Lab 9: Temperature ON-OFF control

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Humber Polytechnics

Programmable Logic Controllers: MENG 3500 0NB

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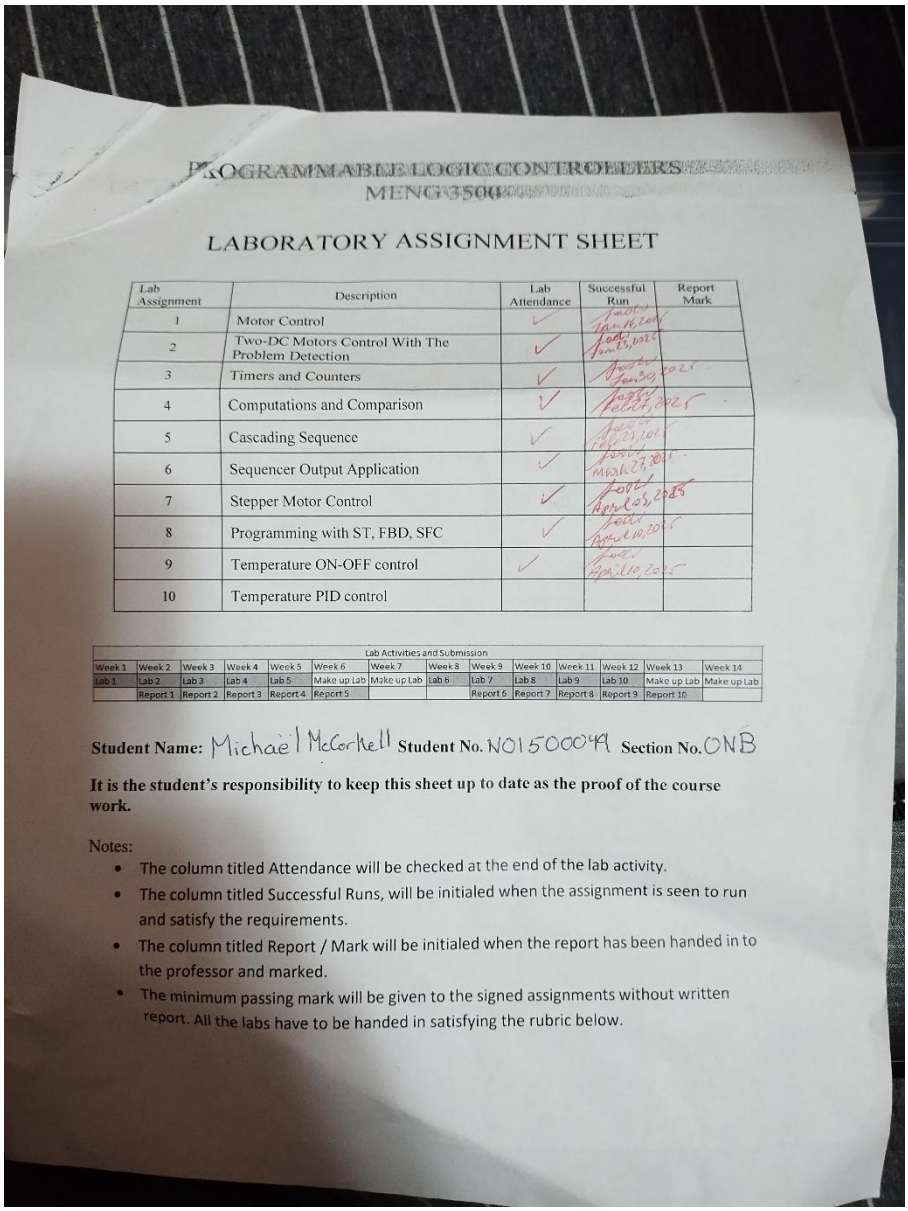

PROGRAMMABLE LOGIC CONTROLLERS
MENG 3500

LABORATORY ASSIGNMENT SHEET

Lab Assignment	Description	Lab Attendance	Successful Run	Report Mark
1	Motor Control	✓		
2	Two-DC Motors Control With The Problem Detection	✓		
3	Timers and Counters	✓		
4	Computations and Comparison	✓		
5	Cascading Sequence	✓		
6	Sequencer Output Application	✓		
7	Stepper Motor Control	✓		
8	Programming with ST, FBD, SFC	✓		
9	Temperature ON-OFF control	✓		
10	Temperature PID control			

Lab Activities and Submission

Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11	Week 12	Week 13	Week 14
Lab 1	Lab 2	Lab 3	Lab 4	Lab 5	Make up Lab	Make up Lab	Lab 6	Lab 7	Lab 8	Lab 9	Lab 10	Make up Lab	Make up Lab
	Report 1	Report 2	Report 3	Report 4	Report 5			Report 6	Report 7	Report 8	Report 9	Report 10	

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It is the student's responsibility to keep this sheet up to date as the proof of the course work.

Notes:

- The column titled Attendance will be checked at the end of the lab activity.
- The column titled Successful Runs, will be initialed when the assignment is seen to run and satisfy the requirements.
- The column titled Report / Mark will be initialed when the report has been handed in to the professor and marked.
- The minimum passing mark will be given to the signed assignments without written report. All the labs have to be handed in satisfying the rubric below.

Assignment Summary: PLC LAB 9 – Temperature ON-OFF Control
Objectives
This lab focused on the implementation of **temperature control logic** using **analog signal processing**, **ON-OFF control methods**, and **Human-Machine Interface (HMI) integration**. The primary objectives were:

1. Configuring **analog input modules** to process temperature signals.
2. Designing **ON-OFF temperature control logic** using both **single** and **dual set points**.
3. Applying **mathematical instructions** to scale and interpret analog input values.
4. Creating a user-friendly **HMI using FactoryTalk Studio ME** to monitor and control temperature parameters.
5. Implementing **trend analysis** for real-time and historical temperature behavior.
6. Verifying hardware connectivity and control accuracy through **field device wiring** and **live program testing**.

Description of Work Completed

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1. Analog Signal Processing & Scaling

- The RTD (Resistance Temperature Detector) sensor signal, read via the **analog input module** (Local:3:I.CH0Data), was configured to scale from **1–5 V to 0–100°C**.
- The scaled temperature was stored in a PLC tag named **TEMPERATURE**, representing the **Process Variable (PV)**.

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2. ON-OFF Temperature Control Logic
Single Set Point Mode:

- Heater turns **ON** when **temperature < 30°C**.
- Heater turns **OFF** when **temperature ≥ 31°C**.

Two Set Points (Deadband) Mode:

- Heater turns **ON** below **SP_LOW (e.g., 35°C)**.
- Heater turns **OFF** above **SP_HIGH (e.g., 36°C)**.
- This prevents excessive relay toggling and ensures smoother system control.

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3. Pushbutton Controls & RUN Logic

- **START_PB (green):** Initiates temperature control operation (RUN = TRUE).
- **STOP_PB (red):** Immediately halts the control process (RUN = FALSE).
- **RUN** tag was used to conditionally enable or disable the heater and indicator logic.

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4. HMI Design – FactoryTalk Studio ME
Display 1: Main Monitoring Panel

- **Start/Stop Pushbuttons**
- **Multi-state Indicator:** Shows whether the program is running.
- **Numeric Inputs:** For **SP_LOW** and **SP_HIGH**.
- **Analog Indicator:** Displays **real-time TEMPERATURE**.
- **Navigation Buttons:** Link to Display 2, Configuration, and Shutdown.

Display 2: Advanced Monitoring

- **Real-Time Trend Graph** displaying:
  - **SP_LOW**
  - **SP_HIGH**
  - **TEMPERATURE**
- **Navigation Buttons** as above.

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5. Overshoot & Undershoot Evaluation

- From the **PanelView screen**, temperature was monitored in real-time to evaluate:
  - **Overshoot:** Peak temperature above SP_HIGH.
  - **Undershoot:** Lowest dip below SP_LOW.
- When SPs were adjusted to **40°C and 42°C**, overshoot and undershoot were re-evaluated to assess the system's control accuracy and responsiveness.

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6. Indicators & Output Devices

- **GREEN_LIGHT:** Indicates the system is actively controlling temperature (RUN = TRUE).
- **RED_LIGHT:** Turns on when the heater is OFF and RUN is inactive or temperature is above SP_HIGH.
- **HEATER (Local:2:O.Data.3):** Activated based on the ON-OFF logic derived from temperature comparison.

Conclusions

The lab successfully demonstrated how to integrate **analog processing, temperature control logic, and HMI visualization** in a real-world automation system. The use of **dual set point ON-OFF control** improved system stability by reducing relay chatter. The **FactoryTalk HMI** enabled effective real-time monitoring and control, while the trend tools provided valuable data for evaluating **system dynamics**, such as **overshoot and undershoot**. Overall, the lab reinforced important skills in **process automation, analog I/O scaling, PID alternatives, and user interface design**.

0

This rung initiates or enables the "MM_Run" status, serving as the starting point for the main control sequence. Checks the state of input conditions (e.g., start command via and) and ensures no stop command (MM_StopPB) is pressed to activate MM_Run.

MM_StopPB
<Local:1:I.Data.1>

MM_StartPB
<Local:1:I.Data.0>

MM_Run

MM_Run

1

Monitors the "MM_Run" status and compares MM_Temperature with MM_LowerTemp (30.0) using LES. If MM_Temperature is less than 30.0, moves 0.0 to MM_Tempature to reset or stabilize the temperature value.

MOV
Source Local:3:I.Ch0Data
33.369263
Dest MM_Tempature
33.369263

2

Monitors the "MM_Run" status and compares MM_Temperature with MM_LowerTemp (30.0) using LES. If MM_Temperature is less than 30.0, moves 0.0 to MM_Tempature to reset or stabilize the temperature value.

MM_Run

LES
Source A MM_Tempature
33.369263
Source B MM_LowerTemp
31.0

Out of Order
MM_Heater
<Local:2:O.Data.2>
L

Out of Order
MM_GreenLight
<Local:2:O.Data.0>

3

Maintains the "MM_Run" operation and compares MM_Temperature with MM_UpTemp (30.0) using GRT. If MM_Temperature exceeds 30.0, activates MM_Heater and MM_GreenLight (via and) to indicate heating or normal operation.

MM_Run

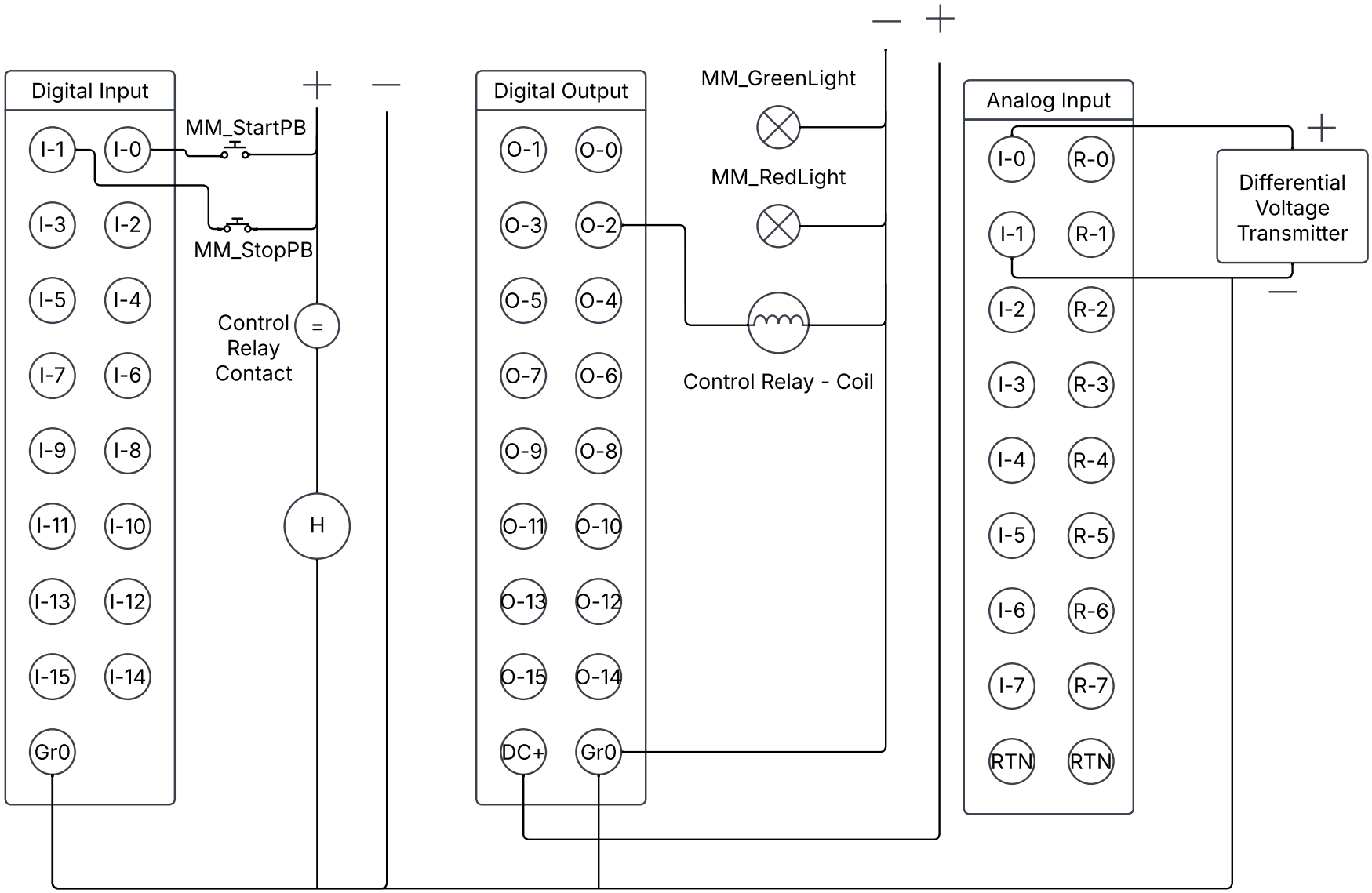
GRT
Source A MM_Tempature
33.369263
Source B MM_UpTemp
32.0

MM_Run

Out of Order
MM_Heater
<Local:2:O.Data.2>
U

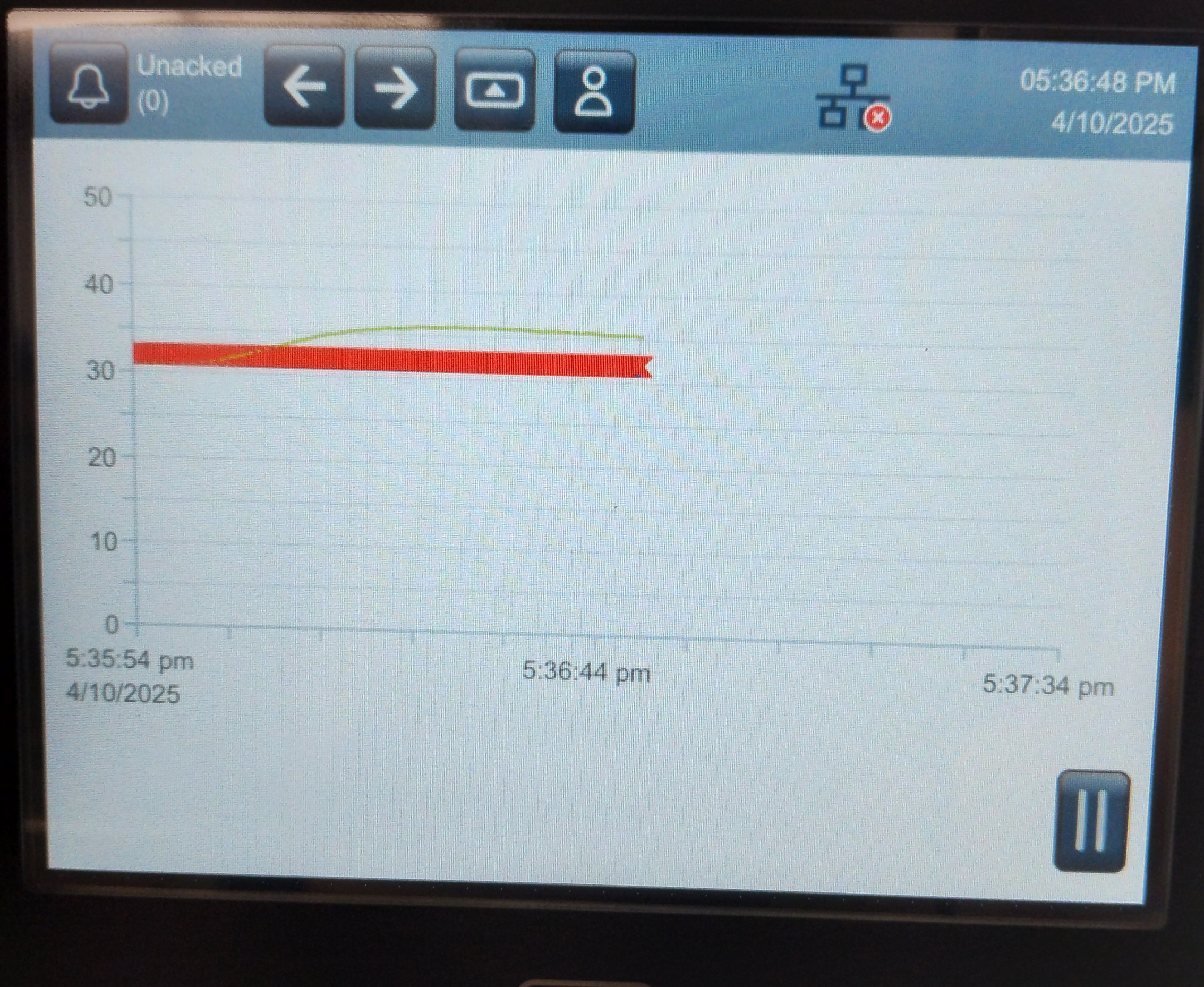
MM_RedLight
<Local:2:O.Data.1>

(End)


Digital Input
I-1
I-0
I-3
I-2
I-5
I-4
I-7
I-6
I-9
I-8
I-11
I-10
I-13
I-12
I-15
I-14
Gr0
MM_StartPB
MM_StopPB
Control
Relay
Contact
=
H
+
—
Digital Output
O-1
O-0
O-3
O-2
O-5
O-4
O-7
O-6
O-9
O-8
O-11
O-10
O-13
O-12
O-15
O-14
DC+
Gr0
MM_GreenLight
MM_RedLight
Control Relay - Coil
Analog Input
I-0
R-0
I-1
R-1
I-2
R-2
I-3
R-3
I-4
R-4
I-5
R-5
I-6
R-6
I-7
R-7
RTN
RTN
Differential
Voltage
Transmitter
+
—

PLC IP:10.116.254.216

-Bradley



PanelView 5510

HMI IP:10.116.254.217