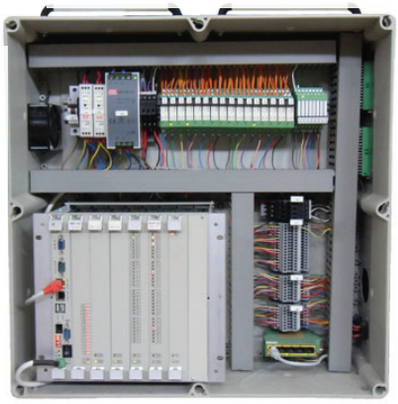
ARS-TSSimATLAS

Hardware real-time simulator of ATLAS MAX-RTL® steam turbine

institute MIHAILO PUPIN
AUTOMATION & CONTROL SYSTEMS



Thermal Power Plant – Heating Plant Novi Sad TA-2

Financed by: Panonske Thermal Power Plant-Heating Plant" Ltd Novi Sad, Serbia

Project completion year: 2014.

PROJECT DESCRIPTION

A particular challenge from the point of signal acquisition and fast issuing of analogue and digital control signals is control of the steam turbine, a central part of the thermal generator for electric power production. For optimal turbine operation, the turbine governor, as a part of the DCS (*Distributed Control System*) turbine unit SCADA system, must acquire process parameters, process required signals and issue control orders to the turbine unit in the real time with great precision. Since adjustment and testing of the turbine governor, in connection with the real system, is a very complex task during which errors may occur causing large-scale damages, the hardware simulator which simulates the real system operation has been implemented.

The hardware *real-time* simulator of the **condensing - district heating steam turbine T-110/120-130-4**, nominal power 110MW, produced by ZAO "UTZ", has been implemented within the project "Modernisation of the regulation and protection system on the turbo generator TA-2".

The role of the hardware real-time simulator is very useful in testing and verification of the hardware and software components of the modernised turbine regulation system, before the implementation in the real system. Considering that the implemented mathematical model on the simulator presents the model of the turbine real system, it is possible to adjust the approximate and precise controller parameters (PID) without presence of the real system during the implementation and testing of the turbine regulation system logic. Apart from the testing of the implemented controller functionality, the simulator can also be used for training the staff of the thermal power plant, without any danger to the real system equipment. Thus it is possible to acquaint the thermal power plant staff with all scenarios that can occur during the thermal power unit operation. As it is possible to simulate the emergency situations that may occur during the unit operation, the power plant staff is trained to react promptly.

The hardware real-time simulator is connected with the turbine regulation cabinet via I/O (analogue and digital) modules. In this way, the feedback marked as HIL (*Hardware in the loop*) simulation is realized (Figure 1).

Implementation of the hardware simulator has required the following steps:

- implementation of the simulator electro-project, with devices manufactured by the "Mihajlo Pupin" Institute;
- development of the steam turbine T2 TE-TO Novi Sad mathematical model.

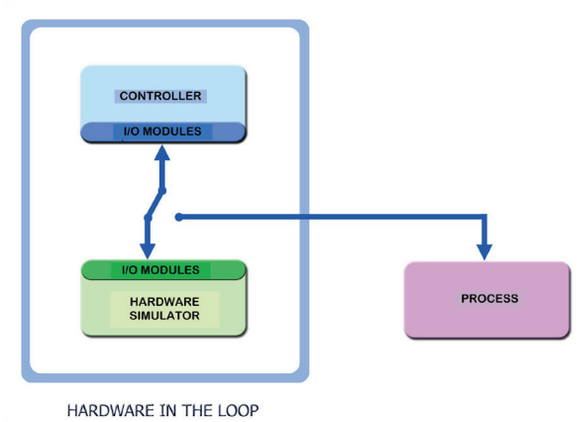


Figure1 - HIL simulation scheme

The mathematical model is realized to be identical to the real system, and thus it is enabled to calculate all important parameters (speed, power, pressure, temperature, etc.), which are essential for the turbine governor testing.

Development of the hardware simulator provided the following performances:

- acquisition of input signals with period of 10ms (analogue), i.e. (digital) with period of 1ms,
- period of 10ms for performing PLC algorithms,
- calculating response of the simulated process in the real time in all process operation modes,
- visualisation of signals/data and parameters during simulation,
- possibility of changing simulation parameters,
- stability,
- mobility - small size cabinet with external connectors,
- modularity - standard PLC components,
- flexibility to adapt to industrial regulators of similar or same industrial processes with appropriate change of parameters.

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The implementation in the real system followed after the realization of the hardware simulator and testing of the hardware and software components of the turbine governor cabinet.

Figure 2 - Overview (frontal) of the turbine regulation (left) and hardware simulator (right)

APPLIED TECHNOLOGY

One of the basic technical requirements demanded by the Investor is to place a hardware simulator in an electrical cabinet (of appropriate dimensions), which is connected to the cabinet system of the turbine governor by the wire via the connectors predicted by the turbine governor electrical project.

The hardware simulator of the steam turbine, ARS - TSSimATLAS (Figure 2), based on the ATLAS - MAX RTL® controller (in single configuration) is produced by the "Mihajlo Pupin" Institute. The system is designed so that it consists of components which are also of the family ATLAS®, produced by IMP:

- Atlas®XP2 - CPU module of the unit Atlas Max-RTL®
- BIF16 - module of the analogue current inputs,
- BAO08 - module of the analogue current outputs,
- BIS32W - module of the digital inputs,
- BOF32 - module of the digital outputs,
- BGT01 – module for speed sensor signal emulation – digital signal generator with configurable frequency (0 - 100Hz).

All above mentioned ATLAS components are located in one rack. Number of signals in the cabinet is as follows:

- 13 analogue output signals in the range [0.20]mA (max 16),
- 2 analogue input signals in the range [0.20]mA (max 16),
- 7 digital output signals (max 32),
- 2 digital input signals (max 32),
- 3 impulse digital output signals with variable frequency in the range [0.4]kHz.

Signals from the module go to the appropriate terminals and from there through the cable of the appropriate length to the connectors (Figure 3).

Figure 3 - Overview (rear) and method of connecting turbine control cabinet (right) with hardware simulator (left)

ADVANTAGES OF THE HARDWARE SIMULATOR IMPLEMENTATION

All Investor's requirements are fulfilled completely within the project. After the completion of the hardware simulator, the turbine control cabinet was tested successfully confirming the quality of the hardware and software components of the modernized turbine control systems. Besides the initial testing of the turbine control system, it is safe and simple to connect the unit with the hardware simulator and perform the additional testing when it is not in operation before the implementation in the real plant, or even later if one notices some issues regarding the logic of the turbine control. In such cases, mobility and dimensionality of the simulator are very important features. Also, it is possible to connect the ARS - TSSimATLAS simulator with turbine control systems of other manufacturers and thus to perform the performance testing of such systems and to train the operating personnel for the turbine plant control.

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