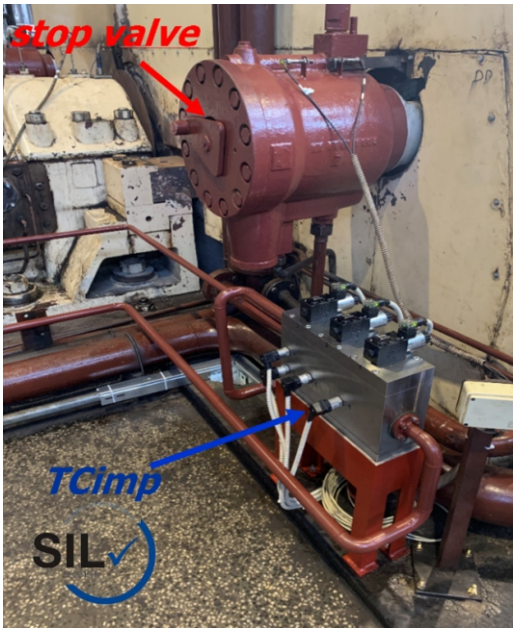
TCimp

"2 out of 3" trip block

institute MIHAILO PUPIN
IMP-AUTOMATION & CONTROL SYSTEMS
TurboCom

Device description

TCimp is an electro-hydraulic block that is applied in the steam, hydro and gas turbines protection systems, as well as in the process industry.



The protection function is based on the interruption of the oil flow and hydraulic drives closing in case two of the three protection channels are active - the "2 out of 3" principle. The oil cut-off channels are controlled via three solenoid two-position valves, which are wired to an electronic protection system. At the same time, when the oil supply is interrupted, the oil is drained from the hydraulic drives towards the oil tank.
In case of the protection activation on only one of the three channels or due to a measurement error or due to failure of a part of the protection block, the alarm is activated, but the oil flow to the hydraulic drives is not interrupted (the turbine or the process remains in operation). Channel condition monitoring is performed via four pressure switches that are mounted on the protective block and wired to the regulation and/or monitoring system.
According to the API-670 standard, periodic testing of all components in the protective circuit of rotary machines (except the final drive) is required, without affecting its operation. The TCimp electro-hydraulic block is designed on the principle of "2 out of 3" so that it is possible to check the disconnection of only one channel, without affecting the other two, which does not interfere with the machine operating. In the electronic part of the protection system, the automatic channel test function is implemented, which is periodically activated every 24 hours in normal operation, without any disturbances in the operating of the turbo unit.
Tcimp electro-hydraulic block is certified according to the requirements of the IEC 61508 standard and can be applied in systems where SIL3 level of functional safety is required (DEKRA Certificate No. ZP/C002/22, 3. 3. 2022).
By virtue of the "2 out of 3" principle, it has been achieved a high level of reliability, together with the compliance with industry standards API-670, API-612 and API-611.
The application of the TCimp block diagram in the steam turbine protection circuit is shown in the Figure 1.

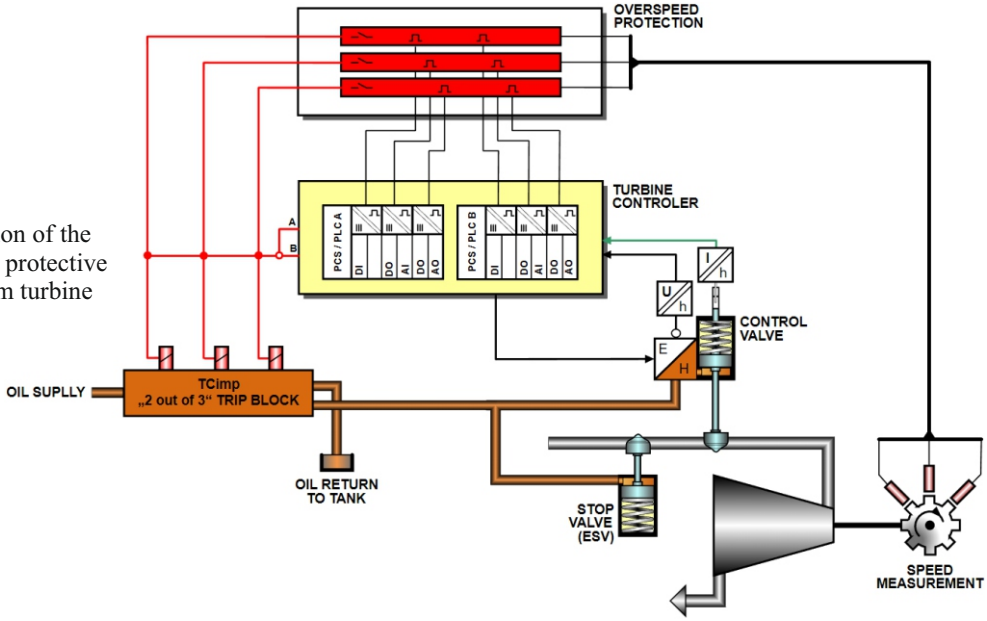


Figure 1 - Application of the TCimp block in the protective and regulatory steam turbine system

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Technical characteristics

Performance
· "2 out of 3" protection function
· Three solenoid valves cut off the feed oil supply and drain the system in the case of a power failure on "2 out of 3" channels
· The solenoid distributor response time from 0.05s to 0.1s
· The protective function action detection on 3 protective channels is carried out via 4 pressure switches
· The safety function is realized by an internal spring on each individual solenoid distributor
· Functional safety level SIL3
· Average failure probability PFD_{AVG} 1,54 x 10^{-4}

Hydraulic characteristics
· Working pressure [1.50] bar
· Maximum flow 720 l/min at 10 bar differential pressure (Figure 2)
· Oil temperature [30, 60] °C
· Oil type: hydraulic oils ISO 6743/4 (L-HV), DIN 51524/3-HVLP
· Recommended oil purity 20/18/15 according to ISO 4406
· Viscosity ISO VG32, ..., ISO Vg46 according to DIN 51519
· Diameter of the inlet and drainage (into the tank) of oil connection Dn25
· Diameter of oil connection according to hydraulic drives DN20

Electrical characteristics
· Supply voltage 24 VDC
· Consumption of one solenoid distributor 1.29A (31W) out of a total (3) distributors
· Maximum allowed current through the pressure switch contacts 4A (96W)
· The electrical connection diagram is shown on the Figure 3

Ambient characteristics
· Ambient temperature [-25, 60] °C
· Ingress protection IP65
· ATEX II 2G Ex IIC T4 Gb on request

Physical characteristics
· External dimensions (length x width x height) 380 mm x 223 mm x 309 mm
· Package dimensions (length x width x height) 470 mm x 250 mm x 340 mm
· Mass net 92 kg, gross 96 kg

Technical data for ordering:
• working oil pressure _____ [bar]
• maximum flow _____ [l/min]

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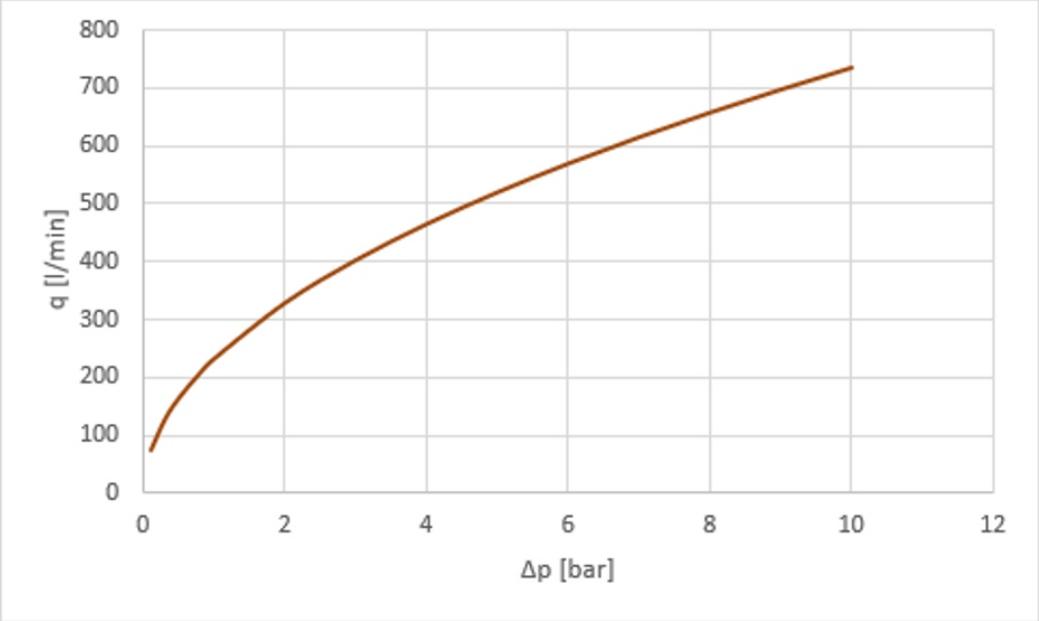

Figure 2 - PQ characteristic of the TCimp protection block

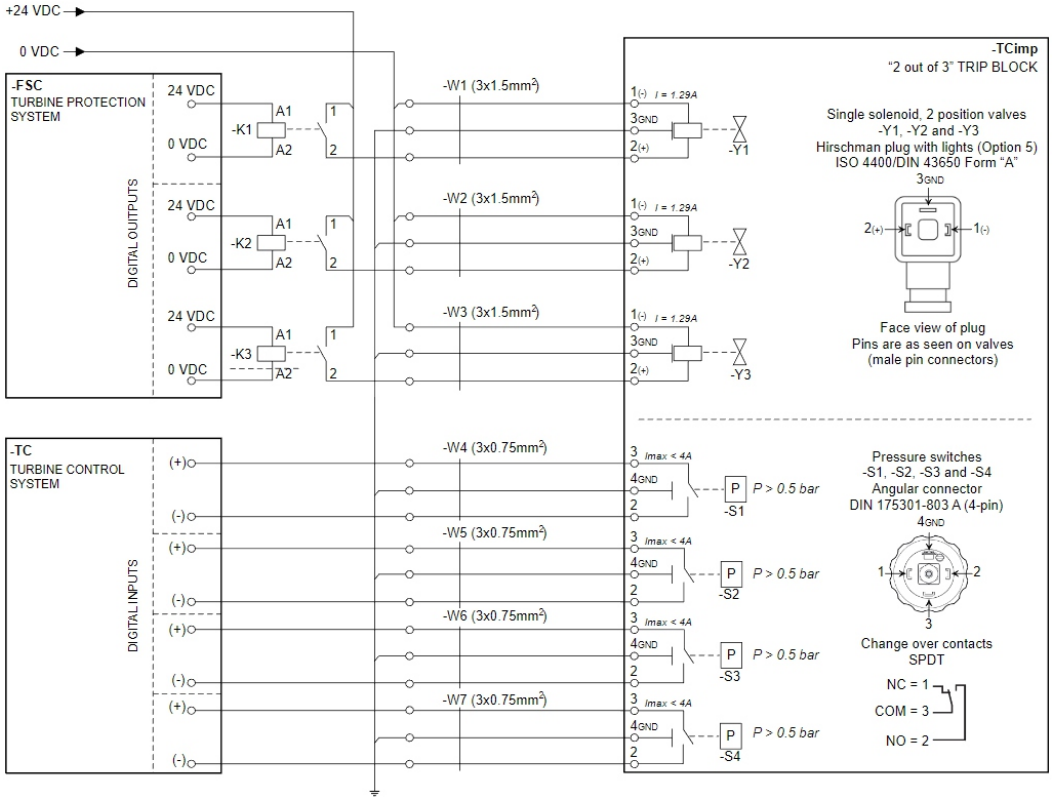

Figure 3 - Electrical wiring diagram of the TCimp protection block

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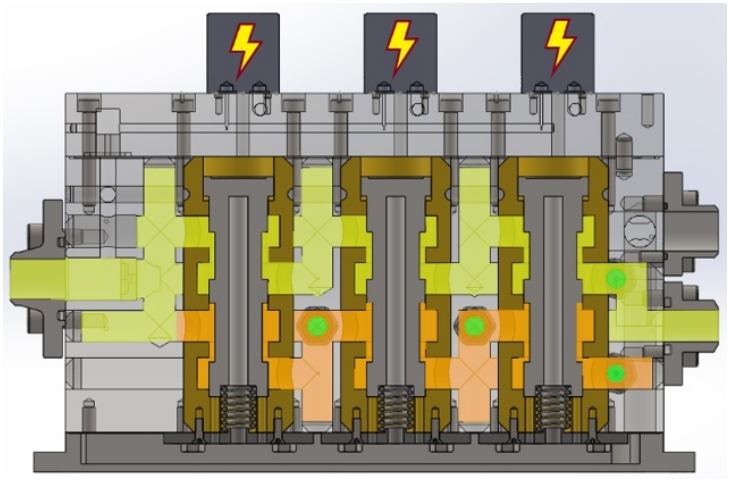
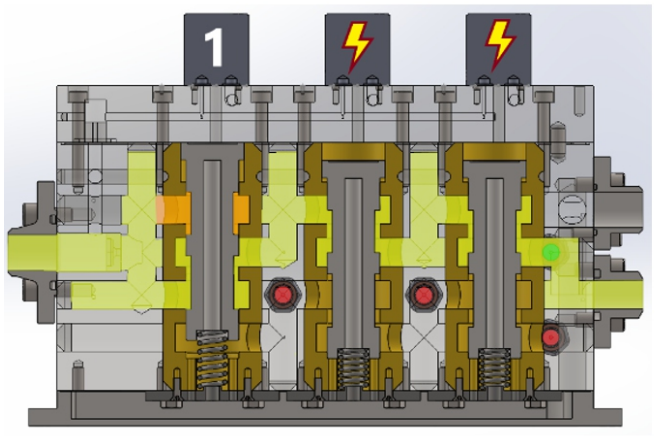
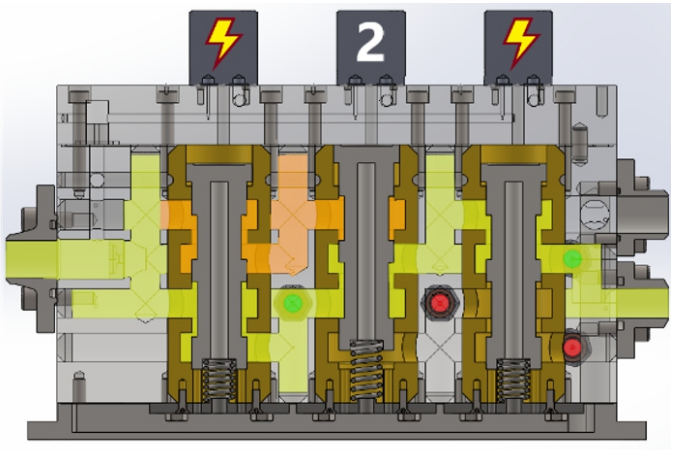
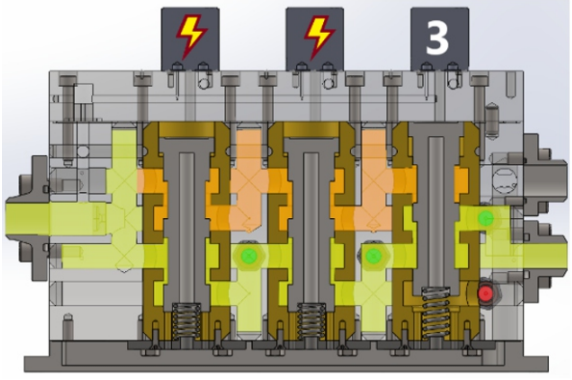
Working principle

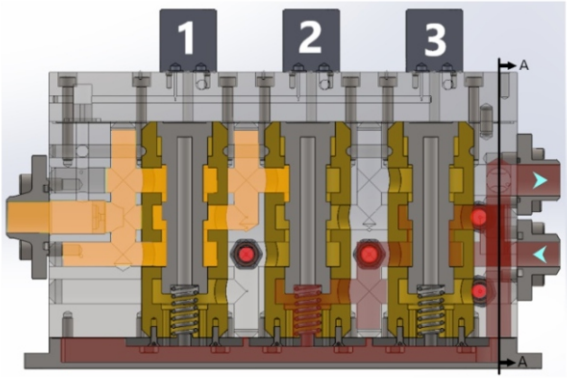


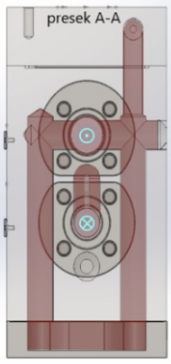
Display of oil flow when there are aroused (label ⚡) certain solenoid hydraulic distributors: 3 aroused, 2 awake and all awake.











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Testing

IMP conducts a variety of tests throughout the development process, during and after the production. Tests provide calculation data (eg. number of test cycles in the endurance test), showing machine characteristics (eg. reaction time), ensure production quality (eg. input inspection, dimensional testing, non-destructive testing, leak test and functional test). Figure 4 shows the test settings for the TCimp block.

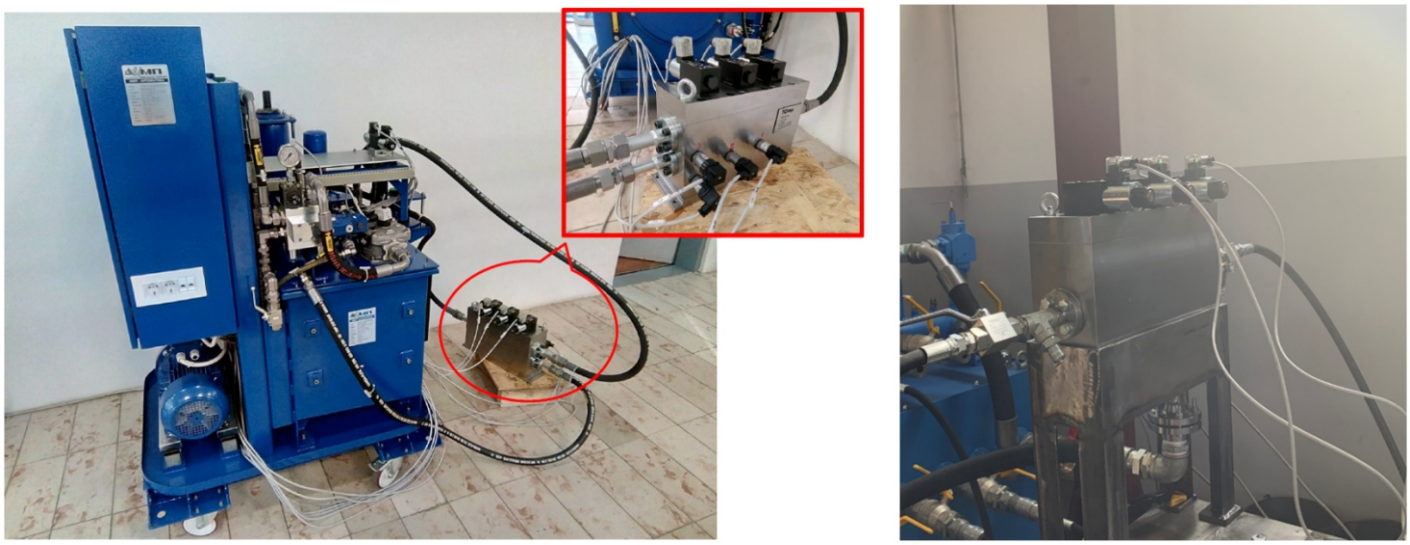
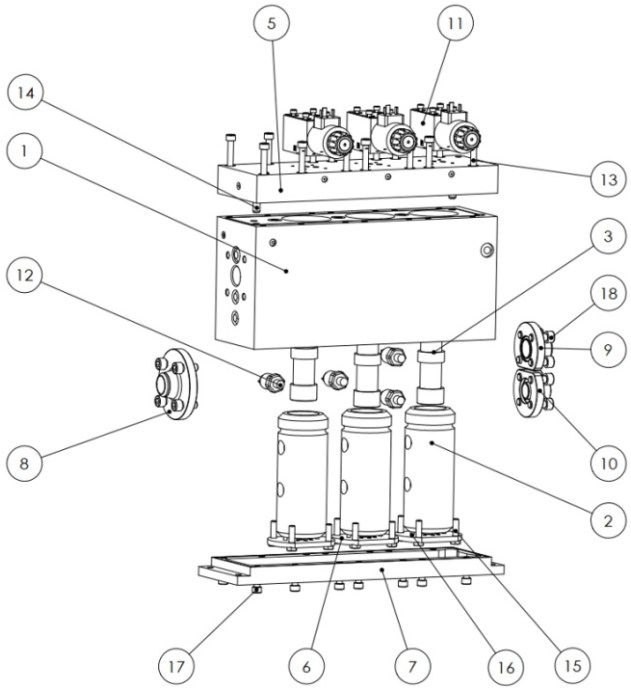


Figure 4 - Test settings for the TCimp block

Assembly drawing

Tcimp parts list:

Housing (with chokes)	- pos. 1 - 1 piece
Piston sleeve	- pos. 2 - 3 pieces
Clip	- pos. 3 - 3 pieces
Spring	- pos. 4 - 3 pieces
Housing cover (with chokes)	- pos. 5 - 1 piece
The bottom of the piston sleeve	- pos. 6 - 3 pieces
The bottom of the housing	- pos. 7 - 1 piece
Inlet flange	- pos. 8 - 1 piece
Drainage flange	- pos. 9 - 1 piece
Outlet flange	- pos. 10 - 1 piece
Parker solenoid valve	- pos. 11 - 3 pieces
Wika pressure switch	- pos. 12 - 4 pieces
Screw M8 DIN 912	- pos. 13 - 14 pieces
Centering pin DIN EN ISO 8735	- pos. 14 - 2 pieces
Screw M8 DIN EN 24015	- pos. 15 - 12 pieces
Screw M5 DIN EN ISO 7046-1	- pos. 16 - 6 pieces
Screw M8 DIN 912	- pos. 17 - 14 pieces
Screw M10 DIN 912	- pos. 18 - 12 pieces



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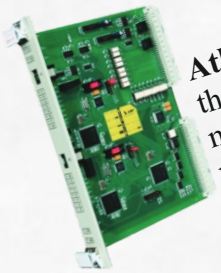
Turbine control system components and ARS TSControl-Atlas protection

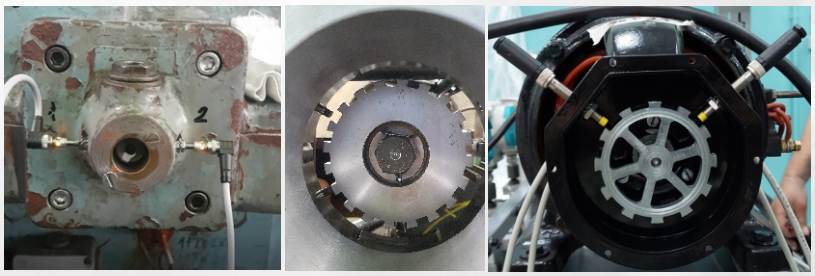


Atlas BPC/BOP
the turbine speed measurement/overspeed protection module

Atlas dAPV-p
digital automatic hydraulic positioner servo-motor

IMP-PHA
movable hydraulic generator

Atlas BVM8
module for vibromonitoring and rotary machine protection



Turbine speed measurement systems

ARS TSControl-Atlas
Steam turbine regulation and protection system of the Institute Mihajlo Pupin - Automation & Control System

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