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Novel Use of Single Phase Electromechanical Energy Meter for Standardized Testing of Digital Energy Meters

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Abstract: *To ensure reliability and high accuracy testing of energy meters has been imperative. The conventional testing of digital energy meters poses some drawbacks viz. slow process, power loss and requirements of resistor and capacitor banks. This paper proposes the modified single phase energy meter, making it standard for the testing of Digital Energy Meters. For the purpose 72 holes are drilled on the disc of electromechanical energy meter and then recalibration of the same is done before using it as "standard". The holes on the disc shall be detected by the sensor which is connected with the microcontroller which counts the pulses obtained. The number of pulses obtained from electromechanical meter and Digital Energy meter are compared to gauge the error in Digital Meter.*

Key Words: Calibration, Standardization, Digital Energy Meter (DEM).

I Introduction:

At present the Digital Energy Meters are widely used and the prevailing testing methodology the number of meters are connected in series with the standard meter. Before the start of the test existing readings on each meter is recorded manually and then power supply is given to start the testing. Testing time is stretched till standard meter records approximately one Unit of power consumption. After this load test, consumption is recorded for each meter. All the readings are compared with that of the standard meter after the test and manually error is calculated. The limitation of this kind of prevailing testing practice is low accuracy and more time required for the testing with the power loss inclusive. Moreover the cost of standard digital meter is also exorbitant.

This paper proposes an innovative method for the testing of DEM with the help of single phase electromechanical energy meter with incorporating some additional electronic circuits with sensors and microcontroller is proposed to address the drawbacks or limitations involved in the conventional testing methodology. This proposed innovative idea dishes out cheaper, more accurate and less time and less power consuming solution.

II Methodology Proposed:

1. Single-phase electromechanical energy meter with equidistant 72 holes on the disc
2. Holes will be detected by the sensor
3. Sensor is connected with microcontroller.
4. Programmed counting of the pulse.
5. Numbers of pulses of both the meters are compared.
6. Display the results in terms of error in digital meter.

III Functional Block Diagram:

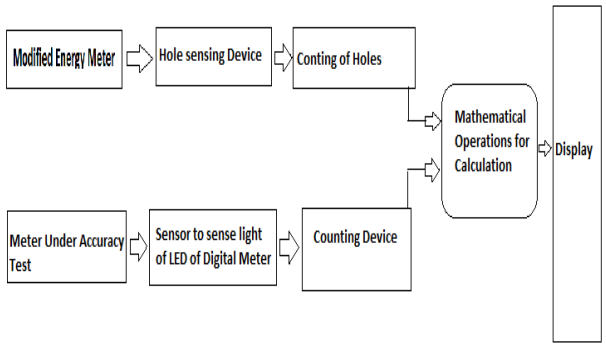


Fig.1 Functional Block diagrams.

IV Strategy Involved:

- Proposed changes in the Electro mechanical meter:

  The revolution of the disc is to be sensed and for that we use sensor which generate pulse when exposed to the light beam through the hole and connected microcontroller will increment its counter by 1(one). If we drill a single hole on the disc, then per KWh consumption the counter will count the pulses equal to the meter constant of energy meter. If we provide more holes say "N" then counter will receive pulses, N times the meter constant. This will enhance the accuracy of testing.

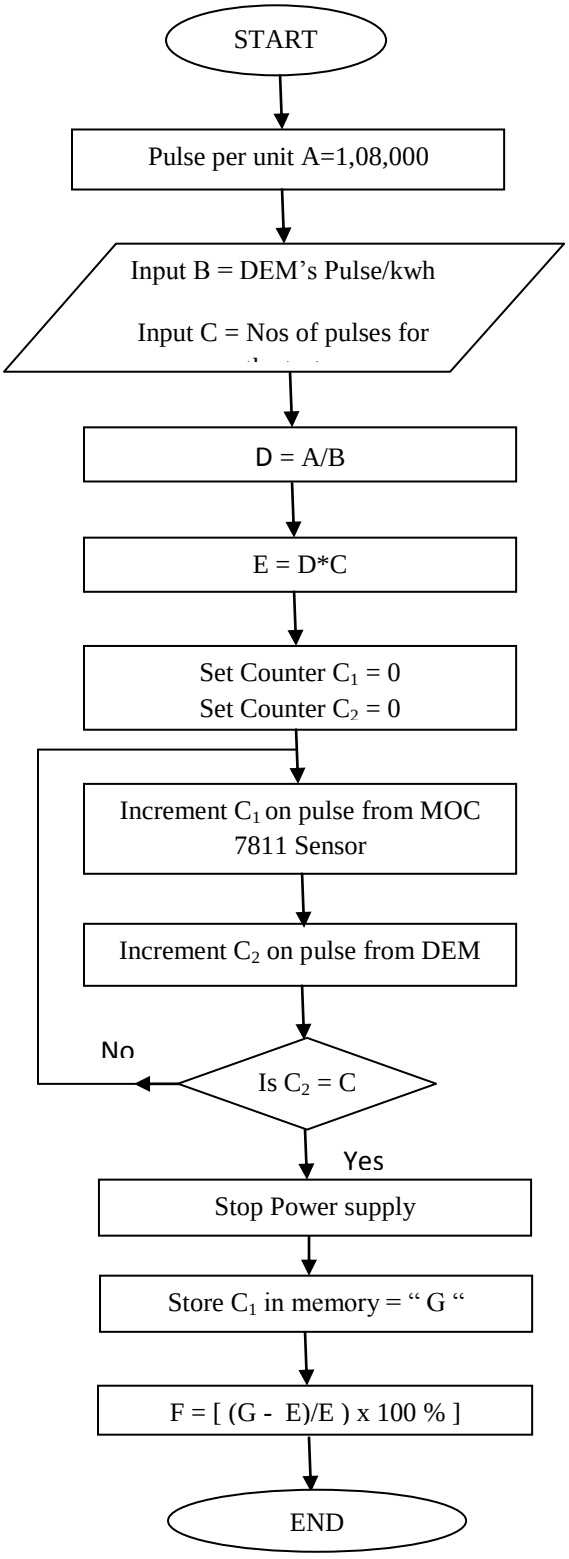
- Sensing Device Deployed:

  In DEM there is 1200 light on-off pulsed per KWh. We simply need to deploy sensing device for on-off pulsating light. Then we count on-off pulses and give it to the microcontroller for comparisons and accuracy calculation. At last microcontroller gives output on digital display in terms of accuracy of digital meter.

- Conceptualization:

1. Suppose meter constant of 1-phase electromechanical meter is 1500/KWh
2. Number of holes on disc= 72 (Each at 5^0 apart)
3. Number of pulses counted per KWh consumption = 1500* 72=1,08,000
4. This would give us high resolution per KWh
5. This meter is further calibrated by standard electromechanical meter available in the laboratory to cope up with the error on account of drilling holes and fixing additional circuits for sensing.
6. Standard electromechanical meters are comparatively cheaper than the standard DEMs.
7. Higher the meter constant more accuracy we get.
8. Suppose, if we take Digital Energy Meter having 1200 impulse/KWh for the test.
9. In our standard meter prepared we get 1,08,000 counts /KWh.
10. Eventually we get 90 counts per one impulse of digital meter.
11. Suppose we test DEM for 100 pulses, the standard meter must give 90*100=9000 counts.
12. Error = {(Actual Count – Standard Count)/ Standard Count } * 100 %
13. If Error is negative then DEM is slow and would be recording less amount of energy and positive Error indicates fast metering.
14. E.g. If counter counts 8765 numbers of impulses of the standard energy meter while 100 pulse of 1200 impulses / KWh DEM, The Accuracy Calculation = {(8765-9000)/9000} * 100 %= -2.61%
15. So, we can conclude that the Digital Energy Meter under test is faster.

Flow Chart:



Where,

A= 1,08,000 impulses / KWh

B= Digital meter's impulse/ KWh

C= Number of impulses for test

F= Error in %age

G= Actual Counts

E=Standard Counts

Counter C_1 = Connected with MOC 7811 sensor and incremented by 1 on receiving pulse from the sensor.

Counter C_2 = Connected with LDR (Sensing impulse of Digital Meter) and incremented by 1 on receiving pulse from the sensor.

Major Components Used:

(a) Single Phase Electromechanical Energy Meter: With modification as discussed earlier is used as a standard meter for testing Digital Energy Meter.
(b) 8051 Microcontroller (8-bit): Used to count as well as compare pulses from Digital as well as from modified single phase electromechanical energy meters. This contains CPU, ROM, RAM, clock and I/O control units on a single chip.
(c) MOC 7811 Sensor: It is a slotted opto-isolator module, with IR transmitter and having photo diode mounted on it.

- It has four legs, 2 each for photo diode and IR sensor respectively.

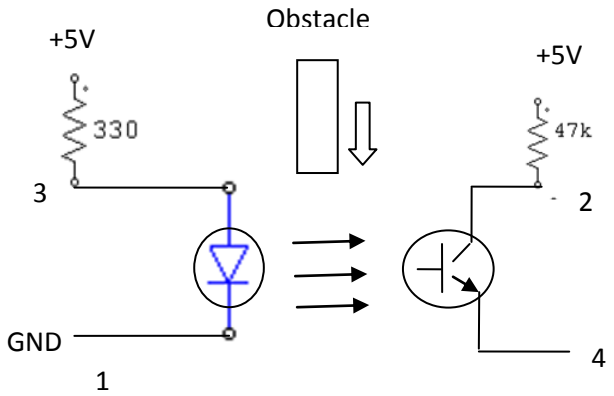


Fig.2 MOC 7811 Sensor

- Both photo diode and IR are inbuilt and no external connections are required.
- Current limiting resistances are required.

(d) Light Sensor: To sense the light from Digital Energy Meter this sensor is used.
(e) Display: LCD flashes output in terms of error of the tested Digital Energy Meter.

Conclusion: This proposed innovative idea of testing the Digital Energy Meter with the modified electromechanical meter has resulted into a reliable, prompt and high accuracy testing, provided enough care is taken while preparing a modified electromechanical single phase energy meter and during its final calibration.

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