The Need For An Effective Calibration On An Electricty Meter: A Case Study Of Momas Electricity Meters Manufacturing Company Limited (Memmcol)

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ABSTRACT
Electricity meters are used in measuring the quantities of electrical energy consumed by a load. They are used by distribution companies to measure the energy consumed by a customer which in turn is used in billing them. Currently, there are only two types of energy meters. The Electromechanical Energy Meters and the Electronics meters. In the Electromechanical type of meters, the electrical energy consumption is measured based on the induction principle recorded by the resolution of the counter. The main principle used here is Electromagnetic Induction. While in the Electronics Meters, also known as Solid State meters, no moving part is seen, no mechanical parts are present. All we see is the Microcontroller, Analog Front End (AFE), Resistors, Diodes all mounted on the Printed Circuit Board. This paper presents the importance of an effective calibration on Electronics meters. A calibration test was carried out on 15 Solid State meters on the Test Bench using the Telemetry Test Equipment (TMTE) software. Then a comparison was made between the data obtained from the passed calibration meters and the failed calibration meters in terms of their error. From the result gotten, it was seen that 7 meters passed calibration and the remaining 8 failed. These failed meters need to be worked upon and they recalibrated before they are certified to be used for a residential, industrial or commercial purpose otherwise, there will be a fluctuation and inconsistent measurement of basic electrical quantities.

Keywords-- Calibration, Electromechanical, Energy, Meters, Micro Controller

INTRODUCTION

Concept of Metering

Electricity is the set of physical phenomena associated with the presence and flow of electric charge. Electricity meters are used by distribution companies to measure the energy consumed by consumers which in turn is used to bill them. There are two types of Electricity meters. The Electromechanical meters and the Electronics meters. (Ortiz, Lehtonen, Mañana, Renedo, & Eguíluz, 2009).

Electromechanical Meters

This example of meters works on the principle of Electromagnetic Induction. Here, the electrical energy consumption is measured based on the induction principle recorded by the resolution of the counter.

The driving system of this meter consists of two electromagnets. The coil of one of the electromagnets is excited by the load current. This coil is called the current coil. The coil of the second electromagnet is connected across the supply voltage as shown in Figure 1. This coil is called the pressure coil or voltage coil.

An aluminum disc is positioned in between the electromagnets [1]. The function of the registering or counting mechanism is to record the revolutions continuously, a number which is proportional to the revolutions made by the moving system. Magnetic Flux Generated within the POTENTIAL coil, when energized by line voltage, passes through the Potential Core and is directed to the disk as shown in Figure 2. Magnetic Flux is also generated around the CURRENT coil, as Load is applied, passes through the current core and is also directed to the Disc. The Interaction of these magnetic Flux and eddy currents developed produces a FORCE within the disk to push or drive it in a specific direction.

The NET effect of all the forces acting together on the disk causes rotation at a speed proportional to line voltage and current LOAD. (MEMMCOL, 2018).

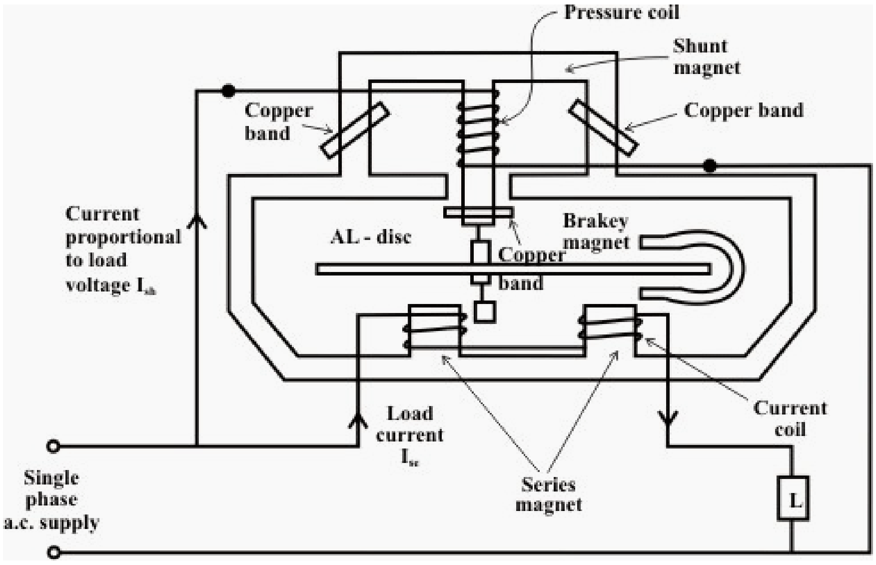

Figure 1: *The two coils of the Electromagnets in an Electromechanical meter.*

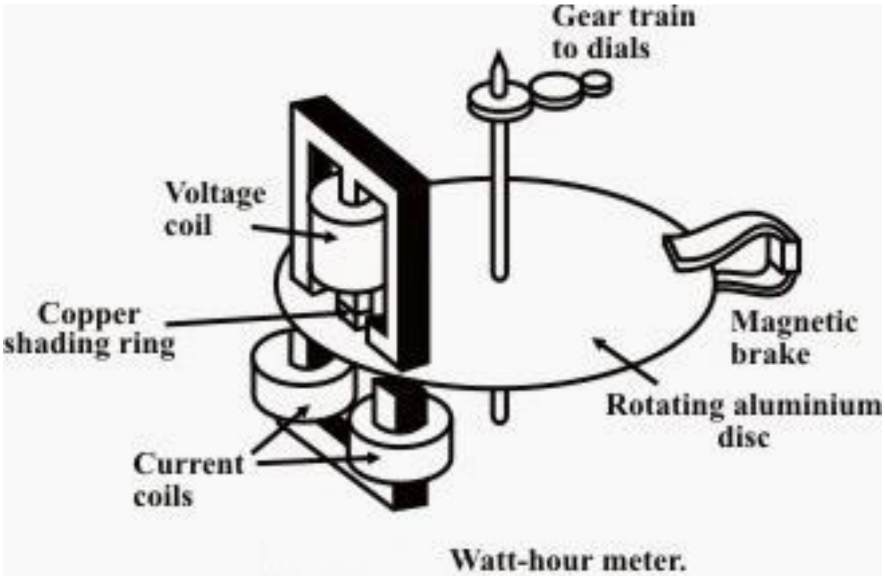

Figure 2: *An Aluminum disk separating the Voltage and Current coil.*

Figure 3: *The Electromechanical Meters.*

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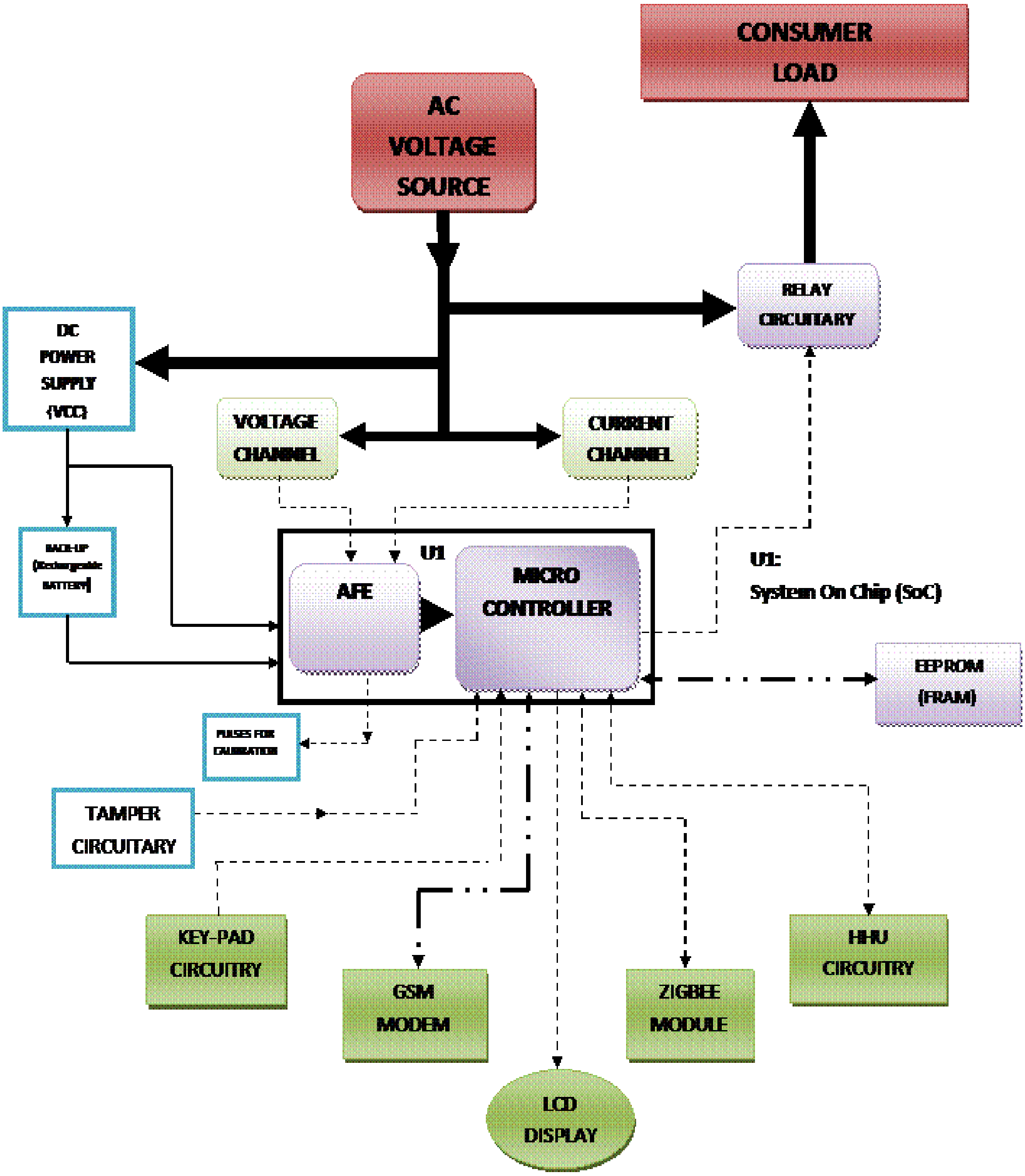
Solid State Meters

These meters are otherwise known as Electronics meters. Here, no moving parts are seen [2]. It includes electronic components like the Analogue Front End (AFE), Microcontroller Unit, Resistors, Capacitors Inductors as shown in Fig. 3. For the display section, it uses the Liquid Crystal Display (LCD). All these are mounted on the Printed Circuit Board.



(MEMMCOL, 2018)

Figure 4: *Block representation showing the interconnection of the components of Solid-State Meters.*

These meters can either be Single-phase or Three-phase. Single-phase meters measure energy only in one phase. It has a maximum of 80Amps current Rating and it can be used for residential purposes. The Three-phase meters measure current on all the three phases and it has a maximum of 100Amps Current rating. (Parker & Hunt 2015).

For communication with these meters, different means are used. These include: Optical/ Infrared Port, Keypad means, GPRS/GSM Module, RS232/RS485, Wireless means as shown in Fig. 4.

(MEMMCOL, 2018)
Figure 5: *The Electronic Meters (3 phase and 1 phase).*

METHODOLOGY
Calibration

Calibration is simply a comparison between a known component (the standard) and the measuring device under test. Conventionally, for calibration to be done, the standard must be 10times accurate than the measuring device under test but a ratio of 3:1 is still acceptable.

For meter calibration, the meter is calibrated against a Standard Reference meter. Here, a Telemetry Test Equipment (TMTE) Software was used and the meters were calibrated on the Test Bench. The meters were placed on the Test bench and Voltage and Current were injected into them. A mathematical modeling was then done involving a percentage error calculation of the Reference meter and meter under test each for Voltage, Current and Phase. The importance of meter calibration is to compensate for error current measurement, voltage measurement, and phase angle measurement as shown in Fig. 5. Most solid-state meters have an energy to frequency converter, that outputs a digital pulse at a frequency that is proportional to the rate of energy consumption.

This pulse rate is measured in imp/kWh and is called the Meter constant. This frequency output is made available either as a digital pin that can be connected to a frequency counter on a piece of equipment, or as an LED which outputs visible light as a visual indication of the meter's readings [3]. This constant defines how many impulses are equivalent to 1kWh of energy consumed. For example, a meter with a constant of 4000imp/Kwh means that for every 4000 blinks of the LED light, it automatically records 1Kwh of energy.

$$Error = \frac{Actual - Ideal}{Ideal} = \frac{Value_{UOT} - Value_{RF}}{Value_{RF}}$$

UOT = Unit Under Test (The meter).
RF = Reference Meter.

RESULT

Figure 6: *Meters on the Test Bench undergoing Calibration.*

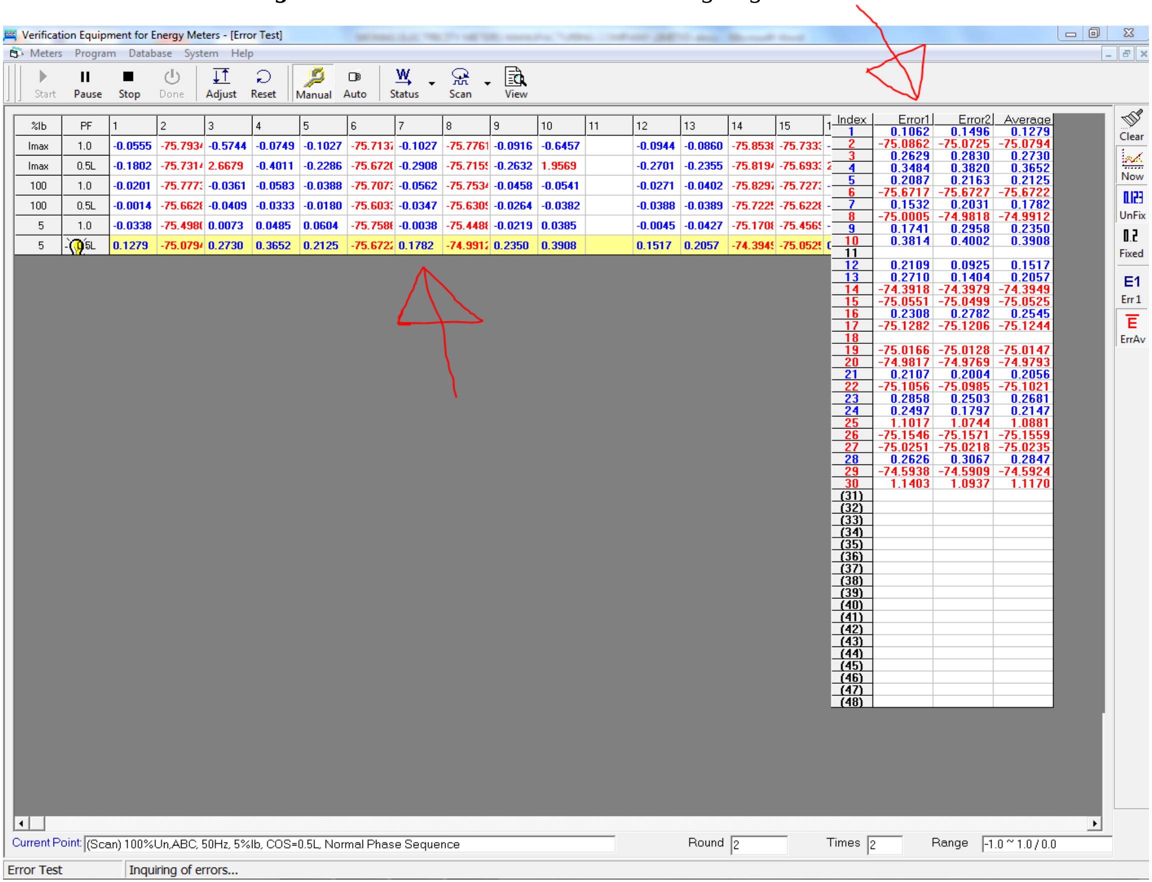


Figure 7: *Error Display of meters undergoing calibration.*

DISCUSSION OF RESULT

As seen from the figures above, the meters were tested under a very low current (0.25A), Normal current (5A) and under high current(100A) to see how it will behave under these currents. The values are displayed in errors [4]. Only meters having blue color throughout passes calibration hence can be used for industrial, commercial or residential purposes. Meters on red color failed calibration and hence need to be worked on and then recalibrated.

CONCLUSION

Calibration is very important for any measuring device. This is usually necessary for others to have an accurate and precise reading when it is used. For a calibrated meter, it is usually done ones and it is expected that once done, it can function for up to 10years when used. No meter is expected out of a meter production factory without it being calibrated [5]. This shows how important calibration is as shown in Fig. 6 and 7. Once done properly, the meter owners are rest assured that they are actually paying exactly for what they used and the Distribution Company is equally in the peace of mind they the consumers are not paying lower compared to their energy usage.

REFERENCES

1. Antonio Delle Femine, Daniele Gallo, Carmine Landi, Mario Luiso (2009), "Advanced Instrument For Field Calibration of Electrical Energy Meters", *IEEE Transactions on Instrumentation and Measurement*, Volume 58, Issue 3, pp. 618-625, DOI: 10.1109/TIM.2008.2005079.
2. SA Parker, BK Boyd, WD Hunt, KL Mc Mordie Stoughton, KM Fowler, TM Koehler WF Sandusky, R Pugh, GP Sullivan (2015), "Metering Best Practices, A Guide to Achieving Utility Resource Efficiency, Release 3.0", *Pacific Northwest National Laboratory*, Available at: https://datacenters.lbl.gov/sites/default/files/Metering%20Best%20Practices_2015.pdf.
3. Amicone D., Bernieri A., Betta G., Ferrigno L., Laracca M. (2008), "IMEKO TC4 Int. Symp. Exploring New Frontiers of Instrum. and Methods for Electrical and Electronic Measurements; TC21 Int. Workshop on ADC Modelling and Testing - Joint Session, Proc.", *Publons*, pp. 645-650, Available at: https://publons.com/journal/72529/imeko-tc4-int-symp-exploring-new-frontiers-of-inst.
4. Rafael M. Inigo (1980), "An Electronic Energy and Average Power-Factor Meter with Controllable Nonuniform Rate", *IEEE Transactions on Industrial Electronics and Control Instrumentation*, Vol. IECI-27, Issue 4, pp. 271-278, DOI: 10.1109/TIECI.1980.351643.
5. J.A. Enokela (2007), "A Comparison of Performances of Electronic And Electromechanical Energy Meters", *Nigerian Journal of Technology*, Vol. 26, Issue 2, pp. 56-62, Available at: https://www.ajol.info/index.php/njt/article/view/123398.

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