

# Microcontroller based Electronic Governor and Control System of a Mini-hydro Power Plant

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**Abstract** - This project is absolute requirement to develop small-scale power plants. The idea is described in the introduction. Then there are some details about the functionality of the system. That is described in both user aspect and technical aspect. The idea will lead to fully automated power plants with remote access, while it is lower cost. Some attractive future development proposals will be at the end of the technical details.

## 1.0 INTRODUCTION

In brief our project is an Microcontroller based Electronic Governor & Control System for Mini Hydro Power Plant. The courses of selecting this project were the expanding the features of the presently available mechanical governor systems and improve the remote controllability of the system in user-friendly manner. In this invention we selected specific mini hydro plant to consideration because of several limitations.

The governor of a mini-hydro power plant considers as a heart of the system. It controls the output power and makes the generator frequency up to the grid frequency by utilizing the available water supply to the turbine. Those operations are achieved by controlling the gate valves of the turbine. Almost all the turbine units use this method of control and it comprises of a mechanical actuator and electrical control device to give the desired command signals to the actuator to open or close valves appropriately.

Commercially available electronic governors are very expensive. It is very difficult to find a suitable commercial product for a particular power plant and not easy to tune them to reach the best operating condition. Therefore our main focus was to implement an electronic governor system for a user specific circumstance. So the initial stage, we studied the entire control system of a mini-hydro power plant that is situated at **Niriella**. Then we decided to

develop this electronic governor system using newly promoted micro-controller technology. Other than the basic governor operations we implemented several new features. To interact with the micro-controller some of the electronic devices were re-implemented.

## 2.0 BASIC OPERATION

Although it's called an Electronic governor control system, it consists of some plant automating functions as well. All those functions can be categorized as follows.

- Starting and shutting down sequences of the plant.
- Frequency controlling until the generator is synchronized with the national grid.
- Manual and automatic control of the power output.
- Quick safety actions in fatal faulty conditions.

To start the plant the user only has to press the start button. But he has to make sure that the plant not in operation when he press start. Otherwise the plant will shut down due to abnormal condition. After the start button is pressed the control system checks circuit breaker position, water level, valve position and national grid condition. If only all those conditions are satisfied then proceed to start the plant. First it sends a signal to open the Main Inlet Valve (MIV) and wait for 30 seconds until it fully opens. Then opens the valves inside the turbine called wicket gates 18.5% initially.

Then it starts the frequency controlling in order to bring the generator frequency to grid frequency by controlling wicket gates. When the frequency is getting closer to each other it displays a message to user to set the synchronizer to auto mode.

Just after the synchronizer closes the circuit breaker, the control system steps into power control mode and



The voltage signals of the grid and the generator are used in the calculation of their respective frequencies. For this purpose also we use two micro-controllers.

### 3.2. Water Level Sensor

Output power utilization with available water supply is a main function of a governor system. For that purpose water level must be sensed. In the two mode of operation water level input behave slightly different manner. In water mode depending on the water level the valve of the turbine is opened or closed to optimize the power output while consuming all the water available at the fore-bay tank. In power mode for proper operation the water level should be greater than the minimum allowable water level.

### 3.3 Valve Position Sensor

This consists of a sliding variable resistor as its sensing device, which produces an analogue signal according to the valve position. The analogue output is then fed to the ADC of the PIC micro controller then the digital signal is processed in the program.

### 3.4 Stepper Motor Driver

This is a uni-polar stepper motor driver. The driving circuit made up of 8 IGBTs. Number of steps to be moved, are fed to the driver through first bits of the data bus (max of 127 steps at a time) and the direction is fed through the MSB. These input signals are stored in the latch by enabling the "Latch Enable" control signal.

When "start" control signal is given, the JK flip-flop set and the master clock signal pass to the Down counter through AND gate. The down counter starts to down count the number of steps fed. After counting, the counter gives the clear signal to the JK flip-flop. Then the AND gate blocks the clock signal.

When the clock signal is available, 4-bit shift register shifts its shifting pattern left or right according to the direction given. When the driver is powered the shifting pattern (1, 0, 0, 0) is load to the register manually using SET button. This pattern can be directly fed to drive the power transistors of the unipolar stepper motor drive.

The circuit known as "H Bridge", is used to drive bipolar stepper motors. Each coil of the stepper motor needs its own H-bridge driver circuit. Typical bipolar steppers have 4 leads, connected to two isolated coils in the motor.

PIC micro controller produces relevant number of pulses which equal to number of steps to be rotated with the direction signal which decides the rotating direction.

## 5.0 FUTURE DEVELOPMENTS

Microcontroller is capable of communicating with a personal computer. Then user can control the system & observe some detailed presents through that PC.

In addition if the PC is connected to the Internet the system can be controlled and observed via Internet.

Software installed in PC can keep a database of all the details about the operation of the plant such as durations of operations, energy supplied by the plant, etc.

Another good alternative to the microcontroller is Digital System Processor which falls to the latest technologies. It has advances functionalities such as capability of handling the Internet Protocol. So it can directly be connected to the Internet without a PC. On the otherhand, only one chip will do all the processing.

## 6.0 CONCLUSIONS

This has been a successful step to take latest technology into small scale power plants. Among the things already done, we have achieved controlling the governor, small automation in the plant and few protective schemes via a micro controller. As discussed in the future development, enhanced communicating with the PC is the main part remaining. It will require a micro controller with additional ports and modifications in the assembly program as well. Which then lead to achieve more attractive facilities such as remote monitoring.

Cost of this project is about Rs 11 000/- And it's very much cheaper than a PLC governor controller that costs in the market nowadays.

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