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AN INNOVATIVE APPROACH TO ACHIEVE FREQUENCY STABILISTION USING AN ELECTRONIC GOVERNOR

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Abstract – *Micro hydro is a type of hydroelectric power that generates 5kW to 100kW of power using seasonal flow of water. Usually, power is generated from the running water using pelton wheel. Pelton wheel drives the synchronous generator. The speed of rotation of the generator decides the frequency of the AC signal used to drive the load. Electronic governor is an efficient control system which maintains constant frequency at the output irrespective of the changes in the load condition or variation in flow of water. These systems can be implemented successfully to provide power to an isolated home or small community using available water resource.*

Keywords- Electronic governor, speed of rotation, changes in load, pelton wheel, and synchronous generator.

1. INTRODUCTION

A control system manages, commands, regulates or directs other devices or an entire system. A closed loop controller has a feedback to ensure controlling action is provided based on the output condition as well. An electronic governor provides constant frequency, even though, there

is variation in the load side or rapid changes in the speed of rotation of pelton wheel. Hence, electronic governor performs as an efficient closed loop control system. As of now, the oscillator is used instead of pelton wheel to generate different frequencies in the range of 45Hz to 55Hz.The controlling PI action is obtained by Arduino Uno.

This system provides an efficient method to obtain frequency stabilization. The software used to simulate various circuits is Multisim.

2. PELTON WHEEL

Pelton wheel is usually used for power generation from the water. Typically, when the flow rate is low and there is high head. Water (with high head) flows through the nozzles in pelton wheel and hits the bucket. An impulsive force is experienced which rotates the pelton wheel. This rotates the shafts of the generator and produces electricity.

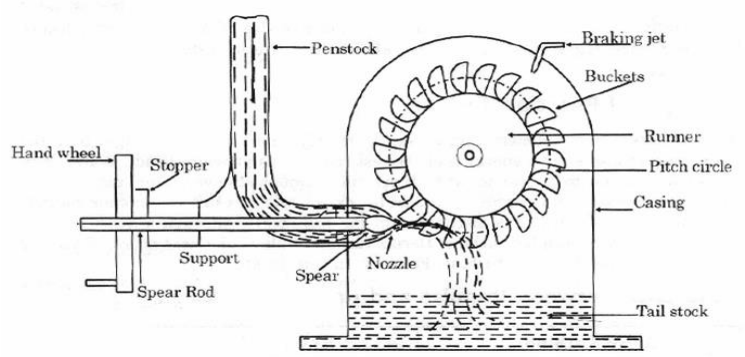

Fig -1: Pelton wheel

To the rotor or the rotating shaft of the pelton wheel, a disk is mounted. The disk is circular in shape and consists of cup-shaped blades .These are known as buckets. The buckets are placed with equal spacing. The wheel consists of nozzles through which water is injected. The nozzles are placed tangentially to the circumference. The number of nozzles varies and is mainly dependent on operating condition, design specifications.

3. SYNCHRONOUS GENERATOR

It mainly works on the principle of dynamically induced emf: "Whenever the number of magnetic lines of force linked with conductor changes, an emf is set in the conductor. Conductors connected in particular manner (armature winding) is placed within the armature (also called stator: stationary winding).Magnetic flux lines that link with the conductors are in relative motion (rotor: rotating winding).

4. BLOCK DIAGRAM

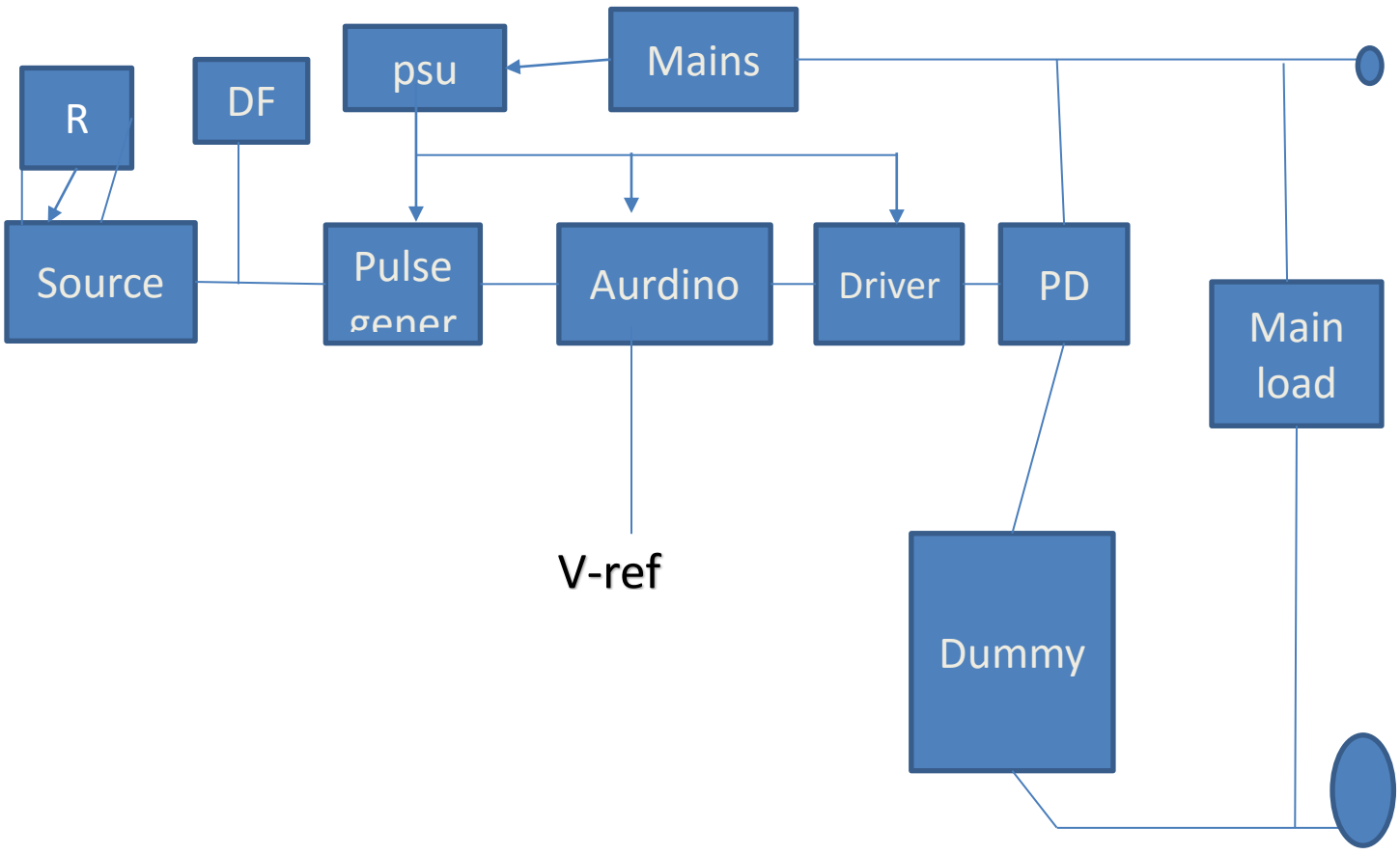

Fig -2: Block Diagram

5. DESCRIPTION

The source used is a Wein bridge oscillator which generates input signal in the frequency range of 45Hz to 55Hz. Digital frequency meter is used to display the frequency of the input signal. Pulse generator unit generates pulse at every zero

crossing of the input signal. Arduino board provides the controlling action based on the reference input (V_{ref}). Power supply unit is required to provide V_{cc}, V_+, V_-, to the integrated circuit chips used in the design.

Driver unit boosts the output signal of the controller and provides isolation to the controller from the power device. Power device used is a triac which provides switching action at the load side which is dependent on the frequency of the input signal. The main load and dummy load is used to compensate for variation in the speed of rotation of generator. This dependency can be expressed as shown below,

$$N = P * \frac{F}{120}$$

N= Speed of rotation

P= Number of poles

F=Frequency of the generator

6. ARDUINO UNO

The Arduino Uno is a development board based on ATMEGA 328.

Fig -3: Arduino Uno Board

Features of the Arduino UNO:

- Microcontroller: ATmega328.
- Operating Voltage: 5V.
- Input Voltage (recommended): 7-12V.
- Input Voltage (limits): 6-20V.
- Digital I/O Pins: 14 (of which 6 provide PWM output)
- Analog Input Pins: 6.
- DC Current per I/O Pin: 40 mA.
- DC Current for 3.3V Pin: 50 mA.

7. TRIAC

Triac is a bidirectional device. It consists of three terminals: gate, anode1, anode2 .Triac conducts in both the directions and is used for generating alternating current. When the gate voltage is positive and if anode 1 has more potential than anode 2, one of the thyristor conducts. When gate voltage is negative and if anode 2 has more potential than anode1, other thyristor conducts. In the design, Triac is the most suitable power device used for switching between main load (bulb) and the dummy load (battery).

The design uses a standard Triac BT-600 having following specifications:

Gate trigger voltage (max) = 1.5V

Holding current (I_h max) = 15mA

Gate trigger current (max) = 35mA

On-state current (I_{rms}) =4A

8. CIRCUIT DESIGN

The wein bridge oscillator source is designed effectively and the effective circuit is shown below.

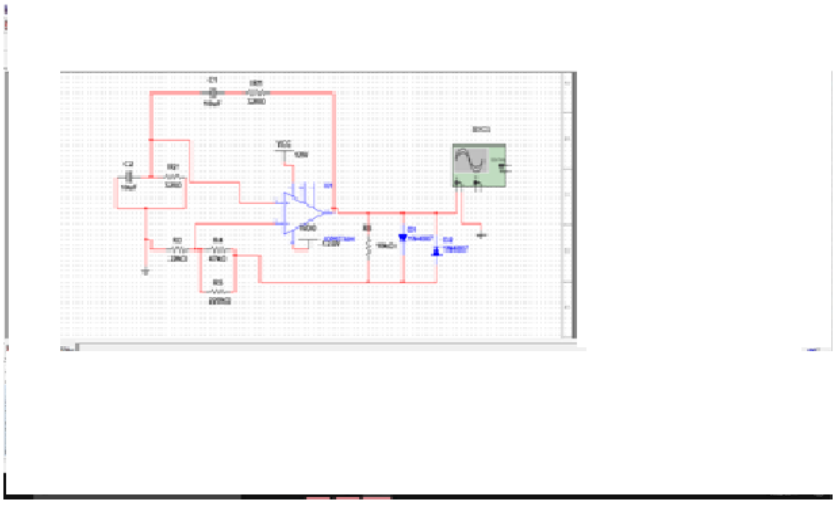

Fig -4: Circuit diagram

The condition for the oscillator design is,

$$\frac{R3}{R4} = \frac{R1}{R2} + \frac{C2}{C1}$$

And the frequency of the oscillation is determined by

$$fo = \frac{1}{2\pi} * \frac{1}{\sqrt{R1.R2.C1.C2}}$$

If R1=R2=R and C1=C2=C, then,

$$f0 = 1/2\pi RC$$

The condition for the circuit to oscillate is

$$\frac{R3}{R4} > 2$$

The pulse generator circuit mainly consists of the zero crossing detector and the differentiator.

The circuit is shown below

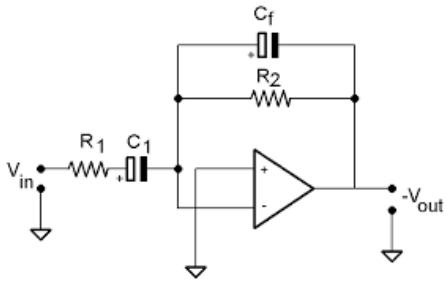

Fig-5: Circuit diagram

The design uses R1=1k, C1=1µF, R_f =25.3K

C_f=0.01µF

9. SIMULATION RESULTS

The circuit is designed using Multisim and the desired output is obtained. The pulse generated is then provided to the controller for further action. The simulation results are shown as follows.

Source (used instead of pelton wheel) generating input signal varying between 45Hz-55 Hz.

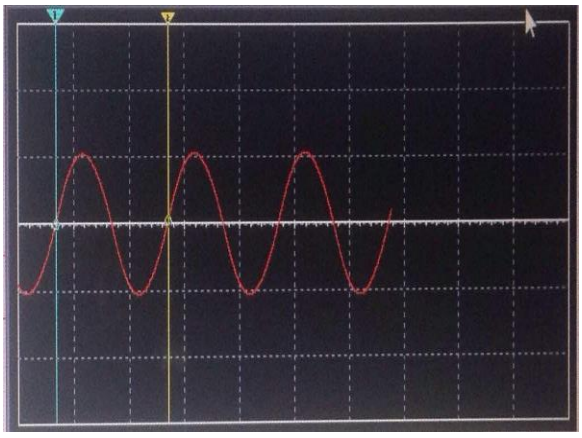

Fig -6: Output Obtained

The following simulation result depicts the pulse generator output.

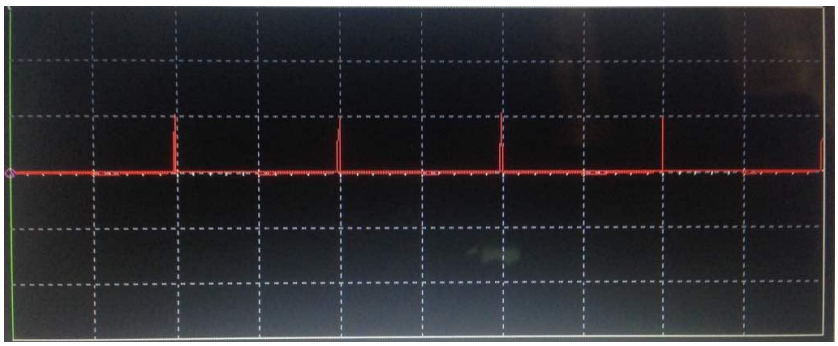

Fig -7: Output Obtained

10. CONCLUSION

The circuit design effectively detects the variation in input frequency. The pulse generation ensures the one complete cycle of the input signal is measured aptly. Further, the design output should be used with Arduino to verify PI action. The proposed design should be verified for the frequency stabilization using power device.

10. REFERENCES

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