



PLC-TG

PLC BASED HYDRAULIC TURBINE SPEED GOVERNOR



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Introduction

Hydro ECI inc. (HECI) is an active partner in the hydro power generation field. Its members have accumulated a large amount of experience through their implication in the design, commissioning and service of BOP equipment for all types and sizes of hydro-electric projects.

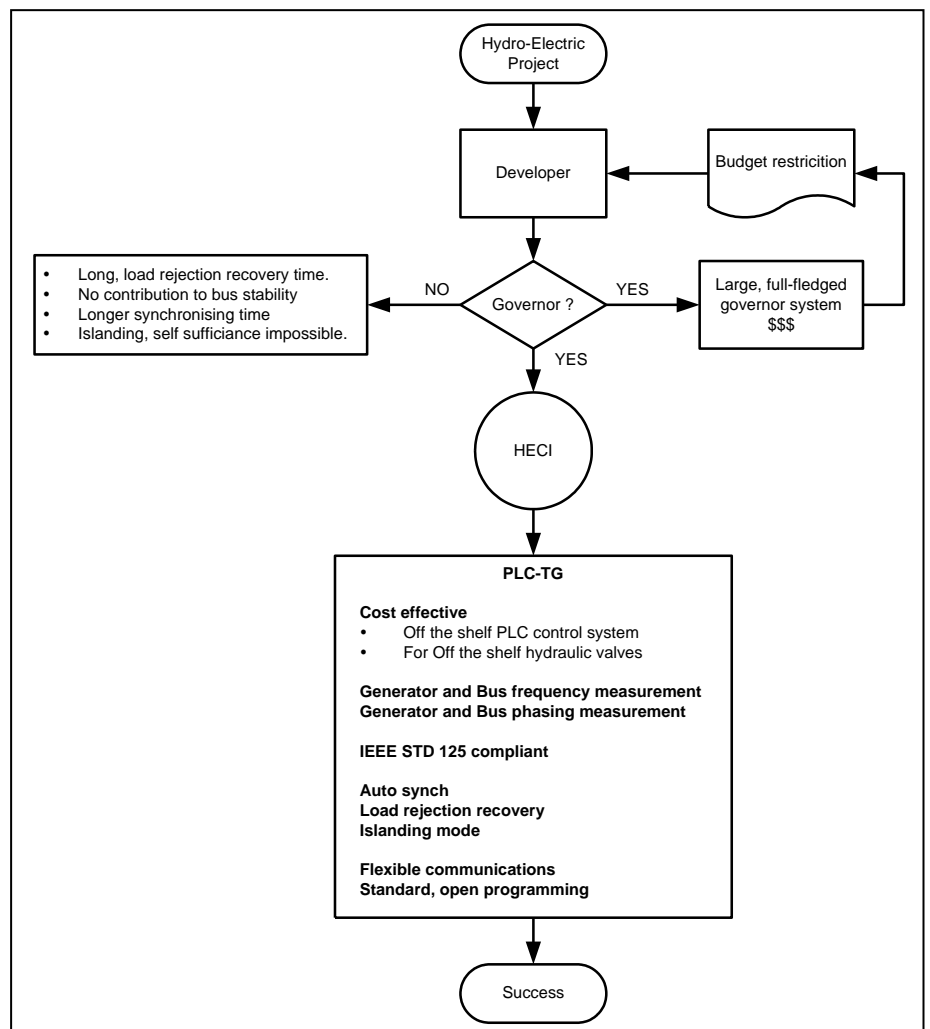
Application

Over the years, HECI has noticed that developers of many small hydro-electric projects chose to do without a full-fledged turbine speed governor due to budget restraints. HECI has thus decided to combine its knowledge in the hydro-electric field with its expertise with many of the leading PLC (Programmable Logic Controllers) systems to design a low cost, PLC based hydraulic turbine speed governor, nicknamed PLC-TG.

HECI has developed a control structure that meets the requirement of the IEEE STD 125¹ standard and can be implemented in standard “off the shelf” PLC equipment.

The PLC-TG drive’s “off the shelf” hydraulic valves².

The PLC-TG is suitable for small and medium size installation with basic speed regulation requirements.



Hydro ECI offers a third choice

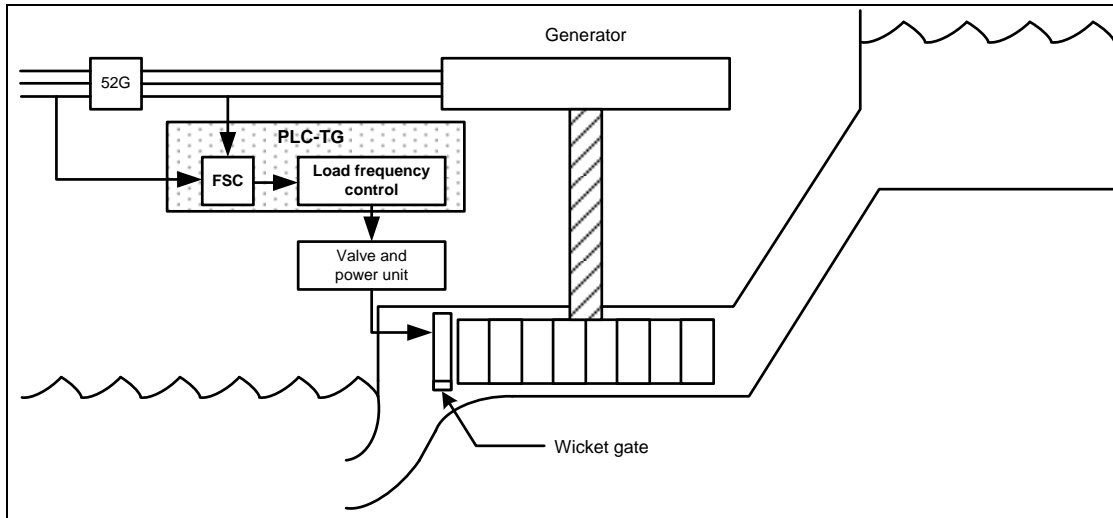
¹ IEEE Std 125: Recommended Practice for Preparation of Equipment Specifications for Speed-Governing of Hydraulic Turbines Intended to Drive Electric Generators.

² The actual performance of the governor is dependant on the PLC system used.



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Simplified schematic – Hydro-electric plant

Measurements

Generator and bus frequency measurement are a critical part of any speed governor. HECI has developed a frequency signal converter (FSC) which measures generator and bus frequency signals from PTs. These signals are isolated and conditioned so the resulting signal can be connected to PLC based high speed counters.

PLC high speed counters are not all the same. For that reason the FSC has been developed with flexibility in mind. Output drivers have sourcing and sinking capabilities and operate at various voltage levels. As well, since some high speed counters do not have internal time base measurement capabilities, the FSC is equipped with a selectable frequency reference source that can be used to acquire a high resolution frequency measurement.

Measurement of generator speed would normally be supplied by PTs via the FSC module but, for added flexibility and signal redundancy, the PLC-TG can accept a speed signal in the form of a 4-20 mA supplied by an external speed sensing device or from a toothed wheel / proximity switch assembly connected to another PLC high speed counter.

The FSC provides another critical signal needed in speed governing. When both the generator and bus frequencies are connected to the module, the FSC can supply the phasing offset between the two frequencies. This signal is connected to another PLC high speed counter and is used by the PLC program to quickly synchronize the generator to the bus frequency. A synchronizing algorithm is also provided to give a contact closure to the generator breaker wired logic to indicate when the generator is in synch with the bus.



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PLC-TG Features

- Flexible generator speed measurement
- Fully configurable speed switches
- Bus frequency measurement
- Phasing offset measurement
- "In synch" contact closure
- Auto/Manual synchronization feature
- Rotor Creep detection
- Speed/load changer
- Wicket gate (Jet) Auto/Manual mode
- Blade (Jet) Auto/Manual mode
- Blade positioning by 3D CAM (in Auto)
- Blade position changer (in Manual)
- Deflector control
- Output limiter
- Power limitation
- Islanding mode
- Speed loop with permanent and transient speed droops
- Load rejection recovery sequence
- Wicket gate servo control can be analog and/or ON/OFF control
- Blade servo control can be analog and/or ON/OFF control

A PLC base system gives the following benefits:

- **Standard "off the shelf" components:** High reliability, multi-vendor...
- **Standard, open programming:** The program can easily be adapted to specific needs.
- **Flexible communication options:** Communications to SCADA, RTU or other PLCs are limited only by the PLC system chosen. Most PLC systems offer a variety of communication protocol including Ethernet and Modbus.

The following is a short list of the PLC families to which the FSC is compatible:

- GE Fanuc
- Allen-Bradley
- Modicon
- Omron

FSC Highlights

- **Power required** 24 V_{DC}
- **Input signals** 2 Frequency signals from PTs
- **Output signals** 2 Conditioned and Isolated square wave from the matching input signal
1 Square wave corresponding to the phase offset of the input signals
1 Oscillator with range from 10 kHz to 3 MHz
- **Mounting** DIN rail or back mount screws
- **Enclosure** Metallized inner side for EMC protection
- **Connectors** Pluggable

Rev.: 1.0