WSN Based Advanced Energy Meter Billing

L. L. Patil[1] R. R. Patil[2] S. S. Ahirrao[3] P. D. Patil[4] S. R. Chaudhari[5]
[1,2,3,4]B.E. Student
[1,2,3,4,5]Department of Electrical Engineering
[1,2,3,4,5]Godavari College of Engineering, Jalgaon, Maharashtra, India

Abstract— From the system performance analysis it is seen that the system can withstand by all the tests taken for better results of the system. Also in comparison with existing measurement system it is found that the intelligent energy meter is having better efficiency than that of the existing system. Upon initial inspection of the circuit operation, multiple problems were noted. The serial data is transmitted from the zigbee module but it is not detected by the receiver. Troubleshooting of the circuit was undertaken to isolate causes of circuit failure. Generally the commercial system are overpriced, the main goal of this project was that the low cost with global connectivity and controllability is possible. The total cost was expected to be less when selecting hardware components clearly this goal has been achieved. Core objective of "WSN Energy meter theft monitoring system" successfully achieved, the microcontroller AT89C51 controller is the main brain and has burned program in it. The project is a grant success and real time output have been successfully achieved.

Key words: Wireless Sensor Networks, APSIM, ECG Signals

I. INTRODUCTION

A. Power Scenario in India:

Everybody must have faced problem with energy meter reading. After getting faulty bill, it is problem of user to get it corrected from the MSEB. Person has to visit the office, stand in a queue and get it corrected. The problem is just because of human intervention. To avoid this, new generation, energy meter will be equipped WSN.

The reason for selecting WSN (wireless sensor network) is, Wide range. And communication through sensor network through mesh topology. By any means the data is transferred to the next level or meter by their connectivity network. The data is transferred to the office along with metering value and any other theft detected. The new feature is introduced in this system when any person tempers or tries to remove the box cover of the energy meter it is detected by the sensor and the output of the comparator is set and fed to the microcontroller and also the magnetic sensing is provided and the system sends the message to the MSEB that theft for electricity is done.

The system is advantageous to both, EB and user.

1) User, now onwards will not get any problematic bill.
2) Due to wireless facility, person should not be appointed to get the reading from the electricity meter. Thus man power requirement is reduced.
3) Complaints regarding bill we tend to ZERO, so in near future EB has to simply shunt down the complaint department related to the wrong bills.

II. REVIEW OF LITERATURE

Industrial automations which are mostly depend upon the power systems & which requires distance controlled and regulated systems. The author monitored power related parameters and enabled remote switching devices for proper power management systems using ZigBee and proposed a digital system for condition monitoring, diagnosis, and supervisory control for electric systems parameters like voltage and current using wireless sensor networks (WSNs) based on ZigBee. Recently, the modern agriculturists are demanding sophisticated instrumentation for Measurement and control of environmental parameters of the poly house. The humidity is Important parameter, which plays vital role on the crop yield. Therefore, the author designed and Implemented monitoring of humidity of playhouse and the results of implementation are interpreted. The data from the sensor nodes are monitored and logged using packet sniffer. The available Sniffers in the market need additional hardware with dedicated software which costs more. The Author had implemented sniffing of packets at the base station using Lab View. The author established tree topology and temperature monitored, logged with time stamping and packet data analysis was presented. APSIM has been used in a broad range of applications, including support for on-farm decision making, farming systems design for production or resource management objectives, assessment of the value of seasonal climate forecasting, analysis of supply chain issues in agribusiness activities, development of waste management guidelines, risk assessment for government policymaking and as a guide to research and education activity. The Authors provided an extensive citation list of model testing and application studies. Electrocardiogram and heart rate are vital physiological signals that have received increasing attention in recent years. Research indicates that each year more than millions of people around the world die of cardiovascular disease. The Researcher deals with the easy monitoring of electrocardiogram signals for people who are leading a normal daily life and wireless transmission of the analyzed ECG signals is sent to the doctor in case of only abnormal beats and rhythms which leads to effective reduction in power consumption.

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III. DESIGN OF SYSTEM

A. *Block Diagram of the Project:*

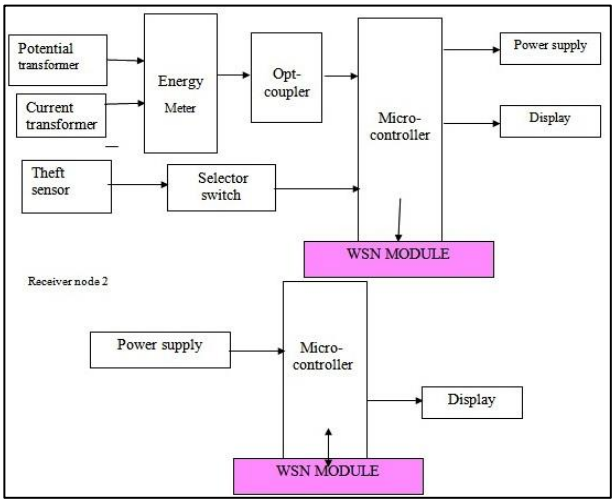

Fig. 1: Block diagram of the system

Description:

1) To sense V and I, step down transformer(s), PT (Potential transformer) and CT (Current Transformer) are used.
2) Output of CT and PT is given to AD7756, which is dedicated IC for energy measurement.
3) Energy will be displayed on the display.
4) Micro-controller will continuously check for billing value and tampered situations
5) After every two months the present reading will be transmitted to MSEB.
6) Micro-controller / PC will communicate with mobile/WSN card via IR port or serial cable.

B. *Circuit Diagram:*

1) *Transmiter Circuit:*

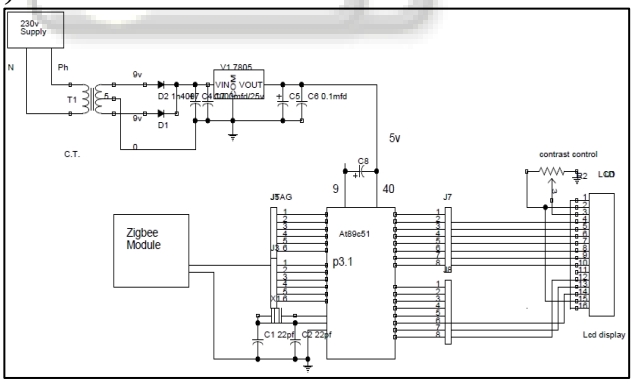

Fig. 2: Circuit Diagram of Transmiter Circuit

2) *Receiver Circuit:*

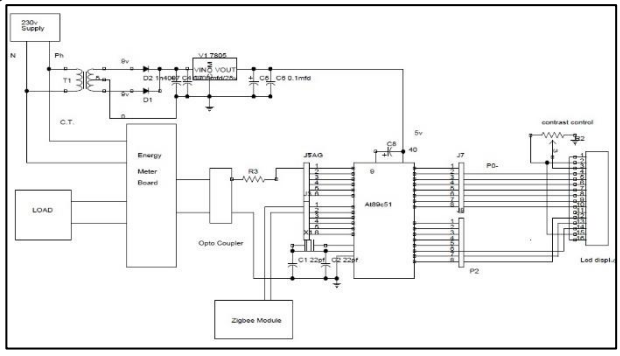

Fig. 3: Circuit Diagram of Receiver Circuit

IV. WORKING

A wireless sensor network is a potential candidate for Building Area Network, and it has been widely adopted in industrial automation which transmitted the data over large areas using its multi-hopping ability. ZigBee is one of the well-known wireless sensor network standards, and it has been widely adopted in different projects as a result of its intrinsic mesh property. Here the zigbee's are connected through router. One zigbee placed at one floor and other zigbee is at mseb. We can monitor the conditions in different floors through zigbee. If we want to control any devices also we can control from different floors. These zigbee's are connected through router so that we can monitor and control from different floors. The values can be monitored on display unit which is connected to micro controller. By using this zigbee router we can cover large areas. Here we are using 8 bit micro controller to implement this project.In this project, energy metering circuit is connected to the microcontroller, here when the load is connected the energy consumed is measured and the value is in the form of pulses. That pulses are measured to generate the amount of energy used. That value of unit consumed is shown on LCD. It is a 16*2 type back light intelligent lcd. Which is interfaced with microcontroller on P0.which is 8 bit data mode of interfacing. Power supply consists of step down transformer of 230 to 9 v centre tap. Centre tap full wave rectifier is used for rectification that is converting the ac to dc voltage. dc voltage is then filtered to get pure DC voltage. That is pure dc voltage is regulated using IC 7805 to get fixed voltage of 5v.that fixed voltage is operating voltage is given to the circuit. Crystal oscillator is used for generating fixed frequency to operate the microcontroller. The crystal oscillator frequency is used for 11.0592 Mhz.

V. HARDWARE DISCRIPTION

Our project consists of the following components.

A. *Microcontroller:*

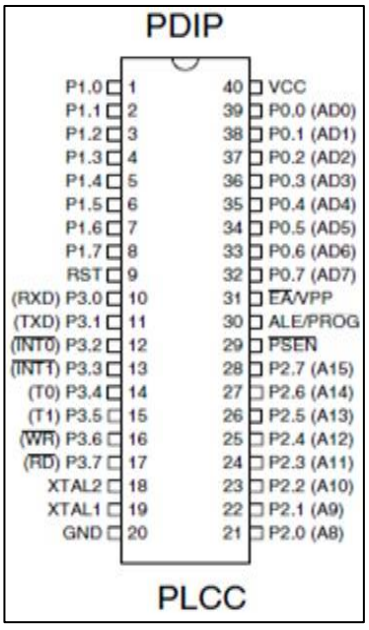

Fig. 4: Pin Diagram of Microcontroller

The AT89C51 is a low-power, high-performance CMOS 8-bit microcomputer with 4K Bytes of Flash programmable and

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erasable read only memory (PEROM). The device is manufactured using Atmel's high-density nonvolatile memory technology and is Compatible with the industry-standard MCS-51 instruction set and pinout. The on-chip Flash allows the program memory to be reprogrammed in-system or by a conventional nonvolatile memory programmer. By combining a versatile 8-bit CPU with Flash on a monolithic chip, the Atmel AT89C51 is a powerful microcomputer which provides a highly-flexible and cost-effective solution to many embedded control applications.

The AT89C51 provides the following standard features: 4Kbytes of Flash, 128 bytes of RAM, 32 I/O lines, two 16-bittimer/counters, five vector two-level interrupt architecture, a full duplex serial port, on-chip oscillator and clock circuitry. In addition, the AT89C51 is designed with static logic for operation down to zero frequency and supports two software selectable power saving modes. The Idle Mode stops the CPU while allowing the RAM, timer/counters, serial port and interrupt system to continue functioning. The Power-down Mode saves the RAM contents but freezes the oscillator disabling all other chip functions until the next hardware reset.

B. Pin Description:

– VCC - Supply voltage.
– GND - Ground.
– Port 0

Port 0 is an 8-bit open-drain bi-directional I/O port. As an output port, each pin can sink eight TTL inputs. When 1s are written to port 0 pins, the pins can be used as high impedance inputs. Port 0 may also be configured to be the multiplexed low order address/data bus during accesses to external program and data memory. In this mode P0 has internal pullups. Port 0 also receives the code bytes during Flash programming, and outputs the code bytes during program verification. External pullups are required during program verification.

- Port 1:

Port 1 is an 8-bit bi-directional I/O port with internal pullups.The Port 1 output buffers can sink/source four TTL inputs. When 1s are written to Port 1 pins they are pulled high by the internal pullups and can be used as inputs. As inputs, Port 1 pins that are externally being pulled low will source current (IIL) because of the internal pullups. Port 1 also receives the low-order address bytes during Flash programming and verification.

- Port 2:

Port 2 is an 8-bit bi-directional I/O port with internal pullups.The Port 2 output buffers can sink/source four TTL inputs. When 1s are written to Port 2 pins they are pulled high by the internal pullups and can be used as inputs. Port 2 pins that are externally being pulled low will source current (IIL) because of the internal pullups.Port 2 emits the high-order address byte during fetches from external program memory and during accesses to external data memory that use 16-bit addresses (MOVX @DPTR). In this application, it uses strong internal pullups when emitting 1s. During accesses to external data memory that uses 8-bit addresses (MOVX @ RI), Port 2 emits the contents of the P2 Special Function Register. Port 2 also receives the high-order address bits and some control signals during Flash programming and verification.

- Port 3:

Port 3 is an 8-bit bi-directional I/O port with internal pullups.The Port 3 output buffers can sink/source four TTL inputs. When 1s are written to Port 3 pins they are pulled high by the internal pullups and can be used as inputs. As inputs, Port 3 pins that are externally being pulled low will source current (IIL) because of the pullups.Port 3 also serves the functions of various special features of the AT89C51 as listed below:

Port 3 also receives some control signals for Flash programming and verification.

- RST:

Reset input. A high on this pin for two machine cycles while the oscillator is running resets the device.

- ALE/PROG:

Address Latch Enable output pulse for latching the low byte of the address during accesses to external memory. This pin is also the program pulse input (PROG) during Flash programming. In normal operation ALE is emitted at a constant rate of 1/6theoscillator frequency, and may be used for external timing or clocking purposes.

- Port 3 Pin Alternate Functions:

P3.0 RXD (serial input port)
P3.1 TXD (serial output port)
P3.2 INT0 (external interrupt 0)
P3.3 INT1 (external interrupt 1)
P3.4 T0 (timer 0 external input)
P3.5 T1 (timer 1 external input)
P3.6 WR (external data memory write strobe)
P3.7 RD (external data memory read strobe)

- PSEN:

Program Store Enable is the read strobe to external program memory. When the AT89C51 is executing code from external program memory, PSEN is activated twice each machine cycle, except that two PSEN activations are skipped during each access to external data memory.

- EA/VPP:

External Access Enable. EA must be strapped to GND in order to enable the device to fetch code from external program memory locations starting at 0000H up to FFFFH.Note, however, that if lock bit 1 is programmed, EA will be internally latched on reset. EA should be strapped to VCC for internal program executions. This pin also receives the 12-volt programming enable voltage (VPP) during Flash programming, for parts that require12-volt VPP.

- XTAL1:

Input to the inverting oscillator amplifier and input to the internal clock operating circuit.

- XTAL2:

Output from the inverting oscillator amplifier.

C. ATMEL 89C51:

The AT89C51 is a low-voltage, high-performance CMOS 8-bit microcontroller with 4K bytes of Flash programmable and erasable read-only memory. The device is manufactured using Atmel's high-density nonvolatile memory technology and is compatible with the industry-standard MCS-51 instruction set. By combining a versatile 8-bit CPU with Flash on a monolithic chip, the Atmel AT89C51 is a powerful microcontroller which provides a highly-flexible and cost-effective solution to many embedded control applications. The AT89C51 provides the following standard features: 4K

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bytes of Flash, 128 bytes of RAM, 15 I/O lines, two 16-bit timer/counters, a five-vector, two level interrupt architecture, a full duplex serial port, a precision analog comparator, on-chip oscillator and clock circuitry. In addition, the AT89C51 is designed with static logic for operation down to zero frequency and supports two software-selectable power saving modes. The Idle Mode stops the CPU while allowing the RAM, timer/counters, serial port and interrupt system to continue functioning. The power-down mode saves the RAM contents but freezes the oscillator disabling all other chip functions until the next hardware reset.

D. Internal Block Diagram:

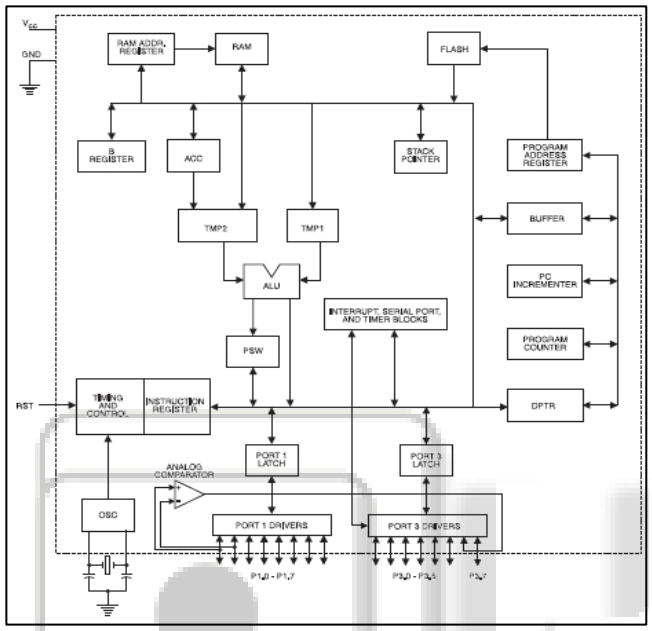

Fig. 5: Internal Block diagram 89C51

E. LCD Display:

Features:

- Maximum input voltage: 5.3VDC
- Operating input voltage: 5VDC
- 8-bit interface data bus
- Controller: HD47780 equivalent
- Character font size: 0.125"W x 0.200"H
- 16 pin/terminals
- Display size: 2.5"L x 0.7"W
- Module size: 3.4"L x 1.2"W x 0.5"T

1) Description of LCD:

This is a 16 character by 2 line display, with the standard HD44780 chipset. It works great with any microcontroller and it is very easy to interface. This LCD has 8-bit parallel interface. It is possible to use all 8 bits plus 3 control signals or 4 bits plus the control signals.

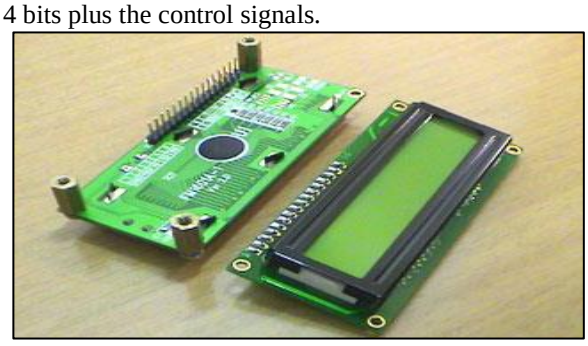

Fig. 7: LCD Display

2) LCD Interfacing diagram:

The diagram below gives the interfacing configuration of the LCD with the microcontroller.

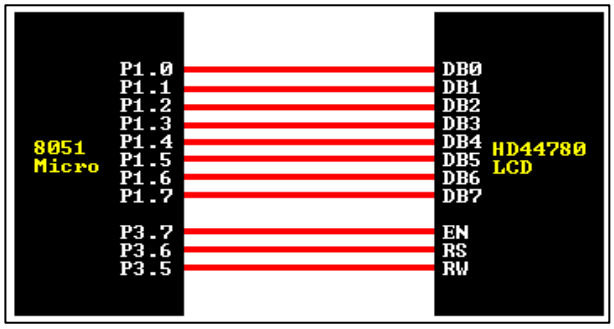

Fig. 8: LCD Interfacing diagram

3) Software:

As our project required involved the application of software, on consulting with our project guide we came to the conclusion that we shall use Embedded C for programming utilizing the Keil software. Use of embedded processors cars, mobile phones, medical equipment, aerospace systems etc is widespread. The applications of embedded C are exploited through the Keil software. Keil was founded in 1986 to market add on products for development tools provided by many of the silicon vendors. It soon became evident that there was a void in the market placethat must be filled with quality software development tools. It was then that Keil introduced the first C compiler designed from the ground-up specifically for 8051 microcontroller.

4) Power Supply:

Power supply is the first and the most important part of our project. For our project we require +5V regulated power supply with maximum current rating500mA. Following basic building blocks are required to generate regulated power supply.

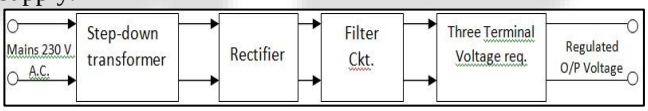

Fig. 10: Block Diagram of Power Supply

5) Energy measurement methods:

There are two main methods of energy measurement.

- VI COSΦ Method:

In VI COSΦ Method, the RMS value of voltage and current are found out over a Time period. The product of VRMS, IRMS and the power factor (COSΦ) gives the power. Energy consumed over a period is given by the product of power and the time interval.

True Power,

$P = V I \cos\Phi$

Where V= R.M.S Voltage = $Vm/\sqrt{2}$

I= R.M.S current = $Im/\sqrt{2}$

$\cos\Phi$ = Power factor

$\Phi = \tan^{-1}(\text{reactance/resistance})$

Energy = Power x t

- Instantaneous Measurement Method:

In Instantaneous Energy measurement method, the AC mains voltage and current are sampled at same frequency. The instantaneous values of voltage and current are multiplied and the average of these instantaneous values over time period gives the power and integration with respect to time gives energy consumed.

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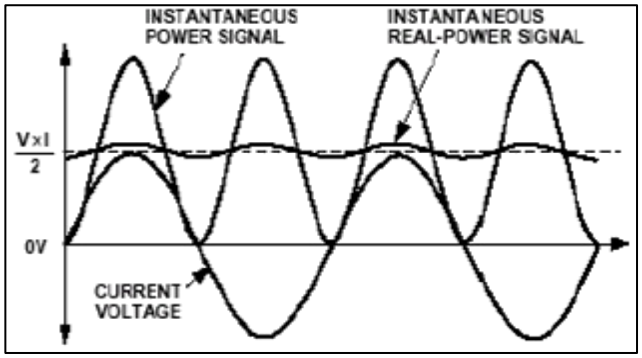

Fig. 9:

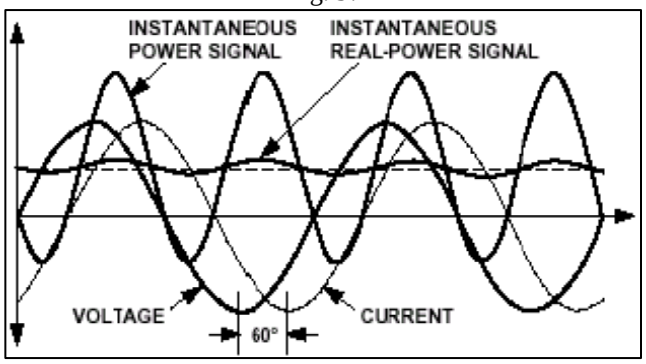

Fig. 10: Waveforms

Instantaneous Power = v i = Vm Sin ωt × Im Sin (ωt-Φ)

= ½ Vm Im [CosΦ – Cos (2 ωt- Φ)]

Power = **1** / T $\int_0^T$ p dt = 1 /2 Vm Im CosΦ

= Vm/√2 x Im/√2 CosΦ

= V I CosΦ

In Instantaneous method, it is found that the power comes out be VI CosΦ which is same as in VI CosΦ method. So it automatically takes into account the power factor. The advantages of instantaneous methods are,

1) CosΦ factor is removed effectively.
2) Instantaneous method is applicable to any type of wave form whereas,

VI CosΦ method is applicable for pure sine wave. So it is decided to use Instantaneous method to calculate energy consumed for which ASIC are available.

VI. List of Component

Sr. No.	NAME OF COMPONENTS	Qty	COSTING (in Rupees)
1	IC 7805	2	15
2	CM 8870	1	35
3	AT 89c51	1	150
4	Relay	1	65
5	LED'S	19	38
6	10 KΩ Resistor	1	0.25
7	100kΩ Resistor	2	0.50
8	300kΩ Resistor	1	0.25
9	1000µf 63V Electrolytic	1	6
10	10 µf, 26 V Electrolytic	2	2
11	100 nf, Ceramic	1	050
12	Crystal Oscillator(3.579545mhz)	1	9
13	Transformer 12-0-12v	1	120
14	IC Max232	1	120
15	PCB Copper Clad	1	500
16	270Ω Resistor	19	4.75
17	33 µf, Ceramic	2	1
18	Oscillator Crystal(11.0592mhz)	1	9
19	Multi Strand Wire	2m	8
20	Mobile Phone HeadSet	1	60
21	Misc.		200

Table 1: Cost Estimation

VII. Experimental Result

A. *Initial Reading:*

For meter 1

- Meter reading - 0.00 watt/hour.
- Voltage -230 volt.
- Current -0.26 Amp.
- Total Load - 60 watt.

For meter 2

- Meter reading - 0.00 watt/hour.
- Voltage -230 volt.
- Current -0.26 Amp.
- Total Load - 60 watt.

B. *Receiver reading:*

Sr. No.	Time Min	Meter Reading (1 Wt/Hr)	Meter Reading (2 Wt/Hr)	Receiver Reading (Wt/Hr)
1	0	0	0	0
2	30	0.3	0.3	0.6
3	60	0.6	0.6	1.2
4	90	0.9	0.9	1.8
5	120	1.3	1.3	2.6
6	150	1.6	1.6	3.2
7	180	1.9	1.9	3.8

Table 2: Initial Reading Chart

VIII. Conclusion

From the system performance analysis it is seen that the system can withstand by all the tests taken for better results of the system. Also in comparison with existing measurement system it is found that the intelligent energy meter is having better efficiency than that of the existing system. After debugging the circuit's individual modules, it was found that each of them function as were expected, and with some modifications the output of each components is right and consistent. Overall the project was satisfactorily completed. Components functioned properly in isolation and with interconnection. There is problem in circuit due to interference between decoder and driver but when we separate the two components apart from each other than whole circuit works properly. Most importantly it is confirmed that with some modification in programming and hardware. Data or meter read out can received on any receiver in the limited area is a network.

Core objective of "WSN Energy meter theft monitoring system" successfully achieved, the microcontroller AT89C51 controller is the main brain and has burned program in it. The project is a grant success and real time output have been successfully achieved.

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