

INTRODUCTION

In modern industrial applications, maintaining precise temperature control is critical to ensure the efficiency and safety of processes. The integration of Programmable Logic Controllers (PLCs) with Proportional-Integral-Derivative (PID) control is widely used for this purpose. This report documents the implementation of a thermal system control using the PID block of a PLC. The task involves using two analog input channels and one analog output channel to control the thermal plant. A temperature sensor provides feedback, ensuring the system maintains a specific setpoint temperature, which can vary in real-time.

OBJECTIVES:

The primary objective of this task is to:

- Develop a PID control logic using a PLC to maintain the temperature of a thermal system at a desired setpoint.
- Demonstrate real-time processing and system behavior.

SYSTEM DESCRIPTION:

Components Used

- **PLC:** The control unit hosting the PID block logic.
- **Analog Input Channels:**
 - **Channel 1:** Accepts the setpoint temperature value.
 - **Channel 2:** Reads the process variable (actual temperature) from the temperature sensor.
- **Analog Output Channel:** Sends the manipulated output to the heating element or actuator.
- **Temperature Sensor:** Provides feedback on the current system temperature.
- **Thermal Plant:** The system or device being heated or cooled to maintain the desired temperature.

PID Control Overview

The PID controller compares the setpoint (desired temperature) with the process variable (measured temperature) to compute an error value. The controller then adjusts the manipulated variable (e.g., heater power) based on the proportional, integral, and derivative components to minimize this error.

PID Control Block

We use the SFB/FB "CONT-C" (continuous controller) programmable logic controller to control technical processes with continuous input and output variables. During parameter assignment, we can activate or deactivate sub-functions of the PID controller to adapt the controller to the process. The SFB/FB implements a complete PID controller with continuous manipulated variable output and the option of influencing the manipulated value manually.

IMPLEMENTATION:

Logic Development

The logic is developed using the PID block available in the PLC programming environment. The steps include:

➤ **Input Configuration:**

Configure analog input channels to read the setpoint and process variable values.

Ensure proper scaling of analog signals to match the temperature range.

➤ **PID Block Setup:**

Link the setpoint and process variable inputs to the PID block.

Tune PID parameters (K_p , K_i , K_d) for optimal control.

➤ **Output Configuration:**

Map the manipulated output from the PID block to the analog output channel.

➤ **Safety and Alarms:**

Include conditions for system safety, such as maximum temperature limits and fault detection.

Real-Time Process

To control a thermal system through the PID block of a PLC, the following steps are followed:

- **Set the Setpoint:** The desired temperature setpoint for the thermal system is defined.
- **Measure the Process Variable:** The process variable, i.e., the actual temperature of the system, is measured using a temperature sensor. This sensor provides an analog signal that is read by one of the analog input channels of the PID block. These values are adjusted using the simulation block.
- **Calculate the Error:** The error is calculated as the difference between the setpoint and the process variable. This error value is input to the PID block.
- **Calculate the Control Output:** The PID block uses the error value to compute the appropriate control output based on proportional, integral, and derivative parameters. The control output is sent to the analog output channel (e.g., PQW752).
- **Apply the Control Output:** The control output manipulates the thermal system, such as turning on or off a heater or adjusting a valve, to maintain the temperature at the setpoint.
- **Monitor the Process:** The process variable is continually measured, and the error is recalculated to ensure that the thermal system remains at the setpoint temperature. PID control parameter assignment is used for monitoring.

RESULTS AND ANALYSIS:

Observations

- The system maintained the temperature at the setpoint with minimal overshoot and steady-state error.
- The PID tuning effectively reduced oscillations, providing a stable response.
- Real-time adjustments to the setpoint were successfully handled without system instability.

Performance Metrics

- **Rise Time:** Time taken to reach the setpoint.
- **Settling Time:** Time to stabilize within a specified range of the setpoint.
- **Steady-State Error:** Difference between setpoint and actual temperature in steady state.

Adjustments

- Fine-tuning of K_p , K_i , and K_d values was necessary to achieve optimal performance.
- Signal noise was minimized by adding filtering to the analog input channels.

CONCLUSION:

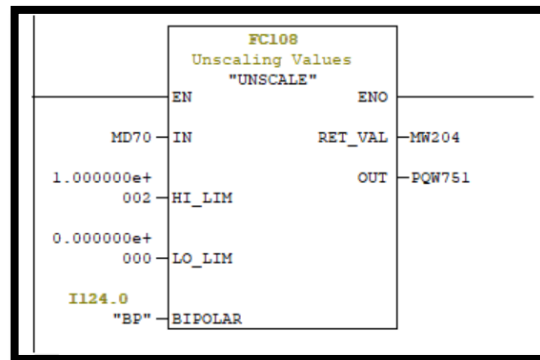
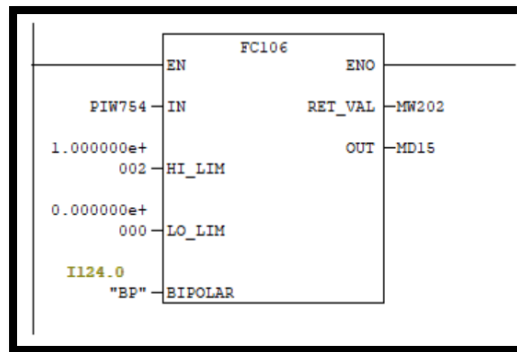
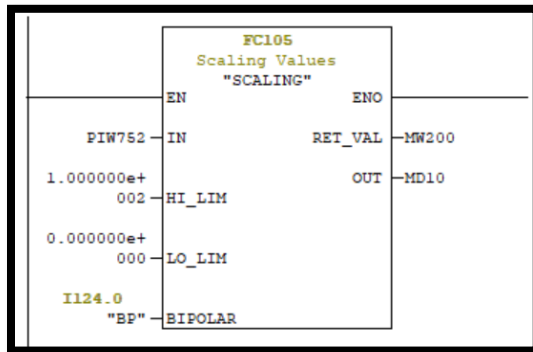
The thermal system control using the PLC PID block was successfully implemented. The system demonstrated effective real-time temperature control, achieving the desired setpoints with stability and minimal error. The task highlighted the importance of precise PID tuning and the robustness of PLC-based solutions for industrial applications.

The result of implementing a PID control algorithm in a PLC for a thermal system is a controlled and stable temperature. The PID block continuously monitors the temperature and makes adjustments based on the error value. This results in precise control, reducing fluctuations and errors, leading to better product quality, increased efficiency, and reduced operating costs.

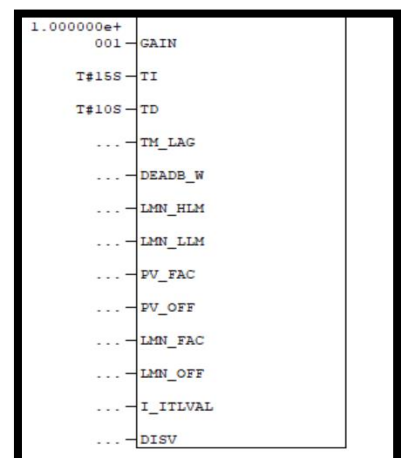
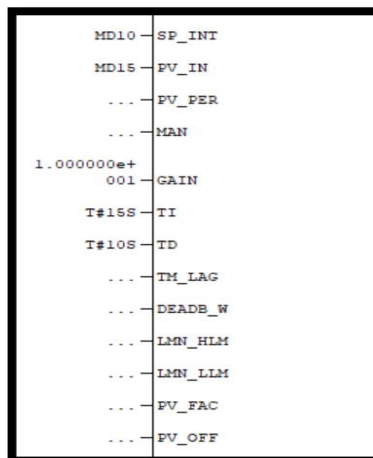
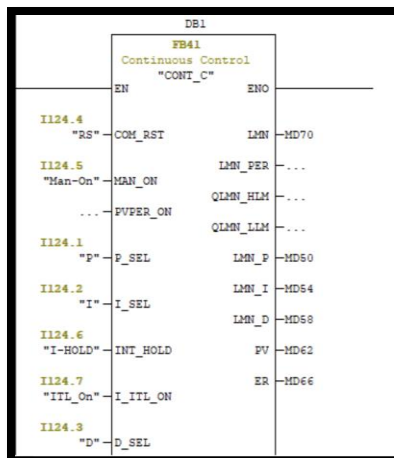
ATTACHMENTS:

- **Figure 1:** PLC Ladder Logic Screenshot.
- **Figure 2:** Real-Time Process Monitoring Graph.
- **Appendix:** Parameter Tuning Values and Additional Notes.

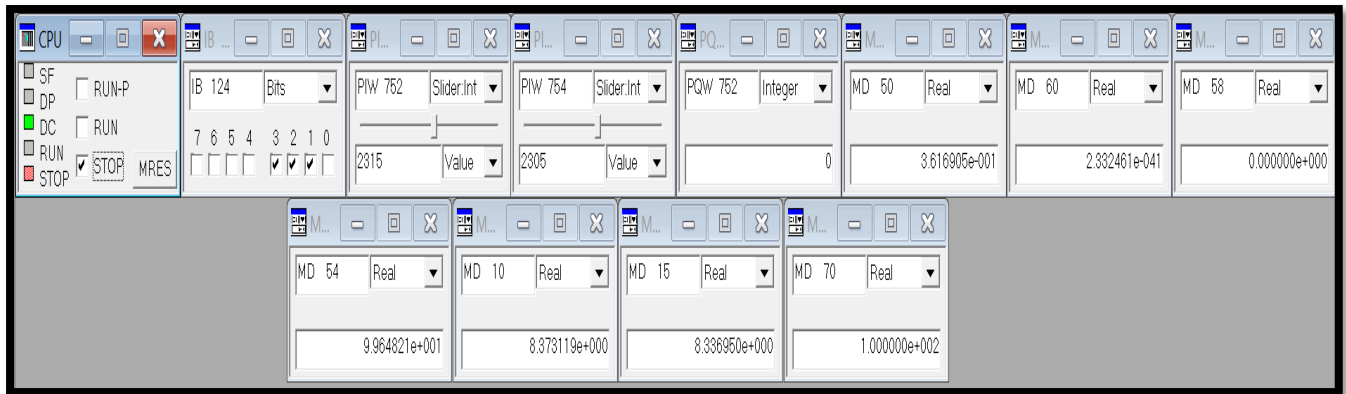
OB1:



OB35:



OUTPUT:



VARIABLE TABLE:

I 124.0	"BP"	BOOL	false
I 124.1	"P"	BOOL	true
I 124.2	"T"	BOOL	true
I 124.3	"D"	BOOL	true
I 124.4	"RS"	BOOL	false
I 124.5	"Man-O"	BOOL	false
I 124.6	"I-HOLD"	BOOL	false
I 124.7	"TL_On"	BOOL	false
PW 752		DEC	2315
PW 754		DEC	2305
PQW 752		DEC	0
MD 10		FLOATING_POINT	8.373119
MD 15		FLOATING_POINT	8.33695
MD 70		FLOATING_POINT	100.0

GRAPH OF PID CONTROLLER:

