## ABSTRACT

Science and technology with all its miraculous advancements has fascinated human life to a great extent that imagining a world without these innovations is hardly possible. While technology is on the raising slope, we should also note the increasing immoral activities. With a technical view, "Power Theft" is a non-ignorable crime that is highly prevalent, and at the same time it directly affects the economy of a nation. Data collected over **Tirunelveli District**, **Bhel** Trichy proves the necessity of this project.

Detecting and eradicating such crimes with the assistance of the developing scientific field is the "Need of the Hour". With these views was this paper conceived and designed. Our paper provides a complete and comprehensive tool to prevent power theft which is very simple to understand and easy to implement(Accepted by **T.N.E.B** officials). It includes four sections – transmitting, receiving, counter display and processing sections.

**DESCRIPTION OF OUR IMPLEMENTATION IDEAS**:

The disc revolutions are sensed into pulses by optical slot sensor. These pulses are shaped and given as control signal to the CMOS switch which bypasses carrier wave generated by PLL provides as input to receiving section where transmitted signal is selected by the Intermediate frequency transformer. For each lock a pulse is sent out. The counter section is designed to send out pulse for every six input pulse from the receiver section. This count is parallely distributed in a 7-segmentdisplay and then to µc for further processing. µc performs the function of indication and identification. Pindetails, features, connections and software employed for µc89c51 are described in detail.

We believe our implementation ideas is a boon to the electricity board offering them a chance to detect accurately the location and amount of power theft. Logical view for a digital meter is also included in our presentation.

## INTRODUCTION:

> "TODAY'S TECHNICIANS ARE SO FOCUSSED ON THE TREES OF TECHNOLOGICAL CHANGE THAT THEY FAIL TO SEE THE FOREST; THE UNDERLYING ECONOMIC FORCES THAT DETERMINE SUCCESS AND FAILURE…"
> "TECHNOLOGY CHANGES ECONOMY LAWS DO NOT"

Electricity is the modern man's most convenient and useful form of energy without which the present social infrastructure would not be feasible. The increase in per capita production is the reflection of the increase in the living standard of people. When importance of electricity is on the increasing side, then how much should theft of this energy or illegal consumption of power from the transmission lines be averted? Power theft has become a great challenge to the electricity board. The dailies report that Electricity Board suffers a total loss of 8 % in revenue due to power theft every year, which has to controlled. Our paper identifies the Power theft and indicates it to the Electricity board through Power line. We had also dealt about the remote monitoring of an energy meter.

**MICROCONTROLLER BASED AUTOMATION**:

Embedded systems - a combination of software, hardware and additional mechanical parts that together forms a component of a larger system, to perform a specific function. It's a technology, characterized by high reliability, restricted memory footprint and real time operation associated with a narrowly defined group of functions. Automation has made the art of living comfortable and easy. Embedded systems have made the process of automation a most successful one. Here, we have focused on automotive, an area of embedded controllers, in which we have dealt with the Power theft identification and also about the remote monitoring of an energy meter.

> **"Technology have taken the world by storm**
> **performance ratings and exceptionally value for money prices"**

The microcontroller chip is preprogrammed to perform a dedicated or a narrow range of functions as a part of a larger system, usually with minimal end user or

operator intervention. Our paper throws light on automated monitoring of theft identification, which is an application of embedded controllers.

## MODES OF THEFT:

It has been seen that there are 4 common methods of power theft as given below :-

- Bogus seals and tampering of seals.
- Meter tampering, meter tilting, meter interface and meter bypassing.
- Changing connection.
- Direct tapping from line.

Due to introduction of modern electronic metering equipments, power thieves are utilizing more technological methods. Recent cases of power theft discovered by British inspectors included customers tunneling out to roadside mains cables and splicing into the supply, a garage taking its night time power supply from the nearest lamp post and domestic customers drilling holes into meter boxes and attempting to stop the counter wheels from turning. Another method of Power theft is by keeping a strong magnet in front of the disc in the energy meter and thus arresting the rotation of the disc, connecting the load directly to the power line bypassing the energy meter. But, it can be avoided easily by providing a non magnetic enclosure.

## MODERN DETECTING TOOLS:

There are many modern tools that assist in power theft identification. Some of them are :-

- ✓ Tamper proof seals and labels.
- ✓ Meter leaders.
- ✓ Tamper resistant screws / locks.
- ✓ Check meter and remote meter readers.
- ✓ Tamper alarms and sensors.

This paper undertakes the Check meter and remote meter readers for power theft identification. In our case, the consumption recurred by the check

meter is compared with the revenue meters consumption. If there is a difference, then it indicates either there is a theft or revenue meter malfunction . The check meter can also be used to monitor the energy used on the secondary of a distribution transformer serving several customer and compared to the sum of all the meter usage. Besides spotting out the line where power theft is suspected to occur, it also detects the amount of energy stolen. Compact size, lightweight for quick and high accuracy make the system more effective.

## BLOCK DIAGRAM:

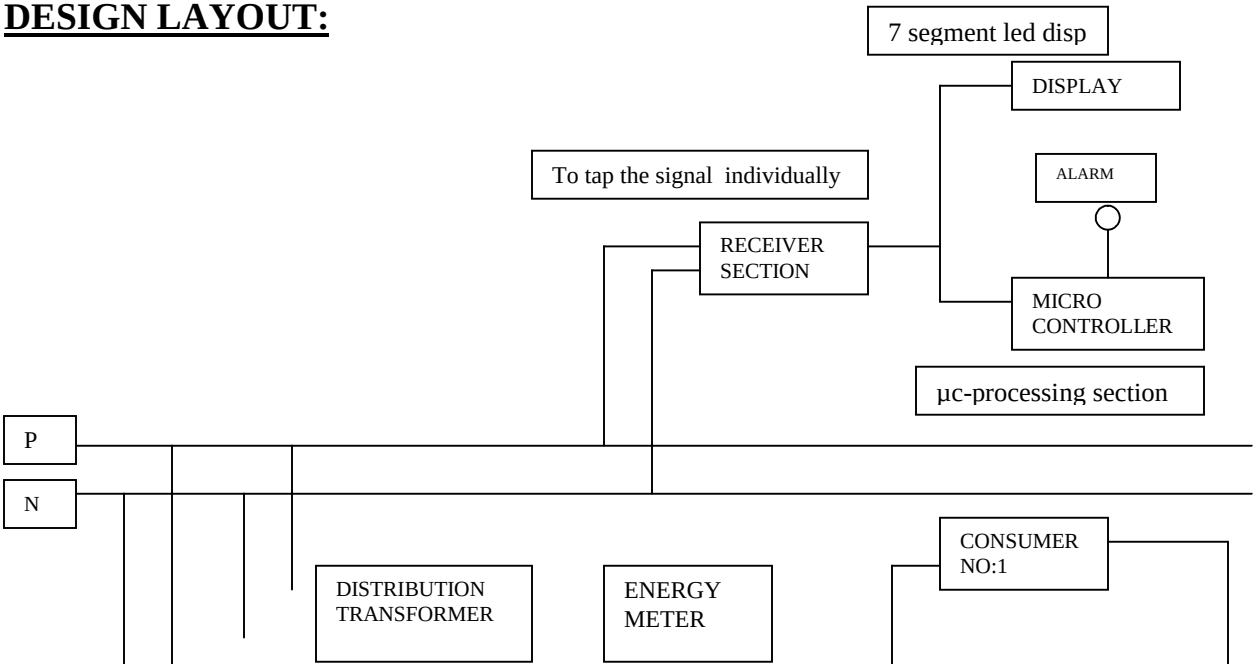
Power theft identification, in this paper, is done by converting the disc revolutions of each consumer's energy meter and distribution transformer into pulses. These pulses are frequency division multiplexed and transmitted through power line. These signals are individually picked and counted at the receiver end. If the difference of the sum of the consumer's readings and that of distribution transformer exceeds the preset value, which is set by considering transmission loss, the power theft is said to occur.

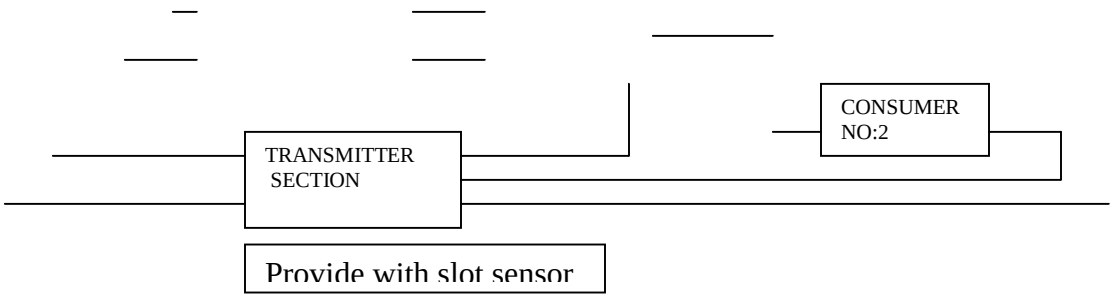
The project can be categorized into 4 modules :-

- ☺ Transmitting section
- ☺ Receiving section
- ☺ Processing section
- ☺ Counter section

The transmitted signal is selected at the receiving end by the inter-mediate frequency transformer.

## DESIGN LAYOUT:



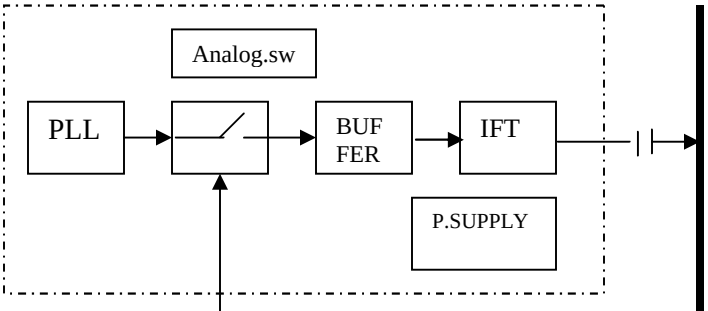


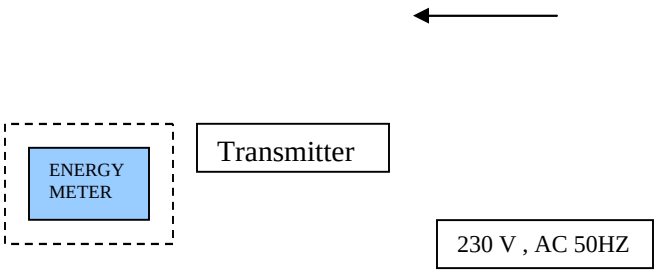

## TRANSMITTING SECTION:

The first and foremost requirements for a transmitter section are the

- The sensing unit
- Phase locked loop
- CMOS analog switch
- Buffer
- Intermediate Frequency Transformer

In this section, the disc revolutions of the rotating non-magnetic disc of the electro magnetic energy meter are sensed by opto coupler slot sensor. This slot sensor employs an infrared light source and a photo detector. For each revolution of the disc, the sensing unit has to produce pulses which are shaped and given as control signal to the analog CMOS switch. The analog switch employed in the circuit is IC 4066 which is a quad bilateral switch intended for the transmission of analog or digital signals. It offers a very low on state resistance and bypasses carrier wave generated by Phase Locked Loop to the next part of the circuit. Here, PLL acts as a carrier signal generator, which produces carrier signals of high frequency of band 300 kHz. The IC 567, that has an internal voltage-controlled oscillator is used. The output carrier signal is passed on to CMOS switch. From there, the modulated high frequency carrier signal is passed through a buffer circuit in order to have sufficient drive current and for isolation purpose.





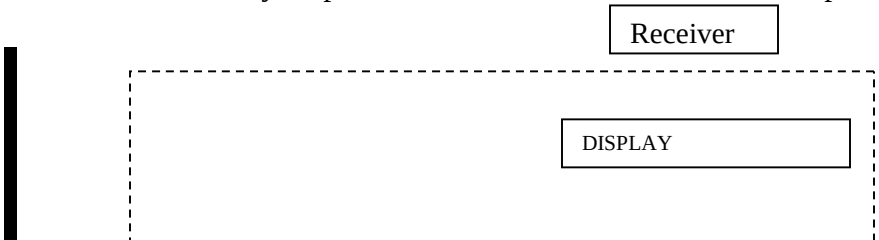

The buffer used in the module is IC 4049 which act as current amplifiers. Then an IFT is placed which is a step down transformer. It provides current gain and impedance matching. The carrier wave is current amplified, FM modulated and sent through power line. Selected signal at the receiving end is clipped off to a desired value and is demodulated by Phase Locked Loop. For every lock condition of the Phase Locked Loop, a pulse is sent out of the receiver end.

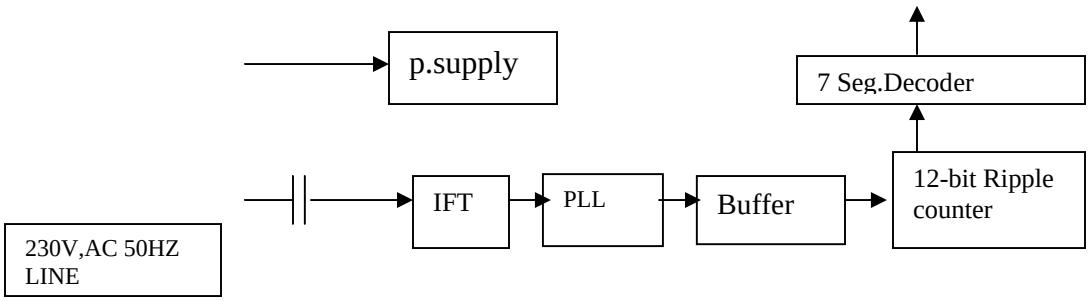
## RECEIVING SECTION:

The FM signal that are transmitted from the transmitter section travels through the power line and reaches the receiving section, where these signals are tapped individually. The basic components in the receiver section are :-

- Intermediate Frequency Transformer
- Clipper
- Phase locked loop

The IFT used in this section is of the same type as that of that transmitter. The frequency range is between 100 – 300 KHz as that used in radios. The IFT is externally tuned to the same value as that of the transmitter so that only signals of tuned value enters into the receiver circuit. The signal is sent to a simple diode clipper which clips off it to a value of about 0.7 V. Two diodes IN 4148 are connected back to back so that clipping is done at both positive and negative levels. This clipped signal is then given us an input signal of PLL which is a closed loop feedback system. Its function is to lock the output frequency and phase to the frequency and face of an input signal and it acts as a tone detector. The output of PLL is low whenever it goes into ‘lock’ state. This low state will open circuit a transistor whereby a pulse of +8 V is obtained as its output.

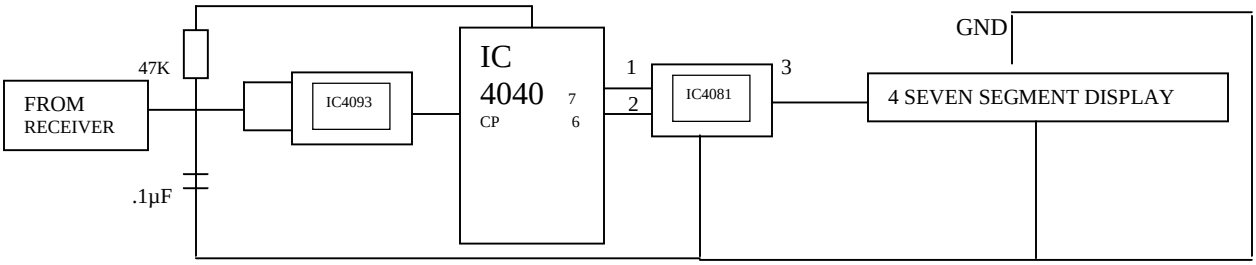





The pulses due to the locking of PLL is of +8 V but micro controller requires only +5 V. For this purpose an opto coupler is used which acts as an isolator circuit between receiver and micro controller.

## COUNTER CUM DISPLAY SECTION:

The energy meter disc rotates faster or slower depending on the amount of electrical energy being consumed. Whenever a carrier signal is detected at the receiver, a pulse is passed on to a counter. It counts six pulses and gives an output for every unit consumed. The output of this counter is fed to a decimal counter cum display unit. Four numbers of IC 4033 decade counters are connected in cascade to count as well as to drive the four digit seven segment LED display. The display enable pin 3 of this IC is tied to $V_{cc}$. A reset push button is provided to reset the decade counters and thereby the display. In IC4026 the carryout pin 5 is connected to clock input pin 1 of the next stage for cascading.




During power out the last reading of the display can be retained in the decade counters by providing a 3 V battery backup through a diode to the $V_{dd}$ pin.

## PROCESSING SECTION:

This section being the final and the most important part, performs all necessary manipulation and processing work. This processing work is done by

micro controller, which performs the final identification and indication by connecting an alarm. The use of micro controller resulted in a giant leap in the processing field. Our paper takes up the help of the micro controller to obtain quick, swift and accurate responses. The entire processing work is done by micro controller, which performs the final identification and indication .

**THE NEED FOR MICRO CONTROLLER:**

The necessity of using micro controller arise from the fact that, for a product design which requires only a simple system, the use of microprocessor is undesirable. The micro controller identifies all the function needed to make up a simple microprocessor system and puts as many as possible in a single IC. The micro controller used in this project is AT 8951, which is a 40 pin dip IC. It helps in scanning, debouncing, matrix decoding and serial transmission circuits etc. IC 89c51 is second generation 8-bit micro controller. Parallel counting of energy meter reading and simultaneous comparison of these readings are performed by the **IC**. The use of microcontroller has made the entire system more effective and accurate.

## AN OVERVIEW OF 89c51:

The microcontroller 89c51 is a 40 pin dip IC

- **EPROM**

  It includes EPROM of 4 kilobytes. This space is for storing codes. It can be programmed electrically. All instruction fetches are taken from the program memory space.

- **RAM of 128 bytes**

  The data memory space is read-write memory space. The processor can read data from memory space and can write into it. All variables and their values are stored in this memory.

- **Input output ports**

  The I/O ports of 8951 are full duplex serial in nature which carries 8 bit information to and fro simultaneously. It consists of four ports P0, P1, P2 and P3, which are used for different purposes. An external memory is connected to IC 8951 addressed by port 0 and 2. Port 0 is used to exchange data with this

memory with the help of multiplexed address data bus. Port 3 is used to perform external data memory WRITE and READ functions.

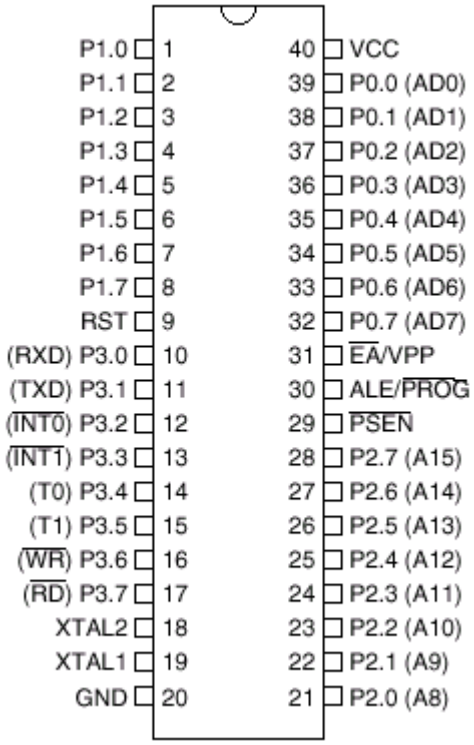
The entire programming in the controller is looked after by the instruction set. The IC 8951 instruction set has 50 instructions, which can be summarized as data transfer instructions, multiplication, division, call, jump etc. Comparing the instruction set of a general purpose 8-bit microprocessor, it's obvious that in some ways it has more power or in other words the micro controller has some real imitations. The major demerit is the availability of limited stack which can be extended by connecting external memory to it.

**Power saving modes:**

It is designed when static logic for operation down to zero frequency and supports two software selectable power saving modes,

- IDLE mode stops the CPU while allowing the RAM, the timer/counter, serial port and Interrupt system to continue functioning.
- POWER DOWN mode saves the RAM contents but freezes the oscillator, disabling all other functions until the next hardware reset.

## PIN DIAGRAM OF IC 89C51:




## PORTS DESCRIPTION

PORT 1 & 3 (1-8,10-17)

A 8-BIT BI-DIRECTIONAL I/O PORT WITH INTERNAL PULL-UPS. IT RECEIVES LOWER ORDER ADDRESS BYTES DURING FLASH PROGRAMMING.

PORT O (32-39)

A 8-BIT BI-DIRECTIONAL I/O PORT. IT IS CONFIGURED TO BE THE MULTIPLEXED LOW ORDER ADDRESS/DATA BUS DURING ACCESSES TO EXTERNAL PROGRAM AND DATA MEMORY.

PORT 2 (21-28)

IT PERFORMS THE SAME FUNCTION AS THE PORT 1 INADDITION IT RECEIVES SOME CONTROL SIGNALS DURING FLASH PROGRAMMING AND

## OPERATION OF MICRO CONTROLLER:

- The different connections are shown in the design layout. The set value can be given through port P1 by means of DIP switches. The possible values can be set by it.
- The pulses from each energy meter after being received is given as input individually to pin 12 & 13 and 16 of port 3.
- The frequency of operation of the controller can be varied by choosing crystal of desired value. The ceramic crystal is connected across $18^{th}$ and $19^{th}$ pin of the IC 8951. High frequency of about 8 MHz is chosen.
- Power theft identification is done by means of an alarm, which is connected to the $39^{th}$ pin of IC. Once the alarm is set on, the resetting of the controller can be done by connecting a push button to pin 9.
- It can be noted that the other pins of the ICs are unused and hence no connection are given to them. As the program written occupies space less than is 4 kbytes, no external memory is used hence $31^{st}$ pin is made high.
- The program is written and is down loaded to the IC 8751 by means of PC. The program is written so as to assign the function of each pin.

Also it initials continuous counting of units and simultaneous comparison. If error is predicted the buzzer is made to give alarm signal.

## SOFTWARE DESCRIPTION FOR IC 89C51:

The program for 89c51 is shown in this section. We present it in the form of several blocks to make it more clear and easily readable.

***INITIALISING THE PARAMETERS***

```
0016  75DOE7        MOV PSW,#0E7H
0019   7581FS        MOV SO,#SFH
001C   758000        MOV P0,#00H
001F   7590FF        MOV P1,$OFFH
0022   75A000        MOV P2,#00H
0025   75B0FF        MOV P3,#00FH
```

**INITIALISING THE PULSE REGISTERS**

```
0028   7800     MOV PULSE.1.REG,#00H
002A   7900     MOV PULSE.2.REG,#00H
002C   7A00     MOV PULSE.3.REG,#00H
002E   D288     SETB IT0
0030    D28A    SETB IT1
```

**EXECUTION OF CHECKING CONDITON (CHECKING FIRST CONDITION)**

```
0047    98          SUBB A,PULSE.1.REG
0048    FB          MOV RES.REG,A
0049    E590        MOV A,P1PULSE.1.REG
004B    54OF        ANL A,#00001111B
004D    FC          MOV KEY.SET.REG,A
004E BC0105 CJNE KEY.SET.REG,#001H,CHE
```

**EXECUTION OF SECOND CHECKING CONDITON**

```
0051    7C06        CK.FOR.2
0053    020086     MOV KEY.SET.REG,#006H
 0056               JMP CHECK.DIFF
0056   BC0205CJNE KEY.SET.REG,#002H,CHE
```

**CHECKING THE SEVENTH CONDITION**

```
0079   7C24        CK.FOR.7
007B   020086      MOV KEY.SET.REG,#036D
007E   BC0705      JMP CHECK.DIFF
0081    7C2A    CJNE KEY.SET.REG,#007H,CHE
```

**CHECK DIFFERENCE FOLLOWED BY ALARM**

```
0083       020086      CK.DIFF
0086                   MOV KEY.SET.REG,#420
0086       EB          JMP CHECK.DIFF
0087       C3          MOV R,RES.REG
0088       9C          CLR C
0089       5110        SUBB AMKEY.SET.REG
008B       8BAO        JNC SET.ALARM
```

**FREQUENT LOOPING OF AN ALARM CKT**

```
008D    80AF          MOV P2,RES.REG
008F                  JMP X1
008F   C2A8           CLR EXO
0091    08            INC PULSE.1.REG
0092    D2A8          SETB EXO
0094    32            RET1
0095    C2AA
0097   D2             INC
0098   AA             SETB
009A                  RETI
```

**EXECUTION OF THIRD CHECKING CONDITION**

```
0059   7COC     CH.FOR.3
005B   020086   MOV KEY.SET.REG,#012
005E            CHECK.DIFF
005E   BC0305   CJNE KEY.SET.REG,#003H,CHE
```

**OPCODE TO DIRECT AN ALARM**

```
009B   8BAO     MOV P2,RES.REG
009D   D280     SETB ALARM.PIN
009F   C2A8     CLR EX0
00A1   C2AA     CLR EX1
00A3   80F6     JMP SET.ALARM
```

The execution of first three and last conditions are shown here. Other conditions are executed in a similar way.

The process will be executed and the µ c enables simple, cost effective ,accurate and much more reliable system. It's high frequency enables all the pulses without missing any.

## MONITORING MEASURES:

- The display need not be kept always on, and can be powered up using a push switch whenever required to note down the reading.
- Protection against high voltage on the transmitter or receiver is possible by the usage of special high voltage suppressers like gas discharge tubes provided with a coupling point with fuses to disconnect the respective transmitter or receiver.
- Distance coverage is an important limitation which can be overcome by providing the repeaters at regular intervals when applied in a large scale.
- The display need not be kept always on, and can be powered up using a push switch whenever required to note down the reading.
- Effects of PF improvement capacitors on the line and distribution transformers may interfere with the message signal or the effect of atmospheric noises is to be analyzed before implementing in a large scale.

## MERITS:

- Due to the availability of digital energy meter, this implementation can be easily performed for power theft identification.
- Highly accurate, low loss and economical one.

- Our implementation may gives a big hand to vigilance squad to control theft quickly and easily
- Using this same logic, instead of micro controller we can adapt computer for more number of uses
- In day-to-day conventional methods, it's possible to identify the theft but the extent of theft cannot be identified but it's possible with our Check meter and remote meter readers.
- Compact size, Reliability, lightweight for quick operation and high accuracy makes the system more effective.
- Maintenance – holds more value than construction. In our case, cost is very less, it involves the planned serving of equipment at regular interval. Emergency maintenance is the case when the maintenance crew due to repair of any sections can be succeeded by,
  - A rational spare parts policy.
  - A maintenance staff of highly skilled, highly trained personnel.

## CONCLUDING LINES:

**"When you don't have a thing to worry about, those signs of age will stay away. It's just dumping obsolete technology with no peace of mind"**

This paper is designed for industrial purpose, but it can be extended to domestic purposes also. It gives a big hand to vigilance squad to control theft quickly and easily. With its usage, the crime of stealing power may be brought to an end and thereby a new bloom may be expected in the economy of our motherland. The prime limitation of the system in the present form is the distance coverage. To overcome this when applied in a large scale, repeaters can be employed at suitable intervals. To certain extent the power level of the transmitter may be improved. Our paper not only indicates the place of power theft but also the amount of energy being stolen that is, it gives the best of the expected results. The use of this technique gives a new hope and accuracy for the satisfaction to complete the work.

# TAMIL NADU ELECTRICITY BOARD
## Tirunelveli urban division

Lt line loss study for the period form 5.2.2002 to 20.2.2002

| SI.NO | NAME OF THE SECTION | NAME OF DIST. TRANSFORMER | CONSUMPTION AT THE TRANSFORMER END | CONSUMPTION AT THE CONSUMER END | LOSS IN UNITS | LOSS IN % |
|---|---|---|---|---|---|---|
| 1. | JUNCTION | TAMILNADU HOTEL SS | 3116 UNITS | 2975 UNITS | 141 UNITS | 4.5% |
| 2. | MAHARAJANAGAR | SAVAI ILLAM SS | 4010 UNITS | 3599 UNITS | 411 UNITS | 10.24 % |
| 3. | MELAPALAYAM | KALIAMMANKOIL SS | 8936 UNITS | 8086 UNITS | 850 UNITS | 9.5% |
| 4. | PALAYAPETTAI | ABISEKAPATTI 63KVA | 1840 UNITS | 1538 UNITS | 302 UNITS | 16.41 % |
| 5. | PETTAI | MALAYALAMEDU | 11552 UNITS | 9520 UNITS | 2032 UNITS | 17.5% |
| 6. | THACHANALLUR | KATTUDIYAR KUDIRUPPU | 291 UNITS | 5942 UNITS | METER DEFECT | |
| 7. | V.M.CHATRAM | TNHB SS V100 | 4583 UNITS | 4450 UNITS | 133 UNITS | 2.9% |
| 8. | SAMATHANAPURAM | MADIKONDU SS 100 KVA | 6841 UNITS | 6674 UNITS | 167 UNITS | 2.44% |
| 9. | VANNARPETTAI | MURUGANKURICHI 33 III 100KVA | 8678 UNITS | 8402 UNITS | 271 UNITS | 3.12% |

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# TRANSFORMER LOSS FOR DT's:

**LOSS IN DT's=(TOTAL COPPER LOSS+TOTAL IRON LOSS)/1000**

| STATEMENT SHOWING THE TRANSFORMER LOSS FOR VARIOUS OF DISTRIBUTION TRANSFORMERS | | | |
|---|---|---|---|
| SI.NO | DISTRIBUTION TRANSFORMER | MAX. IRON LOSS(WATTS) | MAX. COPPER LOSS(WATTS) |
| 1. | 63KVA/11KV | 180 | 1235 |
| 2. | 63KVA/22KV | 210 | 1300 |
| 3. | 100KVA/11KV | 260 | 1760 |