	%Q0.5	Bool	☐ FALSE		
15	"Drill_Motor_On_..."	%Q0.6	Bool	☐ FALSE		
16	"Tap_Motor_On_..."	%Q0.7	Bool	☐ FALSE		
17	"Tap_Motor_Reve..."	%Q1.0	Bool	☐ FALSE		
18	"Seq_Run"	%M0.5	Bool	☒ TRUE		
19	"Start Sw"	%M0.3	Bool	☐ FALSE		
20	"Reset_Step_Sequ..."	%M1.5	Bool	☒ TRUE		
21	"Stop Sw"	%M0.4	Bool	☐ FALSE		

Figure 27 Manual/Auto test two

	Name	Address	Display format	Monitor value	Modify value	
1	"Stepper_Home_..."	%I0.0	Bool	☐ FALSE	TRUE	
2	"Stepper_back_Li..."	%I0.1	Bool	☐ FALSE		
3	"Stepper_front_Li..."	%I0.2	Bool	☐ FALSE		
4	"Drill_Up_Positio..."	%I0.3	Bool	☒ TRUE		
5	"Drill_Down_Posit..."	%I0.4	Bool	☐ FALSE		
6	"Tap_Up_Position..."	%I0.5	Bool	☒ TRUE		
7	"Tap_Down_Posit..."	%I0.6	Bool	☐ FALSE		
8	"Index_Table_Ref..."	%I0.7	Bool	☐ FALSE		
9	"Capacitive_Sens..."	%I1.0	Bool	☒ TRUE		
10	"Stepper_Pulse"	%Q0.0	Bool	☐ FALSE		
11	"Stepper_Direction	%Q0.1	Bool	☐ FALSE		
12	"Drill_Up_Down_..."	%Q0.3	Bool	☐ FALSE		
13	"Table_Lock_Sole..."	%Q0.4	Bool	☐ FALSE		
14	"Tap_Up_Down_S..."	%Q0.5	Bool	☐ FALSE		
15	"Drill_Motor_On_..."	%Q0.6	Bool	☐ FALSE		
16	"Tap_Motor_On_..."	%Q0.7	Bool	☐ FALSE		
17	"Tap_Motor_Reve..."	%Q1.0	Bool	☐ FALSE		
18	"Seq_Run"	%M0.5	Bool	☐ FALSE		
19	"Start Sw"	%M0.3	Bool	☐ FALSE		
20	"Reset_Step_Sequ..."	%M1.5	Bool	☐ FALSE		
21	"Stop Sw"	%M0.4	Bool	☐ FALSE		
22	"Stepper_Rese..."	%M10.1	Bool	☐ FALSE		
23	<Add new>					

Figure 28 Manual/Auto test Three

	Name	Address	Display format	Monitor value	Modify value	
1	"Stepper_Home_..."	%I0.0	Bool	☐ FALSE	TRUE	☒
2	"Stepper_back_Li..."	%I0.1	Bool	☐ FALSE		☐
3	"Stepper_front_Li..."	%I0.2	Bool	☐ FALSE		☐
4	"Drill_Up_Positio..."	%I0.3	Bool	☒ TRUE		☐
5	"Drill_Down_Posit..."	%I0.4	Bool	☐ FALSE		☐
6	"Tap_Up_Position..."	%I0.5	Bool	☐ FALSE		☐
7	"Tap_Down_Posit..."	%I0.6	Bool	☐ FALSE		☐
8	"Index_Table_Ref..."	%I0.7	Bool	☒ TRUE		☐
9	"Capacitive_Sens..."	%I1.0	Bool	☒ TRUE		☐
10	"Stepper_Pulse"	%Q0.0	Bool	☐ FALSE		☐
11	"Stepper_Direction"	%Q0.1	Bool	☐ FALSE		☐
12	"Drill_Up_Down..."	%Q0.3	Bool	☐ FALSE		☐
13	"Table_Lock_Sole..."	%Q0.4	Bool	☐ FALSE		☐
14	"Tap_Up_Down_S..."	%Q0.5	Bool	☒ TRUE		☐
15	"Drill_Motor_On..."	%Q0.6	Bool	☐ FALSE		☐
16	"Tap_Motor_On..."	%Q0.7	Bool	☒ TRUE		☐
17	"Tap_Motor_Reve..."	%Q1.0	Bool	☒ TRUE		☐
18	"Seq_Run"	%M0.5	Bool	☒ TRUE		☐
19	"Start Sw"	%M0.3	Bool	☐ FALSE		☐
20	"Reset_Step_S..."	%M1.5	Bool	☐ FALSE		☐
21	"Stop Sw"	%M0.4	Bool	☐ FALSE		☐
22				☐		☐
23	-add new-					☐

Figure 29 Manual/Auto test four

	Name	Address	Display format	Monitor value	Modify value	
1	"Stepper_Home_Sensor"	%I0.0	Bool	☐ FALSE	TRUE	☒
2	"Stepper_back_Limit"	%I0.1	Bool	☐ FALSE		☐
3	"Stepper_front_Limit"	%I0.2	Bool	☐ FALSE		☐
4	"Drill_Up_Position_Sensor"	%I0.3	Bool	☒ TRUE		☐
5	"Drill_Down_Position_Sensor"	%I0.4	Bool	☐ FALSE		☐
6	"Tap_Up_Position_Sensor"	%I0.5	Bool	☒ TRUE		☐
7	"Tap_Down_Position_Sensor"	%I0.6	Bool	☐ FALSE		☐
8	"Index_Table_Ref_Position_S..."	%I0.7	Bool	☐ FALSE		☐
9	"Capacitive_Sensor"	%I1.0	Bool	☒ TRUE		☐
10	"Stepper_Pulse"	%Q0.0	Bool	☐ FALSE		☐
11	"Stepper_Direction"	%Q0.1	Bool	☐ FALSE		☐
12	"Drill_Up_Down_Solenoid"	%Q0.3	Bool	☐ FALSE		☐
13	"Table_Lock_Solenoid"	%Q0.4	Bool	☐ FALSE		☐
14	"Tap_Up_Down_Solenoid"	%Q0.5	Bool	☐ FALSE		☐
15	"Drill_Motor_On_Off_Solenoi..."	%Q0.6	Bool	☐ FALSE		☐
16	"Tap_Motor_On_Off_Solenoi..."	%Q0.7	Bool	☐ FALSE		☐
17	"Tap_Motor_Reverse_Forwar..."	%Q1.0	Bool	☐ FALSE		☐
18	"Seq_Run"	%M0.5	Bool	☐ FALSE		☐
19	"Start Sw"	%M0.3	Bool	☐ FALSE		☐
20	"Reset_Step_Sequence"	%M1.5	Bool	☐ FALSE		☐
21	"Stop Sw"	%M0.4	Bool	☐ FALSE		☐
22	"Stepper_Run_Bit_90"	%M1.4	Bool	☒ TRUE		☐
23	"Stepper_Run_Bit_180"	%M1.2	Bool	☐ FALSE		☐
24	"Stepper_Run_Bit_270"	%M1.3	Bool	☐ FALSE		☐
25	"Stepper_Enable"	%Q0.2	Bool	☐ FALSE		☐

Figure 30 Sequence test 1

	Name	Address	Display format	Monitor value	Modify value	
1	"Stepper_Hom..."	%I0.0	Bool	☐ FALSE	TRUE	
2	"Stepper_back_Li..."	%I0.1	Bool	☐ FALSE		
3	"Stepper_front_Li..."	%I0.2	Bool	☐ FALSE		
4	"Drill_Up_Positio..."	%I0.3	Bool	☒ TRUE		
5	"Drill_Down_Posit..."	%I0.4	Bool	☐ FALSE		
6	"Tap_Up_Position..."	%I0.5	Bool	☒ TRUE		
7	"Tap_Down_Posit..."	%I0.6	Bool	☐ FALSE		
8	"Index_Table_Ref..."	%I0.7	Bool	☐ FALSE		
9	"Capacitive_Sens..."	%I1.0	Bool	☐ FALSE		
10	"Stepper_Pulse"	%Q0.0	Bool	☐ FALSE		
11	"Stepper_Direction"	%Q0.1	Bool	☐ FALSE		
12	"Drill_Up_Down..."	%Q0.3	Bool	☐ FALSE		
13	"Table_Lock_Sole..."	%Q0.4	Bool	☐ FALSE		
14	"Tap_Up_Down_S..."	%Q0.5	Bool	☐ FALSE		
15	"Drill_Motor_On..."	%Q0.6	Bool	☐ FALSE		
16	"Tap_Motor_On..."	%Q0.7	Bool	☐ FALSE		
17	"Tap_Motor_Reve..."	%I1.0	Bool	☐ FALSE		
18	"Seq_Run"	%M0.5	Bool	☐ FALSE		
19	"Start_Sw"	%M0.3	Bool	☐ FALSE		
20	"Reset_Step_Sequ..."	%M1.5	Bool	☐ FALSE		
21	"Stop_Sw"	%M0.4	Bool	☐ FALSE		
22	"Stepper_Run_Bit..."	%M10.4	Bool	☒ TRUE		
23	"Stepper_Run_Bit..."	%M11.2	Bool	☐ FALSE		
24	"Stepper_Run_Bit..."	%M11.3	Bool	☐ FALSE		

Figure 31 Sequence test 2

	Name	Address	Display format	Monitor value	Modify value	
1	"Stepper_Home_Sensor"	%I0.0	Bool	☐ FALSE	TRUE	
2	"Stepper_back_Limit"	%I0.1	Bool	☐ FALSE		
3	"Stepper_front_Limit"	%I0.2	Bool	☐ FALSE		
4	"Drill_Up_Position_Sensor"	%I0.3	Bool	☒ TRUE		
5	"Drill_Down_Position_Sensor"	%I0.4	Bool	☐ FALSE		
6	"Tap_Up_Position_Sensor"	%I0.5	Bool	☒ TRUE		
7	"Tap_Down_Position_Sensor"	%I0.6	Bool	☐ FALSE		
8	"Index_Table_Ref_Position_S..."	%I0.7	Bool	☐ FALSE		
9	"Capacitive_Sensor"	%I1.0	Bool	☒ TRUE		
10	"Stepper_Pulse"	%Q0.0	Bool	☐ FALSE		
11	"Stepper_Direction"	%Q0.1	Bool	☐ FALSE		
12	"Drill_Up_Down_Solenoid"	%Q0.3	Bool	☐ FALSE		
13	"Table_Lock_Solenoid"	%Q0.4	Bool	☐ FALSE		
14	"Tap_Up_Down_Solenoid"	%Q0.5	Bool	☐ FALSE		
15	"Drill_Motor_On_Off_Solenoi..."	%Q0.6	Bool	☐ FALSE		
16	"Tap_Motor_On_Off_Solenoi..."	%Q0.7	Bool	☐ FALSE		
17	"Tap_Motor_Reverse_Forwar..."	%I1.0	Bool	☐ FALSE		
18	"Seq_Run"	%M0.5	Bool	☐ FALSE		
19	"Start_Sw"	%M0.3	Bool	☐ FALSE		
20	"Reset_Step_Sequence"	%M1.5	Bool	☐ FALSE		
21	"Stop_Sw"	%M0.4	Bool	☐ FALSE		
22	"Stepper_Run_Bit_90°"	%M10.4	Bool	☐ FALSE		
23	"Stepper_Run_Bit_180°"	%M11.2	Bool	☐ FALSE		
24	"Stepper_Run_Bit_270°"	%M11.3	Bool	☒ TRUE		
25	"Stepper_Enable"	%Q0.2	Bool	☐ FALSE		

Figure 32 Sequence test 3

	Name	Address	Display format	Monitor value	Modify value	
1	"Stepper_Home_..."	%I0.0	Bool	☐ FALSE	TRUE	
2	"Stepper_back_Li..."	%I0.1	Bool	☐ FALSE		
3	"Stepper_front_Li..."	%I0.2	Bool	☐ FALSE		
4	"Drill_Up_Positio..."	%I0.3	Bool	☒ TRUE		
5	"Drill_Down_Posit..."	%I0.4	Bool	☐ FALSE		
6	"Tap_Up_Position..."	%I0.5	Bool	☒ TRUE		
7	"Tap_Down_Positio..."	%I0.6	Bool	☐ FALSE		
8	"Index_Table_Ref..."	%I0.7	Bool	☐ FALSE		
9	"Capacitive_Sens..."	%I1.0	Bool	☒ TRUE		
10	"Stepper_Pulse"	%Q0.0	Bool	☐ FALSE		
11	"Stepper_Direction"	%Q0.1	Bool	☐ FALSE		
12	"Drill_Up_Down_..."	%Q0.3	Bool	☐ FALSE		
13	"Table_Lock_Sole..."	%Q0.4	Bool	☐ FALSE		
14	"Tap_Up_Down_S..."	%Q0.5	Bool	☐ FALSE		
15	"Drill_Motor_On_..."	%Q0.6	Bool	☐ FALSE		
16	"Tap_Motor_On_..."	%Q0.7	Bool	☐ FALSE		
17	"Tap_Motor_Reve..."	%Q1.0	Bool	☐ FALSE		
18	"Seq_Run"	%M0.5	Bool	☐ FALSE		
19	"Start_Sw"	%M0.3	Bool	☐ FALSE		
20	"Reset_Step_Sequ..."	%M1.5	Bool	☐ FALSE		
21	"Stop_Sw"	%M0.4	Bool	☐ FALSE		
22	"Stepper_Rese..."	%M10.1	Bool	☐ FALSE		
23	<Add new>					

Figure 33 Sequence 4

	Name	Address	Display format	Monitor value	Modify value	
1	"Stepper_Home_Sensor"	%I0.0	Bool	☐ FALSE	TRUE	
2	"Stepper_back_Limit"	%I0.1	Bool	☐ FALSE		
3	"Stepper_front_Limit"	%I0.2	Bool	☐ FALSE		
4	"Drill_Up_Position_Sensor"	%I0.3	Bool	☒ TRUE		
5	"Drill_Down_Position_Sensor"	%I0.4	Bool	☐ FALSE		
6	"Tap_Up_Position_Sensor"	%I0.5	Bool	☒ TRUE		
7	"Tap_Down_Position_Sensor"	%I0.6	Bool	☐ FALSE		
8	"Index_Table_Ref_Position_S..."	%I0.7	Bool	☐ FALSE		
9	"Capacitive_Sensor"	%I1.0	Bool	☒ TRUE		
10	"Stepper_Pulse"	%Q0.0	Bool	☐ FALSE		
11	"Stepper_Direction"	%Q0.1	Bool	☐ FALSE		
12	"Drill_Up_Down_Solenoid"	%Q0.3	Bool	☐ FALSE		
13	"Table_Lock_Solenoid"	%Q0.4	Bool	☐ FALSE		
14	"Tap_Up_Down_Solenoid"	%Q0.5	Bool	☐ FALSE		
15	"Drill_Motor_On_Off_Solenoid..."	%Q0.6	Bool	☐ FALSE		
16	"Tap_Motor_On_Off_Solenoid..."	%Q0.7	Bool	☐ FALSE		
17	"Tap_Motor_Reverse_Forward..."	%Q1.0	Bool	☐ FALSE		
18	"Seq_Run"	%M0.5	Bool	☐ FALSE		
19	"Start_Sw"	%M0.3	Bool	☐ FALSE		
20	"Reset_Step_Sequence"	%M1.5	Bool	☐ FALSE		
21	"Stop_Sw"	%M0.4	Bool	☐ FALSE		
22	"Stepper_Run_Bit_90"	%M10.4	Bool	☒ TRUE		
23	"Stepper_Run_Bit_180"	%M11.2	Bool	☐ FALSE		
24	"Stepper_Run_Bit_270"	%M11.3	Bool	☐ FALSE		
25	"Stepper_Enable"	%Q0.2	Bool	☐ FALSE		

Figure 34 Sequence 5

	Name	Address	Display format	Monitor value	Modify value	
1	"Stepper_Home_..."	%I0.0	Bool	☐ FALSE	TRUE	
2	"Stepper_back_Li..."	%I0.1	Bool	☐ FALSE		
3	"Stepper_front_Li..."	%I0.2	Bool	☐ FALSE		
4	"Drill_Up_Positio..."	%I0.3	Bool	☒ TRUE		
5	"Drill_Down_Posit..."	%I0.4	Bool	☐ FALSE		
6	"Tap_Up_Position..."	%I0.5	Bool	☒ TRUE		
7	"Tap_Down_Posit..."	%I0.6	Bool	☐ FALSE		
8	"Index_Table_Ref..."	%I0.7	Bool	☐ FALSE		
9	"Capacitive_Sens..."	%I1.0	Bool	☒ TRUE		
10	"Stepper_Pulse"	%Q0.0	Bool	☐ FALSE		
11	"Stepper_Direction"	%Q0.1	Bool	☐ FALSE		
12	"Drill_Up_Down..."	%Q0.3	Bool	☐ FALSE		
13	"Table_Lock_Sole..."	%Q0.4	Bool	☐ FALSE		
14	"Tap_Up_Down_S..."	%Q0.5	Bool	☐ FALSE		
15	"Drill_Motor_On..."	%Q0.6	Bool	☐ FALSE		
16	"Tap_Motor_On..."	%Q0.7	Bool	☐ FALSE		
17	"Tap_Motor_Reve..."	%Q1.0	Bool	☐ FALSE		
18	"Seq_Run"	%M0.5	Bool	☐ FALSE		
19	"Start_Sin"	%M0.3	Bool	☐ FALSE		
20	"Reset_Step_Sequ..."	%M1.5	Bool	☐ FALSE		
21	"Stop_Sin"	%M0.4	Bool	☐ FALSE		
22	"Stepper_Rese..."	%M10.1	Bool	☐ FALSE		
23	<Add new>					

Figure 35 Stepper Home

	Name	Address	Display format	Monitor value	Modify value	
1	"Stepper_Home_Sensor"	%I0.0	Bool	☐ FALSE	TRUE	
2	"Stepper_back_Limit"	%I0.1	Bool	☐ FALSE		
3	"Stepper_front_Limit"	%I0.2	Bool	☐ FALSE		
4	"Drill_Up_Position_Sensor"	%I0.3	Bool	☒ TRUE		
5	"Drill_Down_Position_Sensor"	%I0.4	Bool	☐ FALSE		
6	"Tap_Up_Position_Sensor"	%I0.5	Bool	☒ TRUE		
7	"Tap_Down_Position_Sensor"	%I0.6	Bool	☐ FALSE		
8	"Index_Table_Ref_Position_S..."	%I0.7	Bool	☐ FALSE		
9	"Capacitive_Sensor"	%I1.0	Bool	☒ TRUE		
10	"Stepper_Pulse"	%Q0.0	Bool	☐ FALSE		
11	"Stepper_Direction"	%Q0.1	Bool	☐ FALSE		
12	"Drill_Up_Down_Solenoid"	%Q0.3	Bool	☐ FALSE		
13	"Table_Lock_Solenoid"	%Q0.4	Bool	☐ FALSE		
14	"Tap_Up_Down_Solenoid"	%Q0.5	Bool	☐ FALSE		
15	"Drill_Motor_On_Off_Solenoi..."	%Q0.6	Bool	☐ FALSE		
16	"Tap_Motor_On_Off_Solenoi..."	%Q0.7	Bool	☐ FALSE		
17	"Tap_Motor_Reverse_Forwar..."	%Q1.0	Bool	☐ FALSE		
18	"Seq_Run"	%M0.5	Bool	☐ FALSE		
19	"Start_Sin"	%M0.3	Bool	☐ FALSE		
20	"Reset_Step_Sequence"	%M1.5	Bool	☐ FALSE		
21	"Stop_Sin"	%M0.4	Bool	☐ FALSE		
22	"Stepper_Run_Bit_90"	%M10.4	Bool	☐ FALSE		
23	"Stepper_Run_Bit_180"	%M11.2	Bool	☐ FALSE		
24	"Stepper_Run_Bit_270"	%M11.3	Bool	☐ FALSE		
25	"Stepper_Enable"	%Q0.2	Bool	☐ FALSE		

Figure 36 Table Unlock

	Name	Address	Display format	Monitor value	Modify value	
1	"Stepper_Home_Sensor"	%I0.0	Bool	☐ FALSE	TRUE	☒
2	"Stepper_back_Limit"	%I0.1	Bool	☐ FALSE		☐
3	"Stepper_Front_Limit"	%I0.2	Bool	☐ FALSE		☐
4	"Drill_Up_Position_Sensor"	%I0.3	Bool	☒ TRUE		☐
5	"Drill_Down_Position_Sensor"	%I0.4	Bool	☐ FALSE		☐
6	"Tap_Up_Position_Sensor"	%I0.5	Bool	☒ TRUE		☐
7	"Tap_Down_Position_Sensor"	%I0.6	Bool	☐ FALSE		☐
8	"Index_Table_Ref_Position_S...	%I0.7	Bool	☐ FALSE		☐
9	"Capacitive_Sensor"	%I1.0	Bool	☒ TRUE		☐
10	"Stepper_Pulse"	%Q0.0	Bool	☐ FALSE		☐
11	"Stepper_Direction"	%Q0.1	Bool	☐ FALSE		☐
12	"Drill_Up_Down_Solenoid"	%Q0.3	Bool	☐ FALSE		☐
13	"Table_Lock_Solenoid"	%Q0.4	Bool	☒ TRUE		☐
14	"Tap_Up_Down_Solenoid"	%Q0.5	Bool	☐ FALSE		☐
15	"Drill_Motor_On_Off_Solenoi...	%Q0.6	Bool	☐ FALSE		☐
16	"Tap_Motor_On_Off_Solenoi...	%Q0.7	Bool	☐ FALSE		☐
17	"Tap_Motor_Reverse_forwar...	%Q1.0	Bool	☐ FALSE		☐
18	"Seq_Run"	%M0.5	Bool	☐ FALSE		☐
19	"Start Sw"	%M0.3	Bool	☐ FALSE		☐
20	"Reset_Step_Sequence"	%M1.5	Bool	☐ FALSE		☐
21	"Stop Sw"	%M0.4	Bool	☐ FALSE		☐
22	"Stepper_Run_Bit_90°"	%M10.4	Bool	☐ FALSE		☐
23	"Stepper_Run_Bit_180°"	%M11.2	Bool	☐ FALSE		☐
24	"Stepper_Run_Bit_270°"	%M11.3	Bool	☐ FALSE		☐
25	"Stepper_Enable"	%Q0.2	Bool	☐ FALSE		☐

Figure 37 Table Lock on

	Name	Address	Display format	Monitor value	Modify value	
1	"Stepper_Home_..."	%I0.0	Bool	☐ FALSE	TRUE	☒
2	"Stepper_back_Li..."	%I0.1	Bool	☐ FALSE		☐
3	"Stepper_Front_Li..."	%I0.2	Bool	☐ FALSE		☐
4	"Drill_Up_Positio..."	%I0.3	Bool	☒ TRUE		☐
5	"Drill_Down_Posit..."	%I0.4	Bool	☐ FALSE		☐
6	"Tap_Up_Positio..."	%I0.5	Bool	☒ TRUE		☐
7	"Tap_Down_Posit..."	%I0.6	Bool	☐ FALSE		☐
8	"Index_Table_Ref..."	%I0.7	Bool	☐ FALSE		☐
9	"Capacitive_Sens..."	%I1.0	Bool	☐ FALSE		☐
10	"Stepper_Pulse"	%Q0.0	Bool	☐ FALSE		☐
11	"Stepper_Direction"	%Q0.1	Bool	☐ FALSE		☐
12	"Drill_Up_Down_..."	%Q0.3	Bool	☐ FALSE		☐
13	"Table_Lock_Sole..."	%Q0.4	Bool	☐ FALSE		☐
14	"Tap_Up_Down_S..."	%Q0.5	Bool	☐ FALSE		☐
15	"Drill_Motor_On_..."	%Q0.6	Bool	☐ FALSE		☐
16	"Tap_Motor_On_..."	%Q0.7	Bool	☐ FALSE		☐
17	"Tap_Motor_Reve..."	%Q1.0	Bool	☐ FALSE		☐
18	"Seq_Run"	%M0.5	Bool	☐ FALSE		☐
19	"Start Sw"	%M0.3	Bool	☐ FALSE		☐
20	"Reset_Step_S_..."	%M1.5	Bool	☐ FALSE		☐
21	"Stop Sw"	%M0.4	Bool	☐ FALSE		☐
22				☐ FALSE		☐
23	<Add new>					☐

Figure 38 Auto sequence 1

	Name	Address	Display format	Monitor value	Modify value	
1	"Stepper_Hom..."	%I0.0	Bool	☐ FALSE	TRUE	
2	"Stepper_back_Li..."	%I0.1	Bool	☐ FALSE		
3	"Stepper_front_Li..."	%I0.2	Bool	☐ FALSE		
4	"Drill_Up_Positio..."	%I0.3	Bool	☒ TRUE		
5	"Drill_Down_Posit..."	%I0.4	Bool	☐ FALSE		
6	"Tap_Up_Positio..."	%I0.5	Bool	☒ TRUE		
7	"Tap_Down_Posit..."	%I0.6	Bool	☐ FALSE		
8	"Index_Table_Ref..."	%I0.7	Bool	☐ FALSE		
9	"Capacitive_Sens..."	%I1.0	Bool	☐ FALSE		
10	"Stepper_Pulse"	%Q0.0	Bool	☐ FALSE		
11	"Stepper_Direction"	%Q0.1	Bool	☐ FALSE		
12	"Drill_Up_Down..."	%Q0.3	Bool	☐ FALSE		
13	"Table_Lock_Sole..."	%Q0.4	Bool	☐ FALSE		
14	"Tap_Up_Down_S..."	%Q0.5	Bool	☐ FALSE		
15	"Drill_Motor_On..."	%Q0.6	Bool	☐ FALSE		
16	"Tap_Motor_On..."	%Q0.7	Bool	☐ FALSE		
17	"Tap_Motor_Reve..."	%Q1.0	Bool	☐ FALSE		
18	"Seq_Run"	%M0.5	Bool	☐ FALSE		
19	"Start Sw"	%M0.3	Bool	☐ FALSE		
20	"Reset_Step_Sequ..."	%M1.5	Bool	☐ FALSE		
21	"Stop Sw"	%M0.4	Bool	☐ FALSE		
22	"Stepper_Run_Bit..."	%M10.4	Bool	☒ TRUE		
23	"Stepper_Run_Bit..."	%M11.2	Bool	☐ FALSE		
24	"Stepper_Run_Bit..."	%M11.3	Bool	☐ FALSE		

Figure 39 Auto sequence 2

	Name	Address	Display format	Monitor value	Modify value	
1	"Stepper_Home_Sensor"	%I0.0	Bool	☐ FALSE	TRUE	
2	"Stepper_back_Limit"	%I0.1	Bool	☐ FALSE		
3	"Stepper_front_Limit"	%I0.2	Bool	☐ FALSE		
4	"Drill_Up_Position_Sensor"	%I0.3	Bool	☐ FALSE		
5	"Drill_Down_Position_Sensor"	%I0.4	Bool	☒ TRUE		
6	"Tap_Up_Position_Sensor"	%I0.5	Bool	☒ TRUE		
7	"Tap_Down_Position_Sensor"	%I0.6	Bool	☐ FALSE		
8	"Index_Table_Ref_Position_S..."	%I0.7	Bool	☐ FALSE		
9	"Capacitive_Sensor"	%I1.0	Bool	☒ TRUE		
10	"Stepper_Pulse"	%Q0.0	Bool	☐ FALSE		
11	"Stepper_Direction"	%Q0.1	Bool	☐ FALSE		
12	"Drill_Up_Down_Solenoid"	%Q0.3	Bool	☒ TRUE		
13	"Table_Lock_Solenoid"	%Q0.4	Bool	☐ FALSE		
14	"Tap_Up_Down_Solenoid"	%Q0.5	Bool	☐ FALSE		
15	"Drill_Motor_On_Off_Solenoi..."	%Q0.6	Bool	☒ TRUE		
16	"Tap_Motor_On_Off_Solenoi..."	%Q0.7	Bool	☐ FALSE		
17	"Tap_Motor_Reverse_forwar..."	%Q1.0	Bool	☐ FALSE		
18	"Seq_Run"	%M0.5	Bool	☐ FALSE		
19	"Start Sw"	%M0.3	Bool	☐ FALSE		
20	"Reset_Step_Sequence"	%M1.5	Bool	☐ FALSE		
21	"Stop Sw"	%M0.4	Bool	☐ FALSE		
22	"Stepper_Run_Bit_90"	%M10.4	Bool	☐ FALSE		
23	"Stepper_Run_Bit_180"	%M11.2	Bool	☐ FALSE		
24	"Stepper_Run_Bit_270"	%M11.3	Bool	☐ FALSE		
25	"Stepper_Enable"	%Q0.2	Bool	☐ FALSE		

Figure 40 Auto sequence 3

	Name	Address	Display format	Monitor value	Modify value	
1	"Stepper_Home_Sensor"	%I0.0	Bool	☐ FALSE	TRUE	☒
2	"Stepper_back_Limit"	%I0.1	Bool	☐ FALSE		☐
3	"Stepper_Front_Limit"	%I0.2	Bool	☐ FALSE		☐
4	"Drill_Up_Position_Sensor"	%I0.3	Bool	☒ TRUE		☐
5	"Drill_Down_Position_Sensor"	%I0.4	Bool	☐ FALSE		☐
6	"Tap_Up_Position_Sensor"	%I0.5	Bool	☒ TRUE		☐
7	"Tap_Down_Position_Sensor"	%I0.6	Bool	☐ FALSE		☐
8	"Index_Table_Ref_Position_S..."	%I0.7	Bool	☐ FALSE		☐
9	"Capacitive_Sensor"	%I1.0	Bool	☒ TRUE		☐
10	"Stepper_Pulse"	%Q0.0	Bool	☐ FALSE		☐
11	"Stepper_Direction"	%Q0.1	Bool	☐ FALSE		☐
12	"Drill_Up_Down_Solenoid"	%Q0.3	Bool	☐ FALSE		☐
13	"Table_Lock_Solenoid"	%Q0.4	Bool	☐ FALSE		☐
14	"Tap_Up_Down_Solenoid"	%Q0.5	Bool	☐ FALSE		☐
15	"Drill_Motor_On_Off_Solenoi..."	%Q0.6	Bool	☐ FALSE		☐
16	"Tap_Motor_On_Off_Solenoi..."	%Q0.7	Bool	☐ FALSE		☐
17	"Tap_Motor_Reverse_forwar..."	%Q1.0	Bool	☐ FALSE		☐
18	"Seq_Run"	%M0.5	Bool	☐ FALSE		☐
19	"Start Sw"	%M0.3	Bool	☐ FALSE		☐
20	"Reset_Step_Sequence"	%M1.5	Bool	☐ FALSE		☐
21	"Stop Sw"	%M0.4	Bool	☐ FALSE		☐
22	"Stepper_Run_Bit_90°"	%M10.4	Bool	☐ FALSE		☐
23	"Stepper_Run_Bit_180°"	%M11.2	Bool	☐ FALSE		☐
24	"Stepper_Run_Bit_270°"	%M11.3	Bool	☐ FALSE		☐

Figure 41 Auto sequence 4

	Name	Address	Display format	Monitor value	Modify value	
1	"Stepper_Home_Sensor"	%I0.0	Bool	☐ FALSE	TRUE	☒
2	"Stepper_back_Limit"	%I0.1	Bool	☐ FALSE		☐
3	"Stepper_Front_Limit"	%I0.2	Bool	☐ FALSE		☐
4	"Drill_Up_Position_Sensor"	%I0.3	Bool	☒ TRUE		☐
5	"Drill_Down_Position_Sensor"	%I0.4	Bool	☐ FALSE		☐
6	"Tap_Up_Position_Sensor"	%I0.5	Bool	☒ TRUE		☐
7	"Tap_Down_Position_Sensor"	%I0.6	Bool	☐ FALSE		☐
8	"Index_Table_Ref_Position_S..."	%I0.7	Bool	☐ FALSE		☐
9	"Capacitive_Sensor"	%I1.0	Bool	☒ TRUE		☐
10	"Stepper_Pulse"	%Q0.0	Bool	☐ FALSE		☐
11	"Stepper_Direction"	%Q0.1	Bool	☐ FALSE		☐
12	"Drill_Up_Down_Solenoid"	%Q0.3	Bool	☐ FALSE		☐
13	"Table_Lock_Solenoid"	%Q0.4	Bool	☐ FALSE		☐
14	"Tap_Up_Down_Solenoid"	%Q0.5	Bool	☐ FALSE		☐
15	"Drill_Motor_On_Off_Solenoi..."	%Q0.6	Bool	☐ FALSE		☐
16	"Tap_Motor_On_Off_Solenoi..."	%Q0.7	Bool	☐ FALSE		☐
17	"Tap_Motor_Reverse_forwar..."	%Q1.0	Bool	☐ FALSE		☐
18	"Seq_Run"	%M0.5	Bool	☐ FALSE		☐
19	"Start Sw"	%M0.3	Bool	☐ FALSE		☐
20	"Reset_Step_Sequence"	%M1.5	Bool	☐ FALSE		☐
21	"Stop Sw"	%M0.4	Bool	☐ FALSE		☐
22	"Stepper_Run_Bit_90°"	%M10.4	Bool	☐ FALSE		☐
23	"Stepper_Run_Bit_180°"	%M11.2	Bool	☐ FALSE		☐
24	"Stepper_Run_Bit_270°"	%M11.3	Bool	☐ FALSE		☐
25	"Stepper_Enable"	%Q0.2	Bool	☐ FALSE		☐

Figure 42 Auto sequence 5

	Name	Address	Display format	Monitor value	Modify value	
1	"Stepper_Home_Sensor"	%I0.0	Bool	☐ FALSE	TRUE	☒
2	"Stepper_back_Limit"	%I0.1	Bool	☐ FALSE		☐
3	"Stepper_Front_Limit"	%I0.2	Bool	☐ FALSE		☐
4	"Drill_Up_Position_Sensor"	%I0.3	Bool	☒ TRUE		☐
5	"Drill_Down_Position_Sensor"	%I0.4	Bool	☐ FALSE		☐
6	"Tap_Up_Position_Sensor"	%I0.5	Bool	☐ FALSE		☐
7	"Tap_Down_Position_Sensor"	%I0.6	Bool	☒ TRUE		☐
8	"Index_Table_Ref_Position_S..."	%I0.7	Bool	☐ FALSE		☐
9	"Capacitive_Sensor"	%I1.0	Bool	☒ TRUE		☐
10	"Stepper_Pulse"	%Q0.0	Bool	☐ FALSE		☐
11	"Stepper_Direction"	%Q0.1	Bool	☐ FALSE		☐
12	"Drill_Up_Down_Solenoid"	%Q0.3	Bool	☐ FALSE		☐
13	"Table_Lock_Solenoid"	%Q0.4	Bool	☐ FALSE		☐
14	"Tap_Up_Down_Solenoid"	%Q0.5	Bool	☒ TRUE		☐
15	"Drill_Motor_On_Off_Solenoi..."	%Q0.6	Bool	☐ FALSE		☐
16	"Tap_Motor_On_Off_Solenoi..."	%Q0.7	Bool	☒ TRUE		☐
17	"Tap_Motor_Reverse_forwar..."	%Q1.0	Bool	☒ TRUE		☐
18	"Seq_Run"	%M0.5	Bool	☐ FALSE		☐
19	"Start Sw"	%M0.3	Bool	☐ FALSE		☐
20	"Reset_Step_Sequence"	%M1.5	Bool	☐ FALSE		☐
21	"Stop Sw"	%M0.4	Bool	☐ FALSE		☐
22	"Stepper_Run_Bit_90°"	%M10.4	Bool	☐ FALSE		☐
23	"Stepper_Run_Bit_180°"	%M11.2	Bool	☐ FALSE		☐
24	"Stepper_Run_Bit_270°"	%M11.3	Bool	☒ FALSE		☐
25	"Stepper_Enable"	%Q0.2	Bool	☐ FALSE		☐
26	<Add new>					

Figure 43 Auto sequence 6

	Name	Address	Display format	Monitor value	Modify value	
1	"Stepper_Home_Sensor"	%I0.0	Bool	☐ FALSE	TRUE	☒
2	"Stepper_back_Limit"	%I0.1	Bool	☐ FALSE		☐
3	"Stepper_Front_Limit"	%I0.2	Bool	☐ FALSE		☐
4	"Drill_Up_Position_Sensor"	%I0.3	Bool	☒ TRUE		☐
5	"Drill_Down_Position_Sensor"	%I0.4	Bool	☐ FALSE		☐
6	"Tap_Up_Position_Sensor"	%I0.5	Bool	☒ TRUE		☐
7	"Tap_Down_Position_Sensor"	%I0.6	Bool	☐ FALSE		☐
8	"Index_Table_Ref_Position_S..."	%I0.7	Bool	☐ FALSE		☐
9	"Capacitive_Sensor"	%I1.0	Bool	☒ TRUE		☐
10	"Stepper_Pulse"	%Q0.0	Bool	☐ FALSE		☐
11	"Stepper_Direction"	%Q0.1	Bool	☐ FALSE		☐
12	"Drill_Up_Down_Solenoid"	%Q0.3	Bool	☐ FALSE		☐
13	"Table_Lock_Solenoid"	%Q0.4	Bool	☐ FALSE		☐
14	"Tap_Up_Down_Solenoid"	%Q0.5	Bool	☐ FALSE		☐
15	"Drill_Motor_On_Off_Solenoi..."	%Q0.6	Bool	☐ FALSE		☐
16	"Tap_Motor_On_Off_Solenoi..."	%Q0.7	Bool	☐ FALSE		☐
17	"Tap_Motor_Reverse_forwar..."	%Q1.0	Bool	☐ FALSE		☐
18	"Seq_Run"	%M0.5	Bool	☐ FALSE		☐
19	"Start Sw"	%M0.3	Bool	☐ FALSE		☐
20	"Reset_Step_Sequence"	%M1.5	Bool	☐ FALSE		☐
21	"Stop Sw"	%M0.4	Bool	☐ FALSE		☐
22	"Stepper_Run_Bit_90°"	%M10.4	Bool	☐ FALSE		☐
23	"Stepper_Run_Bit_180°"	%M11.2	Bool	☐ FALSE		☐
24	"Stepper_Run_Bit_270°"	%M11.3	Bool	☒ FALSE		☐
25	"Stepper_Enable"	%Q0.2	Bool	☐ FALSE		☐

Figure 44 Auto sequence 7

	Name	Address	Display format	Monitor value	Modify value	
1	"Stepper_Hom_...	%I0.0	Bool	☐ FALSE	TRUE	
2	"Stepper_back_Li...	%I0.1	Bool	☐ FALSE		
3	"Stepper_front_Li...	%I0.2	Bool	☐ FALSE		
4	"Drill_Up_Positi...	%I0.3	Bool	☒ TRUE		
5	"Drill_Down_Posit...	%I0.4	Bool	☐ FALSE		
6	"Tap_Up_Position...	%I0.5	Bool	☒ TRUE		
7	"Tap_Down_Posit...	%I0.6	Bool	☐ FALSE		
8	"Index_Table_Ref...	%I0.7	Bool	☐ FALSE		
9	"Capacitive_Sens...	%I1.0	Bool	☐ FALSE		
10	"Stepper_Pulse"	%Q0.0	Bool	☐ FALSE		
11	"Stepper_Direction	%Q0.1	Bool	☐ FALSE		
12	"Drill_Up_Down_...	%Q0.3	Bool	☐ FALSE		
13	"Table_Lock_Sole...	%Q0.4	Bool	☐ FALSE		
14	"Tap_Up_Down_S_...	%Q0.5	Bool	☐ FALSE		
15	"Drill_Motor_On_...	%Q0.6	Bool	☐ FALSE		
16	"Tap_Motor_On_...	%Q0.7	Bool	☐ FALSE		
17	"Tap_Motor_Reve...	%Q1.0	Bool	☐ FALSE		
18	"Seq_Run"	%M00.5	Bool	☐ FALSE		
19	"Start Sw"	%M00.3	Bool	☐ FALSE		
20	"Reset_Step_Sequ...	%M01.5	Bool	☐ FALSE		
21	"Stop Sw"	%M00.4	Bool	☐ FALSE		
22	"Stepper_Run_Bit...	%M10.4	Bool	☒ TRUE		
23	"Stepper_Run_Bit...	%M11.2	Bool	☐ FALSE		
24	"Stepper_Run_Bit...	%M11.3	Bool	☐ FALSE		

Figure 45 Auto sequence 8

	Name	Address	Display format	Monitor value	Modify value	
1	"Stepper_Home_Sensor"	%I0.0	Bool	☐ FALSE	TRUE	
2	"Stepper_back_Limit"	%I0.1	Bool	☐ FALSE		
3	"Stepper_front_Limit"	%I0.2	Bool	☐ FALSE		
4	"Drill_Up_Position_Sensor"	%I0.3	Bool	☐ FALSE		
5	"Drill_Down_Position_Sensor"	%I0.4	Bool	☒ TRUE		
6	"Tap_Up_Position_Sensor"	%I0.5	Bool	☒ TRUE		
7	"Tap_Down_Position_Sensor"	%I0.6	Bool	☐ FALSE		
8	"Index_Table_Ref_Position_S_...	%I0.7	Bool	☐ FALSE		
9	"Capacitive_Sensor"	%I1.0	Bool	☒ TRUE		
10	"Stepper_Pulse"	%Q0.0	Bool	☐ FALSE		
11	"Stepper_Direction"	%Q0.1	Bool	☐ FALSE		
12	"Drill_Up_Down_Solenoid"	%Q0.3	Bool	☒ TRUE		
13	"Table_Lock_Solenoid"	%Q0.4	Bool	☐ FALSE		
14	"Tap_Up_Down_Solenoid"	%Q0.5	Bool	☐ FALSE		
15	"Drill_Motor_On_Off_Solenoi...	%Q0.6	Bool	☒ TRUE		
16	"Tap_Motor_On_Off_Solenoi...	%Q0.7	Bool	☐ FALSE		
17	"Tap_Motor_Reverse_forwar...	%Q1.0	Bool	☐ FALSE		
18	"Seq_Run"	%M00.5	Bool	☐ FALSE		
19	"Start Sw"	%M00.3	Bool	☐ FALSE		
20	"Reset_Step_Sequence"	%M01.5	Bool	☐ FALSE		
21	"Stop Sw"	%M00.4	Bool	☐ FALSE		
22	"Stepper_Run_Bit_90°"	%M10.4	Bool	☐ FALSE		
23	"Stepper_Run_Bit_180°"	%M11.2	Bool	☐ FALSE		
24	"Stepper_Run_Bit_270°"	%M11.3	Bool	☐ FALSE		
25	"Stepper_Enable"	%Q0.2	Bool	☐ FALSE		

Figure 46 Auto sequence 9

	Name	Address	Display format	Monitor value	Modify value	
1	"Stepper_Home_Sensor"	%I0.0	Bool	☐ FALSE	TRUE	
2	"Stepper_back_Limit"	%I0.1	Bool	☐ FALSE		☐
3	"Stepper_Front_Limit"	%I0.2	Bool	☐ FALSE		☐
4	"Drill_Up_Position_Sensor"	%I0.3	Bool	☒ TRUE		☐
5	"Drill_Down_Position_Sensor"	%I0.4	Bool	☐ FALSE		☐
6	"Tap_Up_Position_Sensor"	%I0.5	Bool	☒ TRUE		☐
7	"Tap_Down_Position_Sensor"	%I0.6	Bool	☐ FALSE		☐
8	"Index_Table_Ref_Position_S..."	%I0.7	Bool	☐ FALSE		☐
9	"Capacitive_Sensor"	%I1.0	Bool	☒ TRUE		☐
10	"Stepper_Pulse"	%Q0.0	Bool	☐ FALSE		☐
11	"Stepper_Direction"	%Q0.1	Bool	☐ FALSE		☐
12	"Drill_Up_Down_Solenoid"	%Q0.3	Bool	☐ FALSE		☐
13	"Table_Lock_Solenoid"	%Q0.4	Bool	☐ FALSE		☐
14	"Tap_Up_Down_Solenoid"	%Q0.5	Bool	☐ FALSE		☐
15	"Drill_Motor_On_Off_Soleno..."	%Q0.6	Bool	☐ FALSE		☐
16	"Tap_Motor_On_Off_Solenoi..."	%Q0.7	Bool	☐ FALSE		☐
17	"Tap_Motor_Reverse_forwar..."	%Q1.0	Bool	☐ FALSE		☐
18	"Seq_Run"	%M0.5	Bool	☐ FALSE		☐
19	"Start Sw"	%M0.3	Bool	☐ FALSE		☐
20	"Reset_Step_Sequence"	%M1.5	Bool	☐ FALSE		☐
21	"Stop Sw"	%M0.4	Bool	☐ FALSE		☐
22	"Stepper_Run_Bit_90°"	%M10.4	Bool	☐ FALSE		☐
23	"Stepper_Run_Bit_180°"	%M11.2	Bool	☐ FALSE		☐
24	"Stepper_Run_Bit_270°"	%M11.3	Bool	☐ FALSE		☐
25	"Stepper_Enable"	%Q0.2	Bool	☐ FALSE		☐
26	<Add new>					☐

Figure 47 Auto sequence 10

	Name	Address	Display format	Monitor value	Modify value	
1	"Stepper_Home_Sensor"	%I0.0	Bool	☐ FALSE	TRUE	
2	"Stepper_back_Limit"	%I0.1	Bool	☐ FALSE		☐
3	"Stepper_Front_Limit"	%I0.2	Bool	☐ FALSE		☐
4	"Drill_Up_Position_Sensor"	%I0.3	Bool	☒ TRUE		☐
5	"Drill_Down_Position_Sensor"	%I0.4	Bool	☐ FALSE		☐
6	"Tap_Up_Position_Sensor"	%I0.5	Bool	☒ TRUE		☐
7	"Tap_Down_Position_Sensor"	%I0.6	Bool	☐ FALSE		☐
8	"Index_Table_Ref_Position_S..."	%I0.7	Bool	☐ FALSE		☐
9	"Capacitive_Sensor"	%I1.0	Bool	☒ TRUE		☐
10	"Stepper_Pulse"	%Q0.0	Bool	☐ FALSE		☐
11	"Stepper_Direction"	%Q0.1	Bool	☐ FALSE		☐
12	"Drill_Up_Down_Solenoid"	%Q0.3	Bool	☐ FALSE		☐
13	"Table_Lock_Solenoid"	%Q0.4	Bool	☐ FALSE		☐
14	"Tap_Up_Down_Solenoid"	%Q0.5	Bool	☐ FALSE		☐
15	"Drill_Motor_On_Off_Soleno..."	%Q0.6	Bool	☐ FALSE		☐
16	"Tap_Motor_On_Off_Solenoi..."	%Q0.7	Bool	☐ FALSE		☐
17	"Tap_Motor_Reverse_forwar..."	%Q1.0	Bool	☐ FALSE		☐
18	"Seq_Run"	%M0.5	Bool	☐ FALSE		☐
19	"Start Sw"	%M0.3	Bool	☐ FALSE		☐
20	"Reset_Step_Sequence"	%M1.5	Bool	☐ FALSE		☐
21	"Stop Sw"	%M0.4	Bool	☐ FALSE		☐
22	"Stepper_Run_Bit_90°"	%M10.4	Bool	☐ FALSE		☐
23	"Stepper_Run_Bit_180°"	%M11.2	Bool	☒ TRUE		☐
24	"Stepper_Run_Bit_270°"	%M11.3	Bool	☐ FALSE		☐
25	"Stepper_Enable"	%Q0.2	Bool	☐ FALSE		☐

Figure 48 Auto sequence 11

	Name	Address	Display format	Monitor value	Modify value	
1	"Stepper_Home_Sensor"	%I0.0	Bool	☐ FALSE	TRUE	
2	"Stepper_back_Limit"	%I0.1	Bool	☐ FALSE		
3	"Stepper_Front_Limit"	%I0.2	Bool	☐ FALSE		
4	"Drill_Up_Position_Sensor"	%I0.3	Bool	☒ TRUE		
5	"Drill_Down_Position_Sensor"	%I0.4	Bool	☐ FALSE		
6	"Tap_Up_Position_Sensor"	%I0.5	Bool	☒ TRUE		
7	"Tap_Down_Position_Sensor"	%I0.6	Bool	☐ FALSE		
8	"Index_Table_Ref_Position_S..."	%I0.7	Bool	☐ FALSE		
9	"Capacitive_Sensor"	%I1.0	Bool	☒ TRUE		
10	"Stepper_Pulse"	%Q0.0	Bool	☐ FALSE		
11	"Stepper_Direction"	%Q0.1	Bool	☐ FALSE		
12	"Drill_Up_Down_Solenoid"	%Q0.3	Bool	☐ FALSE		
13	"Table_Lock_Solenoid"	%Q0.4	Bool	☐ FALSE		
14	"Tap_Up_Down_Solenoid"	%Q0.5	Bool	☐ FALSE		
15	"Drill_Motor_On_Off_Solenoi..."	%Q0.6	Bool	☐ FALSE		
16	"Tap_Motor_On_Off_Solenoi..."	%Q0.7	Bool	☐ FALSE		
17	"Tap_Motor_Reverse_forwar..."	%Q1.0	Bool	☐ FALSE		
18	"Seq_Run"	%M0.5	Bool	☐ FALSE		
19	"Start Sw"	%M0.3	Bool	☐ FALSE		
20	"Reset_Step_Sequence"	%M1.5	Bool	☐ FALSE		
21	"Stop Sw"	%M0.4	Bool	☐ FALSE		
22	"Stepper_Run_Bit_90°"	%M10.4	Bool	☐ FALSE		
23	"Stepper_Run_Bit_180°"	%M11.2	Bool	☐ FALSE		
24	"Stepper_Run_Bit_270°"	%M11.3	Bool	☐ FALSE		
25	"Stepper_Enable"	%Q0.2	Bool	☐ FALSE		

Figure 49 Auto sequence 12

	Name	Address	Display format	Monitor value	Modify value	
1	"Stepper_Home_Sensor"	%I0.0	Bool	☐ FALSE	TRUE	
2	"Stepper_back_Limit"	%I0.1	Bool	☐ FALSE		
3	"Stepper_Front_Limit"	%I0.2	Bool	☐ FALSE		
4	"Drill_Up_Position_Sensor"	%I0.3	Bool	☒ TRUE		
5	"Drill_Down_Position_Sensor"	%I0.4	Bool	☐ FALSE		
6	"Tap_Up_Position_Sensor"	%I0.5	Bool	☐ FALSE		
7	"Tap_Down_Position_Sensor"	%I0.6	Bool	☒ TRUE		
8	"Index_Table_Ref_Position_S..."	%I0.7	Bool	☐ FALSE		
9	"Capacitive_Sensor"	%I1.0	Bool	☒ TRUE		
10	"Stepper_Pulse"	%Q0.0	Bool	☐ FALSE		
11	"Stepper_Direction"	%Q0.1	Bool	☐ FALSE		
12	"Drill_Up_Down_Solenoid"	%Q0.3	Bool	☐ FALSE		
13	"Table_Lock_Solenoid"	%Q0.4	Bool	☐ FALSE		
14	"Tap_Up_Down_Solenoid"	%Q0.5	Bool	☒ TRUE		
15	"Drill_Motor_On_Off_Solenoi..."	%Q0.6	Bool	☐ FALSE		
16	"Tap_Motor_On_Off_Solenoi..."	%Q0.7	Bool	☒ TRUE		
17	"Tap_Motor_Reverse_forwar..."	%Q1.0	Bool	☒ TRUE		
18	"Seq_Run"	%M0.5	Bool	☐ FALSE		
19	"Start Sw"	%M0.3	Bool	☐ FALSE		
20	"Reset_Step_Sequence"	%M1.5	Bool	☐ FALSE		
21	"Stop Sw"	%M0.4	Bool	☐ FALSE		
22	"Stepper_Run_Bit_90°"	%M10.4	Bool	☐ FALSE		
23	"Stepper_Run_Bit_180°"	%M11.2	Bool	☐ FALSE		
24	"Stepper_Run_Bit_270°"	%M11.3	Bool	☐ FALSE		
25	"Stepper_Enable"	%Q0.2	Bool	☐ FALSE		

Figure 50 Auto sequence 13

	Name	Address	Display format	Monitor value	Modify value	
1	"Stepper_Home_Sensor"	%I0.0	Bool	☐ FALSE	TRUE	 
2	"Stepper_back_Limit"	%I0.1	Bool	☐ FALSE		☐
3	"Stepper_Front_Limit"	%I0.2	Bool	☐ FALSE		☐
4	"Drill_Up_Position_Sensor"	%I0.3	Bool	☒ TRUE		☐
5	"Drill_Down_Position_Sensor"	%I0.4	Bool	☐ FALSE		☐
6	"Tap_Up_Position_Sensor"	%I0.5	Bool	☒ TRUE		☐
7	"Tap_Down_Position_Sensor"	%I0.6	Bool	☐ FALSE		☐
8	"Index_Table_Ref_Position_S..."	%I0.7	Bool	☐ FALSE		☐
9	"Capacitive_Sensor"	%I1.0	Bool	☒ TRUE		☐
10	"Stepper_Pulse"	%Q0.0	Bool	☐ FALSE		☐
11	"Stepper_Direction"	%Q0.1	Bool	☐ FALSE		☐
12	"Drill_Up_Down_Solenoid"	%Q0.3	Bool	☐ FALSE		☐
13	"Table_Lock_Solenoid"	%Q0.4	Bool	☐ FALSE		☐
14	"Tap_Up_Down_Solenoid"	%Q0.5	Bool	☐ FALSE		☐
15	"Drill_Motor_On_Off_Solenoi..."	%Q0.6	Bool	☐ FALSE		☐
16	"Tap_Motor_On_Off_Solenoi..."	%Q0.7	Bool	☐ FALSE		☐
17	"Tap_Motor_Reverse_forwar..."	%Q1.0	Bool	☐ FALSE		☐
18	"Seq_Run"	%M0.5	Bool	☐ FALSE		☐
19	"Start Sw"	%M0.3	Bool	☐ FALSE		☐
20	"Reset_Step_Sequence"	%M3.5	Bool	☐ FALSE		☐
21	"Stop Sw"	%M0.4	Bool	☐ FALSE		☐
22	"Stepper_Run_Bit_90°"	%M10.4	Bool	☐ FALSE		☐
23	"Stepper_Run_Bit_180°"	%M11.2	Bool	☐ FALSE		☐
24	"Stepper_Run_Bit_270°" 	%M11.3	Bool	☐ FALSE		☐
25	"Stepper_Enable"	%Q0.2	Bool	☐ FALSE		☐

Figure 51 Auto sequence 14

Good extensive testing carried out

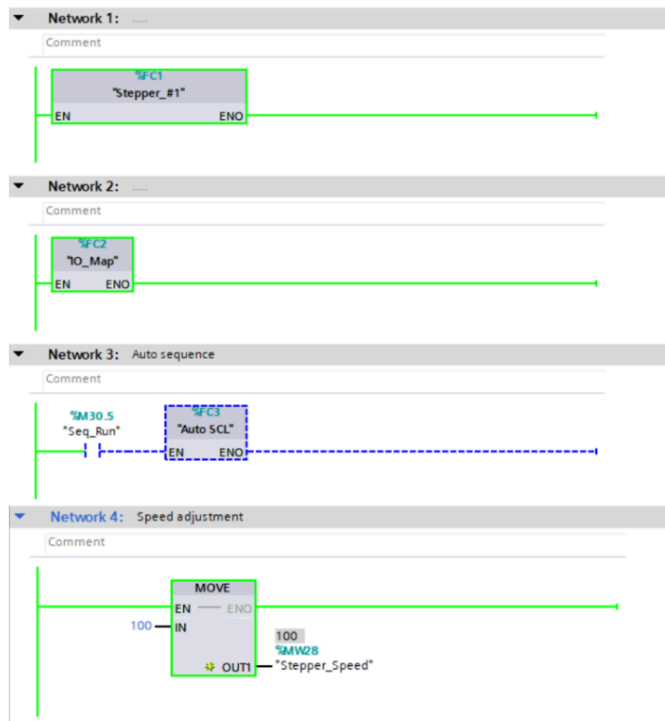


Figure 52 Manual ladder/FBD Code example 1

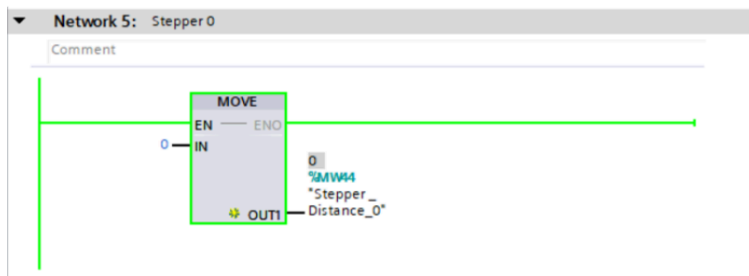


Figure 53 Manual/FBD Code example 2

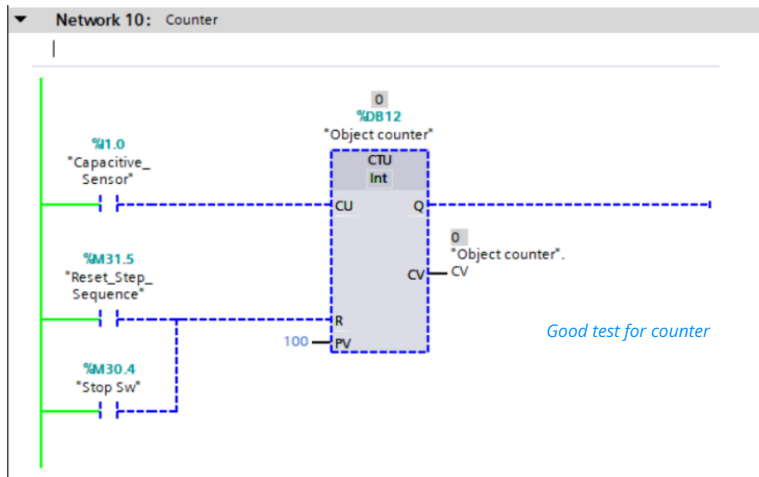


Figure 54 Manual code example 3

```

1 IF ("FirstScan" = 1) OR ("Auto" = 0) OR ("Reset_Step_Sequence" = 1) THEN
2   "Step" := 0; //reset all values to zero
3   "Next_Step" := 0; //this includes the step number
4   "Auto_Request_Drill_Down" := 0;
5   "Auto_Request_Drill_Up" := 0;
6   "Auto_Request_Tap_Down" := 0;
7   "Auto_Request_Tap_Up" := 0;
8   "Auto_Request_90" := 0;
9 END_IF;
10
11 CASE "Step" OF
12
13   0:
14     "Auto_Request_Tap_Up" := 1;
15     "Auto_Request_Drill_Up" := 1;
16     IF ("Drill_Up_Position_Sensor" = 1) AND ("Tap_Up_Position_Sensor" = 1) THEN
17       "Auto_Request_Drill_Up" := 0;
18       "Auto_Request_Tap_Up" := 0;
19       "Next_Step" := 1;
20     END_IF;
21
22   1:
23     // IF "Index_Table_Ref_Position_Sensor" = 1 THEN
24     "Auto_Request_90" := 1;
25     // END_IF;
26     IF "MC_MoveRelative_DB_2".Done = 1 THEN
27       "Auto_Request_90" := 0;
28       "Next_Step" := 2;
29     END_IF;
30

```

Figure 55 Automation SCL ex 1

```

31 2:
32     "Auto_Request_Drill_Down" := 1;
33     IF ("Drill_Down_Position_Sensor" = 1) AND ("Timer_Drill_Down" = 1) THEN
34         "Auto_Request_Drill_Down" := 0;
35         "Auto_Request_90" := 0;
36         "Next_Step" := 3;
37     END_IF;
38
39 3:
40     "Auto_Request_Drill_Up" := 1;
41     IF "Drill_Up_Position_Sensor" = 1 THEN
42         "Auto_Request_Drill_Up" := 0;
43         "Next_Step" := 4;
44     END_IF;
45
46 4:
47     // IF "Index_Table_Ref_Position_Sensor" = 1 THEN
48     "Auto_Request_180" := 1;
49     // END_IF;
50     IF "MC_MoveRelative_DB".Done = 1 THEN
51         "Auto_Request_180" := 0;
52         "Next_Step" := 5;
53     END_IF;
54
55 5:
56     "Auto_Request_Tap_Up" := 1;
57     IF ("Tap_Up_Position_Sensor" = 1) AND ("Drill_Up_Position_Sensor" = 1) THEN
58         "Auto_Request_Tap_Up" := 0;
59         "Next_Step" := 6;
60     END_IF;

```

Figure 56 Automation SCL ex 2

```

62
63 6:
64     "Auto_Request_Tap_Down" := 1;
65     IF ("Tap_Down_Position_Sensor" = 1) AND ("Drill_Up_Position_Sensor" = 1) AND ("Timer_Tap_Down" = 1) THEN
66         "Auto_Request_Tap_Down" := 0;
67         "Next_Step" := 7;
68     END_IF;
69
70 7:
71     "Auto_Request_Tap_Up" := 1;
72     IF ("Tap_Up_Position_Sensor" = 1) AND ("Drill_Up_Position_Sensor" = 1) THEN
73         "Auto_Request_Tap_Down" := 0;
74         "Next_Step" := 8;
75     END_IF;
76
77 8:
78     // IF "Index_Table_Ref_Position_Sensor" = 1 THEN
79     "Auto_Request_90" := 1;
80     // END_IF;
81     IF "MC_MoveRelative_DB_2".Done = 1 THEN
82         "Auto_Request_90" := 0;
83         "Next_Step" := 9;
84     END_IF;
85

```

Figure 57 Automation SCL ex 3

```

86 9:
87
88 "Auto_Request_Drill_Down" := 1;
89 IF ("Drill_Down_Position_Sensor" = 1) AND ("Timer_Drill_Down" = 1) THEN
90 "Auto_Request_Drill_Down" := 0;
91 "Auto_Request_90" := 0;
92 "Next_Step" := 10;
93 END_IF;
94
95 10:
96 "Auto_Request_Drill_Up" := 1;
97 IF ("Drill_Up_Position_Sensor" = 1) THEN
98 "Auto_Request_Drill_Up" := 0;
99 "Next_Step" := 11;
100 END_IF;
101
102 11:
103 // IF "Index_Table_Ref_Position_Sensor" = 1 THEN
104 "Auto_Request_180" := 1;
105 // END_IF;
106 IF "MC_MoveRelative_DB".Done = 1 THEN
107 "Auto_Request_180" := 0;
108 "Next_Step" := 12;
109 END_IF;
110
111 //UNLOAD OBJECT 2
112 //LOAD OBJECT 3
113

```

Figure 58 Automation SCL ex 4

```

113
114 12:
115 "Auto_Request_Tap_Up" := 1;
116 IF ("Tap_Up_Position_Sensor" = 1) AND ("Drill_Up_Position_Sensor" = 1) THEN
117 "Auto_Request_Tap_Up" := 0;
118 "Next_Step" := 13;
119 END_IF;
120
121 13:
122 "Auto_Request_Tap_Down" := 1;
123 IF ("Tap_Down_Position_Sensor" = 1) AND ("Drill_Up_Position_Sensor" = 1) AND ("Timer_Tap_Down" = 1) THEN
124 "Auto_Request_Tap_Down" := 0;
125 "Next_Step" := 14;
126 END_IF;
127
128 14:
129 "Auto_Request_Tap_Up" := 1;
130 IF ("Tap_Up_Position_Sensor" = 1) AND ("Drill_Up_Position_Sensor" = 1) THEN
131 "Auto_Request_Tap_Down" := 0;
132 "Next_Step" := 0;
133 END_IF;
134
135
136 END_CASE;
137 "Step" := "Next_Step";
138

```

Figure 59 Automation SCL example 5

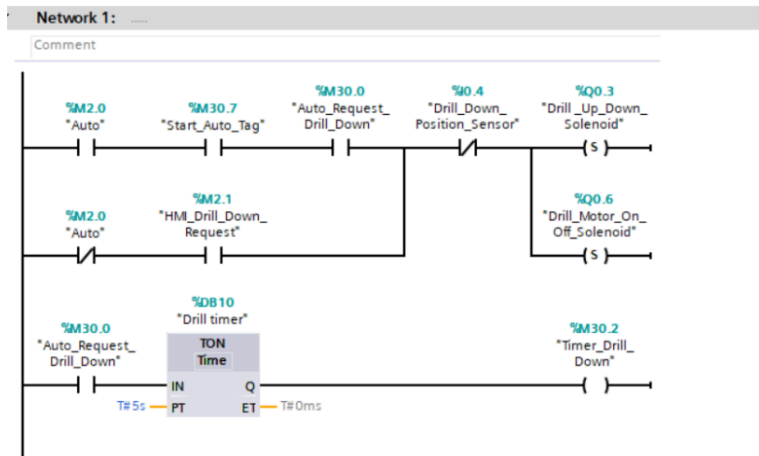


Figure 60 Drill down ladder control

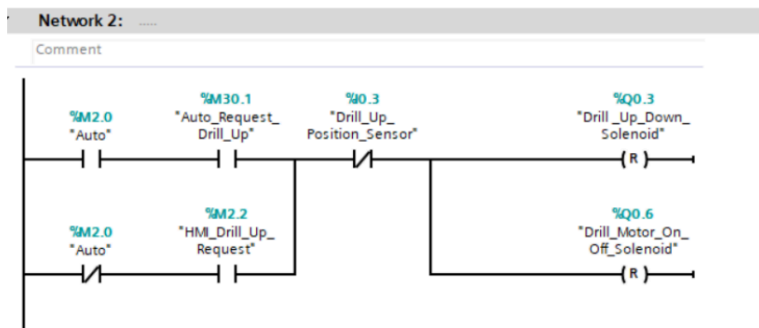


Figure 61 Drill up ladder control

Network 4:

Comment

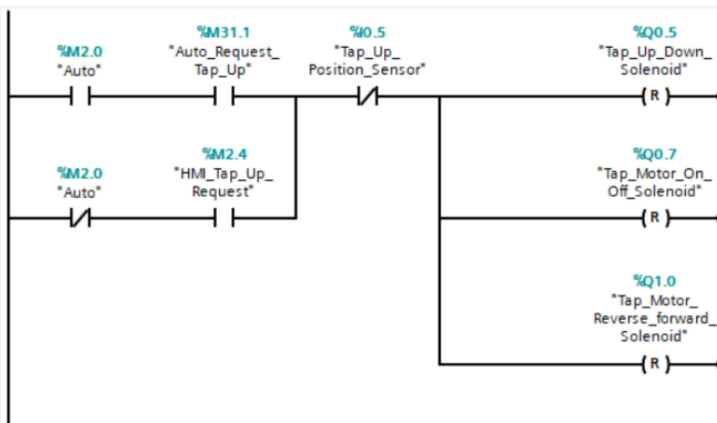


Figure 63 Tap Up control

Network 5:

Comment

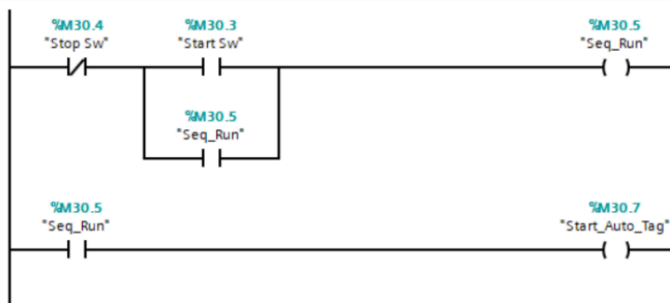


Figure 64 Sequence start Ladder control

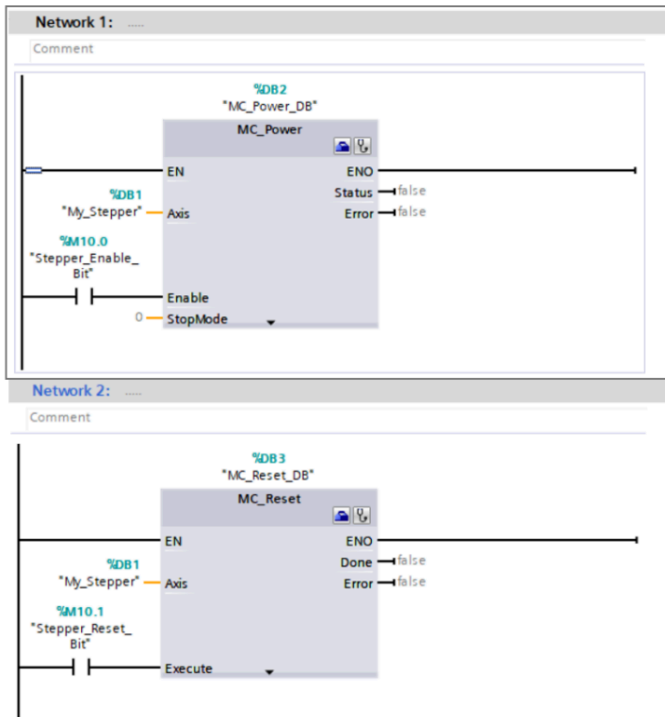


Figure 65 Motion control example 1

Network 3:

Comment

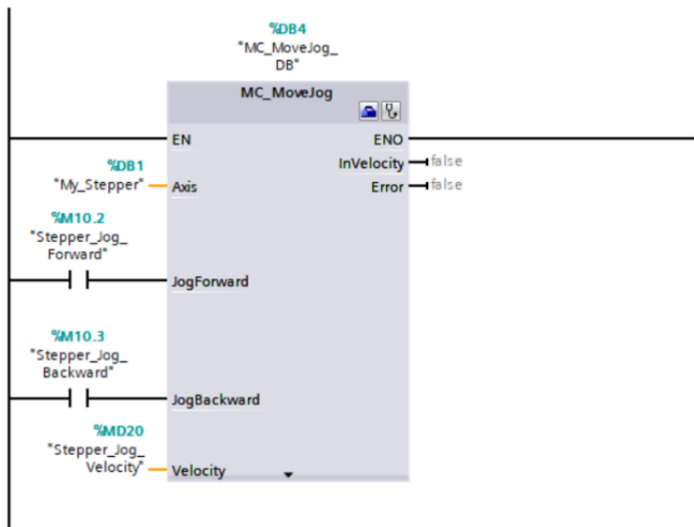


Figure 66 MC Jog control

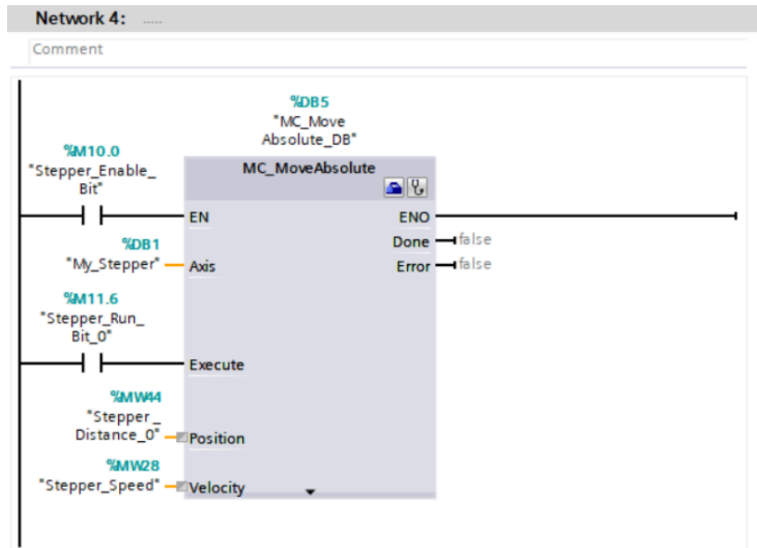


Figure 67 MC Absolute control

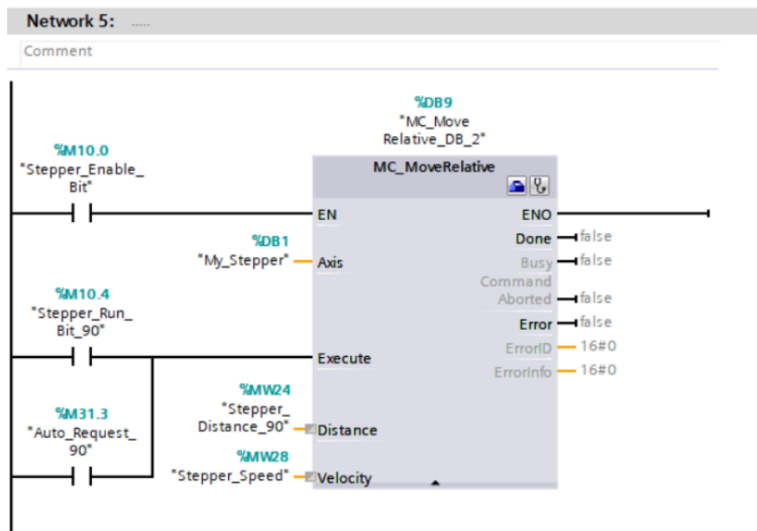


Figure 68 MC Relative 90 control

Network 6:

Comment

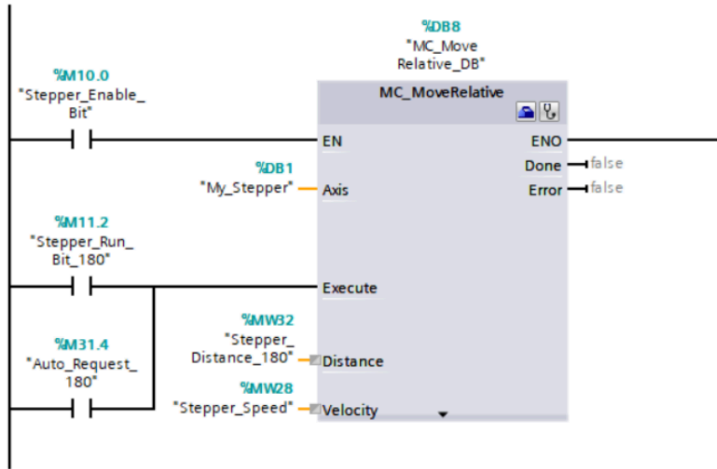


Figure 69 MC Move relative 180 control

Network 7:

Comment

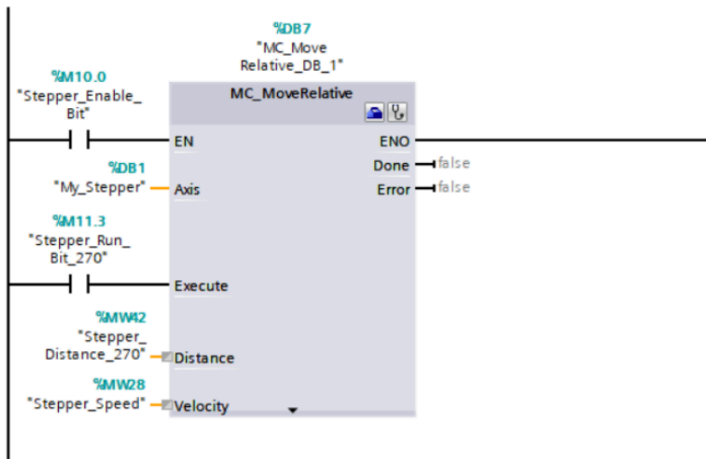


Figure 70 MC Move 270 control

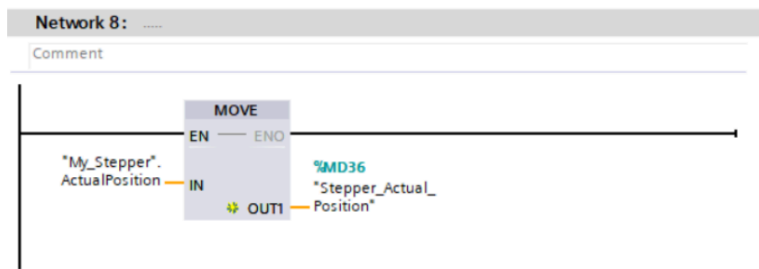


Figure 71 Stepper conversion

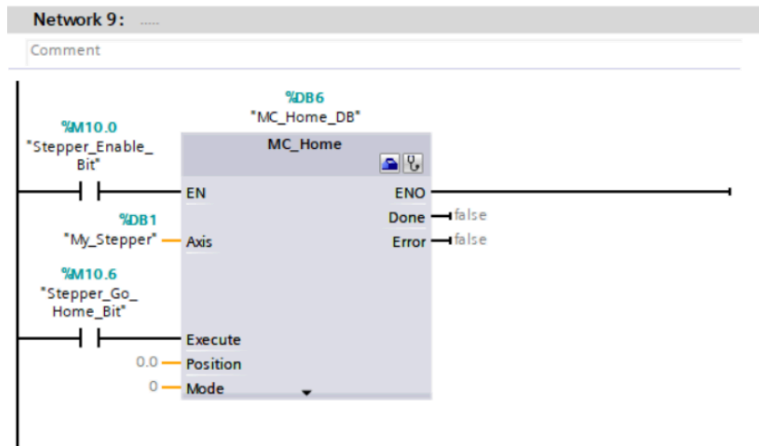


Figure 72 MC Home position

Default tag table							
	Name	Data type	Address	Retain	Acces...	Writa...	Visibl...
1	System_Byte	Byte	%MB1	☐	☒	☒	☒
2	FirstScan	Bool	%M1.0	☐	☒	☒	☒
3	DiagStatusUpdate	Bool	%M1.1	☐	☒	☒	☒
4	AlwaysTRUE	Bool	%M1.2	☐	☒	☒	☒
5	AlwaysFALSE	Bool	%M1.3	☐	☒	☒	☒
6	Clock_Byte	Byte	%MB0	☐	☒	☒	☒
7	Clock_10Hz	Bool	%M0.0	☐	☒	☒	☒
8	Clock_5Hz	Bool	%M0.1	☐	☒	☒	☒
9	Clock_2.5Hz	Bool	%M0.2	☐	☒	☒	☒
10	Clock_2Hz	Bool	%M0.3	☐	☒	☒	☒
11	Clock_1.25Hz	Bool	%M0.4	☐	☒	☒	☒
12	Clock_1Hz	Bool	%M0.5	☐	☒	☒	☒
13	Clock_0.625Hz	Bool	%M0.6	☐	☒	☒	☒
14	Clock_0.5Hz	Bool	%M0.7	☐	☒	☒	☒
15	Stepper_Home_Sensor	Bool	%I0.0	☐	☒	☒	☒
16	Stepper_back_Limit	Bool	%I0.1	☐	☒	☒	☒
17	Stepper_Front_Limit	Bool	%I0.2	☐	☒	☒	☒
18	Stepper_Pulse	Bool	%Q0.0	☐	☒	☒	☒
19	Stepper_Direction	Bool	%Q0.1	☐	☒	☒	☒
20	Stepper_Enable	Bool	%Q0.2	☐	☒	☒	☒
21	Stepper_Enable_Bit	Bool	%M10.0	☐	☒	☒	☒
22	Stepper_Reset_Bit	Bool	%M10.1	☐	☒	☒	☒
23	Stepper_jog_Forward	Bool	%M10.2	☐	☒	☒	☒
24	Stepper_jog_Backward	Bool	%M10.3	☐	☒	☒	☒
25	Stepper_Run_Bit_90	Bool	%M10.4	☐	☒	☒	☒
26	Stepper_Enabled	Bool	%M10.5	☐	☒	☒	☒
27	Stepper_Go_Home_Bit	Bool	%M10.6	☐	☒	☒	☒
28	Stepper_Homed	Bool	%M10.7	☐	☒	☒	☒
29	Stepper_Enable_Error	Bool	%M11.0	☐	☒	☒	☒

Figure 73 MC Data block

30	Stepper_Pause_Bit	Bool	%M11.1	☐	☒	☒	☒
31	Stepper_jog_Velocity	Real	%MD20	☐	☒	☒	☒
32	Stepper_Distance_90	Int	%MW24	☐	☒	☒	☒
33	Stepper_Speed	Int	%MW28	☐	☒	☒	☒
34	Stepper_Home_Position	Real	%MD32	☐	☒	☒	☒
35	Stepper_Actual_Position	Real	%MD36	☐	☒	☒	☒
36	Stepper_Home_Mode	Int	%MW12	☐	☒	☒	☒
37	Stepper_Run_Bit_180	Bool	%M11.2	☐	☒	☒	☒
38	Stepper_Distance_180	Int	%MW32	☐	☒	☒	☒
39	Stepper_Run_Bit_270	Bool	%M11.3	☐	☒	☒	☒
40	Stepper_Distance_270	Int	%MW42	☐	☒	☒	☒
41	Table_Lock_bit	Bool	%M11.4	☐	☒	☒	☒
42	Table_Lock_Solenoid	Bool	%Q0.4	☐	☒	☒	☒
43	Table_Unlock_Bit	Bool	%M11.5	☐	☒	☒	☒
44	Stepper_Distance_0	Int	%MW44	☐	☒	☒	☒
45	Stepper_Run_Bit_0	Bool	%M11.6	☐	☒	☒	☒

Figure 74 Data block ex 1

Auto Control Tags								
	Name	Data type	Address	Retain	Acces...	Writa...	Visibl...	
1	Auto_Request_Drill_Down	Bool	%M30.0	☐	☒	☒	☒	
2	Auto_Request_Drill_Up	Bool	%M30.1	☐	☒	☒	☒	
3	Timer_Drill_Down	Bool	%M30.2	☐	☒	☒	☒	
4	Start Sw	Bool	%M30.3	☐	☒	☒	☒	
5	Stop Sw	Bool	%M30.4	☐	☒	☒	☒	
6	Seq_Run	Bool	%M30.5	☐	☒	☒	☒	
7	Step	UInt	%MW202	☐	☒	☒	☒	
8	Next_Step	UInt	%MW200	☐	☒	☒	☒	
9	Start_Auto_Tag	Bool	%M30.7	☐	☒	☒	☒	
10	Auto_Request_Tap_Down	Bool	%M31.0	☐	☒	☒	☒	
11	Auto_Request_Tap_Up	Bool	%M31.1	☐	☒	☒	☒	
12	Timer_Tap_Down	Bool	%M31.2	☐	☒	☒	☒	
13	Auto_Request_90	Bool	%M31.3	☐	☒	☒	☒	
14	Auto_Request_180	Bool	%M31.4	☐	☒	☒	☒	
15	Reset_Step_Sequence	Bool	%M31.5	☐	☒	☒	☒	

Figure 75 Data block ex 2

IO_Tags								
	Name	Data type	Address	Retain	Acces...	Writa...	Visibl...	
1	Drill_Up_Position_Sensor	Bool	%I0.3	☐	☒	☒	☒	
2	Drill_Down_Position_Sensor	Bool	%I0.4	☐	☒	☒	☒	
3	Tap_Up_Position_Sensor	Bool	%I0.5	☐	☒	☒	☒	
4	Tap_Down_Position_Sensor	Bool	%I0.6	☐	☒	☒	☒	
5	Index_Table_Ref_Position_Senso	Bool	%I0.7	☐	☒	☒	☒	
6	Capacitive_Sensor	Bool	%I1.0	☐	☒	☒	☒	
7	Drill_Up_Down_Solenoid	Bool	%Q0.3	☐	☒	☒	☒	
8	Tap_Up_Down_Solenoid	Bool	%Q0.5	☐	☒	☒	☒	
9	Drill_Motor_On_Off_Solenoid	Bool	%Q0.6	☐	☒	☒	☒	
10	Tap_Motor_On_Off_Solenoid	Bool	%Q0.7	☐	☒	☒	☒	
11	Tap_Motor_Reverse_forward_S...	Bool	%Q1.0	☐	☒	☒	☒	
12	Auto	Bool	%M2.0	☐	☒	☒	☒	
13	HMI_Drill_Down_Request	Bool	%M2.1	☐	☒	☒	☒	
14	HMI_Drill_Up_Request	Bool	%M2.2	☐	☒	☒	☒	
15	HMI_Tap_Down_Request	Bool	%M2.3	☐	☒	☒	☒	
16	HMI_Tap_Up_Request	Bool	%M2.4	☐	☒	☒	☒	

Figure 76 Data block ex 3



Figure 77 Automatic Screen

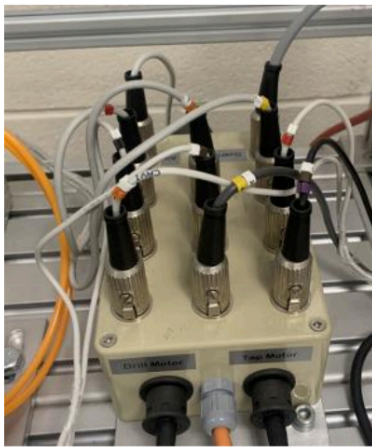


Figure 78 Drill and tap motor control wiring

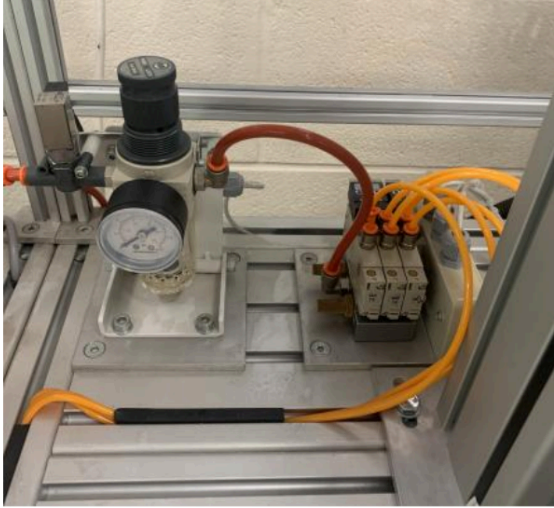


Figure 79 Pneumatic control system



Figure 80 Compressor



Figure 81 Internal panel wiring

Good images to support implementation

77 /100

PAGE 1

PAGE 2

Text Comment. Good table of contents

PAGE 3

PAGE 4

PAGE 5

Text Comment. Good extensive and detailed list of figures

PAGE 6

Text Comment. Good points

Text Comment. Good points

Text Comment. Good points covered

Text Comment. Good and informative

Text Comment. Good work

PAGE 7

Text Comment. Good explanation and ref source

Text Comment. Good relevant example

PAGE 8

Text Comment. Good example

Text Comment. Good program example

Text Comment. Excellent work here

PAGE 9

Text Comment. Good points

Text Comment. This is a good feature of modern drivers

Text Comment. Good citations

Text Comment. Very good features researched relevant to this project

Text Comment. Correct citation

PAGE 10

PAGE 11

Text Comment. Good point about purpose of interlock

Text Comment. Good arguments

PAGE 12

Text Comment. Good project plan

PAGE 13

Text Comment. A good solution forth system

Text Comment. Ref source should be used here

PAGE 14

Text Comment. Good arguments and supporting image

Text Comment. Ref source should aslo be included

PAGE 15

Text Comment. Good arguments for this solution

Text Comment. Good evaluation table

Text Comment. Good work here

PAGE 16

Text Comment. Good arguments put forward for the justification

Text Comment. Good explanation as this is not easy to explain in a short paragraph

PAGE 17

Text Comment. Good identification of parameters

Text Comment. Parameters identified

Text Comment. This is very good technical development

Text Comment. Very good development work

PAGE 18

Text Comment. Good work here

Text Comment. Good work with mapping io

Text Comment. This is excellent work. The timer is a great improvement to a system like this

Text Comment. This is a good point to mention here

PAGE 19

Text Comment. Good parameters identified for the function block

Text Comment. A very good HMI for motor parameter testing

Text Comment. Good point as this function allows any speed or distance to be set and tested

PAGE 20

Text Comment. Parameters of sequence are identified

Text Comment. Good explanation

PAGE 21

Text Comment. Good HMI design with manual and auto options

Text Comment. Good plan with comparator timeline

PAGE 22

Text Comment. Good table of results

Text Comment. Good table of results

Text Comment. Good test results

PAGE 23

Text Comment. Good extensive test results

Text Comment. Good point covered

PAGE 24

Text Comment. Good conclusion

Text Comment. Good recommendation

Text Comment. Good recommendation and this is possible from the control function blocks

Text Comment. Good future recommendation

PAGE 25

Text Comment. Good number of ref sources

PAGE 26

Text Comment. Good io data acquired

PAGE 27

Text Comment. Good data acquired

Text Comment. Good image

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Text Comment. Good extensive testing carried out

PAGE 41

PAGE 42

Text Comment. Good test for counter

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PAGE 44

PAGE 45

PAGE 46

Text Comment. Good images to support implementation

GRADING FORM: CSG-RUBIC

RHYS WILLIS

0

RESEARCH-INFORMED LITERATURE



Good research with good relevant ref sources.
Very good information included. 7/10
The solutions should have included a ref source for
each solution.
Ref sources. 7/10

14/20

KNOWLEDGE AND UNDERSTANDING



Good spec with details of what the project
requirements are. 7/10
Good relevant solutions with explanations and
supporting images. 7/10

14/20

ANALYSIS



Very good results in test tables obtained from extensive testing. Good realtime tables create for the test sequence. This worked well for the system. 8.5/10
Very good conclusion and excellent recommendations. 8.5/10

17/20

PRACTICAL APPLICATION AND DEP.



Very good Gantt charts for project plan with comparative timeline and explanetions. 4/5
Good practical explanations for solutions and good supporting images. 7.5/10
Implementation was excellent and good methods used throughout the development. 8.5/10

20/25

SKILLS FOR PROFESSIONAL PRAC.



A very good structured report with content in good order.

12/15