



# Design and Implementation of a GSM Based Automated Meter Reading System

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**Abstract – In Nigeria, electricity consumers often complain about inaccurate collections of data from their respective meters which resulted to over charged bills issued to consumers for the power consumed, while the energy distribution companies also face the continuous challenge of boycotting distribution service mains and low payment in return. This paper presents solution to enable accurate collection and delivery of consumer data by Automated Meter Reading (AMR) through the use of Global System for Mobile Communication (GSM). Automated Meter Reading consist of different modules connected together. This device receives data through the GSM phone number integrated into the devices via the microcontroller coupled to the wattmeter using an opto-coupler. The accurate data of energy consumed is then transferred via the GPRS to the distribution company database collection system. This eliminates the challenges encounter when using manual means of collecting data and allows collection of large numbers of relevant data from the residential and commercial consumers meters and then process to different information beneficiaries.**

*Keywords: AMR, Energy, GPRS, GSM, Opto - Coupler, Wattmeter, etc.*

## 1. Introduction

In Nigeria today, consumers and power distribution companies are always at logger head due to estimated wattage system that the power distribution company use to bills the consumers at the end of every month. Estimated bill of power consumed is not only given to consumer that does not have wattmeter to measure the quantity of energy the consumer has consumed but also to consumer's functional wattmeter. Another factor that leads to estimated billing is the use of analog method of calculating the values of energy consumed. This method is however noticed to be inaccurate, inefficient and also required much labour to achieved as to measure up with the increasing commercial and residential needs of electric power. Therefore, the need for automated meter reading system using Global System for Mobile Communication (GSM) based technology of information delivery is highly important. AMR is a communication device that allows the transmission of data from the consumer wattmeter to the distribution data collection system for adequate processing. The processed data i.e. the information is therefore used to calculate the exact value of energy consumed. This method enables large amount of data to be collected from the consumer meter and process accordingly, and such information will not only be of benefits to the distribution company only but also to the consumers. The GSM based technology make use of phone number of the consumer which is either dedicated or shared with voice or Short Message Services (SMS) to send consumers wattmeter data. With this system, automated dialer is installed at the consumer meter which whenever there is a signal or an alarm received by the utility the dialer will dial the distribution officer in charge at a pre- set times continuously until the information is acknowledged. The GSM based technology tends to be cost effective for wattmeter values, reduce various error generated as a result of manual means of collections of data and can be typically used to monitors enormous residential and commercial consumers. It also reduces or eliminate misunderstanding between consumers and distribution companies. Also consumer that are unable to pay the bills as expected by the company can be easily disconnect from their supply. (Arun S. and Sidappa Naidu, 2015).

## 2. Materials and Methods

### 2.1 Circuit design and development

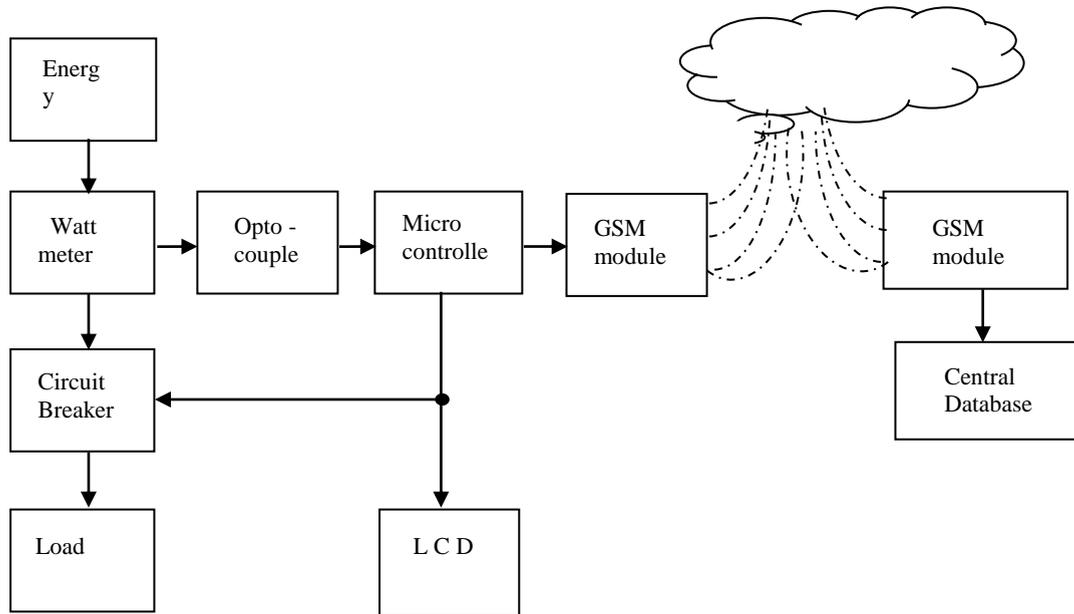


Fig. 1: Block Diagram of Automated Meter Reading.

#### 2.1.1 Energy meter.

The meter is an integrating instrument and takes into account both the power and the time quantities, the product is used to measure the energy utilises in installed domestic and industrial load, at a particular interval of time and the unit of measurement is kilowatt hour (kWhr). (Yaduvir Singh and Mandhir Verma, 2010).

#### 2.1.2. Circuit breaker.

It is an electromechanical protective and switching device used for making, carrying and breaking currents under normal circuit conditions and also making, carrying for a specified time and breaking currents under abnormal circuit condition such as those of short circuit. In normal operating condition, a circuit breaker opens its contact when a tripping signal is received. (Juan A. Martinez-Velasco, 2010).

#### 2.1.3. Opto-coupler.

It is an integrated circuit that contains an optical transmitter such as LED or an Injection Laser Diode (ILD) driving a photo-detector such as photo diode, photo- transistor, a photo FET, a photo-SCR or a Photo-Op-Amp. There is a space between the two parts and the whole components are sealed in a plastic, this allows digital signals to be sent between two circuits with different grounds. The digital signals are transmitted on a light beam; the two circuits are 100 % electrically isolated. This device protects the circuit from static electricity, relay and loop damage. It is imperative to include opto-coupler in A.C controlled projects such as AMR. (B. Somanathan Nair, 2006).

#### 2.1.4: Microcontroller.

A microcontroller is a small computer on a chips or a single computer chips that are used to control objects, process or events. It contains memory and input and output interface in addition to the central processing unit (CPU). (Jan Axelson,1997).

#### 2.1.4.1: AT89S52 Micro-controller.

It is a low-power, high-performance CMOS 8-bit micro controller with 8Kilo bytes of in-system programmable Flash memory. the program memory can be reprogrammed in-system or by a conventional nonvolatile memory programmer with the aid of on-chip Flash. By combining a versatile 8-bit CPU with in-system programmable Flash on a monolithic chip, the Atmel AT89S52 is a powerful micro controller which provides a highly-flexible and cost-effective solution to many embedded control applications.(www.tecnocare.com).

#### 2.1.4.2 Power supply.

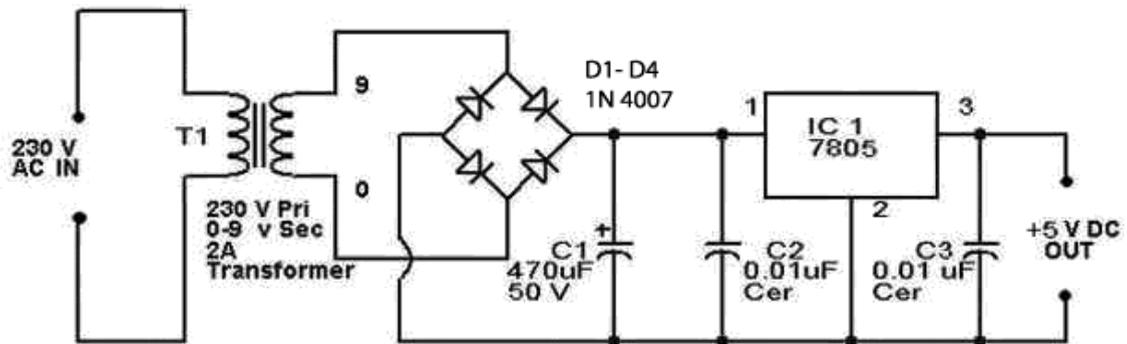


Fig. 2. Circuit diagram of power supply to automated meter reading.

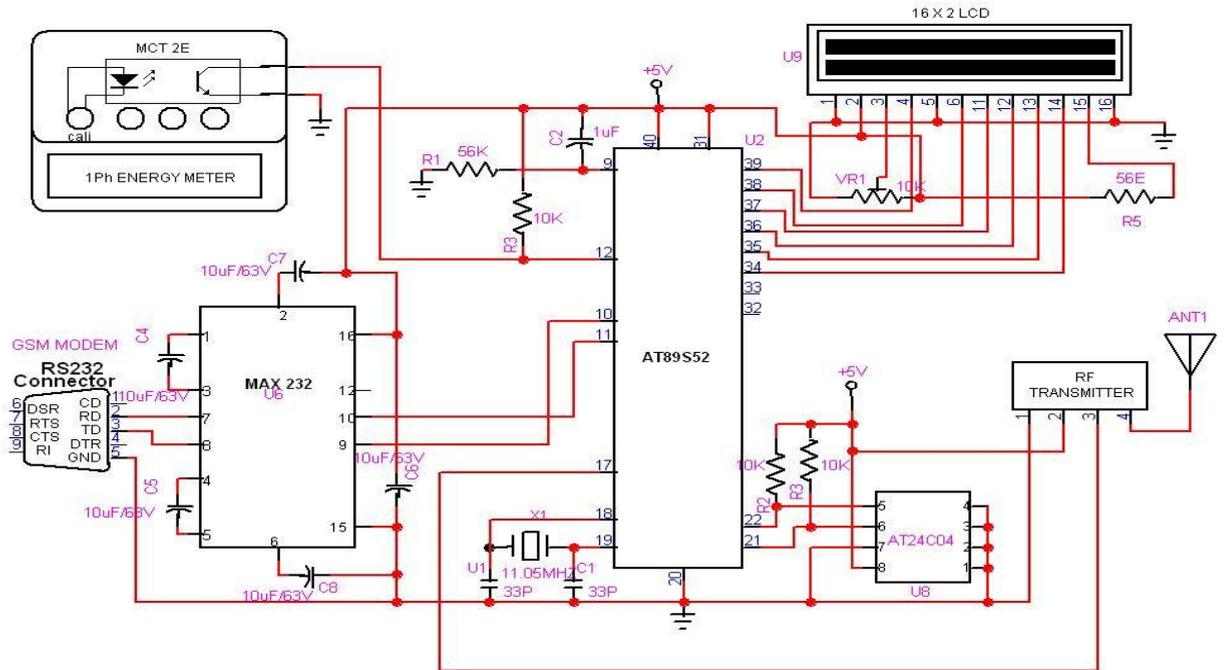
The microcontroller AT89S52 requires +5V regulated power supply circuit to function. A useful device for microcontroller power source is the 7805 Voltage Regulator IC. It is a three pin IC which belongs to 78xx chips family and it is employed to regulate and stabilized the supply to voltage supply to the microcontroller. Excess voltage above 5V is dissipated in form of heat to the surrounding through the heat sink attached to the IC. It requires two capacitors to function. A 9V 2A steps down transformer is used to convert 240V to 9 V from mains while the bridge rectifier made up of four 1N 4007 diode was used to convert AC to DC, 470 micro-farad 50v electrolytic capacitor was used for filtering the circuit.

#### 2.1.4.3. GSM module.

It is a device which serves as a connection to exchange information or data between automatic rationing system and the central data base provider by the government. It creates an interfacing environment between microcontroller and government database for exchanging messages. The GSM modules can accept GSM network operator SIM card and acts as a mobile phone with its own unique number.to connect GSM module to microcontroller the RS232 module is required. (HCTL Open Journal, 2013).

#### 2.1.4.4. LCD

A Liquid Crystal Display, is a type of screen that is used in many computers, TVs, digital cameras, tablets, and cell phones. LCDs are very thin but are actually composed of several layers. Those layers include two polarized panels, with a liquid crystal solution between them. Light is projected through the layer of liquid crystals and is colorized, which produces the visible image. (Liane Cassavoy, 2017).



**Fig. 3.** Circuit Diagram of Automated Meter Reading.  
(Source: <http://www.8051projects.info>).

## 2.2 Principle operation

The digital energy meter records the amount of power consumption. It works on the basis of blinks of the LEDs located inside the meter. An opto-coupler, which consists of an IR diode and a photo transistor, is used to detect the number of blinks by connecting it to an LED. Each time the LED blinks, current flows through the IR diode within the opto-coupler. It then emits infrared light proportional to the current. This emitted light is incident and fed to the microcontroller as an interrupt to count the total consumption of the user. These readings are stored using an external memory, EEPROM. At the end of each cycle, the microcontroller via MAX 232 IC which converts the RS232 levels into TTL logic levels and vice versa. The GSM module is programmed using micro basic commands to wirelessly transmit the information received to the data base.

## 3. Result and Discussion

The circuit developed for the design and implementation of automated Meter Reading has been subjected to the following test.

**Table 1.** Various test performed

s/n	Type of test		Result	Remark
a.	Open circuit		Continuity	Normal
b.	Short circuit	Current in amperes	0.98A	Normal
c.	Earthing		Resistance greater than 1MΩ	Normal
d.	Sound		No humming sound noticed	Normal

### Interpretation of result

- Open Circuit Test was conducted on the designed project and there was a continuity in the connection which shows that the working condition of the circuit is normal.

- b. An ammeter was used to measure the current in the control circuit and it was observed to be 0.98A which is observed to be normal.
- c. A meggar tester was also used to measure the resistance of the project and also observed to be normal.
- d. No humming and vibration sound was noticed.

#### **4. Conclusion**

The design and implementation of the automated meter reading is an effective way by which the power supply distribution company can simply deal with their numerous customer. This design acquire data from the consumer wattmeter through the opto coupler process the data to information and display the corresponding information to the user through the LCD for notification and then save the information in the database of the distribution company. This will not only reduce argument, quarrelling, theft of energy by consumers but will also increase their performance, monitoring and effective payment of consumer bills with little or no human interventions.

#### **5.0 References**

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