Monitoring and Control for MPD, Time Projection Chamber LV, and HV Subsystems for Nuclotron-Based Ion Collider Facility "NICA"

Full name

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Let's move on to an abstract of Slow control for MPD TPC LV and HV systems based on CAEN Equipment

For the MPD detector control system, the Master SCADA and SCADA *software were proposed. The TPC low-voltage and high-voltage systems concepts are presented. It is based on CAEN equipment and the OPC UA (OLE for Process Control) server protocol.*

The status of interface design for CAEN equipment based on OPC UA, Master SCADA server, of HV and LV during the monitoring.

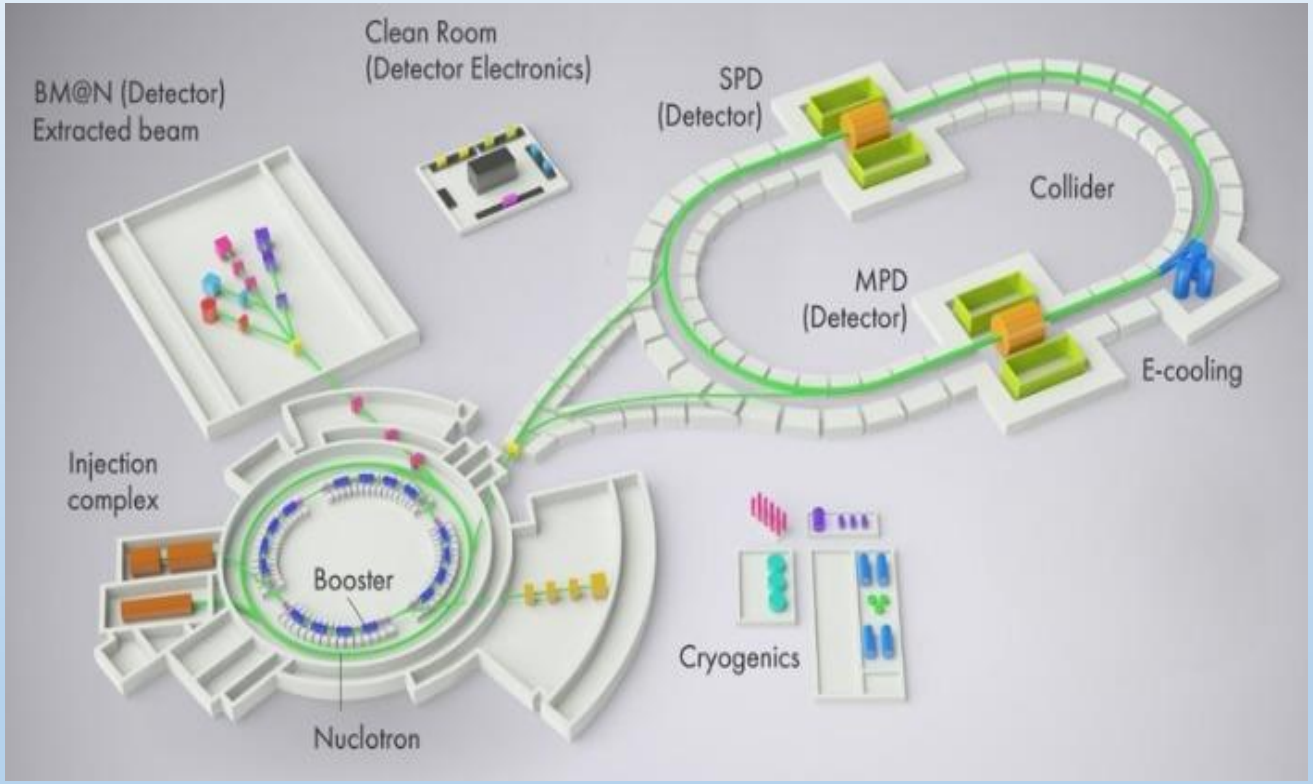
In our research work, we use Master Scada and Scada as visualizations instead of grafana, as they are more applicable according to the results.

NICA collider

The NICA collider provides two beam intersection points, one of which will house the Multi-Purpose Detector (MPD) experimental setup.

The first phase will implement the following configuration of this setup: time-projection chamber (TPC), time-of-flight (TOF), zero-angle calorimeter (FHCAL), fast forward detector (FFD), and electromagnetic calorimeter (ECAL).

The TPC is the main track detector of the MPD installation.

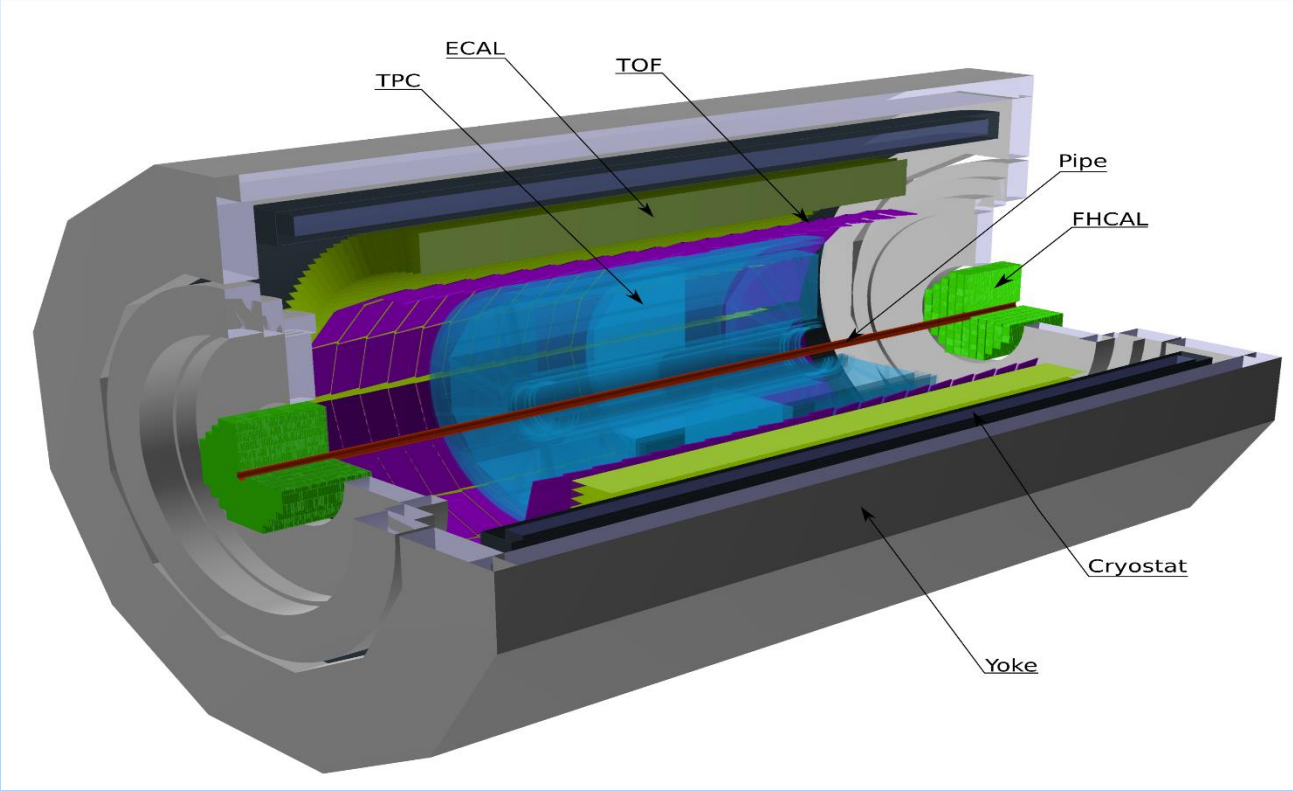


NICA Collider

MPD at NICA collider

The **Multi-Purpose Detector (MPD)** is a 4π spectrometer. It is designed to detect charged hadrons, electrons, and photons in high luminosity heavy-ion collisions within the energy range of the NICA collider.

A general view of the MPD detector with the end doors pulled back to see the internal parts of the detector. Drawn are the following subsystems: Forward Hadron Calorimeter (FHCAL), Time-Projection Chamber (TPC), Time-of-Flight System (TOF), Electromagnetic Calorimeter (ECAL).



A general view of the MPD detector (stage 1)

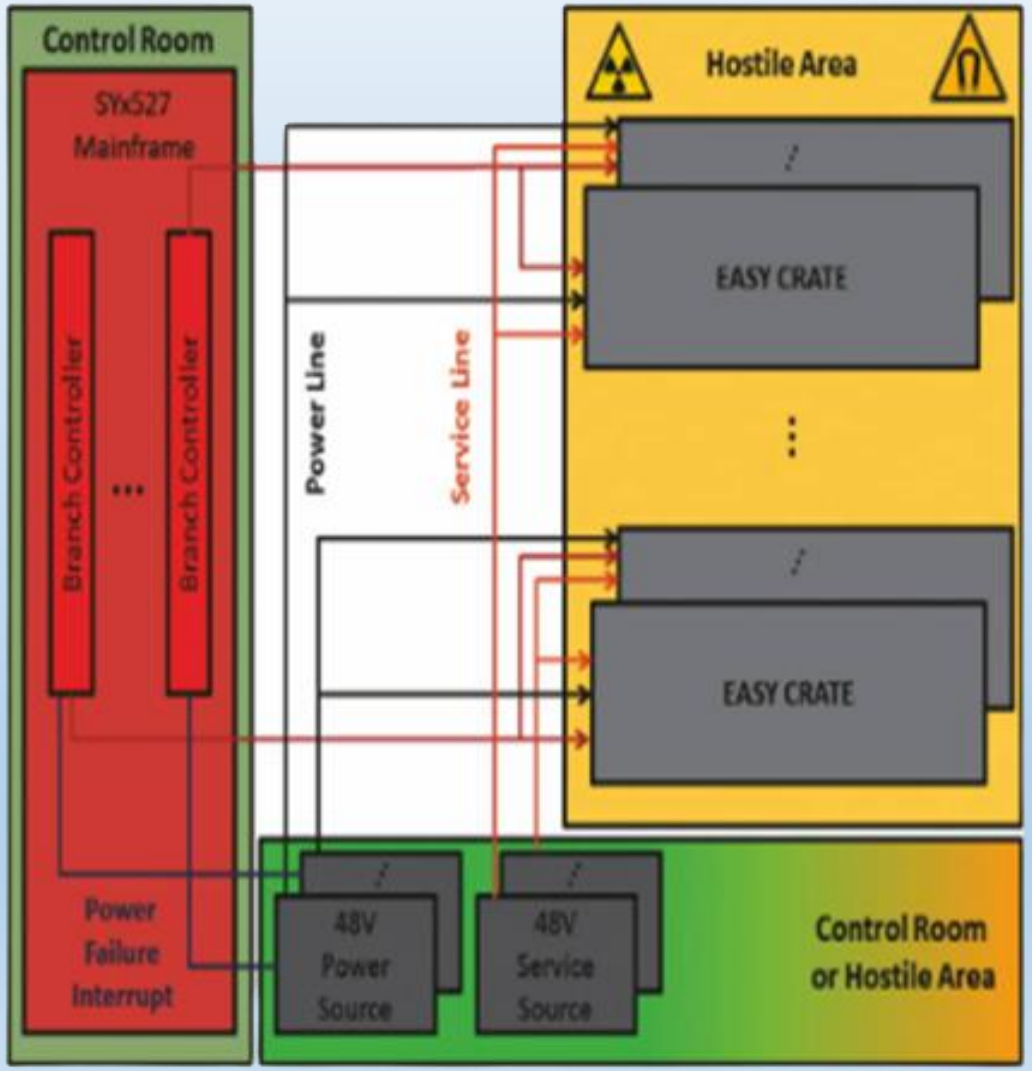
EASY (Embedded Assembly System)

Architecture

- The EASY3000 (for boards up to 40 cm long, A3XXX family) can house up to 10 boards (depending on board width). As illustrated in the figure on the right, the branch controller is the EASY interface between the mainframe unit (SY4527 or SY5527) and the remote boards in the EASY create.

- The branch controller role is to configure the EASY channels as the belong to the supply unit slot in which the branch controller is placed.

- In this way, all channels of the EASY boards will be considered as channels of the branch controller board, increasing the number of channels the system can handle.



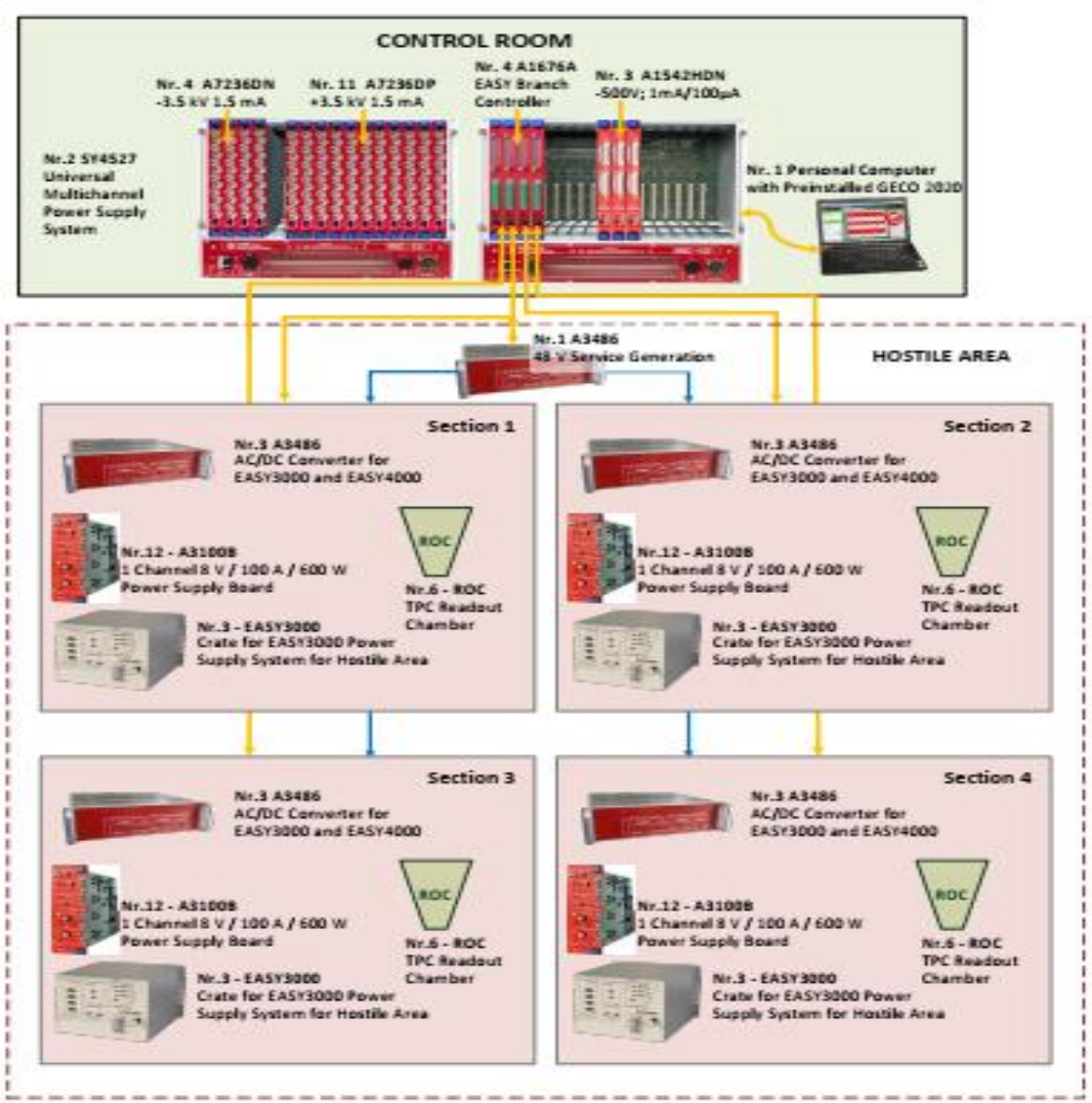
TPC HV+LV System

CONTROL ROOM (no radiation and magnetic field):

- SY4527 – 2 pc
- controller A1676A – 4 pc
- HV modules –A72360P (+3.5kV/1.5mA) - 11 pc
- HV modules –A72360N (- 3.5kV/1.5mA) - 4 pc
- HV modules –A1542HDN (- 500V/1mA) - 3 pc

LV&HV system based on CAEN rad. hard design:
(up to 2000 Gauss and 15 kRad)

- Power converters A3486 AC/DC (380 V -> 48 V) – 15 pc
- EASY3000 crates - 14 pc
- LV module - A3100B (8V/100A) - 48 pc
- LV module - A3100HBP (14V/50A) - 6 pc
- HV modules –A3540P (+4kV/1mA) - 8 pc
- HV modules –A3540N (- 4kV/1mA) - 2 pc



Crate SY4527 (Non Radiation Area)

The **SY4527** system is the fully equipped experimental version of a new line of power supply systems which represent CAEN's latest proposal in the matter of High Voltage and Low Voltage Power Supplying.

This system outlines a completely new approach to power generation and distribution by allowing the housing, in the same mainframe, of a wide range of boards with different functions, such as High/Low Voltage boards, generic I/O boards (temperature, pressure monitors, etc.) and branch controllers, where the latter are used to control other remote generators and distributors.

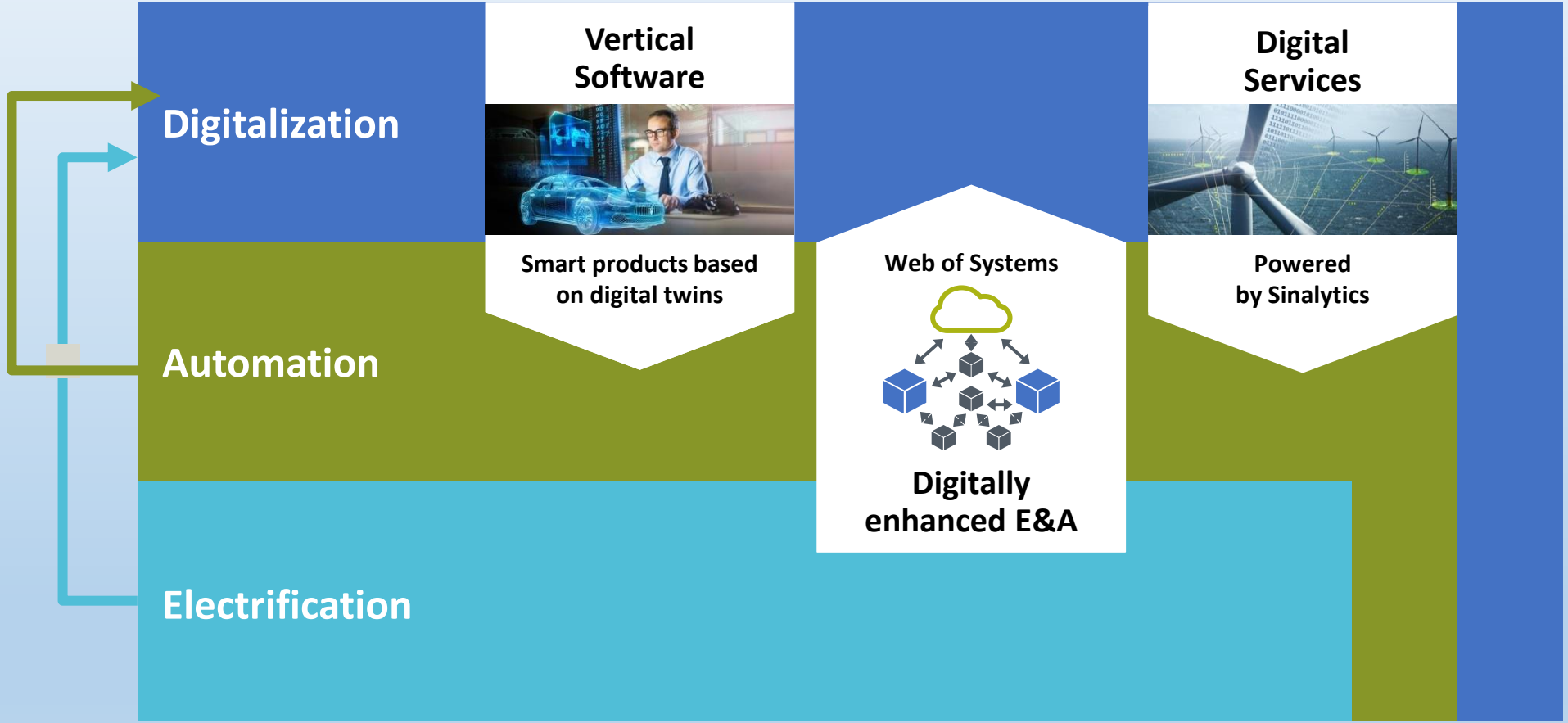
Crate SY5527

The **CAEN Mod. SY5527** is the fully equipped experiment version of a new line of power supply systems which represent CAEN's latest proposal in the matter of High Voltage and Low Voltage Power Supplying. This system outlines a completely new approach to power generation and distribution by allowing the housing, in the same mainframe, of a wide range of boards with different functions, such as High/Low Voltage boards, generic I/O boards.

- the **Board Section**, with 6 slots to house boards, distributors and branch controllers; "Low cost" version with 4 slots is available
- the **Fan Tray Section**, housing 3 fans arranged on two rows, with programmable rotation speed regulation;

Scada solutions combine Digitalization with Automation and Electrification

SCADA is used to assist in automating and managing industrial processes that have become too complex or cumbersome for human monitoring and control.
especially in cases where it is possible to improve efficiency.

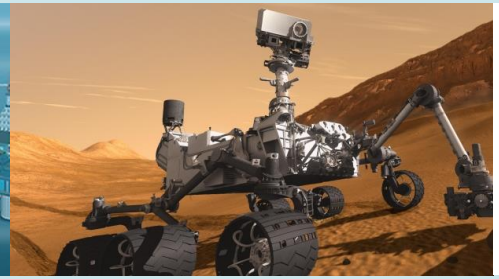


Domain and product know-how for Digitalization

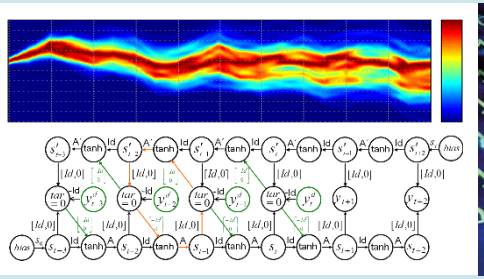
Areas of activity for SCADA: Technology and research Securing

Digitalization

Engineering & modeling & simulation & communication

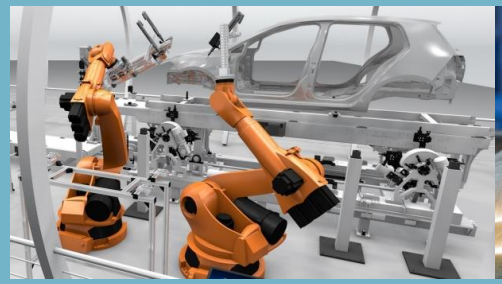
Data analytics & monitoring



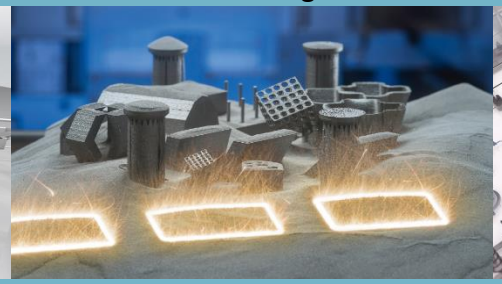
Security architectures

Automation

Future automation & sensors

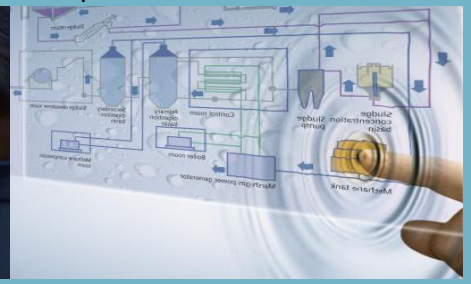


Additive manufacturing



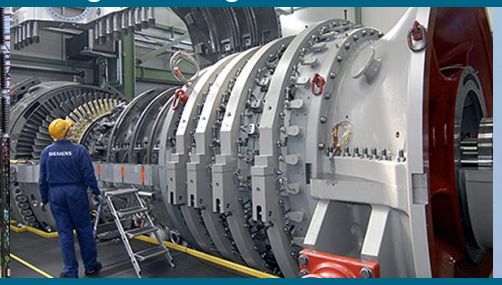
Modern user interface design

Enterprise IT

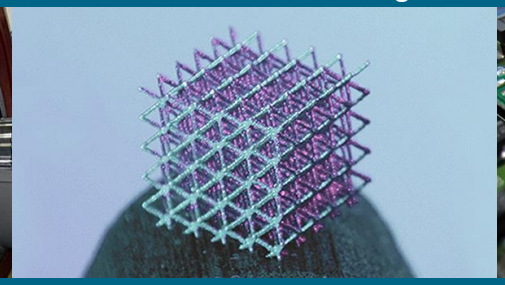


Electrification

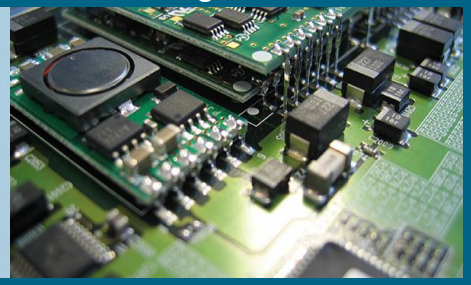
Smart grids & power electronics & switching technologies

Innovative materials & coatings



Electronic design



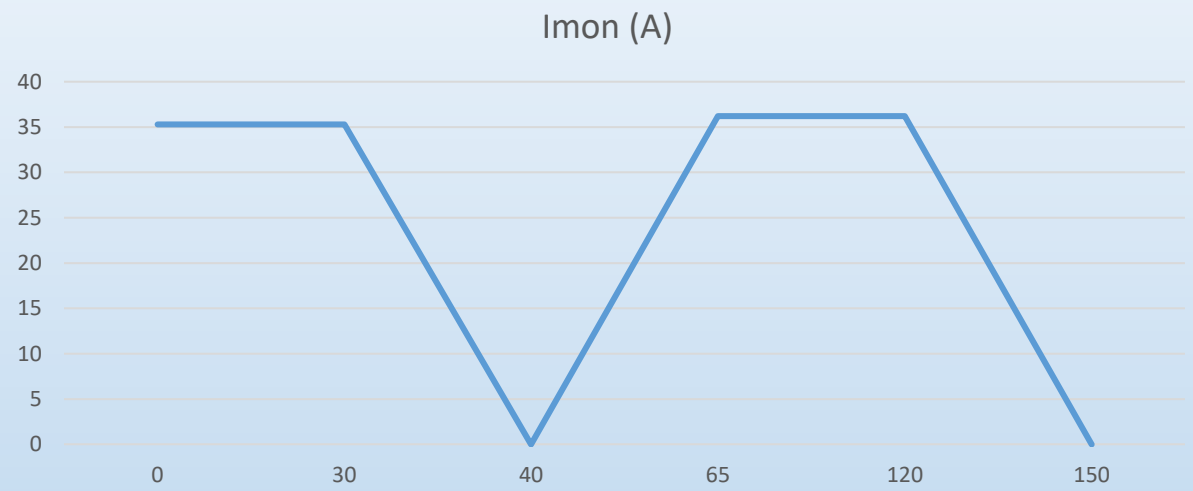
CAEN Control Software Models

OPC Server for CAEN Power Supplies

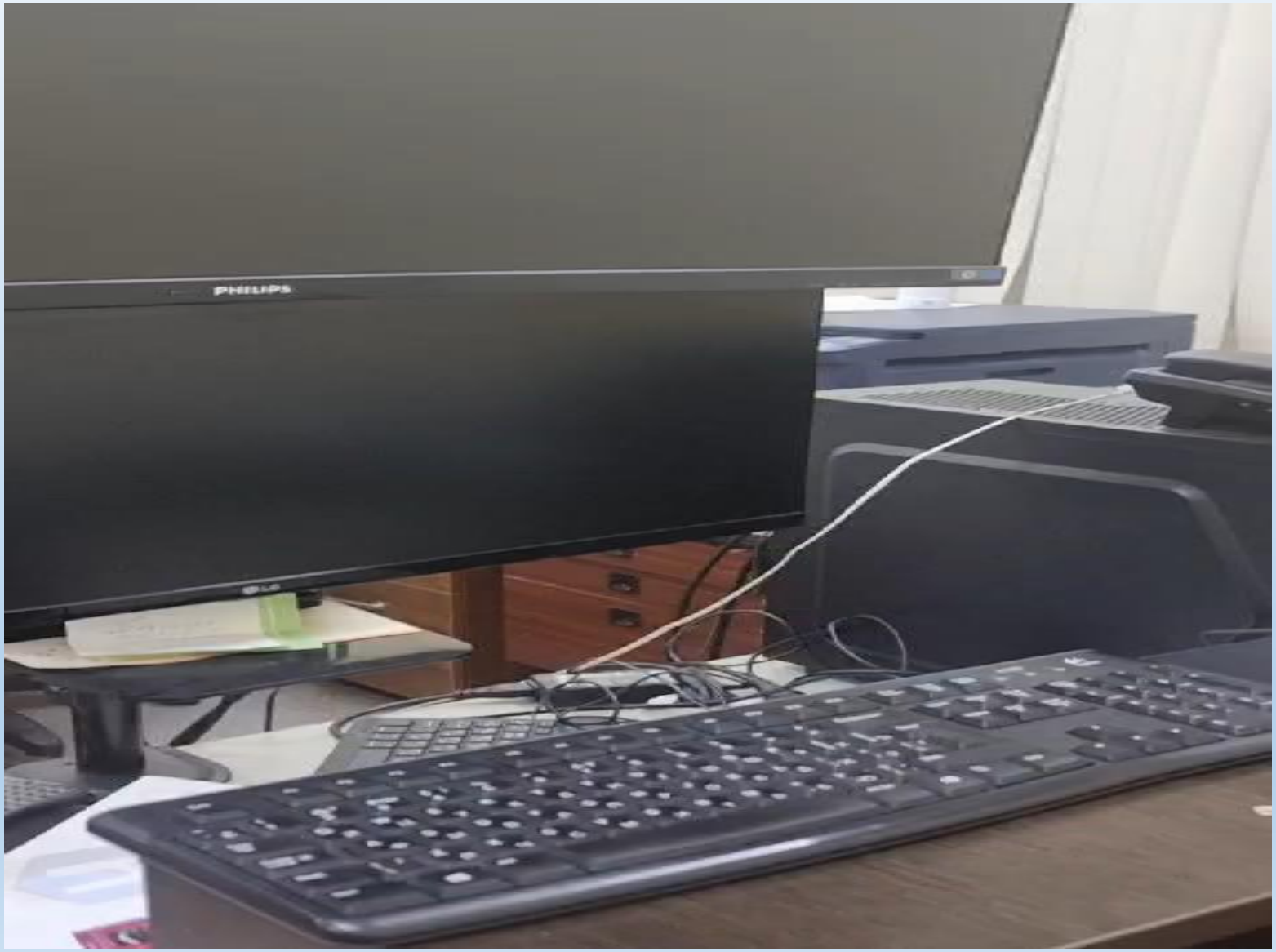
- CAEN, in close collaboration with CERN, has developed an **OPC Server** which allows powerful, flexible and yet simple control of its power supply systems by any OPC compliant client application.

- OPC (OLE for Process Control) is an open interface based on the OLE/COM and DCOM technology; OPC offers “Plug & Play” connectivity between disparate hardware devices.

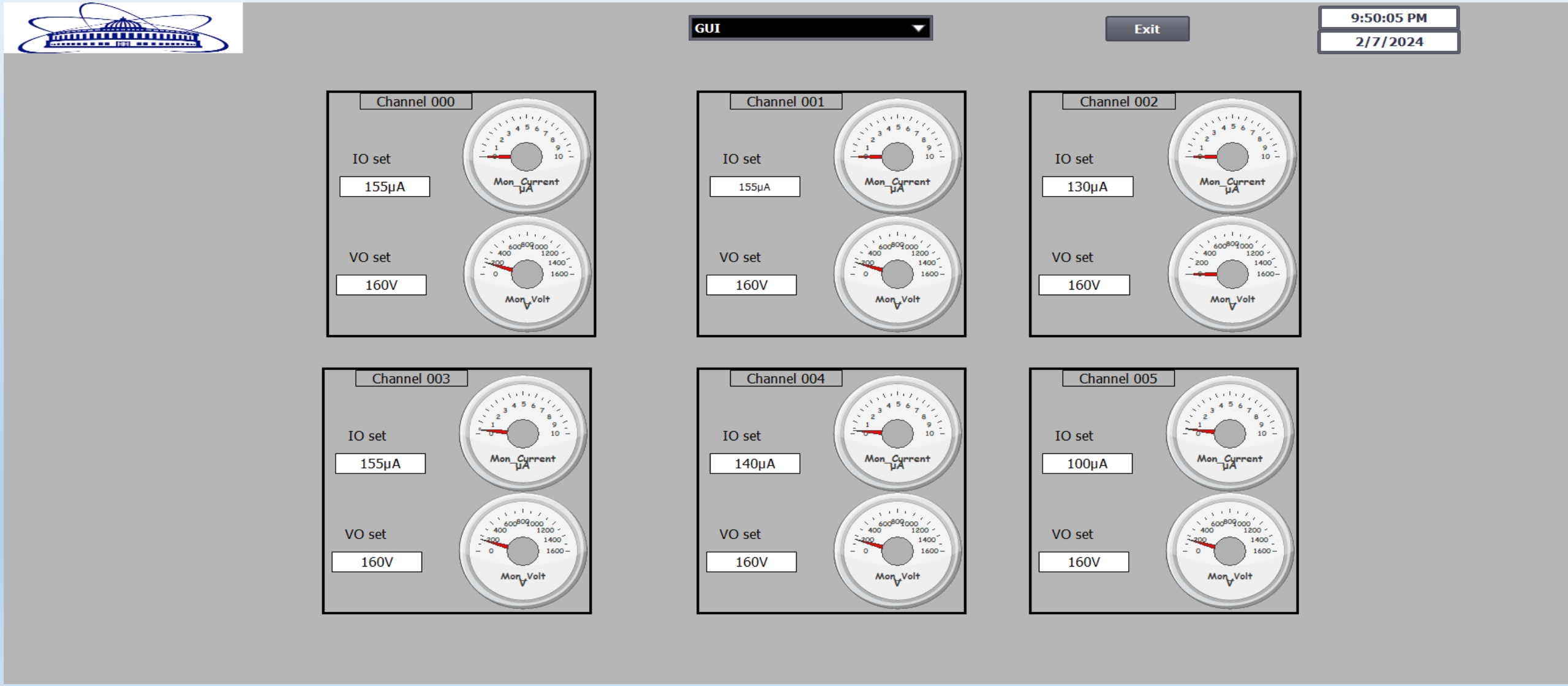
Relationship between Current and Time for Channel 3 Connected to Test Resistive Load



High Voltage Hardware SY4527



Results for HV and LV Control, Monitoring Using SCADA, GUI Interface for High Voltage



Interface for High Voltage Board 01 , Board 14

Hv_interface

Exit

9:34:41 PM

2/7/2024

Temperature of Board 1

32°C

Temperature of Board 14

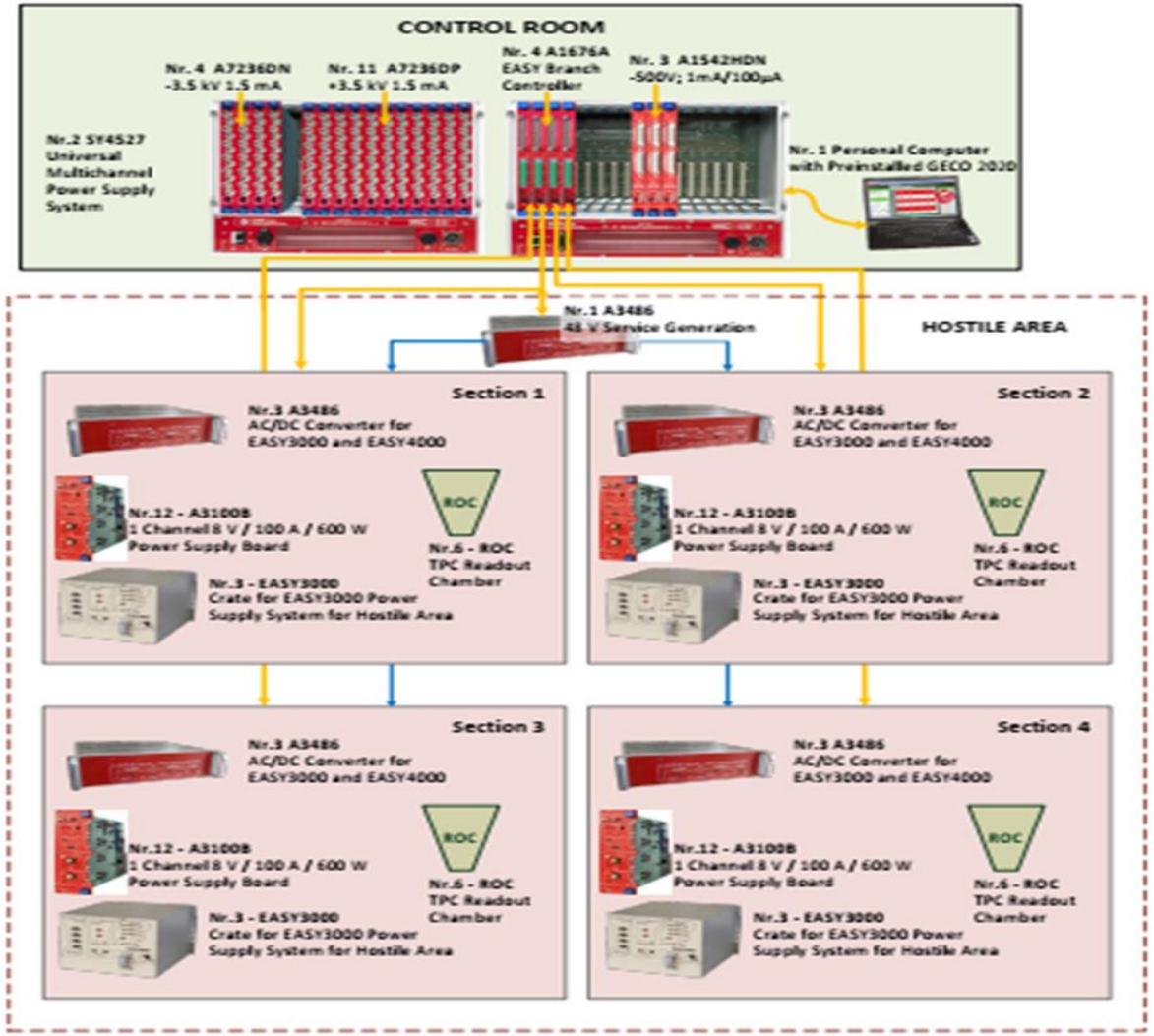
10°C

Clear Alarm

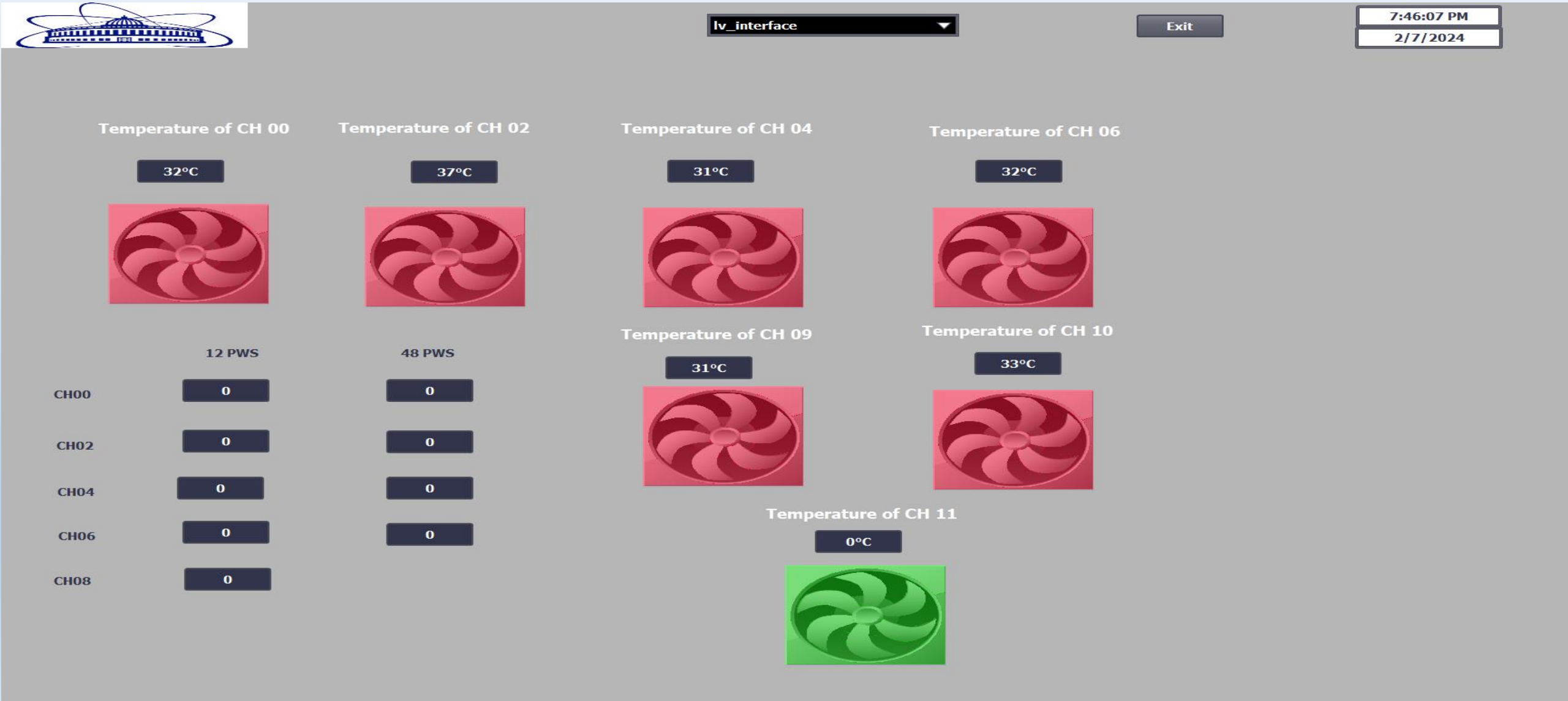
0000

Kill

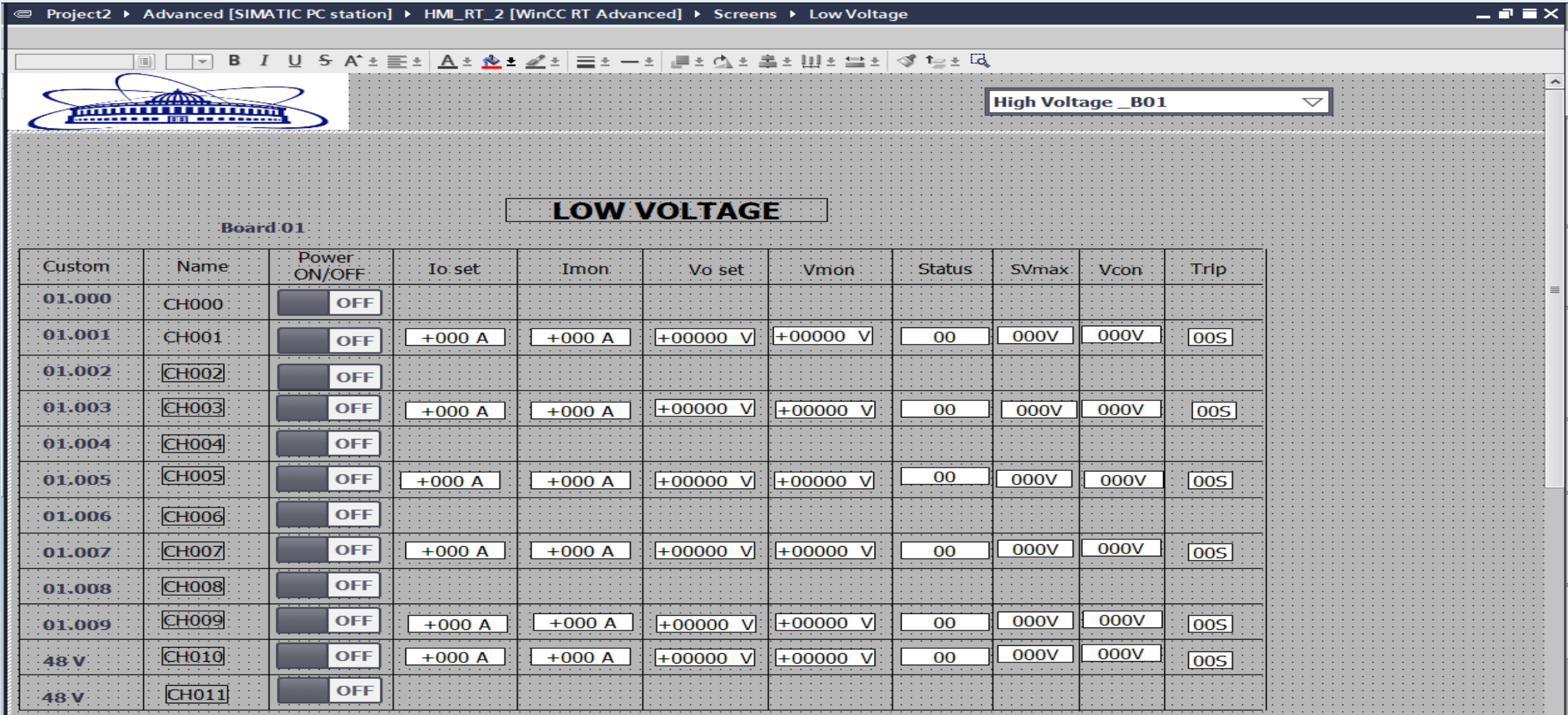
0000



Interface for Low Voltage

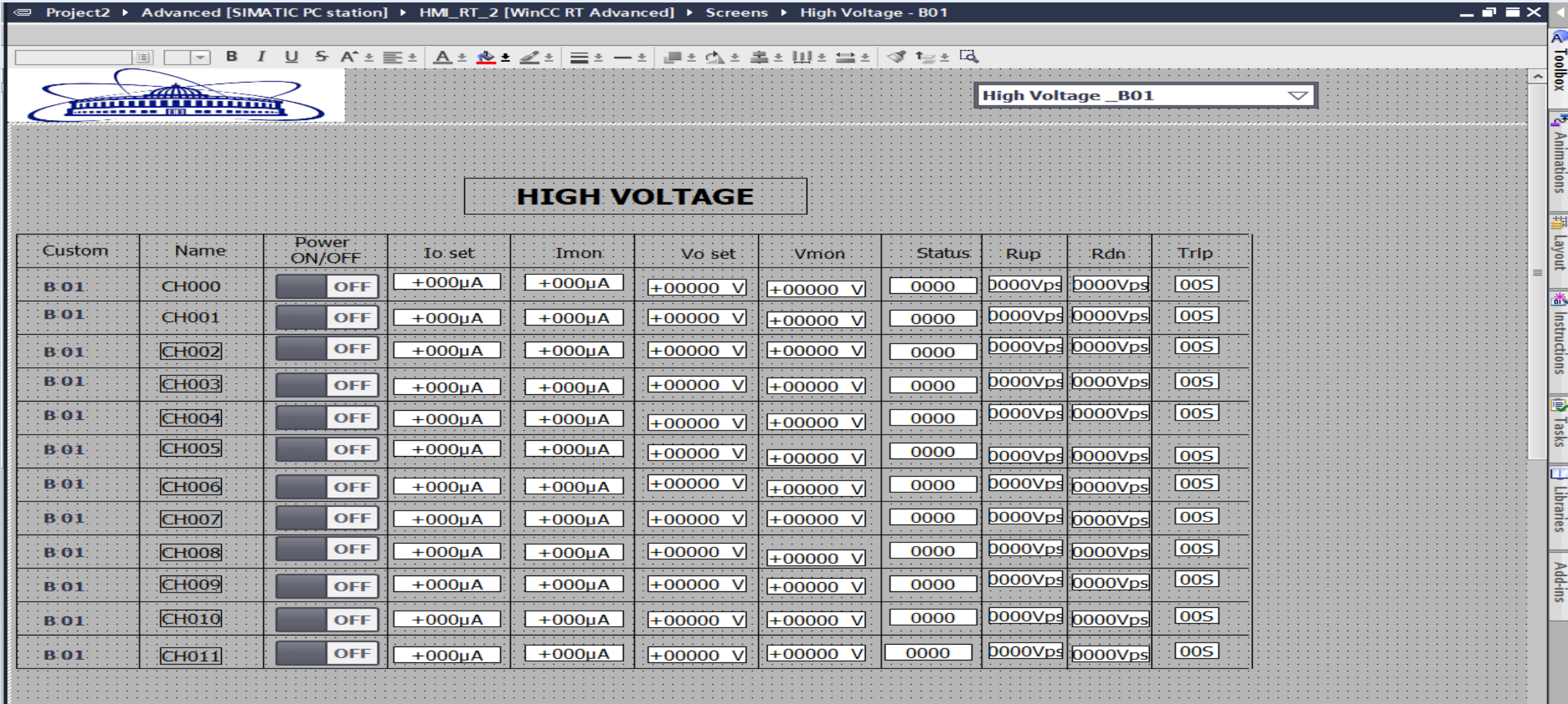


Low Voltage interface

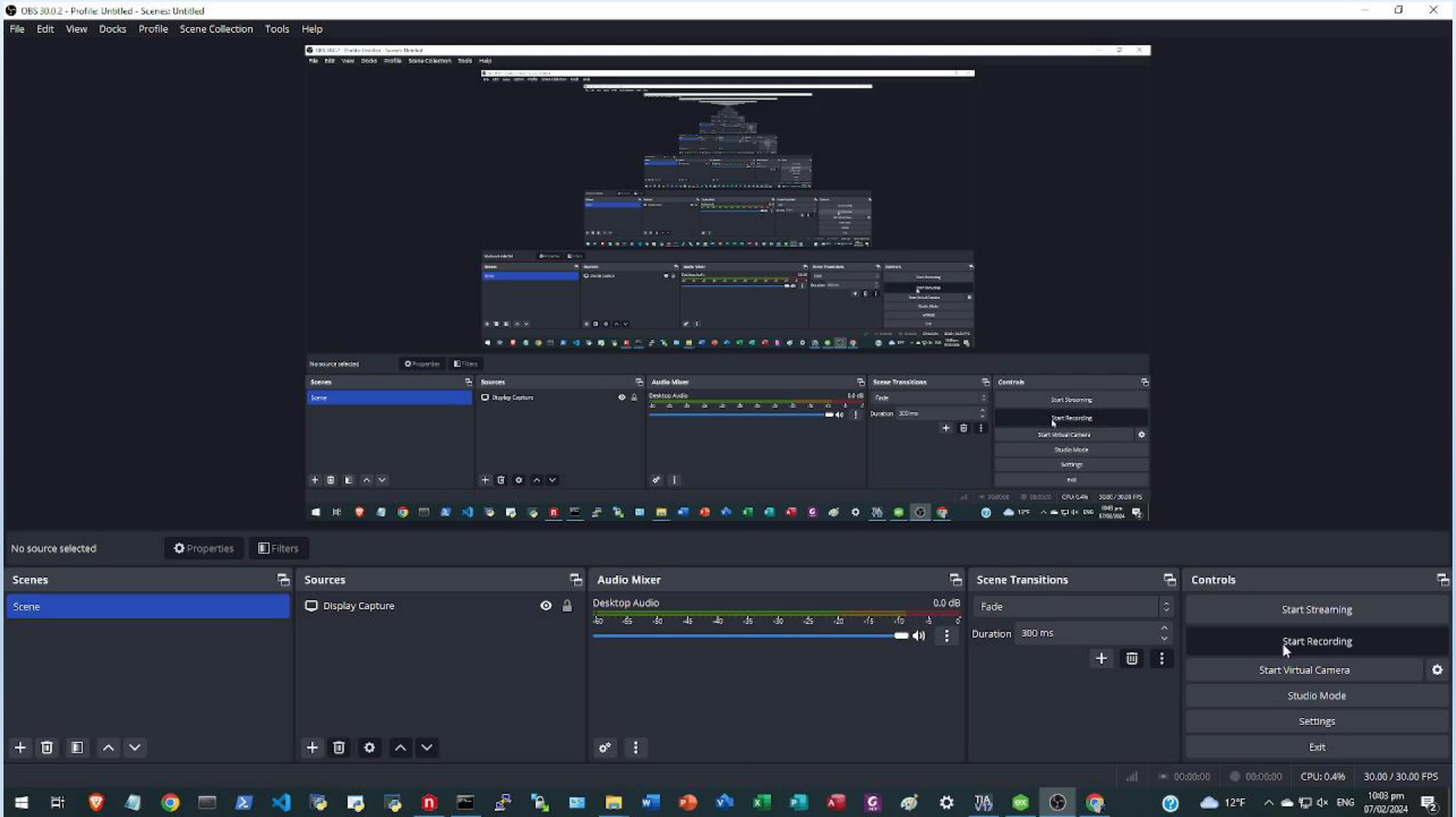


Custom	Name	Power ON/OFF	Io set	Imon	Vo set	Vmon	Status	SVmax	Vcon	Trip
01.000	CH000	OFF								
01.001	CH001	OFF	+000 A	+000 A	+00000 V	+00000 V	00	000V	000V	00S
01.002	CH002	OFF								
01.003	CH003	OFF	+000 A	+000 A	+00000 V	+00000 V	00	000V	000V	00S
01.004	CH004	OFF								
01.005	CH005	OFF	+000 A	+000 A	+00000 V	+00000 V	00	000V	000V	00S
01.006	CH006	OFF								
01.007	CH007	OFF	+000 A	+000 A	+00000 V	+00000 V	00	000V	000V	00S
01.008	CH008	OFF								
01.009	CH009	OFF	+000 A	+000 A	+00000 V	+00000 V	00	000V	000V	00S
48 V	CH010	OFF	+000 A	+000 A	+00000 V	+00000 V	00	000V	000V	00S
48 V	CH011	OFF								

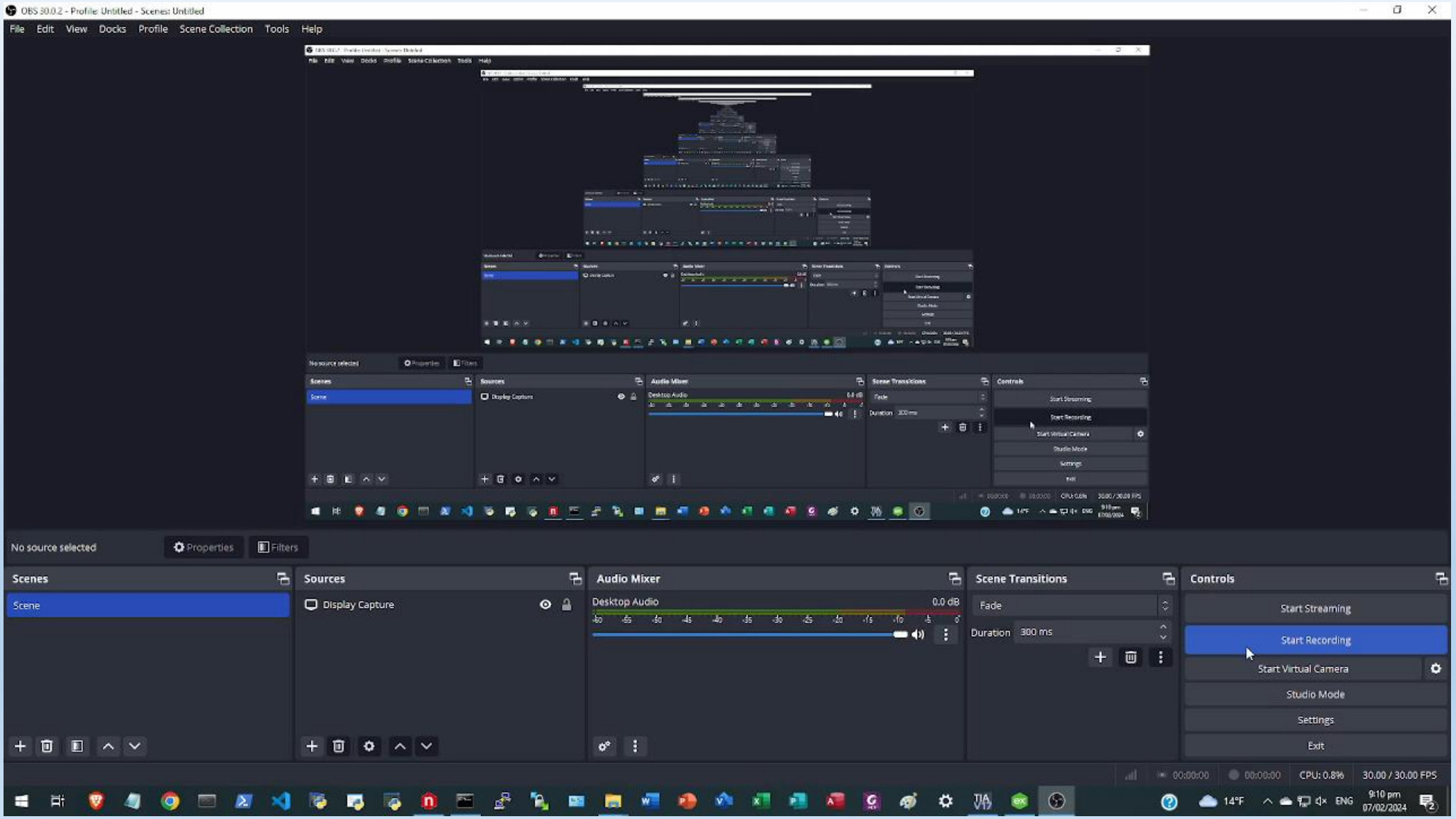
High Voltage interface for Board _01



GUI interface for High Voltage, Board 01,Board 14



GUI interface for Low Voltage

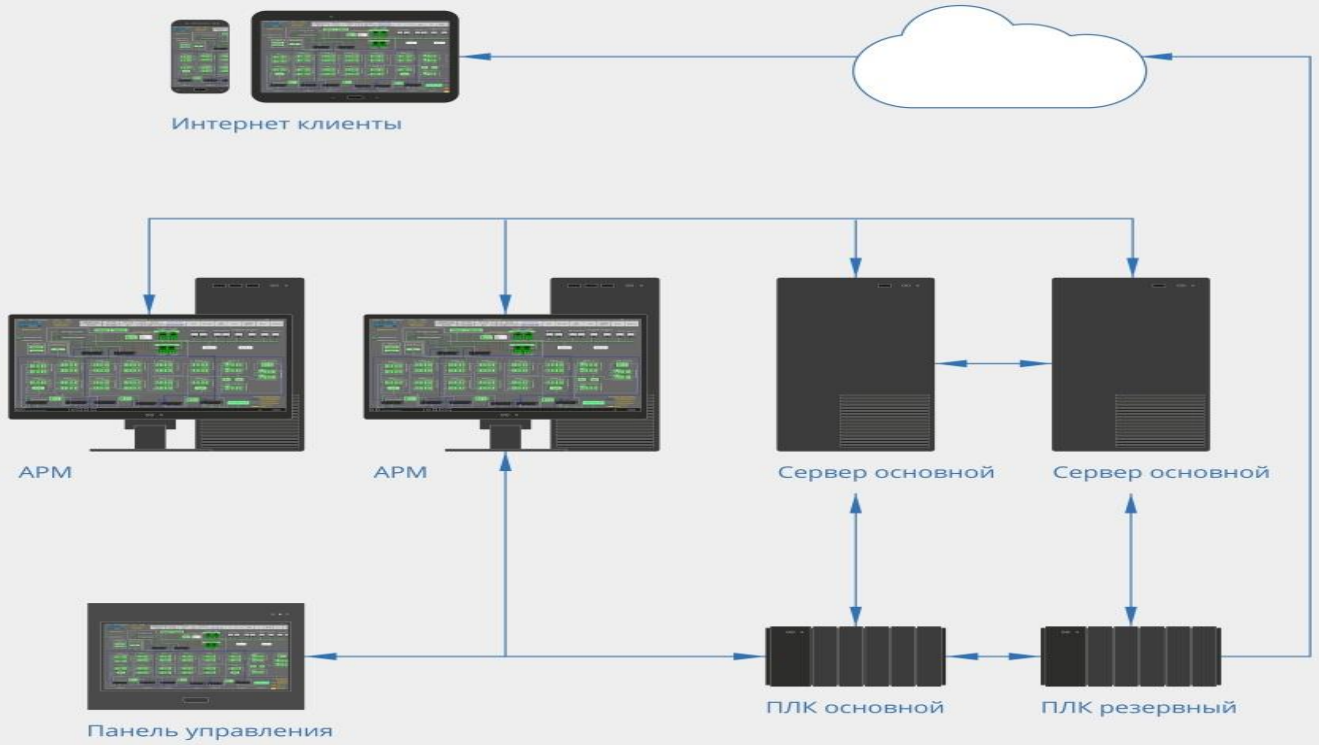


Master SCADA 4D – New Generation of SCADA

Master SCADA 4D is a product of a new generation of SCADA systems developed by MPS software. In it, compared to the previous version, the tools for creating large distributed systems with the ability to use Internet of Things technologies are significantly expanded.

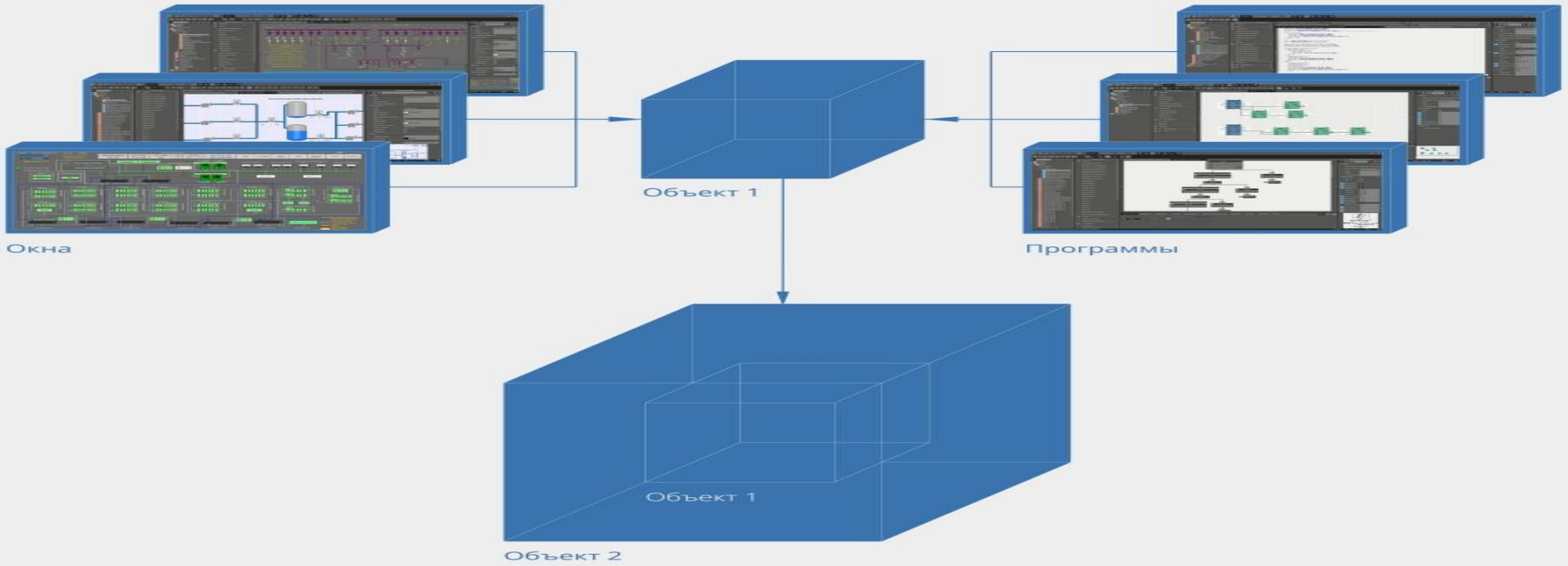
Such integration assumes that all levels of the management system are included in the project.
These are levels like:

- programmable controllers;
- local HMI panels;
- Operators' workstations;
- Servers
- Cloud services.

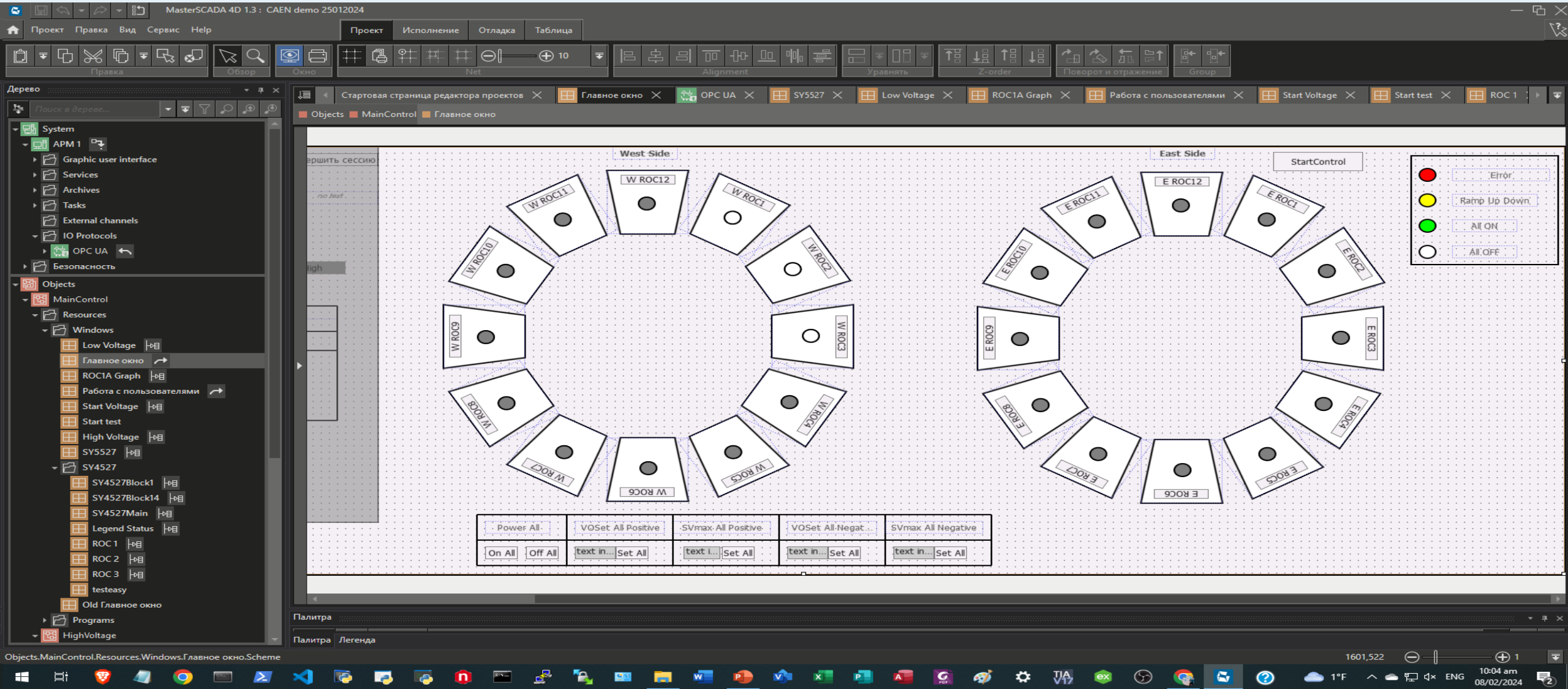


Master SCADA 4D – New Generation of SCADA

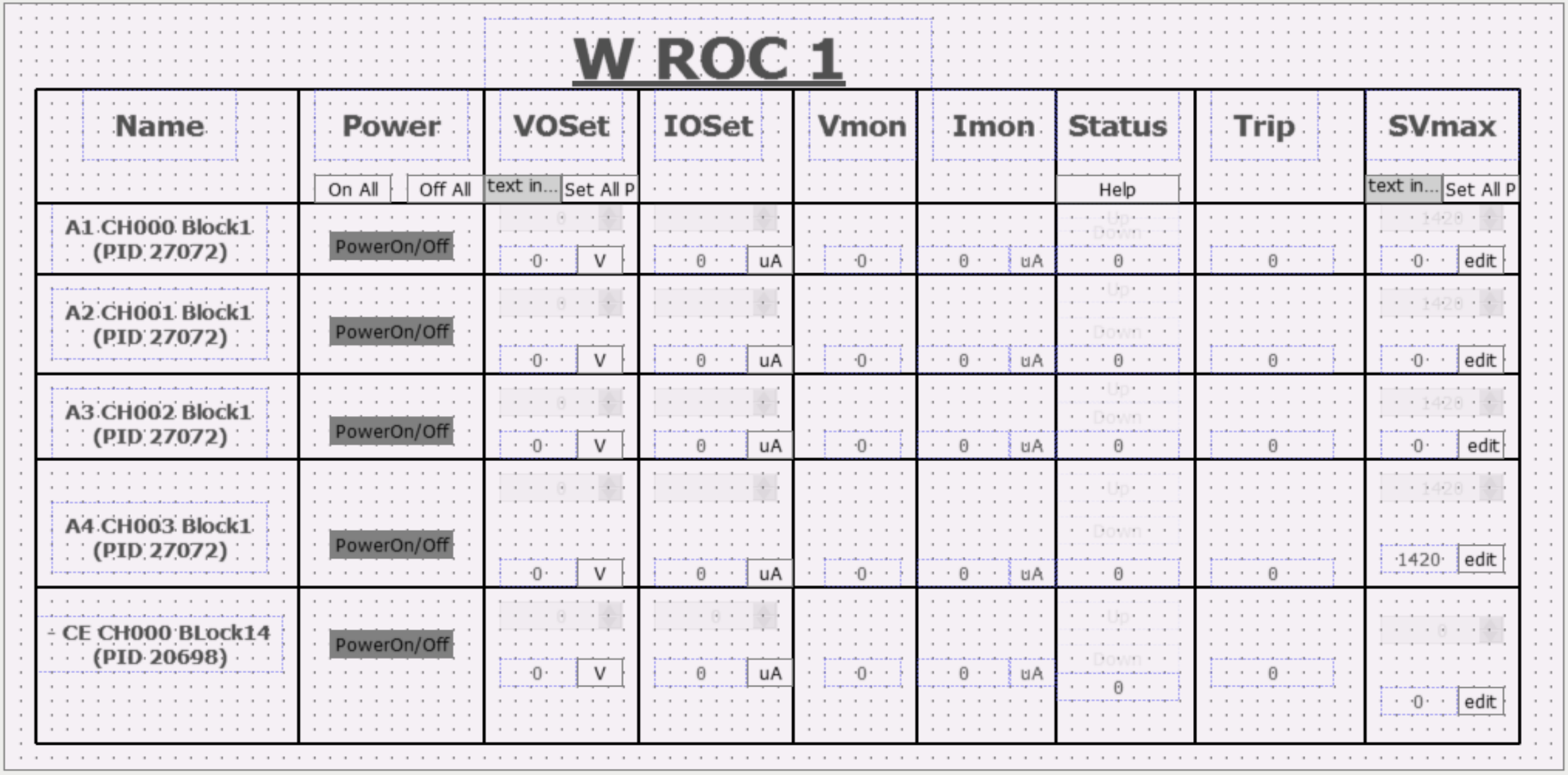
Objects in Master SCADA 4D are understood as a named set of graphical representation of a technological object, its parameters, monitoring and control algorithms, control windows and other available project elements (including other objects).



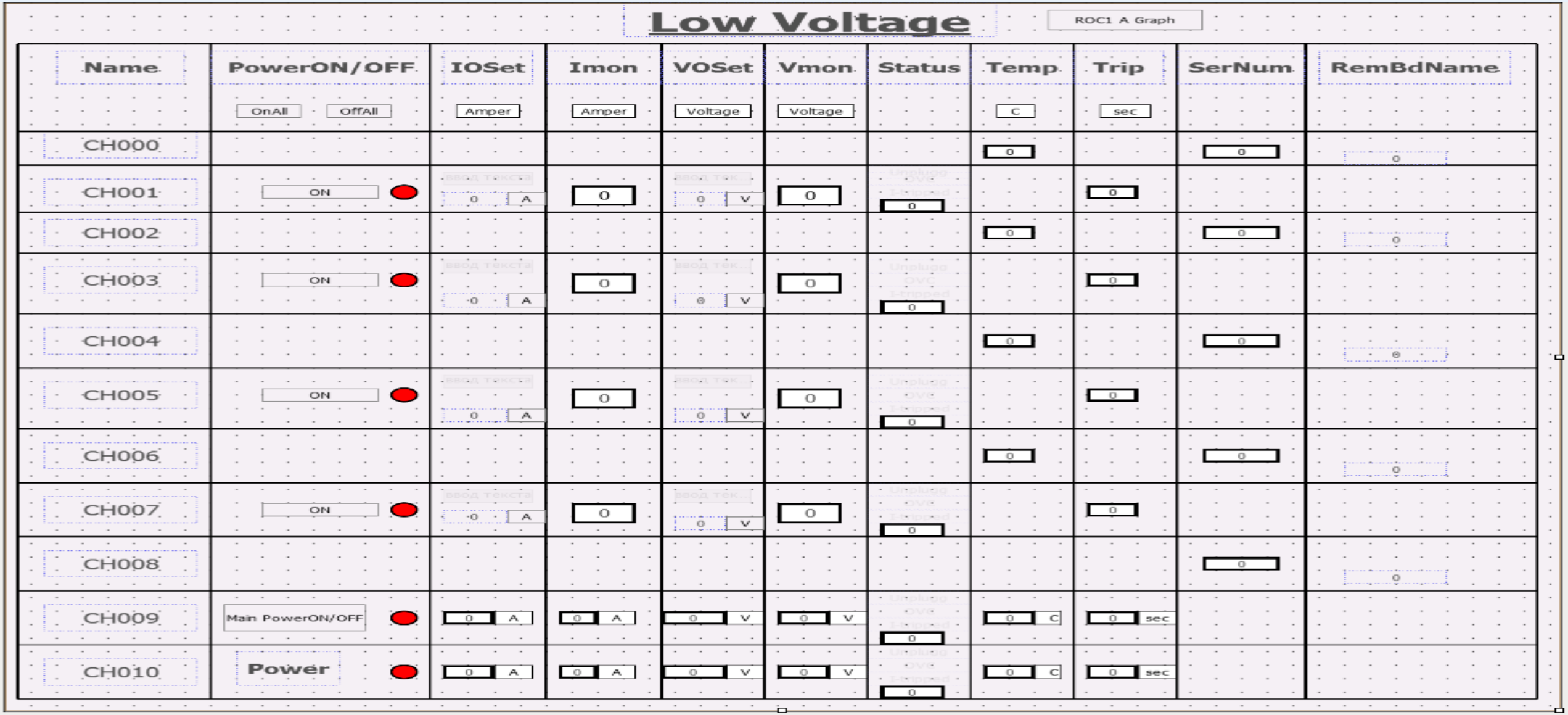
Results for HV and LV Control, Monitoring Using Master SCADA, Main window Interface.



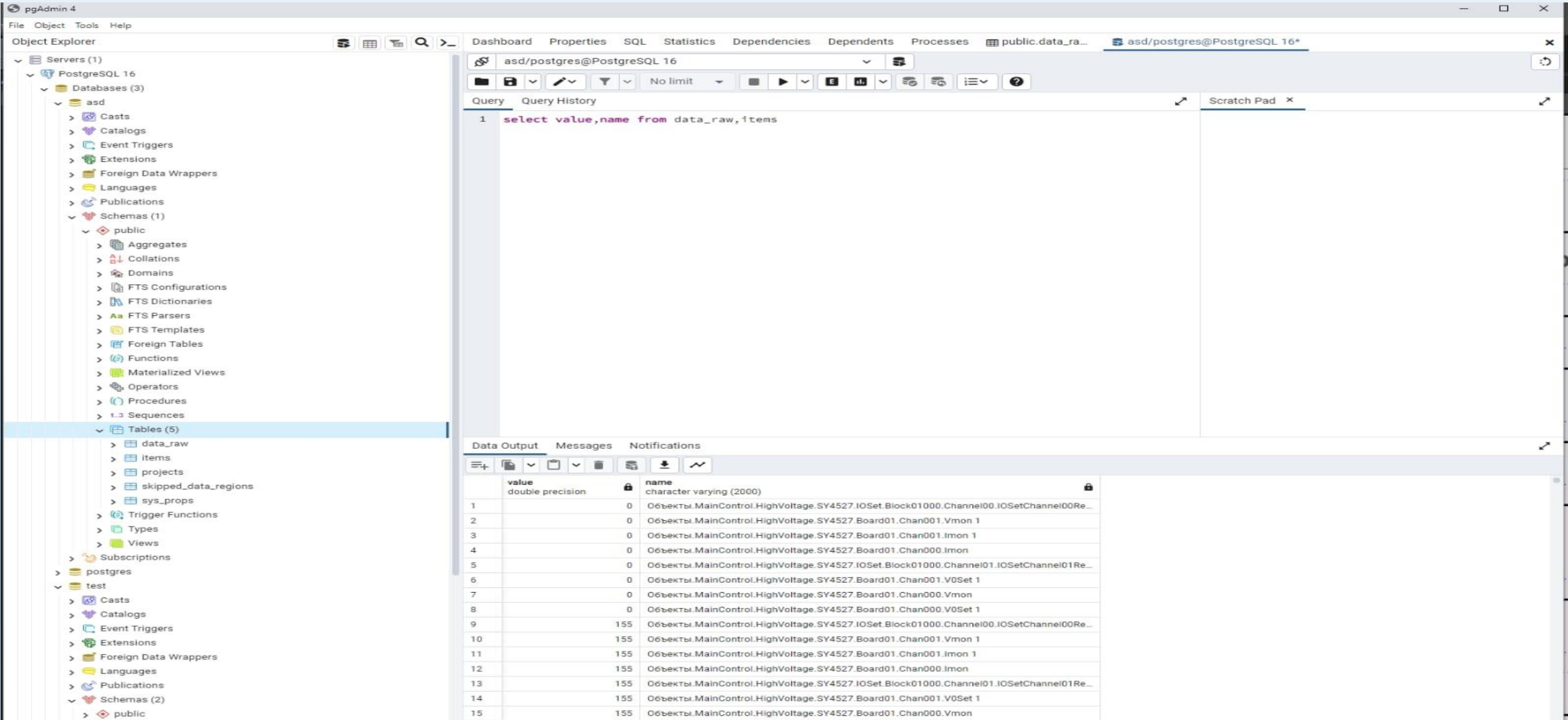
High Voltage interface



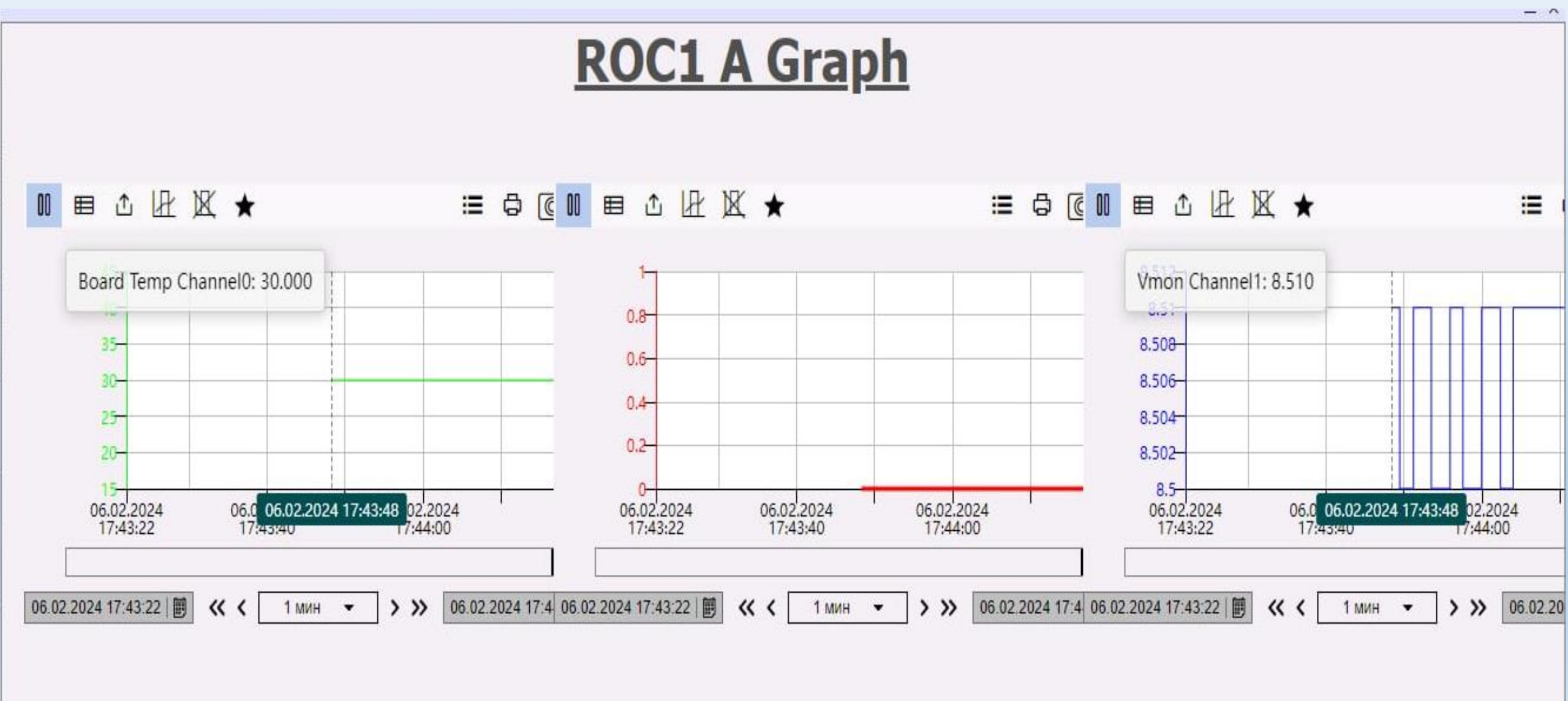
Low Voltage interface



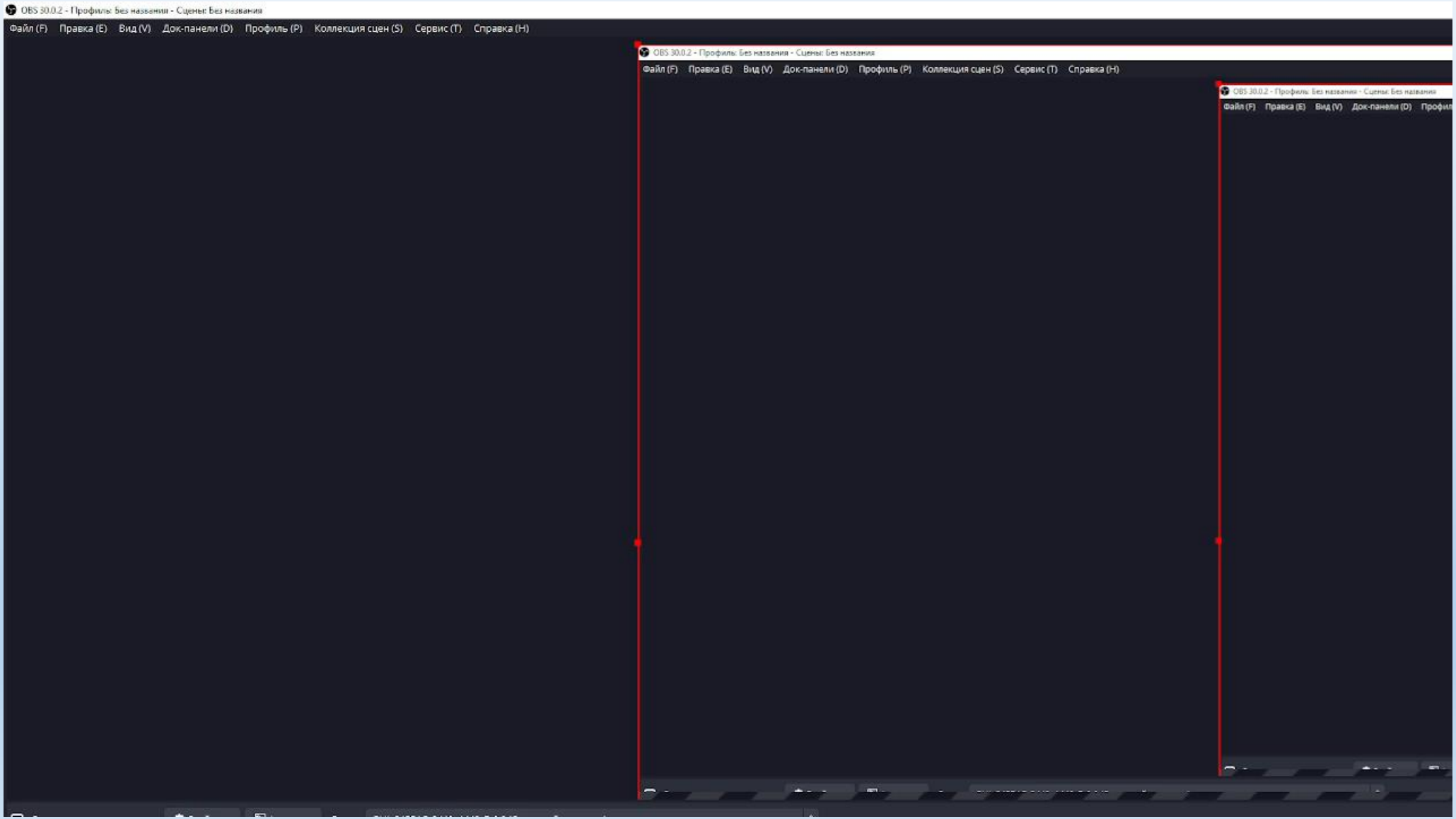
Data Transfer from Master Scada to the database of PostGreSQL16



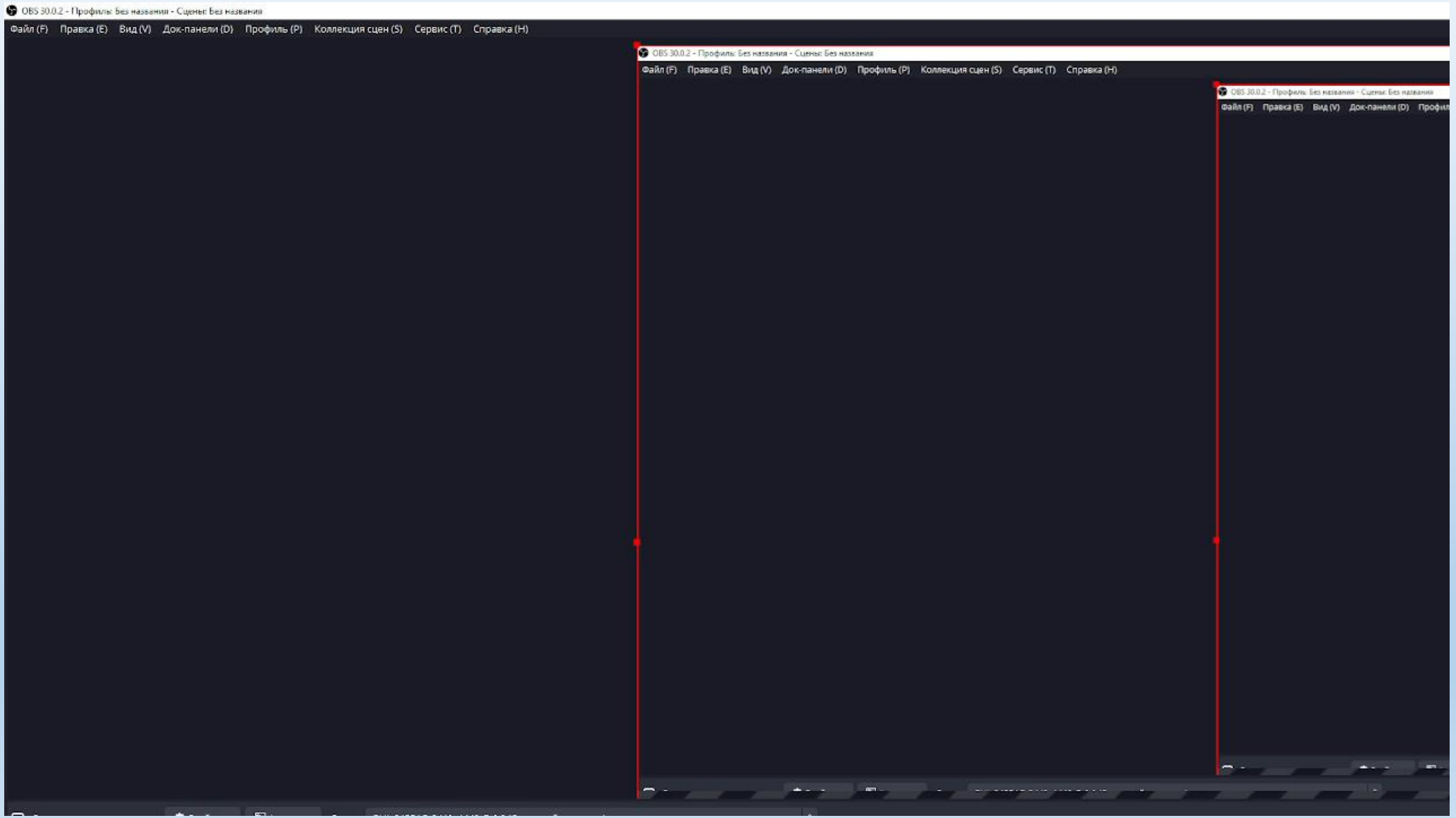
Roc 1 HV Monitoring for Current, Temperature, Voltage, Versus Time



Low Voltage GUI interface



High Voltage GUI interface

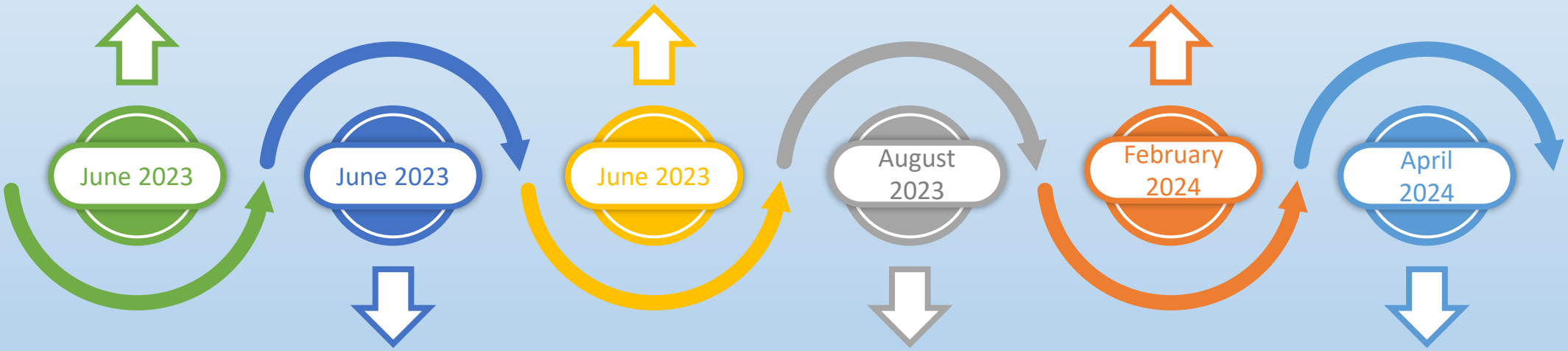


Time Frame

1.Connect between Server, Client to our Mainframe.

3.Read Data from modules through the Mainframe.

5. Create a graphic user interface (GUI) for TPC LV+HV subsystem



2.Install software tools used for control and monitoring variety of parameters.

4.Control and read data using Tango and OPC Server Tools.

6. Test and improve GUI

Conclusion

- Our main goal is to create software using the tools of Master Scada ,Scada software and the CAEN OPC server for control and monitoring of all the parameters of high- and low-voltage TPC subsystem.

1. Connect the server, client, and CAEN Mainframe.

2. Install software tools used for controlling and monitoring a variety of parameters.

3. Control and read data using SCADA and OPC Server Tools.

4. Create a graphic user interface (GUI) for the TPC LV+HV subsystem.

- Create, test and optimize a graphic user interface (GUI) for TPC LV+HV subsystem. To do GUI for each TPC subsystem. combine the GUIs for each TPC subsystem to control and monitoring TPC detector (TPC DCS).

Acknowledgement

I am grateful to everyone who helped me with this research.
I would like to convey my heartfelt gratitude to Dr. Sergey Movchan, Dr.Alexander Pillar, and Vlad Chepurnov for their tremendous support and assistance in the completion of our Research work and Poster.

Stay Tuned!

More Details Coming Soon...

Thanks for your Attention

Scan here for PPT

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