Online Energy Measurement of Smart Energy Meter Using Advanced Technology

R. RUBAN RAJA[1], S. SHOBANA[2], R. ESAITHENDRAL[3], T. GANGOTHIRI[4]

[1] *Assistant Professor, Department of Power Systems Engineering, Vivekanandha College of Engineering for Women*

[2, 3, 4] *PG Student, Department of Power Systems Engineering, Vivekanandha College of Engineering for Women*

Abstract- The vast developmental changes that are overtaking the world, energy is the most basic utility required and so monitoring and controlling of energy consumption is a major priority and doing this starting at the domestic level is the best solution. The Existing domestic Energy meter reading systems universally has many problems, such as difficulty in construction, too narrow bandwidth, poor real time, no quick two way communications etc. Thus, a smart meter is proposed based on the wireless technology. Our Energy meter is an advanced meter that measures consumption of electrical energy providing additional compared to a conventional energy meter as well as it is used for power theft identification. Integration of smart meters into electricity grid involves implementation of variety of techniques and software. Design of an energy meter depends on the requirements of the utility company as well as the customer. Further, this system enables equal power management from the central server's side and minimizes power shut downs. With this smart energy meter, the user can also be notified about the energy consumption at regular interval through GSM. The proposed system also helps in detecting power theft.

I. INTRODUCTION

An energy meter is usually an electrical meter that records consumption of electric energy in intervals of an hour or less communicates that information to the utility for monitoring and billing purposes smart meters enable two way communication between the meter and the central system unlike home energy monitors, energy meter can gather data for remote reporting such an advanced metering infrastructure(AMI) differs from traditional automatic meter reading (AMR) in that it enables two-way communications with the meter. As well as it is used for power theft identification. Electricity Theft is a very problem in countries like India, where population is very and the users are ultimately tremendous. In India, every year there is a very increasing no of electricity thefts across domestic electricity connections as well as industrial electricity supply, which results in loss of electricity companies energy and because of which we are facing the frequent problems of load shading in urban as well as rural area so as to overcome the need electricity for whole state.

The Government of India calculates that between ¾% and 1% of total energy is stolen. In many instances there are several Unauthorized connections-and on occasion a legal one as well. Tampering the meter to change the accuracy of the reading scale anytime a meter has any holes or metal on the plastic cover, it is a sign of electricity theft. Certain objects can force a meter's gears to slow down, which will cause the meter to not count the electricity properly. For example, strong magnets are often used that would stop the meter from turning.

II. PROPOSED SYSTEM FUNCTION

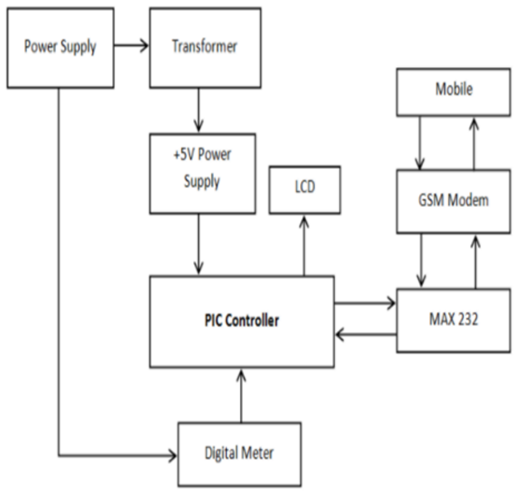

Figure 2. Block Diagram

2.1 BLOCK DIAGRAM DESCRIPTION

2.1.1 ENERGY METER:

An electricity meter or energy meter is a device that measures the amount of electric energy consumed by a residence, business, or an electrically powered device. Electricity meter are typically calibrated in billing units, the most common one being the kilowatt hour [kWh]. A periodic reading of electric meters establishes cycles and energy used during a cycle.

2.1.2 MICROCONTROLLER (PIC)

PIC is a family of Harvard architecture microcontrollers made by Microchip Technology, derived from the PIC16F877A originally developed by General Instrument's Microelectronics Division. The name PIC initially referred to "Peripheral Interface controller". PICs are popular with developers and hobbyists alike due to their low cast, wide availability, large user base, and extensive collection f application notes, availability of low cost or free development tools, and serial programming and re-programming with flash memory capability.

2.1.3 GSM MODULE

It describes the hardware interface of the SIMCOM SIM300 module that connects to the specific application and the air interface. As SIM300 can be integrated with a wide range of application all functional components of SIM300.

2.1.4 POWER SUPPLY:

There is need power supply unit to provide the appropriate voltage supply. The unit consists of transformer, rectifier, regulator & filters.

2.1.5 MOBILE NETWORKS:

The mobile station (MS) consists of the mobile equipment the terminal and smart card called the Subscriber Identity Module (SIM). The SIM provides personal mobility, so that the user can have access to subscribed services irrespective of a specific terminal. By inserting the SIM card into another GSM terminal, the user is able to receive calls at that terminal, make calls from that terminal, and receive other subscribed services.

III. HARDWARE DESCRIPTION

3.1 ANALOG ENERGY METER

An electricity meter or energy meter is a device that measures the amount of electric energy consumed by a residence, business, or electrically powered device. Electricity meters are typically calibrated in billing units, the most common one being the kilowatt hour [kWh]. Periodic readings of electric meters establish billing cycles and energy used during a cycle. In settings when energy savings during certain periods are desired, meters may measures demand the maximum use of power in some interval? "Time of day" metering allows electric rates to be changed during a day, to record usage during peak high cost periods and off-peak, lower-cost, periods. Also, in some areas meters have relays for demand response shedding of loads during peak load periods.

3.2 DIGITAL ENERGY METER

Electronic methods of power and energy are based on different principles. The methods suitable for digital meters may use Hall effect, pulse-width modulation (time-division multiplier), analogue multiplying IC, three-terminal thermoconverter (TTTC) or digital multiplication to mention only a few published paper, The last mentioned method may use one A/D converter with multiplexed inputs, or it may use separate A/D converter for each input. The method used in electricity meter depends on the desired accuracy and on the allowed price of the instrument. The following considerations concern digital electricity meters based on digital multiplication.

3.3 ELECTRICITY METER DESCRIPTION

The proposed instruments is able to measures all basic three-phase not parameters including rms values of voltage and current, active, reactive and apparent power, power factor, net frequency, and energy delivered into the load.

Block diagram of the designed instrument fir power and energy measurement (PEM6711) is in. Analogue part contains circuit for sensing the net voltage and currents, [10]. A block of A/D converters digitises the signal from the analogue part. The DSP part with the Texas Instruments TMS320C6711 processor makes necessary calculations and signal processing in digital form.

Microcontroller board with the Texas Instruments TMS3206711 processor controls the operation of the device. It controls some circuits of the analogue part, displays the results and enables communication with other instruments via standard interfaces. For presentation of time and frequency characteristics, graphical LCD display with the resolutions of 240x128 dots is used.

3.3.1 ERROR CORRECTION IN ELECTRICITY METER

To increase the accuracy of the electricity meter the start of sampling is synchronised with the frequency of the input signals. The sampling frequency was chosen to be f_s = 50 kHz. This makes it possible to average the samples with good accuracy even during one period of the net frequency. It is then possible to register even short transitions in power consumption, to synchronise the start of the measurements and to change the frequency output practically after one period of the net signal.

To set the parameters of the device, calibration procedure must be run. The exact values of the measured voltage and currents must be entered for the device the measurement is the speed of calculation. Even very fast DSP is not able to make corrections of every sample (for the three-phase system six samples must be corrected per one sampling period and all other calculations and operations must be also done).

The simplest error corrections only the offset correction, which I done by measuring the value of the quality with short-circuited, input and storing this value in the memory for use as the corrections value. To correct the gain error multiplication coefficient must be evaluated. This needs some reference value of the input quantity to be connected to the input and measured by the instruments. In such case, a nonlinear characteristic of such an instrument needs more values of the input quantity to be connected to the input and measured by the instrument. In such case, a nonlinear function or a table of correction values must be calculated.

3.4 MICROCONTROLLERS:

3.4.1 PERIPERAL NTERFACE CONTROLLER

PIC is a family of Harvard architecture microcontrollers made by Microchip Technology, derived from the PIC16F877A originally developed by General Instrument's Microelectronics Division. The name PIC initially referred to "Peripheral Interface Controller".

PIC_s are popular with developers and hobbyists alike due to their low cast, wide availability, large user base, and extensive collection of application notes, availability of low cost or free development tools, and serial programming and re-programming with flash memory capability.

These devices feature a 12-bit wide code memory, a 32-byte register file, and a tiny two level deep call stack. They are represented by the PIC10 series, as well as by some PIC12 and PIC16 devices. Baseline devices are available in 6-pin to 40-pin packages.

Generally the first 7 to 9 bytes of the register file are special-purpose register, and the remaining bytes are general purpose RAM is implemented, the bank number is selected by the high 3 bits of the FSR. This affects register numbers 16-31; registers 0-15 are global and not affected by the bank select bits.

3.4.2 REGISTER

The ROM address space is 512 words (12 bits each), which may be extended to 2048 words by banking. CALL and GOTO instruction specify the low 9 bits of the new code location; additional high-order bits are taken from the status register. Note that a CALL instruction only includes 8 bits of address, and may only specify addresses in the first half of each 512-word page. The instruction set is as follows. Register numbers are referred to as "f", while constants are referred to as "k". Bit numbers (0-7) are selected by "b". The "d" bit selects the destinations: 0 indicates W, while 1 indicates that the result is written back to source register f.

3.5 CORE ARCHITECTURE

The PIC architecture is distinctively minimalist. It is characterized by the following features:

- Separate code and data spaces(Harvard architecture)
- A small number of fixed length instructions.
- Most instruction are single cycle execution (4 clock cycles), single delay cycles upon branches and skips
- A single accumulator (W), the use of which (as source operand) is implied (i.e. is not encoded in theopcode)
- All RAM location function as register as both source and/or destination of math and other function.
- A hardware stack for storing return address
- A fairly small amount of addressable data space(typically 256 bytes), extended through banking
- Data space mapped CPU, port, and peripheral registers
- The program counter is also mapped into the data space and writable (this is used to implement indirect jumps).
- Unlike most other CPU_s, there is no distinction between memory space and register space because the RAM serves the job of both memory and register, and the RAM is usually just referred to as the register file or simply as the register.

3.6 DATA SPACE (RAM)

PIC_s have a set of register that function as general purpose RAM. Special purpose control register for on-chip hardware resource are also mapped into the data space. The addressability of memory varies depending on device series, and all PIC devices have some banking mechanism to extend the addressing to additional memory. Later series of devices features move instructions which can cover the whole addressable space, independent of the selected bank. In earlier devices (i.e., the baseline and mid-range cores), any register move had to be achieved via the accumulator.

- CODE SPACE

All PIC_s feature Harvard architecture, so the code space and the data space are separate. PIC code space is generally implemented as EPROM, ROM, or flash ROM.

In general, external code memory is not directly addressable due to the lack of an external memory interface. The exceptions are PIC16F877A and select high pin count PIC18 devices.

- WORD SIZE

The word size of PIC_s can be a source of confusion. All PIC handle (and address) data in 8-bit chunks, so they should be called 8-bit microcontrollers. However, the unit of addressability of the code space is not generally the same as the data space. For example, PIC_s in the baseline and mid-range families have program memory addressable in the same word size as the instruction width, i.e. 12 or 14 bits respectively, In contrast, in the PIC18 series, the program memory is addressed in 8-bit increments (bytes), which differs from the instruction width of 16 bits. In order to be clear, the program memory capacity is usually states in number of (single word) instruction, rather than in bytes.

3.7 MOBILE NETWORK

GSM is a cellular network, which means that cell phones connect to it by searching for cells in the immediate vicinity. There are five different cell sizes in a GSM network-macro, micro, pico, femto and umbrella cells. The coverage area of each cell varies according to the implementation environment. Macro cells can be regarded as cell where the base station antenna is installed on a mast or a building above average rooftop level.

Indoor coverage is also supported by GSM and may be achieved by using an indoor Picocell base station, or an indoor repeater with distributed indoor antennas fed through power splitters, to deliver the radio singles from an antenna outdoors to the separate indoor distributed like in shopping centres or airports. However, this is not a prerequisite, since indoor coverage is also provided by in building penetration of the radio singles from any nearby cell.

3.7.1 SUBSCRIBER INDENTITY MODULE (SIM)

One of key features of GSM is the Subscriber Identity Module, commonly known as a SIM card. The SIM is a detachable smart card containing the user subscription information and phone book. This allows the user to retain his or her information after switching handsets. Alternatively, the user can also change operations while retaining the handset simply by changing the SIM. Some operators will block this by allowing the phone to use only a single SIM or only a SIM issued by them; this practice is known as SIM locking.

3.7.2 GSM SERVICE SECURITY

GSM was designed with a moderate level of service security. The system was designed to authenticate the subscriber and the base station can be encrypted. The development of UMTS introduces an optional Universal Subscriber Identity Module(USIM),that uses a longer authentication key to give greater security, as well as mutually authenticating the network and the user ,whereas GSM only authenticates the user to the network (and not vice versa).The security model therefore offers confidentiality and authentication capabilities ,and no non-repudiation.

GSM uses several cryptographic algorithms for security. The A5/1, A5/2, and A5/3 stream ciphers are used for ensuring over the air voice privacy.A5/1 was developed first and is a stronger algorithm used within Europe and the United States; A5/2 is weaker and used in other countries. Serious weaknesses have been found in both algorithms: it is possible to break A5/2 in real-time with a cipher text-only attack, and in January 2007, The Hacker's Choice started the A5/1 cracking project with plans to use FPGAs that allow A5/1 to be broken that cipher with a rainbow table attack. The system supports multiple algorithms so operators may replace that ciper with a stronger one.

On 28 December 2009 German computer engineer Karsten Nohl announced that they had cracked the A5/1 cipher. According to Nohl, he developed a number of rainbow tables (static values which reduce the time needed to carry out on attack)and have found new sources for now plaintext attacks. He also said that it is possible to build "a full GSM interceptor.......from open-source components" but that they had not done so because of legal concerns. Nohl claimed that he was able to intercept voice and text conversations by impersonating another user to listen to voicemail, make calls, or send text message using a seven-year-old Motorola cell phone and decryption software available for free online.

New attacks have been observed that take advantages of poor security implementations, architecture, and development for Smartphone applications. Some wiretapping and eavesdropping techniques hijack the audio input and output providing an opportunity for a third party to listen in to the conversation.

GSM uses General Packet Ratio Service (GPRS) for data transmission like browsing the web. The most commonly deployed GPRS ciphers were publicly broken in 2011.

The researchers revealed flows in the commonly used GEA/1 and GEA/2ciphers and published the open-source "gprs decode" software for sniffing GPRS networks. They also noted that some carriers do not encrypt the data (i.e., using GEA/0) in order to detect the use of traffic or protocols they do not like (e.g., Skype), leaving customers unprotected. GEA/3 seems to remain relatively hard to break and is said to be in use on some more modern networks. If used with USIM to prevent connections to fake base stations and downgrade attacks, users will be protected in the medium term, though migration to 128-bit GEA/4 is still recommended.

3.7.3 MOBILE STATION:

The mobile station (MS)consists of the mobile equipment (the terminal)and a smart card called the subscriber Identity Module(SIM).The SIM provides personal mobility, So that the user can have access to subscribed services irrespective of a specific terminal. By inserting the SIM card into another GSM terminal, the user is able to receive calls at that terminal, make calls from that terminal, and receive other subscribed services.

The mobile equipment is uniquely identified by the International Mobile Equipment Identity (IMEI).The SIM card contains the International Mobile Subscriber Identity(IMSI)used to identify the subscriber to the system, a secret key for authentication, and other information. The IMEI and the IMSI are independent, thereby allowing personal mobility. The SIM card may be protected against unauthorized use by a password or personal identity number.

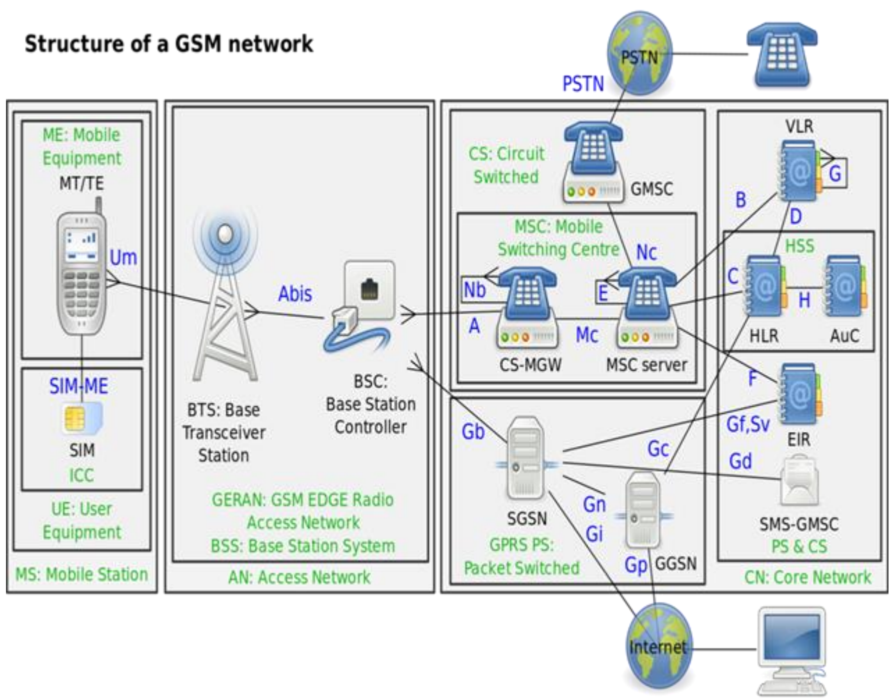

Figure 2. Structure of GSM Network

IV. SIMULATIONS

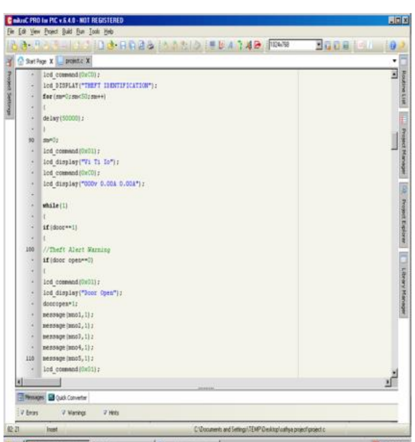

Figure 3. Simulations Screen Shot-1

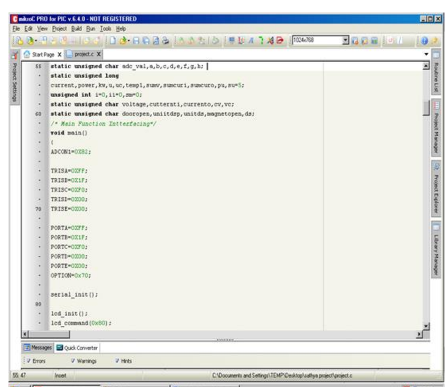

Figure 4. Simulations Screen Shot-2

CONCLUSION

This paper discussed various features and technologies that can be integrated with a smart energy meter for calculating the electrical power consumption and identifying the power theft. Thus by using ONLNE ENERGY METER project we can simply reduce the power consumption and can use the available power to its peak extent. Further, this system enables equal power management from the central server's side and minimizes power shut downs. With this smart energy meter, the user can also be notified about the energy consumption at regular interval through GSM. The proposed system also helps in detecting power theft.

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