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Modeling and Design of Smart Card Prepayment System for Efficient Utilisation of Electrical Energy in the Distribution System

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Abstract: ***Today the metering instrument technology grown up significantly, such that the Consumed energy can be calculated mathematically displayed, data can be stored, data can be transmitted etc. Presently the micro-controllers are playing major role in metering instrument technology. The present project work is designed to collect the consumed energy data of a particular energy consumer through wireless communication system (without going to consumer house); the system can be called as Automatic Meter Reading (AMR) system. The automatic meter reading system is intended to remotely collect the meter readings of a locality using a communication system, without persons physically going and reading the meters visually. The application of the e-metering system is extended to streamline power distribution with online monitoring of power quality, real time theft detection and automatic billing. The power utility can recharge the prepaid card remotely through mobile communication based on customer requests. The proposed prepaid meter is implemented in a software model and MATLAB has been used for simulation. This meter has the characteristics of high accuracy, prepayment, multi-metering, agile measuring approaches, different events record and complete data freezing.***

Keywords: smart energy meter, e-metering system, MATLAB, power theft, distribution system, GSM system ,power quality, automatic meter reading

1. Introduction

The Electrical metering instrument technology has come a long way from what it was more than 100 years ago. From the original bulky meters with heavy magnets and coils, there have been many innovations that have resulted in size & weight reduction in addition to improvement in features and specifications [1]. Resolution and accuracy of the meter have seen substantial improvements over the years. Introduction of the digital meter in the later part of last century has completely changed the way Electrical parameters are measured. Starting with Voltmeters & Ammeters the digital meter has conquered the entire spectrum of measuring instruments due to their advantages like ease of reading, better resolution and rugged construction [2]. The particular significance is the introduction of the Electronic Energy Meter in the mid-eighties [7]. Now a days, the energy consumption and energy distribution has become a big subject for discussion because of huge difference in energy production and consumption. In this regard, energy consumers are facing so many problems due to the frequent power failures; another important reason for power cuts is due to the un-limited energy consumption of rich people [1]. In this aspect, to minimize the power cuts and to distribute the energy equally to all areas, some restriction should have over the power consumption of each and every energy consumer, and according to that the Government should implement a policy, by introducing Autonomous Energy Meters everywhere in domestic sector[4].Hence, the need has come to think on this line and a solution has to be emerged out.

From the customer's perspective, if electrical equipment is to operate correctly, the electrical energy must be supplied at a voltage that is within a specified range around the rated value of the equipments in operation [9]. Most of the equipments in use today require good power quality. However, due to several factors the significant amount of distortion is present in the supply in most of the cases [11]. These factors may be external disturbances in interconnected power grids, environmental disturbances like lightning strike or the non-linear characteristics of the equipments in operation now-a-days [12].Maintaining the power quality within acceptable limits is critical not only for the utility companies, but also for the consumers [1].Keeping the above issues in mind, we have worked on the development of a micro-controller based smart meter with data logging capacity and ability to monitor some basic power quality variations at the same time [14].The idea is to attempt to develop a meter that will give us sufficient data to analyze customer behavior and at the same time will be capable of tracking power quality variations [21].

1.1 Motivation and Objective

In the distribution power system, electric power is distributed among various consumers, thus a number of tapings are taken from a distribution line. In the developing countries and even in the small areas there is a lots of problems related to the power theft. Which results in a large amount of power wastage and the overall efficiency of power system is reduced to a great extent. The objective of

this project report is to analyze the effect on the power flow in the distribution lines, when an extra tapping or an unauthorized load is connected in a distribution line i.e. called POWER THEFT in general language. And further to detect this unauthorized tapping and give signals for taking appropriate action against the tapping. So that the efficiency of power system gets increased. [1]

Today the metering instrument technology grown up significantly, such that the Consumed energy can be calculated mathematically displayed, data can be stored, data can be transmitted etc. Presently the micro-controllers are playing major role in metering instrument technology. The present project work is designed to collect the consumed energy data of a particular energy consumer through wireless communication system (without going to consumer house); the system can be called as Automatic Meter Reading (AMR) system. The automatic meter reading system is intended to remotely collect the meter readings of a locality using a communication system, without persons physically going and reading the meters visually.[2]

2. Smart Meters

2.1 Overview

Introduction to Smart meters are innovative and advanced utility metering systems that record several quantities like a consumer's energy, water or gas usage in real time. The term smart meter is most commonly used to refer to electricity meters that keep detailed statistical data on the energy usage. It is designed to record how much electrical energy is consumed and at what time. Commercially available smart meters can vary with respect to the features but they have the same basic functionalities. Smart meters are meant to facilitate real time data acquisition and remote communication of the data to the utility companies. In addition, they may perform additional functions like power outage notification and power quality monitoring. Smart meters may also be capable of implementing time-of-use pricing. [18]

Internationally, smart meter deployment has been a critical aspect of the intelligent energy network. Various countries have been promoting the installation of intelligent meters, especially over the last decade. The most successful implementation of smart meters in the world has been in Italy. Italy has more than 30 million smart meters, which covers around 80% of their households. Besides, the smart meter deployment scenario in USA, Canada, Australia and Europe are discussed in.[2]

2.2 Remote Metering of Energy Meters

The introduction of electronic energy meters for electrical energy metering has resulted in various improvements in the operations of utilities apart from the increase in revenue due to better recording of energy consumption. One such additional benefit is the possibility of reading the meters automatically using meter-reading instruments even without going near the meter. Meter Reading Instruments (MRI) is intelligent devices with built in memory and keyboard. The meter reader can download the energy consumption and related information from the electronic meter into the meter reading instrument either by connecting the MRI physically to the meter using their communication ports or by communicating with the meter from a distance using Radio Frequency (RF) communication media. [8] RF communication method is similar to a cordless telephone, which is quite common these days. The meter and the MRI are provided with an antenna. When the meter reader presses a button on the MRI, it communicates with the meter through RF and asks for all the data that are preset. The meter responds with all relevant data like meter identification number, cumulative energy consumed till that time etc. After reading many meters like that in one MRI, the meter reader can go to the office and transfer all these data into a computer, which will have all these data for the previous billing period. Using these two data, the computer calculates the consumption for the current billing period and prepares the bill for each consumer. [10]

The use of RF communication enables the utility to install the meters on top of the electric pole out of reach of the consumers thereby eliminating chances of tamper of the meter. Frequencies in the range of 400 MHz to 900 MHz communication can be achieved using low power transmitters at reasonable costs. Power line carrier communication is another method of remote metering. In this method the meter data is transferred to an MRI or computer by using the power line itself as the medium of transmission. This solution is generally cheaper than RF but needs good quality power lines to avoid loss of data. This method is more attractive for limited distance communication. Third medium of communication possible is telephone line. This is viable only for industrial meters like the Trivector meter because of the cost of Modems required and the need for a telephone line, which may not be available in every house. This medium has the advantage of unlimited distance range. Remote metering is typically not a default option, but something provided for selected customers. The preferred customer base may include suspicious clients or those located very close to others, such as in a high-rise building. In the latter case, tens or hundreds of meters may use RF to send billing data to a common collector unit, which then decodes the data with microcontrollers or computers. [8]

2.3 Prepayment Metering

Yet another advantage of the electronic meter is the possibility of introducing Prepaid metering system. Prepaid metering system is the one in which the consumer pays money in advance to the utility and then feeds this information into his meter. The meter then updates the credit available to the consumer and starts deducting his consumption from available credit. Once the credit reaches a minimum specified value, meter raises an alarm. If the credit is completely exhausted the meter switches off the loads of the consumer. [21]

2.4 Prepaid Energy Metering

Energy meters, the only direct revenue interface between utilities and the consumers, have undergone several advancements in the last decade. The conventional electro-mechanical meters are being replaced with electronic meters to improve accuracy in meter reading. Asian countries are currently looking to introduce prepaid electricity meters across their distribution network, after the success of this novel methodology in South Africa. The existing inherent problems with the post-paid system and privatization of state held power distribution companies are the major driving factors for this market in Asia. [17]

Over 40 countries have implemented prepaid meters in their markets. In United Kingdom the system, has been in use for well over 70 years with about3.5 million consumers. The prepaid program in South Africa was started in 1992 since then they have installed over 6 million meters. Other African counties such as Sudan, Madagascar are following the South African success. The concept has found ground in Argentina and New Zealand with few thousands of installations. The prepaid meters in the market today are coming up with smart cards to hold information on units consumed or equivalent money value. When the card is inserted, the energy meter reads it, connects the supply to the consumer loads and debits the value. The meters are equipped with light emitting diodes (LED) to inform consumers when 75 percent of the credit energy has been consumed. The consumer then recharges the prepaid card from a sales terminal or distribution point and during this process any changes in the tariff can also be loaded in the smart card. [15]

2.5 Benefits of Smart Meters

Smart meters are beneficial to both the utility companies as well as the consumer, whether commercial or domestic. From the perspective of the utility companies, the smart meters offer the following advantages:

- It eliminates the requirement for manual meter reading since the remote meter reading facility incorporated in the meters enable the consumption data to be communicated back to the utility.
- The continuous data inflow from the smart meters over long periods of time may ultimately help the utility companies to forecast the load demand at a particular time of the day.
- It gives better overall monitoring and control over the system and enables better management of the available power resources.
- It provides near real-time data to the utility companies. This in turn makes it possible for the utilities to detect power outages and load fluctuations more quickly and hence take necessary steps to restore the system.[21]
- It allows the utility companies to have sufficient data to implement tariff rates based on time-of-use. The electricity cost per unit can be raised during periods of high demand and lowered during periods when the consumption is low.
- Smart meters and time-of-use billing may offer a limited degree of control over the load demand during peak load periods.[21]

Smart meters offer the following advantages to the consumers:

- If the smart meter data is available to the consumers, it will enable them to continuously monitor their energy consumption.
- From the consumer's perspective, smart meter will put an end to the practice of estimated billing by the utility companies. The consumers will also know for sure that there are no anomalies in the number of units of energy they are paying for and the number of units of energy they have actually consumed.
- Smart meters, when combined with time-of-use based billing, will encourage consumers to be flexible with respect to the non-critical loads, as this will in turn reduce their energy bills.[19]

2.6 Limitation of Smart Meters

From the discussions of the previous section, smart meters seem to have a clear edge over the traditional meters. However, smart meters also have certain drawbacks. These drawbacks pose a significant impediment in the implementation of the smart meters.

The drawbacks of smart meters can be summarized as follows:

- The biggest problem facing the utility companies in implementing the smart meters is the capital investment required from the consumer. It is difficult for the utilities to convince the consumer about the financial benefits they are going to enjoy in the long run. In order to convince the consumers into investing in the smart meters, it is necessary to educate the customers and change their outlook.
- Implementation of smart meters is faced with the difficulties associated with the transition to a new technology. Overhauling the older metering system and replacing them with the new meters is a long drawn and critical process that requires extensive planning. In order to reap the benefits associated with the smart metering system, the entire network must be equipped with the new advanced meters. Consequently, it becomes necessary to reach out to all consumers connected to the network and convince them to upgrade to the new metering system.
- One of the greatest disadvantages associated with the smart meters is that the consumers feel it is an invasion of their privacy. The argument towards this concern is that the meter data will give considerable indications to outsiders about their private life. The vulnerabilities arise from the fact that meter data is communicated to the utility via the internet or via a wireless network. Also, third party corporations will be able to access and analyse the private household data without the consent of the user.[12]

3. Problem Statement

Energy meter are typically calibrated in billing units, the most common one being the kilowatt hour. Periodic reading of electric meters establishes billing cycles & energy used during a cycle. In settings, when energy savings during

certain periods are desired, meters may measure demand, the maximum use of power in some interval. In some areas electric rates are higher during certain times of day, reflecting the higher cost of power resources during peak demand time periods. Also in some areas meter have relays to turn off non-essential equipment.[17]

Following are the associated problems regarding traditional energy meters:

- If there is an error on billing, the error will not be detected easily.
- There is a problem of energy thief by person to person and no one can catch the thief.
- On billing time, there is a huge line for paying. People were stands for many hours and facing problems.
- Power distribution system is not efficient
- Illiterate people do not understand billing system.

There is no prevention of manipulation of reading. [21]

4. Solution

The main objective of this dissertation is to design and develop an intelligent energy metering system that can efficiently control the amount of electricity consumed by the user.

GSM technology is used so that the consumer would receive messages about the consumption of power (in watts) and if it reaches the minimum amount, it would automatically alert the consumer to recharge The aim of the project is to minimize the queue at the electricity billing counters and to restrict the usage of electricity automatically, if the bill is not paid. The project also aims at proposing a system that will reduce the loss of power and revenue due to power thefts and other illegal activities. The GSM module provides a mode of communication between the user/meter and the EB Station. This will enable the user to recharge his/her electricity account from their home.[21]

5. Methodology

A smart card is to be entered in Radio Frequency ID (RFID). It will then send command to energy meter. It will allow the power to user through solid state relay. As long as power is consumed by the user the reading on energy-meter will start increasing till it reinserts the card. Whenever the power is put off, energy-meter will stop the reading. Whenever the card is reintroduced into card reader (RFID), the command will go to energy-meter to cut-off the power and stop the energy-meter. Whenever power is increased by second load, then energy-meter will increment faster.

220V AC supply feed into the step down transformer, it down to 220V AC to 12V AC. Then it introduced to the rectifier and filter circuit to convert it into the 12V DC value. After that it is passes through the voltage regulator (7805), by which it produced 5V DC. 5V DC supplied to the RFID, GSM Module and Microcontroller.

Microcontroller activate to the relaying scheme. Then switch is used to connect the desired amount of the load. Load consumption is recorded by the energy meter in KWh. Data taken from the energy meter by the microcontroller is display into the LCD in digital numeric form. Microcontroller initiates the GSM scheme, which transfers the information to the transmitter. Load consumption is also received in the form of message into the mobile. [21]

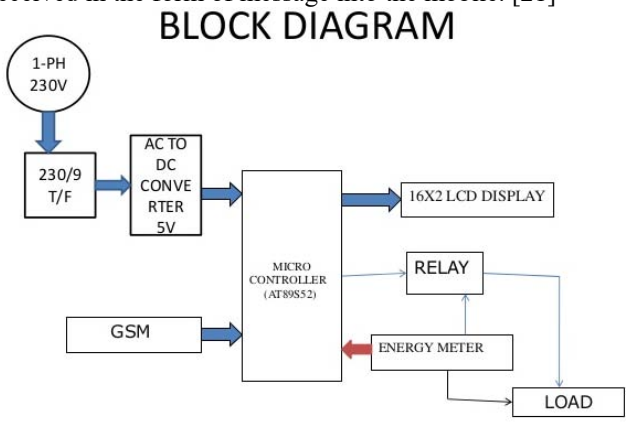


Figure: block diagram smart card base energy meter

As the card is brought near to card reader it reads the value of the card and the value is stored in the pre-paid energy meter. As the load is connected its current is sensed and converted to digital signal and then computed to KWH (kilowatt hour) unit. The readings are decremented as long as load is connected. When the card value is reduced to zero, the load does not get power. The load is also not ON when some different card is brought near to card reader. The display of reading can be shown on LCD display or seven segments LED display.

5.1 Hardware Analysis

5.1.1 Main Components

1.Transformer 2.Relay 3.Resistor 4.Bridge rectifier 5. LCD 6.Transistor 7.Capacitor 8.Diode 9.ICs 10.Power supply 11.Energy meter 12.Microcontroller 13.Regulator 14.LED 15.PCB 16.Opto Coupler 17.Temperature Sensor 18.Analog to Digital Converter.

5.1.1.1 Transformer

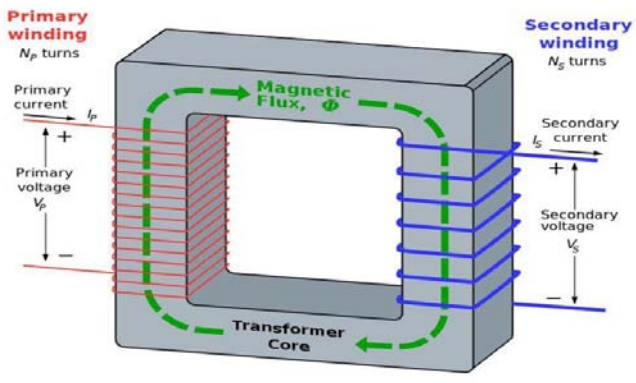


Figure: Transformer symbol

Transformers convert AC electricity from one voltage to another with little loss of power. Transformers work only with AC and this is one of the reasons why mains electricity is Accosted-up transformers increase voltage, step-down transformers reduce voltage. Most power supplies use a

step-down transformer to reduce the dangerously high mains voltage (230V in UK) to a safer low voltage. [21]

$$\text{Turns ratio} = \frac{V_p}{V_s} = \frac{N_p}{N_s}$$

Power Out = Power In (i.e. transformer is constant power device)

$$V_s \times I_s = V_p \times \text{Ip}$$

Where,

V_p = Primary voltage Is= Secondary current

Ip= Primary current V_s= Secondary voltage

N_p = Number of turns on primary coil

N_s= Number of turns on secondary coil

Step down 230 to 12v Turn ratio ‹ **1**

5.1.1.2 Relay

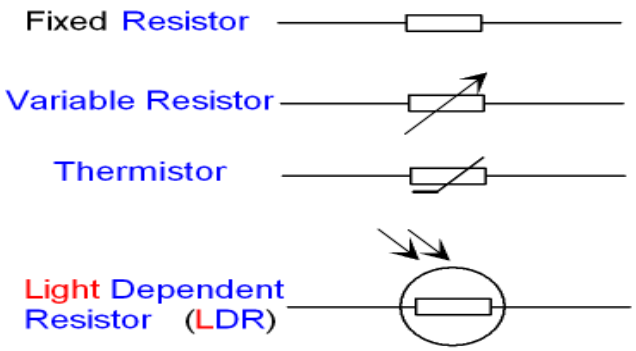
A relay is an electrical switch that opens and closes under the control of another electrical circuit. In the original form, the switch is operated by an electromagnet to open or close one or many sets of contacts. A relay is able to control an output circuit of higher power than the input circuit. It can be considered to be, in a broad sense, a form of an electrical amplifier.

0-18A 0-32A

Figure: Relays [21]

5.1.1.3 Resistor

Resistors are the electronic components used to control the current passing through the circuit. They are calibrated in ohms. In other word resistance are circuit elements having the function of introducing electrical resistance into the circuit.



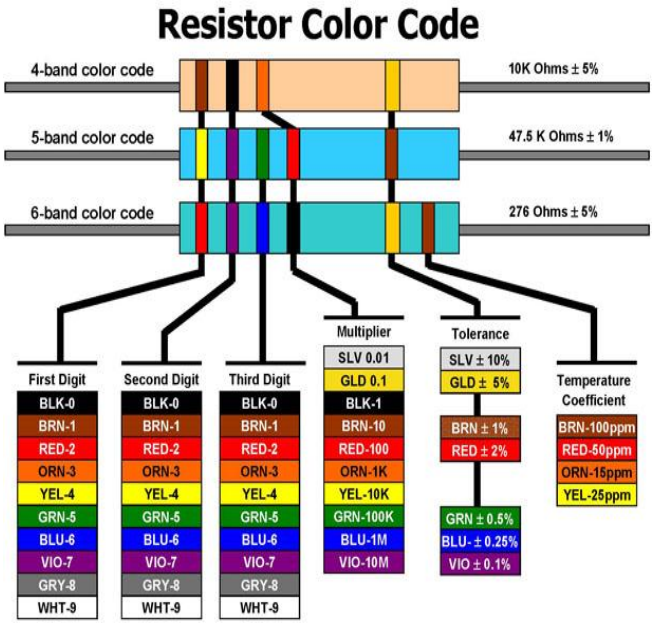


Table: Resistor Colour Coding

5.1.1.4 Diode

The most common function of a diode is to allow an electric current to pass in one direction (called the diode's forward direction), while blocking current in the opposite direction (the reverse direction). Thus, the diode can be viewed as an electronic version of a check valve. This unidirectional behavior is called rectification, and is used to convert alternating current (AC) to direct current (DC), including extraction of modulation from radio signals in radio receivers—these diodes are forms of rectifiers.

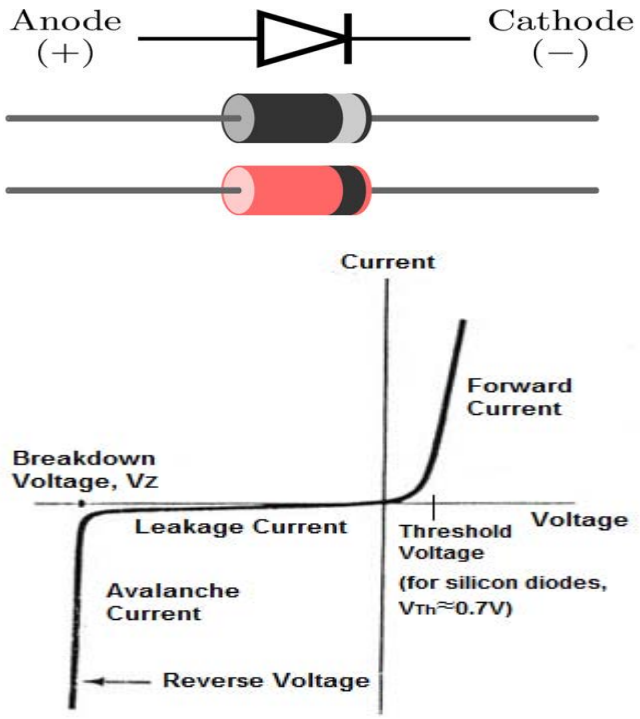


Figure: Diode characteristics

5.1.1.5 Prepayment Meters

Figure: Prepayment Meters **Figure:** A Prepayment Key

Prepayment meter and magnetic stripe tokens, from a rented accommodation in the UK, describe by the fig. 4.16. The button labeled a displays information and statistics such as current tariff and remaining credit. The button labeled B activates a small amount of emergency credit should the customer run out The standard business model of electricity retailing involves the electricity company billing the customer for the amount of energy used in the previous month or quarter. In some countries, if the retailer believes that the customer may not pay the bill, a prepayment meter may be installed. This requires the customer to make advance payment before electricity can be used. If the available credit is exhausted then the supply of electricity is cut off by a relay. In the UK, mechanical prepayment meters used to be common in rented accommodation. Disadvantages of these included the need for regular visits to remove cash and risk of theft of the cash in the meter.[21]

5.1.1.6 Liquid Crystal Display (LCD)

A liquid crystal display (LCD) is an electro-optical amplitude modulator realized as a thin, flat display device made up of any number of color or monochrome pixels arrayed in front of a light source or reflector, it is often utilized in battery-powered electronic devices because it uses very small amounts of electric power.

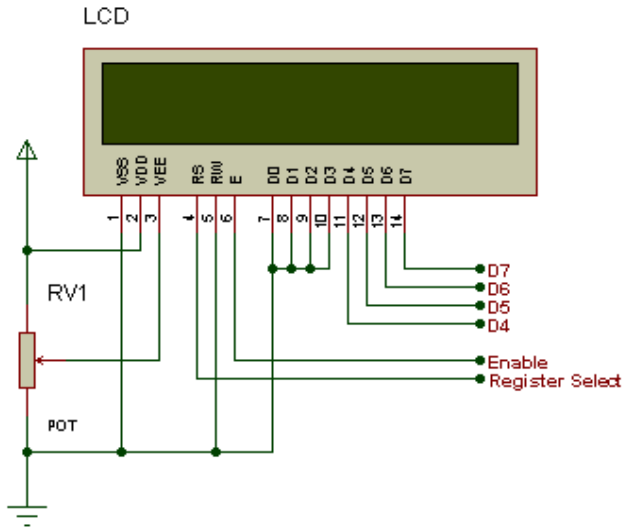
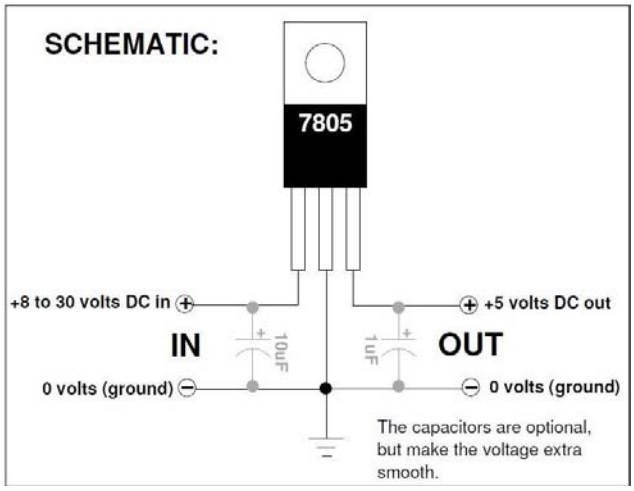


Figure: Liquid crystal display (LCD) circuit diagram

5.1.1.7 Regulator IC (7805)

Voltage regulator ICs are available with fixed (typically 5, 12 and 15V) or variable output voltages. They are also rated by the maximum current they can pass. Negative voltage regulators are available, mainly for use in dual supplies. Most regulators include some automatic protection from excessive current ('overload protection') and overheating ('thermal protection').It is a three pin IC used as a voltage regulator; it converts unregulated DC current into regulated DC current. The voltage regulator we are using here has a rating of 35V and it gives an output of 5V. Its ratings and characteristics arc provided in the table below. [22]



Characteristic	Rating
Input Voltage	9 V
Output Voltage	5V
Power Dissipation	20.8 W
Storage Temperature	-55 to 150°C

6. Advantages of Project

- Cost saving of energy-meter reading.
- Prevention of manipulation of reading both by technician & consumer.
- Advance collection of revenue.
- Power distribution management is efficient.
- Analysis of load consumption is easy.
- User who does not know unit of energy (in KWH) can't understand billing methodology.
- Saves lot of time and power for electricity department.
- Energy conservation.
- User can recharge number of unit's required (prepaid system).
- Lots of time and power saving for electricity department.
- Automatic controlling of energy meter.
- Non-volatile memory based energy meter storage.

7. Limitation of Project

- Such systems are costlier compare to bill that consumer pays per month.
- Such system installation cost is huge.

8. Application of Smart Card Based Energy Meter

- It is used in residential areas like homes, hotels, apartments, complex etc.
- In large & big factories, it is used for saving the power.
- In big textile industries, it is also used for saving the power.
- In field areas like farms, there are large power motors are used, so for their power saving purpose, we use smart card based energy meter.
- With the help of smart card based energy meter, we can prevent to commit a theft of electricity.
- Household electrical systems.
- Hotels and short term residential houses.
- Industrial power consumers.
- Shared meter systems.

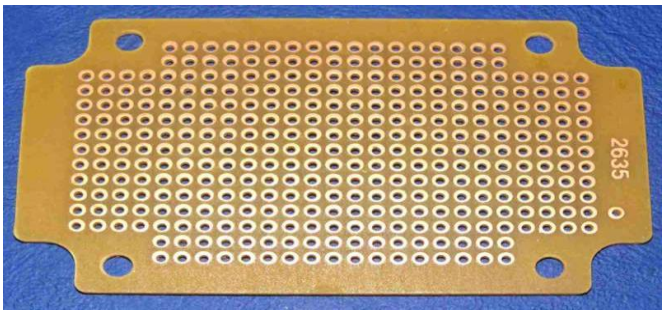
9. Design Specification

9.1 Steps Taken While Preparing Circuit

9.1.1 PCB Designing

The main purpose of printed circuit is in the routing of electric currents and signal through a thin copper layer that is bounded firmly to an insulating base material sometimes called the substrate. This base is manufactured with an integrally bounded layer of thin copper foil which has to be partly etched or removed to arrive at a pre-designed pattern to suit the circuit connections or other applications as required. The term printed circuit board is derived from the original method where a printed pattern is used as the mask over wanted areas of copper. The PCB provides an ideal baseboard upon which to assemble and hold firmly most of the small components. [21]

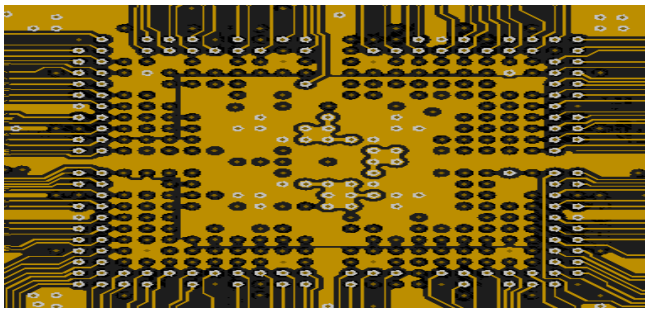
From the constructor's point of view, the main attraction of using PCB is its role as the mechanical support for small components. There is less need for complicated and time consuming metal work of chassis contraception except perhaps in providing the final enclosure [18].Most straight forward circuit designs can be easily converted in to printed wiring layer the thought required to carry out the inversion can be footed high light an possible error that would otherwise be missed in conventional point to point wiring. The finished project is usually neater and truly a work of art.



Actual size PCB layout for the circuit shown is drawn on the copper board. The board is then immersed in $FeCi_3$ solution for 12 hours. In this process only the exposed copper portion is etched out by the solution. [21]Now the petrol washes out the paint and the copper layout on PCB is rubbed with a smooth sand paper slowly and lightly such that only the oxide layers over the Cu are removed. Now the holes are drilled at the respective places according to component layout. [18]

9.1.2 Layout Design

When designing the layout one should observe the minimum size (component body length and weight). Before starting to design the layout we need all the required components in hand so that an accurate assessment of space can be made. Other space considerations might also be included from case to case of mounted components over the printed circuit board or to access path of present components. [17]



It might be necessary to turn some components around to a different angular position so that terminals are closer to the connections of the components. The scale can be checked by positioning the components on the squared paper. If any connection crosses, then one can reroute to avoid such condition. All common or earth lines should ideally be connected to a common line routed around the perimeter of the layout. This will act as the ground plane. If possible try to route the outer supply line to the ground plane. If possible try to route the other supply lines around the opposite edge of the layout through the centre. [21]

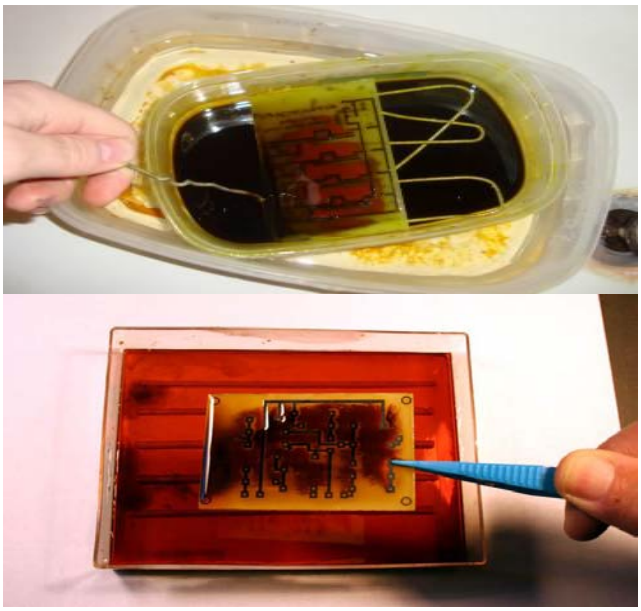
9.1.3 Etching Process

Etching process requires the use of chemicals. Acid resistant dishes and running water supply. Ferric chloride is mostly used solution but other etching materials such as ammonium per sulphate can be used. Nitric acid can be used but in general it is not used due to poisonous fumes.

The pattern prepared is glued to the copper surface of the board using a latex type of adhesive that can be cubed after use. The pattern is laid firmly on the copper using a very sharp knife to cut round the pattern carefully to remove the paper corresponding to the required copper pattern areas. Then apply the resistant solution, which can be a kind of ink solution for the purpose of maintaining smooth clean outlines as far as possible [17].While the board is drying, test all the components. Before going to next stage, check the whole pattern and cross check with the circuit diagram. Check for any free metal on the copper. The etching bath should be in a glass or enamel disc. If using crystal of ferric-chloride these should be thoroughly dissolved in water to the proportion suggested. There should be 0.5 it, of water for 125 gm of crystal. To prevent particles of copper

hindering further etching, agitate the solutions carefully by gently twisting or rocking the tray.[18]

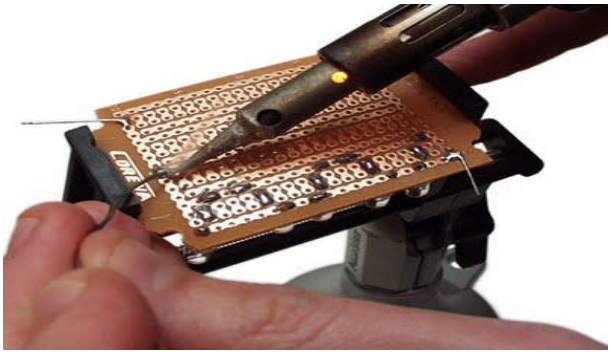
Drilling is one of those operations that calls for great care. For most purposes a 0.5mm drill is used. Drill all holes with this size first those that need to be larger can be easily drilled again with the appropriate larger size.



9.1.4 Component Assembly

From the greatest variety of electronic components available, which runs into thousands of different types, it is often a perplexing task to know which is right for a given job. There could be damage such as hairline crack on PCB. If there are, then they can be repaired by soldering a short link of bare copper wire over the affected part. The most popular method of holding all the items is to bring the wires far apart after they have been inserted in the appropriate holes.[19] This will hold the component in position ready for soldering. Some components will be considerably larger.So it is best to start mounting the smallest first and progressing through to the largest. Before starting, be certain that no further drilling is likely to be necessary because access may be impossible later.

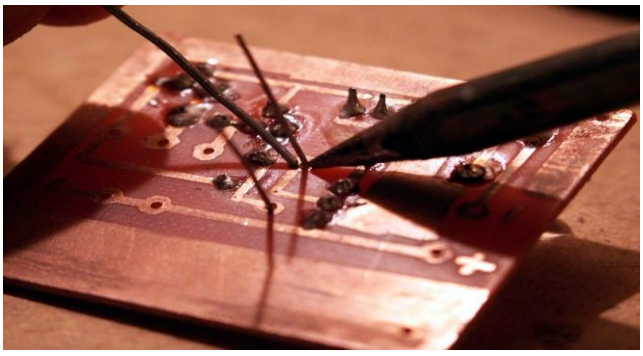
Although transistors and integrated circuits are small items there are good reasons for leaving the soldering of these until the last step. The main point is that these components are very sensitive to heat and if subjected to prolonged application of the soldering iron, they could be internally damaged. All the components before mounting are rubbed with sand paper so that oxide layer is removed from the tips. Now they are mounted according to the component layout.[18]



9.1.5 Soldering

This is the operation of joining the components with PCB after this operation the circuit will be read to use to avoid any damage or fault during this operation following care must be taken:

- A longer duration contact between soldering iron bit & components lead can exceed the temperature rating of device & cause partial or total damage of the device. Hence before soldering we must carefully read the maximum soldering temperature & soldering time for device.
- The wattage of soldering iron should be selected as minimum as permissible for that soldering place.
- To protect the devices by leakage current of iron its bit should be earthed properly.
- We should select the soldering wire with proper ratio of Pb & Tn to provide the suitable melting temperature.
- Proper amount of good quality flux must be applied on the soldering point to avoid dry soldering.[21]



10. Result

Three bulb's of each 60W rating was used as a load that draw currents of up to 5.5 A. The supply voltage was between 210 V and 230 V. Energy measurement process is described step by step. At first wattmeter was used to measure the power consumed by the load. Then energy consumption was measured after every 20 seconds using the obtained power information from the load. The computed energy consumption is read from the Liquid Crystal Display. The experimental result for the testing of prepaid energy meter is summarized, 1.2 kW and time and energy output from measurement that is displayed by LCD after every 20 sec. A certain amount of power is supplied to the load, this power is maintained over a certain period of time and the energy consumption is calculated and finally displayed. The tests were done over a 3 minute period, measurements were taken every 20 sec and a very high accuracy level is

observed particularly after longer periods of time. The result can also obtain to the user in mobile by the help of GSM module and that can also transfer to the nearest sub-station for load consumption analysis.

11. Final Project Image

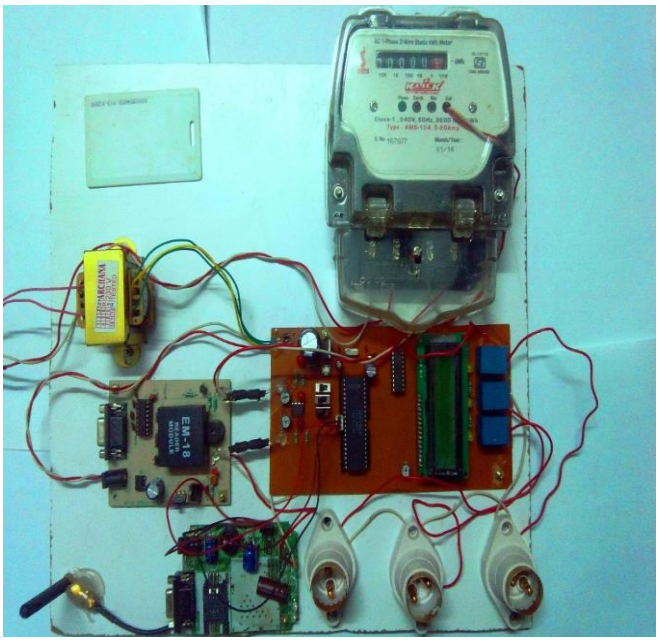


Figure: Final Project Image

12. Circuit Diagram of Project

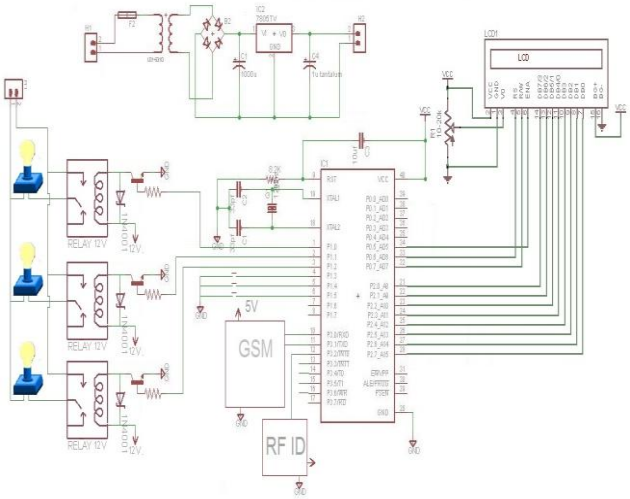


Figure 4.32: Project circuit diagram

13. Conclusion

With completion of this project we shall be able to design the circuit, know about cards, interfacing of display with circuit and interfacing of electrical load.

Why exiting companies have not designed such system. Such systems are costlier compare to the bill that consumer pays per month. Such system installation is not easy. Since electricity boards are having lot of burden of transmission and distribution losses it does not want to invest in such systems but as we are using mobiles of each and every activity why should energy meter be read manually. In addition, the process of reading the energy consumption is facilitated by the LCD display that is simpler than that for the analog meters which reduces human errors while noting down the meter reading. The energy billing system may help the energy distribution companies to reduce costs and increase profits, to improve metering and billing accuracy and efficiency and to contribute the energy in a sustainable way. To recharge the microcontroller chip, it must be taken to the server terminal or unit. The energy billing system provides employment for nearly 2-3 people in every server terminal for jobs like recharging smart card and processing the distribution of power in a convenient way.

14. Further Scope

The application of the e-metering system is extended to streamline power distribution with online monitoring of power quality, real time theft detection and automatic billing. The power utility can recharge the prepaid card remotely through mobile communication based on customer requests. The proposed prepaid meter is implemented in a software model and MATLAB has been used for simulation.

This meter has the characteristics of high accuracy, prepayment, multi-metering, agile measuring approaches, different events record and complete data freezing.

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