# IMPROVEMENT OF POWER QUALITY OF A STAND-ALONE MICRO HYDRO POWER PLANT

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# Abstract

Stand-alone micro hydro power schemes providing electricity to rural villages in hilly areas in Sri Lanka where the grid electricity is not available has become a viable and popular alternative to grid electricity. For generation of electricity, most of the micro hydro schemes employ induction generators converted from ordinary induction motors. Due to many advantages such as robustness, lower cost, less maintenance, readily availability, induction machines are popular over traditionally used synchronous machines in this application. Micro hydro power plants, which employ capacitor-excited (self-excited) induction machines have been considered in this research work.

Stand-alone micro hydro schemes are often located on streams and small rivers where the flowing water can be diverted to the generation of power without constructing reservoirs or ponds. Since these plants are usually less than 50 kW in capacity, they require little amount of water flow for its rated power output. Even though the water source of the plant is capable of supplying required flow for the majority period of an average year, there are some extended periods of drought, which results in reducing the rated flow to the plant. In such situations, micro hydro systems have problem of maintaining its power quality in terms of voltage and frequency, since the control systems are designed only for rated flow conditions. This results in variations in supply voltage and frequency thus making difficulties to the consumers such as reduction of voltage at customer end, inability to use fluorescent and CFL lamps, difficulty in using electrical motors and other appliances such as TVs.

In this research work, the problem was analyzed using the existing micro hydro controllers and discussed the suggested solution by analyzing the required level of control of voltage and frequency in plant output in part flow conditions. Even though there are expensive alternatives for voltage and frequency control in such situations, emphasis made to economical development of such system to suit and feasible for

actual implementation in community based micro hydro schemes. The suggested control system was designed using power electronics and discrete electronic components and it was tested at partial load conditions. Further another control system was suggested for simultaneous voltage and frequency control in rated flow conditions where existing controllers have the facility of controlling either voltage or frequency.

Finally, it was discussed to extend the improvement of power quality at customer end by reducing the harmonics that create by the electronic switching in the control systems.

## DECLARATION

I hereby declare that this submission is my own work and that to the best of my knowledge and behalf it contains no material previously published or written by another person or material, which to substantial extent has been accepted for the award of any other academic qualification of any university or institute of higher learning except where acknowledgement is made in the text.

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***UOM Verified Signature***

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## ACRONYMS

| | | |
|---|---|---|
| IGC | - | Induction generator controller |
| ELC | - | Electronic load controller |
| kWh | - | Kilo Watt hour |
| kW | - | Kilo Watt |
| kVA | - | Kilo volt-amperes |
| kHz | - | Kilo Hertz |
| uF | - | Micro Farad |
| $V_{ref}$ | - | Reference voltage |
| $V_{av}$ | - | Average voltage |
| $V_m$ | - | Maximum voltage |
| $V_{rated}$ | - | Rated Voltage |
| $F_{rated}$ | - | Rated frequency |
| NNV | - | Nominal national voltage |
| AVR | - | Automatic voltage regulator |
| RPM | - | Revolutions per minute |
| PWM | - | Pulse width modulation |
| IGBT | - | Insulated gate bipolar transistor |