

# AN AUTOMATIC SMART TELEMETERING TELEBILLING AND TELE-CONDITIONAL ACCESS CONTROL OF ELECTRICAL ENERGY

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## ABSTRACT

**An electrical energy meter measures and records electrical power consumed over time by electrical appliance. Energy meter can be electromechanical or electronic-based, and it can be deployed in domestic or industrial environment. However, electromechanical meters have been with us for a very long time, it is of late that electronic meters start to appear in electrical metering scene. The manual reading of electromechanical meter for the purpose of billing is fraught with many social and management problems. This paper presents a simple automatic smart device developed to automate the process of remote meter reading, remote-billing, and remote disconnection, in case of defaulting in payment, of existing electromechanical energy meter without modification.**

## 1.0 INTRODUCTION

An electrical energy meter measures and records electrical power consumed over time by electrical appliance. Energy meter can be electromechanical or electronic-based, and it can be deployed in domestic or industrial, that is commercial, environment. However, electromechanical meters have been with us for a very long time, it is of late that electronic meters start to appear in electrical metering scene. Electromechanical meters have technical, social, and management problems. The technical problems are manifested by the moving parts of an electromechanical meter, which cause wear and tear vis-à-vis its magnetic component whose operation depends on prevailing temperature. These culminate into errors which degrade the reliability and accuracy of the meter over time. The manual reading of electromechanical meter for the purpose of billing is fraught with many social and management problems. Some of these problems are possible lock-out of a meter from easy accessibility, human error in reading, gross inaccurate estimated reading, controversial billing, lack of information on detailed breakdown of energy consumption over a period of time, irregularities in billing time, tampering prone, high overhead cost of meter reading, and possible misplaced paper bill. The existing manual method of disconnecting the power lines to the meter has its own wagon of disadvantages ranging from exposure of the meter readers to corrupt practices,

illegal reconnection of the power lines, bypassing of the energy meter, and very weak conditional access enforcement. Therefore, manual reading, billing, and enforcement of conditional access are either inefficient or inadequate and tantamount to aiding and abetting diversion of revenue to unauthorized people. It is certain that in a deregulated electrical energy economy, something has to be done to remedy these shortcomings. The answer to these problems is provided by electronic energy metering.

It is found out that electronic meters are better and preferable to electromechanical meters in terms of superior performance, and measurement accuracy [1], and other available features as a result of digitilisation. Some of the features which are taken advantage of are possibility of telemetering, more accurate measurements and reading devoid of environmental condition, and aging, possibility of enforcing conditional access, removal of controversial billing, and provision of information for planning and effective management of electrical energy. Readings available from an electronic meter include active power and energy, reactive power and energy, apparent power and energy; computation and archiving of peak power; multiple tariff counters, root mean square values of phase voltages and currents ; frequency, and power factor [1,2]. However, electronic meters were not popular in their early days because of their inaccuracy compared to the electromechanical meters. Things have changed for the better for electronic meters since the introduction of digital signal processors and analogue to digital converters into the process of energy measurements which have made electronic meters more reliable and accurate [3,4].

There are millions of existing electromechanical energy meters in the developing worlds which may be difficult to discard by the introduction of a more enviable all digital electronic meters. For instance, Nigeria with a population of about 120 Millions and at an average of one meter per ten inhabitants put the number of estimated electromechanical energy meters at about 12 Millions for domestic use only. Hence, a technique which can marry the advantages of digital electronic energy meter without significant modification of the existing meters will be most welcome.

Therefore, this paper presents a simple automatic smart device developed to automate the process of remote meter reading, remote-billing, and remote disconnection, in case of defaulting in payment, of existing electromechanical energy meter without modification.

## **2.0 ELECTROMECHANICAL ENERGY METER**

An electromechanical energy meter consists of a series connected load current sensing electromagnet, and a parallel connected load voltage sensing electromagnet. The two fluxes produced by the electromagnets induce emf in a disc resulting in an eddy current. The reaction between the fluxes and the eddy current causes a driving torque on the disc which makes it to rotate. Hence, electrical power is measured by the multiplying effect of the induced fluxes. The measured power is converted to energy by a set of five or six mechanical gearing system connected in tandem, with each carrying a dial, driven by a rotating disc. Each dial is calibrated into ten divisions, and advances by  $1/10^{\text{th}}$  of a revolution for each complete revolution of its adjacent dial in the tandem. The energy consumed is recorded by counting the number of complete revolutions made by the rotating disc, a complete revolution measures a unit of electrical energy in KWh. Therefore, a typical electromechanical energy meter displays the energy consumed in units of KWh as 10000, 1000, 100, 10, 1,  $1/10$  digits.

## **3.0 INFORMATION TECHNOLOGY BASED ELECTROMECHANICAL ENERGY METER**

Fig 1. depicts the block diagram of the system architecture of the integrated information technology system and electromechanical energy meter. The system architecture consists of five major units, namely, the electromechanical energy meter, the sensor unit, the conditional access monitoring and enforcement unit, the microcontroller unit, and the communication unit. All these units except the electromechanical energy meter constitute the information technology interface between the electromechanical meter and the energy central office. The sensor unit is the only invasive and retrofitted component to the meter. It consists of an infrared emitter diode on one side of the meter's disc, a hole drilled on the disc which is of the size of the aperture of the emitter diode, and on the other side of the disc is an infrared phototransistor. The emitter diode emits light continuously which is only detected when the hole on the rotating disc aligns with the emitter and phototransistor. This occurs once per revolution resulting in the phototransistor generating a pulse per revolution. The train of pulses representing the energy in KWh is fed to the microcontroller via a signal conditioning circuitry.

The microcontroller unit consists of an 8031 microcontroller, an MC146818 Real-Time Clock module, LCD display module, a 16-key keypad, and a software module. The 8031 microcontroller is responsible for counting the number of revolutions representing the energy consumed, information on the time stamp of consumed energy is available from the real time clock. The schedule for uploading of the integer value of the consumed energy unit for billing purpose is based on the real time clock. The 8031 generates all the control signals required by the relays, phototransistors, the communication unit, keypad, and the display module. The display module displays the digital energy reading, and the bill, and deadline for bill settlement. The bill can be according to schedule or on demand. The keypad is used for requesting information from the energy central office and time information from the real time clock module. The software package developed in assembly language consists of various drivers, schedules, and host address number for uniquely communicating with the system.

The conditional access monitoring and enforcement unit is responsible for cutting off remotely a defaulting consumer, monitoring of illegal attempt to reconnect, and reconnection remotely of the consumer. It consists of a contactor driven by relay activated by the microcontroller; it also has a phototransistor in its enclosure for effecting tamper proof. If an unauthorized attempt is made to open the enclosure for illegal reconnection the phototransistor is activated which in turn alerts the microcontroller which obtains the time stamp information and uploads it to the energy central office. The feature is deactivated by a password for authorized reconnection.

The communication unit is full duplex consisting of a gsm modem interfaced to the microcontroller for effecting bi-directional communicating channel between the microcontroller and the energy central office. A landline telephone modem can also be used, a conventional gsm with RS232 data cable is used in this project. The only requirement is that your gsm service provider must support data. A smart card for prepayment and other conditional access feature can be included with this system.

## **4.0 SYSTEM PERFORMANCE**

The performance of this integrated information technology and electromechanical meter synergy is impressive. Most of the features available from a fully digital electronic meter such as telemetering, tamper proof, loading information for effective planning and management are also available from this synergy. A patent application for this development is being processed.

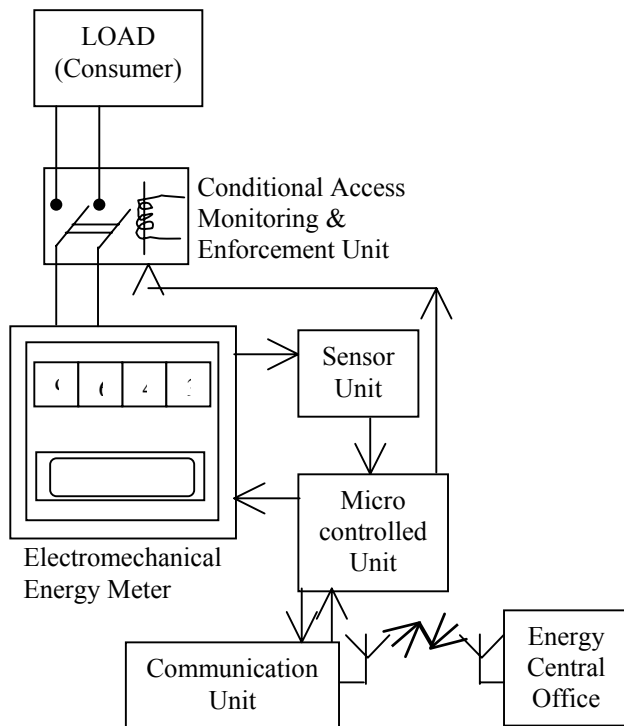


Fig 1. Block Diagram of an Integrated Information Technology and Electromechanical Meter System

## 5.0 CONCLUSIONS

A telemetering, tele-billing, and tele-conditional access was crafted into an existing electromechanical energy meter with only a simple sensor module retrofitted invasively to the electromechanical meter. The performance of this integrated information technology and electromechanical meter synergy was impressive with most of the features available from a fully digital electronic meter made available. A smart card could be included in this system for effecting pre-payment.

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