Intelligent solutions for hydropower plant controls

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ABB offers advanced control solutions for hydropower plants. With global experience across a variety of plant configurations, ABB's solutions provide your plant with a highly integrated control scheme utilizing reliable, optimized, and proven practices.

Hydropower plant AGC overview

Automatic Generation Control (AGC) of generating units by governor control action is commonly referred to as Primary Frequency Regulation (PFR). The main objective of the governor is to maintain or attempt to return the frequency of the system to scheduled value as soon as an upset occurs. This is done using a proportional gain controller, also referred to as droop control. Typically, governor droop control action can quickly recover a significant part of the frequency change, but cannot completely return the system to its nominal frequency alone. Eliminating the frequency deviation is therefore performed by what is known as the Secondary Frequency Regulation (SFR). The SFR is used to make up the difference in generation that is not covered by the governing system. This is achieved by increasing or decreasing the MW generation by way of unit MW setpoint or an entire plant MW setpoint when Joint Control (JC) is available. This is typically done by a dispatch centre in which one of the main tasks is to correct for the long term frequency and generation schedules.

The AGC and JC portion of the station controls manages the selection, activation and supervision of the included joint operating modes for each of the units in a plant. Joint control is only applicable to plants with two or more units. The AGC applications provide the plant operator with full (or partial) station control via a single point of control. Hydropower plants are extremely suitable for remote and unmanned operation. This is typically achieved with the use of JC of the active and reactive power functions described in this brochure.

Applicability

- Run-of-the-river hydropower plants
- Pumped storage facilities
- Reservoir type hydropower plants
- Regulating dam (see gate flow applications)
- Any size hydropower plant, with any number or types of turbines

Joint Control Active Power (JCAP)

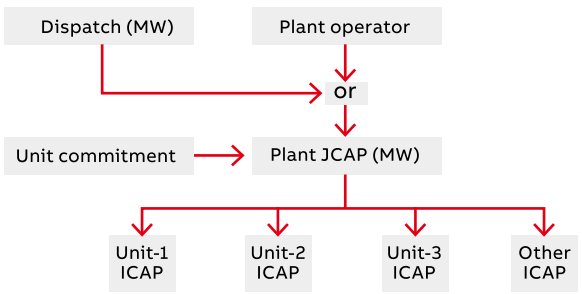
Joint Control Active Power (JCAP) provides a plant the ability to receive a single MW generation setpoint that may be shared among a group of several turbine generators. The plant MW setpoint may be either modified at the plant itself, or from any pre-designated remote location. Generating units that desire to operate separately from the JCAP group may be selected to individual mode. The Individual Control Active Power (ICAP) provides a setpoint that will be introduced by the operator HMI normally local to the plant. It is possible for the operator to combine any turbine/generator associated to the joint control operation mode i.e. JCAP or ICAP mode at any time.

JCAP functionality

Cost effective active power control features includes:

- Dispatch centre communication data-link
- Dispatch centre generation MW setpoint
- Plant generation MW setpoint
- Unit commitment (plant auto start/stop)
- Unit priority (operator selected, or run time hours)
- Plant optimization (economic dispatch)
- Daily generation schedules
- Frequency control
- Automatic Time Error Correction (ATEC)
- Communication with governing system
- Spinning reserve margin control
- Spinning reserve monitoring
- Plant efficiency calculations (optional)
- Plant net head and losses calculations (optional)
- MW ramp management
- Turbine rough zone management

Typical Joint Control Active Power flowchart

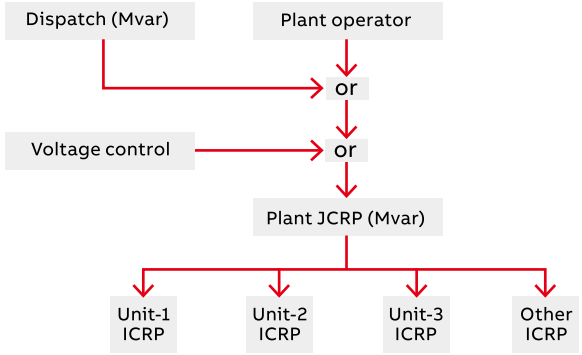


Joint Control Reactive Power (JCRP)
Joint Control Reactive Power (JCRP) logic is used to control the total reactive power production/absorption of the power plant. The setpoint is entered as a reactive power value (Mvar),or in KV when voltage control. When the operator makes a JCRP setpoint change, the Mvar of each unit in JC is moved simultaneously and in parallel. Generating units that are desired to operate separately from the JCRP group may be selected to individual mode. The Individual Control Reactive Power (ICRP) provides a setpoint that will be introduced by the operator HMI normally local to the plant.

This function is completely implemented in the application software of the distributed controllers and the operator stations. It is possible for the operator to combine any turbine/generator associated to the joint control operation mode i.e. JCRP or ICRP mode at any time.

JCRP functionality
Reactive power and voltage control features includes:
- Dispatch centre (SCADA) communication data-link
- Dispatch centre generation Mvar and/or volt setpoint
- Plant Mvar and/or volt setpoint
- Reactive power capability curve monitoring
- Communication with excitation system
- Daily Mvar and/or voltage schedule
- Synchronous condenser operation
- Synchronous condenser turbine/pump modes (pumping units)

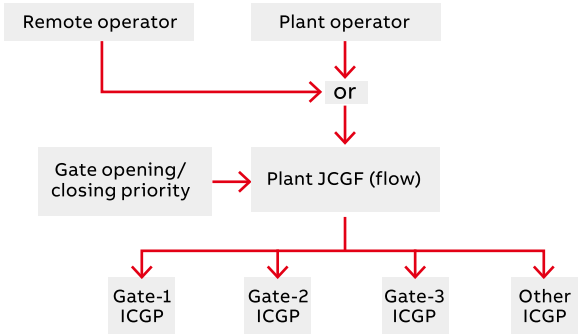
Typical Joint Control Reactive Power flowchart



Joint Control Gate Flow (JCGF)
Joint Control Gate Flow (JCGF) provides a plant the ability to receive a single flow setpoint that may be shared among a group of sluice gates. The plant flow setpoint may be either modified at the plant itself, or from any pre-designated remote location. Gates that desired to operate separately from the JCGF group may be selected to individual mode. The Individual Control Gate Position (ICGP) provides a setpoint that will be introduced by the operator HMI normally local to the plant. It is possible for the operator to combine any gate associated to the joint control operation mode i.e. JCGF or ICGP mode at any time.

JCGF functionality
Hydropower plant, regulating dam flow control features includes:
- Remote centre communication data-link
- Remote centre flow setpoint
- Plant flow setpoint
- Downstream flow rate-of-change control
- Reservoir level rate-of-change monitoring
- Volume/flow control (pumped storage applications)
- Gate flow calculations
- Gate priority control
- Riparian release flow control

Typical Joint Control Gate Flow flowchart



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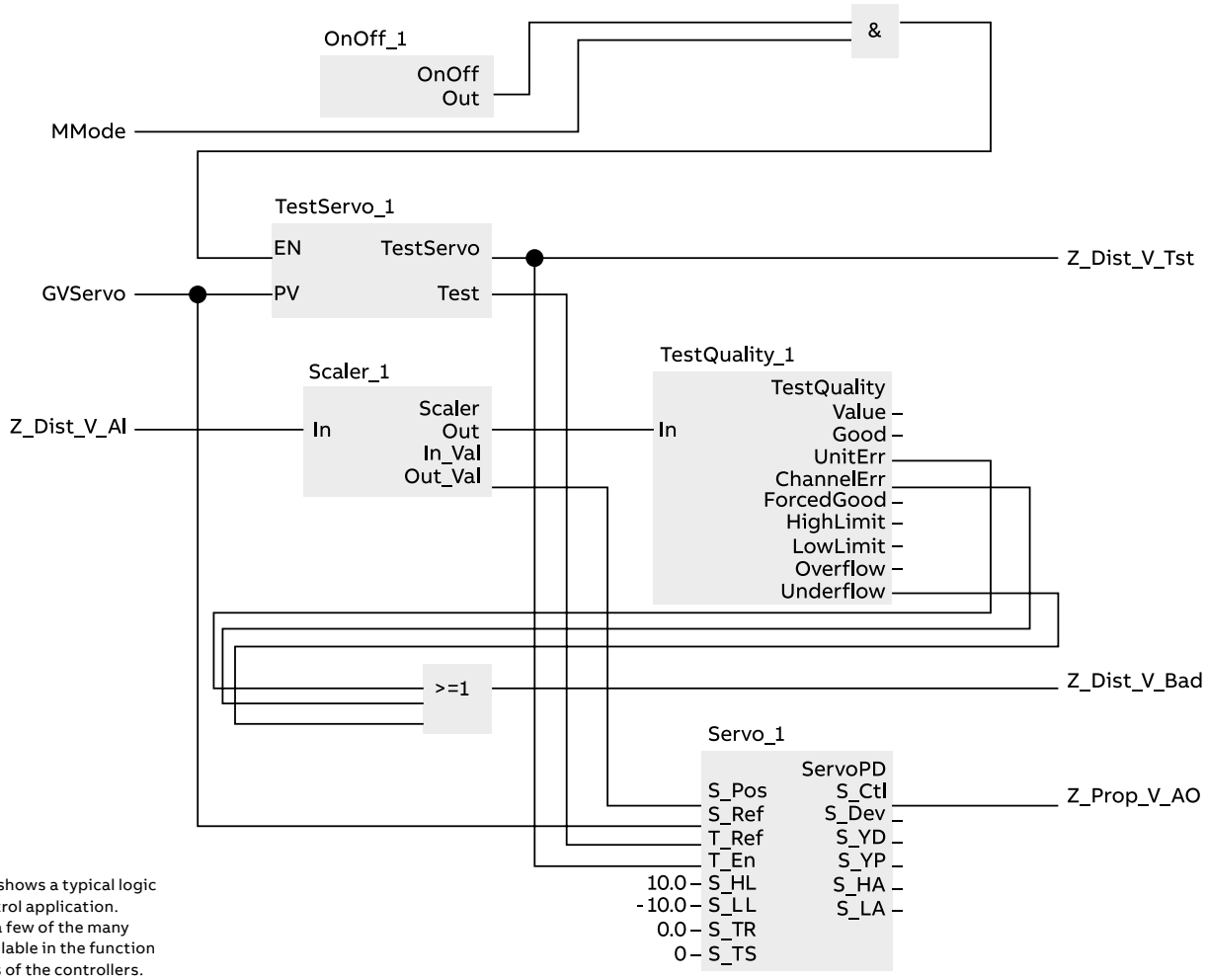
Application software
The ABB Hydro Plant AGC and Gate Flow applications use the latest microprocessor based technology based on the AC800M controller. These are programmed using function block type programming, selected from a set of factory built libraries for functions. In addition to function blocks, this controller also supports all IEC-61131-3 programming languages: structured test, instructions list, sequential function charts, and ladder diagrams, all of which may be used to add additional custom built user functions.

Example of a Control Logic Application Program



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This diagram shows a typical logic page of a control application. It shows just a few of the many functions available in the function block libraries of the controllers.

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