International Journal of Academic Engineering Research (IJAER)
ISSN: 2643-9085
Vol. 5 Issue 4, April - 2021, Pages: 12-15

Design and Implementation of an Automatic Pre-Paid Meter System

Eng. Kalyankolo Umaru [1]

Department of Electrical and Computer Engineering, Muni University, Arua-Uganda

[1]u.kalyankolo@muni.ac.ug

Abstract**:** *Yaka metering system includes a Customer interface unit (CIU) that is easily accessible on the user premises. Upon any payment, a 20-digit token **MUST** be entered to have units loaded into the meter. The process of entering a 20-digit token number is a challenge to users as it requires their physical presence to enter the 20-digits. Where one requires remote entry of the tokens to activate the units bought, it is currently impossible as tokens require physical presence at the CIU. To bring convenience to the users, we have developed a GSM based a Yaka-meter activation system that doesn't require user to input the 20-digit token number on CIUs. The meter ensures that upon any payment, the 20-digit token is automatically loaded into the meter through a mobile platform.*

Keywords: GSM module, Current sensor, Voltage sensor.

I. INTRODUCTION

This article discusses the design and physical modeling of a GSM-based Energy Recharge System for prepaid Metering systems in Uganda, commonly known as **YAKA**. The 20-digit token number provided upon any form of payment MUST be entered at most three times and beyond which the meter can be locked. When a meter is locked, the customer is required to go into the same procedures as taken during a new account acquisition process. However, the chances of entering a correct token wrongly are very high as the token number is so long to get all token numbers right in order. The process of entering a 20-digit token number is a challenge to users as it requires their physical presence to enter the 20-digits. Where one requires to remotely enter the token to activate the units purchased, it is currently impossible.

The aim of the project is to minimize the error by introducing a new mechanism of loading the 20-digits token number provided without requiring physical pressing of the buttons on the customer interface unit provided. This will enable the user to recharge his/her electricity account from anywhere without physically being at the customer interface device currently provided by the power utility company.

II. LITERATURE SURVEY

Shwehdi and Jackson (1996) in their paper, presented the Digital Tele-Wattmeter System as an example of a microcontroller- based meter. The meter was implemented to transmit data on a monthly basis to a remote central office through dedicated telephone line and a pair of modems. The meter however loses its data every when a power blackout is experienced and hence making it unreliable.

Zhang, Oghanna and Bai (1998) utilized a DSP-based meter to measure the electricity consumption of multiple users in a residential area. A Personal Computer (PC) at the control center was used to send commands to a remote meter, which in turn transmitted data back, using the Power Line Communication (PLC) technique. The major problem with this system is that it cannot detect tampering by consumers.

Koay, Cheah, Sng, Chong, Shun and Tong (2003) in their work, designed and implemented a Bluetooth energy meter where several meters are in close proximity, communicated wirelessly with a Master PC. Distance coverage is a major set-back for this kind of system because the Bluetooth technology works effectively at close range. In their paper, Scaradozzi and Conte (2003) viewed home- automation systems as Multiple Agent Systems (MAS). Home automation system was proposed where by home appliances and devices are controlled and maintained for home management. It is only a home management system and does not measure the amount of energy consumed by users.

Hong and Ning (2005) in their paper, proposed the use of Automatic Meter Reading (AMR) using wireless networks. Some commercial AMR products use the internet for data transmission. Stanescu, D, Ciubotaru-Petrescu, Chiciudean, and Cioarga (2006) present a design and implementation of SMS -based control for monitoring systems. The paper has three modules involving sensing unit for monitoring the complex applications. The SMS is used for status reporting such as power failure. Issues on billing system for electricity board usage were not considered.

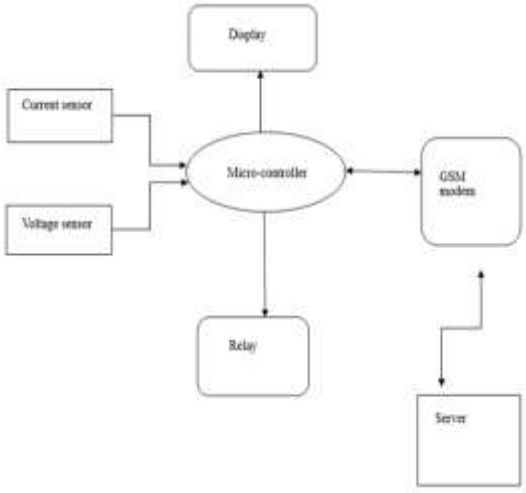
Prepaid meters can also make use of state of art technologies like WiMAX owing to the idea of centralized accounting, monitoring and charging. It brings telecommunication to the core of its activities to support more Smart Grid applications such as Demand Response and Plug-in electric vehicles (Khan et al, 2007). Prepayment polyphase electricity metering systems have also been developed consisting of local prepayment and a card reader-based energy meter (Ling et al, 2010).

In their paper, Maheswari and Sivakumar (2009) aimed to develop an energy efficient and low-cost solution for street lighting system using Global System for Mobile communication [GSM] and General Packet Radio Service [GPRS]. The whole set-up provides the remote operator to turn off the lights when not required, regulate the voltage supplied to the streetlights and prepare daily reports on glowing hours.

Sharma and Shoeb (2011), in their paper suggested a method where we utilize telecommunication systems for automated transmission of data to facilitate bill generation at the server end and also to the customer via SMS, Email.

Amit. J and Mohnish (2011). Suggested in their paper, a prepaid energy meter behaving like a prepaid mobile phone. The meter contains a prepaid card analogous to mobile SIM card. The prepaid card communicates with the power utility using mobile communication infrastructure. Once the prepaid card is out of balance, the consumer load is disconnected from the utility supply by the contactor. The power utility can recharge the prepaid card remotely through mobile communication based on customer requests.

III. BLOCK DIAGRAM



IV. HARDWARE USED

GSM MODULE

SIM800L GSM/GPRS module is a miniature M modem, which can be integrated into a great number of IoT projects. You can use this module to accomplish almost anything a normal cell phone can; SMS text messages, Make or receive phone calls, connecting to internet through GPRS, TCP/IP, and more! To top it off, the module supports quad-band GSM/GPRS network, meaning it works pretty much anywhere in the world.

DC Buck Converter

Any 2A-rated DC-DC buck converter like **LM2596** would work. These are much more efficient than a liner voltage regulator like LM317 or LM338.

Current measurement using ACS712 Current sensor:

The cool thing about an ACS712 is that current is measured in two directions. What this means is that if we sample fast enough and long enough, we are sure to find the peak in one direction and the peak in another direction.

Voltage regulator

The L7805 series of three-terminal positive regulators is available in TO-220 TO-220FP TO-3 and D2PAK packages and 5V fixed output voltage, making it useful in a wide range of applications. These regulators can provide local on-card regulation, eliminating the distribution problems associated with single point regulation. This regulator type employs internal current limiting, thermal shut-down and safe area protection, making it essentially indestructible. If adequate heat sinking is provided, they can deliver over 1A output current. Although designed primarily as fixed voltage

regulators, these devices can be used with external components to obtain adjustable voltages and currents. The device outputs a stable 5V for any input in range of 7V to 18V DC.

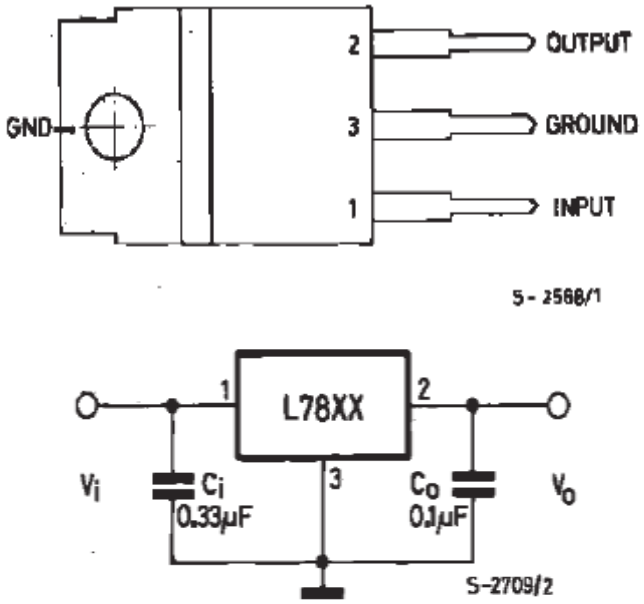
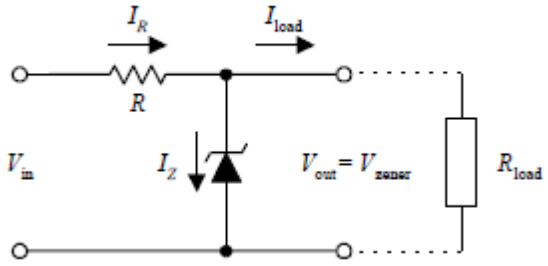


Figure 1: 7805 typical application circuit. Source: LM7805 datasheet

Zener Diodes

A Zener diode is a device that acts as a typical pn-junction diode when it comes to forward biasing, but it also has the ability to conduct in the reverse-biased direction when a specific breakdown voltage (VB) is reached. Zener diodes typically have breakdown voltages in the range of a few volts to a few hundred volts (although larger effective breakdown voltages can be reached by placing Zener diodes in series).



LIQUID CRYSTAL DISPLAY

Liquid crystal display is a type of display which used in digital watches and many portable computers. LCD displays utilize two sheets of polarizing material with a liquid crystal solution between them. An electric current passed through the liquid causes the crystals to align so that light cannot pass through them. Each crystal, therefore, is like a shutter, either allowing light to pass through or blocking the light. The liquid crystals can be manipulated through an applied electric voltage so that light is allowed to pass or is blocked. By carefully controlling where and what wavelength (color) of light is allowed to pass, the LCD monitor is able to display images.

V. CHALLENGES:

- The ACS712 30A current sensor had fluctuating offset voltage which could exhibit a leakage current in the readings at no load. The sensor datasheet specifies a 2.5V offset voltage when no load is connected to the sensor. However, the sensors were showing a fluctuating offset that could cause an error in the readings.
- The SIM800L GSM modem had delays in connecting to the network and the microcontroller was programmed to execute GSM modem initialization commands after 20s at boot up as an average network connection time. On connection delay, the modem could fail to respond as commands MUST be passed when the modem is fully connected to the network.
- Most of the parts were not on local market and sill hard to locate online e.g. ACS712 current sensor and SIM800L GSM modem
- Some components were of low quality and were not giving results as expected especially the ACS712 30A current sensor.

VI. RECOMMENDATION

The project has been done to demonstrate the concepts as defined in the project objectives. However, it will be a good move if the university further assigns another team to make remarkable improvements on the current device design especially on the server side of the application to have two-way communications much more reliable.

VII. CONCLUSION

Despite challenges with test to speech sound quality, the device development was a total success. The project objectives were all achieved as listed.

REFERENCES

[1] J. Wire, 'Is UMEME's pre-paid Smart Metering a time bomb?', The New Vision, 2014. [Online]. Available: http://newvision.com. [Accessed: 11- Nov- 2019].

[2] FBI, 'Smart Electric Energy meters altered to steal electricity', 2010. [Online]. Available: http://fbi.gov/cybercrime. [Accessed: 27- May- 2019].

[3] Patriot & Paulies (Editors), '5 Hacks that render Smart Meters dumb', 2012. [Online]. Available: http://patriotandpaulies.wordpress.com. [Accessed: 16- Aug- 2019].

[4] T. Leautier, 'Is Mandating "Smart Meters" Smart?', *EJ*, vol. 35, no. 4, 2014.

[5] D. Baker, 'Malware based Smart meters' attack', *Ioactive.com*. Available: http://www.ioactive.com/. [Accessed: 08- Oct- 2019].

[6] H. M. Zahid Igbal, M. Waseem and Dr. Tahir Mahmood, *Automatic Energy Meter Reading using Smart Energy Meter*. .

[7] S. Arun and Dr. Sidappa Naidu, 'Hybrid Automatic Meter Reading System', ISSN: 2277 128X, *International Journal of Advanced Research in Computer Science and Software Engineering*, vol. 2, no. 7, pp. 361-365, 2012.

[8] Depuru, S. S, Wang, L., Devabhaktuni, V.: Electricity theft: Overview, issues, prevention and a smart meter-based approach to control theft. Energy Policy. 39, 1007–1015 (2011)

[9] Kasita, I. :UMEME starts pre-paid power billing. The New Vision, Kampala (2011). http://www.newvision.co.ug