Calibration of Energy Meter using PID microcontroller

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Abstract:
The Calibration can be defined as the process of testing any meter or instrument to give a result in sufficient range. The primary significance of calibration is that it maintains accuracy, standardization and repeatability by eliminating or minimizing factors that cause inaccurate measurement. Now days many electromechanical, electrical and electronic power and energy meter at different frequencies are available. This can be used in power distribution systems as well as in industry in day to day life. Now the process of calibration of energy meter is considered as metrological system concern which means that the system connected with measurement and with the scientific study of measurement.

This project is designed with Proportional Integral Derivative (PID) controller, LCD display, Voltage regulation, LDR sensor and Metering unit. To improve the performance without increasing its cost PID controller is used. Because of this the stability of system is maintained and increases the accuracy of the system. The traditional calibration methods for analog energy meter are not applicable to digital meters in past hence, to reduce this problem in this paper a calibration method for both analog and digital energy meter is discussed. This calibration can be suitable for onsite as well as offsite. This calibration method also has some advantages as compared to other existing systems this also described in the next sections

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1. Introduction

The process of calibrating equipment or systems involves comparing the readings from one element of the system or equipment to another system or equipment that has been calibrated and referenced to a predetermined set of parameters. The reference apparatus should be capable of being immediately traced to apparatus. The term calibration refers to a process that determines the precision a standard of measurement taken using a piece of equipment. When employing a particular technology or measuring a specific thing such a wattmeter or energy meter, there is a propensity for the precision of the result to drift with time, making the measurement less reliable. In order to provide repeatable, accurate, and dependable measurements it is necessary to keep the equipment calibrated over its lifespan. By verifying the accuracy of test equipment, calibration aims to minimise any measurement uncertainty. The measurement process's error or uncertainty is quantified and controlled through calibration to a permissible range or level.

In order to reduce risk and cost for both energy producers and consumers, the accuracy of an energy metre is essential. Due to high expense of metre verification, it is frequently practice to replace the entire lot instead of verifying it. In this, we can see how can the calibration of a Non-invasive energy meter is done using proportional integral derivative controller.

PID controller is a control loop mechanism which is used in the industrial control system sector for employing the feedback. The variety of other applications requires continuous modulating control. the majority of the industrial control circuits are currently dominated by PID controller. Although characteristic of the control system and its internal sensor vary over the time. These controllers are frequently maintained in their original settings. Peoples frequently are unaware of the system potential for optimization. When PID parameters are set improperly, the results are mistakenly thought of as control system characteristics. Another cause can be apprehension of applying a labour intensive optimisation process without any assurance of getting a suitable outcome. in this scenario PID plays the vital role for calibration of energy meter.

2. Block Diagram

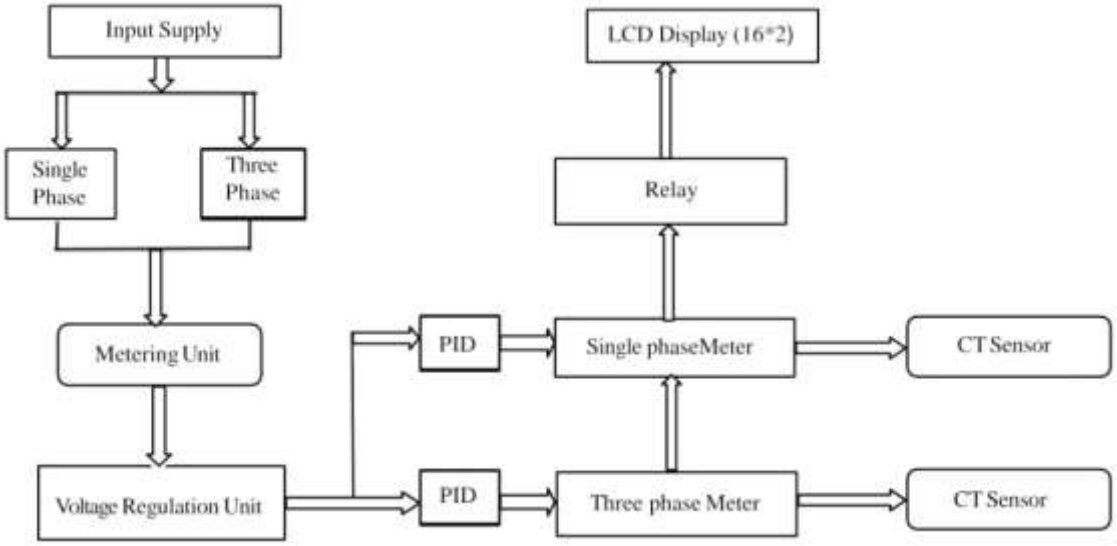

Fig 1: Block diagram of proposed system

Above fig no. 1 show the block diagram of Calibration of energy meter using PID controller. The main part in this diagram is the PID which control all the blocks and calibrate the meter. First we connect the supply, there are two supplies first is the single phase 230V and second one is 440V for three phases.

After the supply section we connects a metering unit for measuring the incoming supply. Next block is Voltage Regulation unit which gives a constant DC supply from rectified voltage.

PID is electronic device so we need this conversion. After this we can connect a PID controller to each calibration section for programming a program and connect this programmed PID to the single phase and three phase meter.

A resistive load is used to measure how much current is flowing to load and this process is done by CT sensors and this CT sensor connects to the each metering unit. Later during the calibration process sometimes errors are generated and this errors is sensed by the sensors in relay unit and displays in the LCD display, this two block are connect one after another and find the accuracy of meter.

3. Working

Calibration is an important in electrical sector. Every electrical equipment or instruments need to be calibrated, a calibration of energy meter using PID controller is designed.

A PID controller is an instruments used to regulate the electrical parameters such as pressure, temperature and flow in industrial control application. It is closed loop control have accurate and stable controller. Energy is power consumed by load for duration of time. Energy meter is used to measures for energy. Any automated process needs three things, first it have to sense then process and switching. Calibration of two types of meter is possible i. e single phase and three phase meter. So single phase and three phase input supply is taken as well. Calibration of meter is carried out in basis of pulses single phase meter having 3200,6400 pulses and three phase meter having 480,850,1200 & 1600 pulses this pulses are defined by Indian electricity rule, accord to that meter is calibrated. Inputs supply is passes to metering unit as shown in fig 1.

Metering unit consists of an ammeter, voltmeter, and frequency meter for each phase and this measures the output which goes to rectifier for rectification. PID is nothing but proportional integral derivative, PID is a electronic device, we know that electronic device need a constant DC supply so we need to use a rectifier for rectification and for constant DC supply need a voltage regulation unit. Voltage regulator regulates a variable DC supply into a constant output DC supply. After that it gives to a PID controller, in PID controller a fixed program is inbuilt according to that it compares actual value to fixed value. The pulses for meter are programmed in PID. The meter which is being to be calibrates the calibration unit, with CT sensor. CT sensor used for measuring high load current from load for both the three phase and single phase meter. Relay is used to sense error generating from comparing pulses by meter. The error is displayed on LCD display in term of percentage i. e how much percentage meter is slow or fast. So it is used in substation in for calibration.

4. Hardware model

Fig 2: Single Phase Unit

As fig 2 refers the connection diagram for single phase. Here 2 pins are used for phase and neutral. The Red pin for Phase and Black pin for Neutral. First the supply is given to the left side of the banana pins after that voltage regulator is used for constant DC supply required for the

PID controller. PID controller compares the pulses as per the defined program. After that single phase energy meter is connected this is to be calibrated. For that purpose can 2 pins on both the sides are used. One for input and another for output. Comparison on the basis of pulses there are 3200 and 6400 standard pulses for single phase. For this pulse one switch is used.

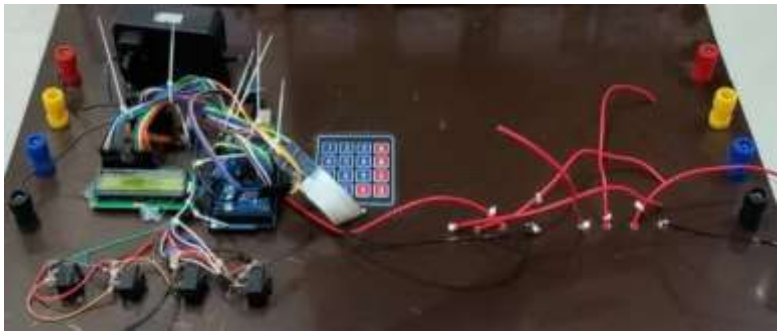

Fig 3: Three Phase Unit

As Fig 3 shows the connection diagram for the 3 phase, here are the 4 pins, Red for R phase, Yellow for Y phase, Blue for B phase and Black for the Neutral. First the supply is given to the left side of the banana pins after that voltage regulator is used for constant DC supply required for the PID controller. PID controller is electronic device which compares the pulses as per the defined program.

After that 3 phase supply is connected to energy meter which is to be calibrated. For that purpose 4 pins on both sides can be used. One for input and another is for output. As we compared on the basis of pulses there are 4 standard ratings of pulses that is 450,800,1200 and 1600 pulses. For this pulse 4 black switches is used. For analyzing how much energy is consumed by existing meter connect with a resistive load.

Metering unit is used for the measurement purpose. For voltage measurement voltmeters are used and for current measurement ammeter is used. There are 6 meters are used in metering unit out of which 3 are voltmeter and 3 are ammeter. For separate phase each meters are used.

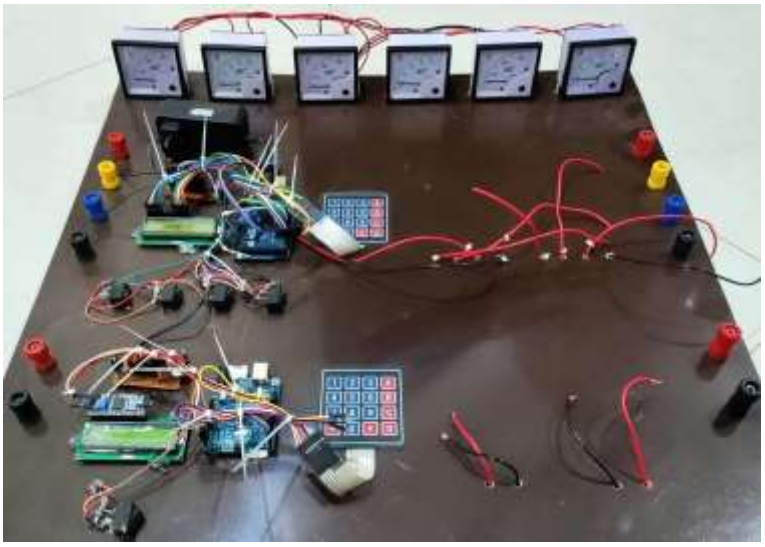

Fig 4: Hardware Model

5. Components

PID controller

In this project PID is used as microcontroller. The PID controller is consisting of mainly of three parts: 1.Proportional 2.Integral and 3.Derivative. The Proportional part which drives the output in proportion to the instantaneous error. The first part which is the Proportional part obtains the output of the system in proportion with the immediate or instant error. The second part that is integral part derives the output of the system in proportion with the acquired or assembled error and the last derivative part drives the output of the system in proportion to the instant or immediate rate of change of error.

These 3 parts are combined that is proportional integral and derivative controller to produce a control signal. Due to flexibility and reliability of the PID controller these are mostly used in process control application. In PID controller control loop feedback device is used to regulate all the process variable.

Parameter	Specification
PID controller	Digital 2566 and Atmel 328 PID controller
Voltage	0 – 5 V

Fig 5: PID controller

LDR Sensor

Light dependent resistor (LDR) also known as photoresistor. LDR also measures the Intensity of the light. The indication of the presence and absence of the light can be identified by the LDR sensor. The resistance of the light dependent resistor is increases with decrease in light intensity and resistor is decreased with increase in light intensity. The working principle of LDR is based on the photoconductivity. When the light is absorbed by the material the conductivity increases.

Parameter	Specification
LDR sensor	5 V operated digital sensor

Metering Unit

In metering unit various meters are used such as Voltmeter for single phase and three phase, Ammeter for single phase and three phase. Voltmeter and Ammeter used for voltage and current measuring purpose.

Parameter	Specification
Voltmeter	0 – 500 V Analog type
Ammeter	0 – 20 A Analog type

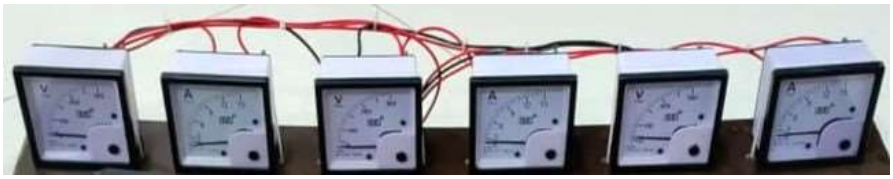

Fig 6: Metering Unit

LCD Display

LCD display means Liquid crystal display. 16×2 LCD displays are used it can be means that 16 characters are displayed per line and there are such types of 2 lines. LCD is an electronic device module uses liquid crystal to produce visible image. It can be operated on 5 V.

Fig 7: LCD display

6. Regulator

Regulator are used for getting constant and steady output. Voltage source cannot able to give fixed output voltage due to fluctuation in the circuit. In this 7805 voltage regulator is used. It can be gives +5V DC regulated power supply.

Parameter	Specification
Regulator	7805 transistor based 5V regulator.

7. Current transformer

Current transformer used to measure the current. CT is a type of transformer used to reduce or multiply the alternating current.

Parameter	Specification
CT	5/30 A wound type current transformer

8. Advantages

1.It can maintains the accuracy , standardization.

2.It has less maintenance.

3.It is simple in construction

4.It has cheap cost, compact size and light weight.

5.It can be more reliable

9. Conclusion

From this project we can conclude that a method to calibrate the energy meter. The calibration of single phase and three phase has been developed for residential, industrial as well as commercial applications.

We can find out how much the percentage of the error occurs in the meter, that is whether the meter is slow or fast in the percentage. and defines the accuracy. The calibration process involves taking feedback from the meter output and comparing with the standard pulse(defined or programmed in the microprocessor). This process is very efficient and time saving compared to the existing method.

It also helps to improve the energy consumed over a specific period of time in terms of unit, and performance of the system as well as the meter.

Calibration ensures the instruments developed error fulfills the requirement. Energy meter calibration is a process required to determine the error when the energy is measured.

The project is extremely beneficial to the consumers who are experiencing meter reading issues and any other issues.

10.Future Scope:

In this project of calibration of single phase and three phase energy meter,,we can add calibration for net meter. This net meter is a bidirectional meter. Net meter is used for the measuring the power from MSEB and also from solar panel. This can be obtained by using a new program for calibration of net meter.

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