

Turbine Regulator

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1.1 Controller system

System is based on the Allen-Bradley 1756-L61 ControlLogix controller. It is a scalable controller solution that is capable of addressing a large amount of I/O points. Controller is placed in the backplane chassis powered by 1756-PA75 power supply. The backplane is able to serve up to eight independent modules.

Due to critical process structure and to ensure uninterrupted control operation as well as high reliability are used two base chassis with 1756-RM redundancy modules connected to separate backplanes. Redundancy modules are connected by high speed optical cable to ensure fast switching between “Active” and “Standby” controller in case of any failure.

The I/O modules are placed on three separate backplane chassis powered by the same power supply as controller chassis. Basically there are used five different types of I/O modules.

There are used ControlNet 1756-CN2 modules for communication among controllers and I/O modules.

The system structure is shown on the Figure 1.

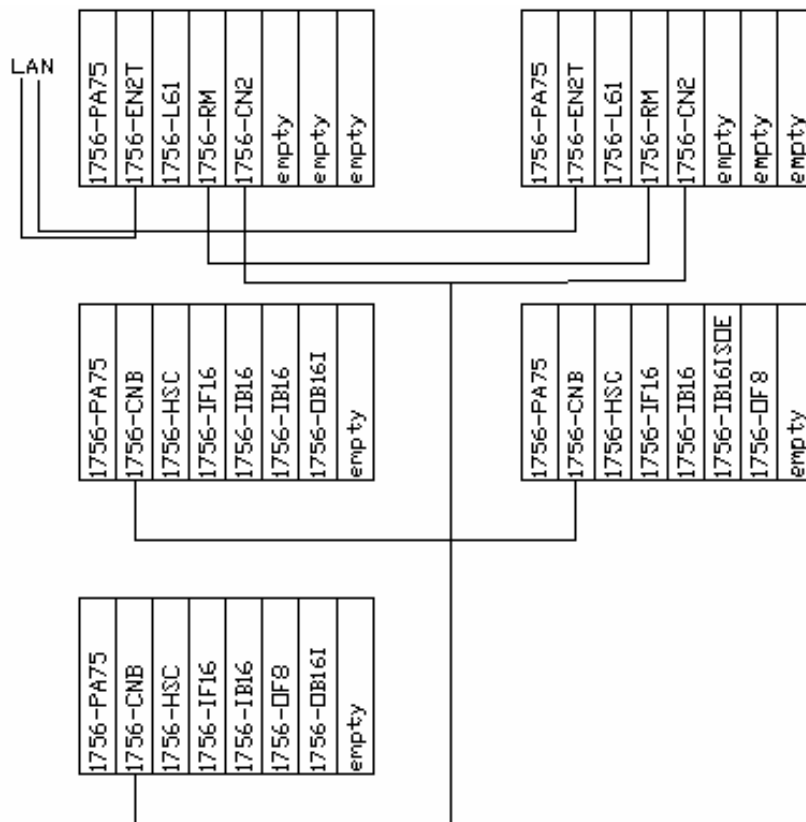


Figure 1. System Diagram

1.1.1 1756-EN2T module specification

The module is using the Ethernet Industrial (EtherNet/IP) network protocol which is industrial-networking standard that supports both real-time I/O messaging and message exchange. The EtherNet/IP network uses off-the-shelf Ethernet communication chips and physical media.

Specification:

- EtherNet/IP communication rate - 10/100 Mbps
- Logix communication connections - 256
- TCP/IP communication connections - 128

1.1.2 1756-L61 controller specification

Feature	1756-L61
Controller tasks	32 tasks 100 programs/tasks Event tasks: all event triggers
Built-in communication ports	RS-232 serial
Communicating options	EtherNet/IP ControlNet DeviceNet Data Highway Plus Remote I/O SynchLink Third-party process and device networks
Serial port communication	ASCII DF1 full/half-duplex DF1 radio modem DH-485 Modbus via logic
Controller connections supported	Max 250
Controller redundancy	Full support
Attribute	
User memory	2 MB
I/O memory	478 kB
Digital I/O	Max 128 000
Analog I/O	Max 4000
Total I/O	Max 128 000

1.1.3 1756-RM redundancy module specification

Modules are used for establish redundancy between a pair of controller chassis without additional programming and transparent to any devices connected over network. The primary controller chassis automatically determines what data changes during its scan and sends that data to the secondary controller.

- Reduce switchover times to as little as 20 ms
- Reduce ControlLogix footprint to a single slot
- Use CIP Time Synchronization with the 1756-EN2T in local redundant chassis
- Increase communication capacity with support for multiple ControlLogix L6x controllers and ControlLogix 1756-CN2B

1.1.4 1756-CN2 ControlNet module specification

ControlLogix ControlNet communication modules bridge ControlNet links to route messages to devices on other networks. The modules also monitor and control I/O modules located remotely from the ControlLogix controller.

ControlNet module provides:

- High-speed I/O bridge functionality to manage distributed I/O modules
- Transfer of scheduled data via produced/consumed tags
- Unscheduled MSG instruction communication with other ControlNet nodes
- Messaging data for configuration and programming information, operator interfaces, upload/download

1.1.5 1756 I/O modules

1756-HSC module

The module counts pulses by using a Counter or Frequency operational mode. The counts are presented as either 'accumulated count' or 'frequency' depending on the mode that is configured for the module.

Pulse count values can be calculated by using different types of Counter and Frequency modes. The simple counter uses only input A to count pulses. An encoder uses both input A and input B to count pulses. The relationship between the two channels is how the encoder determines if the count is positive (clockwise) or negative (counterclockwise).

- Number of counters – 2
- Number of outputs – 4
- Inputs per counter – 3

Input frequency (max): 1 MHz in Counter mode
500 kHz in Rate Measurement mode
250 kHz in Encoder mode

Count range: 0...16.777.214

IF/OF modules

Basic features: on-board data alarming, scaling to engineering units, real-time channel sampling

Data format: integer mode (left justified)

Conversion method: sigma-delta

1756-IF16 module

Inputs: 16 single ended, 8 differential or 4 differential (high speed)

Input range: $\pm 10.5\text{V}$, 0...21 mA

Resolution: 16 bits (10.5V: 343 $\mu\text{V/bit}$; 0...21 mA: 0,34 $\mu\text{A/bit}$)

1756-OF8 module

Outputs: 8 voltage or current

Output range: $\pm 10.4\text{V}$, 0...21 mA

Resolution: 15 bits (across 21 mA – 650 nA/bit; 10,4 V – 320 $\mu\text{V/bit}$)

IB/OB modules

Basic features: variety of voltage interface capabilities, point-level output fault states, direct-connect or rack-optimized communication, field-side diagnostics

1756-IB16 module

Inputs: 16 (8 points/group)

Voltage category: 12/24 V DC sink

Operating voltage range: 10 ... 31,2 V DC

Digital filter, off to on: 0,1, or 2 ms

1756-OB16I module (Isolated output module)

Outputs: 16 individually isolated

Voltage category: 12/24 V DC sink/source

Operating voltage range: 10 ... 30 V DC

Output delay, off to on: 1 ms

1756-OB16ISOE module (sequence of events input module)

Inputs: 16 individually isolated, sequence of events

Voltage category: 24/48 V DC sink/source

Operating voltage range: 10 ... 55 V DC

Digital filter, off to on: 0 ... 50 ms

1.2 Valve positioner system

The valve positioner system is based on MOOG M3000 automation system. The system is consists of programmable controller (Moog Servo Controller – MSC), software (Mood Axis Control Software - MACS) and components (servomotors, servo-drives, servo-valves, etc.)

Moog Servo Controller MSC

MSC is freely programmable multi-axis controller with IEC 61131 development environment. It is designed to realization of fast and precise controls, suitable for electrical and hydraulic drives. Controller structures are definable with cycle times from 400 µs.



Figure 2. The Moog Servo Controller PLC

Module data	MSC controller
Assembly	Plug-in terminal strips for screwing or clamping
Temperature range	+5 °C to 55 °C
Processor	PowerPC Processor
Memory	32 bit, RISC architecture with floating point unit 2MB burst RAM 4,5MB burst Flash EEPROM
Interfaces	
Ethernet (10BaseT)	10 Mbit/s; 8-pled RJ45 connection

2 independent CAN interfaces	10 kBit/s to 1 Mbit/s (adjustable)
>>WCAN<<	WideCan: 2 Sub-D >>WCAN<< connectors
LocalCAN	LocalCAN: in the side E-bus socket
>>MACS<< on front cover	Communication with the MACS software on the PC
>>SIO<< on front cover	For free use in the application program
Extension bus (E-bus)	Connectors on right and left of module for connecting up to 7 additional M3000 modules.
Digital inputs/outputs	
Voltage supply of the digital I/O	24 V DC (18-32 V DC) SELV pursuant to IEC 61131-2
Current consumption of the digital I/O	0,3 A in idling; all outputs active: 4 A
8 digital inputs and outputs	Individually configurable in MACS as input or output. Inputs: type 1 (current-consuming) pursuant to IEC 61131-2 Outputs: max. 0.5 A Sustained short-circuit protected
Watchdog output	Signalizes readiness for operation of the analog and digital outputs.
Analog Inputs/Outputs	
Voltage supply to analog I/O	Internal via a DC/DC converter
8 analog inputs	16 Bit; individually configurable in the MACS software as ± 10 V, ± 10 mA or 4–20 mA; overvoltage protection up to ± 40 V
2 analog outputs	16 Bit; each ± 10 V, additionally individually configurable in the MACS software as ± 10 mA, ± 50 mA or 4–20 mA Overvoltage protection up to ± 40 V; sustained short-circuit protected

MOOG D633 servo control valves

The D633 is Direct Drive Valve (DDV) with electric closed spool position control. Valve is throttle valve for 3-, 4-, and 2x2-way applications. It is suitable for electrohydraulic position, velocity, pressure or force control systems including those with high dynamic response requirements.

The spool drive device is a permanent magnet linear force motor which can actively stroke the spool from its spring centered position in both directions. This is an advantage compared with proportional solenoids with one force direction only. The closed loop spool position electronics and pulse width modulated (PWM) drive electronics are integrated into the valve.

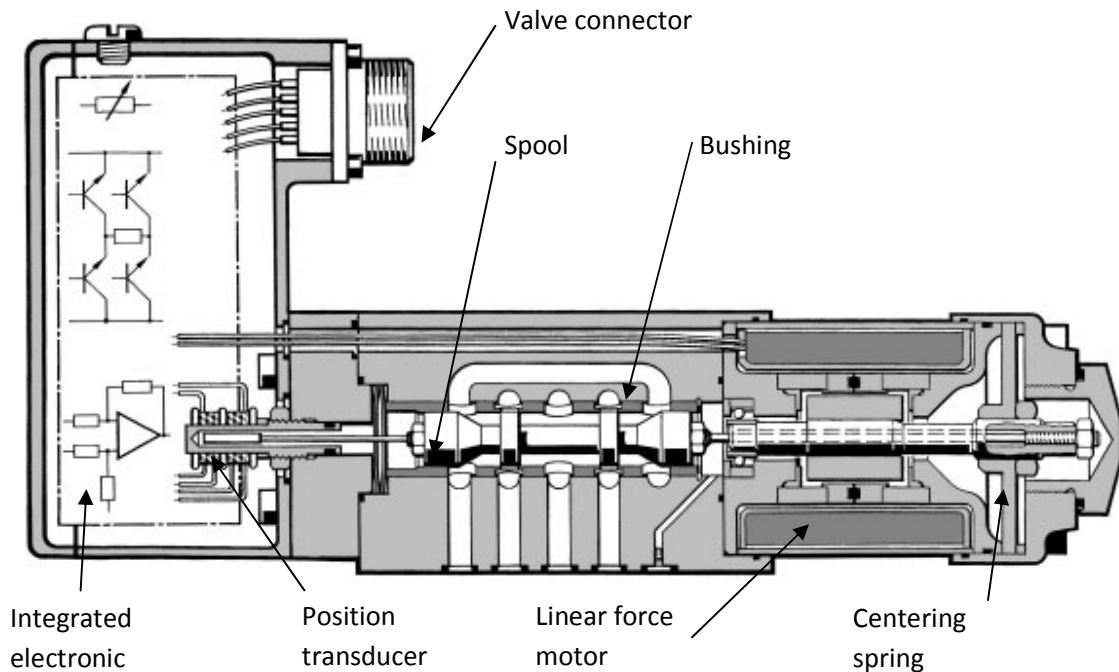


Figure 3. Servo Control Valve Schematics

Micropulse transducers

There are used Balluff BTL5-E Profile for detection of the actual position of valves. Balluff Micropulse transducers in the Profile housing are an alternative to linear transducers such as potentiometers, glass scales, and LVDTs. The linear sensing element is protected in an aluminum extrusion.

The measuring point along the sensing element (waveguide) is indicated by a passive marker (magnet), which needs no power.

Specification:

- Output - Potential-free
- Output current – 4 ... 20 mA
- Hysteresis - $\leq 4 \mu\text{m}$
- Sampling rate - $f_{\text{STANDARD}} = 1 \text{ kHz}$



Figure 4. Balluff Micropulse Transducers

A whole valve positioner system is shown on the Figure 5.

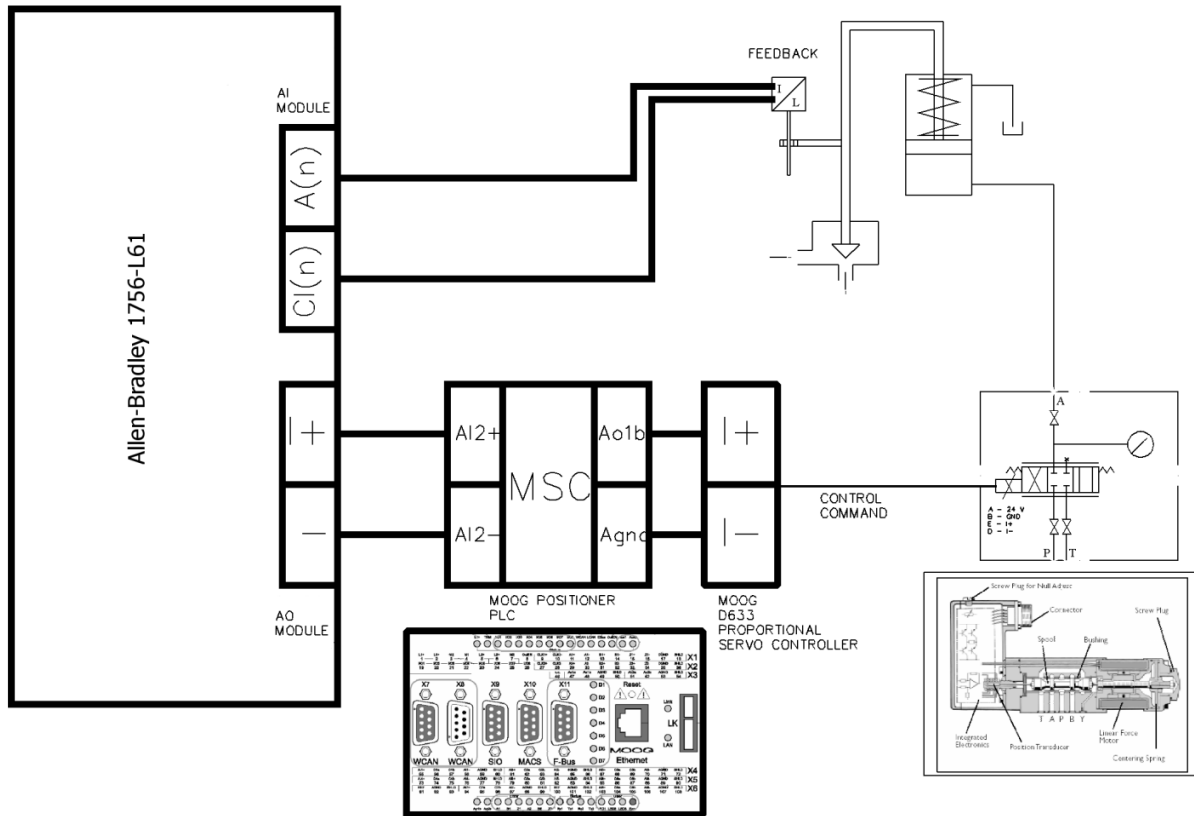


Figure 5. Positioning System Diagram

1.3 Turbine rotation speed sensors

The RPM Transducer PR 9376 is ideally suited for contactless measurement of rotational frequency of ferromagnetic machinery components. Universal design, simple mounting and excellent characteristics enable it to be used in a wide range of applications.

Due to high resolution, fast internal electronic and the sharp edged output pulses the PR 9376 is suitable for measurement of extremely high as well as very low rotational speeds with high resolution.

The head of PR 9376 is a differential sensor consisting of two magneto sensitive semiconductor resistors which are connected in series and mounted above a small permanent magnet. Two resistors of the transducer- electronic part complete this configuration into a Wheatstone Bridge which controls a following DC-switching amplifier with fast push-pull short circuit proof output.

Specification:

- Principle measurement - Differential magnetic field sensor
- Triggering - Contactless by mechanical trigger marks
- Trigger frequency range – 0 ... 20 kHz
- Output - Short circuit proof push-pull output stage
- Output pulse voltage – HIGH 10 V, LOW 1 V
- Pulse rise and fall time - < 1 μ s



Figure 6. Rotation Speed Sensors

1.4 Control logic

According to used hardware solution there is a used RSLogix 5000 software for design and configuration. Logix technology offers a unique approach — one control platform using a common control engine with a common development environment.

The logic is divided into 5 tasks according to control option:

- Control Logic (main program)
- Load Loop
- Pressure Loop
- Speed Loop
- Valve control

1.4.1 Control Logic

It consists of 18 separate control sheets.

S05_TC_mjerenja:

Related inputs – MW measurement, Pressure setpoint from LDC, throttle pressure (and signal quality), LDC output MW, control oil pressure (and signal quality)

Related outputs – active power > 30 MW, active power < 10 MW, active power, pressure setpoint value from LDC, throttle pressure, throttle pressure measurement failed, load setpoint value from LDC

S06_SPEED_MED_SEL_OVERSPEED_SETPOINTS:

Related inputs – turbine rotor rotation speed, speed measurement failed, valve position frequency limiter, mechanical over speed test

Related outputs – speed sensor manual request, turbine rotation speed, close cv protection setpoint, turbine over speeded, turbine speed in limits, over speed protection setpoint, mechanical turbine over speed, speed measurement failed

S08_MUT_control_logic:

Related inputs – turbine latched/not latched, IP stop valve opened/closed, HP stop valve opened/closed, open safety valves, external TG protection, close safety valves, MUT ready/opened/closed

Related outputs – HP SV not opening/closing, IP SV not opening/closing, all safety valves are opened, MUT open/close command

S09_TC_DUMP_CV_LOGIC:

Related inputs – active power > 30 MW, generator synchronized, turbine latched/not latched, turbine over speeded, block speed protection over speed test, external TG protection, speed measurement failed

Related outputs – overload protection, over speed protection, HP valve PLW, IP valve PLW, bypass valve PRA, valve position frequency limiter

S10_TC_PROTECTIONS:

Related inputs – turbine valves contingency, external turbine protection, boiler protection, off turbine safety valves, mechanical turbine over speed, speed measurement failed, speed sensor manual request, generator synchronized, acknowledge turbine protection, TG trip reason

Related outputs – external TG protection, TG trip is active, open turbine solenoid command, TG trip reason

S11_Turbine_latched_logic:

Related inputs – generator breaker on, control oil pressure to safety valves is OK

Related outputs – generator synchronized/not synchronized, turbine latched/not latched

S12_OVER_SPEED_TEST_LOGIC:

Related inputs – on/off over speed test, generator synchronized, external TG protection

Related outputs – block speed protection over speed test

S19_AUTO_SYNCHRONIZATION_LOGIC:

Related inputs – on/off auto synchronization, turbine in manual control, generator synchronized, turbine speed > 2950 rpm, synchronization request more rpm, increase/decrease pushbutton for synchronization

Related outputs – auto synchronization on, auto synchronization is valid, synchronizer increase/decrease

S20_TURBINE_MANUALAUTO_LOGIC:

Related inputs – TP loop on/off, speed loop on, turbine in auto, turbine latched, HP/IP governor in manual, speed loop selected, turbine to manual, HP valves contingency, IP or LPBP valves contingency, mechanical turbine over speed, generator synchronized, turbine latched, manual reject HP/IP governor

Related outputs – turbine in auto/manual, manual reject HP/IP governor, HP/IP valves in auto, initial MW pickup, turbine valves contingency, engage SP loop, engage LDC loop, engage MW loop, engage TP loop

S21_OVERSPEED_SELECTION_LOGIC:

Related inputs – engage SP loop, generator synchronized, speed loop on, speed measurement failed, speed loop off, open loop on, block speed protection over speed test, mechanical turbine speed test, turbine not latched

Related outputs – speed loop selected, selected loop interlock, mechanical over speed test, mechanical and el. Over speed test is not active, electrical test turbine speed is not active, electrical test turbine speed

S22_SPEED_LOOP_SELECTION_LOGIC:

Related inputs – select SP setpoint, new speed demand is not valid, auto synchronization on, speed setpoint in resonance range, new speed rate out of limits, select SP rate, generator synchronized, speed controller is tracking valve position, generator synchronized, external TG protection, turbine not latched, speed delta > 50 rpm, turbine in manual control

Related outputs – new speed setpoint is not valid, new speed setpoint enabled, wrong speed rate selection, new speed rate enabled, speed SP is tracking

S23_SPEED_LOOP_SELECTION:

Related inputs – turbine speed > 3000 rpm, turbine in manual control, turbine speed in limits, hold over speed test, mechanical and electrical over speed test is not active, speed SP is tracking, speed demand is changing, select SP setpoint, speed loop selected, hold changes pushbutton, auto synchronization on, go to change, speed in resonance range, block speed protection over speed test, engage over speed test, over speed protection, turbine not latched, generator not synchronized

Related outputs – speed controller is tracking valve position, hold changes, close valves

S24_MW_LOOP_LOGIC:

Related inputs – generator not synchronized, MW loop selected, MW controller is tracking valve position, MW delta in limits, hold changes pushbutton, select MW setpoint, go to change, boiler runback, turbine remote control

Related outputs – MW controller is tracking PV, hold MW changes

S25_MW_LOOP_LOGIC:

Related inputs – turbine in manual control, MW delta high limit active, generator not synchronized, MW loop selected, select MW setpoint, MW rate out of limits, select MW rate,

Related outputs – MW controller is tracking valve position, enter MW setpoint from keyboard, enter MW rate enabled

S26_REMOTE_LOOP_SELECTION:

Related inputs – LDC in auto mode, generator synchronized, remote control on/off, MW loop selected, engage LDC loop, open loop on, LDC MW output demand quality, LDC does not track LDC in BF, boiler follow mode, coordinate control – boiler follow mode, turbine remote control, MW loop on, TP loop selected, MW loop off, turbine follow mode, TP demand is not valid

Related outputs – turbine remote control, select MW loop interlock, MW loop on

S27_TP_RATE_SELECTION_LOGIC:

Related inputs – select TP rate, operator entered setpoint/TP rate in limits, select TP setpoint, TP loop selected, hold changes pushbutton, TP demand is changing, go to change, take nominal parameters, turbine remote control

Related outputs – new setpoint/TP rate enabled, TP controller is tracking PV, hold TP changes

S28_LOOPS_SELECTION_LOGIC:

Related inputs – TP loop off, turbine remote control, coordinate control boiler follow mode, engage MW loop, open loop on, engage LDC loop, LDC base mode, TP loop on, turbine follow mode, boiler runback, active power < 10 MW, boiler follow mode, throttle pressure measurement failed, MW loop on

Related outputs – MW loop selected, TP loop selected, on TP loop entry rate selected, selected TP loop interlock

S29_OPEN_LOOP_LOGIC:

Related inputs – on open loop, turbine speed rotation speed, generator synchronized, turbine in auto, speed loop selected, TP loop selected, turbine valves contingency, turbine over speeded, turbine not latched, MW loop on, turbine in manual control, turbine remote control, open loop on, go to change, select open loop interlock, hold changes pushbutton, open loop demand is changing

Related outputs – open loop on, select open loop interlock, go to change valve position

1.4.2 Load Loop

It consists of 3 separate control sheets. The logic of this loop is used for turbine control when running in load loop.

S45_MW_Loop_Setpoint_Rate_Memory:

Related inputs – initial MW setpoint, initial MW pickup, MW loop selected, MW loop on, turbine remote control, select MW rate, turbine remote control, runback limit, active power, MW controller is tracking PV, enter MW rate enabled, runback rate, TG runback load limit enabled, generator synchronized, hold MW changes

Related outputs – LDC does not track LDC in BF, MW demand in memory, MW rate out of limits, MW rate in memory, MW rate

S46_MW_Loop_Output:

Related inputs – MW rate, MW controller is tracking PV, MW demand in memory, initial pickup, frequency corrector, active power

Related outputs – MW reference demand, MW delta high limit active, MW delta in limits, MW loop delta

S47_MW_Loop_Demand:

Related inputs – throttle pressure, valve position setpoint, MW reference demand, active power, MW loop on, generator synchronized, MW loop selected, open loop on, MW controller is tracking valve position

Related outputs – initial MW setpoint, MW loop valve position demand

1.4.3 Pressure Loop

It consists of 2 separate control sheets. The logic is used when turbine operates in pressure loop.

S55_TP_Setpoint_Rate_Memory:

Related inputs – select TP setpoint/rate, take nominal parameters, new TP setpoint/rate enabled, pressure setpoint value from LDC, turbine remote control, boiler follow mode, TP controller is tracking PV, on TP loop entry rate selected, turbine remote control, hold TP changes

Related outputs – select TP setpoint, operator entered setpoint/rate is in limits, TP demand in memory, TP rate in memory, TP rate value

S56_TP_Setpoint_Calculation:

Related inputs – TP rate value, TP controller is tracking PV, engage TP loop, active power, throttle pressure, TP demand in memory, valve position setpoint, TP loop selected,

Related outputs – TP demand is changing, TP loop delta, TP loop valve position demand, TP reference

1.4.4 Speed Loop

It consists of 5 separate control sheets. The loop is providing logic when turbine is operating in speed loop mode.

S30_RESONANCE_RANGES_CALCULATING:

Related inputs – turbine speed rotation speed, speed reference, generator synchronized, speed, in resonance range

Related outputs – resonance range calculator output, speed in resonance range, resonance range 1 - 4

S32_FREQUENCY_CORECTION:

Related inputs – turbine rotation speed, MW loop on, primary control ON/OFF pushbutton

Related outputs – frequency corrector, frequency corrector to LDC, turbine speed > 2970

S35_Speed_Setpoint_Rate_Memory:

Related inputs – synchronizer increase/decrease, mechanical over speed test is not active, electrical turbine speed is not active, new speed setpoint enabled, generator synchronized, speed SP is tracking, resonance range calculator output, select SP setpoint, select SP rate, new speed rate enabled, auto synchronization on, mechanical and electrical over speed test is not active, hold changes,

Related outputs – speed rate in memory, speed loop rate, new speed rate out of limits, speed demand in memory, new speed demand is not valid, speed setpoint in resonance range, setpoint in resonance range 3

S36_Speed_Setpoint_calculation:

Related inputs – speed loop rate, speed in resonance range, speed SP is tracking, speed demand in memory, turbine rotation speed

Related outputs – speed demand is changing, speed delta > 50 rpm, SP loop delta, speed reference

S37_Speed_Loop_Demand:

Related inputs – throttle pressure, IP/HP governor in manual, speed controller is tracking valve position, turbine rotation speed, speed reference, valves position setpoint, close valves

Related outputs – speed loop valve position demand

1.4.5 Valve Control

It consists of 6 separate control sheets. The loop is providing logic for valve control.

S32_LPBP_Valves_Control:

Related inputs – IP valves position setpoint

Related outputs – LPBP valves position setpoint

S60_Loop_Selection:

Related inputs – turbine valves contingency, turbine over speeded, valves position setpoint, open loop reference, speed loop valve position demand, speed loop selected, MW loop valve position demand, TP loop valve position demand, MW loop selected, TP loop selected, open loop on, turbine in auto, open loop rate in memory, go to change valve position, open loop on, valve position loop delta, valves position setpoints, open loop demand in memory, open loop reference

Related outputs – open loop demand in memory, open loop delta, open loop demand is changing, open loop reference, valve position loop delta, valve position demand

S61_HP_IP_Valves_Output:

Related inputs – turbine latched/not latched, open loop on, turbine in manual control, TG trip is active, valve position demand, turbine rotation speed, block speed protection over speed test, valve position frequency limiter, valves position set point, IP valves to auto, manual reject IP governor, IP governor to auto/manual, HP valves to auto, manual reject HP governor, HP governor to auto/manual

Related outputs – IP valves position setpoint, IP governor in manual, HP valves position setpoint, HP governor in manual, valves position setpoint, IP/HP mastation track

S62_HP_Valves_Output:

Related inputs – HP valve #1 – 7 measurement # 1 – 2, HP valves position setpoint, Moog valve HP #1 – 7 ready, TP #1 – 2 HP valve #1 – 7 ready, MCS #1 – 2 ready

Related outputs – HP valve #1 – 7 selected position measurement, contingency HP valve #1 – 7, HP valve #1 – 7 setpoint and electrical error HP valve #1 - 7

S64_LPBP_Valves_Output:

Related inputs – IP valve #1 – 2 position measurement #1 – 2, IP valves position setpoint, Moog valve IP #1 – 2 ready, TP #1 - 2 IP valve #1 – 2 ready, MSC #5 - 6 ready, LPBP valve #1 – 2 position measurement #1 -2, LPBP valves position setpoint, Moog valve BV #1 – 2 ready, TP #1 – 2 BV #1 – 2 ready

Related outputs – IP valve #1 – 2 position measurement, contingency IP valve #1 – 2, IP valve #1 – 2 position, electrical error IP valve #1 – 2, LPBP valve #1 – 2 selected position measurement, contingency LPBP valve #1 – 2, LPBP valve #1 – 2 position setpoint, electrical error LPBP valve #1 - 2

S65_Valves_Contingency:

Related inputs – electrical error HP valve #1 – 7, electrical error IP valve #1 – 2, electrical error LPBP valve #1 - 2

Related outputs – HP valves contingency, IP or LPBP valves contingency

1.5 Operator interface

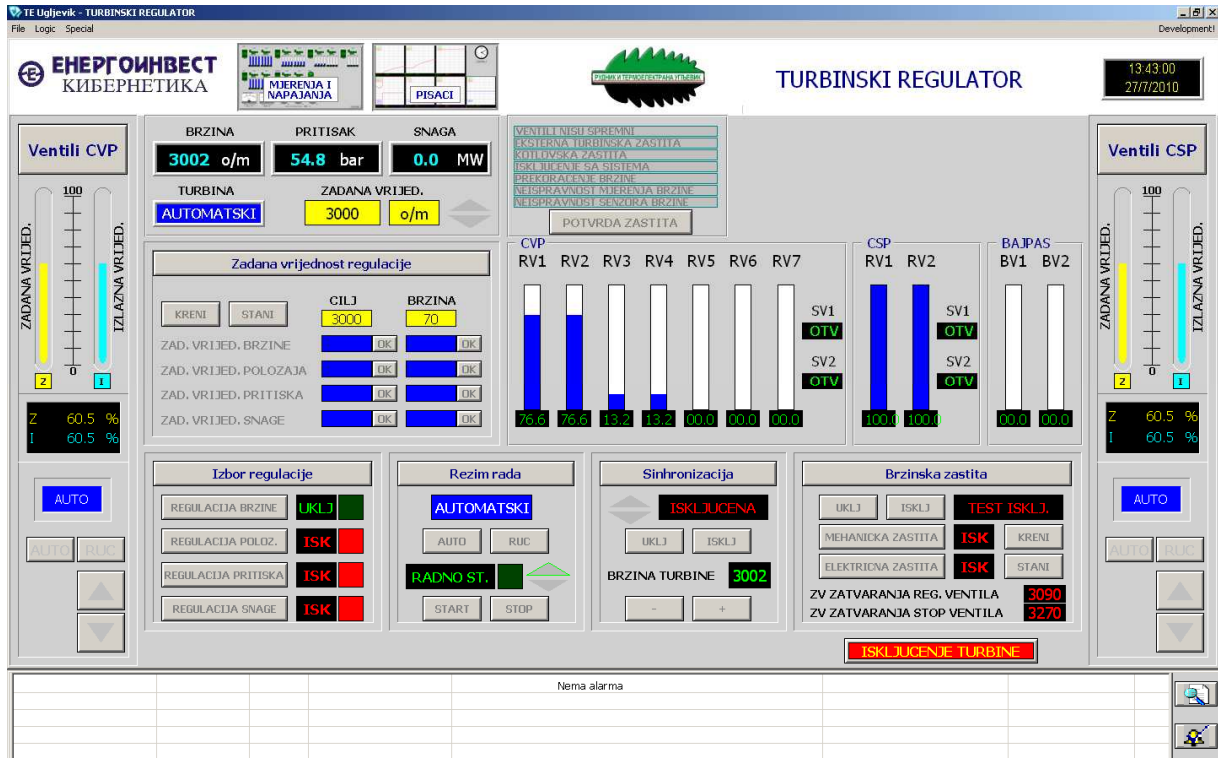


Figure 7. Main Graphic Window

The main operator graphic window is shown on the Figure 7. All important process information is visible on the main graphic.

The window is divided into 11 parts according to scope of control. Only one part can be managed at the same time.

1.5.1 Header

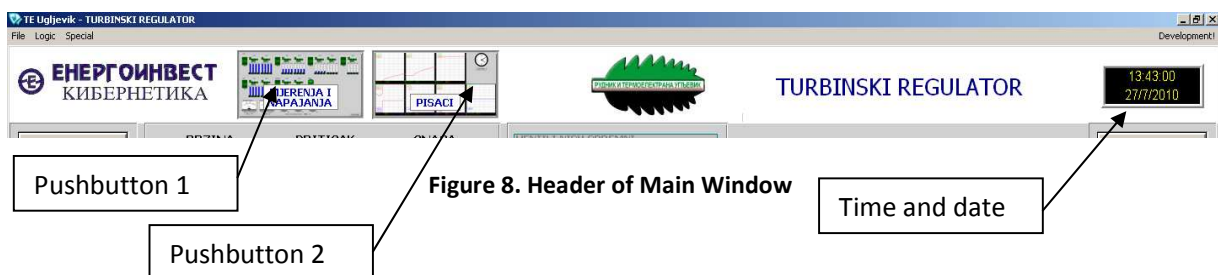


Figure 8. Header of Main Window

On the header part you can find two pushbuttons and one information area. The pushbutton 1 is opening new window „measuring and power supply“ (Figure 99). The pushbutton 2 is opening new window „trends“ (10). The information area contains time stamp information.

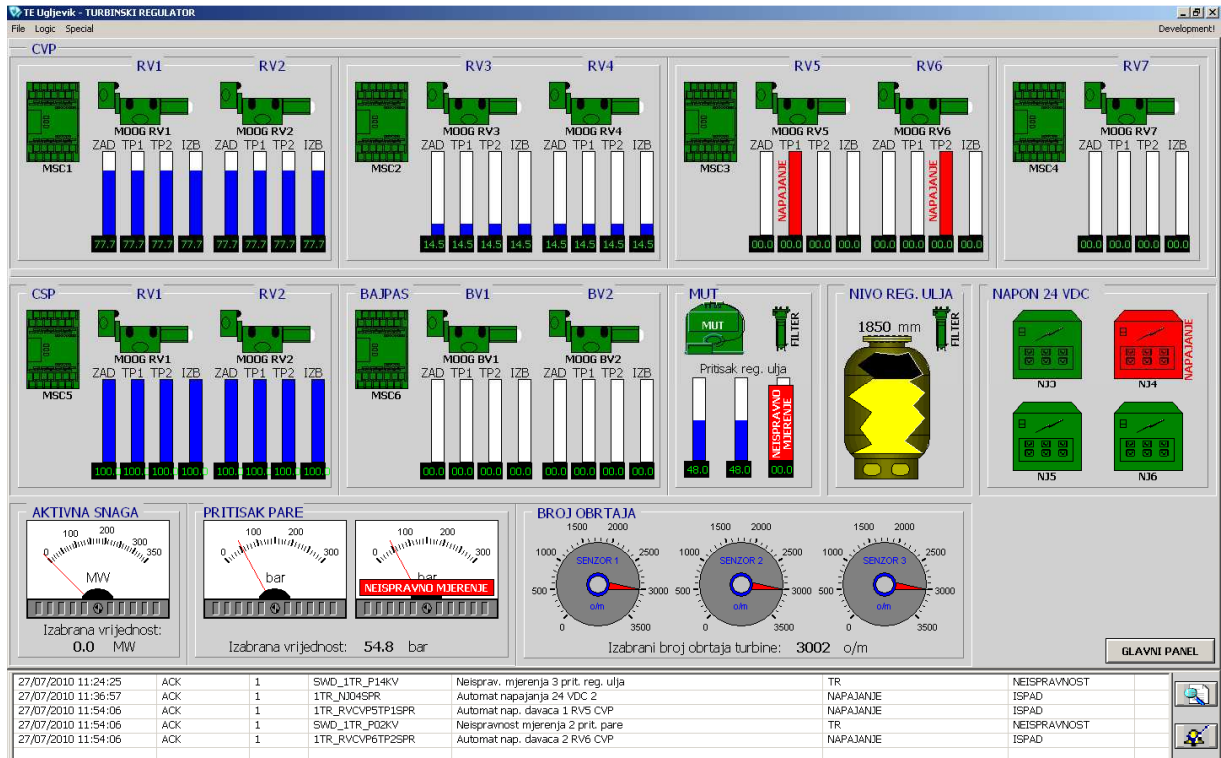


Figure 9. Measuring and Power Supply Window

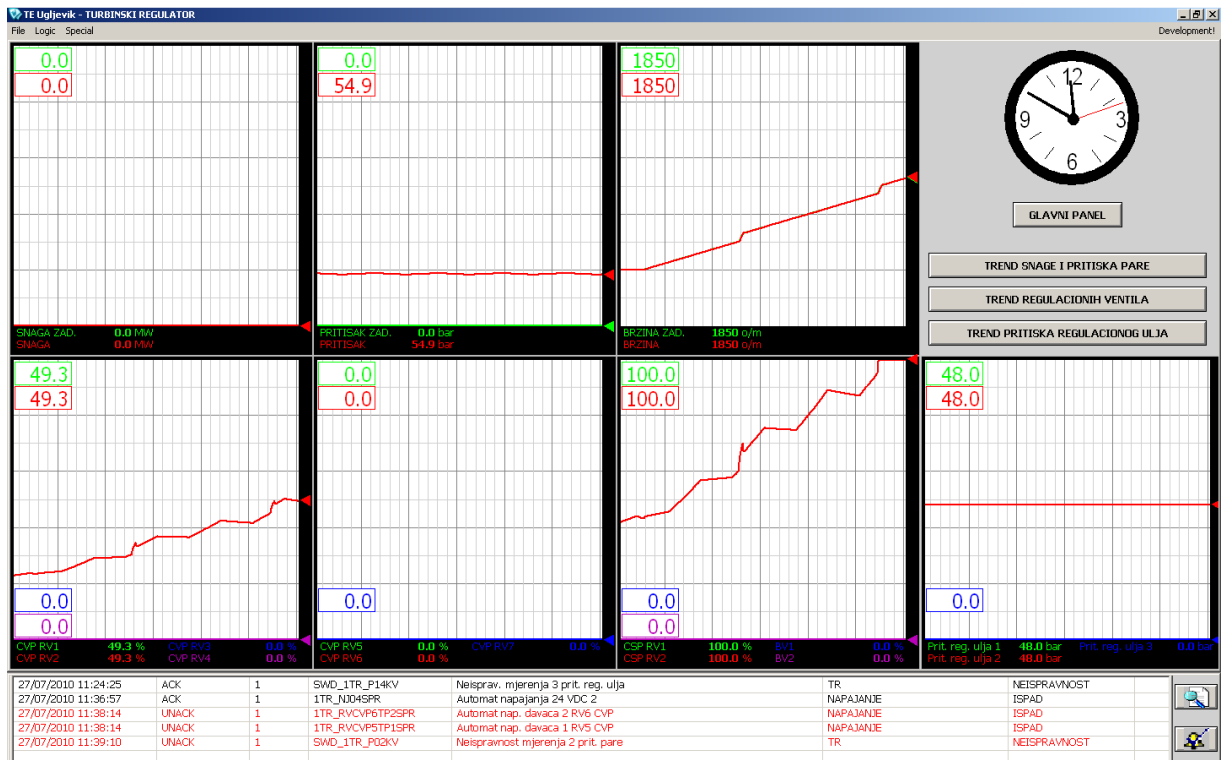


Figure 10. Trends Window

1.5.1.1 Measuring and power supply window

The graphic window is designed to provide online monitoring of:

- actual position of valves (HP, IP, BP, MUT) [%]
- valves setpoint [%]
- Moog valves position [%] (and power supply – red color means out of order)
- Oil pressure on MUT valve [bar]
- Oil filter state (red color means replace)
- Level of oil in tank [mm]
- power supply state (red color means out of order)
- Active power [MW]
- Steam pressure [bar]
- Actual turbine rotation speed [rpm]

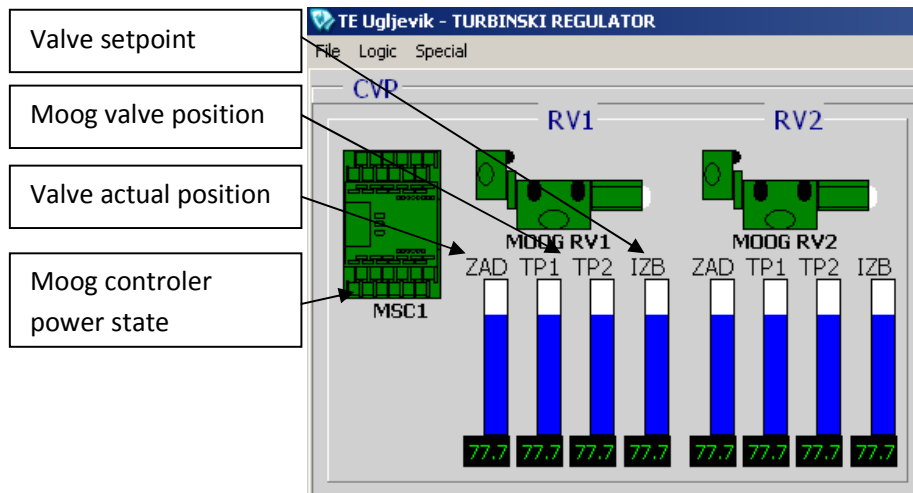


Figure 11. Valve Information

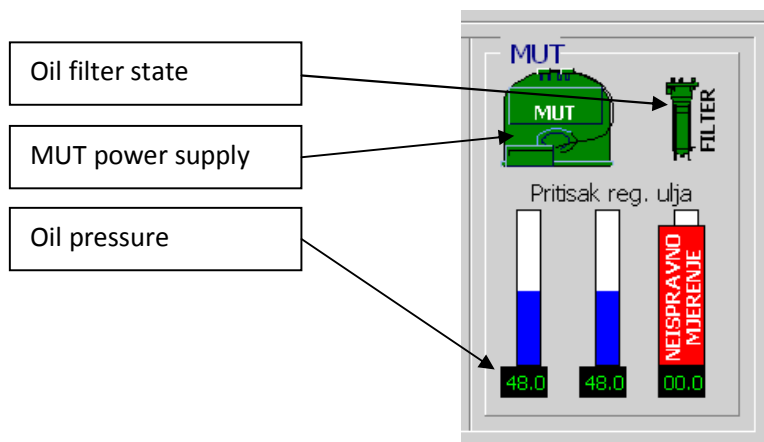


Figure 12. MUT Valve

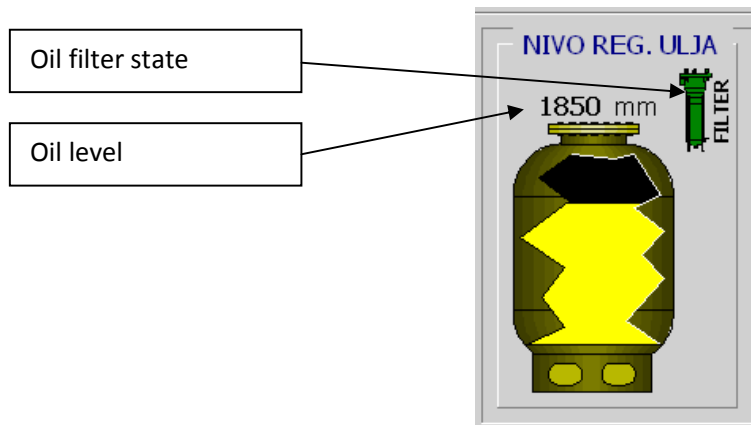


Figure 13. Oil Level

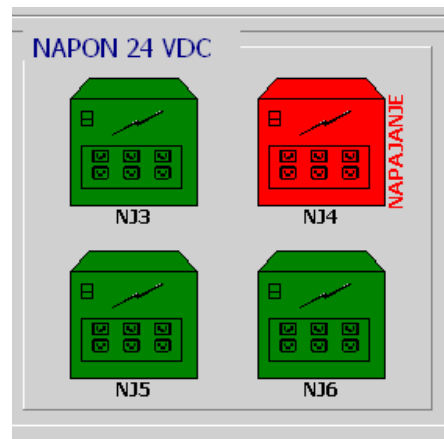


Figure 14. Power Supply State

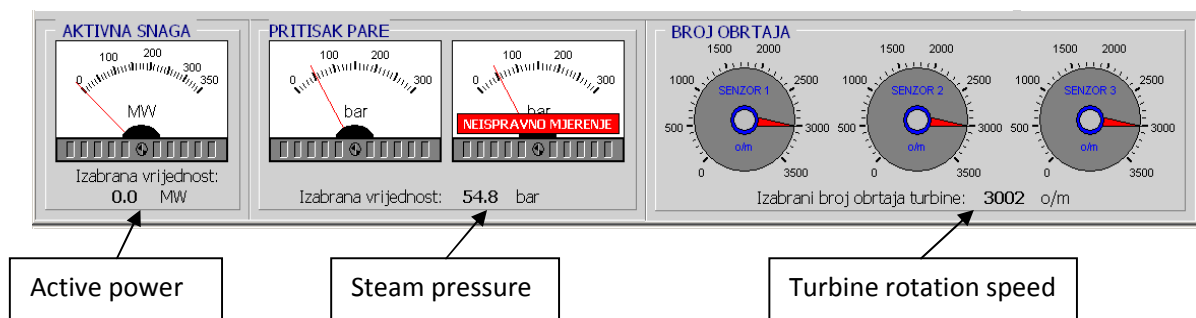


Figure 15. Active Power, Steam Pressure, Turbine Rotation Speed

There is a pushbutton “GLAVNI PANEL” to return back to the main window.

1.5.1.2 Trends window

The window is providing time behavior selected variables and their setpoints:

- Active power
- Steam pressure
- Turbine rotation speed
- Valve position

1.5.2 High/Intermediate pressure valves control

To activate the control field, there is necessary to press the „Ventili CVP“/„Ventili CSP“ button first. Even if the area is not activated there are visible actual information about the setpoint and real value. This information is interpreted by both bar chart for review and exact value.

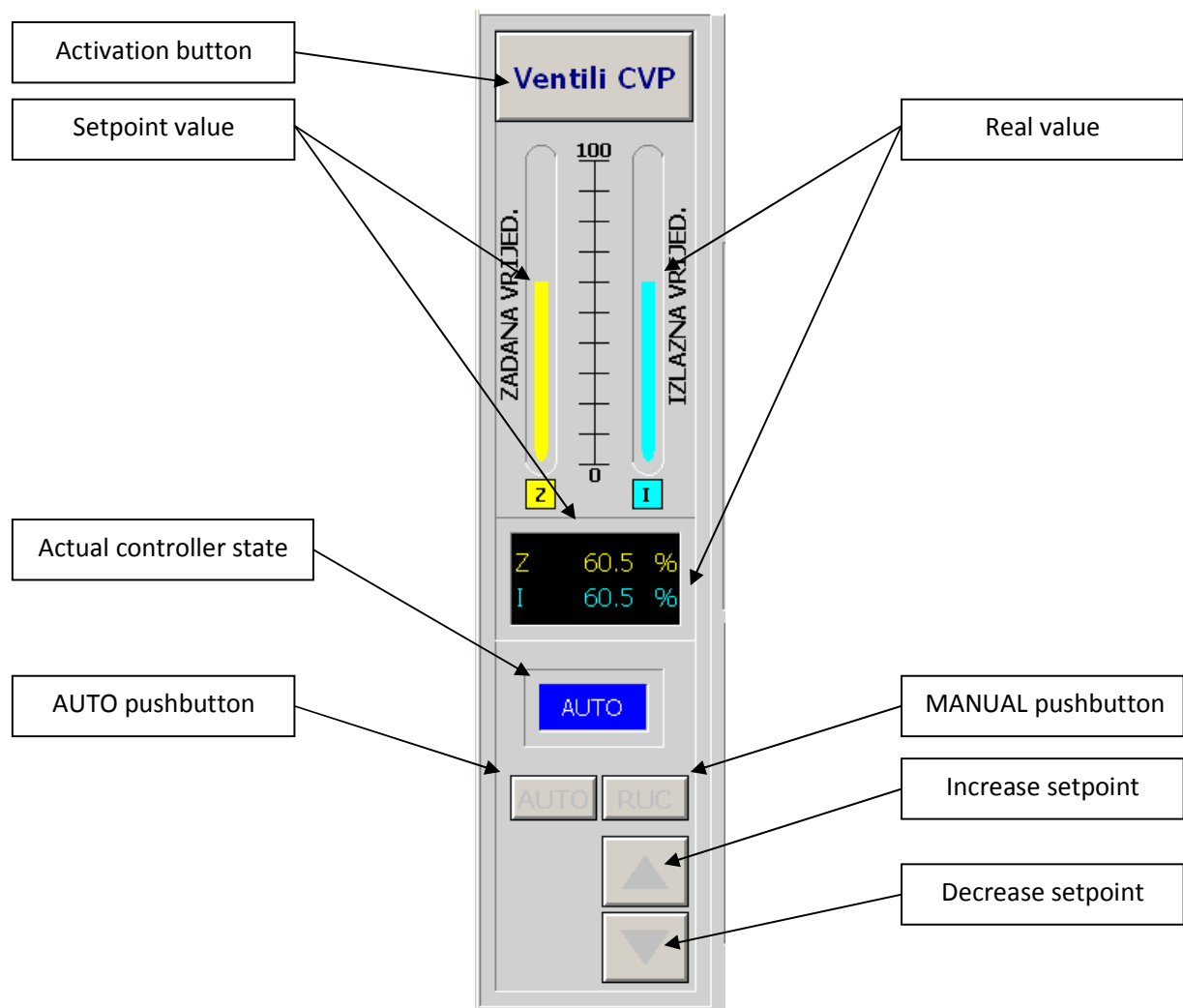


Figure 16. HP Valve Control

To change controller state from/to “AUTO”/“MANUAL” use appropriate pushbutton. When the “MANUAL” mode is active a two pushbuttons are active as well. These pushbuttons are used to increase/decrease setpoint value.

1.5.3 Regulation options

After activation this area you are able to choose the regulation scheme:

- Speed loop
- Open loop
- Pressure loop
- Load loop

The availability of desired regulation is depends on the current turbine state. When the field on the left side of the area is green colored the scheme is available. When the color is red the conditions for regulation are not met.



Figure 17. Regulation Options

1.5.4 Regulation setpoint

The area is closely associated with the previous „Regulation options“ area. When active you are able to setup setpoint and rate for related regulation.

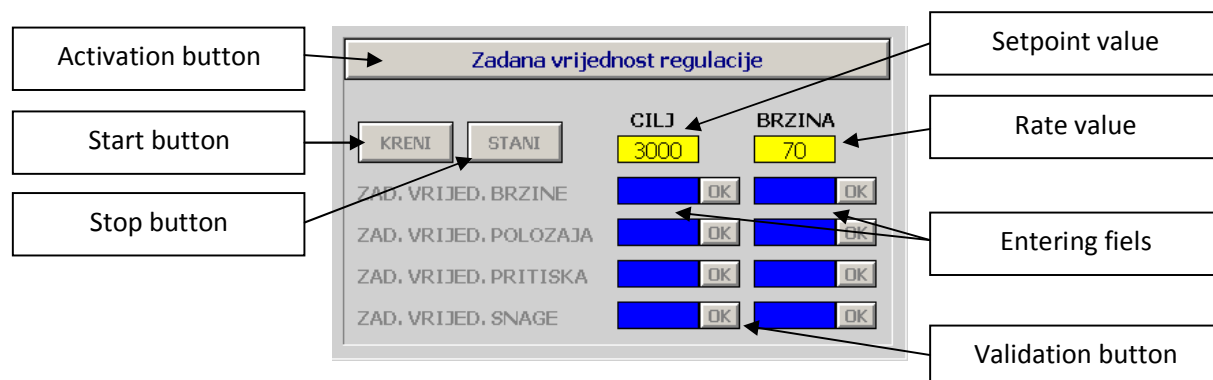


Figure 18. Regulation Setpoint

After mouse click into enabled entering field new window is populated (Figure 19). By mouse click on specified number the new value is created. To correct the entered value you can use the “Backspace” button. By click on the “OK” button the new value is entered to the specified regulation setpoint/rate area. To validate the new value press the button next to the new value.

The image shows a dialog box titled "Unesi novu vrijednost" (Enter new value). It contains the following elements:

- Current Value: 0
- Minimum Value: 0
- Maximum Value: 4000
- New Value: 0 (input field)
- Numeric keypad with buttons for digits 0-9, a backspace button (<...), and OK/Cancel buttons.

Figure 19. Setpoint Value Window

When the entering of the new values is finished the “Start” button need to be pressed (note: when rate value is changed only, no need to press the “Start” button).

1.5.5 Notification area

The area contains both the information fields and control fields as well. The basic information about turbine rotation speed, steam pressure, active power and actual regulation state are available. There is ability to slightly change actual value of variable according to selected regulation.

The image shows a notification area with the following data:

- BRZINA: 3002 o/m
- PRITISAK: 54.8 bar
- SNAGA: 0.0 MW
- TURBINA: AUTOMATSKI
- ZADANA VRIJED.: 3000 o/m
- Buttons: Increase button, Decrease button

Figure 20. Notification Area

1.5.6 Turbine trip notification area

When turbine is going to trip for some reason, you can find it in this part of main graphic window. As shown on the Figure 2121 there are seven options for turbine trip. No other operation is possible until the acknowledge button is pressed.

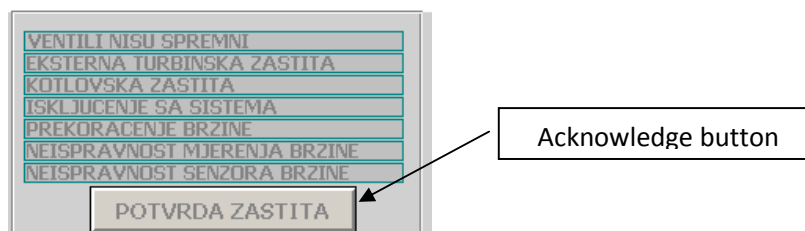


Figure 21. Turbine Trip Information

If there is more than one turbine trip condition met only the first one is signalized by red color. Rests of them are signalized by green color.

1.5.7 Valve area

The part is designed to monitor actual state of the high pressure valves, the intermediate pressure valves and the bypass valves as well. A value represents the percentage of the valve opening range.

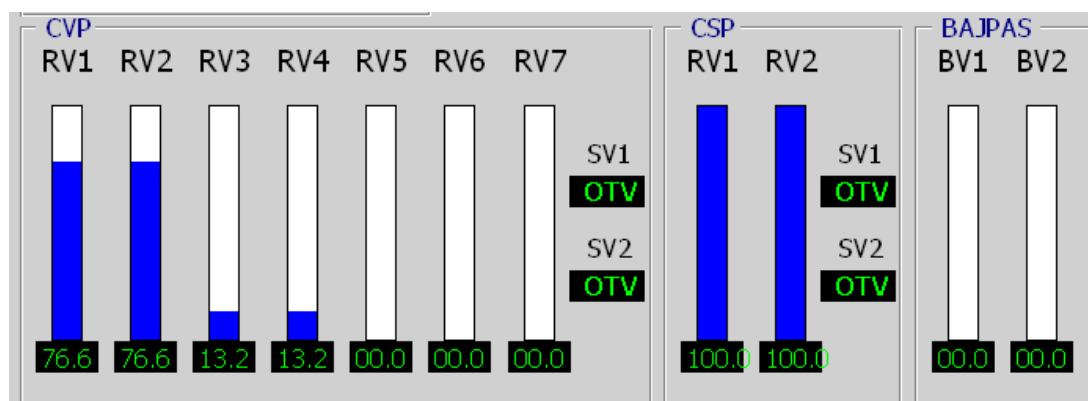


Figure 22. HP/IP/BP Valves Area

On the area you are able to monitor a valve contingency as well. The contingency is signalized by red color mark under the valve name.

There are not any control buttons or active pokes in the area.

1.5.8 Auto/Manual option

This area is used to select between turbine regulation mode – “automatic” and “manual”. Actual regulation mode is signaled by the text field below the activation button.

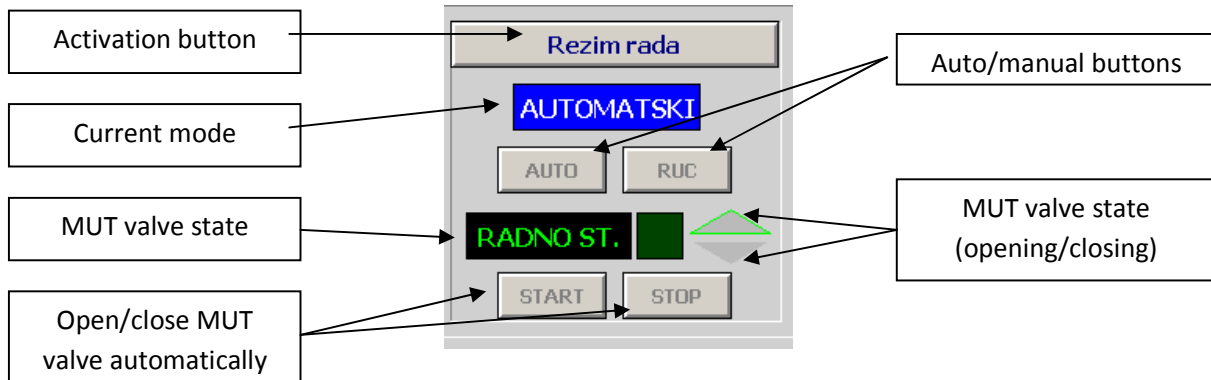


Figure 23. Auto/Manual Area

At the bottom part of the area there are MUT control push buttons. You can open or close MUT valve automatically by pressing the “Start” button or “STOP” button respectively. The notification arrow shows which direction of moving is activated. Green colored arrow means opening; red colored is used for closing.

1.5.9 Synchronization

This part is designed to control automatic synchronization logic. You can turn on the automatic mode by pressing the “UKLJ” button or turn off it by pressing “ISKLJ” button when the area is activated. The actual state of the synchronization is shown on the text field.

When operate in the automatic synchronization mode you can see actual rotation speed tuning on the notification arrows next to text field.

When operate in the manual mode, you can use two push buttons (“-“ and “+”) to slightly change the turbine rotation speed

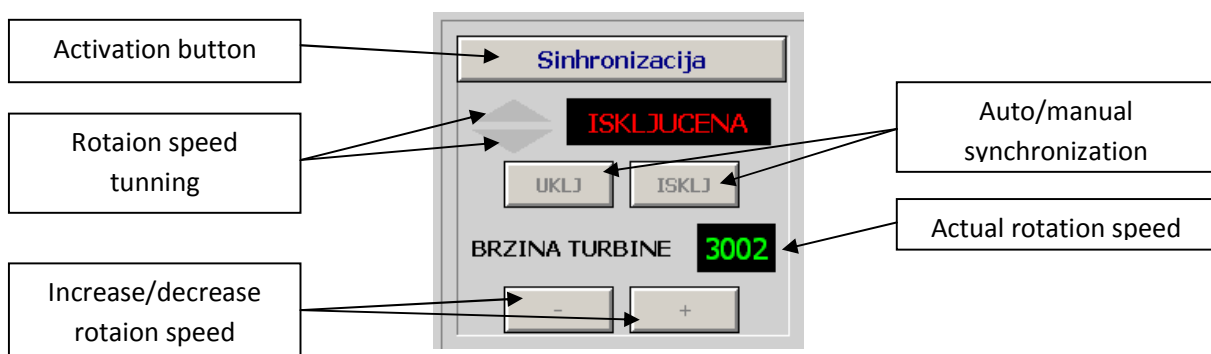


Figure 24. Synchronization Area

1.5.10 Turbine testing

After activation of this part of the main graphic windows you can perform two turbine tests. To start a testing there is necessary to choose what test you want to start and then press the “Kreni” button. To cancel the active test the “Stani” button need to be pressed.



Figure 25. Test Area

The turbine rotation speed limits for the regulation valves and the stop valves are show on the area at the bottom part.

In the bottom part of the area there is button to manual unlatch the turbine (force trip).

1.5.11 Error log

The log area contains all communication information between the controller and the graphic. When some error or alarm occurs you can find it in the log window.

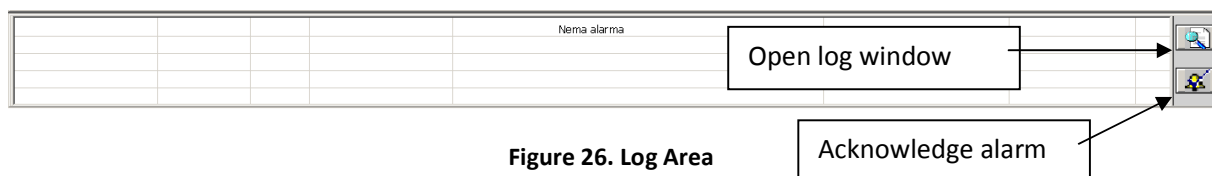


Figure 26. Log Area

Error/alarm messages are red colored in contrast to the normal communication which is blue colored (log 0) or black colored (log 1).

To open a detailed survey of the communication the open log button need to pressed.

TE Ugljevik - TURBINSKI REGULATOR							Development	
Datum	Vrijeme	Stanje	Prior.	Oznaka	Opis	Grupa	Vrijednost	
27/07/2010 10:41:26			700	1TR_ID242	Stop vent. 2 CSP zaboren	TR	Da	
27/07/2010 10:41:26	ACK_RTN		1	1TR_PRRVCP2SPR	Automat nap. MOOG RV2 CVP	NAPAJANJE	UKLJUCEN	
27/07/2010 10:41:26	ACK_RTN		1	1TR_BV2TP1SPR	Automat nap. davaca 1 BV2	NAPAJANJE	UKLJUCEN	
27/07/2010 11:19:17			900	OPD_MUT_OTV	Oper. Turbinu u radni polozej	TR	Da	
27/07/2010 11:19:17			900	OPD_MUT_OTV	Oper. Turbinu u radni polozej	TR	Ne	
27/07/2010 11:19:18			700	1TR_MUTKO	Komanda otvaranja MUT-a	TR	Da	
27/07/2010 11:19:18			700	1TR_MUTS2	Zaboren MUT	TR	Ne	
27/07/2010 11:19:27			700	1TR_MUTKO	Komanda otvaranja MUT-a	TR	Da	
27/07/2010 11:19:27			700	1TR_MUTSO	Otvoren MUT	TR	Da	
27/07/2010 11:19:28			700	1TR_ID212	Stop vent. 1 CVP zaboren	TR	Ne	
27/07/2010 11:19:28			700	1TR_ID222	Stop vent. 2 CVP zaboren	TR	Ne	
27/07/2010 11:19:28			700	1TR_ID232	Stop vent. 2 CSP zaboren	TR	Ne	
27/07/2010 11:19:28			700	1TR_ID242	Stop vent. 2 CSP zaboren	TR	Ne	
27/07/2010 11:19:34			700	1TR_ID210	Stop vent. 1 CVP otvoren	TR	Da	
27/07/2010 11:19:34			700	1TR_ID220	Stop vent. 2 CVP otvoren	TR	Da	
27/07/2010 11:19:34			700	1TR_ID230	Stop vent. 1 CSP otvoren	TR	Da	
27/07/2010 11:19:34			700	1TR_ID240	Stop vent. 2 CSP otvoren	TR	Da	
27/07/2010 11:19:39			600	SWD_TURB_AUTO	Turbina u automatskom režimu	TR	AUTO	
27/07/2010 11:19:39			600	SWD_TURB_RAD	Turbina u radnom položaju	TR	Da	
27/07/2010 11:21:03	UNACK		1	SWD_1TR_P14KV	Neisprav. mjerenja 3 prit. reg. ulja	TR	NEISPRAVNOST	
27/07/2010 11:21:14	ACK_RTN		1	SWD_1TR_P14KV	Neisprav. mjerenja 3 prit. reg. ulja	TR	u redu	
27/07/2010 11:21:28	UNACK		1	SWD_1TR_P14KV	Neisprav. mjerenja 3 prit. reg. ulja	TR	NEISPRAVNOST	
27/07/2010 11:24:25	ACK		1	SWD_1TR_P14KV	Neisprav. mjerenja 3 prit. reg. ulja	IK	NEISPRAVNOST	
27/07/2010 11:24:58			900	OPD_OBR_ZV	Oper. Nova ciljana ZV brzine	TR	Da	
27/07/2010 11:24:58			800	OPA_OBR_ZV	Oper. Ciljana ZV brzine	TR	3000	
27/07/2010 11:24:59			500	SWA_OBR_ZV	Ciljana zadana vrijed. brzine	TR	3000	
27/07/2010 11:24:59			900	OPD_OBR_ZV	Oper. Nova ciljana ZV brzine	TR	Ne	
27/07/2010 11:25:01			900	OPD_OBR_GRD	Oper. Nova brzina prom. ZV brzine	TR	Da	
27/07/2010 11:25:01			800	OPA_OBR_GRD	Oper. Brzina prom. ZV brzine	TR	70	
27/07/2010 11:25:02			900	OPD_OBR_GRD	Oper. Nova brzina prom. ZV brzine	TR	Ne	
27/07/2010 11:25:02			500	SWA_OBR_GRD	Brzina prom. ZV brzine	TR	70	
27/07/2010 11:25:05			900	OPD_ZV_KRENI	Oper. Promena zad. vrijed. kreni	TR	Da	
27/07/2010 11:25:05			900	OPD_ZV_KRENI	Oper. Promena zad. vrijed. kreni	TR	Ne	
27/07/2010 11:28:56			900	OPD_OBR_ZV	Oper. Nova ciljana ZV brzine	TR	Da	
27/07/2010 11:28:56			800	OPA_OBR_ZV	Oper. Ciljana ZV brzine	TR	700	
27/07/2010 11:28:57			500	SWA_OBR_ZV	Ciljana zadana vrijed. brzine	TR	700	
27/07/2010 11:28:57			900	OPD_OBR_ZV	Oper. Nova ciljana ZV brzine	TR	Ne	
27/07/2010 11:28:58			900	OPD_ZV_KRENI	Oper. Promena zad. vrijed. kreni	TR	Da	
27/07/2010 11:28:58			900	OPD_ZV_KRENI	Oper. Promena zad. vrijed. kreni	TR	Ne	

Figure 27. Log Window