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by Aeron Smitham

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Good Structure

Table of Contents

Table of Figures 3
Table of Tables 5
Acknowledgements 6
1. Executive Summary 7
2. Introduction 8
3. Design 9
3.1. Table Feed Servo Drive Design 10
3.2. Table Feed and Hydraulic Upgrade Cable Schedule 12
3.3. PLC & HMI 13
3.3.1. Cutting Motors Start Permissive Code 13
3.3.2. Inhibit Motors After Inactivity 16
4. Implementation and Management 19
5. Testing and Results 22
6. Evaluation of Project Outcomes 24
6.1. Constraints 24
6.1.1. Ethical Engineering 24
6.1.2. Sustainability 25
6.1.3. Legal/Commercial 26
7. Conclusions and Recommendations 27
7.1. Conclusion 27
7.2. Recommendations 29
8. References 31
9. Appendix 34
9.1. Revised FDS 34
9.2. Revised Test Plan and Evidence 36
9.3. Logbook 46
9.4. Electrical Schematics 69
9.6. Cable Schedule 102
9.7. Costing 105
9.8. Gantt Chart 106
9.9. PLC Program 107

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Table of Figures

Figure 1 – Servo Drive Schematic 11
Figure 2 – Alarm Code 13
Figure 3 – Alarm Function Block 14
Figure 4 – Stop Motors SCL Code 17
Figure 5 – Stop Motors FB 18
Figure 6 – Hydraulic, Coolant & Vacuum Alarms 40
Figure 7 – Motor Circuit Breaker Tripped 40
Figure 8 – Coolant Alarm below 20L/min 41
Figure 9 – Vacuum Alarm above -700psi 41
Figure 10 – Beacon/Sounder Red Indicator 42
Figure 11 – Coolant Sensor 21.9L/min 42
Figure 12 – Vacuum at -800psi 43
Figure 13 – Table speed at 6.08m/min (100mm/s) 43
Figure 14 – Table Speed at 0.6m/min (10mm/s) 44
Figure 15 – 24VDC and 110VAC and Power Cabling 44
Figure 16 – Colour coded chevron cable markers 45
Figure 17 – Power Distribution 69
Figure 18 – Star-Delta Starters for Milling Cutters 70
Figure 19 – Coolant & Hydraulic Motor Circuits 71
Figure 20 – PILZ Motor Standstill Relays 72
Figure 21 – Safety Contactors 73
Figure 22 – Safety Contactors 2 74
Figure 23 – 110VAC Distribution 75
Figure 24 – 24VDC Distribution 76
Figure 25 Solenoid Valve Control 77
Figure 26 – Network Switch 78
Figure 27 – PLC and IO Modules 79
Figure 28 – PLC Inputs 80
Figure 29 – PLC Outputs 81
Figure 30 – PLC Analogue IO 82
Figure 31 – PLC Inputs 83
Figure 32 – PLC Inputs 84
Figure 33 – PLC Inputs 85
Figure 34 – PLC Inputs 86
Figure 35 – PLC Outputs 87
Figure 36 – PLC Outputs 88
Figure 37 – PLC Analogue Inputs 89
Figure 38 – PLC Analogue Inputs 90
Figure 39 – PLC Safety Inputs 91
Figure 40 – PLC Safety Outputs 92
Figure 41 – Operator Station Power 93
Figure 42 – Remote IO 94
Figure 43 – Remote Safety Inputs 95
Figure 44 – Remote Inputs 96
Figure 45 – Remote Inputs 97
Figure 46 – Remote Inputs 98

Figure 47 Remote Outputs 99
Figure 48 – Remote Outputs 100
Figure 49 – Solenoid Valve Control 101
Figure 50 – Motor Interlocks 107
Figure 51 – RH Cutter Motor 107
Figure 52 – LH Cutter Motor 107
Figure 53 – Coolant Motor 108
Figure 54 – Hydraulics Start 108
Figure 55 – Vacuum Start 108
Figure 56 – Simulated Table at end position 109
Figure 57 – Simulated table at start positon 109
Figure 58 – Simulated LH coolant inhibiting the two motors 110
Figure 59 – Simulated RH Coolant inhibiting two motors 110
Figure 60 – Simulated Chuck vacuum inhibiting the two motors 111
Figure 61 - Simulated vessel vacuum inhibiting the two motors 111
Figure 62 – Simulated hydraulic pump off so hydraulic sensors not made 112
Figure 63 – Simulated vacuum pump off, inhibiting the two motors 112
Figure 64 – Simulated coolant pump off, inhibiting the two motors 113

Table of Tables

Table 1 - Motor Start Permissives 15
Table 2 – Revised FDS 35
Table 3 – Revised Test plan 39
Table 4 – Cable Schedule 104
Table 5 – Costing Spreadsheet 105
Table 6 – Gantt Chart 106

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I would also like to thank my former colleagues Leo Farquhar and Gavin Barlow for their critical assistance during the implementation phase of this project. Leo's mechanical expertise and hands-on support ensured the successful integration of the servo system with the machines existing infrastructure. Gavin's electrical knowledge and problem-solving abilities were key to the development and testing of the control systems. Their collaboration and professionalism were vital in bringing the project to life.

1. Executive Summary *This is an excellent summary that covers all aspects of the project.*

This independent engineering project focused on modernising an ageing industrial machine by upgrading its servo-controlled table feed system, programmable logic controller (PLC), and human-machine interface (HMI). The project aimed to enhance operational safety, efficiency, and sustainability while aligning with current regulatory standards. Solution 3 was selected due to its comprehensive fulfilment of the Functional Design Specification (FDS) and the company's engineering objectives.

The most critical milestone achieved was the successful implementation of the new Table Feed Servo Drive, which allowed the machine to return to operational status. While the full upgrade, including the installation of the PLC and operator station, was not completed due to the author's departure from the company, all remaining work was designed, simulated, documented, and resourced for seamless handover.

A 15-minute inactivity-based shutdown routine was developed to address inefficiencies caused by motors being left running during breaks, saving an estimated 625,000 kWh annually. Ethical and sustainability considerations guided several key decisions, including the resolution of a hazardous hydraulic oil leak and the use of environmentally responsible suppliers such as Schneider Electric and Siemens.

Safety was a major focus, with emergency stop systems, updated guarding, and interlocks implemented to ensure compliance with EN ISO 13849-1 and the Machinery Directive. The revised FDS reported a 77.5% completion rate, with the uncompleted items limited to physical hardware installations.

In conclusion, the project exemplified sound engineering practice, ethical responsibility, and future-proofed design. Despite being unfinished, it delivered tangible improvements, met core objectives, and positioned the machine for full commissioning by the next engineer. The outcomes underscore the value of multidisciplinary collaboration, structured planning, and sustainable innovation in modern industrial automation.

Should be an introduction to the report not the project. However, this is another excellent section that explains the project to the reader.

2. Introduction

The objective of this project was to implement a comprehensive upgrade to an existing industrial machine to improve its operational performance, safety, and energy efficiency. The machine, previously reliant on hydraulic control and outdated logic systems, required significant modernisation to meet current engineering standards and business needs.

The upgrade centred on replacing the machine's table feed mechanism with a servo-controlled drive, redesigning the PLC and HMI architecture, and integrating advanced safety and monitoring features. The servo system was selected to enhance precision and repeatability in motion control, while the PLC and HMI were programmed using Siemens TIA Portal in accordance with IEC 61131-3 standards. These changes aimed to reduce unplanned downtime, improve user interaction, and support better data acquisition for maintenance and performance tracking.

Beyond technical upgrades, the project also addressed ethical, environmental, and legal concerns. An oil leak from the hydraulic system presented environmental risks and potential legal violations, prompting an investigation and corrective action. Concerns around automation and job displacement were mitigated by involving machine operators in the design process, reinforcing the system's role as a tool for support rather than replacement.

A systematic design methodology was adopted, beginning with the selection of components compliant with site and international standards, followed by CAD-based schematics, simulation-based validation, and detailed documentation. The implementation strategy incorporated engineering management principles such as configuration control, supplier coordination, and risk mitigation.

An updated FDS should be in this section

3. Design

You should have cited your assignment 1 here

The selected solution for this project was Solution 3, as it comprehensively addressed all the requirements of the Functional Design Specification (FDS) and aligned well with the company's engineering objectives. However, the project was not fully realised due to the author accepting a new job outside the company during its implementation.

Despite this, the primary goal of the project was achieved with the successful upgrade of the Table Feed Servo Drive, allowing the machine to resume production. Unfortunately, there was insufficient time to complete the PLC upgrade and operator station enhancements. Nevertheless, the PLC and HMI programs have been written and simulated, new electrical schematics have been drawn, and the necessary parts for the operator station have been procured. This ensures that another engineer within the company can complete the remaining tasks.

in the appendix.

A column has been added to the revised FDS table ^ to detail if the requirements are still achievable.

This section should have contained many more citations as the design process requires research.

3.1. Table Feed Servo Drive Design

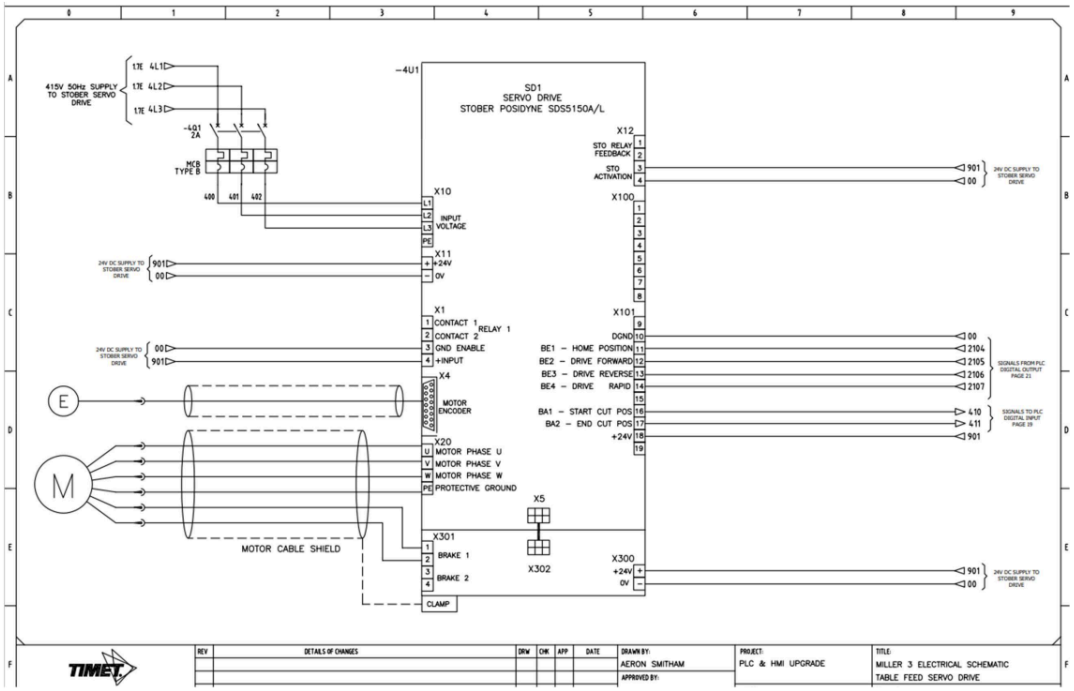
Figure 1 shows the electrical schematic for the Table Feed Servo Drive. The drive will be supplied with three phase 415V AC on cables 400, 401, & 402 to terminal rail X10. 24VDC control voltage is supplied to the drive via cables 901, which is the 24VDC, and cable 00, which is the 0V – to terminal rail X11. 24VDC is also supplied to terminals 3 and 4 of terminal rail X1 to enable the drive. The servo motor connections are on terminal rail X20, with the encoder cable connected to terminal X4.

The control of the servo motor is done through digital inputs on the servo drive, which are outputted from the PLC. The inputs are:

- BE1 – Home Position
- BE2 – Drive Forward
- BE3 – Drive Reverse
- BE4 – Drive Rapid

BE1 is true when the 'Home' limit switch has been made, by the table traversing backwards to the home and loading position. BE2 is true when the operator requests the motor to drive forward, when the operator presses the 'Feed Left PB'. BE3 is true when the operator requests the motor to drive in reverse, when the operator presses the 'Feed Right PB'. BE4 is true when the operator presses the 'Rapid PB'.

This drawing belongs in the appendix



Company name should be blocked out

Figure 1 – Servo Drive Schematic

3.2. Table Feed and Hydraulic Upgrade Cable Schedule

Text format - should be 1.5 line spacing

The cable schedule for the Miller 3 servo drive and hydraulic upgrade can be seen in section 9.6 of the appendix. Each cable is designated for specific functions, segregated by voltage, power, and control requirements. For instance, cables like W101 and W106 handle control signals for solenoids and coolant flow sensors, using 1.0mm YY cables with multiple cores to manage various 24VDC and 110VAC signals. These control cables are crucial for precise operation of the hydraulic pack components, ensuring that each solenoid and sensor receives the correct signals for activation and monitoring.

Text format - should be fully justified

Power cables, such as W103, W104, and W105, are designed to handle higher current loads for the hydraulic and scavenger pumps. These cables use 2.5mm YY cores to accommodate the increased power requirements, ensuring reliable operation of the pumps. The segregation of cables by function and voltage not only enhances the system's efficiency but also improves safety by reducing the risk of electrical interference and ensuring that each component operates within its designated parameters.

Additionally, emergency stop cables like W102 are clearly marked and separated to ensure quick and reliable shutdown of the system in case of an emergency. This careful organisation of the cable schedule is essential for maintaining the integrity and performance of the upgraded servo drive system.

3.3. PLC & HMI

3.3.1. Cutting Motors Start Permissive Code

The code in figure 2, is designed to monitor critical machine conditions, specifically vacuum presence, coolant flow, and hydraulic system readiness, when the operator issues a command to start the cutting motors. Implemented as a Function Block (FB) in TIA Portal using Structured Control Language (SCL), the logic uses four inputs: Vacuum_OK, Coolant_OK, Hydraulics_OK, and Start_Request. These represent real-time statuses of subsystems, and an operator start command.

Alarms should never be cleared by default (only perhaps on power up), you need an alarms handler so that alarms are acknowledged and then only cleared when fault has been removed. However, you seem to have resolved this by calling the function block in the network below.

```
// Clear alarms by default
#Alarm_Vacuum := FALSE;
#Alarm_Coolant := FALSE;
#Alarm_Hydraulic := FALSE;
#Master_Alarm := FALSE;
#Alarm_Buzzer := FALSE;

// If operator is requesting to start
IF #Start_Request THEN
    // Set alarms if conditions are not met
    IF NOT #Vacuum_OK THEN
        #Alarm_Vacuum := TRUE;
    END_IF;

    IF NOT #Coolant_OK THEN
        #Alarm_Coolant := TRUE;
    END_IF;

    IF NOT #Hydraulics_OK THEN
        #Alarm_Hydraulic := TRUE;
    END_IF;

    // Combine into master alarm
    #Master_Alarm := #Alarm_Vacuum OR #Alarm_Coolant OR #Alarm_Hydraulic;

    // Activate buzzer if any alarm is active
    IF #Master_Alarm THEN
        #Alarm_Buzzer := TRUE;
    END_IF;
END_IF;
```

Figure 2 – Alarm Code

The Vacuum_OK signal will become true when both the vessel and chuck vacuum sensor setpoints of -700psi have been satisfied. The Coolant_OK input will become true when both coolant sensors have a flow of 20L/min or above. The Hydraulics_OK input will become true when the hydraulic pressure sensor is above 1bar. The Start_Request input will become true if either of the cutting motor start push buttons are pressed, this can be seen in figure 3.

Program printouts should be in the appendix

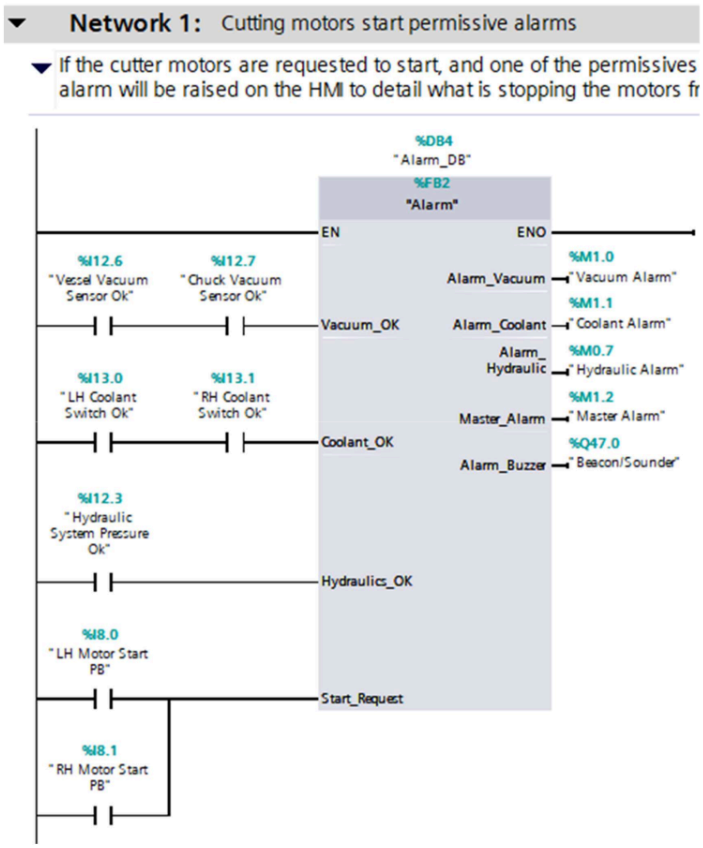


Figure 3 – Alarm Function Block

Table 1 describes the FB input in more depth.

Cutting Motors Start Permissives		
FB Input	Description	Inputs
Vacuum_OK	There are vacuum sensors on the vacuum vessel, which holds the vacuum in the system, and the vacuum chuck, which the work pieces are mounted too. Both these sensors must have a value of -700psi or below before the cutting motors can start and must stop the cutters if the vacuum reduces below the setpoint. If the system loses vacuum while milling, then there is a chance of the work piece being dragged off the vacuum chuck	%I12.6 & %I12.7
Coolant_OK	There are coolant sensors on the piping to the LH cutter and the RH cutter. Both these sensors must have a value of 20L/min or above before the cutting motors can start and must stop the cutters if the coolant flow reduces below the setpoint.	%I13.0 & %I13.1
Hydraulics_OK	There is a hydraulic pressure sensor on the hydraulic pack. This sensor must have a value of 1bar or above before the cutting	%I12.3
Start_Request	If either of the motor start push buttons are pressed, then the request becomes true.	%I8.0 OR %I8.1

Table 1 - Motor Start Permissives

When the Start_Request signal becomes active, the system checks each individual condition. If any of the subsystems are not ready, the code sets an associated alarm output (Alarm_Vacuum, Alarm_Coolant, or Alarm_Hydraulic) to TRUE. If at least one alarm is active, a Master_Alarm output is also activated to signal a general fault condition. To alert the operator immediately, the system controls an additional output, Alarm_Buzzer, which turns on whenever the Master_Alarm is active during a start attempt.

Each alarm output energises a memory bit which is used to bring on a HMI alarm, notifying the operator what has caused the issue.

If the Start_Request is not active, the system clears all individual alarms and the buzzer to prevent false alerts. The design ensures that the operator is notified exactly which subsystem is preventing the machine from starting, while also providing a unified alarm signal and a buzzer output for audible indication.

3.3.2. Inhibit Motors After Inactivity

An internal study was carried out over a six-week period across multiple production cells to investigate discrepancies in energy consumption and machine utilisation data. The findings uncovered widespread misuse of machine controls by operators, resulting in significant inefficiencies and misleading performance reporting.

This suggests they were not running under load

Specifically, the study found that a large number of motors, approximately 100 in total, were left running when no production was occurring. These motors ranged in size from 2.2 kW to 85 kW, with an even distribution across the board. Operators were routinely leaving machines in a "running" state during scheduled breaks, but more concerning was the pattern of extended informal breaks, including extended trips to the toilet, chatting with colleagues, or simply being away from their stations while machines continued running idle.

System logs and HMI interaction data showed that over 70% of these motors remained running throughout operator breaks, and up to 35% were idle for more than 45 minutes per shift without any logged activity. This behaviour was often used to avoid OEE downtime registration, giving the false impression that machines were in use. On average, this inflated OEE utilisation metrics by 6.8% across the lines, which distorted continuous improvement efforts and led to misallocated engineering resources.

From an energy perspective, the impact was substantial. Assuming an average power draw of 35 kW (based on the balanced motor rating distribution), and an average of 45 minutes of idle runtime per motor per shift, this equates to (Carbon Trust, 2021):

When no running under load, motors draw much less power. Do your calculations include this fact?

- $35\,kW \times 0.75\,hrs \times 100\,motors = 2{,}625\,kWh\,wasted\,per\,day$
- 13,125 kWh/week
- 52,000 kWh/month
- 625,000kWh/month
- $625{,}000\,kWh/year\;x\;£0.15/kWh = £93{,}750/year$

This unnecessary consumption is equivalent to the monthly usage of more than 140 UK homes, representing both a cost and environmental concern. Additionally, motors running unloaded experience thermal cycling and mechanical wear, increasing the likelihood of breakdowns and reducing the overall lifespan of equipment (International Energy Agency, 2022).

To correct this issue, a 15-minute inactivity-based motor shutdown system was developed. The logic continuously monitors system activity, and if no movement, interaction, or process signal is detected for 15 consecutive minutes, it issues a controlled stop command to all motors. This ensures that motors cannot be left running indefinitely without production demand, discourages misuse of the control system, and restores accuracy to OEE metrics.

The projected benefits include an annual energy savings of over 625,000 kWh per site, more accurate performance reporting, and better alignment of maintenance with actual usage patterns. The solution also supports broader sustainability goals and demonstrates responsible energy stewardship across the production environment.

The code in figures 4 and 5, is designed to improve machine safety and energy efficiency by automatically stopping all motors after a sustained period of inactivity. Implemented again in TIA Portal using SCL, this logic uses a single input signal, System_Active, to monitor whether the process is currently running or engaged.

Whenever System_Active is TRUE, the system is considered active, and a built-in timer (TON type) is kept reset. If System_Active becomes FALSE, meaning no process activity is detected, the timer begins counting. The preset time for the timer is set to 15 minutes (T#15m0s). If there is no activity for the entire 15-minute period, the timer's output (Q) becomes TRUE. This output is used to activate Stop_All_Motors, an output signal that commands the machine control system to stop all running motors safely.

The design ensures that temporary pauses or short idle periods do not immediately trigger motor shutdowns, only extended inactivity does. This not only helps prevent unnecessary motor stoppages during normal operation but also enhances safety and can save energy by ensuring machines are not left running unattended.

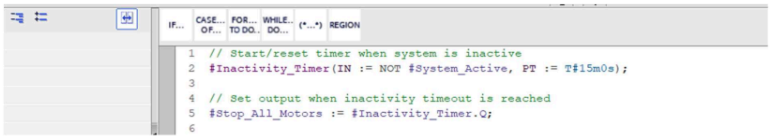


Figure 4 – Stop Motors SCL Code

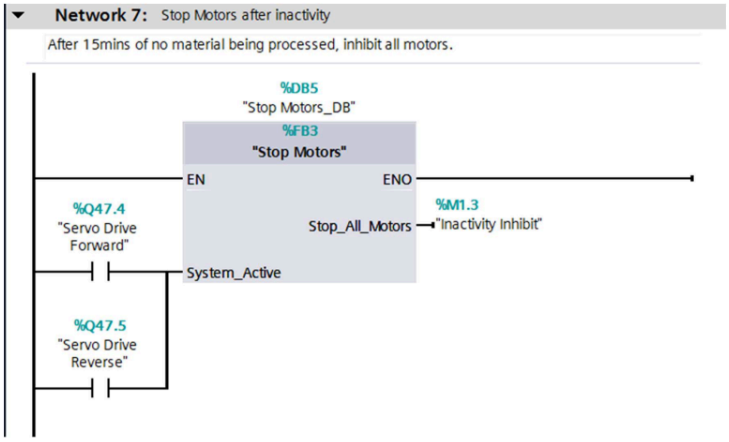


Figure 5 – Stop Motors FB

4. Implementation and Management

Implementation of the servo drive and control system upgrades commenced with the development of a comprehensive Bill of Materials (BoM), which outlined all required components, including the Stober Servo Drive, PLC unit, HMI interface, emergency stop assemblies, digital and analogue I/O modules, control panel hardware, power supplies, relays, contactors, and terminal blocks. Components were selected to ensure compatibility with existing infrastructure while maintaining compliance with IEC 60204-1 and other relevant standards. Supplier reliability, cost, and lead times were factored into procurement decisions, with alternative parts sourced for high-risk items to maintain project continuity.

The machine was disassembled to create mechanical drawings for custom parts and verify the existing hydraulic system layout. A drawing of a coupler was produced to interface the servo motor with the internal spline that was previously connected to the hydraulic motor. The mechanical installation included the mounting of the servo motor, bracket fabrication, and re-routing of hydraulic lines. A new hydraulic pack was installed featuring pressure gauges, pressure switches, solenoid valves, and dual scavenger pumps. These were integrated with the control system to enable centralised control and monitoring.

Inputs such as ‘Home Position’, ‘Drive Forward’, ‘Drive Reverse’, and ‘Drive Rapid’ were mapped into the logic, while outputs for 'Start Cut' and 'End Cut' were programmed to trigger relays based on encoder feedback, using the Stober POSITool software (Stober Drives Inc, 2023). Correctly cited

The electrical design was carried out using CAD-based schematic design software (e.g., EPLAN or AutoCAD Electrical), with layer-based drafting to separate control, power, and safety systems. The control panel layout was optimised for heat dissipation, with thermal management supported by panel ventilation and filtered fan assemblies. DIN rail-mounted terminal blocks were used for organised wiring, and all cabling was specified with reference to load current, voltage drop, and insulation class. A central earth bar and shielded cable glands were included to minimise electrical noise and ensure signal integrity in high-frequency environments such as servo drives.

The PLC was programmed using structured text and ladder logic in accordance with IEC 61131-3 programming standards (IEC, 2013). The PLC handled core logic for machine motion control, safety interlocks, alarm handling, and mode selection. Input signals from the operator station and servo encoder were processed to generate control outputs, which actuate relays, solenoids, and signal the HMI (Bolton, 2021).

The HMI was developed in tandem with the PLC using TIA Portal providing a touch interface with intuitive navigation and user-focused design (Siemens AG, 2024). Visual indicators were used to represent servo status, hydraulic pressure levels, and system interlocks, while password protection was implemented for restricted settings to maintain operational security. Real-time data such as encoder position, drive status, and error codes were made available for operator feedback and fault tracing.

Correctly cited

To facilitate reliable communication between devices, Profinet was used to link the PLC, Remote IO, and HMI in the TIA Portal code. Network topology was mapped to ensure deterministic communication, and cyclic update rates were tuned for optimal response without overloading the PLC CPU. Data blocks were structured and tagged for easy debugging and future scalability.

Early in the commissioning phase, servo control was validated independently before integration with the full machine. The motor was run between its programmed start and end points, and encoder values were verified using measurement tools. Electrical commissioning included insulation resistance testing and validation of correct current ratings, wiring continuity, and proper operation of overload and safety devices.

Electrical safety considerations included integration of emergency stop circuits in both the control panel and operator station, using dual-channel safety relays in accordance with EN ISO 13850. Circuit breakers and fuses were appropriately rated and labelled, and lockout/tagout compliance was enforced during all wiring and installation tasks. An electrical verification and insulation resistance test were completed prior to energising the panel.

Intellectual property considerations were addressed by ensuring that custom PLC routines, HMI graphics, and control panel drawings were documented and protected under institutional policies. All work conformed to ethical and legal standards applicable to engineered solutions in industrial automation environments.

Financial oversight was maintained through a detailed expenditure spreadsheet tracking all bought-out items and labour (Project Management Institute, 2021). The project remained well within budget, with only £19,717 spent.

Correctly cited

Throughout the design and implementation phase, engineering management principles guided decision-making around resource allocation, risk mitigation, documentation, and quality assurance. A project configuration management process was used to track changes to schematics, code versions, and HMI graphics, with backups stored in accordance with version control protocols. The project plan and Gantt chart were updated weekly to reflect progress,

and actual durations were recorded for milestone tracking. The Gantt chart can be seen in section 9.8 of the appendix.

Engineering management principles guided the successful execution of this phase, from procurement and supplier coordination to documentation control, risk mitigation, and resource reallocation. The integration of electrical, mechanical, and software systems was achieved using a multidisciplinary approach. The successful completion of servo commissioning, panel build, and control logic validation demonstrates the effective application of practical engineering skills and structured project planning.

5. Testing and Results

The test plan can be seen in section 9.9 of the appendix. The test results clearly demonstrate that all items listed in the revised FDS were addressed, with each test yielding a "Pass" result. A wide range of systems and components were evaluated to confirm they functioned as intended and met relevant standards. Electrical checks confirmed that panel wiring complied with BS EN 60204, including correct colour coding for 24VDC, 110VAC, and AC power wiring (BSI, 2018). Additional inspections verified that all wires were properly identified at both ends and were fitted with colour-coded chevron cable markers, and that all field cabling included cable number identification that matched the cable schedule. These tests ensured the integrity and traceability of the electrical system, which is critical for both maintenance and safety.

Control and alarm functionality were extensively tested to verify operational safety and user interface reliability. Live and historical motor circuit breaker alarms were displayed correctly on the HMI, with accompanying audible and visual signals through sirens and beacons. Operators were also guided by fault prompts on how to rectify tripped circuit breakers, ensuring clear and actionable feedback in case of system issues. The availability of electrical schematics in both PDF and .DWG formats ensured technical documentation was accessible and standardised. Functional performance testing included verification of motor auto shutoff after 15 minutes of inactivity, confirming energy efficiency and safety protocols.

Mechanical performance was validated using quantitative measurements. The table speed was confirmed to be 10 m/s during milling and 100 m/s in rapid mode, both verified using a handheld tachometer. Similarly, milling cutters were shown to operate at 30 rpm, with all results aligning with expected specifications. Fluid systems were also tested thoroughly. Coolant flow was measured at over 20 L/min using the IFM SM8000 sensor, vacuum pressure was verified to be below -700 psi on the IFM PN2092 sensor, and spindle clutch hydraulic pressure was confirmed to be above 1 bar via the IFM PN2099 sensor.

Additional safety and interlock features were verified through simulation. The code correctly prevented milling cutter operation unless vacuum, coolant, and hydraulic systems were operating within set parameters, and alarms indicated which condition was preventing startup. Sounder alarms were also activated when vacuum or coolant conditions dropped below thresholds. Emergency stop functionality was confirmed across multiple points and was shown to disable all operations until faults were cleared and the system was reset, reinforcing the project’s strong emphasis on safety (IEC, 2011).

The comprehensive range of tests and the use of appropriate equipment, such as handheld tachometers, digital sensors, and alarm systems, demonstrated a solid understanding of

engineering practices and the application of quantitative methods to validate system performance. The successful outcome of all tests indicates that the project meets its design specifications, performs reliably, and incorporates the necessary safeguards for industrial operation. While no adjustments to the design were required due to the successful results, the testing approach was clearly capable of identifying faults and guiding corrective action if needed, showcasing both technical competence and thorough preparation.

6. Evaluation of Project Outcomes

As per the revised FDS, 7 out of the 31 tests could not be achieved, which were mainly requirements that involved the implementation of the physical part of the PLC project, such as the height of the new operator station, and what was to be installed on the station. The remaining 24 tests were carried out successfully, giving the test plan 100% success. Based on the original test plan, the project was 77.5% successful.

$$Original\ Test\ Plan\ Success\ Rate = (24 \div 31) \times 100 = 77.5\%$$

$$Revised\ Test\ Plan\ Success\ Rate = 100\%$$

The costing of the project was a success, with the project coming in well under the budget given. The costing spreadsheet can be seen in section 9.7 of the appendix.

6.1. Constraints

6.1.1. Ethical Engineering

Ethical engineering introduced a critical layer of responsibility to the project, making sure to consider not only technical performance but also the broader human, environmental, and legal implications of their work (Royal Academy of Engineering, 2020). One of the most pressing ethical issues that had to be addressed was the persistent oil leak from the machine. This leak posed a substantial risk to both employee safety and the environment. Oil leaks had the potential to contaminate groundwater and public water supplies, particularly through site drains connected to the effluent treatment plant, which was not equipped to handle oil contaminants (Wessex Water, 2020). This meant that oil-contaminated water could have been discharged into the public sewage system, in direct violation of the Water Resources Act, risking fines or imprisonment for the company (UK Government, 1991). In response, the project scope was expanded to include the identification and rectification of the leak. The hydraulic motor was initially suspected as the source, and a full investigation was undertaken to confirm this and identify any additional leak points, ensuring the issue was fully resolved within the project timeline.

Concerns surrounding automation and job security also had to be ethically addressed. With the control system being upgraded, there was apprehension among operators that these changes were a step toward automating their roles. This concern was valid, especially given that 63.73% of metal working machine operatives were statistically at risk of automation (Office for National Statistics, 2019). To alleviate this, the project team actively involved the operators in the design process and maintained clear communication throughout. It was explained that the new control system would enhance, not eliminate, their roles—providing improved

reliability and ease of operation rather than full automation. This helped maintain trust, reduce resistance, and reinforce the ethical responsibility to preserve fair labour practices.

Furthermore, the ethical obligation to ensure machine safety was taken seriously. Simply restoring functionality without considering updated safety requirem[illegible]ave been both unethical and illegal. In compliance with the Machinery Directive (2019), a thorough risk assessment was conducted to evaluate the impact of the upgrades on operator and maintenance personnel safety. Based on the findings, it was determined that several safety measures needed to be updated, including the addition of physical guarding to protect against new or exposed hazards. These improvements were implemented even though they had the potential to reduce production efficiency, reflecting the project's commitment to placing human safety above convenience.

Correctly cited

6.1.2. Sustainability

Sustainability was also a fundamental constraint that influenced several key project decisions. The recurring oil leak not only posed an ethical issue but also a significant sustainability concern. The machine's 100-litre hydraulic tank had to be refilled on a weekly basis, costing the business around £250 per week and resulting in considerable waste. Addressing the leak thus became essential not only from an environmental standpoint but also from a financial sustainability perspective. A full inspection of the hydraulic system was conducted, and repair efforts were focused on eliminating all sources of leakage to prevent ongoing environmental degradation and reduce unnecessary resource consumption.

In addition to environmental concerns, sustainability goals were supported by the efficient reuse and standardisation of components. All functional parts that were removed during the upgrade were returned to the site's stores for future use as spares. This practice extended the lifecycle of components and reduced electronic waste. Moreover, the project adhered to the site's electrical standards, which promoted the use of common, site-wide components. By standardising parts and selecting from a preferred list of manufacturers, the project reduced inventory complexity, simplified training, and enhanced long-term maintenance efficiency.

An equally important aspect of the sustainability strategy was the careful selection of suppliers. The majority of components used in the upgrade were sourced from Schneider Electric and Siemens—two companies globally recognised for their sustainability efforts. Schneider Electric had been named the most sustainable company in the world in 2024 (TIME, 2024), with a firm commitment to the UN's 2030 Sustainable Development Goals. Siemens ranked 11th (TIME, 2024), and consistently performed in the top 1% in Environmental, Social, and Governance (ESG) evaluations. By choosing these suppliers, the project ensured that

Correctly cited

sustainability was not only practiced at the implementation level but also embedded throughout the supply chain.

6.1.3. Legal/Commercial

Legal and commercial constraints were identified early in the planning stage and were carefully managed throughout the project. Since the control system formed a critical part of the machine's operation, its replacement triggered legal obligations under current machinery safety regulations. As stated by the Health and Safety Executive, replacing key control elements could classify the machine as 'new', thereby invoking the need for a f Correctly cited assessment in line with the Supply of Machinery (Safety) Regulations 2008 (Health and Safety Executive, 2024).

A comprehensive machinery safety review was conducted, including a determination of the required performance levels (PLr) for each safety function as per BS EN ISO 13849-1 (2015). Three primary hazards were identified: access to rotating cutting heads, moving parts of the bed, and moving parts of the machine head. The PLr for these hazards were determined to be c and d, and suitable guarding and interlock systems were designed and installed to achieve the necessary safety levels. These actions ensured that the machine met the latest safety and compliance standards, significantly reducing legal liability and enhancing operator safety. *this belonged in the design section*

Commercially, the project was vulnerable to global supply chain disruptions, particularly concerning the availability of long lead-time components such as PLCs, HMIs, and servo drives. However, i Correctly cited o the global semiconductor shortage experienced between 2020 and 2023 (Forbes, 2024), the company had adopted a proactive inventory strategy. Key components were pre-stocked in the site stores, allowing the project to proceed without delay. Any non-stocked parts were identified early and ordered promptly to prevent bottlenecks. This foresight and preparedness helped keep the project on schedule and within budget, despite potential market volatility.

7. Conclusions and Recommendations

7.1. Conclusion

The project set out to deliver a comprehensive upgrade to an industrial machine by implementing a new servo-controlled table feed system, redesigning the PLC and HMI interfaces, and improving overall safety, sustainability, and efficiency. The selected solution, Solution 3, was chosen due to its holistic alignment with the FDS and the company's engineering objectives. Despite the project not reaching full completion due to the author's departure from the company, a substantial portion of the work was successfully delivered, and the remaining tasks have been positioned for handover with all necessary resources and documentation prepared.

At its core, the project sought to improve production reliability, system safety, and energy efficiency while maintaining a high standard of engineering integrity. The successful implementation of the table feed servo drive was a major achievement. The integration of a modern servo system allowed for precise Correctly cited improved positional accuracy, and smoother transitions between feed rates (Schröder, 2015). This directly enabled the machine to resume production after a period of downtime, meeting the most urgent operational need.

Although the PLC and HMI systems were not physically installed before the project's conclusion, they were fully developed and simulated using TIA Portal. The logic, interlocks, alarm management, and permissive routines were implemented in compliance with IEC 61131-3 standards, and the code was tested for robustness under various simulated conditions. Similarly, the HMI was designed with a us Correctly cited vout that emphasised accessibility, operator guidance, and fault diagnostics (Gould & Lewis, 1985). Together, these efforts ensured that the contr Correctly cited machine was future-proof, scalable, and ready for commissioning (Zuehlke, 2010).

The revised FDS and associated test plan provided a clear framework for evaluating the outcomes of the project. Of the 31 defined requirements, 24 were achieved, representing 77.5% overall completion. The unachieved items related primarily to physical installations on the operator station, tasks that could not be finalised before the transition of project leadership. Nonetheless, these requirements remain clearly defined, and all necessary components have been procured, allowing another engineer to bring the project to full completion with minimal delay.

Ethical engineering was a guiding principle throughout the project, shaping both the approach and execution of technical work. The most urgent ethical concern was the hydraulic oil leak, which posed a serious risk to personnel, the environment, and the company's legal standing.

The leak had the potential to contaminate g Correctly cited nd public water supplies, violating multiple regulations including the Water Resources Act (1991). Addressing this issue went beyond simple maintenance—it reflected a commitment to responsible engineering. A full investigation was conducted, the suspected hydraulic motor was examined, and measures were taken to identify and eliminate all sources of leakage. This resolved an issue that had long been overlooked, thus restoring environmental compliance and safeguarding worker health.

Equally important were concerns about the perceived threat of automation. The project introduced modern control systems that could be misinterpreted as steps toward reducing human involvement in operations. In response, the engineering team took proactive steps to engage machine operators throughout the design process, providing transparency and reassurance. Operators were informed that the changes would support their roles rather than replace them, simplifying control, enhancing safety, and improving system feedback. By involving stakeholders in this way, the project upheld principles of fairness, collaboration, and ethical decision-making in the face of technological advancement (Waldrop, 2015).

The ethical obligation to improve machinery safety was also fulfilled through risk assessments and the implementation of new safeguarding measures. As per the Machinery Directive (2019), the control system upgrade constituted a substantial modification, requiring compliance with current safety standards. Performance Level (PLr) assessments were conducted in accordance with BS EN ISO 13849-1, and the necessary interlocks, e Correctly cited stops, and guarding systems were implemented to achieve safety integrity levels (BSI, 2015). These changes may have introduced operational friction in some cases, but they were vital in protecting operators from mechanical hazards, reinforcing the project's ethical foundation.

Sustainability was another critical constraint that shaped the project's design philosophy. The oil leak, in addition to its ethical implications, represented a financial and ecological burden—resulting in weekly costs of £250 and continuous environmental waste. The repair not only saved costs but also reduced the environmental footprint of the operation, supporting the company's broader sustainability goals. Beyond this, the project embraced a circular economy approach by repurposing removed components as site spares, reducing waste and improving spare parts availability.

Component standardisation also played a key role in the sustainability strategy. By adhering to the site electrical specification, which limited the variety of manufacturers used, the project reduced complexity in inventory, maintenance, and training. Importantly, the selected manufacturers, Schneider Electric and Siemens, are industry leaders in environmental responsibility. Schneider, named the most sustainable company globally in 2024 and

Siemens, ranked 11th, align with the UN's Sustainable Development Goals. Their inclusion in the project helped extend sustainability beyond local operations and into the supply chain.

Legal and commercial constraints were carefully navigated to ensure project success. A thorough safety assessment was completed, and the identified hazards were mitigated through appropriate design interventions. The safety system met the required PLr values for critical functions, ensuring compliance and reducing liability.

From a commercial perspective, the project faced challenges common in the post-pandemic industrial landscape, namely, long lead times for electronic components. However, by leveraging the company's proactive inventory policy, put in place during the semiconductor shortage, the majority of required components were already stocked. This allowed the project to proceed without procurement delays and reinforced the importance of forward-thinking supply chain strategies in modern engineering projects.

In terms of quality assurance and continuous improvement, the project adhered to a structured approach rooted in engineering best practices. All changes were documented, drawings were version-controlled, and configurations were backed up for traceability. Functional testing was exhaustive and methodical, confirming that alarms, interlocks, speed controls, and safety systems performed as expected. A systematic testing phase ensured the project delivered measurable value and met its stated objectives. Further, through features like inactivity-based motor shutdown, the project introduced new layers of energy efficiency, helping to address misuse of machinery, reduce overheads, and support long-term operational sustainability (Kagermann, et al., 2013). Correctly cited

7.2. Recommendations

To fully realise the objectives of the project and bring the machine upgrade to completion, it is recommended that the next stage focuses on the implementation of the PLC and HMI systems, which were fully developed, tested, and simulated during the initial phase of the project. The logic for control, alarms, start permissives, and safety interlocks has already been written in TIA Portal using Structured Control Language (SCL) and has passed simulation-based validation. Similarly, the HMI interface was designed with an intuitive layout, alarm history, fault diagnostics, and real-time system monitoring, making it ready for commissioning without the need for further development (ISO, 2019). Correctly cited

All necessary electrical schematics, documentation, and code files have been completed and archived according to site standards, ensuring that a new engineer can seamlessly pick up the project. It is advised that this engineer reviews the final version of the Functional Design

Specification (FDS) and test plan to understand the scope, implementation requirements, and the components already in place.

To ensure minimal disruption and rapid deployment, the physical installation of the new operator station should follow the predefined wiring diagrams and panel layout plans. All hardware for this stage, including the operator station components, PLC, and HMI, has already been procured and is currently stored on-site.

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9. Appendix

9.1. Revised FDS

Functional Design Specification		
FDS Reference	Design Requirement	Still Achievable
A.1	Operator Station to be sheet steel finished to colour RAL 7035	Unable to complete
A.2	Operator Station to be Rittal AX Command panel with handle strips	Unable to complete
A.3	Symbols and colours of panel actuators and LEDs to follow BS EN 60204-1:2018	Unable to complete
A.4	Engraved labels to be used for all devices mounted on panel doors or operator stations	Unable to complete
A.5	Panel wiring colours in accordance with BS EN 60204	Required
A.6	All wiring to have the same identification at each end of the wiring	Required
A.7	All wiring to have colour coded chevron type cable markers at each end of the wiring	Required
A.8	All field cabling to have cable number identification	Required
B.1	Live alarms to be displayed to operator and logged	Required
B.2	Historical alarms to be displayed to operator and logged	Required
B.3	Alarm siren and beacon to notify operator of live alarm	Required
B.4	Displayed alarms to come with information on how to rectify fault	Required
C.1	Electrical schematics to be provided in pdf and .dwg format	Required
C.2	Declaration of Conformity to be provided	Unable to complete
C.3	O&M manual, Risk Assessment, Safety Function Performance Level (PL) Calculations, Cable Schedule, and FDS to be provided	Unable to complete
D.1	Electrical parts must be in the Company Electrical Specification to reduce number of spares held in stores	Required

D.2	Sources of energy must be automatically turned off after a period of inactivity	Required
E.1	Operator station must be above 1.5m	Unable to complete
F.1	Table speed when milling must be 10m/s	Required
F.2	Table speed in rapid must be 100m/s	Required
F.3	Milling cutters must rotate at 30rpm	Required
F.4	Coolant flow must be above 20L/min	Required
F.5	Vacuum must be less than -700psi	Required
F.6	Spindle clutch hydraulic pressure must be above 1bar	Required
G.1	All motors must be able to be started automatically and manually	Required
G.2	Table must have a rapid speed and running speed	Required
G.3	Vacuum, coolant flow, and hydraulic pressure must be present before milling cutter motors can start	Required
G.4	A sounder must alarm if vacuum is lost or coolant flow is insufficient	Required
H.1	Emergency stop shall stop all operations and inhibit any start commands	Required
H.2	Emergency stops shall be located at the operator station and control panel, as well as other applicable locations in the cell where the operator will work	Required
H.3	Operation cannot be restarted after an emergency stop until the reason has been cleared and system reset	Required

Table 2 – Revised FDS

9.2. Revised Test Plan and Evidence

Test Plan						
Test No.	FDS Reference	Description of Test	Expected Outcome	Actual Outcome	Pass/Fail	Evidence (Figure)
5	A.5	Panel wiring colours in accordance with BS EN 60204	• Check 24VDC wiring is coloured blue • Check 110VAC wiring is coloured red • Check AC power cabling is coloured black	Panel wiring colours are in accordance with BS EN 60204	Pass	15
6	A.6	Each individual wire must have the same identification at each end, i.e. if a wire has L1 at one end, check it also has L1 at the other.	All wiring has the same identification at each end of the wiring	All wiring has the same identification at each end of the wiring	Pass	15
7	A.7	All wiring must have colour coded chevron type cable markers to identify it	All wiring to have colour coded chevron type cable markers at each end of the wiring	All wiring has colour coded chevron type cable markers at each end of the wiring	Pass	16
8	A.8	All field cabling must have cable number identification which matches the	All field cabling to have cable number identification	All field cabling to have cable number identification	Pass	Didn't get a picture before leaving

		cable schedule				
10	B.1	All live motor circuit breaker tripped alarms to be displayed to operator. I.e. “Motor Circuit Breaker - 1Q1 has tripped”	Live alarms to be displayed to operator	Live alarms displayed to operator on HMI	Pass	7
11	B.2	All motor circuit breaker tripped historical alarms to be displayed to operator. “Motor Circuit Breaker - 1Q1 has tripped”	Historical alarms to be displayed to operator	Historical alarms displayed to operator	Pass	7
12	B.3	Alarm siren and beacon activates when there is a live motor circuit breaker tripped alarm	Alarm siren and beacon to notify operator of live alarm when a motor circuit breaker has tripped	Alarm siren and beacon notifies operator of live alarm when a motor circuit breaker has tripped	Pass	10
13	B.4	Motor circuit breaker tripped alarms to come with prompts on how to rectify fault. I.e. “Reset 1Q1 motor circuit breaker	Prompt appears with each alarm on how to rectify fault	Prompt appears on HMI with each alarm on how to rectify fault	Pass	7
14	C.1	Schematics must be	Electrical schematics to	Electrical schematics	Pass	17-49

		provided in pdf .dwg format	be provided in pdf and .dwg format	provided in pdf and .dwg format		
18	D.2	Test that all motors turn off after 15 minutes of inactivity	All motors must be automatically turned off after a period of 15 minutes of inactivity	All motors automatically turned off after a period of 15 minutes of inactivity	Pass	4 & 5
20	F.1	Test that table speed is 10mm/s when milling with a handheld tacho	Table speed when milling must be 10mm/s	Table speed is 10mm/s when milling. Handheld tacho used with a rotary extension bit that was placed on the table bed to get the reading.	Pass	14
21	F.2	Test that table speed is 100mm/s when in rapid with a handheld tacho	Table speed in rapid must be 100mm/s	Table speed is 100mm/s when in rapid. Handheld tacho used with a rotary extension bit that was placed on the table bed to get the reading.	Pass	13
23	F.4	Test that coolant flow is above 20L/min on the IFM SM8000 sensor	Coolant flow must be above 20L/min	Coolant flow is above 20L/min on the IFM SM8000 sensor display	Pass	11
24	F.5	Test that vacuum is less than -700psi on the IFM PN2092 sensor	Vacuum must be less than -700psi	Vacuum less than -700psi on the display of the IFM PN2092 sensor	Pass	12

27	G.2	Test the rapid and operation speed of the table	Table must have a rapid speed and operation speed	Table has a rapid and operation speed that was observed when jogging the motor via the operator push buttons	Pass	13 & 14
28	G.3	Test that the milling cutters cannot be started without vacuum, coolant flow and hydraulic pressure at or above their setpoints	Vacuum, coolant flow, and hydraulic pressure must be present before milling cutter motors can start	Vacuum, coolant flow, and hydraulic pressure are present before the milling cutter motors will start, and an alarm is raised to show what condition is stopping the motor from starting	Pass	50-52
29	G.4	Test the sounder alarms when vacuum is above -700psi or coolant flow is below 20L/min	A sounder must alarm if vacuum is lost or coolant flow is insufficient	Sounder alarms if vacuum or coolant flow is below their setpoints of -700psi and 20L/min respectively.	Pass	8 & 9
31	H.2	Check there is an Emergency Stop at the operator station, control panel and at field junction box	Emergency stops shall be located at the operator station, control panel, and at junction box	E-Stops located at existing operator station, existing control panel, and at junction box	Pass	Didn't get a picture before I left

Table 3 – Revised Test plan

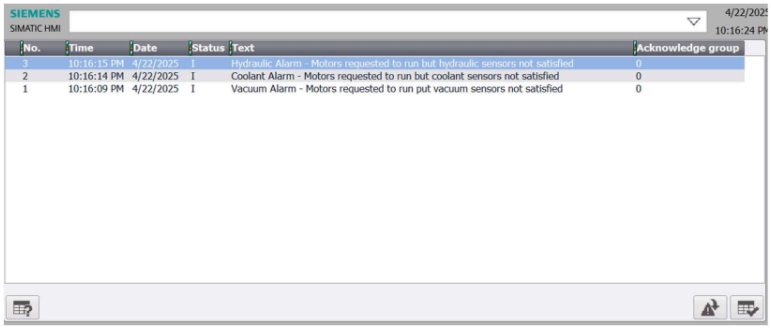


Figure 6 – Hydraulic, Coolant & Vacuum Alarms

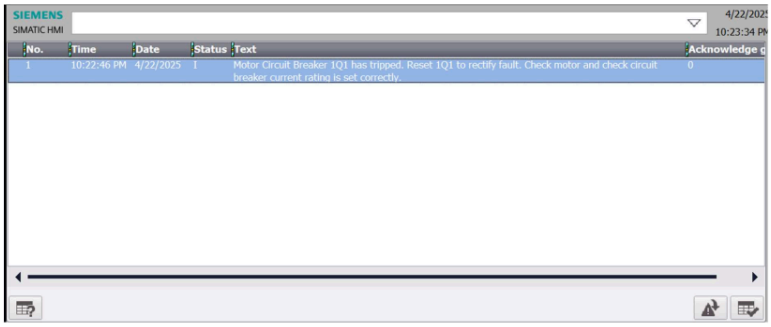


Figure 7 – Motor Circuit Breaker Tripped

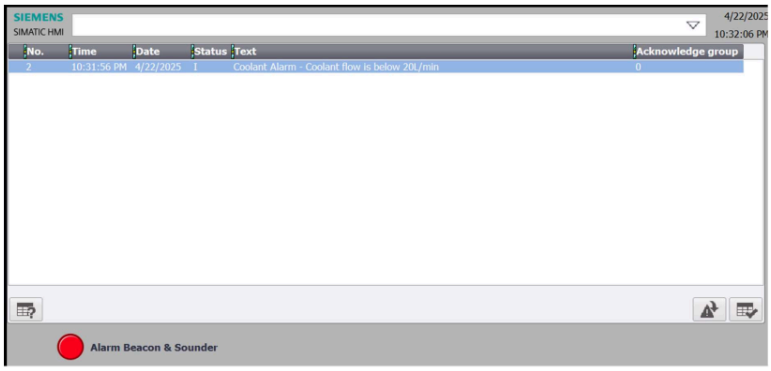


Figure 8 – Coolant Alarm below 20L/min

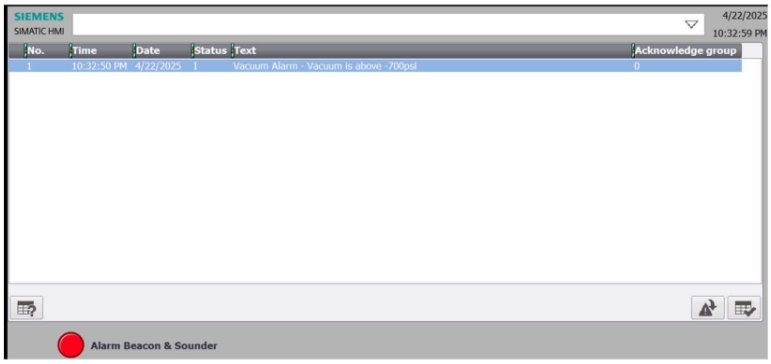


Figure 9 – Vacuum Alarm above -700psi

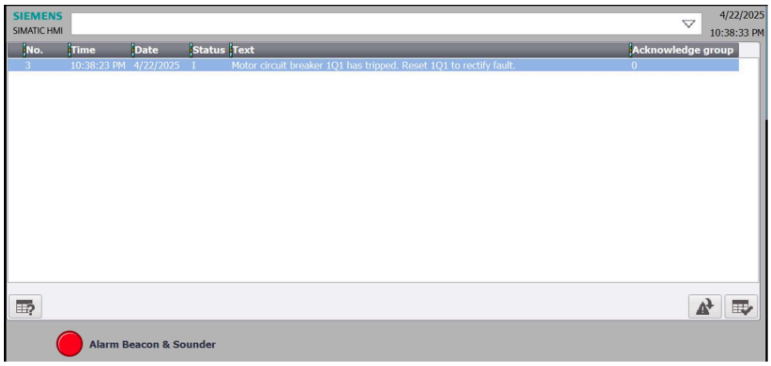


Figure 10 – Beacon/Sounder Red Indicator



Figure 11 – Coolant Sensor 21.9L/min



Figure 12 – Vacuum at -800psi



Figure 13 – Table speed at 6.08m/min (100mm/s)



Figure 14 – Table Speed at 0.6m/min (10mm/s)

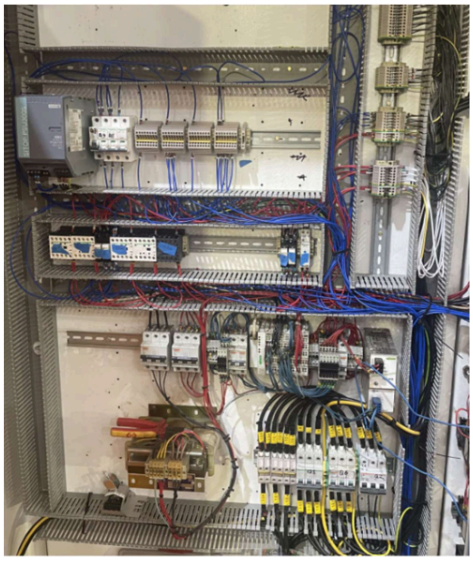


Figure 15 – 24VDC and 110VAC and Power Cabling

where is the servo drive?

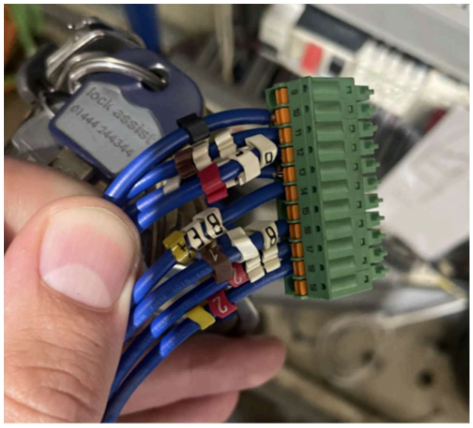


Figure 16 – Colour coded chevron cable markers

Why is there no evidence in the report for the construction of the servo panel and comissioning of the servo drive?

colegsirgâr

SGEL6000

Independent Project

Log Book

Aeron Smitham

Miller 3 ICS Upgrade

2024-2025

Summary of Entries

Log Entry	Date	Brief Description of Activity	Duration (hrs)	Accumulated time (hrs)
1	20/9/24	Discussed project ideas with management	4	4
2	27/9/24	Agreed budget, scope and deadlines with management	4	8
3	04/10/24	Defined initial project problem	6	14
4	11/10/24	Compare options for an electrically driven motor	8	22
5	18/10/24	Worked on Task 4	6	28
6	25/10/24	Task 4 continued	6	34
7	1/11/24	FDS	8	42
8	8/11/24	Test Plan	6	48
9	15/11/24	Test Plan finished and Literature Review	8	56
10	22/11/24	Literature Review Continued	8	64
11	29/11/24	Literature Review Completed	8	72
12	6/12/24	WBS, Gantt Chart, Conclusions and Recommendations	8	80
13	13/12/24	Finishing the Report	16	96
14	10/01/25	Bill of Materials and presentation preparation	38	134
15	17/01/25	Operation station and control panel general arrangement	38	172
16	24/01/25	Electrical schematics	38	210
17	31/01/25	Mechanical design	38	248
18	07/02/25	Start mechanical installation	38	286
19	14/02/25	Finish mechanical installation	38	324
20	21/02/25	Servo motor commissioning	38	362
21	28/02/25	PLC Programming	12	374
22	07/03/25	PLC Programming	12	386
23	14/03/25	PLC Programming	12	398
24	21/03/25	PLC Programming	12	410
25	28/03/25	PLC Programming	12	422
26	04/04/25	PLC Programming	12	434
27	11/04/25	HMI Programming	12	446
28	18/04/25	HMI Programming	12	458
29	25/04/25	HMI Programming	20	478
30	02/05/2025	Report	38	516

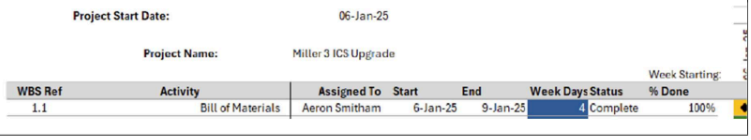
Log Entry Sheet

Log Number	14
Date	10/01/2025
Duration (hrs)	38
Accumulated time (hrs)	134

Record of activities and achievements

This week was spent working on the Bill of Materials required for the Servo drive upgrade and the control system upgrade.

The presentation was also prepared for, working on the first few slides which detailed the project background, problem definition, and project constraints. Important points from the constraints section were highlighted, like the use of manufacturers who use sustainable practices, the ethical concerns of employees regarding automation, and the PLr rating of the system.



Project Start Date: 06-Jan-25

Project Name: Miller 3 ICS Upgrade

Week Starting:

WBS Ref	Activity	Assigned To	Start	End	Week Days	Status	% Done
1.1	Bill of Materials	Aeron Smitham	6-Jan-25	9-Jan-25	4	Complete	100%

Plans for next week

Complete and present presentation.

Complete electrical schematics for control panels and operator station.

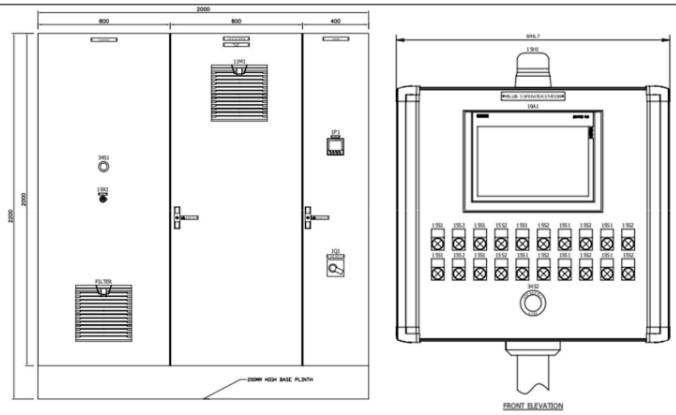
Signed A.Smitham

Signed R.Davies

Log Entry Sheet

Log Number	15
Date	17/01/2025
Duration (hrs)	38
Accumulated time (hrs)	172

Record of activities and achievements



The electrical schematics for the control panel and operation station layout were created. The control panel has a fan & filter, E-Stop and programming port, isolator & power meter. While the operator station has a HMI, E-Stop, alarm beacon, and multiple push buttons and LED indicators.

Project Start Date: 06-Jan-25

Project Name: Miller 3 ICS Upgrade

Week Starting: 06-Jan-25

WBS Ref	Activity	Assigned To	Start	End	Week Days	Status	% Done
1.1	Bill of Materials	Aeron Smitham	6-Jan-25	9-Jan-25	4	Complete	100%
1.2	Op Station & Panel Layout	Aeron Smitham	9-Jan-25	13-Jan-25	3	Complete	100%

Plans for next week

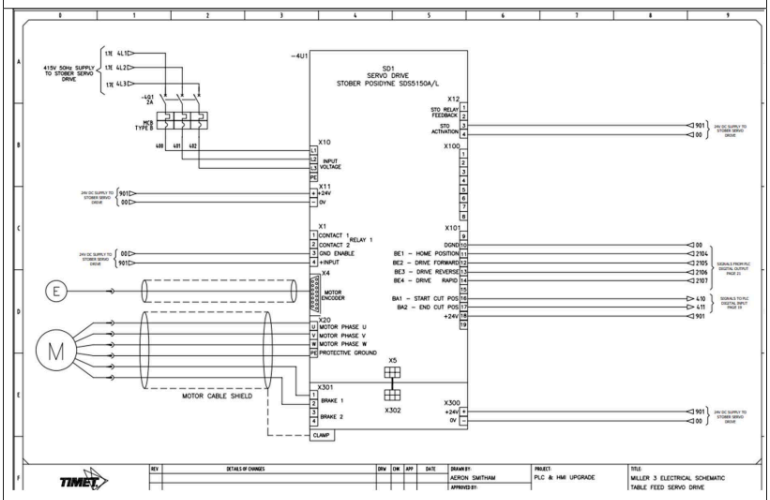
Complete electrical schematics.

Signed _____A.Smitham_____ Signed R.Davies

Log Entry Sheet

Log Number	16
Date	24/01/2025
Duration (hrs)	38
Accumulated time (hrs)	210

Record of activities and achievements



The electrical schematics for the control panel were completed. The schematic for the table feed servo drive can be seen above. The schematic shows the outgoing encoder and motor cables from the drive, with extra cabling for the motor brake connected to the brake expansion unit on the Stober Servo Drive. The rest of the cabling is for the drives digital IO. There are inputs for 'Home Position', 'Drive FWD', 'Drive REV', & 'Drive Rapid'. Two positions, 'Start Cut' & 'End Cut', based on the encoder count have been set up as outputs, so that when the count reaches each value a relay is energised for use in the control circuit.

Plans for next week

Start mechanical work

Signed _____A.Smitham_____ Signed R.Davies

Log Entry Sheet

Log Number	17
Date	31/1/25
Duration (hrs)	38
Accumulated time (hrs)	248

Record of activities and achievements
The hydraulic system and table feed design work was completed. The machine was stripped to make drawings for custom parts required, and to verify how the hydraulic system was piped up. In the first picture below the hydraulic control valves for the table feed can be seen, which control the forward, reverse and rapid speed. The second photo shows the exposed spline which was connected to the hydraulic motor, and where it used to be mounted. A drawing of the coupler required to connect the servo motor and the internal spline has been created.

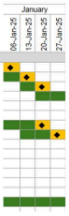




Project Start Date: 06-Jan-25

Project Name: Miller 3 ICS Upgrade

WBS Ref	Activity	Assigned To	Start	End	Week Days	Status	% Done
1.1	Bill of Materials	Aeron Smitham	6-Jan-25	9-Jan-25	4	Complete	100%
1.2	Op Station & Panel Layout	Aeron Smitham	9-Jan-25	13-Jan-25	5	Complete	100%
1.3	Electrical Schematics	Aeron Smitham	14-Jan-25	24-Jan-25	7	Complete	100%
1.4	Servo Drive Programming	Aeron Smitham	20-Jan-25	17-Feb-25	21	In Progress	25%
1.5	PLC Programming	Aeron Smitham	17-Feb-25	15-Mar-25	20	Not Started	0%
1.6	HMI Design	Aeron Smitham	16-Mar-25	19-Mar-25	3	Not Started	0%
1.7	Hydraulic System Design	Leo Farquhar	6-Jan-25	20-Jan-25	11	Complete	100%
1.8	Table Feed Drive Design	Leo Farquhar	17-Jan-25	31-Jan-25	11	Complete	100%
2.1	Operator Station Build	Aeron Smitham	20-Mar-25	27-Mar-25	6	Not Started	0%
2.2	Panel Modification	Aeron Smitham	28-Mar-25	5-Apr-25	6	Not Started	0%
2.3	Hydraulic System Mods	Leo Farquhar	3-Feb-25	14-Feb-25	10	Not Started	0%
2.4	Table Feed Drive Mods	Leo Farquhar	3-Feb-25	14-Feb-25	10	Not Started	0%
2.5	Servo Motor Installation	Aeron Smitham	10-Feb-25	21-Feb-25	10	Not Started	0%
3.1	Comissioning	Aeron Smitham	7-Apr-25	16-Apr-25	8	Not Started	0%
3.2	Technical File	Aeron Smitham	6-Jan-25	21-Apr-25	80	Not Started	25%



Plans for next week

Start mechanical installation.

Signed _____A.Smitham Signed R.Davies

Log Entry Sheet

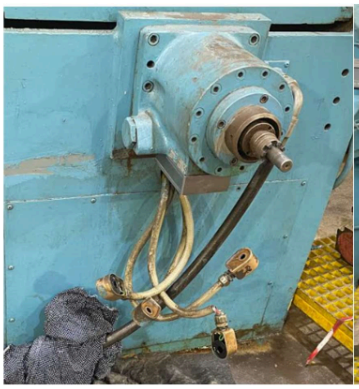
Log Number	18
Date	7/2/2025
Duration (hrs)	38
Accumulated time (hrs)	286

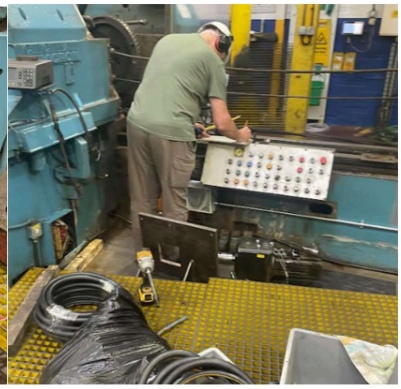
Record of activities and achievements

The hydraulic system and table feed drive mechanical modifications were started, with a plan to complete the modifications in two weeks time.

The first photo shows the original solenoid caps for the cutting head movement, which will be removed and replaced with solenoid valves at the hydraulic pack. The hydraulic pipes will then be run from the pack to the actuators on the machine. This has been done to test and monitor all the hydraulics in one place.

The second photo shows the mechanical design engineer taking measurements for the table feed design modifications, with the servo motor and its mounting bracket below the operator push button station.





Plans for next week

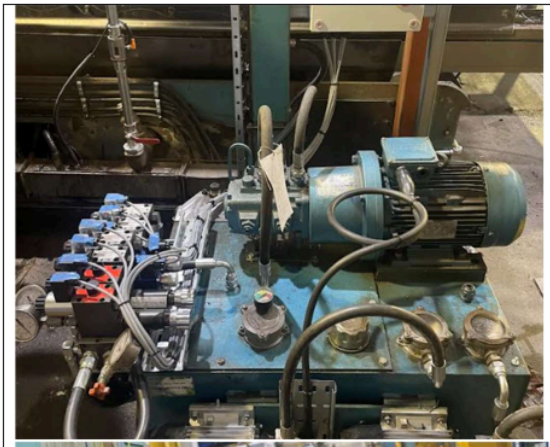
Finish mechanical installation.

Signed _____A.Smitham_____ Signed R.Davies

Log Entry Sheet

Log Number	19
Date	14/2/2025
Duration (hrs)	38
Accumulated time (hrs)	324

Record of activities and achievements
The mechanical installation was finished with the new hydraulic pack and servo motor installed. The first photo shows the new hydraulic pack with all the solenoid valves, pressure gauges and pressure switches mounted locally, the main hydraulic pump, and two electric motor driven scavenger pumps to retrieve any lost oil. The second photo shows the servo motor with its drive coupling attached, with the exposed part of the coupling showing where the internal spline will be coupled with the motor.





Plans for next week
Commission the servo motor.

Signed ____A.Smitham_____ Signed _ R.Davies

Log Entry Sheet

Log Number	20
Date	21/2/2025
Duration (hrs)	38
Accumulated time (hrs)	362

Record of activities and achievements

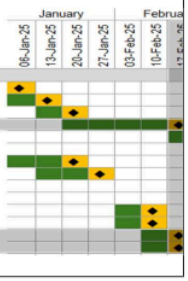
The servo motor installation and commissioning was finished this week. In the picture below the servo motor can be seen on a trolley, connected up to the blue Stober servo drive in the control panel. Commissioning was first undertaken here to prove the servo drive program was correct before being commissioned on the machine. The motor was driven between its start and end position that was setup in the drive to prove it was functioning correctly.



Project Start Date: 06-Jan-25

Project Name: Miller 3 ICS Upgrade

WBS Ref	Activity	Assigned To	Start	End	Week Days	Status	% Done
1.1	Bill of Materials	Aeron Smitham	6-Jan-25	9-Jan-25	4	Complete	100%
1.2	Op Station & Panel Layout	Aeron Smitham	9-Jan-25	13-Jan-25	3	Complete	100%
1.3	Electrical Schematics	Aeron Smitham	14-Jan-25	24-Jan-25	9	Complete	100%
1.4	Servo Drive Programming	Aeron Smitham	20-Jan-25	17-Feb-25	21	Complete	100%
1.5	PLC Programming	Aeron Smitham	17-Feb-25	15-Mar-25	20	Behind	200%
1.6	HMI Design	Aeron Smitham	16-Mar-25	19-Mar-25	3	Behind	600%
1.7	Hydraulic System Design	Leo Farquhar	6-Jan-25	20-Jan-25	11	Complete	100%
1.8	Table Feed Drive Design	Leo Farquhar	17-Jan-25	31-Jan-25	11	Complete	100%
2.1	Operator Station Build	Aeron Smitham	20-Mar-25	27-Mar-25	6	Behind	0%
2.2	Panel Modification	Aeron Smitham	28-Mar-25	5-Apr-25	6	Behind	0%
2.3	Hydraulic System Mods	Leo Farquhar	3-Feb-25	14-Feb-25	10	Complete	100%
2.4	Table Feed Drive Mods	Leo Farquhar	3-Feb-25	14-Feb-25	10	Complete	100%
2.5	Servo Motor Installation	Aeron Smitham	10-Feb-25	21-Feb-25	10	Complete	100%
3.1	Servo Comissioning	Aeron Smitham	10-Feb-25	21-Feb-25		Complete	100%



Plans for next week

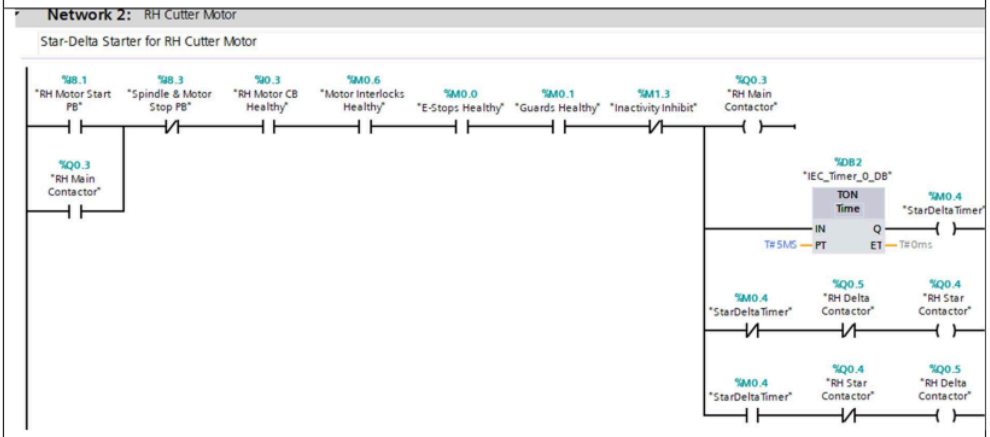
Start the PLC programming.

Signed _____A.Smitham_____ Signed R.Davies

Log Entry Sheet

Log Number	21
Date	28/2/2025
Duration (hrs)	12
Accumulated time (hrs)	374

Record of activities and achievements



The logic begins with a series of input conditions that must all be satisfied to energise the RH Main Contactor (%Q0.3). These conditions include the RH Motor Start push button (%I8.1) being pressed, the Spindle & Motor Stop push button (%I8.3) not being pressed, and several safety interlocks being in a "healthy" state—such as the Motor Circuit Breaker (%I8.4), motor interlocks (%M0.6), emergency stops (%M0.0), safety guards (%M0.1), and an inactivity inhibit (%M1.3) being cleared. If all these conditions are true, the RH Main Contactor (%Q0.3) is energised, allowing power to flow to the motor control system.Once the main contactor is energised, a TON (on-delay) timer block named StarDeltaTimer (%DB2) is started. This timer is configured with a preset time (PT) of 5 seconds. During this time, the RH Star Contactor (%Q0.4) is energised, initiating the motor in star configuration to reduce startup current. After the timer elapses, the Q output of the timer turns ON, signaling the end of the star period. This deactivates the star contactor (%Q0.4) and energises the RH Delta Contactor (%Q0.5), switching the motor to delta configuration for normal operation. To prevent overlap, the logic ensures that the star and delta contactors do not energise simultaneously. This is done using the timer's status (%M0.4) as a control signal to manage the correct sequencing of the contactors.

Plans for next week

Carry on with PLC program

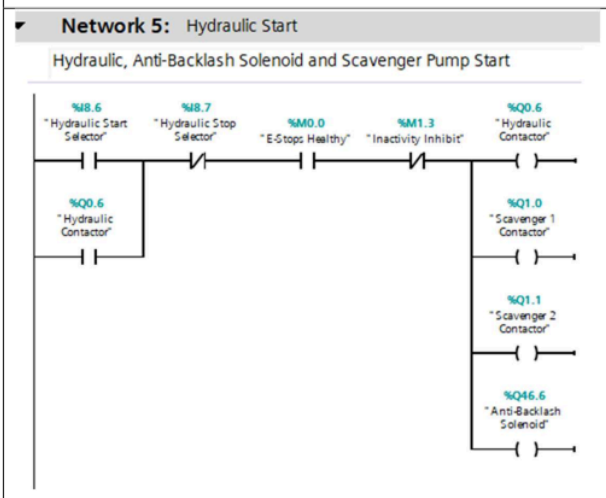
Signed A.Smitham

Signed R.Davies

Log Entry Sheet

Log Number	22
Date	07/03/25
Duration (hrs)	12
Accumulated time (hrs)	386

Record of activities and achievements



This ladder logic diagram from Network 5: Hydraulic Start controls the startup sequence for a hydraulic system, anti-backlash solenoid, and two scavenger pumps. The logic initiates when the Hydraulic Start Selector (%I8.6) is activated and the Hydraulic Stop Selector (%I8.7) is *not* engaged. In addition to this, the system checks for critical safety interlocks: the E-stops must be healthy (%M0.0), and there must be no inactivity inhibit present (%M1.3). When all these conditions are satisfied, the Hydraulic Contactor (%Q0.6) is energised.

Energising the hydraulic contactor then enables several parallel outputs. These include the Scavenger 1 Contactor (%Q1.0), Scavenger 2 Contactor (%Q1.1), and the Anti-Backlash Solenoid (%Q4.6). These outputs likely activate pumps and valves necessary for hydraulic fluid circulation and mechanical backlash compensation, ensuring the system is pressurised and mechanically stable before other machine operations begin. The parallel branching of these outputs from the same control rung ensures they all activate simultaneously once the main hydraulic conditions are met. This design reflects a focus on synchronised startup and safety, where critical systems are only powered when all enabling conditions are confirmed.

Plans for next week

Carry on with PLC program.

Signed A.Smitham

Signed R.Davies

Log Entry Sheet

Log Number	23
Date	14/03/25
Duration (hrs)	12
Accumulated time (hrs)	398

Record of activities and achievements

```
// Clear alarms by default
#Alarm_Vacuum := FALSE;
#Alarm_Coolant := FALSE;
#Alarm_Hydraulic := FALSE;
#Master_Alarm := FALSE;
#Alarm_Buzzer := FALSE;

// If operator is requesting to start
IF #Start_Request THEN
    // Set alarms if conditions are not met
    IF NOT #Vacuum_OK THEN
        #Alarm_Vacuum := TRUE;
    END_IF;

    IF NOT #Coolant_OK THEN
        #Alarm_Coolant := TRUE;
    END_IF;

    IF NOT #Hydraulics_OK THEN
        #Alarm_Hydraulic := TRUE;
    END_IF;

    // Combine into master alarm
    #Master_Alarm := #Alarm_Vacuum OR #Alarm_Coolant OR #Alarm_Hydraulic;

    // Activate buzzer if any alarm is active
    IF #Master_Alarm THEN
        #Alarm_Buzzer := TRUE;
    END_IF;
END_IF;
```

This structured text (ST) code snippet is part of a PLC control program, specifically focused on alarm management and interlock validation during the machine start process. The logic begins by resetting all alarm states to FALSE at the top of the scan cycle, including individual alarms for vacuum, coolant, and hydraulics, as well as the overall Master Alarm and Alarm Buzzer. This ensures that previous alarm conditions are cleared before evaluating the current system state.

When the operator issues a start request (#Start_Request is TRUE), the program checks critical interlocks to determine if it's safe to proceed. If the vacuum system is not okay (NOT #Vacuum_OK), then #Alarm_Vacuum is set to TRUE. The same logic applies to the coolant and hydraulic systems, each has its own condition check and corresponding alarm. These individual alarms are then logically OR-ed together to form a #Master_Alarm. This allows the system to consolidate multiple fault conditions into a single high-level alarm status. If any of the individual alarms are active, the #Master_Alarm becomes TRUE, which in turn activates the #Alarm_Buzzer to audibly alert the operator. This logic ensures that the machine will not start unless all safety-critical systems (vacuum, coolant, hydraulics) are functioning properly.

Plans for next week

Carry on with PLC program.

Signed A.Smitham

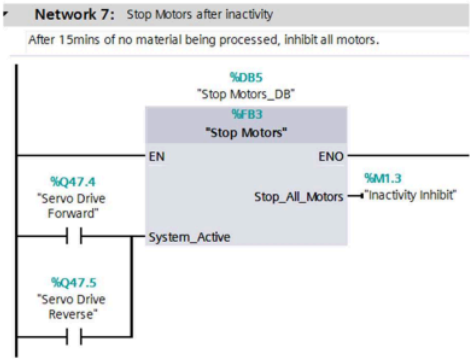
Signed R.Davies

Log Entry Sheet

Log Number	24
Date	21/03/25
Duration (hrs)	12
Accumulated time (hrs)	410

Record of activities and achievements

```
1  // Start/reset timer when system is inactive
2  #Inactivity_Timer(IN := NOT #System_Active, PT := T#15m0s);
3
4  // Set output when inactivity timeout is reached
5  #Stop_All_Motors := #Inactivity_Timer.Q;
6
```



This structured text code is designed to automatically stop all motors after a period of system inactivity, enhancing both safety and energy efficiency. It uses a timer function block named #Inactivity_Timer, which is configured with a preset time (PT) of 15 minutes (T#15m0s). The timer's input (IN) is driven by the inverse of the #System_Active signal. In other words, the timer starts counting only when the system is not active (NOT #System_Active). As long as the system remains inactive for the full 15-minute duration, the timer completes and its output (Q) becomes TRUE. This output is directly assigned to the #Stop_All_Motors signal, meaning all motors will be shut down once the inactivity timeout is reached. If the system becomes active again before the timer elapses, the timer resets, preventing motor shutdown.

Plans for next week

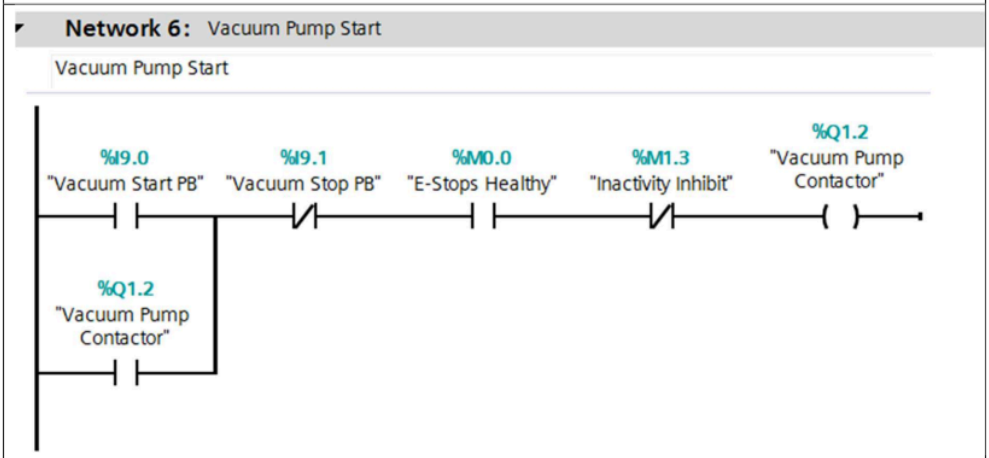
Carry on with PLC program.

Signed A.Smitham _ Signed R.Davies

Log Entry Sheet

Log Number	25
Date	28/03/25
Duration (hrs)	12
Accumulated time (hrs)	422

Record of activities and achievements



This ladder logic diagram from Network 6: Vacuum Pump Start controls the operation of a vacuum pump using a standard start/stop latch configuration with safety interlocks. The circuit begins with the Vacuum Start push button (%I9.0), which, when pressed, attempts to energise the Vacuum Pump Contactor (%Q1.2). For the contactor to activate, several conditions must be true: the Vacuum Stop push button (%I9.1) must not be pressed, the E-stops must be in a healthy state (%M0.0), and the system must not be in an inactivity inhibit state (%M1.3).

Once all these conditions are satisfied and the start button is pressed, the vacuum pump contactor (%Q1.2) is energised, closing its associated contact on the rung to create a latching circuit. This means the contactor will remain energised even after the start button is released, as long as none of the stop or inhibit conditions become active. If the stop button is pressed, an E-stop is triggered, or the system enters inactivity inhibit, the circuit will break and the contactor will de-energise, stopping the vacuum pump.

Plans for next week

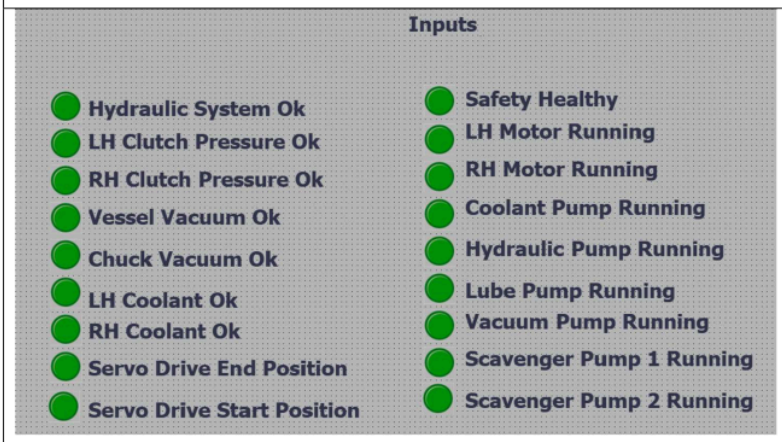
Start HMI design.

Signed A.Smitham Signed R.Davies

Log Entry Sheet

Log Number	26
Date	4/4/25
Duration (hrs)	12
Accumulated time (hrs)	434

Record of activities and achievements



The HMI is divided into two main columns under the heading "Inputs", with each item represented by a green indicator light and a descriptive label. The green indicators signify that each respective input or condition is currently in a healthy or active state.

On the left side, the focus is on system readiness and interlocks. Signals like *Hydraulic System Ok*, *LH/RH Clutch Pressure Ok*, *Vessel Vacuum Ok*, and *Chuck Vacuum Ok* confirm that key process components are pressurised or vacuum-tight as required. Other indicators, such as *LH Coolant Ok* and *RH Coolant Ok*, ensure proper cooling conditions are met. Additionally, servo positioning is monitored via *Servo Drive Start Position* and *End Position* indicators, confirming correct axis locations before motion sequences begin.

On the right side, the indicators primarily monitor machine status and active equipment. These include *Safety Healthy*, which confirms that all emergency stop and safety devices are in a good state, and motor or pump activity indicators such as *LH/RH Motor Running*, *Coolant Pump Running*, *Hydraulic Pump Running*, *Lube Pump Running*, *Vacuum Pump Running*, and *Scavenger Pumps 1 & 2 Running*. These provide a quick snapshot of whether critical pumps and motors are operating as intended.

Plans for next week

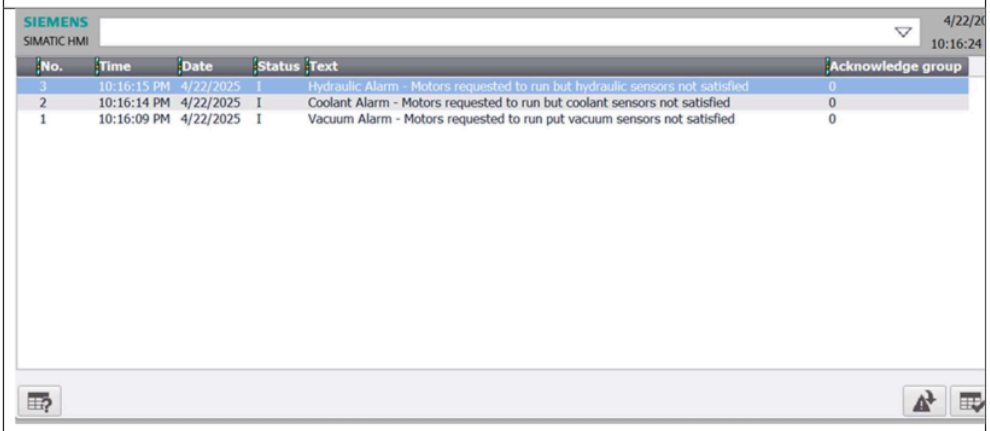
Carry on with HMI

Signed A.Smitham Signed R.Davies

Log Entry Sheet

Log Number	27
Date	11/4/25
Duration (hrs)	12
Accumulated time (hrs)	446

Record of activities and achievements



HMI alarms were created this week for the conditions that were inhibiting the cutting motors from being started. These were simulated to show each one come in at a different time but all displayed on the screen.

Plans for next week

Continue HMI design.

Signed _____A.Smitham_____ Signed R.Davies

Log Entry Sheet

Log Number	28
Date	18/4/25
Duration (hrs)	12
Accumulated time (hrs)	458

Record of activities and achievements



This week was spent adding more HMI alarms to meet the requirements of the FDS. A circuit breaker tripped alarm was created, along with alarms for coolant flow being below the setpoint of 20L/min and vacuum is above the -700psi setpoint.

Plans for next week

Finish HMI.

Signed A.Smitham

Signed R.Davies

Log Entry Sheet

Log Number	29
Date	25/4/25
Duration (hrs)	20
Accumulated time (hrs)	478

Record of activities and achievements
This week was spent finalising the HMI design and adding some more code in the PLC programming.

Plans for next week
Complete assignment.

Signed A.Smitham Signed R.Davies

Log Entry Sheet

Log Number	30
Date	2/5/25
Duration (hrs)	38
Accumulated time (hrs)	516

Record of activities and achievements
Finish the assignment report ready for hand in.

Plans for next week
None.

Signed A.Smitham

Signed R.Davies

9.4. Electrical Schematics

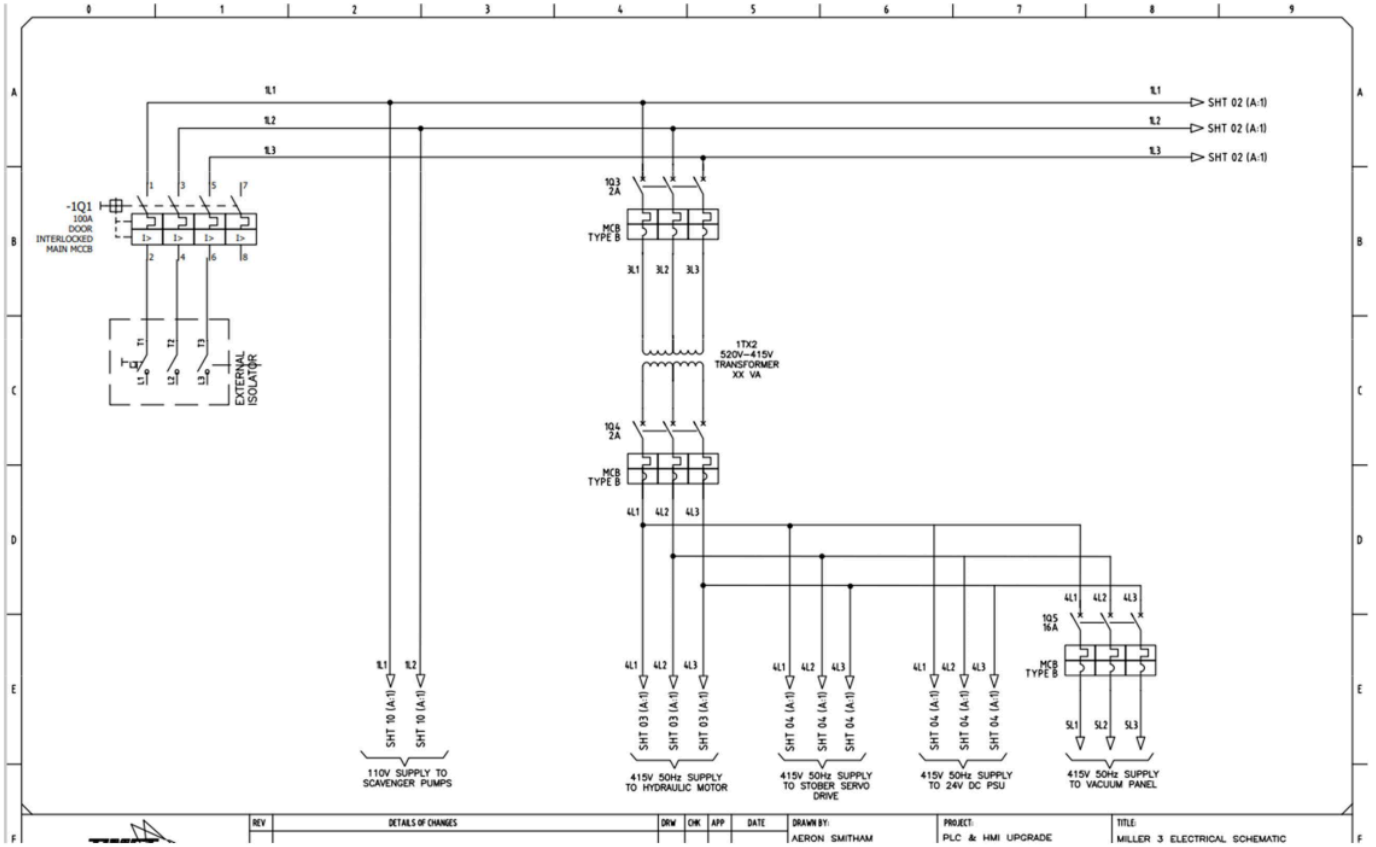


Figure 17 – Power Distribution

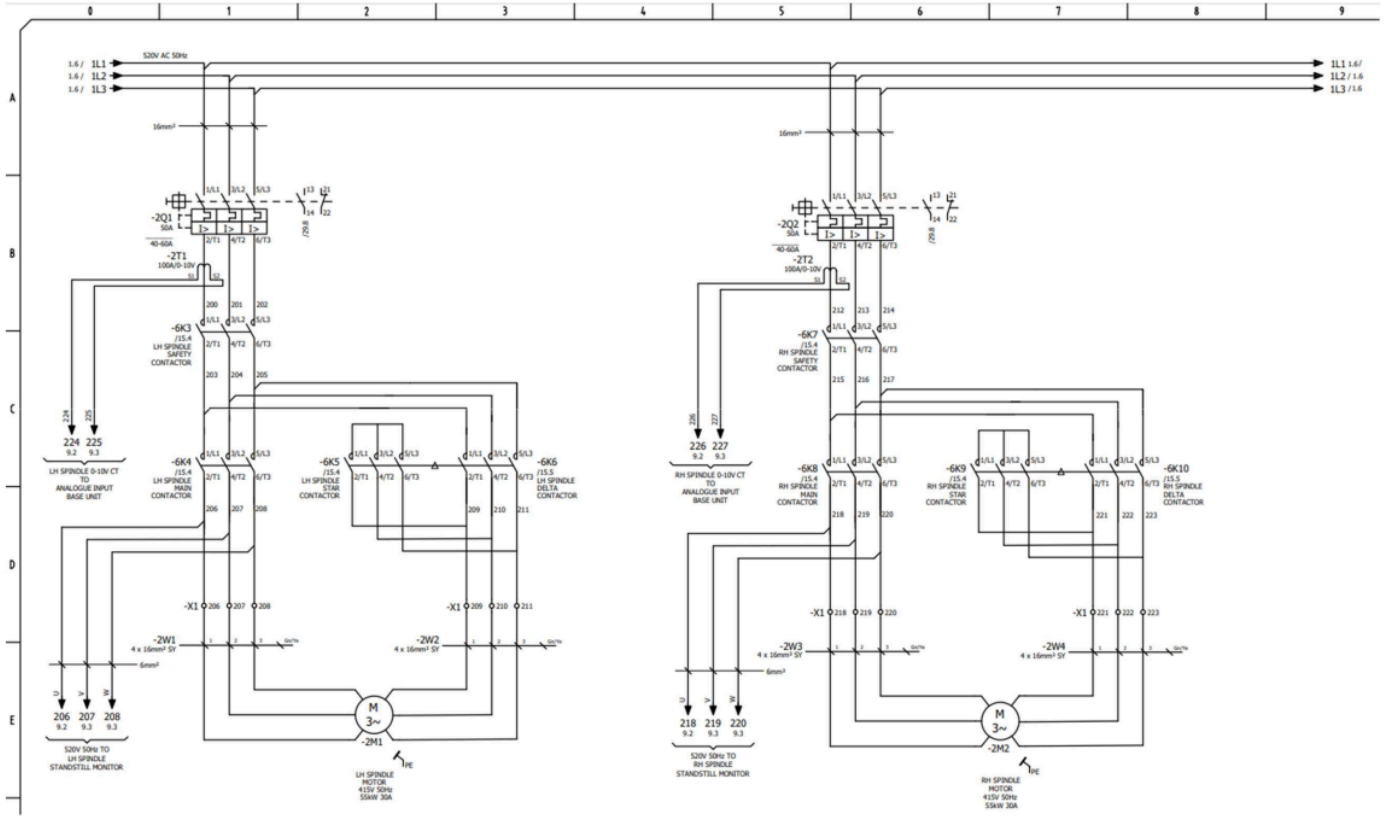


Figure 18 – Star-Delta Starters for Milling Cutters

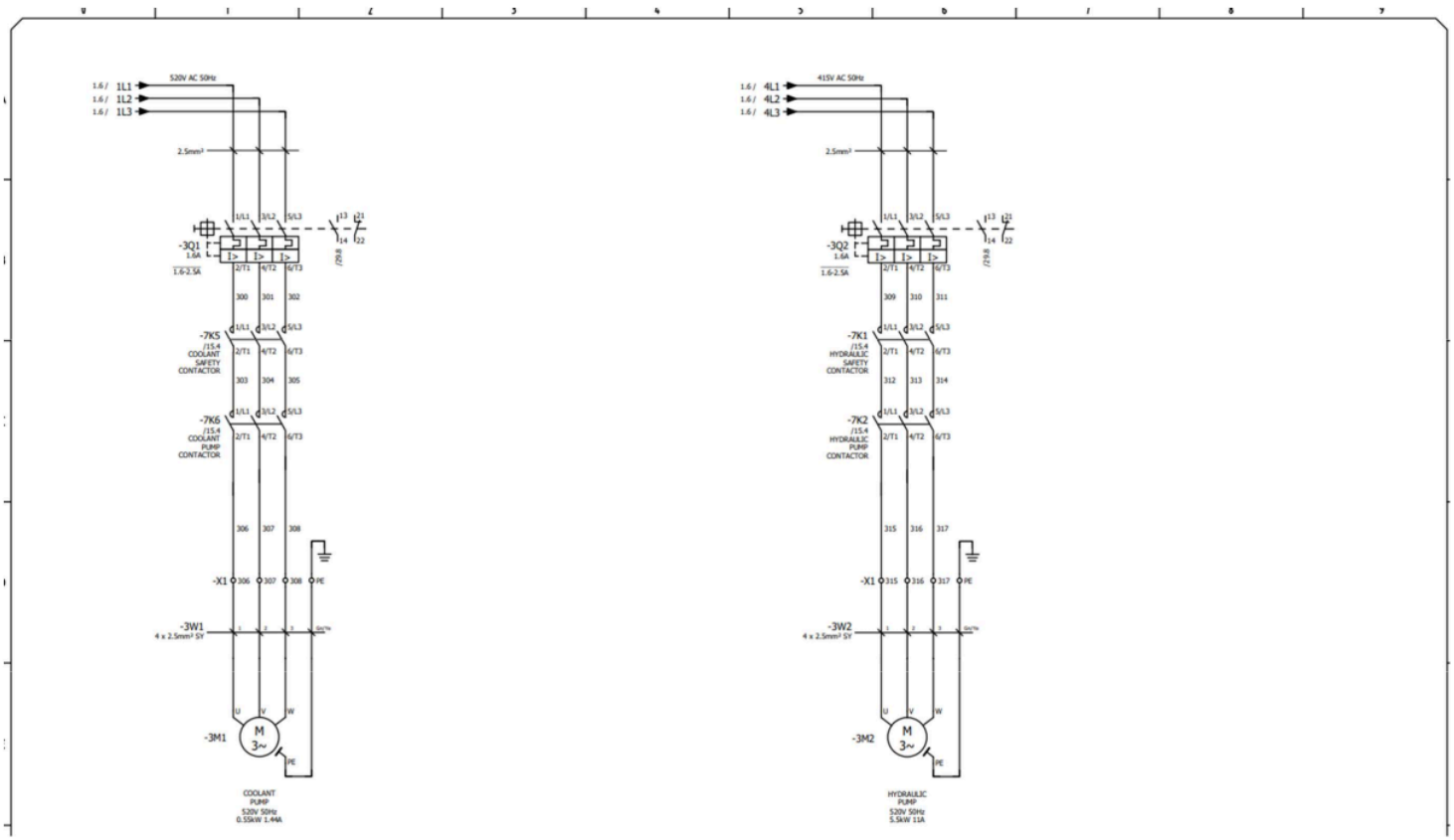


Figure 19 – Coolant & Hydraulic Motor Circuits

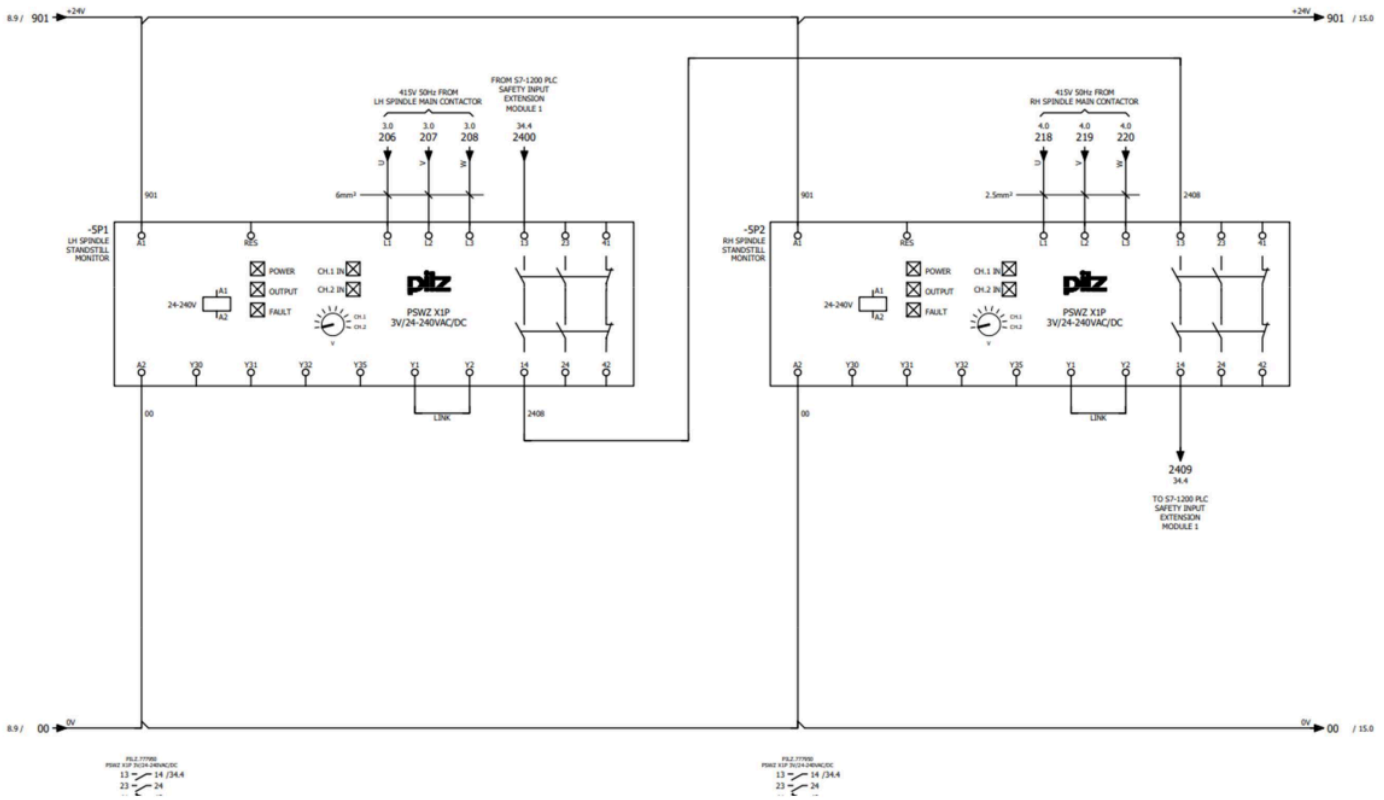


Figure 20 – PILZ Motor Standstill Relays

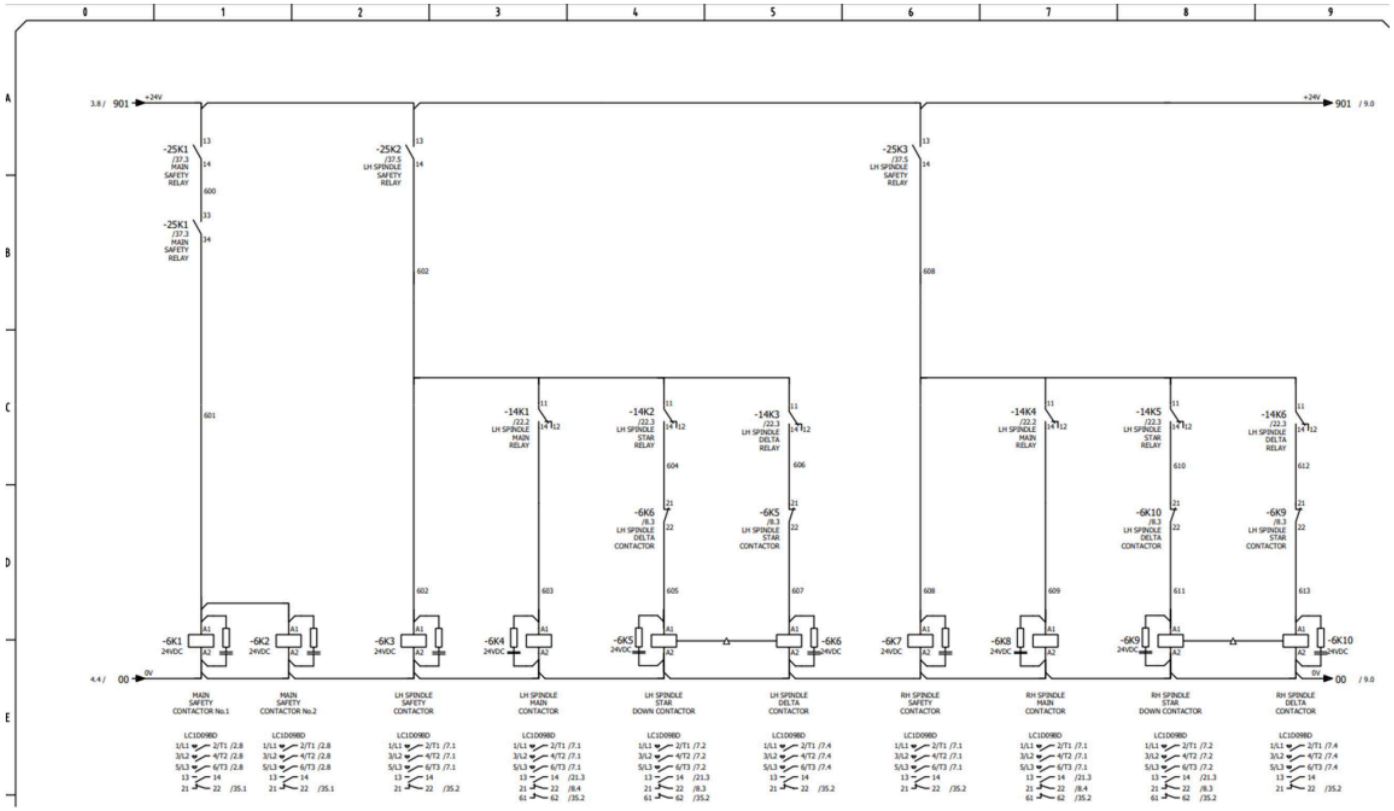


Figure 21 – Safety Contactors

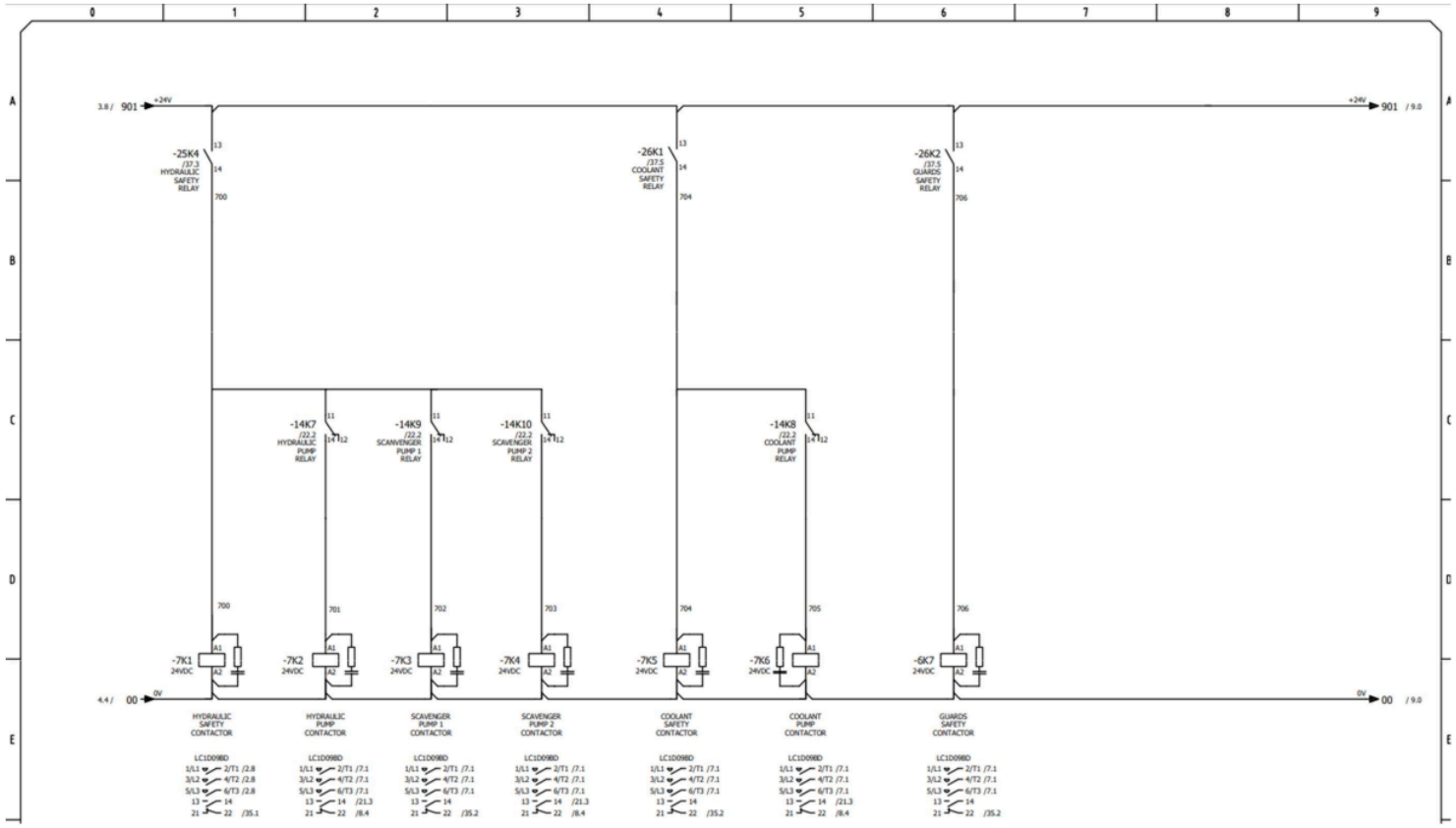


Figure 22 – Safety Contactors 2

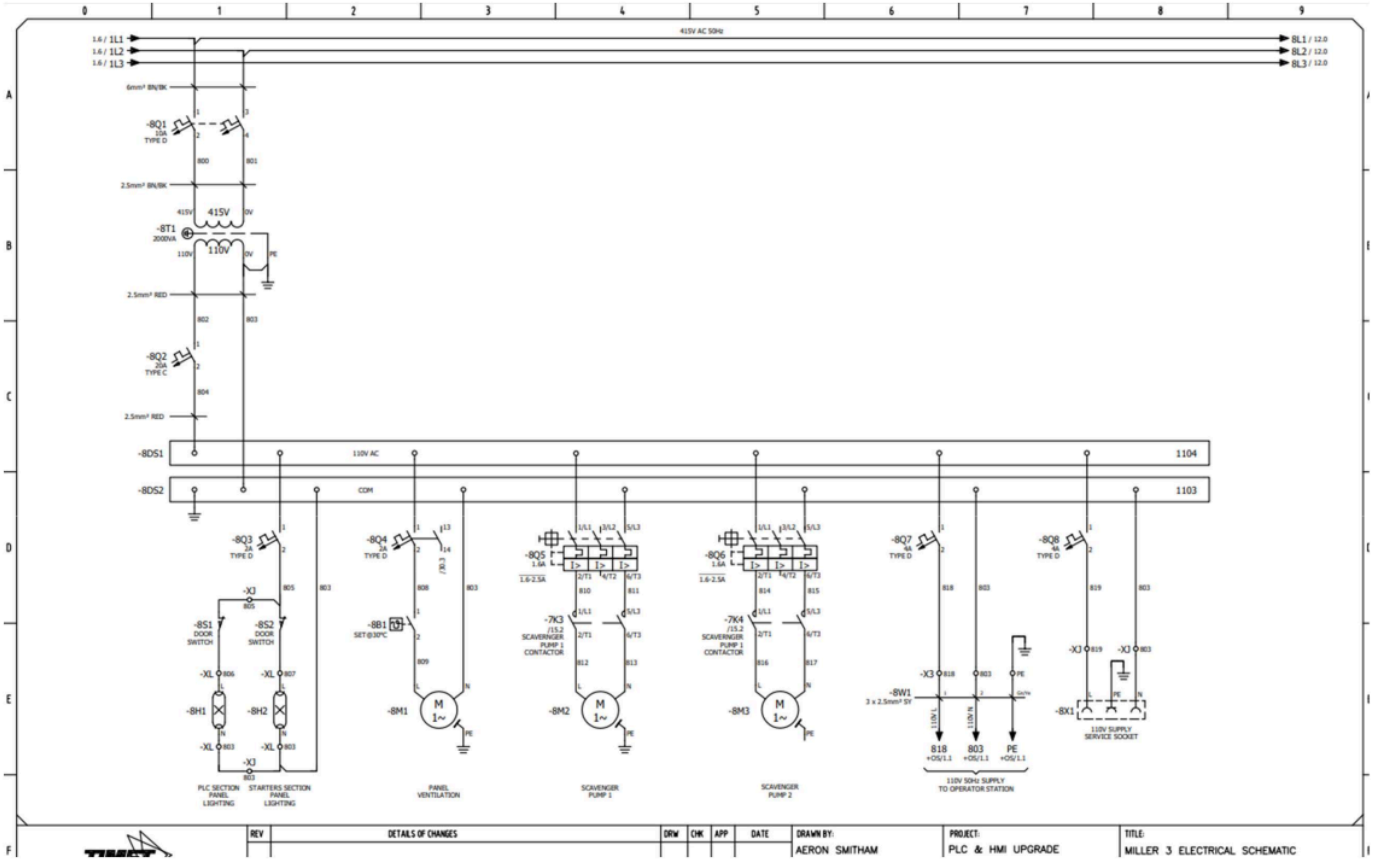


Figure 23 – 110VAC Distribution

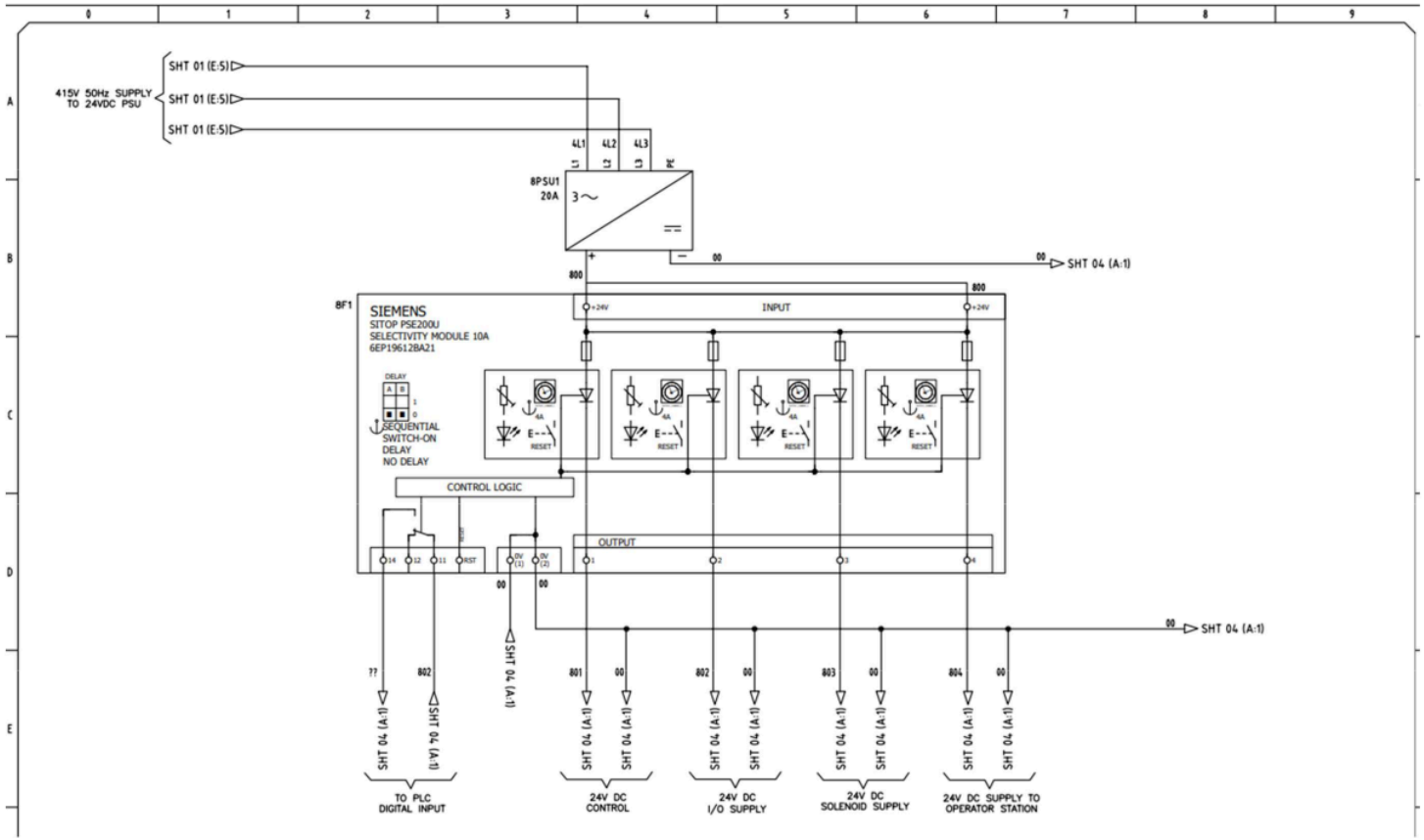


Figure 24 – 24VDC Distribution

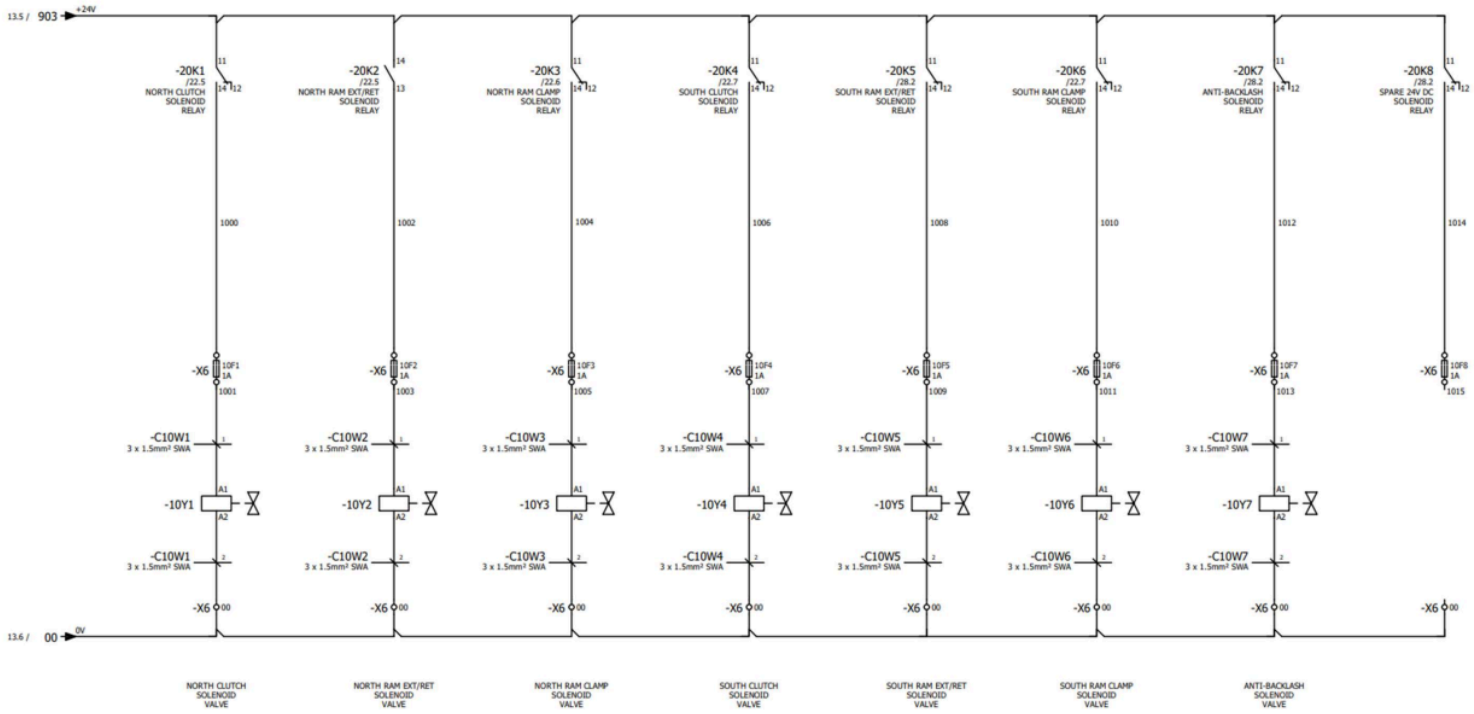


Figure 25 Solenoid Valve Control

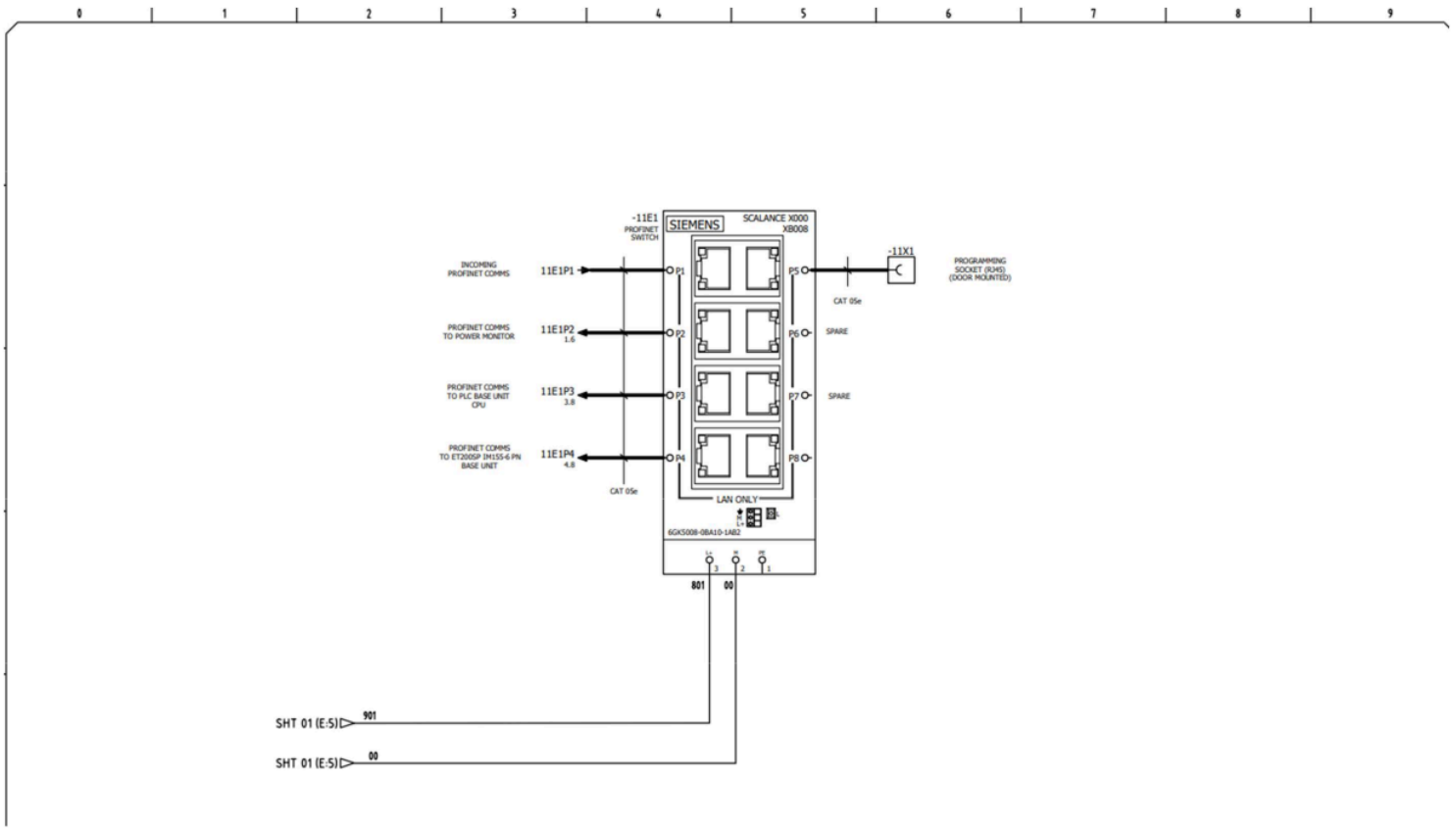


Figure 26 – Network Switch

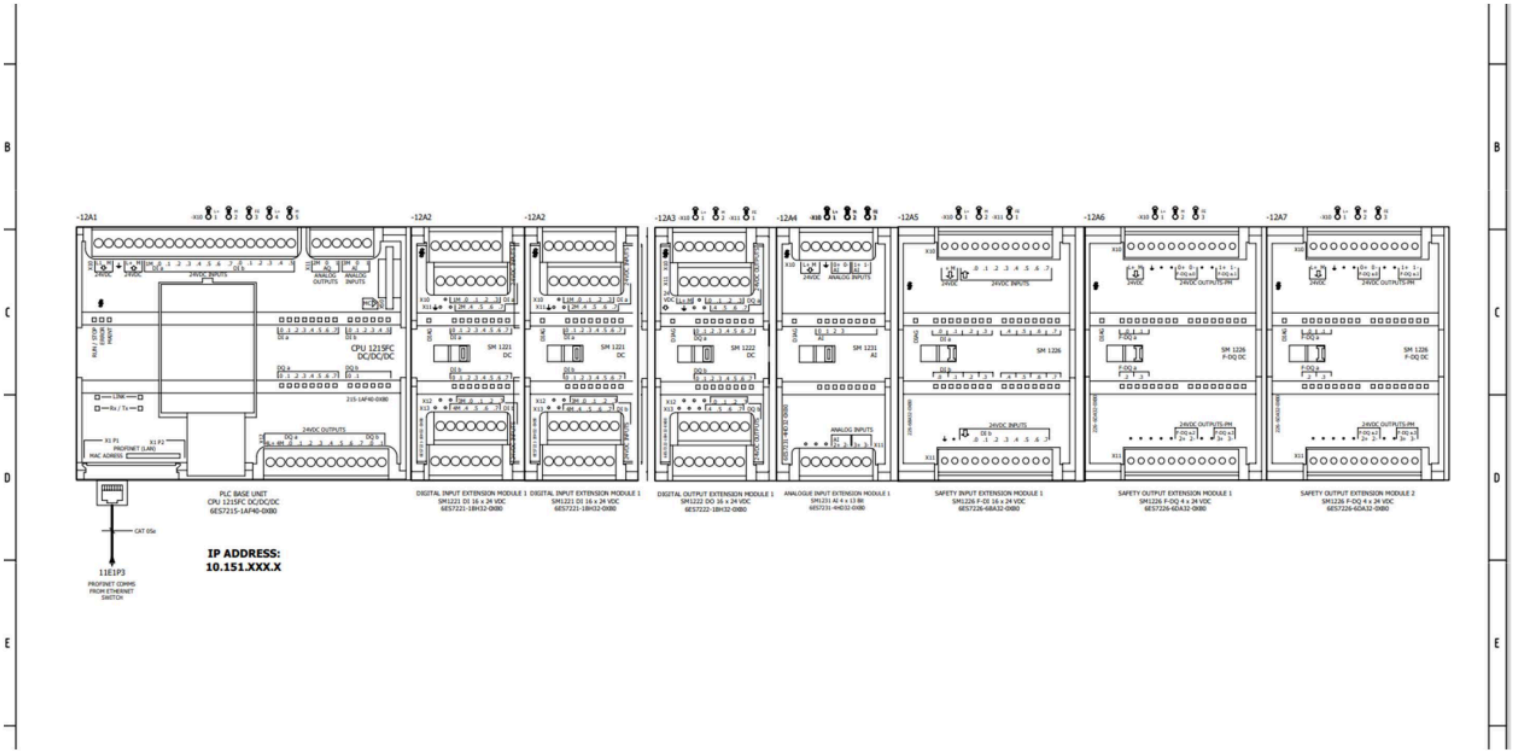


Figure 27 – PLC and IO Modules

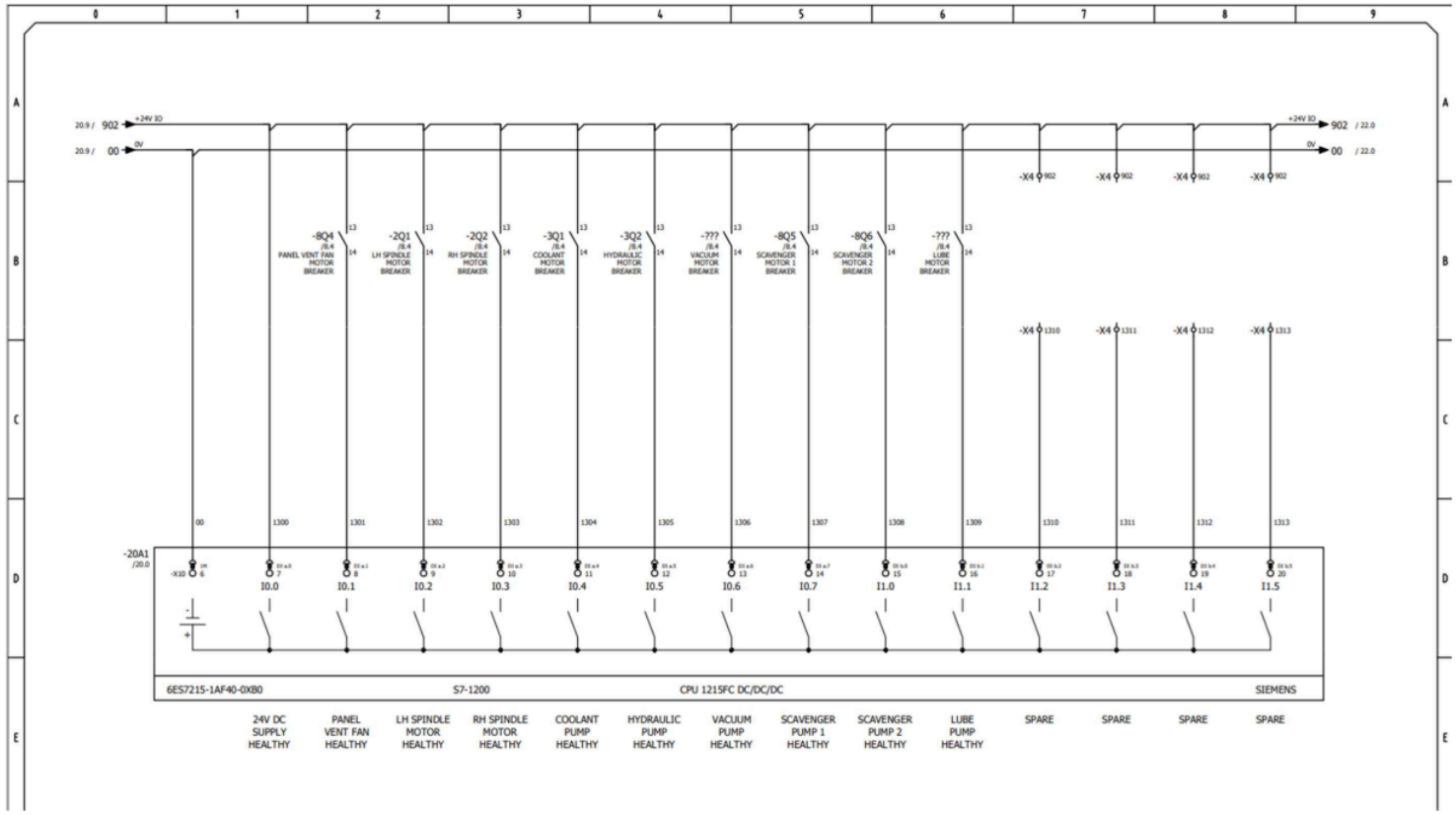


Figure 28 – PLC Inputs

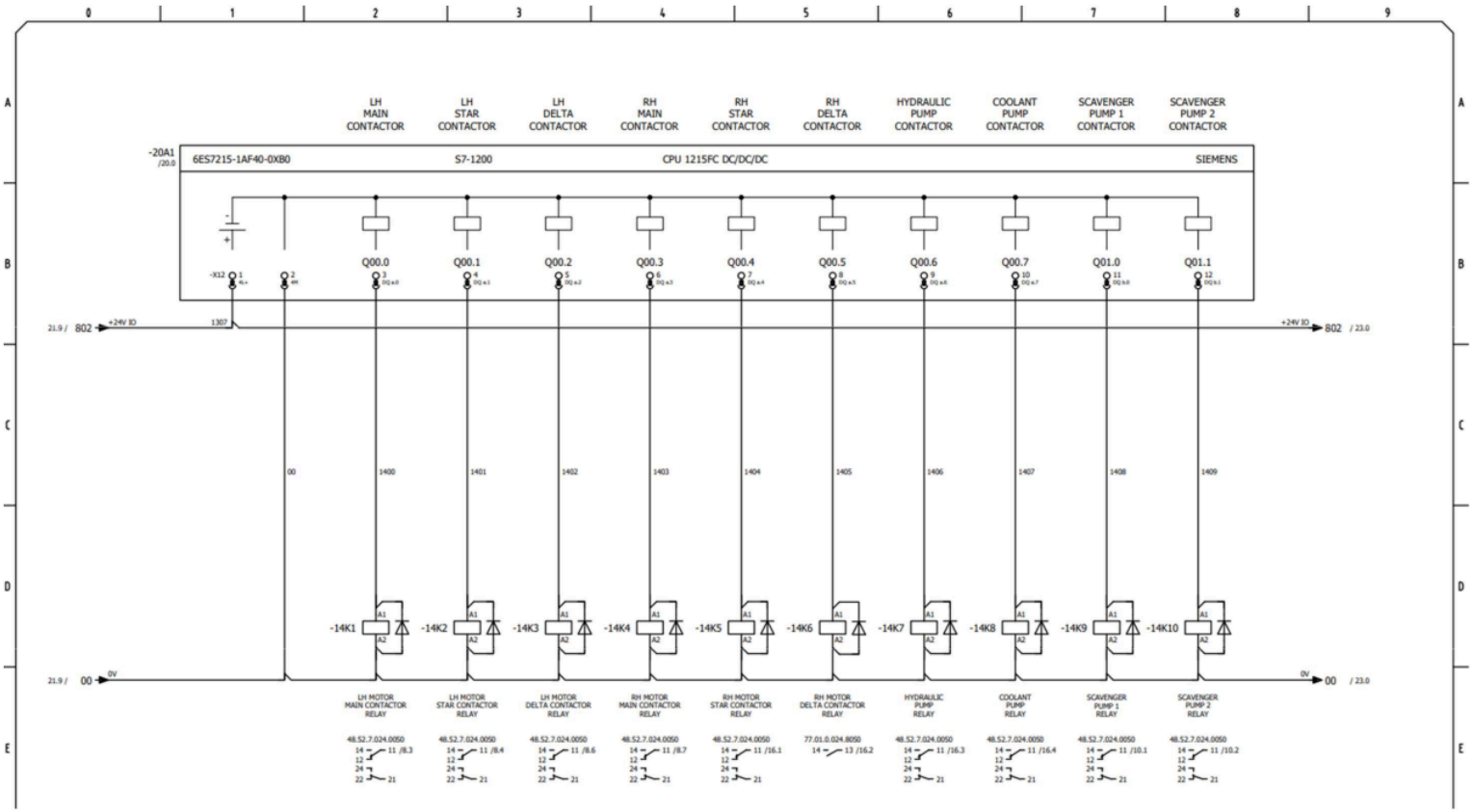


Figure 29 – PLC Outputs

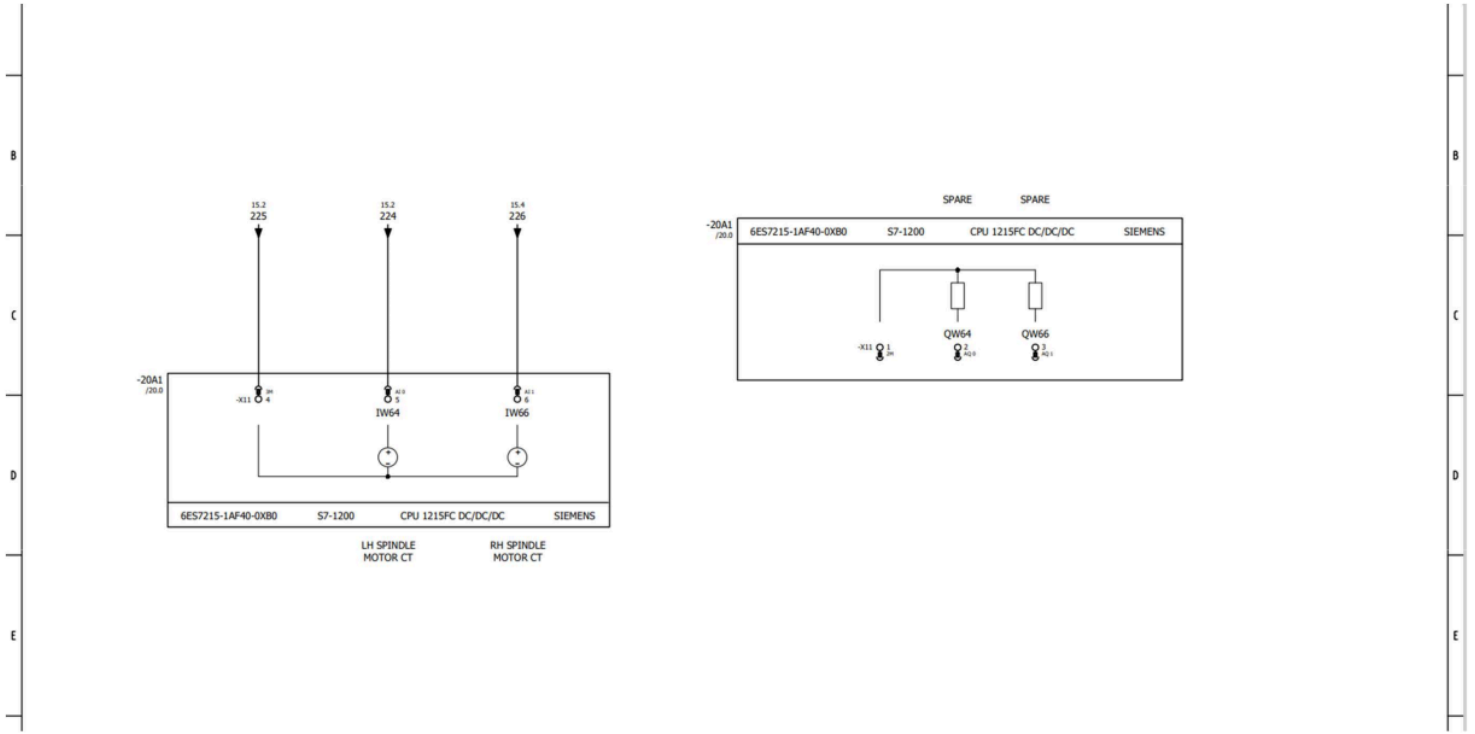


Figure 30 – PLC Analogue IO

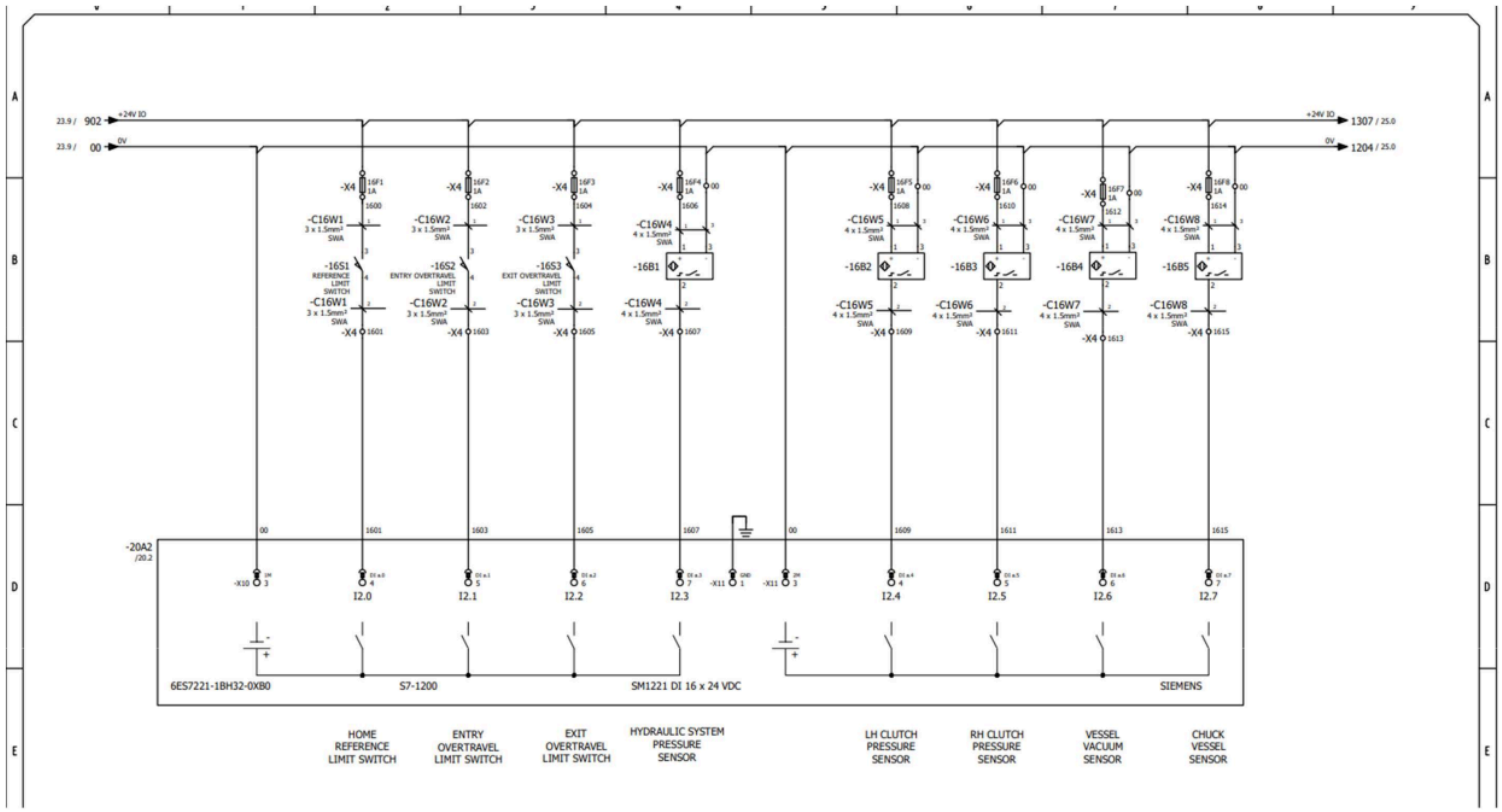


Figure 31 – PLC Inputs

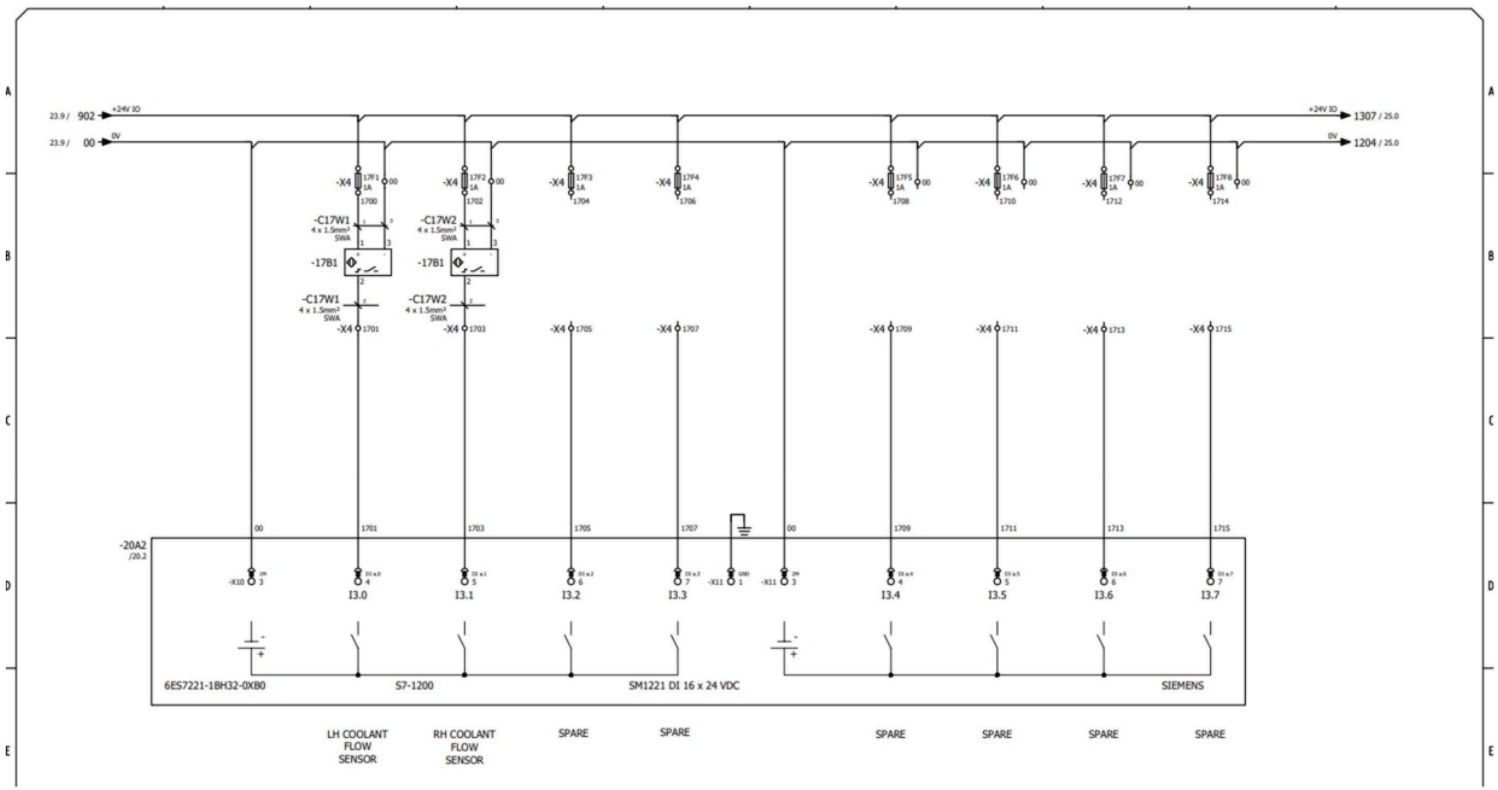


Figure 32 – PLC Inputs

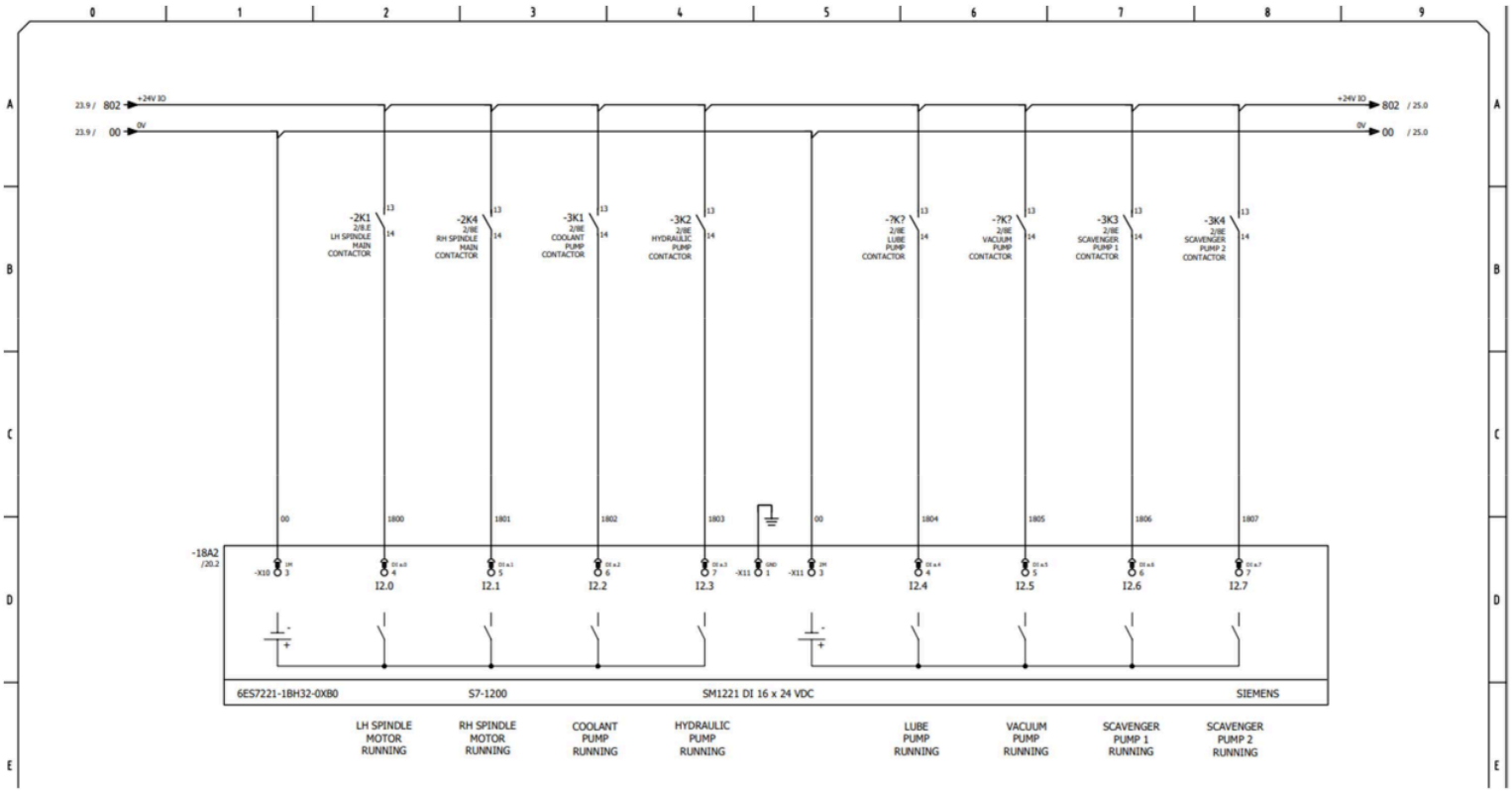


Figure 33 – PLC Inputs

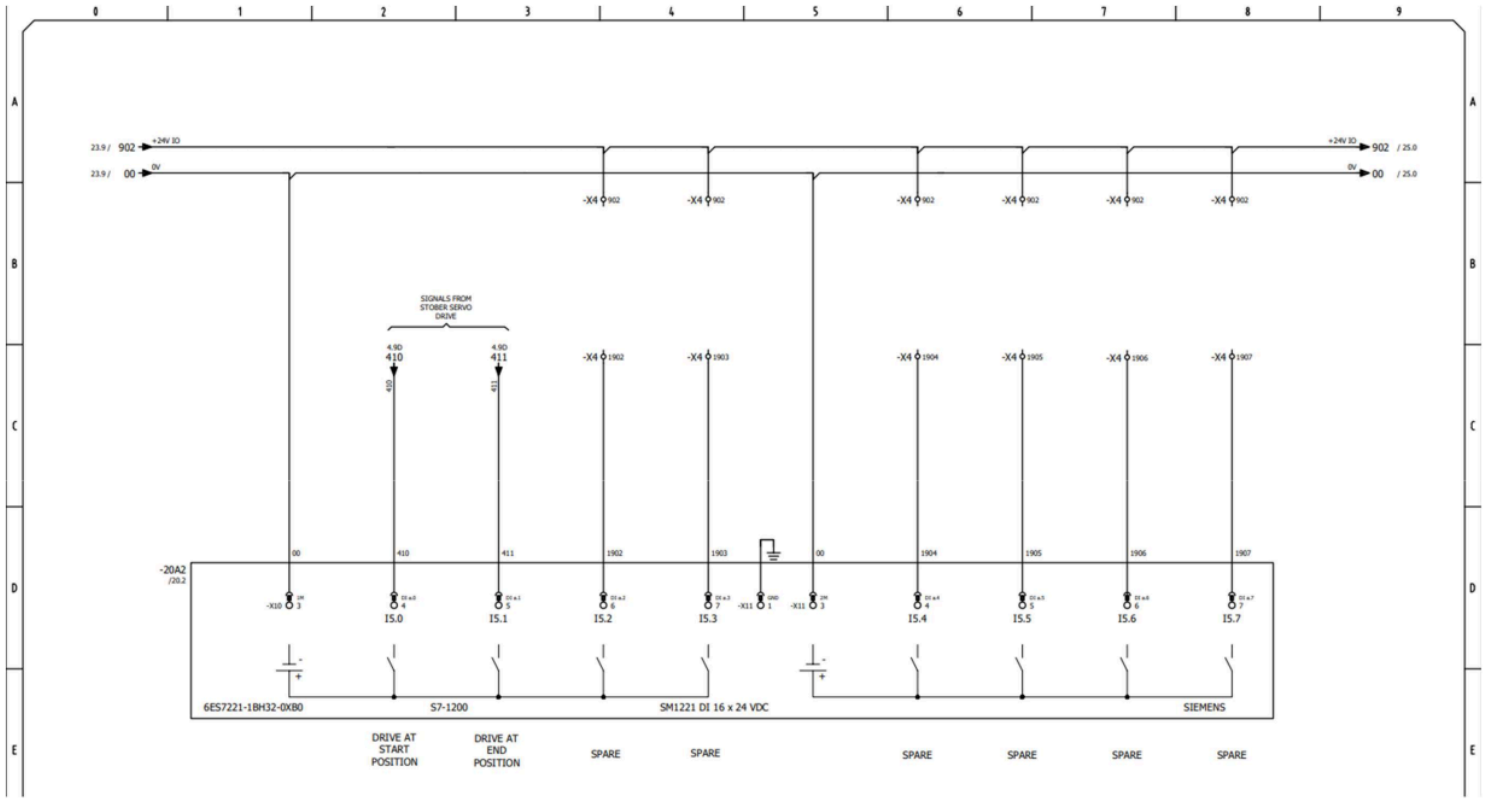


Figure 34 – PLC Inputs

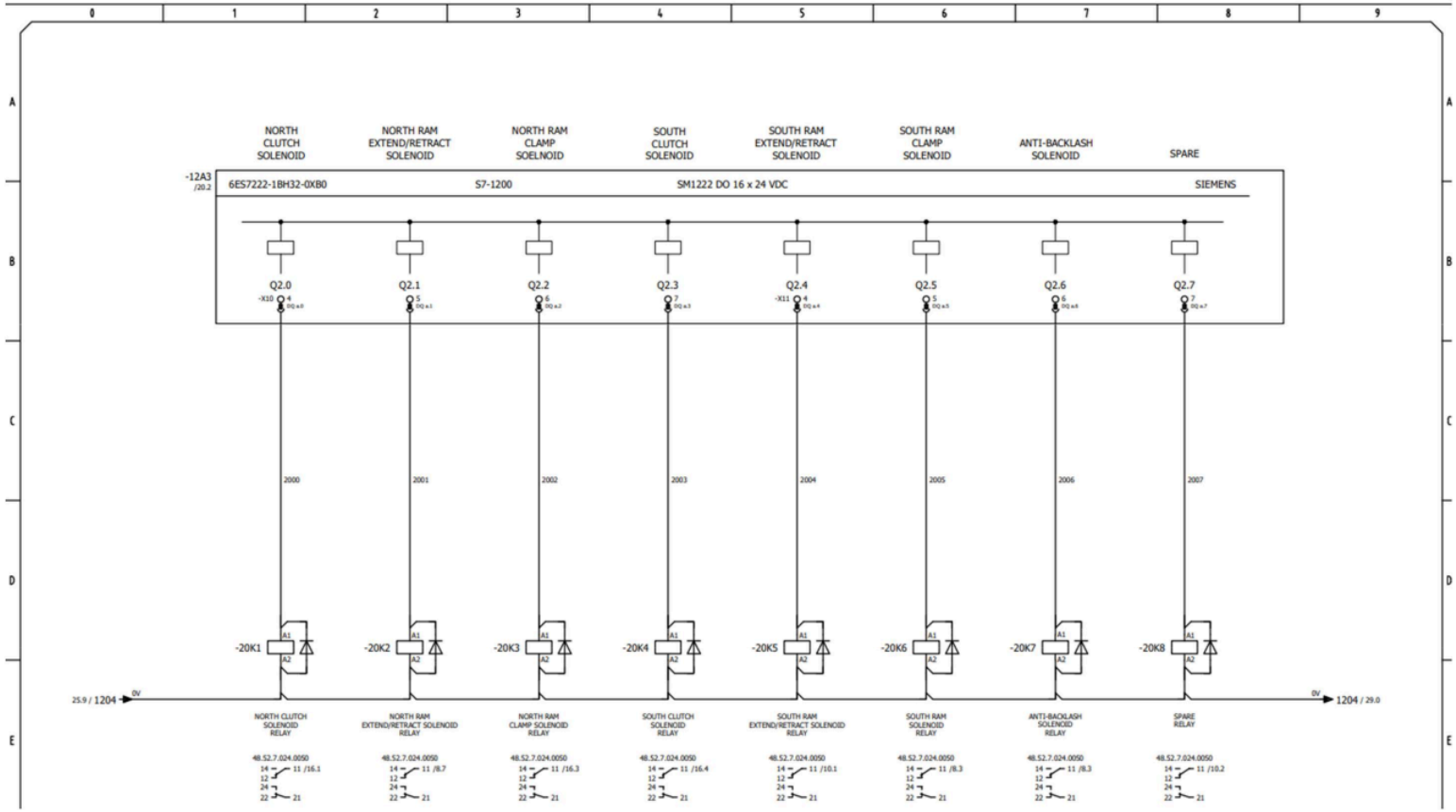


Figure 35 – PLC Outputs

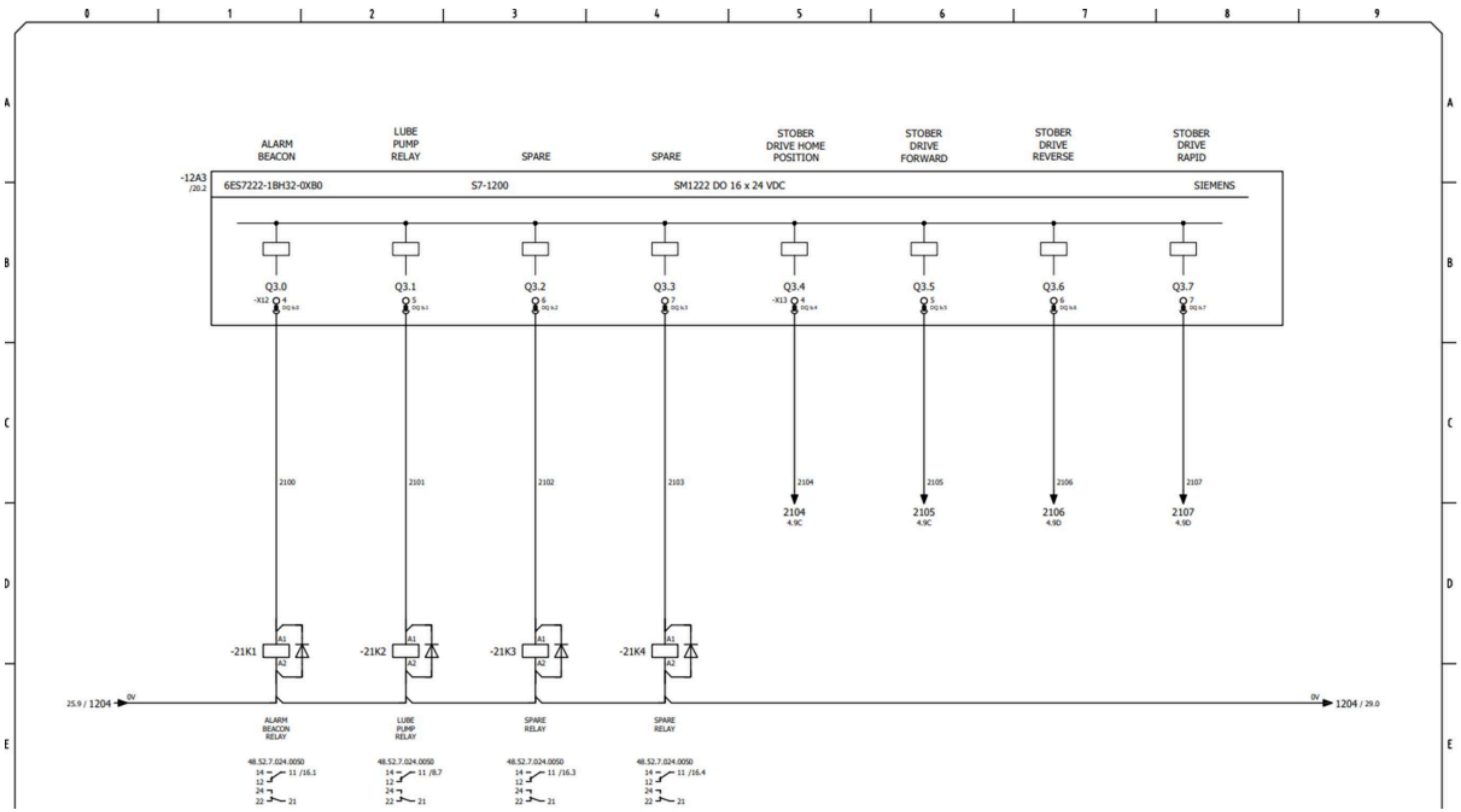


Figure 36 – PLC Outputs

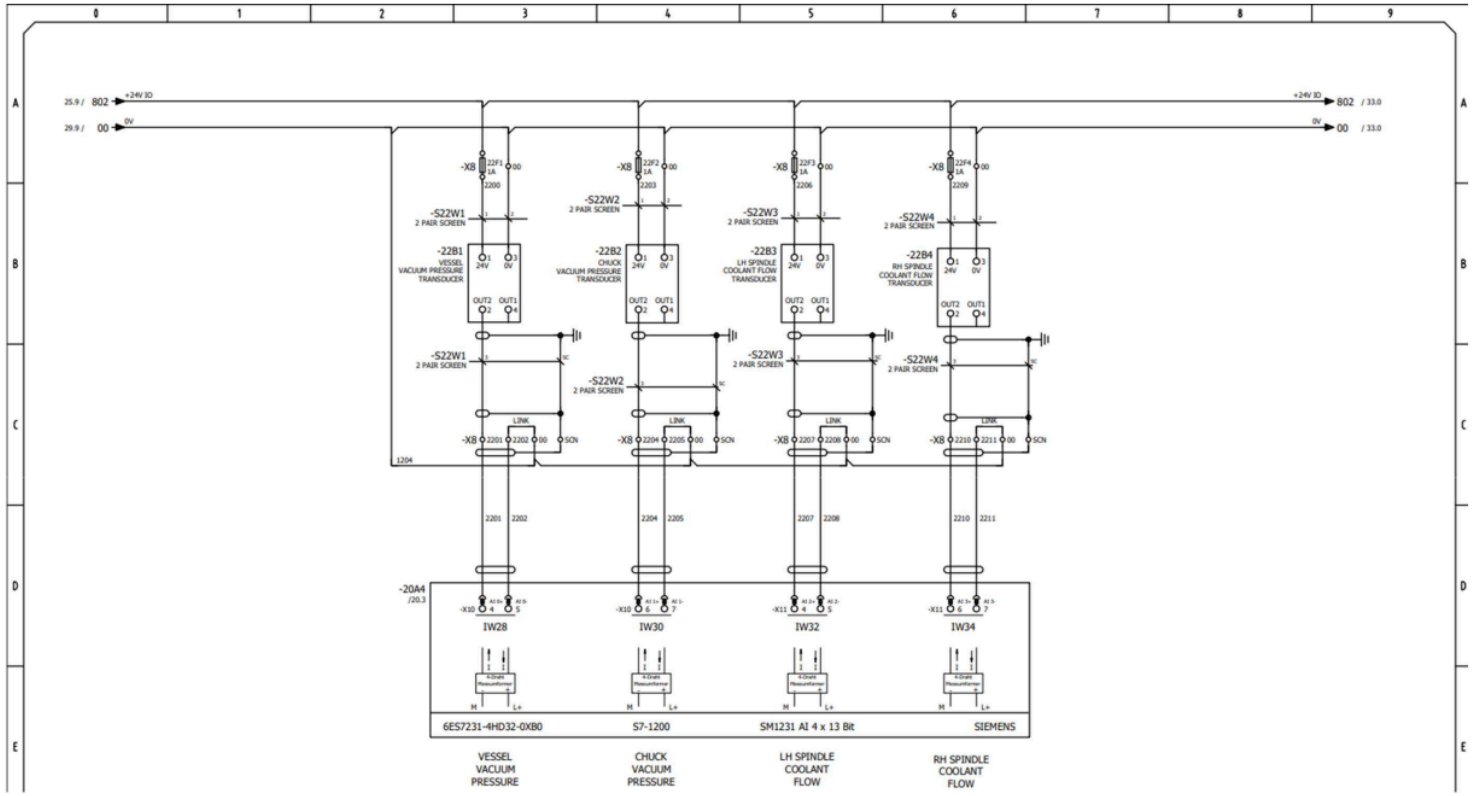


Figure 37 – PLC Analogue Inputs

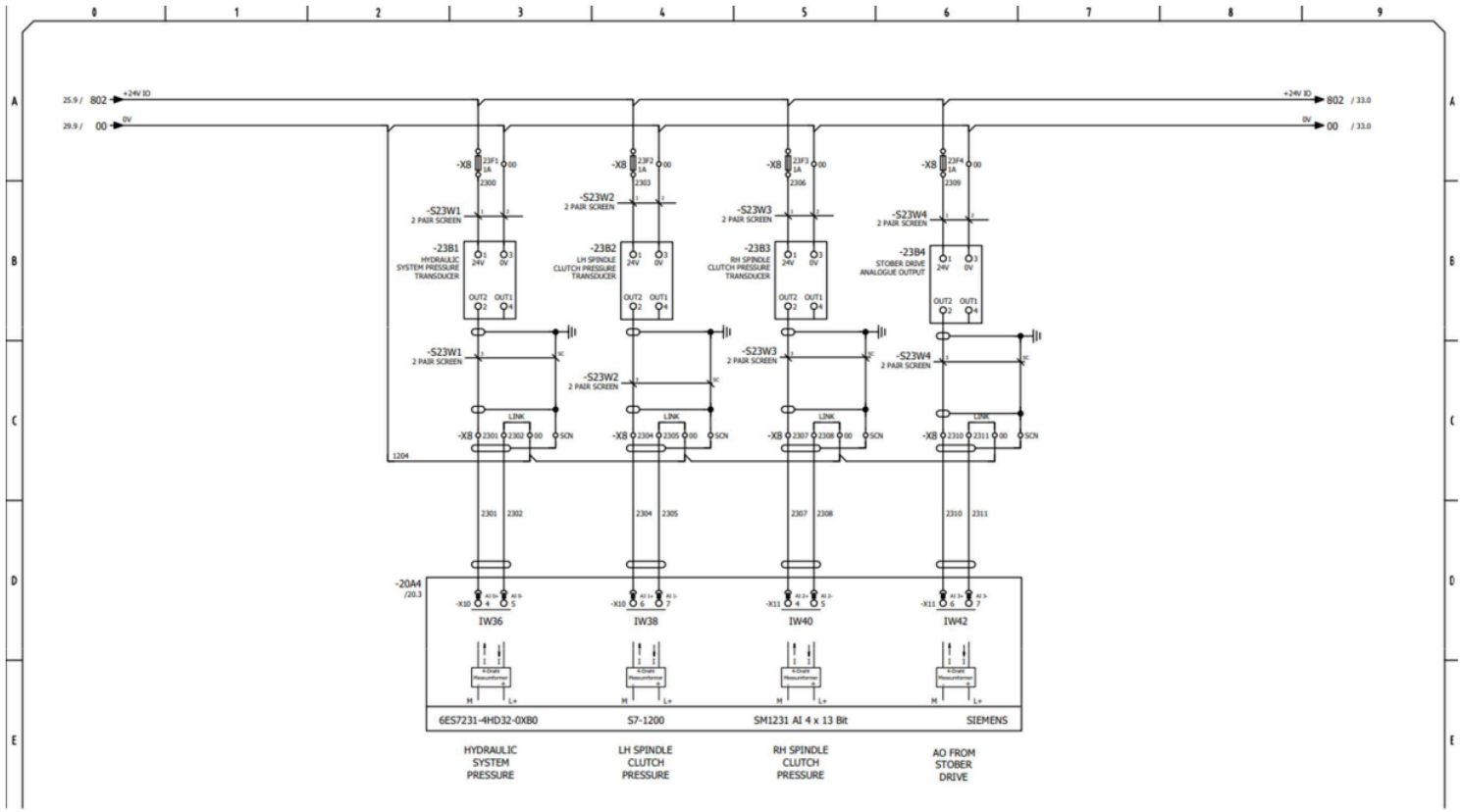


Figure 38 – PLC Analogue Inputs

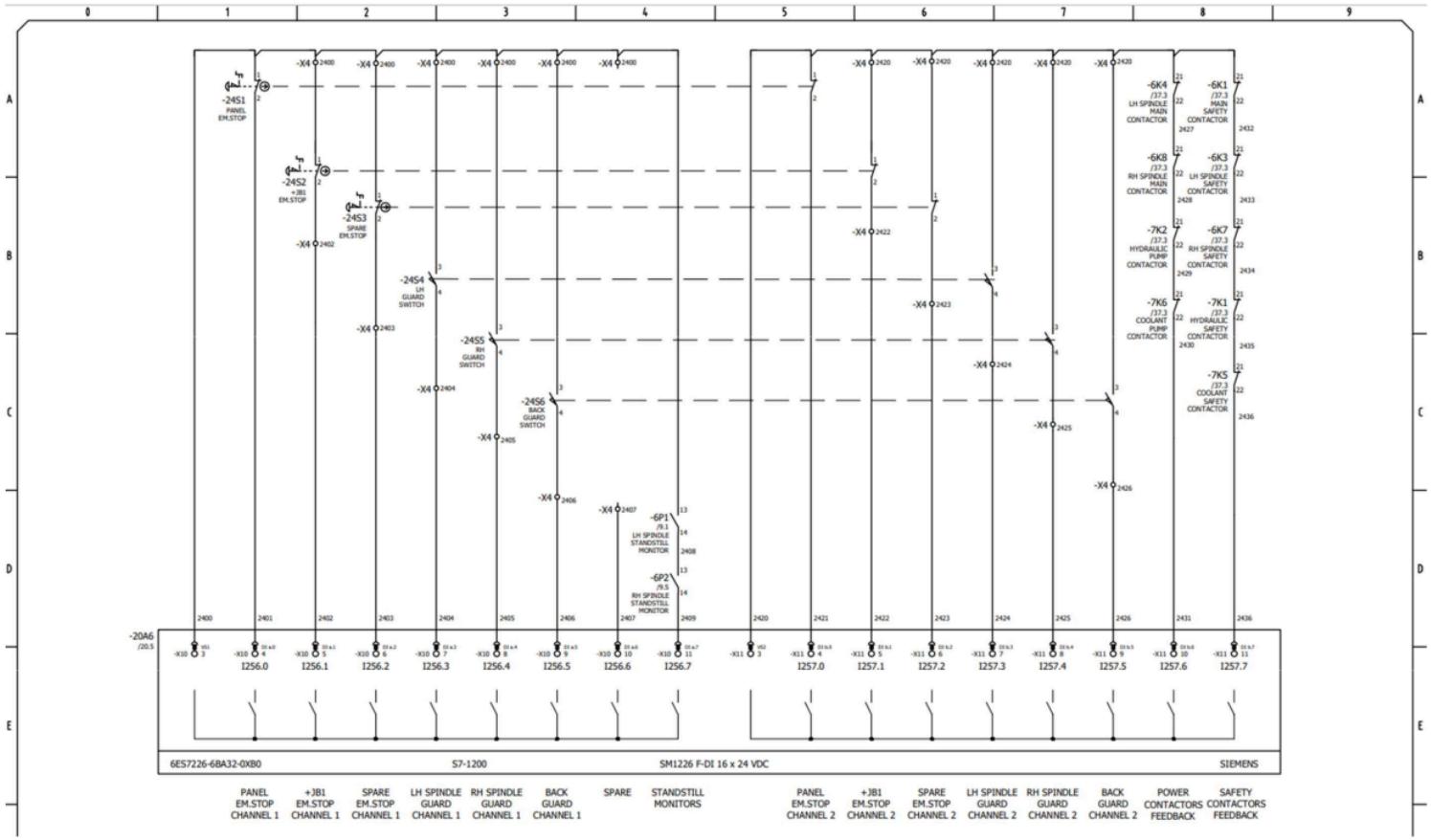


Figure 39 – PLC Safety Inputs

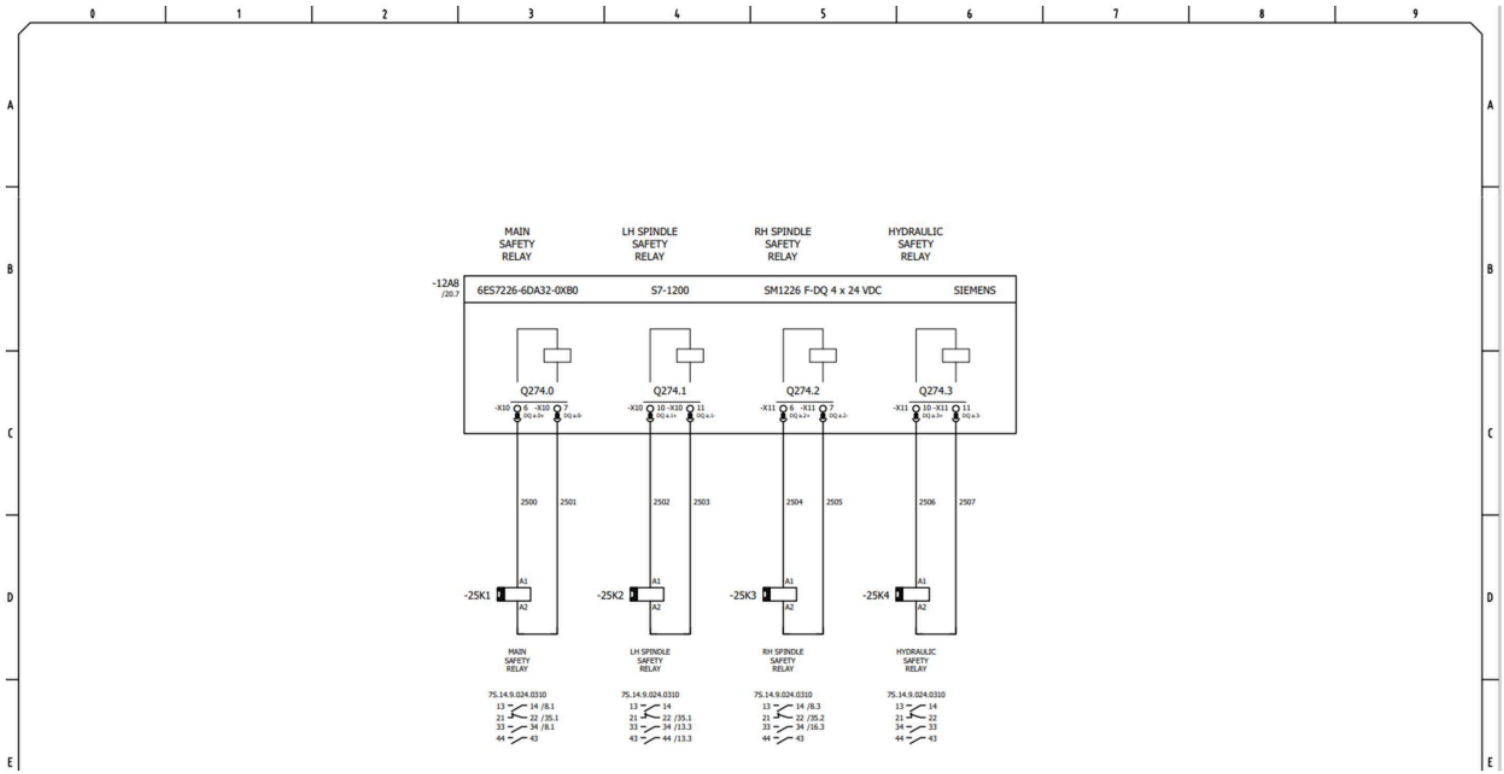


Figure 40 – PLC Safety Outputs

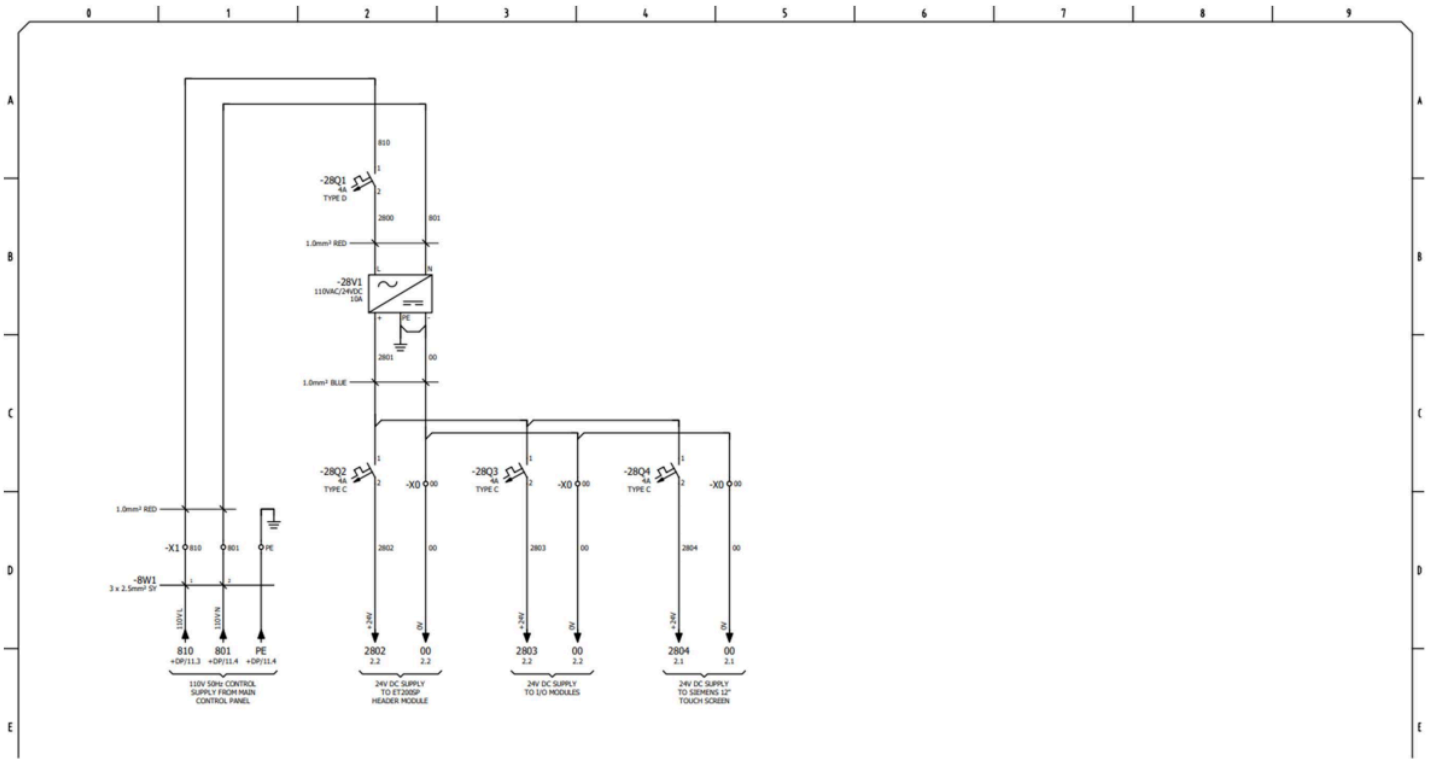


Figure 41 – Operator Station Power

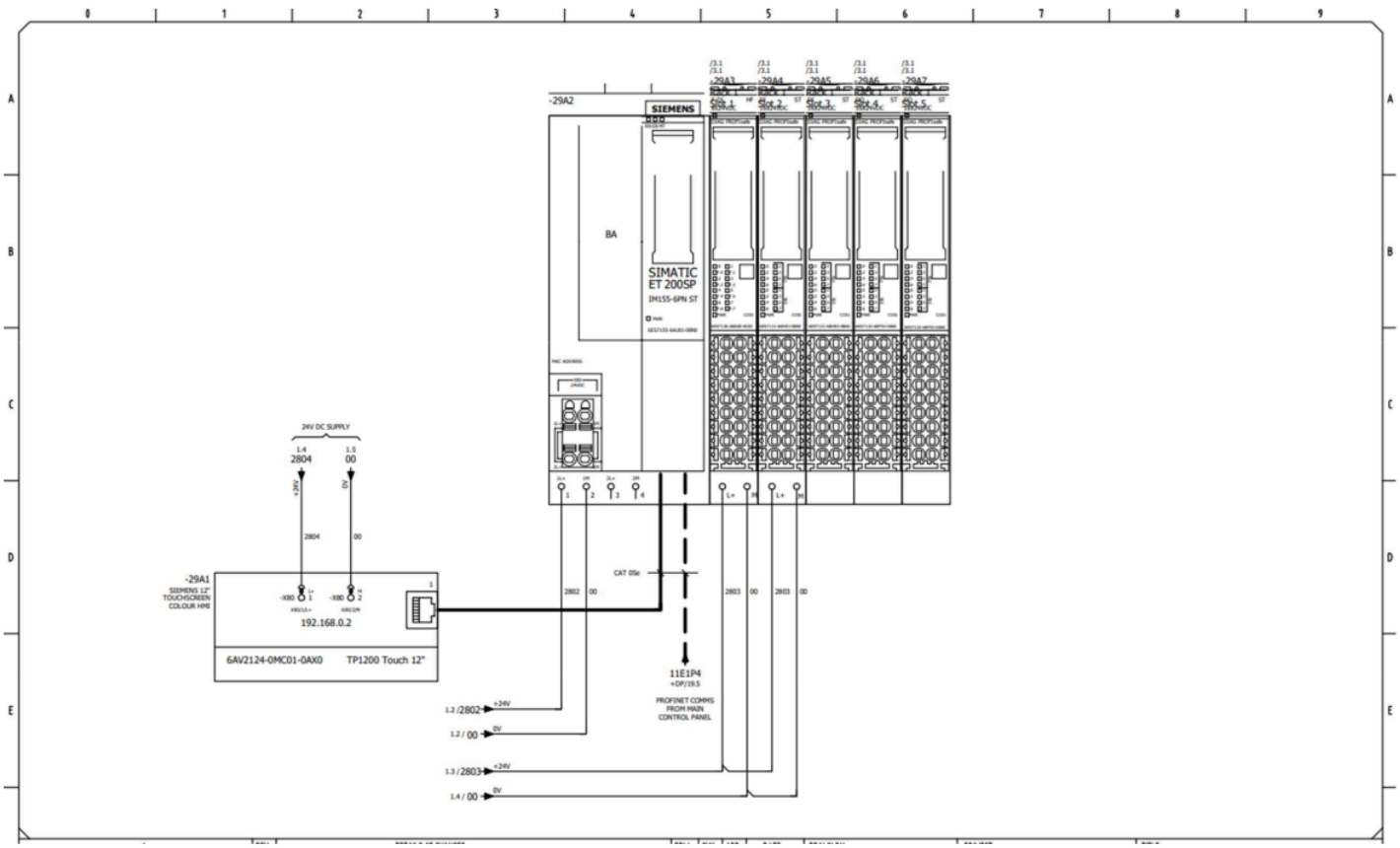


Figure 42 – Remote IO

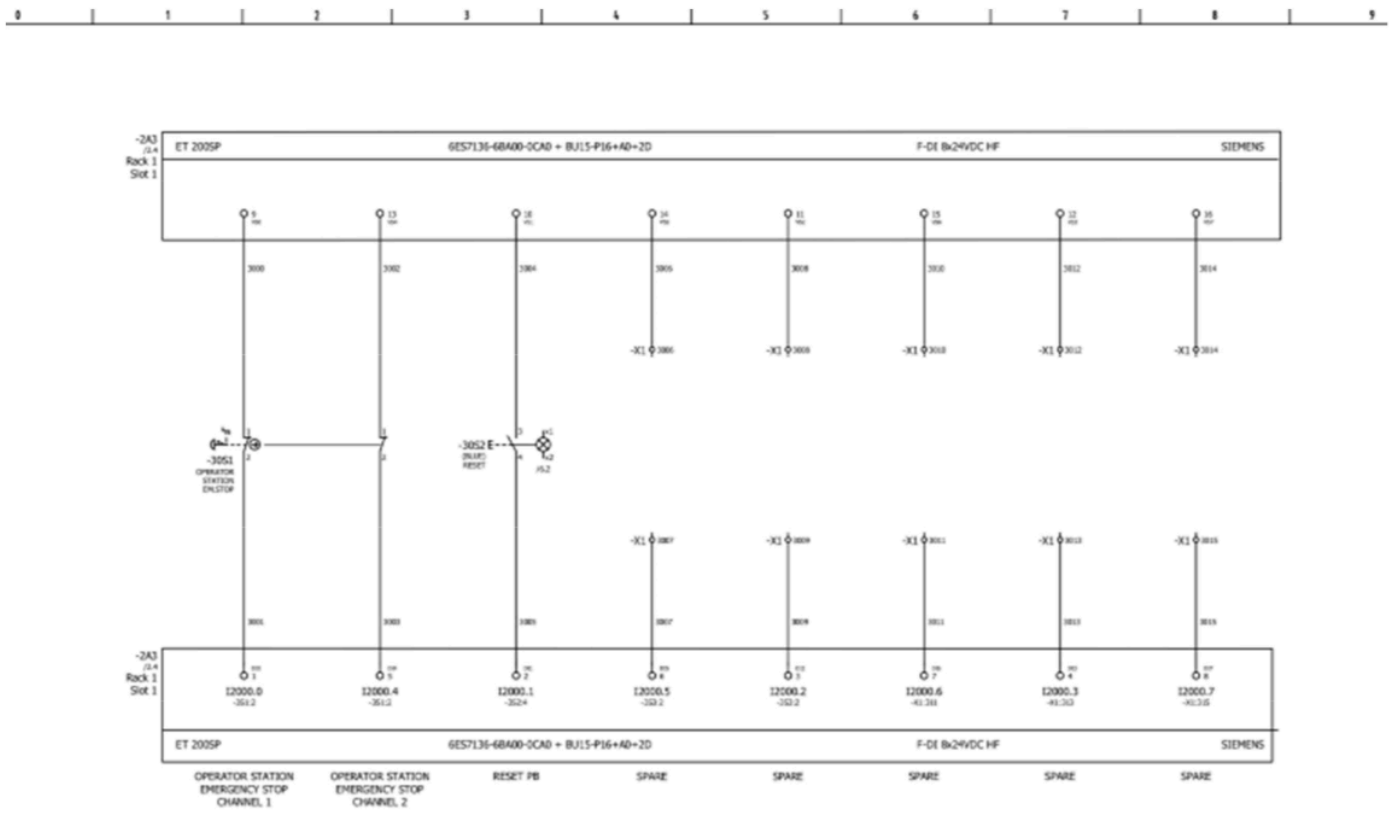


Figure 43 – Remote Safety Inputs

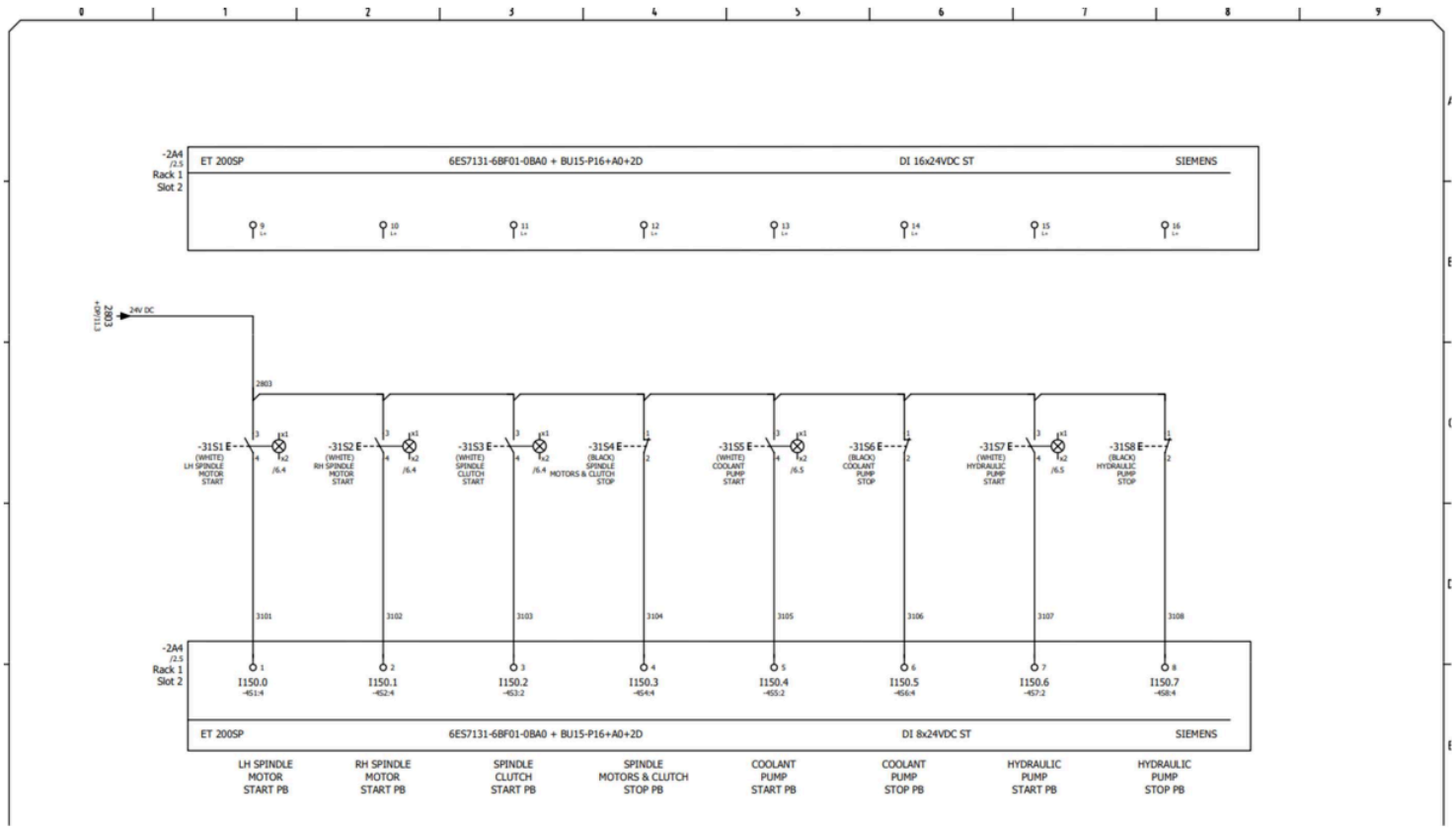


Figure 44 – Remote Inputs

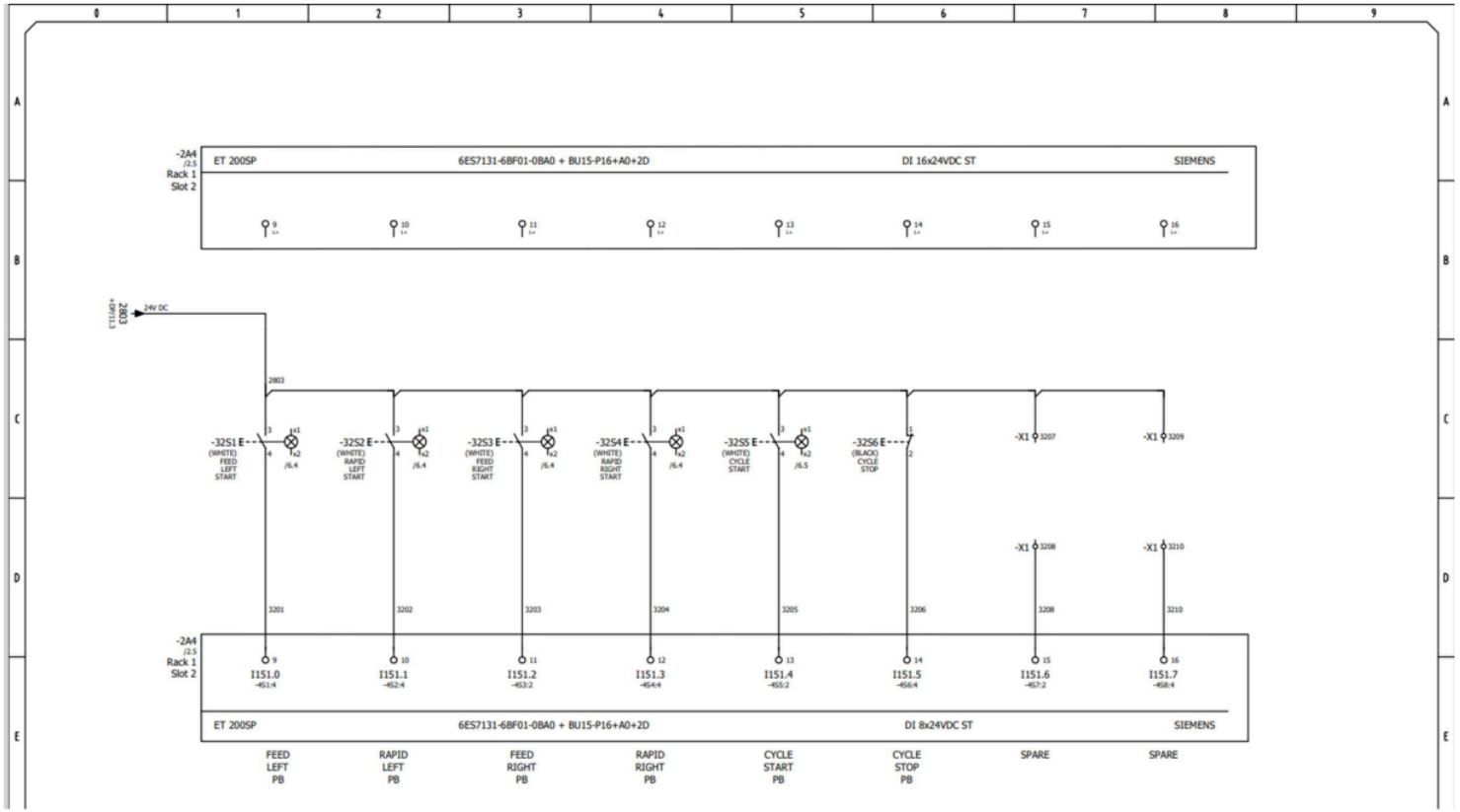


Figure 45 – Remote Inputs

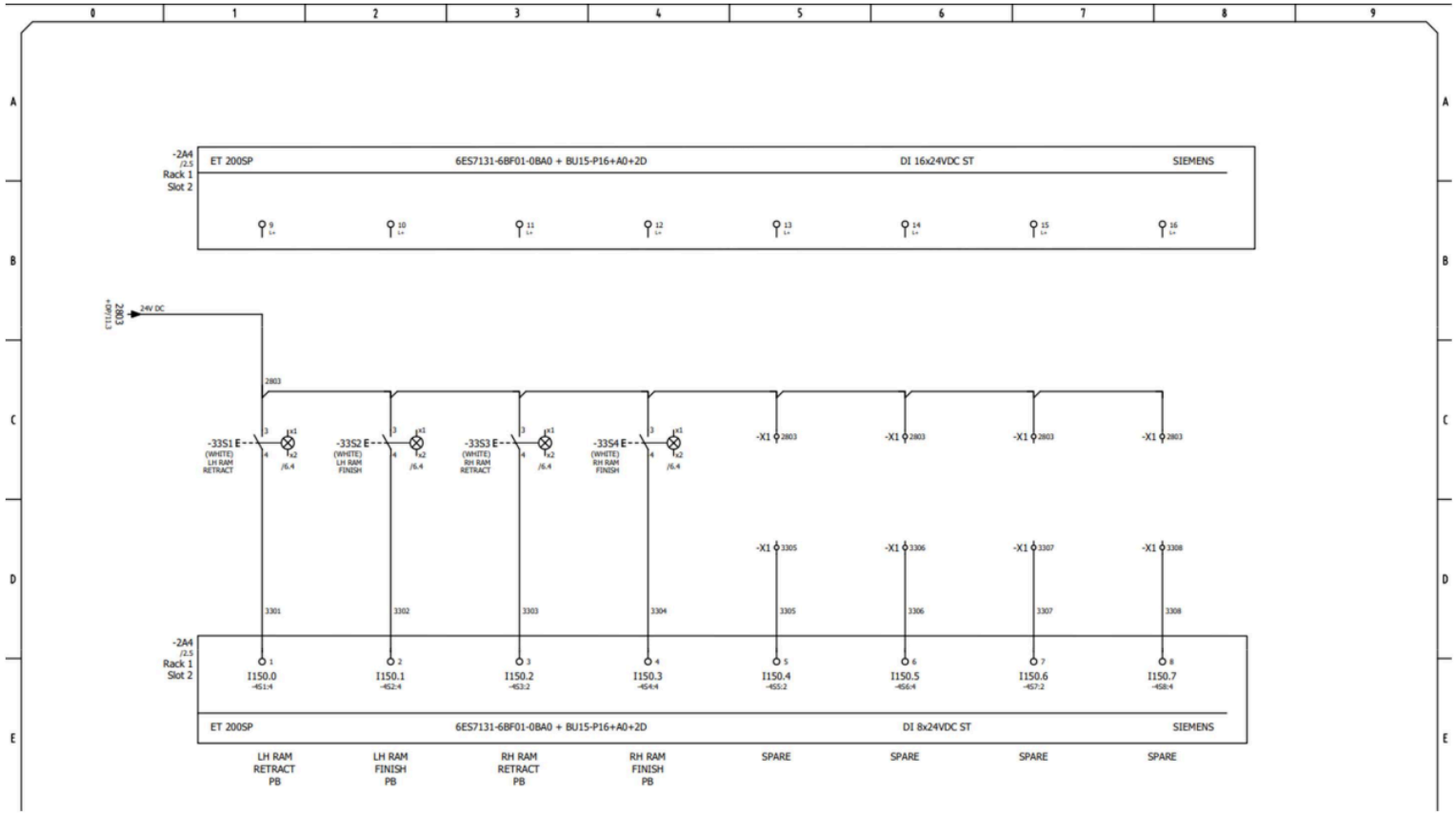


Figure 46 – Remote Inputs

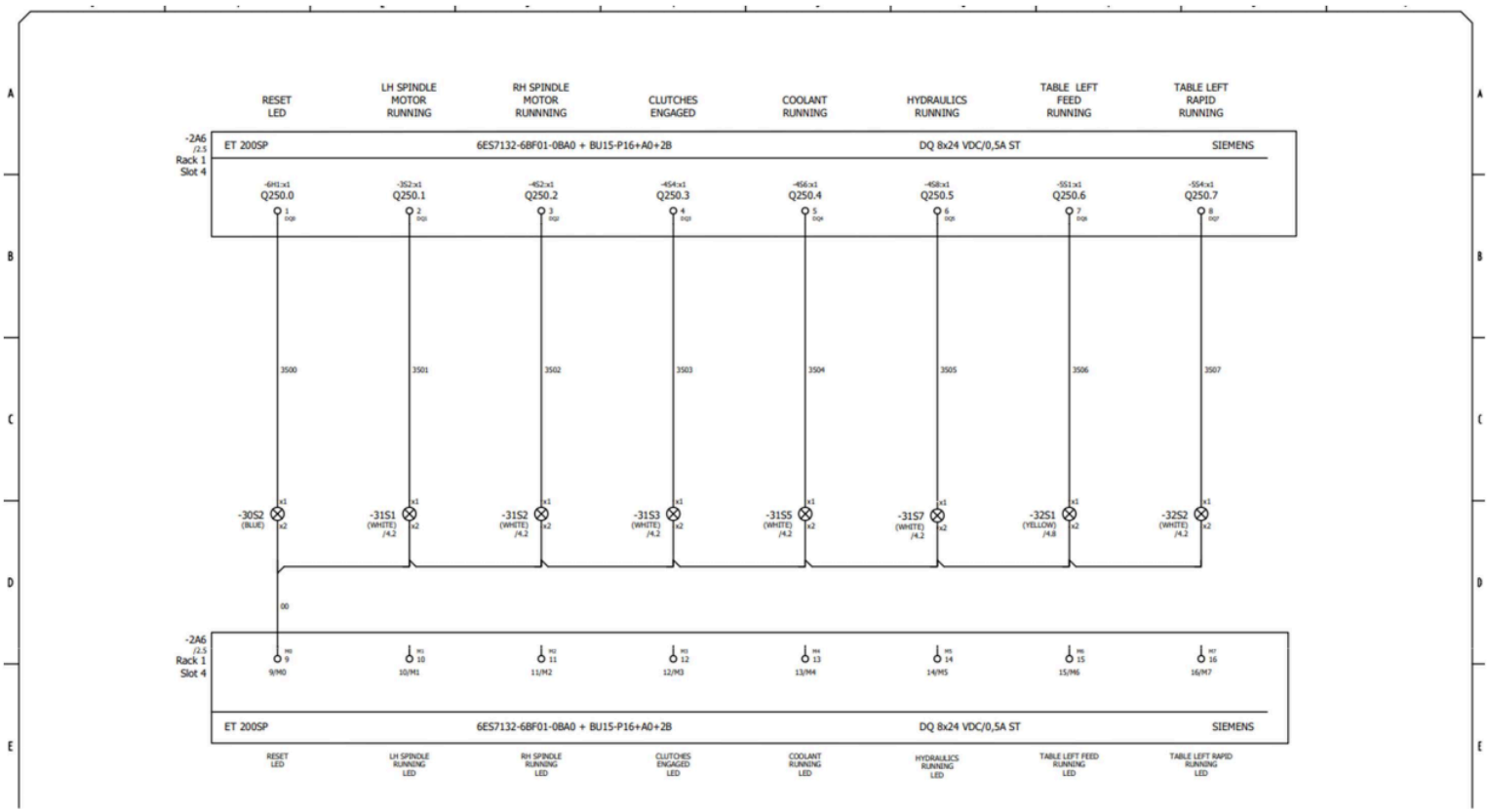


Figure 47 Remote Outputs

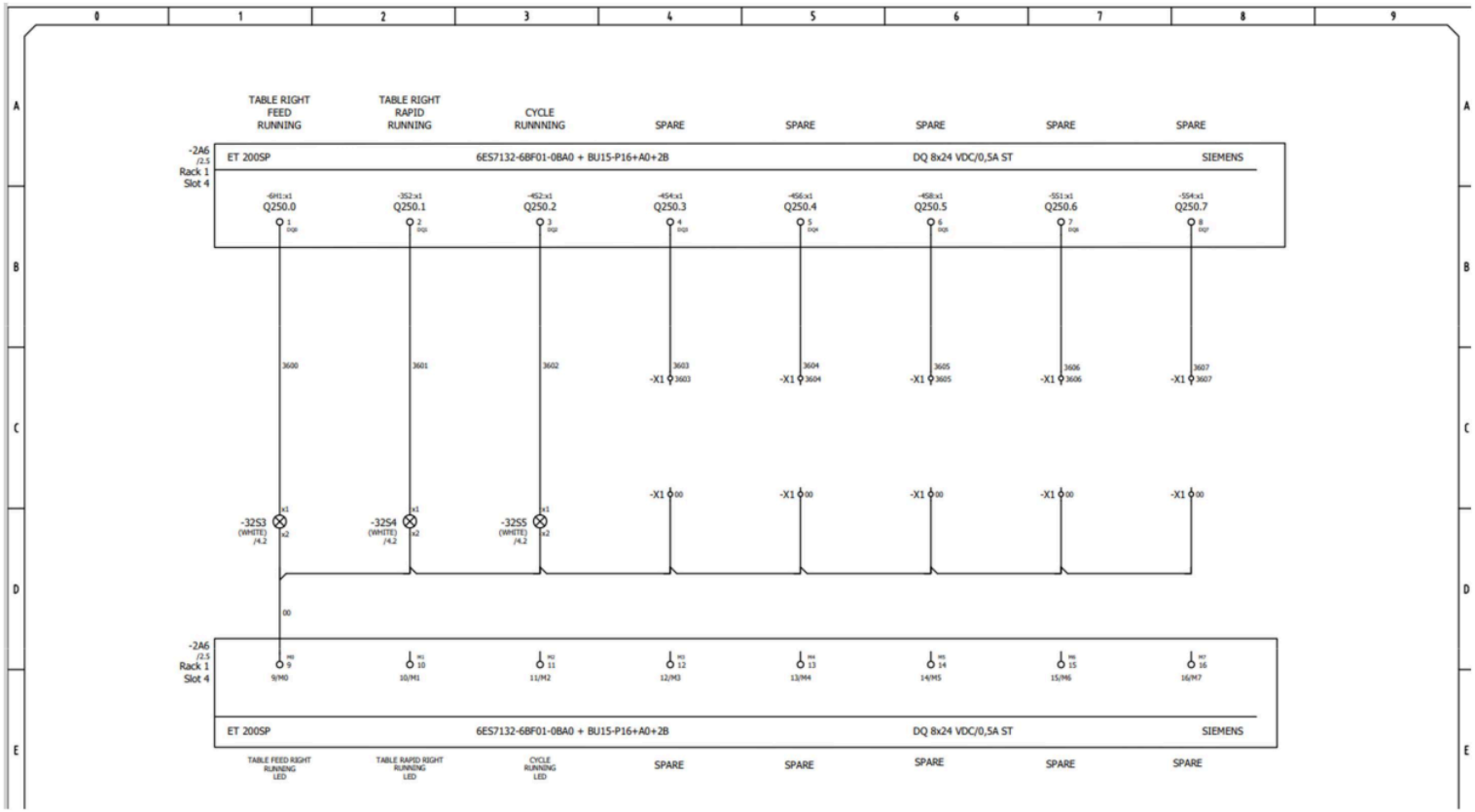


Figure 48 – Remote Outputs

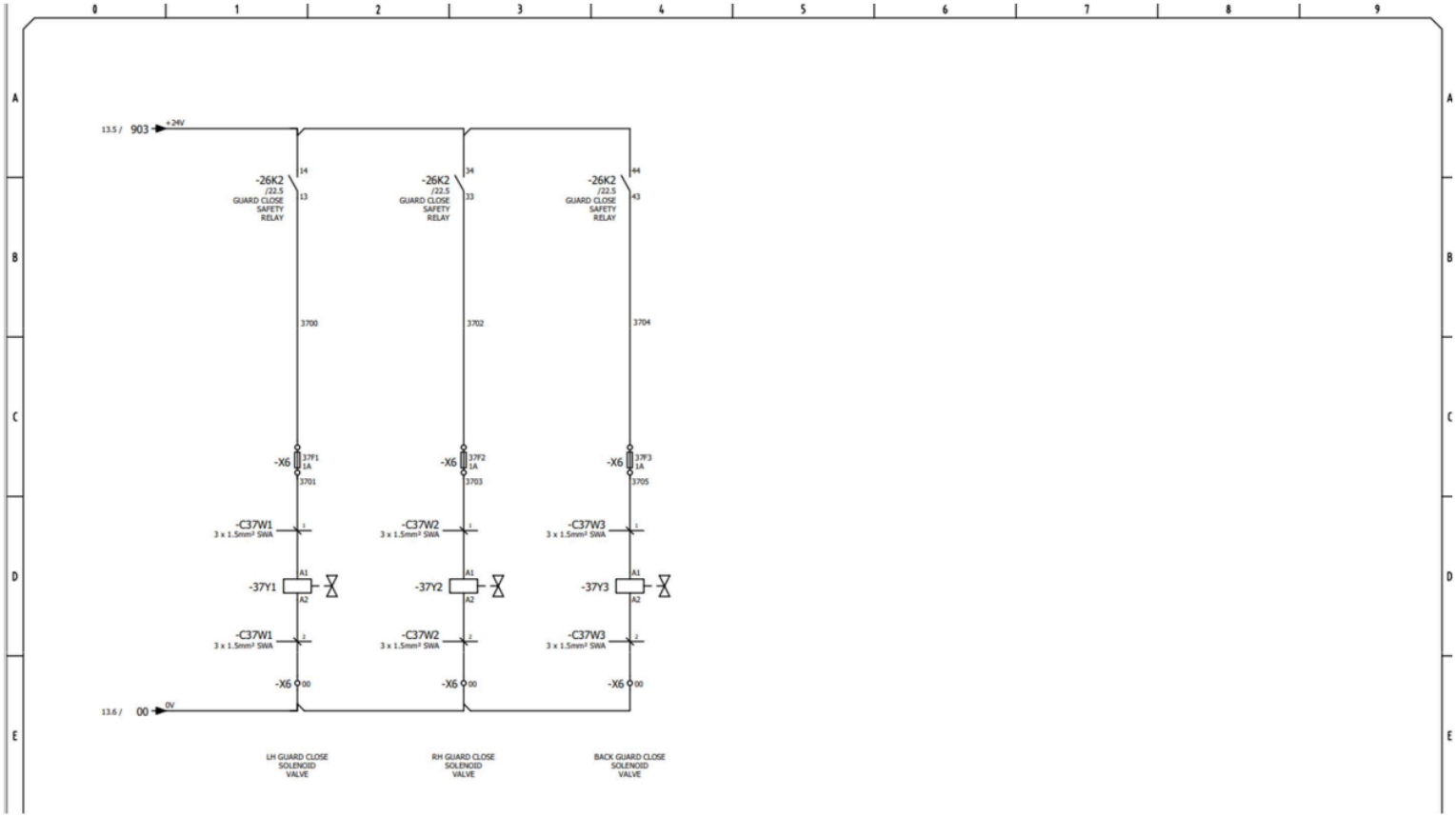


Figure 49 – Solenoid Valve Control

9.6. Cable Schedule

Miller 3 Cable Schedule						
Cable Number	**From**	**To**	**Cable Type**	**Cores**	**Cable ID**	**Function**
W101	Miller 3 Electrical Control Panel	JB101 (Hydraulic pack) - Solenoids / Pressure Sw	20 Core 1.0 YY	1	901	0V Common
				2	947	Solenoid 1 (+24Vdc) - North Spindle Clutch/Brake
				3	939	Solenoid 2 (+24Vdc) - North Ram Ext/Ret
				4	940	Solenoid 3 (+24Vdc) - North Ram Clamp
				5	948	Solenoid 4 (+24Vdc) - South Spindle Clutch / Brake
				6	937	Solenoid 5 (+24Vdc) - South Ram Ext/Ret
				7	938	Solenoid 6 (+24Vdc) - South Ram Clamp
				8	932	Solenoid 7 (+24Vdc) - Anti-backlash
				9	20	2PS (110Vac) - North Spindle Clutch Pressure Switch
				10	98	2PS (110Vac) - North Spindle Clutch Pressure Switch
				11	98	3PS (110Vac)- South Spindle Clutch Pressure Switch
				12	99	3PS (110Vac)- South Spindle Clutch Pressure Switch
				13		Spare
				14		Spare
				15		Spare
				16		Spare
				17		Spare
				18		Spare
				19		Spare
				E		Earth
W102		JB101 (Hydraulic pack) - Estop	7 Core 1.0 YY	1	ES1A	Estop PB (C1)
				2	ES1B	

	Miller 3 Electrical Control Panel			3	ES2A	Estop PB (C2)
				4	ES2B	
				5		Spare
				6		Spare
				E		Earth
W103	Miller 3 Electrical Control Panel	JB101 (Hydraulic pack) - Hydraulic Pump	4 Core 2.5 YY	1	3U1	U1
				2	3V1	V1
				3	3W1	W2
				E	E	Earth
W104	Miller 3 Electrical Control Panel	JB101 (Hydraulic pack) - Scavenger Pump #1	3 Core 2.5 YY	1	402	
				2	403	
				E	E	
W105	Miller 3 Electrical Control Panel	JB101 (Hydraulic pack) - Scavenger Pump #2	3 Core 2.5 YY	1	405	
				2	406	
				E	E	
W106	Miller 3 Electrical Control Panel	JB101 (Hydraulic pack) - Coolant Flow sensors	7 Core 1.0 YY	1	901	Coolant flow switch (0V common)
				2	904	Coolant flow switch (24Vdc common)
				3	951	North Coolant flow Switch OUT1
				4	952	North Coolant flow Switch OUT2
				5	953	South Coolant flow Switch OUT1
				6	954	South Coolant flow Switch OUT2
				E		
W105	Miller 3 Electrical Control Panel	JB101 (Hydraulic pack) - Coolant Flow Alarm Beacon	3 Core 1.0 YY	1	1002	Coolant Flow alarm Beacon (110Vac)
				2	4	Coolant Flow alarm Beacon (0V)
				E		
W107	Miller 3 Electrical Control Panel	JB102 (Near Op control station) - RH OT / Home Limit Switches	7 Core 1.0 YY	1	20	110Vac common
				2	56	SLS2 Home Limit switch
				3	SLS1	SLS1 Right Overtravel Limit Switch
				4		Spare
				5		Spare
				6		Spare

				E	E	Earth
W108	Miller 3 Electrical Control Panel	LH Overtravel Limit Switch	3 Core 2.5 YY	1	20	LH OT Limit Switch
				2	SLS3	
				E	Earth	

Table 4 – Cable Schedule

9.7. Costing

Bill of Materials						
Parts	Part Number	Stores/Req	Stores Number/Vendor	Number of Parts	Cost	Total Cost
Siemens S7-1200 PLC (14DI 10DQ 2AI 2AQ)	6ES7215-1AF40-0XB0	Stores	10071794	1	£773.26	£773.26
SM1226 16F-DI Module	6ES7226-6DA32-0XB0	Stores	10071792	1	£306.68	£306.68
SM1226 4F-DQ Module	6ES7226-6BA32-0XB0	Stores	10071795	2	£173.05	£346.10
SM1221 16DI Module	6ES7221-1BH32-0XB0	Stores	10071750	2	£148.17	£296.34
SM1222 8DQ Module	6ES7222-1BH32-0XB0	Stores	10071791	2	£93.02	£186.04
SM1231 4AI Module	6ES7231-4HD32-0XB0	Stores	10071793	1	£191.80	£191.80
ET200SP IM155-6 PN	6ES7155-6AU01-0BN0	Stores	10075935	1	£224.43	£224.43
ET200SP RJ45 Profinet Adapter	6ES7193-AR00-0AA0	Stores	10077707	1	£57.46	£57.46
ET200SP Module Base	6ES7193-6BP00-0BA0	Stores	10066653	4	£16.20	£64.80
ET200SP 8F-DI Module	6ES7136-6BA00-0CA0	Stores	10066657	1	£167.16	£167.16
ET200SP 16DI Module	6ES7131-6BF01-0BA0	Stores	10075936	2	£90.20	£180.40
ET200SP 8DQ Module	6ES7132-6BF01-0AA0	Stores	10075941	2	£56.27	£112.54
12" HMI TP1200	6AV2124-0MC01-0AX0	Stores	10066651	1	£2,284.20	£2,284.20
IFM PN2099 Pressure Sensor	PN2099	Stores	10064855	2	£294.22	£588.44
IFM PN2092 Pressure Sensor	PN2092	Stores	10077374	3	£406.46	£1,219.38
Multi-core & Ethernet Cable (to Op Station)	N/A	Purchase Requisition	Fastec	1	£1,000.00	£1,000.00
Rittal Panel Operator Station	6315650	Purchase Requisition	RS Components	1	£375.16	£375.16
Rittal 90° Angle Piece Adapter	6212600	Purchase Requisition	RS Components	2	£145.87	£291.74
Rittal 500mm Support Section	6212150	Purchase Requisition	RS Components	1	£72.43	£72.43
Rittal 1000mm Support Section	6212110	Purchase Requisition	RS Components	1	£127.20	£127.20
Rittal Coupling for Support Arm	6212300	Purchase Requisition	RS Components	1	£166.71	£166.71
Rittal Adapter for Support Arm	6212500	Purchase Requisition	RS Components	1	£54.88	£54.88
Rittal Adjustable Wall Hinge	6212740	Purchase Requisition	RS Components	1	£371.74	£371.74
Schneider Illuminated PB	XB4BW33B5	Purchase Requisition	RS Components	20	£31.21	£624.20
Schneider NO Contact	ZBE101	Purchase Requisition	RS Components	10	£4.87	£48.70
Schneider NC Contact	ZBE102	Purchase Requisition	RS Components	10	£4.87	£48.70
Schneider E-Stop	ZB4BS844	Purchase Requisition	RS Components	2	£23.76	£47.52
Siemens Selectivity Module PSE200U	6EP1961-2BA21	Purchase Requisition	RS Components	1	£133.00	£133.00
Siemens Sitop PSU 20A	6EP1436-2BA10	Purchase Requisition	RS Components	1	£254.00	£254.00
Siemens Scalance Ethernet Switch	6GK5008-0BA10-1AB2	Purchase Requisition	RS Components	1	£130.00	£130.00
100A Current Transducer	2308108	Purchase Requisition	RS Components	5	£220.56	£1,102.80
Stober Drive		Stores	10079899	1	£3,000.00	£3,000.00
Servo Motor		Stores	10079900	1	£3,250.00	£3,250.00
Rittal Double Door Floor Standing Enclosure	5842(.)600	Purchase Requisition	RS Components	1	£1,321.40	£1,321.40
Plinth corner with front and rear panel 100 mm	8640.008	Purchase Requisition	RS Components	2	£39.47	£78.94
Base/plinth trim panels, side, 100 mm	8640.031	Purchase Requisition	RS Components	2	£13.95	£27.90
Rittal SZ Wiring Plan Pocket	2514000	Purchase Requisition	RS Components	1	£12.55	£12.55
Rittal Shelf	4638800	Purchase Requisition	RS Components	1	£178.86	£178.86
						£0.00
						£19,717.46

Table 5 – Costing Spreadsheet

9.8. Gantt Chart

Project Start Date: 06-Jan-25

Project Name: Miller 3 ICS Upgrade

WBS Ref	Activity	Assigned To	Start	End	Week Days	Status	% Done
1.1	Bill of Materials	Aeron Smitham	6-Jan-25	9-Jan-25	4	Complete	100%
1.2	Op Station & Panel Layout	Aeron Smitham	9-Jan-25	13-Jan-25	3	Complete	100%
1.3	Electrical Schematics	Aeron Smitham	14-Jan-25	24-Jan-25	9	Complete	100%
1.4	Servo Drive Programming	Aeron Smitham	20-Jan-25	17-Feb-25	21	Complete	100%
1.5	PLC Programming	Aeron Smitham	17-Feb-25	15-Mar-25	20	Behind	250%
1.6	HMI Design	Aeron Smitham	16-Mar-25	19-Mar-25	3	Behind	1200%
1.7	Hydraulic System Design	Leo Farquhar	6-Jan-25	20-Jan-25	11	Complete	100%
1.8	Table Feed Drive Design	Leo Farquhar	17-Jan-25	31-Jan-25	11	Complete	100%
2.1	Operator Station Build	Aeron Smitham	20-Mar-25	27-Mar-25	6	Behind	0%
2.2	Panel Modification	Aeron Smitham	28-Mar-25	5-Apr-25	6	Behind	0%
2.3	Hydraulic System Mods	Leo Farquhar	3-Feb-25	14-Feb-25	10	Complete	100%
2.4	Table Feed Drive Mods	Leo Farquhar	3-Feb-25	14-Feb-25	10	Complete	100%
2.5	Servo Motor Installation	Aeron Smitham	10-Feb-25	21-Feb-25	10	Complete	100%
3.1	Servo Comissioning	Aeron Smitham	10-Feb-25	21-Feb-25		Complete	100%
3.2	PLC Comissioning	Aeron Smitham	7-Apr-25	16-Apr-25	8	Behind	0%
3.3	Technical File	Aeron Smitham	6-Jan-25	21-Apr-25	76	Complete	100%

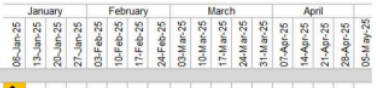


Table 6 – Gantt Chart

9.9. PLC Program

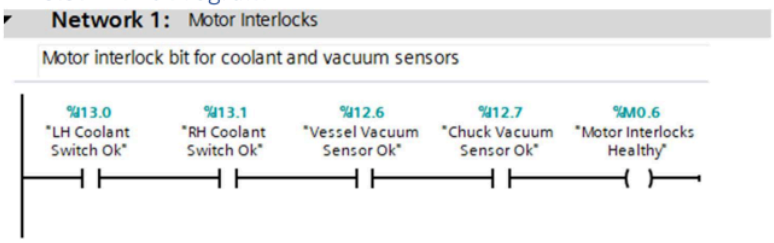


Figure 50 – Motor Interlocks

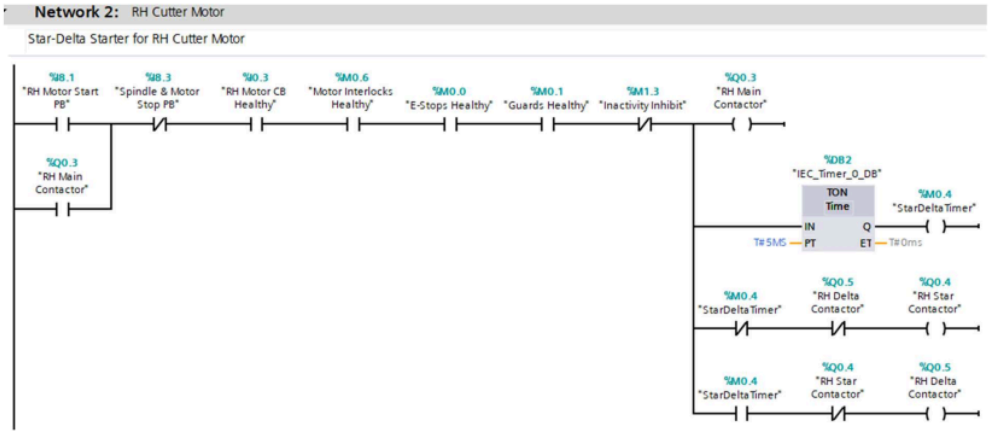


Figure 51 – RH Cutter Motor

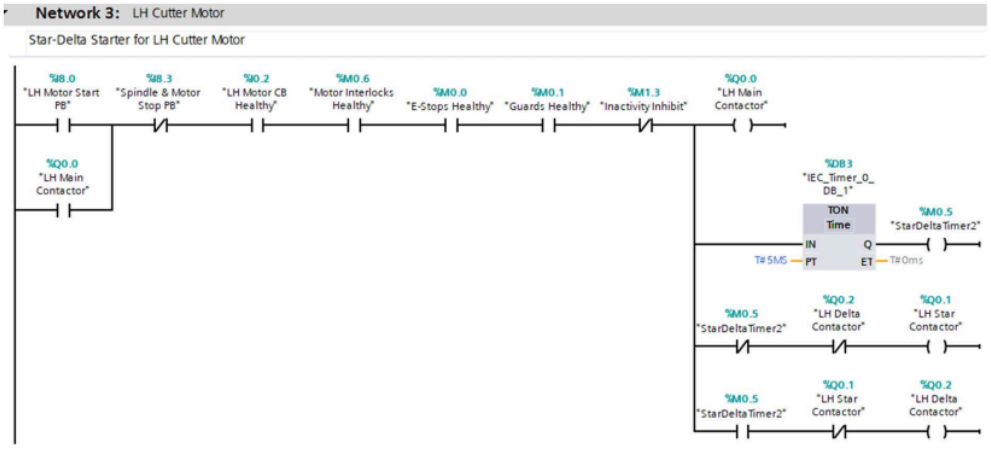


Figure 52 – LH Cutter Motor

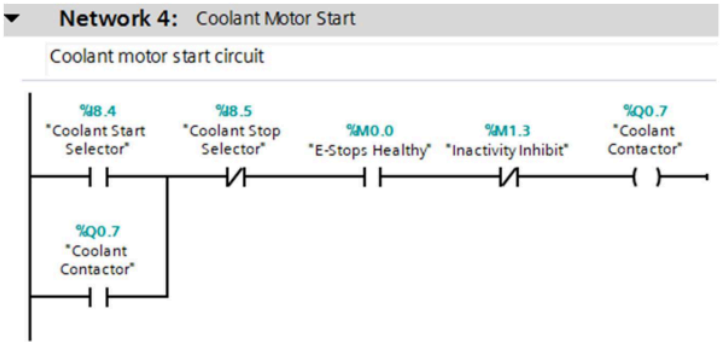


Figure 53 – Coolant Motor

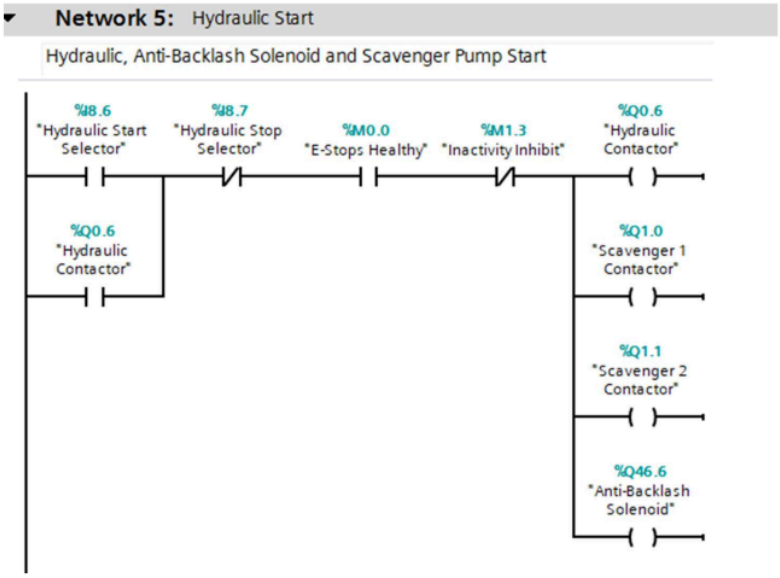


Figure 54 – Hydraulics Start

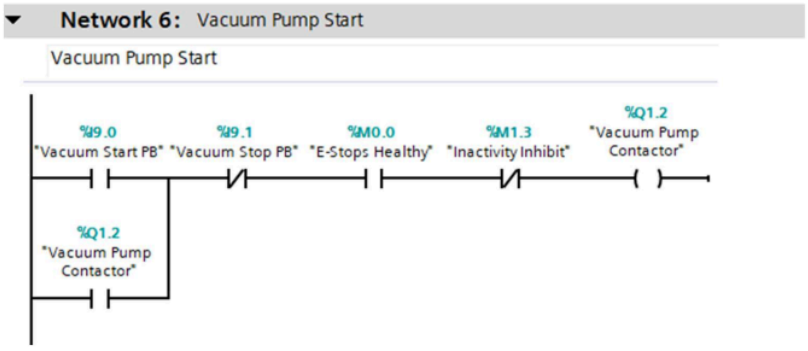


Figure 55 – Vacuum Start

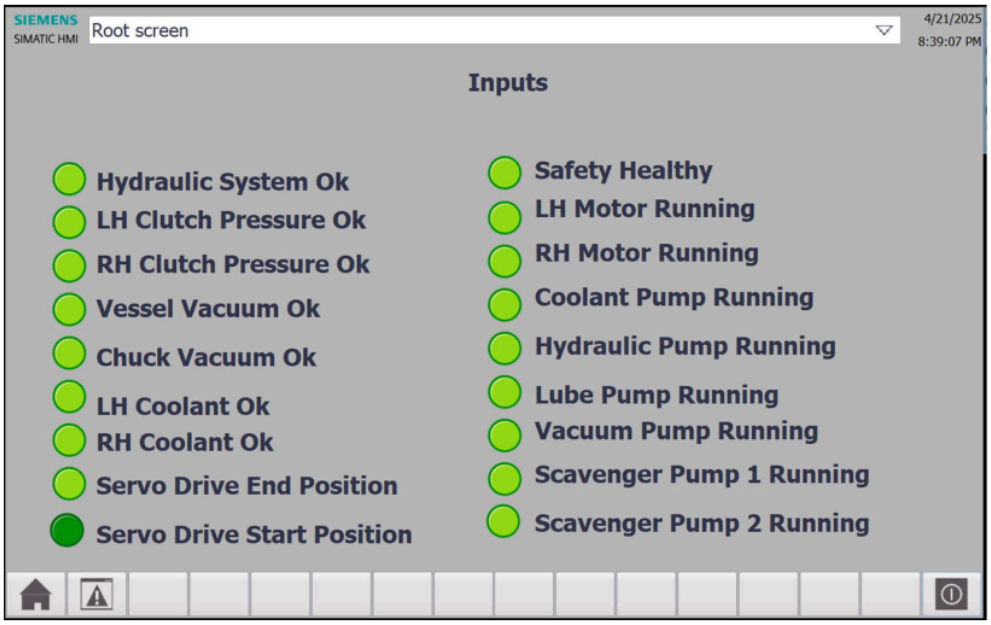


Figure 56 – Simulated Table at end position

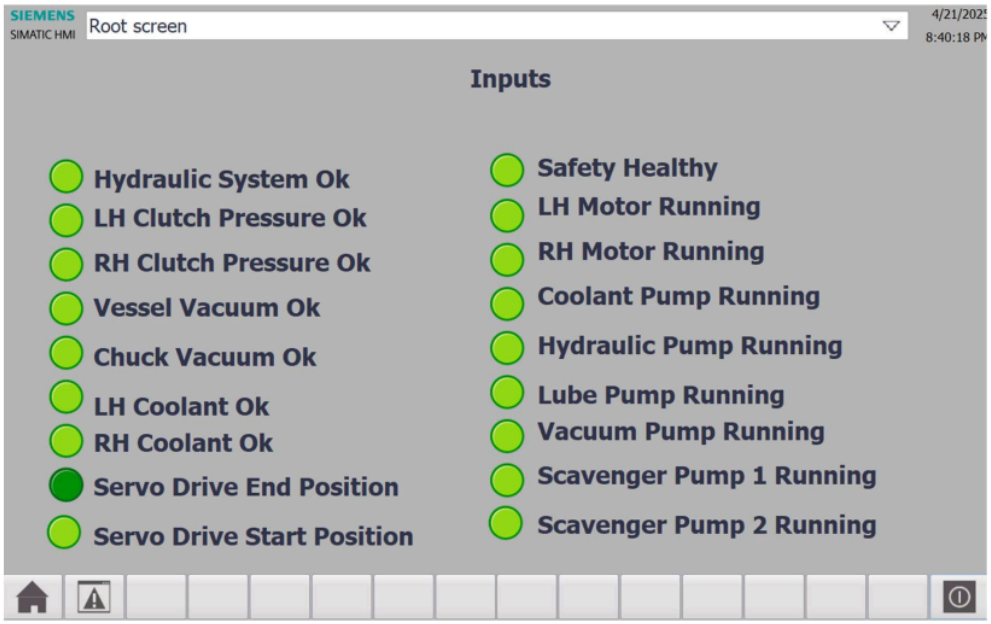


Figure 57 – Simulated table at start positon

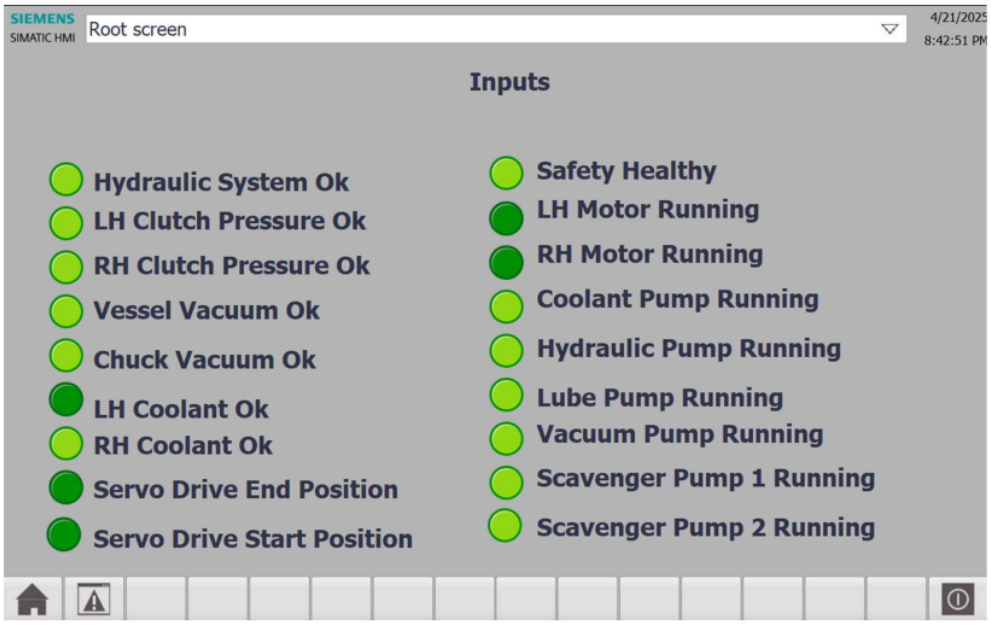


Figure 58 – Simulated LH coolant inhibiting the two motors

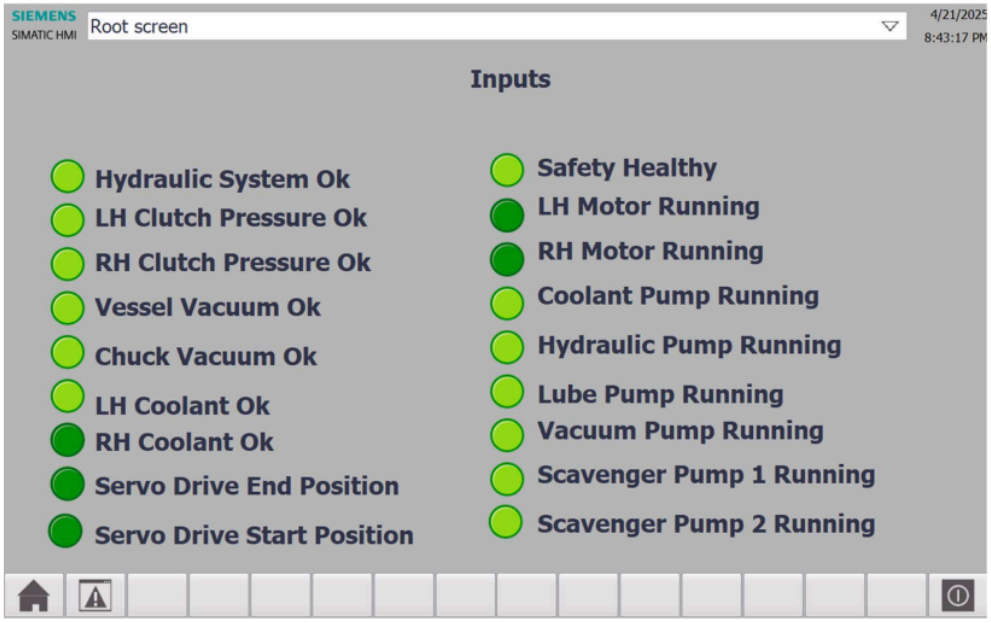


Figure 59 – Simulated RH Coolant inhibiting two motors

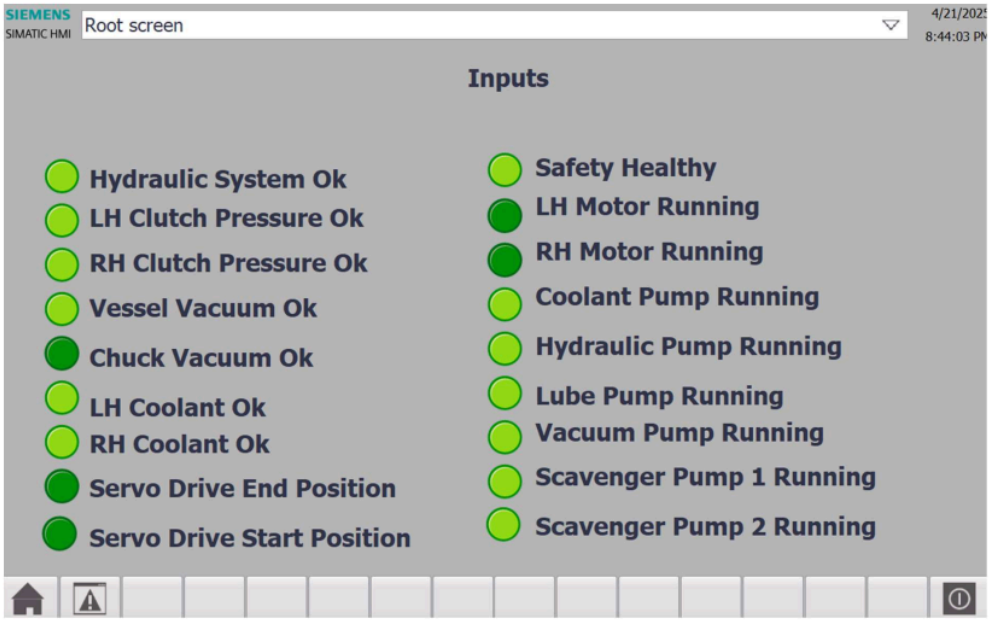


Figure 60 – Simulated Chuck vacuum inhibiting the two motors

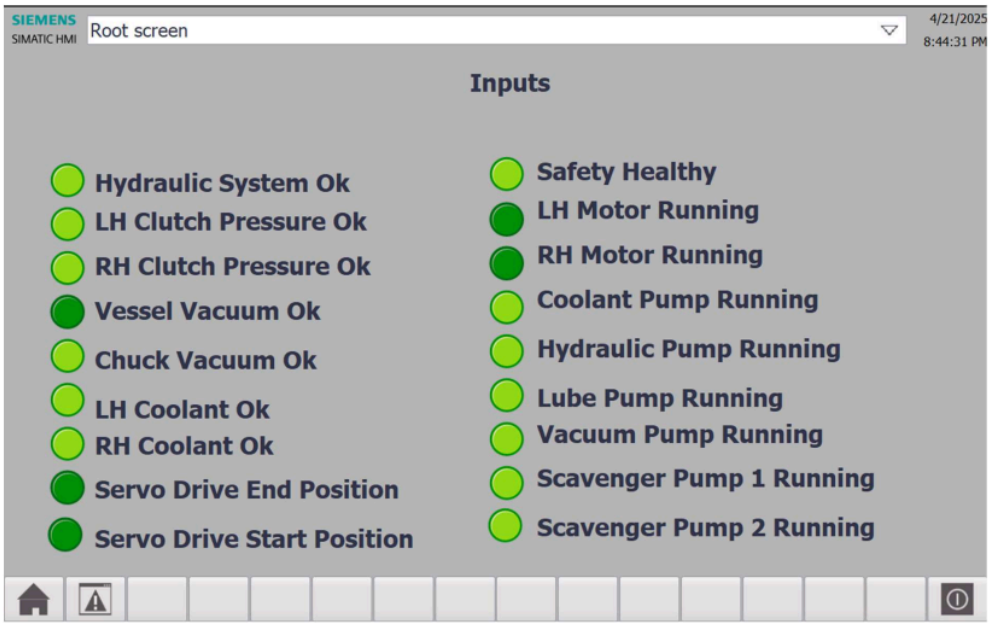


Figure 61 - Simulated vessel vacuum inhibiting the two motors

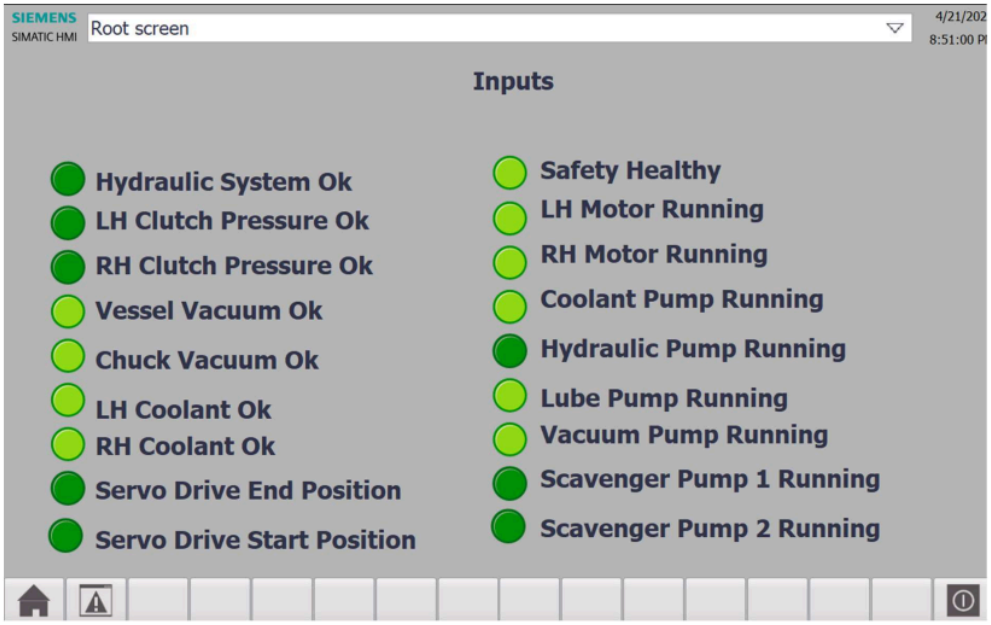


Figure 62 – Simulated hydraulic pump off so hydraulic sensors not made

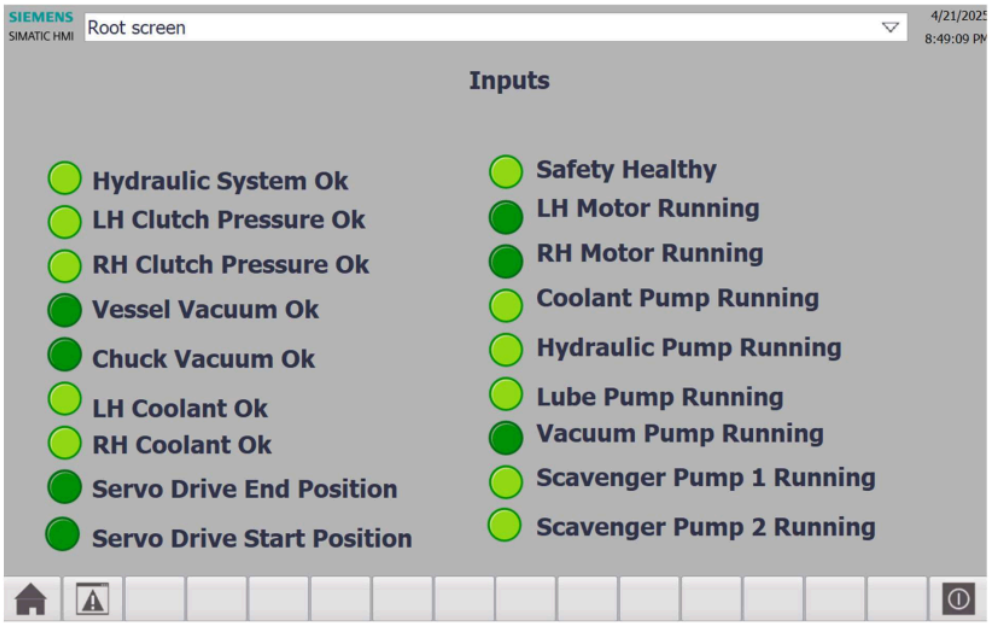


Figure 63 – Simulated vacuum pump off, inhibiting the two motors

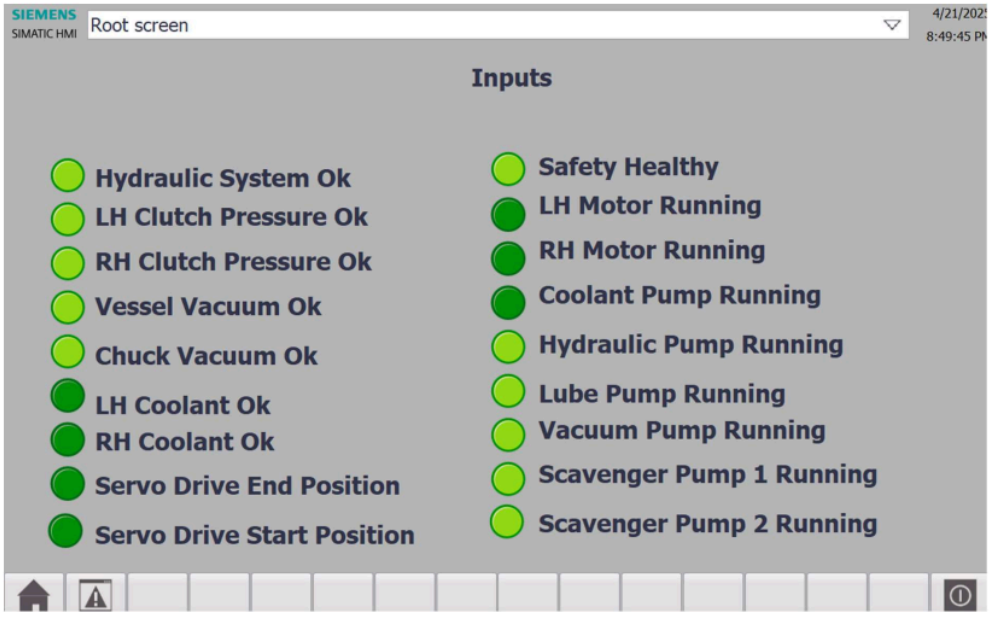


Figure 64 – Simulated coolant pump off, inhibiting the two motors

Where are the pictures of the servo drive?

2017197

GRADEMARK REPORT

FINAL GRADE

GENERAL COMMENTS

63 /100

PAGE 1

PAGE 2

QM

Good Structure

Report is structured exactly as stated in the assignment brief.

Text Comment. log book should be last

PAGE 3

PAGE 4

PAGE 5

PAGE 6

PAGE 7

Text Comment. This is an excellent summary that covers all aspects of the project.

PAGE 8

Text Comment. Should be an introduction to the report not the project. However, this is another excellent section that explains the project to the reader.

PAGE 9

Text Comment. An updated FDS should be in this section

Text Comment. You should have cited your assignment 1 here

Text Comment. in the appendix.

Text Comment. ^

Text Comment. This section should have contained many more citations as the design process requires research.

PAGE 10

PAGE 11

Text Comment. This drawing belongs in the appendix

Text Comment. Company name should be blocked out

PAGE 12

Text Comment. Text format - should be 1.5 line spacing

Text Comment. Text format - should be fully justified

PAGE 13

Text Comment. Alarms should never be cleared by default (only perhaps on power up), you need an alarms handler so that alarms are acknowledged and then only cleared when fault has been removed. However, you seem to have resolved this by calling the function block in the network below.

PAGE 14

Text Comment. Program printouts should be in the appendix

PAGE 15

PAGE 16

Text Comment. This suggests they were not running under load

Text Comment. When no running under load, motors draw much less power. Do your calculations include this fact?

QM **Correctly cited**

Citation method conforms to Harvard standard, well done.

PAGE 17

PAGE 18

PAGE 19

Text Comment. was

Text Comment. ^

QM **Correctly cited**

Citation method conforms to Harvard standard, well done.

QM **Correctly cited**

Citation method conforms to Harvard standard, well done.

PAGE 20

QM **Correctly cited**

Citation method conforms to Harvard standard, well done.

QM **Correctly cited**

Citation method conforms to Harvard standard, well done.

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QM **Correctly cited**

Citation method conforms to Harvard standard, well done.

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Citation method conforms to Harvard standard, well done.

PAGE 26

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Citation method conforms to Harvard standard, well done.

Text Comment. this belonged in the design section

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Correctly cited

Citation method conforms to Harvard standard, well done.

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PAGE 30

PAGE 31

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PAGE 33

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PAGE 36

PAGE 37

PAGE 38

PAGE 39

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PAGE 43

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Text Comment. where is the servo drive?

PAGE 45

Text Comment. Why is there no evidence in the report for the construction of the servo panel and comissioning of the servo drive?

PAGE 46

PAGE 47

PAGE 48

PAGE 49

PAGE 50

PAGE 51

PAGE 52

PAGE 53

PAGE 54

PAGE 55

PAGE 56

PAGE 57

PAGE 58

PAGE 59

PAGE 60

PAGE 61

PAGE 62

PAGE 63

PAGE 64

PAGE 65

PAGE 66

PAGE 67

PAGE 68

PAGE 69

PAGE 70

PAGE 71

PAGE 72

PAGE 73

PAGE 74

PAGE 75

PAGE 76

PAGE 77

PAGE 78

PAGE 79

PAGE 80

PAGE 81

PAGE 82

PAGE 83

PAGE 84

PAGE 85

PAGE 86

PAGE 87

PAGE 88

PAGE 89

PAGE 90

PAGE 91

PAGE 92

PAGE 93

PAGE 94

PAGE 95

PAGE 96

PAGE 97

PAGE 98

PAGE 99

PAGE 100

PAGE 101

PAGE 102

PAGE 103

PAGE 104

PAGE 105

PAGE 106

PAGE 107

PAGE 108

PAGE 109

PAGE 110

PAGE 111

PAGE 112

PAGE 113

Text Comment. Where are the pictures of the servo drive?

GRADING FORM: NEW CSG-RUBRIC

AERON SMITHAM

63

1. ENGAGEMENT WITH LITERATURE

Section 3: Judicial use and critical evaluation of technical literature in the design of the project. There is clear evidence of reading and evaluation of sources. (3/5)
Section 8: Extent of reading, range of credible sources and use of Harvard method.
A wide range of sources have been considered. However, the method of citing is not always correct for quotations (4/5)

7/10

7

2. KNOWLEDGE AND UNDERSTANDING

Sections 3 and 4: Advanced knowledge and critical understanding demonstrated in the design and implementation of the project.
There is excellent evidence of knowledge and understanding throughout the report. Very good evidence for electric drawings and PLC programs. However, not all design has been explained, namely how the safety circuit meets the PLr rating specified. No photos of the servo provided in the main report. (6/10)

6

3. COGNITIVE AND INTELLECTUAL

Section 5: Testing and analysis of results.
Some evidence of testing and good analysis of results. However, photographic evidence of the servo system working has not been provided (5/10)
Section 5: Critical evaluation of the project outcomes.
Good evaluation and comparison between the FDS and actual outcomes. (6/10)
Section 6: Conclusions and recommendations.
A good set of conclusions and recommendations (6/10)

17/30

17

4. PRACTICAL APPLICATION

Section 4: Deployment method, use of material, tools, equipment and techniques in the construction of the project.
There is good evidence for the programming and simulation parts of the project and some for the panel but more was expected in the main report. (6/10)
Section 4: Quality of the final product or system.
The simulated parts of the project appear to be of good quality. However, it is difficult to assess the practical parts are little evidence is provided in the main report. (5/10)
Sections 5, 6 and appendix: Management of the design process including use of plans, costing spreadsheet and log book.

18

There is clear evidence of understanding of project management processes in the report. (7/10)

18/30

5. TRANSFERABLE SKILLS

Section 1: Acknowledgements, executive summary and introduction.
An excellent summary given of all aspects of the project and clear acknowledgments given to those involved. Introduction is very good but should introduce the report not the project. Hence there is much repetition in the report. (3/5)
All Sections: Presentation quality of the report, diagrams, charts, tables, figure numbering, page and section numbering etc..
Generally very good (4/5)
All Sections: Quality of the writing style, use of punctuation and grammar.
Generally very good but there is much repetition of information (3/5)
Word count limit NOT exceeded (5/5)

15/20

15