Development of a GUI interface for the cooling and thermal stabilization systems of the Time Projection Chamber “TPC” and Electromagnetic Calorimeter “ECAL” detectors of the Multi-Purpose Detector “MPD” in the Master-SCADA 4D framework

Full name

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Agenda

📌 System Architecture

- GUI built with TIA Portal + Master-SCADA
- Enables integrated control and monitoring

 Control Capabilities

- Continuous instrumental & logical control
- Supports diagnostics and case analysis

 Data Management

- Archiving of measured data
- Event messages (warnings & errors)

 Monitored Parameters

- Temperature
- Pressure
- Coolant flow rate
- Coolant level
- Vacuum in water vessels
- Other key indicators

 GUI Development Status

- Presentation of the current design stage
-integration from TIA Portal Scada to Master Scada

Introduction

Cooling System – Time Projection Chamber (TPC)

- A graphical user interface (GUI) was developed for the **control, monitoring, and data logging** of the **cooling and thermal stabilization systems** of the **TPC and ECAL detectors** in the **MPD experiment**.
- The system is built using **Master-SCADA 4D** software and communicates via the **OPC protocol with TIA Portal Tool.**
- All cooling systems are designed as **“leakless”**, ensuring coolant pressure remains **below atmospheric pressure** to prevent water leakage inside the detector.

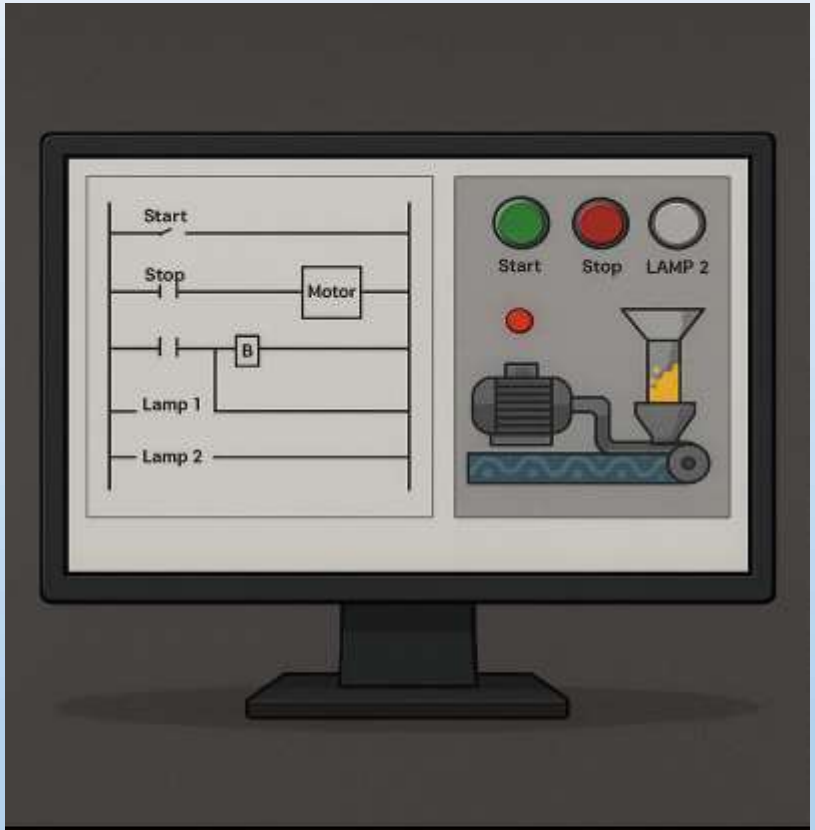
Platform concept for MPD detector cooling system

Cooling System – Time Projection Chamber (TPC)

- The system includes **~110 channels**, with **76 dedicated to thermal stabilization**.

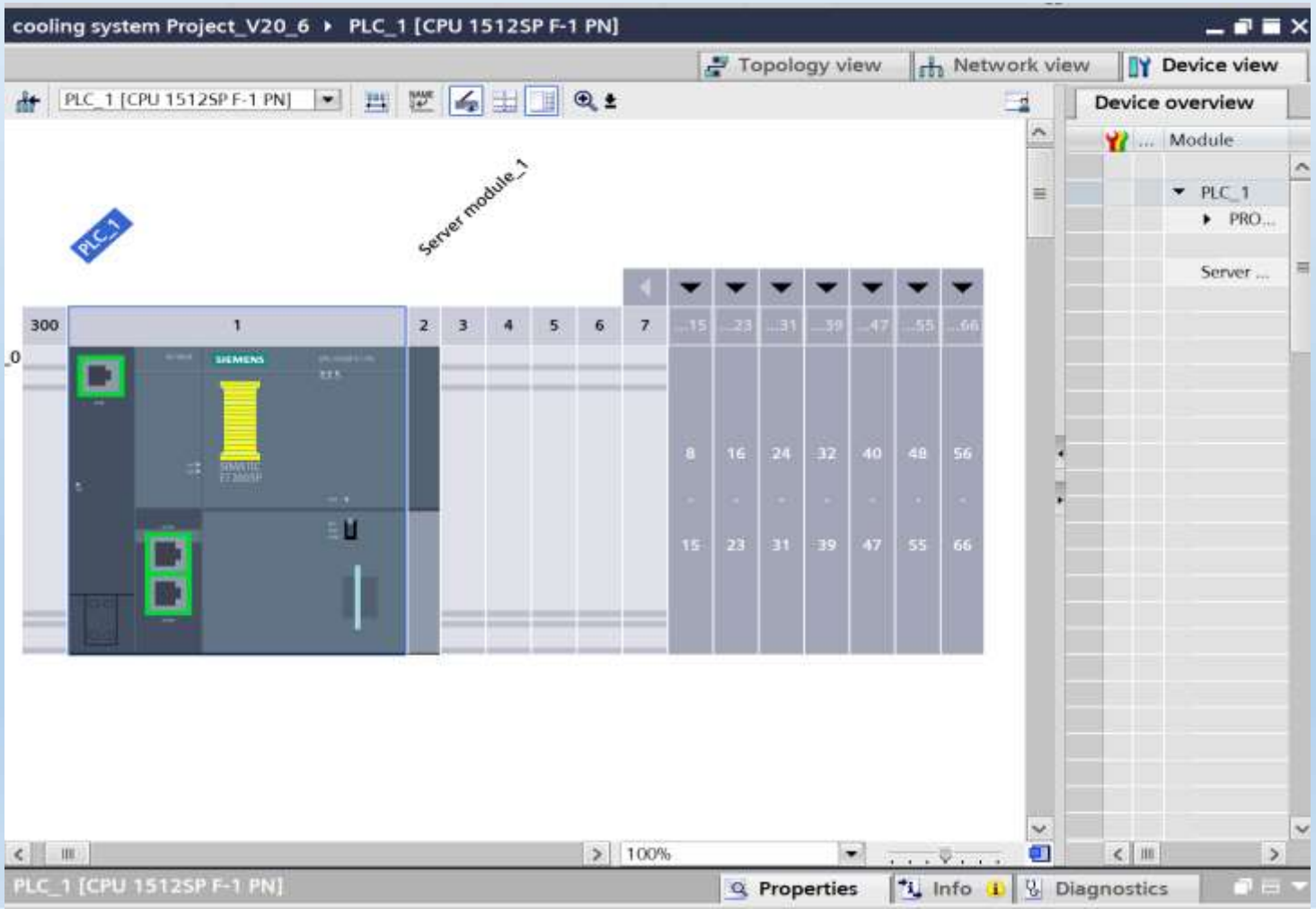
- Each channel comprises:
  - A **water pressure reducer**
  - An **electric heater**
  - **Temperature and pressure sensors**
  - A **flow meter**

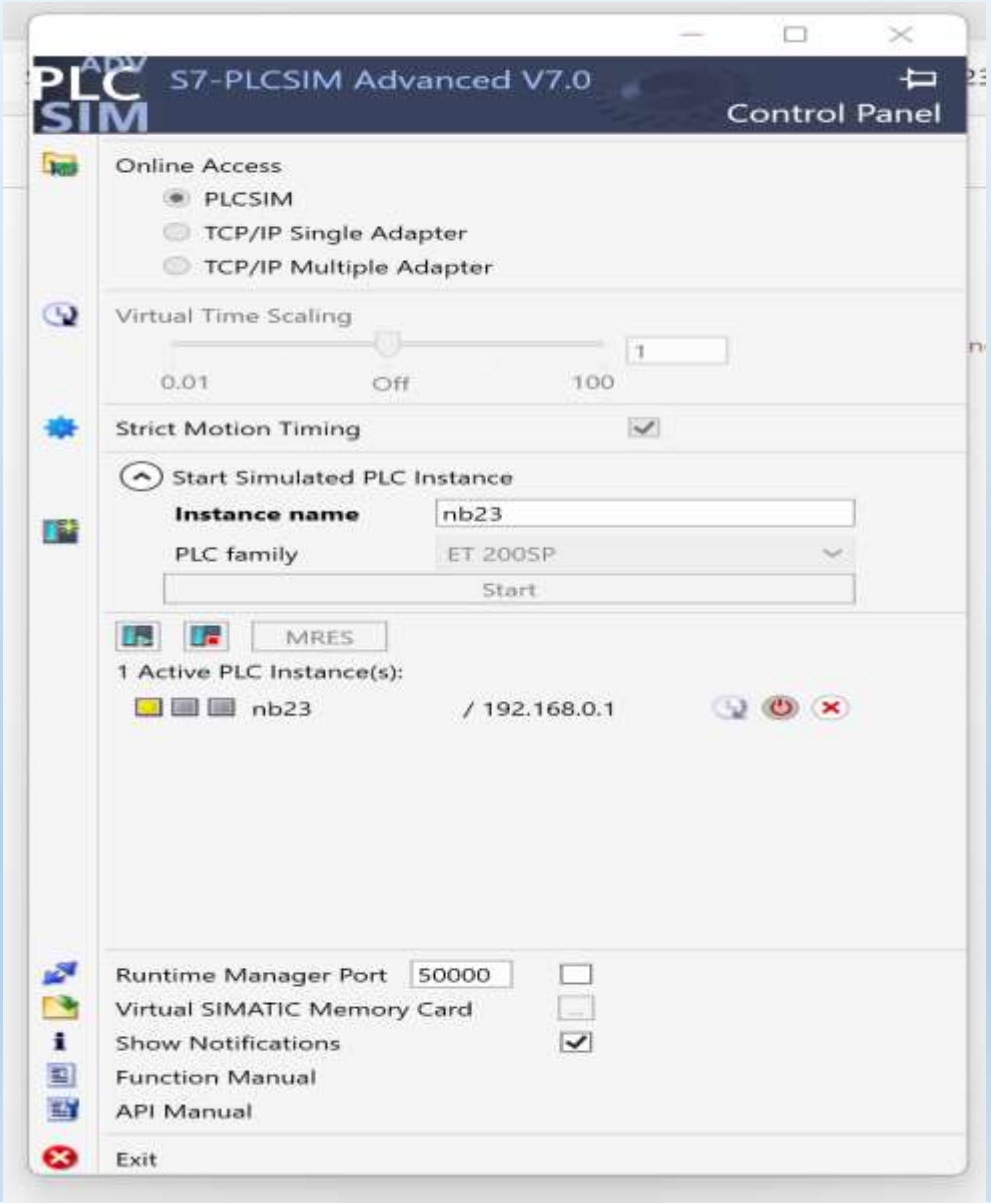
- A network of **250 temperature sensors** on the TPC enables **multi-zone PLC-based temperature control** across all channels.



PLC Simulator & TIA Portal Integration

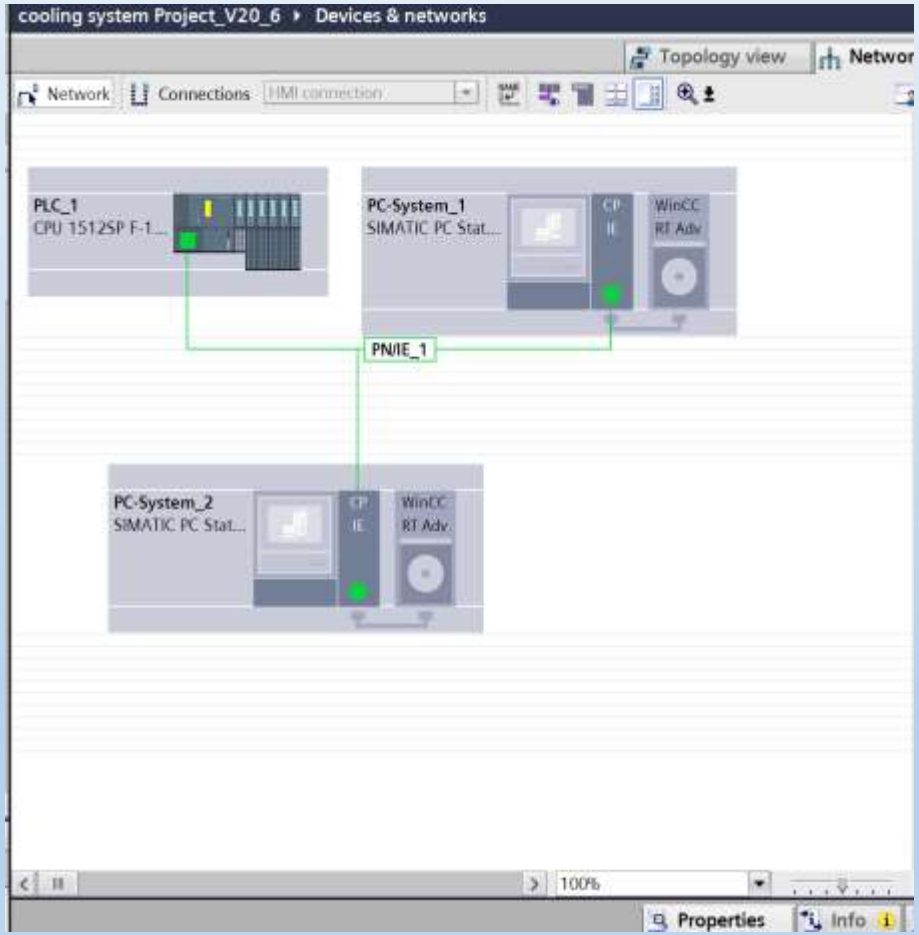
PLC-SIM allows virtual testing of PLC programs in TIA Portal, enabling real-time logic simulation, HMI interaction, and system verification—**without physical hardware**.

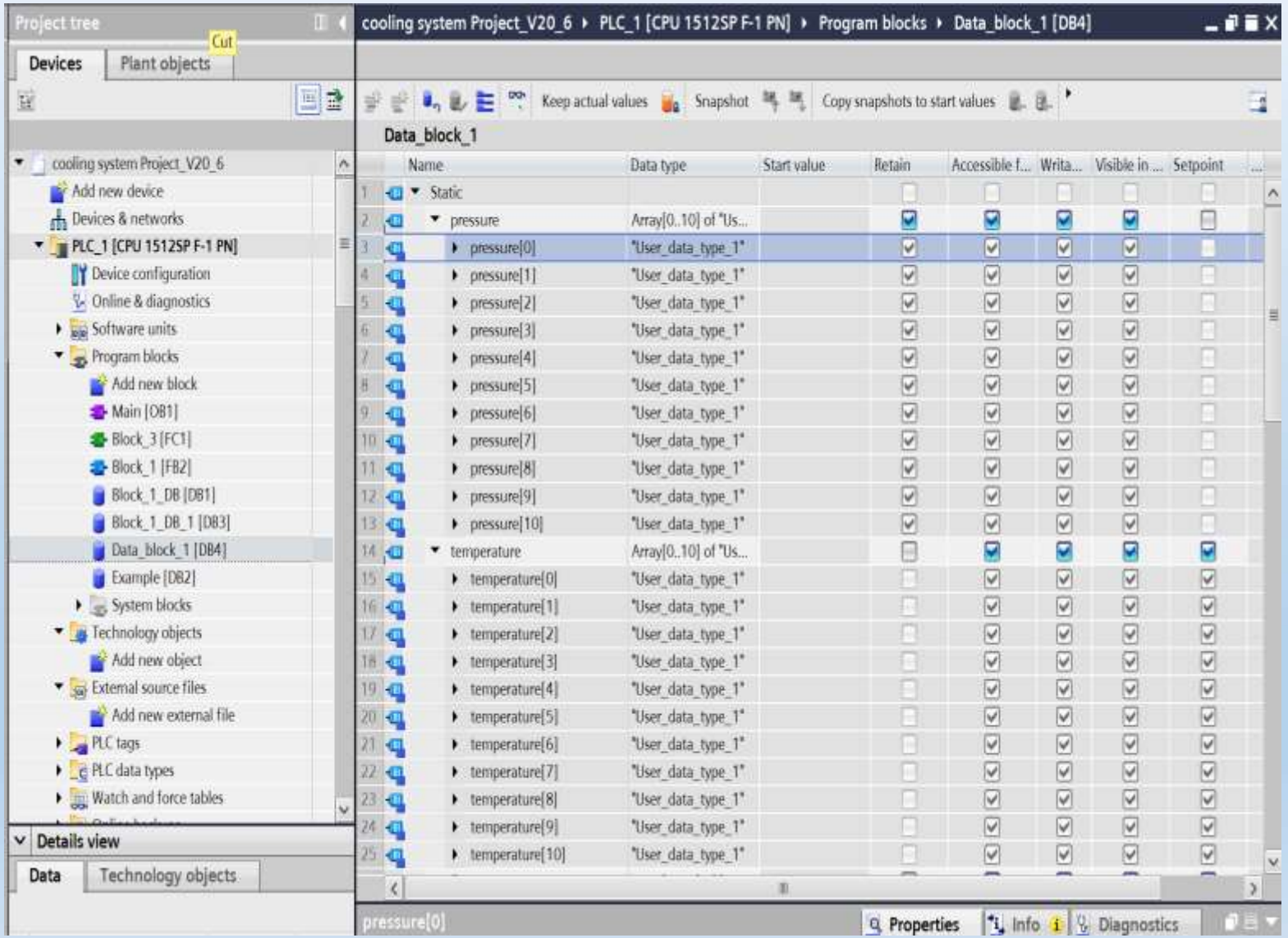




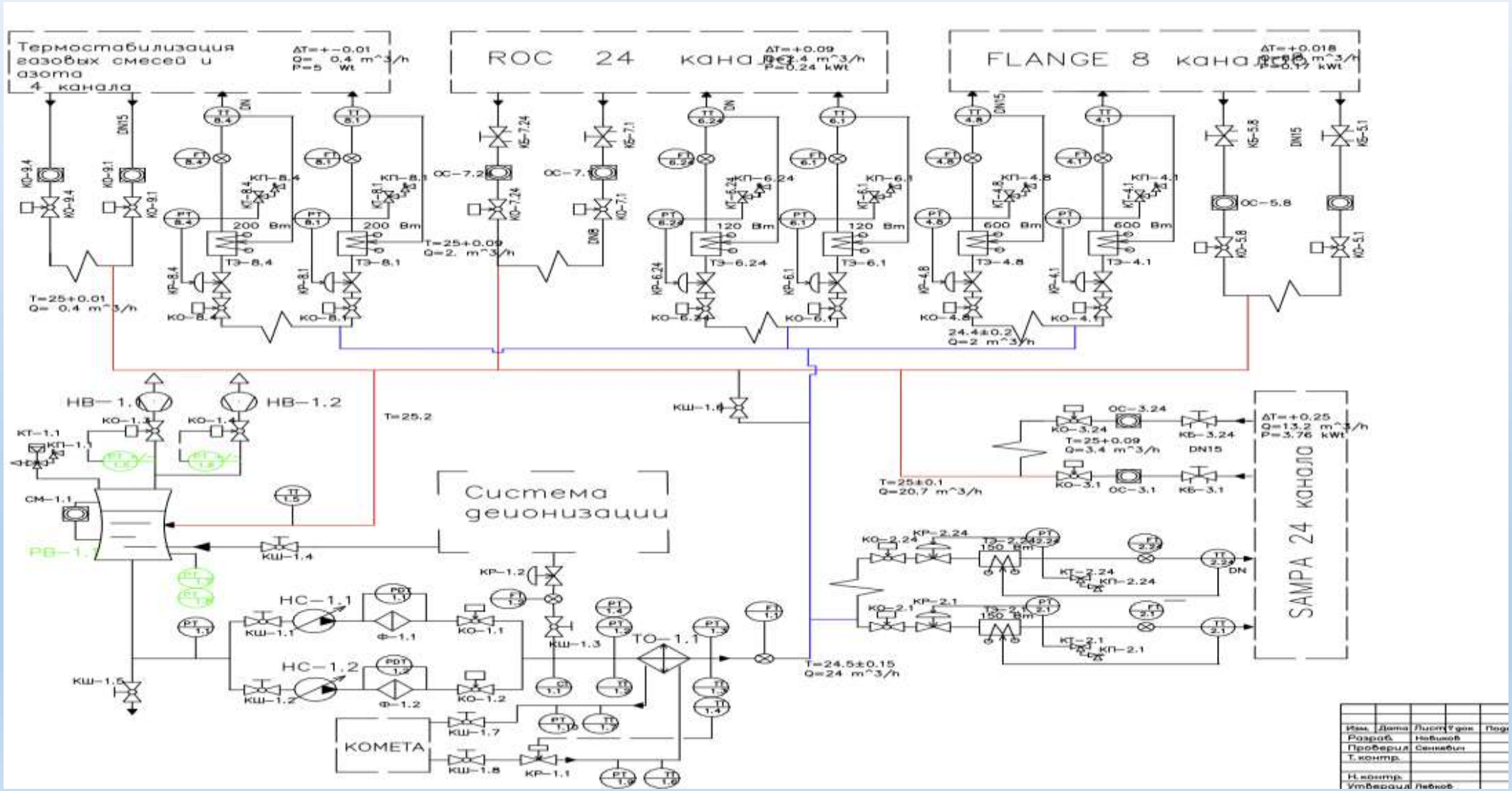
PLC Simulator & TIA Portal Integration

“Device &Networks”

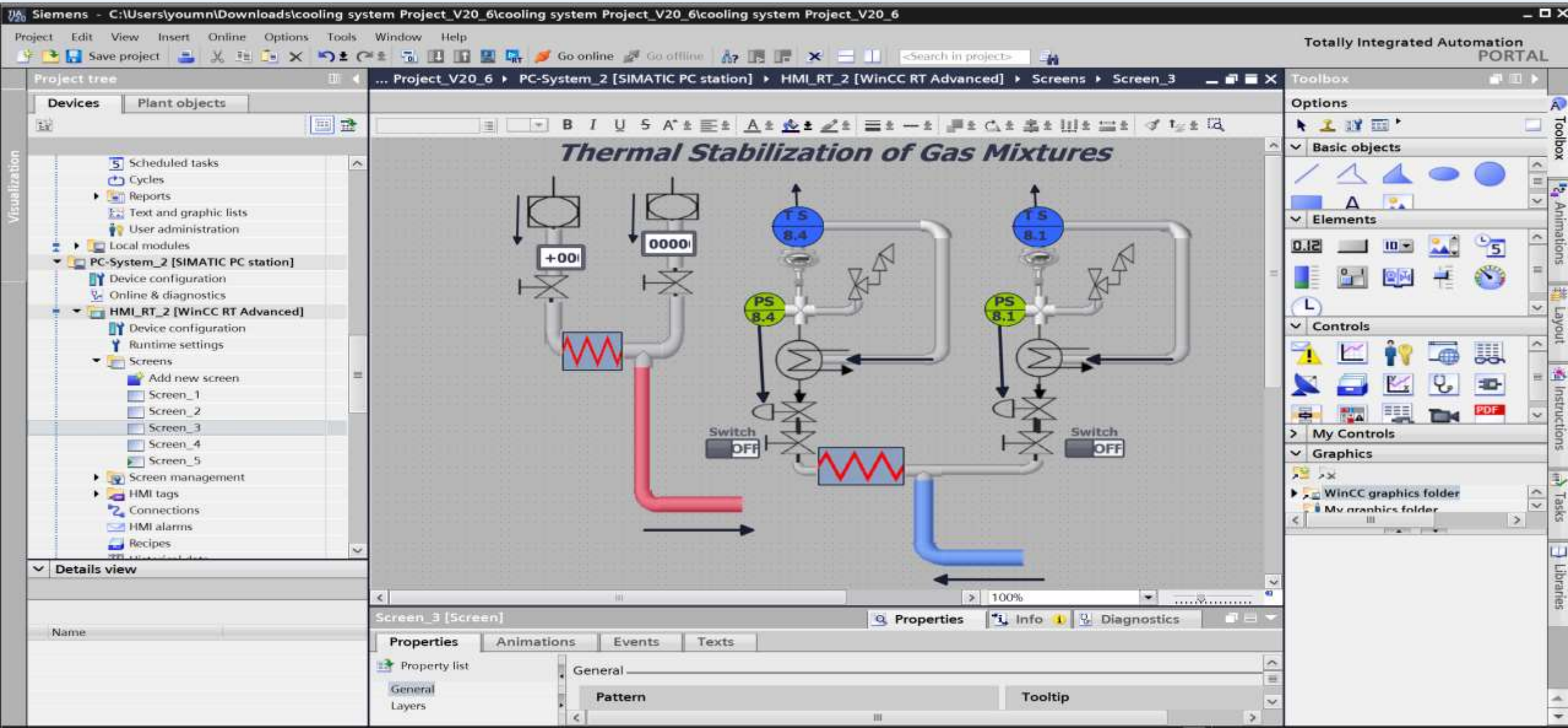




Copper Thermal Stabilization Scheme



GUI Interface screen using TIA Portal



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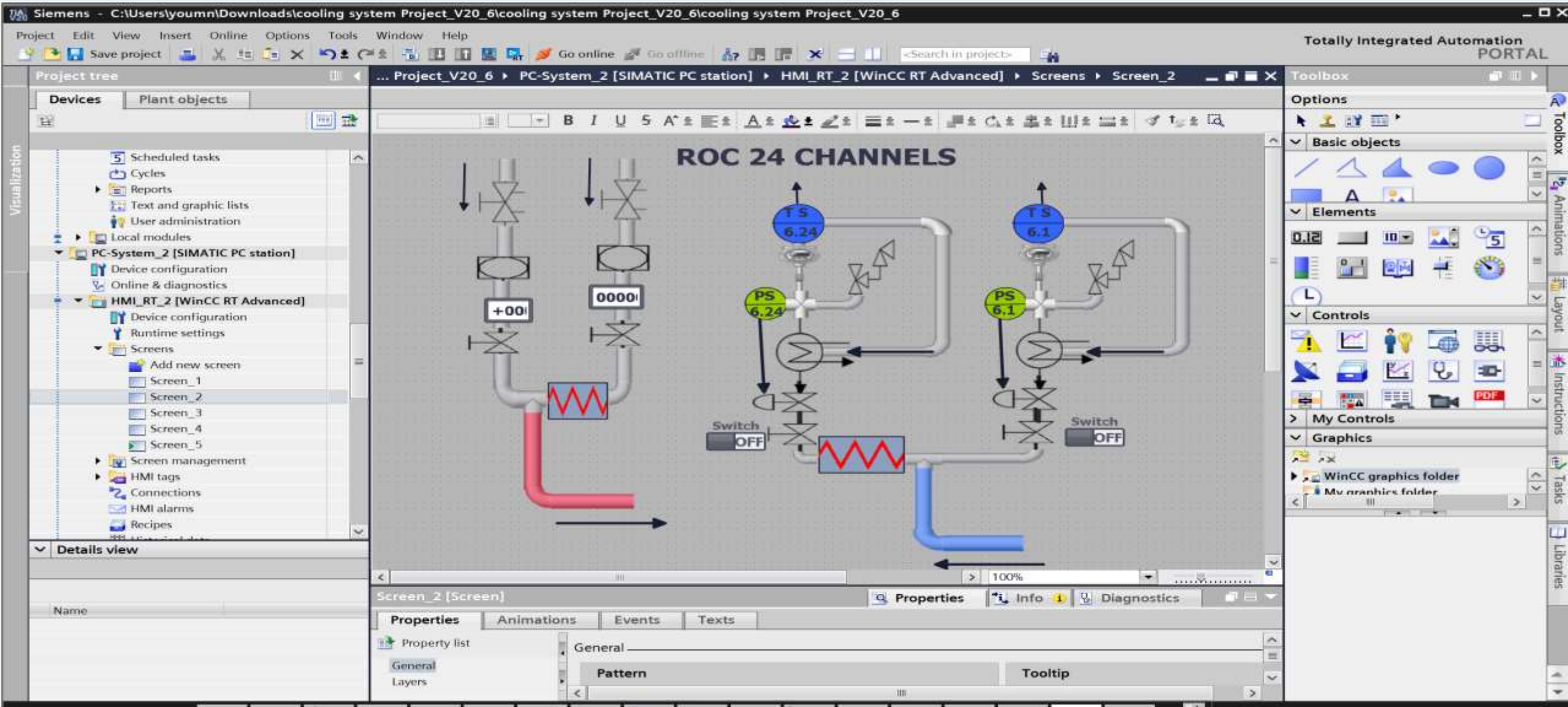
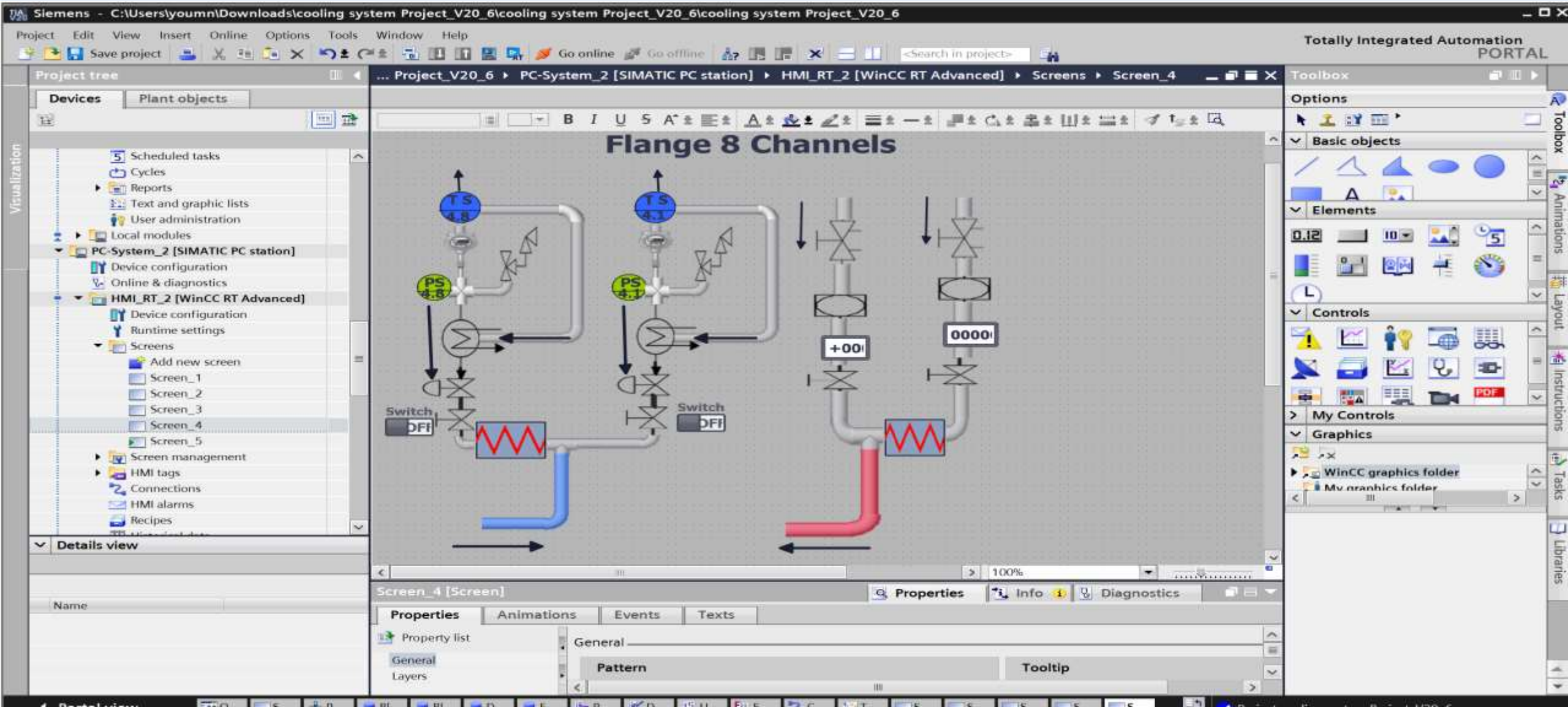


GUI Interface screen using TIA Portal



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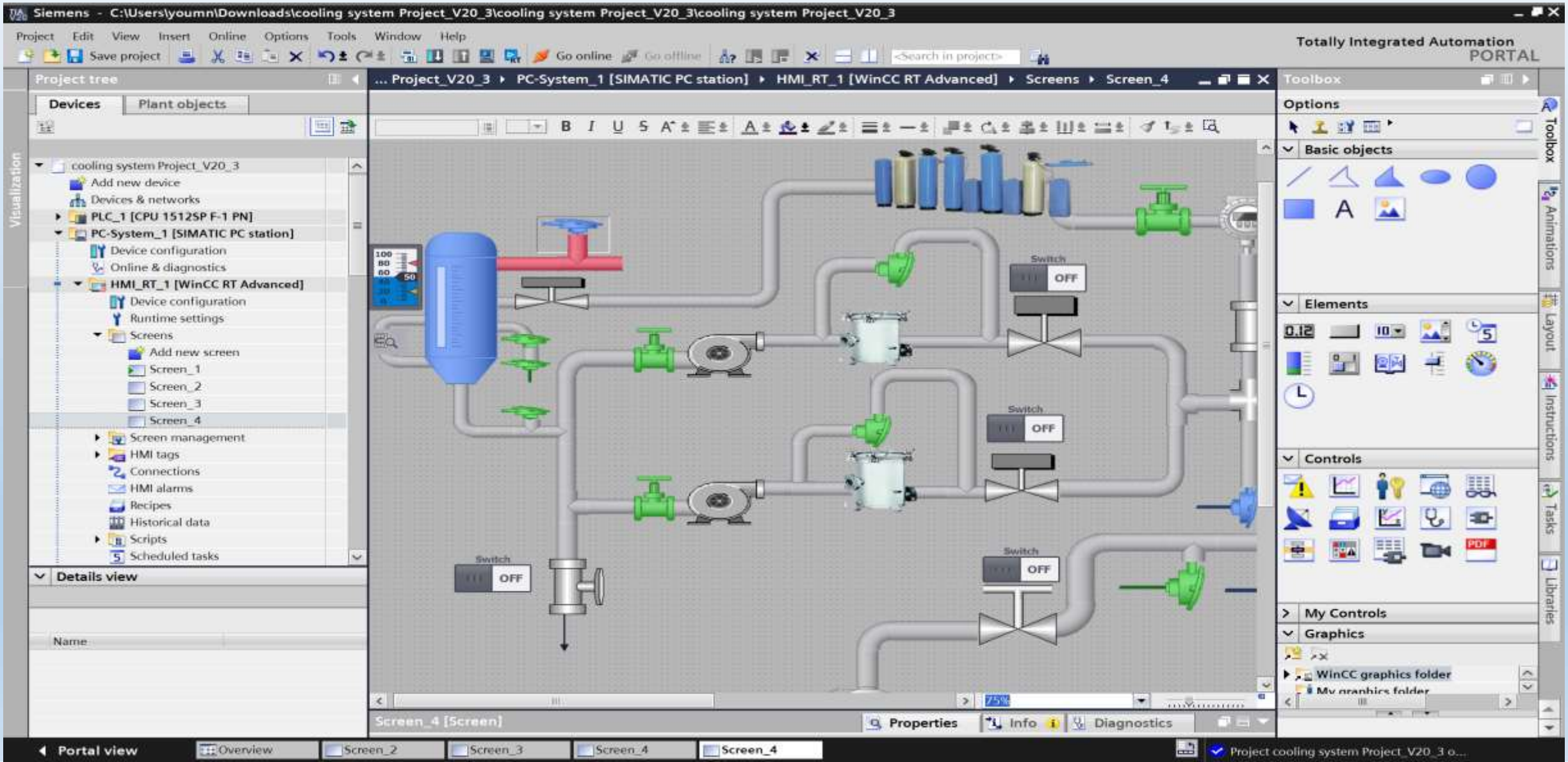
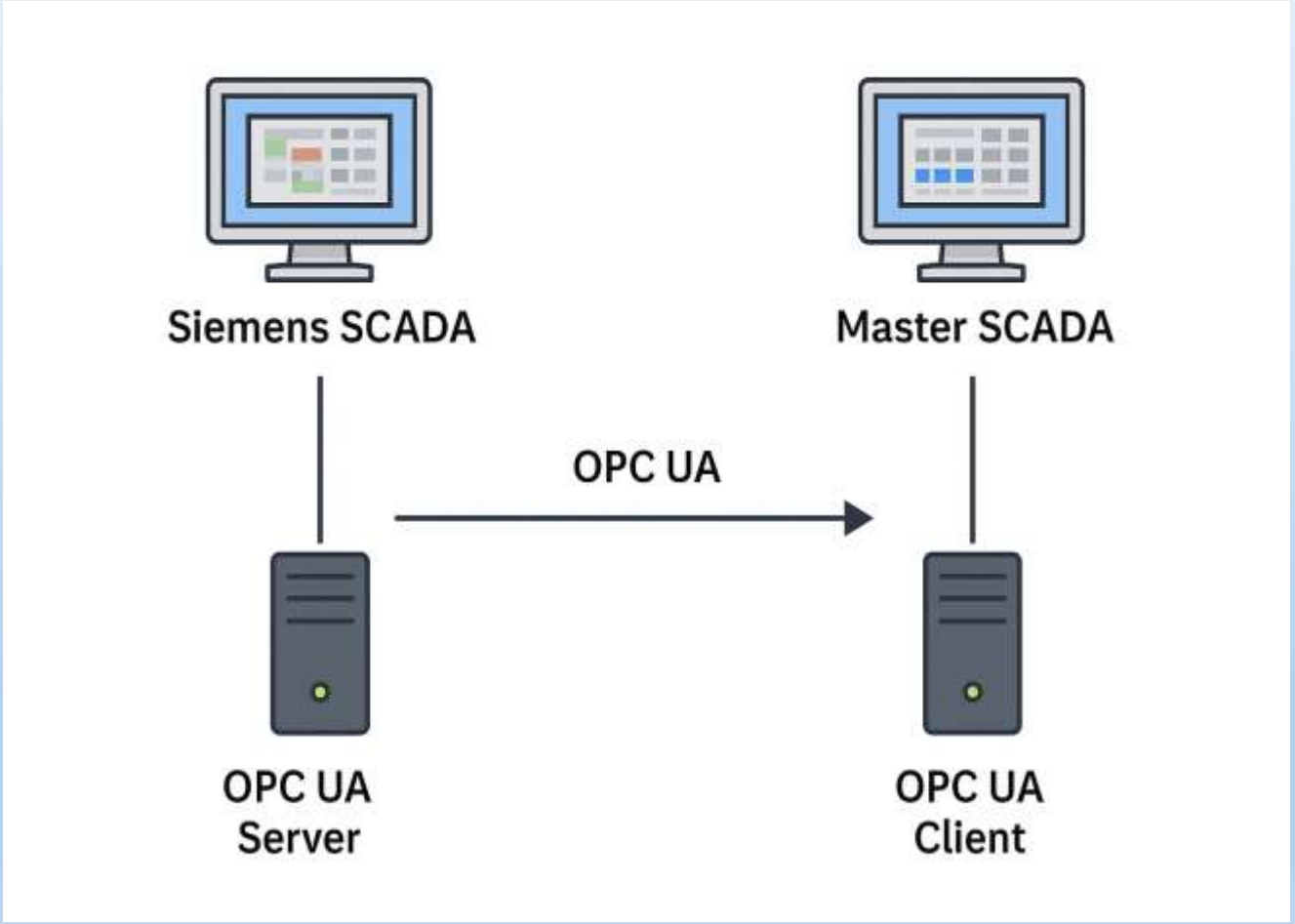


Integration of TIA Portal SCADA into Master SCADA

- Utilize **OPC UA or Modbus TCP** for seamless communication.
- Configure **WinCC (TIA Portal)** as an OPC UA Server.
- Master SCADA connects as an OPC UA Client to read/write data.
- Share and map **key process tags** (e.g., alarms, setpoints, status).
- Implement **security settings**: authentication, access control, encryption.
- Perform real-time **testing and validation** to ensure proper integration.

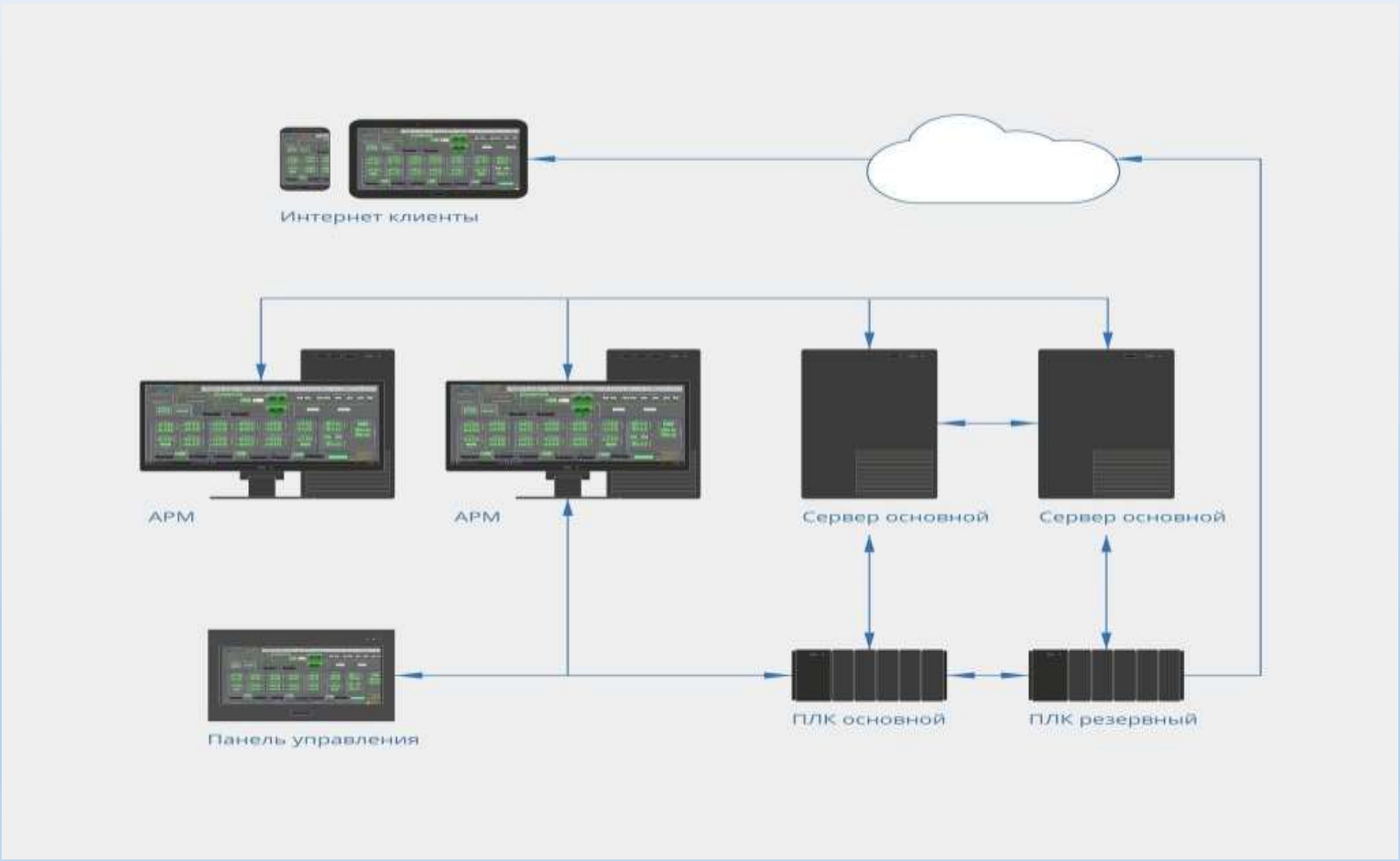


Master SCADA 4D – New Generation of SCADA

•**Next-gen SCADA** system by MPS Software with enhanced support for **IoT and large distributed systems**.

•Enables full integration across all management levels:

- **PLC controllers**
- **Local HMI panels**
- **Operator workstations**
- **Servers**
- **Cloud services**



Integration Strategy Overview

Goal: Connect Siemens SCADA (WinCC/PCS 7) to a Master SCADA system

Key Protocols:

- OPC UA / DA: Standard for SCADA integration
- Modbus TCP: Lightweight and widely used
- MQTT / REST: For IoT or cloud-based systems

Use Siemens SCADA as a Data Server

Use MasterSCADA as the OPC UA Client

- In MasterSCADA, add Siemens as OPC UA data source
- Connect to Siemens OPC UA server (IP, Port 50000)
- Browse and import tags
- Assign tags to screens, trends, alarms, etc.

The two SCADA systems need a way to **communicate in real-time**. Choose a supported protocol:

Protocol	Use Case	Support
OPC UA / OPC DA	Most common & robust for SCADA-to-SCADA	Siemens WinCC, PCS 7 support OPC
Modbus TCP/RTU	Simple, for basic data sharing	Often used in industrial systems
MQTT	For modern IoT-oriented SCADA	May need gateway in Siemens
REST APIs	If master SCADA is cloud or web-based	Siemens usually needs middleware
Database exchange	For historical/logged data	Via SQL, CSV, etc.

GUI-Level Integration Methods

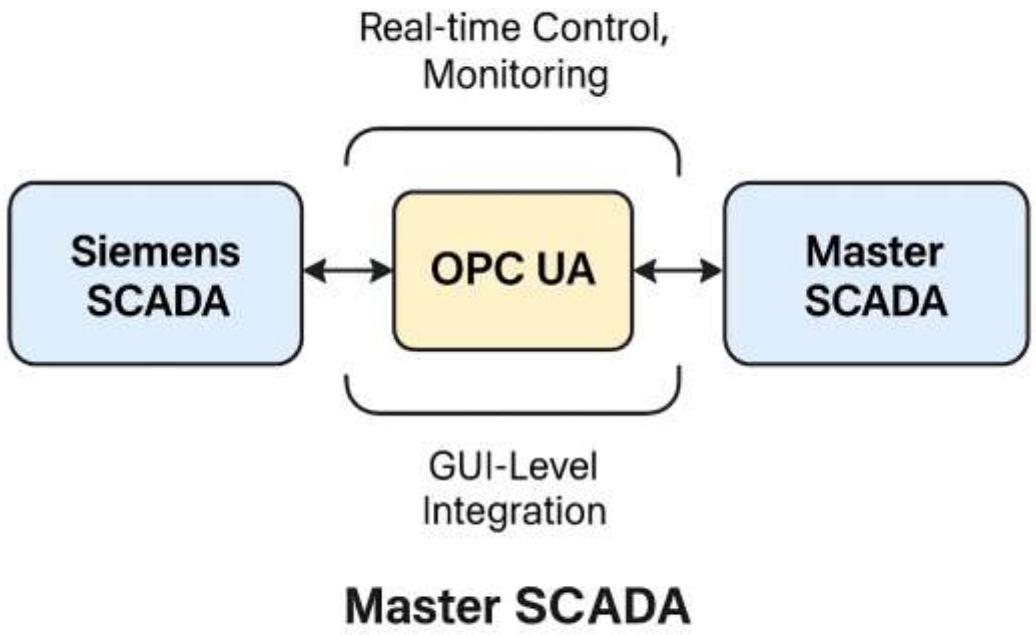
- Remote Desktop / VNC: Directly launch Siemens SCADA interface
- Hyperlink Launcher: Button in MasterSCADA opens Siemens HMI
- Thin Client: Host Siemens SCADA on terminal server for browser access
- Embedded HMI Web Page: Use iframe if web-enabled HMI is available

Recommendation Based on Use Case

Use Case	Recommended Setup
Real-time control + monitoring	OPC UA (Read/Write)
Monitoring only	OPC UA (Read-only) or Modbus TCP
GUI access only	RDP / VNC / Thin Client
Unified control center	Use a Master SCADA that supports OPC aggregation

Integration Layers Overview

1. Real-Time Control: OPC UA Read/Write
2. Monitoring: OPC UA Read-only / Modbus TCP
3. GUI Integration: RDP, VNC, Thin Clients



Method	Description
Remote Desktop Protocol (RDP)	Open Siemens HMI remotely from master
Thin Client / VNC	Access WinCC runtime as a web or VNC session
Hyperlink Button	Use a GUI button in master SCADA to open Siemens SCADA viewer
Embedded HMI Web Page	If Siemens HMI is web-enabled, embed in iframe in master SCADA

Conclusion

- A **GUI interface** was developed using **Master-SCADA 4D** and **TIA Portal**, enabling full control, monitoring, and data logging for the **cooling and thermal stabilization systems** of the MPD experiment.
- The system manages **110 leakless cooling channels**, with **76 dedicated to thermal stabilization**, ensuring safe operation below atmospheric pressure.
- Real-time monitoring of key parameters (temperature, pressure, flow, conductivity, vacuum, etc.) is integrated via **multi-zone PLCs** and **OPC communication**.
- The interface supports **continuous control, diagnostics, and data archiving**, ensuring reliability and efficient system analysis.
- Current status: **GUI design completed**, with performance and diagnostic tools in place.

✓ - Configure Siemens SCADA OPC UA server

✓ - Setup Master-SCADA OPC UA client

✓ - Secure and validate all communication

✓ Optionally enable GUI-level integration

✓ Test and document the full integration

Stay Tuned!

More Details Coming Soon...

Thanks for your Attention

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