

Design and Analysis of Electronics Energy Meter by Impedance Variation to Reduce the Power Consumption

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Abstract – A single-phase digital Energy Meter is predicated on microcontrollers. This digital energy meter doesn't have any rotating components. The energy consumption is calculated to consume the output pulses of the energy meter chip and also the internal counter of a microcontroller. As presently because the provide is rebuilt, energy meter restarts with the hold on values. One section energy meter epitome has been enforced to supply measure up to 40A load current and 230V line to neutral voltage. Necessary program for microcontroller square measure written in c-language. Electrical energy meter may be a device that ready to live electrical energy at anybody time. The energy information is incredibly necessary for the study regarding energy demand, particularly in the residential sector. The meters that may be found within the market these days square measure dear as a result of they work on an operation principle that needs the employment of pricey hardware. Hence, a digital meter that may live power consumed by domestic appliances like kettle, television, toaster, et al. has been developed. This meter is powerful, user-friendly and informative enough for the aim of straightforward information gathering. The correct measure of electricity provide and sequent request to residential properties has historically been achieved through mechanical device meters. Though wide used this answer has many disadvantages as well as future accuracy, price of standardization and restricted communication. These problems will be overcome to consume digital power meters wherever it's potential to realize future accuracy by removing analog parts that square measure susceptible to drift over temperature and time. The goal of this project is to style Associate in electronic energy meter that calculates fast power in any respect power issue and provides low-frequency pulse output that is directly proportional to real power. This low-frequency pulse output is more employed by a microcontroller that calculates the energy in terms of Kwh and displays it on a digital display. The perform of the microcontroller isn't solely restricted to show of Energy however it additionally calculates most demand, detects differing kinds of tamper like magnetic tamper, neutral missing, etc., it is RTC, EEPROM, LCD digital display alphanumeric and also interacts with the skin world.

Keywords – Electronic meter, Microcontroller, Impedance.

I. INTRODUCTION

A. Characteristics of Residential Energy Consumption

Residential buildings currently account for over twenty percent of our nation's total energy demand (approximately 22%) and residential energy use is on the increase. within the past decade alone, residential energy consumption accumulated by twenty-third, and projections through the year 2030 indicate that energy family energy expenditures are probably to extend another twenty-fifth. abundant of the projected increase is anticipated to result from an increase and accumulated demand for energy services. At a similar time, the growing demand for energy within the residential sector is anticipated to be partly offset by on-going enhancements in energy efficiency. Persistent demographic trends are expected to still contribute to increasing residential sector energy demands. One in each of the first drivers of the continuing growth is continuing growth within the U.S. population. Though there are early signs the trend is also reversing, a second and infrequently un-noted driver is that the tendency toward fewer and fewer occupants in every family. The mix of increase including the shrinking size of households can end in a lot of speedy growth within the range of U.S. households. Presently there are associate degree calculable a hundred and fifteen million households within the nation. The biggest proportion of U.S. housing stock (72%) consists of single-family homes, followed by house units (22%), and mobile homes (6%) (EIA 2009b). By 2030 the amount of U.S. households is projected too high 141 million (a twenty-third increase) at associate degree annual rate of 1 Chronicle. Similarly, U.S. population estimates recommend that the U.S. population can grow by sixty-three million folks between 2010 and 2030, reaching 375

million by 2030 (EIA 2009a). In addition to the energy strain that may be elicited by increase, energy service demands per capita have conjointly been on the increase. As per the Energy data Administration's Annual Energy Outlook 2010, "efficiency enhancements are over offset by will increase in air-con use and also the introduction of latest appliances" (EIA 2009a). Specially, because the selection and recognition of home natural philosophy grows—ranging from iPods, cell phones, associate degree pc games to several forms of home appliances—these gadgets are expected to contribute a more and more massive proportion to home energy use, growing from regarding thirty-fourth of residential electricity consumption nowadays to regarding thirty-ninth by 2030.

B. The Invisibleness of Energy Resources

Household energy resources is in some ways invisible to residential energy shoppers. This makes energy management and conservation practices each troublesome and weird. when put next to the employment of wood and coal, a lot of fashionable energy resources give associate degree more and more invisible suggests that of meeting demands for heating, cooling, lighting, refrigeration, food preparation and amusement. Today, each gas and electricity provides flow seamlessly and mutely into our homes, supply our furnaces, powering our air conditioners, and different instrumentation, and meeting our demands for a large form of energy service demands with none notable trace of their presence. For many folks, the sole live of their energy consumption is that the bill that they receive up to forty-five days when consumption. Sadly, the monthly bill— even for the simplest energy detective and also the most energy- acutely aware consumer—is associate degree inadequate tool for managing energy resources. Monthly bills could report the number of kilowatt-hours (kWh) of electricity consumed and also the prices that are incurred, however, they don't indicate that end- uses are exacting the foremost energy, however energy-intensive or energy-efficient existing appliances could be, and the way changes in our own selections and behaviours will either enhance or offset energy demands related to dynamic weather patterns, new appliances, and different equipment. Sadly, most of the people among the energy blind; we tend to cannot see the energy that we consume. The functionality of our current energy system has been recognized for several years. Over 1 / 4 century past, Kempton and Montgomery (1982) illustrated the contradiction in terms of consumption while not important data within the following means, the bulk

of energy employed in the residential sector is devoted to space heating (42%), followed by water heating (17%), air-conditioning (7%), and refrigerators (3%). The remaining half-hour of energy is employed by different appliances and lighting (EIA 2009a). Among home appliances, energy consumption for private computers and connected instrumentality is projected to extend by 0.7% annually, televisions and set-top boxes by 1.2%, and every one different client physics by 1.7% (EIA 2009a). Of explicit note, these and different home physics consume power not only in use, however conjointly once they square measure in standby and off mode. In combination, their power provides alone will draw vital hundreds even once disconnected from the appliance. many different appliances square measure projected to envision ascension in energy demand, as well as chamber fans and boiler circulation pumps (1% each) and change of state (0.7%). the common annual increase in energy consumption through 2030 for all residential finish uses is 0.4% (EIA 2009a). Increasing ranges of residential energy service demand also are expected to result from the growing number of individuals acting from home. Over the last many decades' {the range, the amount, the quantity} of individuals acting from home has exaggerated each in number and as a proportion of the personnel. As a lot of folks pay a larger quantity of your time within the home, their energy demand grows. In 1980, 2.18 million, or 2.3% of the USA personnel worked from home. By 2000, the quantity had grown up to four.18 million folks or 3.3% of the personnel (Census 2004). The increasing penetration of computers and also the web has created engaging at home easier for several professionals. In keeping with the 2007 U.S. Census, over seventy-two million households (61.7%) had access to the web and this proportion is probably going to still rise (Census 2009).

C. Unit Energy Resources

While there square measure 3 major fuels utilized in households within us (electricity, fossil fuel, and fuel oil), fossil fuel and electricity give eighty-six of all energy within the residential sector. fossil fuel and heating oil square measure used preponderantly for a house and water heating, whereas electricity is most frequently used for air-con and different client appliances. A tiny low fraction of households uses liquefied crude oil gas (LPG) and hydrocarbon for house heating, cooling, and powering appliances. In summary, energy use within the residential sector is critical} and growing however the characteristics of residential sector energy use conjointly give

important energy savings opportunities. Currently, the residential sector is liable for over twenty percent (22%) of our nation's energy demand and for over [1] (54%) of all energy consumed at intervals buildings. Moreover, demand is anticipated to still steady increase as a result of increment, the doubtless growth within the size of households, and also the growing demand for energy services. Notably, abundant of the growth of energy service demands is probably going to be joined to discretionary uses like those related to new physics and appliances. Different less discretionary uses can embrace the exaggerated use of air-con and energy used for home-based employment. Whereas electricity and fossil fuel square measure the 2 primary energy resources accustomed to meet energy service demands within the residential sector, all fuels simply lend themselves to advanced metering technologies and different feedback mechanisms which will encourage cost-effectively reductions in residential sector energy consumption.

D. The proliferation of Advanced Metering Initiatives

Unlike old-style meters with their distinctive rotating disks, advanced utility meters square measure digital devices that communicate energy use info directly with the utility and (potentially) with the unit residents and unit appliances and devices. Advanced meters hold the potential of providing energy shoppers with period energy consumption knowledge and energy price info, empowering shoppers to effectively manage their unit energy consumption. In keeping with the Federal Energy restrictive Commission (FERC 2008a) advanced metering is "a metering system that records client consumption (and presumably different parameters) hourly or a lot of oft and provides for daily or a lot of frequent sending of measurements over a communication network to a central assortment purpose." Advanced meters with the potential to record a minimum of hourly info can even give the mechanism to cost electricity and fossil fuel in keeping with the time of usage. These new devices supply a crucial means that of overcoming the historical physical property of unit energy consumption (and production) and of dramatically up the flexibility of households to manage their energy consumption practices. a lot of specifically, recent innovations might give new opportunities for fast energy savings within the terribly close to term by providing household-level feedback and by facilitating higher energy management practices. Several of those AMI-related innovations believe a variety of progressively

present info and communications technologies (ICT). Significantly, the appliance and integration of ICT within the production, distribution, and consumption of energy resources is probably going to supply dramatic enhancements in each the general energy potency of the electrical grid also as household-level energy management practices leading to the elimination of the many antecedent hidden sources of waste. Additional energy-saving opportunities is also achieved through the utilization of advanced meters in conjunction with dynamic valuation structures and "smart" energy devices (such as thermostats, massive unit appliances and electronic devices) which will be sent to mechanically reply to dynamical worth signals. Moreover, the viability of a variety of future technologies like electrical vehicles and on-the-scene renewable generation systems is probably going to rely upon the wide unfold proliferation of advanced metering technologies and their ability to additional optimize unit energy use. In different words, ICT technologies square measure enjoying a vital role each within and out of doors of the house. On the within, ICT square measure doubtless to incorporate new device technologies and good appliances which will be referred to as on to assist automatism good unit energy management practices. On the surface, varied kinds of ICT can play a shaping role within the modernization of the electrical grid. Advanced meters can give the means that for two-way communications between utilities and households. The 2008 FERC study documents the recent proliferation of advanced meters at intervals mistreatment knowledge collected through a survey of nearly 200 entities throughout the electrical power trade, the FERC study indicates that as of Gregorian calendar month 2008 advanced meters delineated 4.7% of all residential electrical meters within The U.S. For all 3 sectors, commercial, industrial, and residential, 6.7 million advanced meters were being employed for advanced metering in 2008, representing a rise of nearly 5.8 million meters throughout the previous 2-year amount. Most of those advanced meters (93%) were put in by cooperatives (2.4 million meters) and investor-owned utilities (3 million meters). equally cooperatives and municipal entities conjointly according the best-advanced metering penetration at 16.4% and 4.9%, severally. Investor-owned utilities reported a penetration rate of 2.7%, whereas public utility penetration was just about 3.3% (FERC 2008a, 2009). Regionally, residential sector penetration of advanced meters were highest at intervals the FL dependability Region (10.8%) followed by the electrical dependability Council of

TX (8.5%). each the Southeast dependability Corporation and also the Southwest Power Pool Region according to residential penetration rates of half dozen with complete regional in keeping with FERC, planned deployments of advanced meters scheduled to require place within the close to term (during successive five to seven years) is almost fifty-two million, representing a virtually eight-fold increase. Once combined with the half dozen million advanced meters already deployed, the overall penetration of advanced meters within the close to term can approach four-hundredth. Notably, however, whereas just about Martina's of advanced meters square measure being employed in worth responsive demand response programs, but I Chronicles is being employed in conjunction with home space networks or with different technologies that have the potential to maximize the buyer advantages and residential energy savings. To date, advanced metering technologies have achieved a comparatively low level of penetration within us but, most utilities have committed to their proliferation within the close to future primarily as a result of the P.E. savings and price advantages that will be captured by the utilities. Utility-based choices concerning the ways in which during which these technologies square measure deployed and enforced square measure doubtless to form the ensuing energy-savings levels in necessary ways in which, also that players can profit the foremost. Of vital importance is the distinction between utility advantages and client advantages and the way the distribution of advantages is probably going to work out overall levels of energy savings.

II. SPECIFICATION

A. Communication Capabilities

The meter shall have facilities for knowledge transfer domestically through CMRI with correct security via Electrical energy meter optically isolated communication port victimization serial communication. It shall be potential to reconfigure the meters for TOD Tariff, DIP (Demand Integration period), charge date, event log etc. through correct authentication method via the communication port. Solely Optical Communication port shall be obtainable no extra RS 232 port is needed. Communication port shall not be littered with any form of injection/unauthenticated signals.

B. Current Inputs

The analog face for this inputs that is flow through load. This through load is live by current electrical device LA 55P. This electrical device is connected

asynchronous with load, it wounded with same wire that is connected to series. The electrical device senses this that is flow through the wounded wire and generates this that is flow through the resistance R. and that we have gotten the voltage resembling this that is flow through load. The sensing voltage is low in amplitude and troublesome to live then it passes through electronic equipment. The amplification issue is rely upon values of R1 and R2, and intensify the below one volt peak to peak. Output consist each positive and negative cycle however processor ADC respond or live solely positive values, it need level shifter to feature a DC offset and pass to preciseness rectifier, It prevents any excursion of negative voltage.

III. PROPOSED WORK

Energy meter's self-consumption was very high. It is around 7.71. According to Indian stander 13779 it should be less than 10kv self-consumption of it. It is waste of power so we will save energy by reducing the self-consumption of Energy meter. We will reduce it less than 7.71 VA.

IV. METHODOLOGY USED

Ohm law

$$V = IR \quad I = V/R$$

$$Z = R = 1/2\pi fC$$

$$\text{If } C = 0.000000410F$$

$$R = 1/2 * 3.14 * 50 * 0.000000410$$

$$= 1/0.000129 = 7751.94$$

$$I = 240/7751.94 = .030A$$

A. Voltage Measurement

Voltage activity is sometimes obtained by voltage division technique or a step down voltage electrical device. Deciding concerning that technique ought to be used, is said to the work wants. Voltage division approaches square measure utilized.

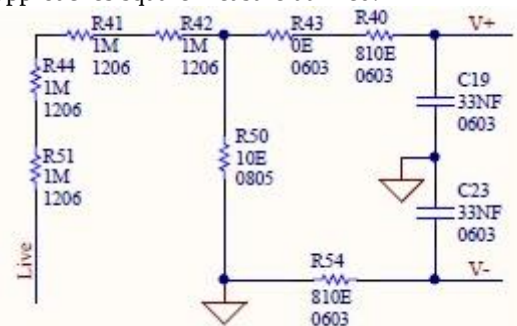


Figure 1: Voltage Measurement Circuit

B. Primary Channel Current Measurement Circuit

This circuit provide mV Voltage's sample to ADC with 500uE shut.

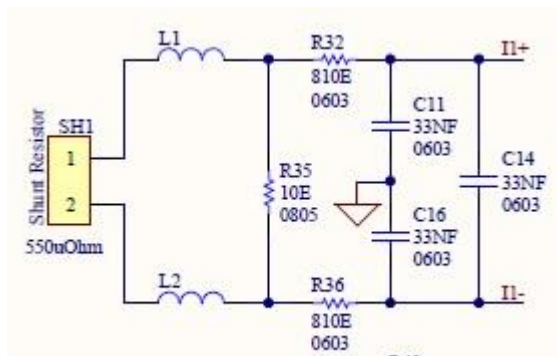


Figure 2: Primary Channel Current Measurement Circuit

C. Secondary Channel Current Measurement

This circuit provide mV Voltage's sample to ADC with 130E-150E CT.

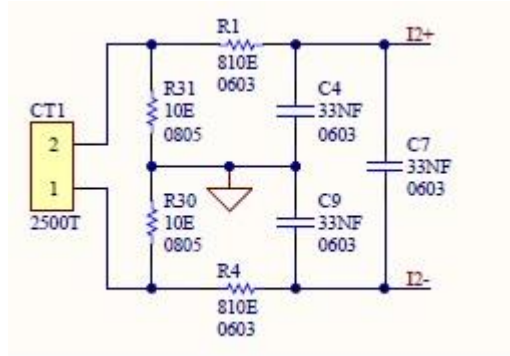


Figure 3: Secondary Channel Current Measurement Circuit

D. Energy Meter Power Supply

In This circuit 410NF capacitor is use in power supply its power composition 0.032A with reference voltage 7.710 VA.

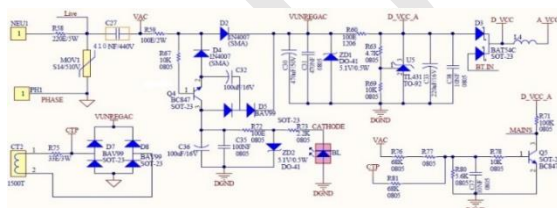


Figure 4: Energy Meter Power Supply circuit

E. Implemented Power Supply

In this circuit 220NF capacitor is use in power supply its power composition 0.016A with reference voltage 3.974 VA.

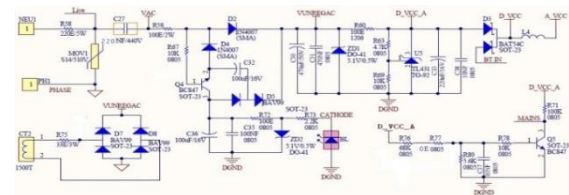


Figure 5: Energy Meter's Implemented Power Supply circuit

Ohm law

$$V = IR \quad I = V/R$$

$$Z = R = 1/2\pi fC$$

$$\text{If } C = 0.000000220F$$

$$R = 1/2 * 3.14 * 50 * 0.000000220$$

$$= 1/0.000069 = 14492.75$$

$$I = 240/14492.75 = .016A$$

F. Data Analysis and Display

After voltage and current measurement procedure, next step is information analysis and show. Sample square measure taken from ADC peripherals and skilful following steps:

- Offset Removal each voltage and current sample contains an offset DC worth, to live the correct worth of RMS voltage and RMS current offset removal is critical.
- Gathering samples when eliminating offset, accumulate one thousand sample in one second and calculate RMS voltage, RMS current, and consumed power on the premise of one thousand samples.
- Display for showing the calculated information or RMS voltage, current and energy, it's necessary. Microsoft Visual Studio C could be an artificial language that's designed for building associate degree application that run on the .NET Framework
- C is straightforward, efficient, type-safe, and object-oriented.

V. EXPERIMENTAL RESULTS

A. Tests on Current measurement

The performance of the model is evaluated by examination the model reading with the quality meter. Table 1 shows true RMS current as measured by normal meter and planned meter and relative (%) error. Table 1: results of Current measuring within the laboratory with normal millimetre meter energy meter variety of measuring Measured RMS price of current (amp) (Standard meter) Measured RMS price of current (amp) (Prototype meter) Relative The measured values of current obtained from the

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readings of the sub-standard meter AR thought of as normal and compared with planned technique values to examine the accuracy of the metering system.

Table 1: Old result at actual load

POWER CONSUMPTION IN ENERGY METER				
Sr. No.	MA	VA	Watt	VOLTAGE
	mA	$240v \cdot ma / 1000$	$240v \cdot ma \cdot 0.08 / 1000$	AC VOLT
1	32	7.680	0.614	240.000
2	31	7.440	0.595	240.000
3	32	7.680	0.614	240.000
4	32	7.680	0.614	240.000
5	32	7.680	0.614	240.000

Table 2: Final result at actual load

POWER CONSUMPTION IN ENERGY METER				
Sr. No.	MA	VA	Watt	VOLTAGE
	mA	$240v \cdot ma / 1000$	$240v \cdot ma \cdot 0.08 / 1000$	AC VOLT
1	16	3.840	0.307	240.000
2	16	3.840	0.307	240.000
3	16	3.840	0.307	240.000
4	17	4.080	0.326	240.000
5	16	3.840	0.307	240.000

B. Tests on Voltage measurement



Figure 6: Old result at reference voltage



Figure 7: Final result at reference voltage

The performance of the paradigm is evaluated by examination the paradigm reading with the quality

meter. Table 2 shows true RMS voltage as measured by normal meter and planned meter and relative (%) error. The measured prices of voltage obtained from the readings of the sub-standard millimetre meter energy meter variety of Measured RMS price of voltage (volt) (Standard meter) Measured RMS value of voltage (volt) (Prototype meter) Relative meter thought-about as normal and compared with planned technique values to see the accuracy of the metering system.

VI. CONCLUSION

In this paper, style and implementation of reliable digital Energy Meter supported 8051 microcontroller is delineate. With the designed new energy meter measurement and LCD of the specified information square measure potential. Every system section is fastidiously designed to fulfil the specified accuracy and information measure. C language code is microcode compact and also the entire energy calculation rule is dead in minimum range of computer hardware cycle. During this accomplishment, completely different ways for sensing the present and voltage square measure planned and enforced. This technique is intended supported associate degree 8051 microcontroller that acts as an information acquisition process and show system. A current and a voltage signals square measure connected to their analog inputs and born-again into digital kind. The sampled signals of the present and voltage square measure manipulated by microcontroller to live energy meter parameter. The microcontroller will thus value the RMS values of measured signals at the side of the consumed energy at the measurement terminals that modify the calculation of all alternative energy related quantities. During this case study we tend to plan a straightforward and versatile show technique wherever the measured information is simply monitored and show for user. The new measurement system will definitely facilitate to decrease economical usage of your time as compared to traditional technique of obtaining an equivalent result. All the table provides comparison between the quality and proto type.

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