CAREER EPISODE 1 –
DIGITAL ENERGY METER

SUBMITTED TO:
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Document control

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CAREER EPISODE 1

DIGITAL ENERGY METER

CE 1. 1 INTRODUCTION

CE 1.1.1 PROJECT DURATION

The project started in April 1994 and was completed by July 1994. This was part of my project work that is a pre requisite for completing my Degree.

CE 1.1.2 PROJECT LOCATION

The project was carried out in College campus. The campus is located in Aiwan-E Shahi area, Gulbarga, Karnataka state, India.

CE 1.1.3 NAME OF ORGANISATION

I was an Engineering student at Poojya Dodappa Appa (P.D.A) college of Engineering, which is an autonomous college, funded by Central Government. It is located in Gulbarga city, Karnataka state, India

CE 1.1.4 MY ROLE

I was Project Lead for this project for a team of 5 members. I reported to Head of Department, who was also our guide for this project.

CE 1.2 BACKGROUND

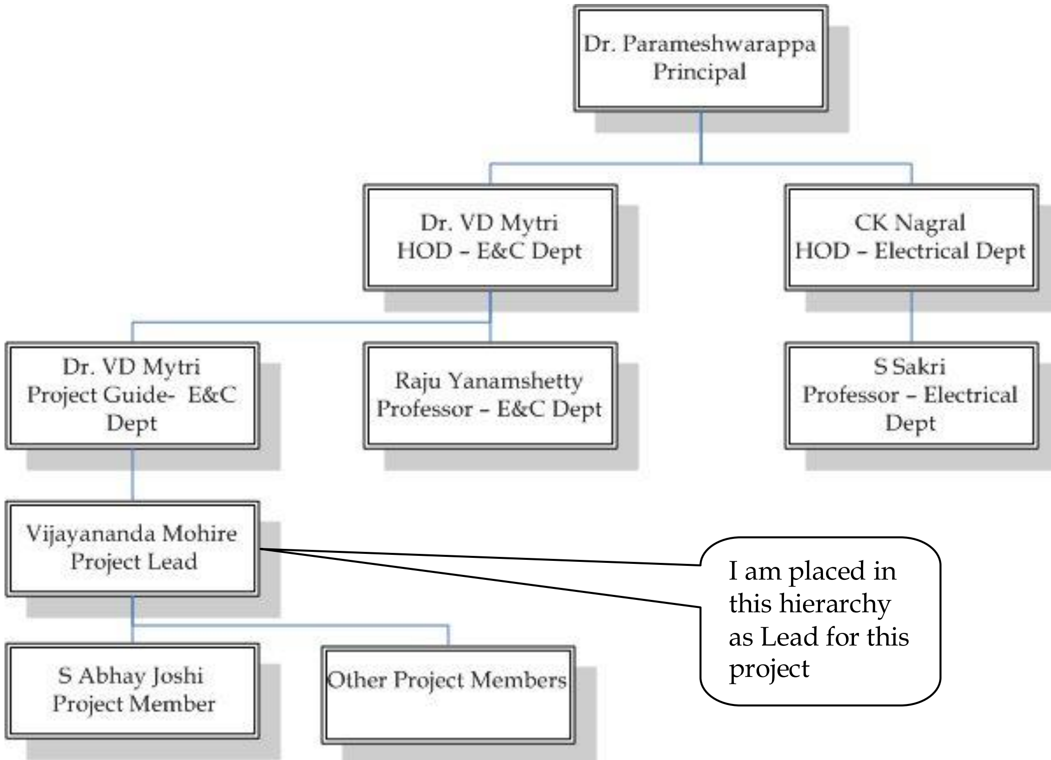

Figure 1: Organizational chart

CE 1.2.1 AIMS & OBJECTIVES OF THE PROJECT

- To demonstrate the shortfalls of Electromechanical energy meter using mathematical formulas.
- To measure accurately the energy consumed using Electrical standards and formulas
- To generate accurate meter readings based on precise mathematical computations upto desired fractions and decimals
- To generate in time bills and reports based on billing intervals and displayed in user understandable format
- To demonstrate basic electronic circuit assembly and use of Microprocessor chipsets
- Demonstrate the use of electronics in utility and practical application to Industry
- To have a modular production unit that has easily replaceable components
- To provide auto trip and glowing of RED LED mechanism in case of faulty operations or abnormal limits
- To have a cost effective replacement for Electromechanical energy meters

- ➔ To reduce power consumption by meters by using Electronic components instead of Electromechanical components
- ➔ Reduced maintenance costs and increased reliability

CE 1.2.2 METHODOLOGY

- ❖ Review of the Electromechnical energy meter and identify the issues in coordination with Electrical and Mechanical Engineering departments
- ❖ Suggest a viable Microprocessor based solution by doing study using IEEE standards and Industry grade electronic components like Chip set, Display units, Capacitors, Resistors, Power transformers etc.
- ❖ Define the Blue print of the solution for Hardware and Software to be used.
- ❖ Develop the Software – here it is programming the Intel 8085 chip using assembly language
- ❖ Develop the Hardware- Fabricate the mother board using printed circuit board, selected chips and devices – here it is assembly of 8085 chip set with Analog to Digital converter(ADC 0809), Operational amplifier (µA 741) , rectifiers, Potentiometers, multivibrators(Monoshot - IC 74121)
- ❖ Deploy the software onto the 8085 chipset
- ❖ Unit and integration test using multimeter and oscilloscope to confirm the voltage levels and phase factors in the Input power
- ❖ Run the tested project and tabulate the results
- ❖ Validate the results against the expected standards
- ❖ Rectify any issues and rerun the project
- ❖ Demonstrate the working project to guide and external reviewer
- ❖ Obtain the necessary credentials for successful completion of the project
- ❖ Handover the project documentation and project assets to department

CE 1.3 PERSONAL ENGINEERING ACTIVITIES

CE 1.3.1 ANALYSIS OF ELECTROMECHNICAL METER

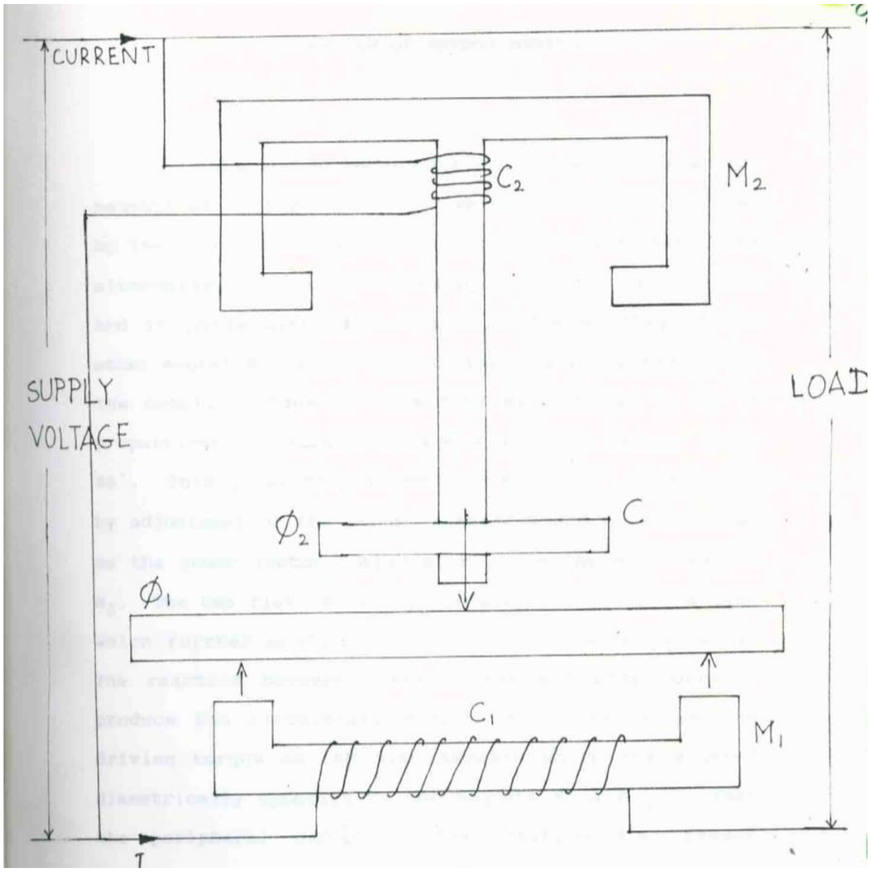

Figure 2: Electro mechanical energy meter

The energy meter consists of two A.C electro- magnets as shown in fig 1. One is M1 is excited by line current, known as Series magnet. Alternating flux Φ1 produced by M1 is proportional and in phase with supply line current. Other magnet called Shunt magnet M2 is connected across supply voltage V and produces flux Φ2. Φ2 is proportional to line voltage and lags behind it by 90^o. This phase lag is achieved by adjusting the copper shading, C (power factor compensator). The two fluxes induce Electro-Magnetic Field (E.M.F) in the rotating disc and produce an eddy current that is converted to mechanical energy called as torque. In a given period of time the total number of revolutions is proportional to electric energy consumed.

Limitations in Induction wattmeter:

1. As the two coils have same resistance, shunt field does not lag behind supply voltage by exactly 90^o. So torque is not zero at zero power factor. To compensate the power factor compensator coil needs to be adjusted at regular intervals to maintain accuracy.

2. Frictional forces at the rotor bearings give rise to a braking torque on the rotor disc. Due to this disc rotates slowly even at no load, which is called as creeping.
3. Pressure coil possesses capacitance in addition to inductance. This produces high readings on lagging power factor on the load.
4. Eddy currents which act as anti fields alter the magnitude and phase of the desired current coil.
5. Temperature induced changes also add to more deviations.

These issues are addressed in the project developed as Digital Energy meter.

CE 1.3.2 DESIGN AND DEVELOP HARDWARE

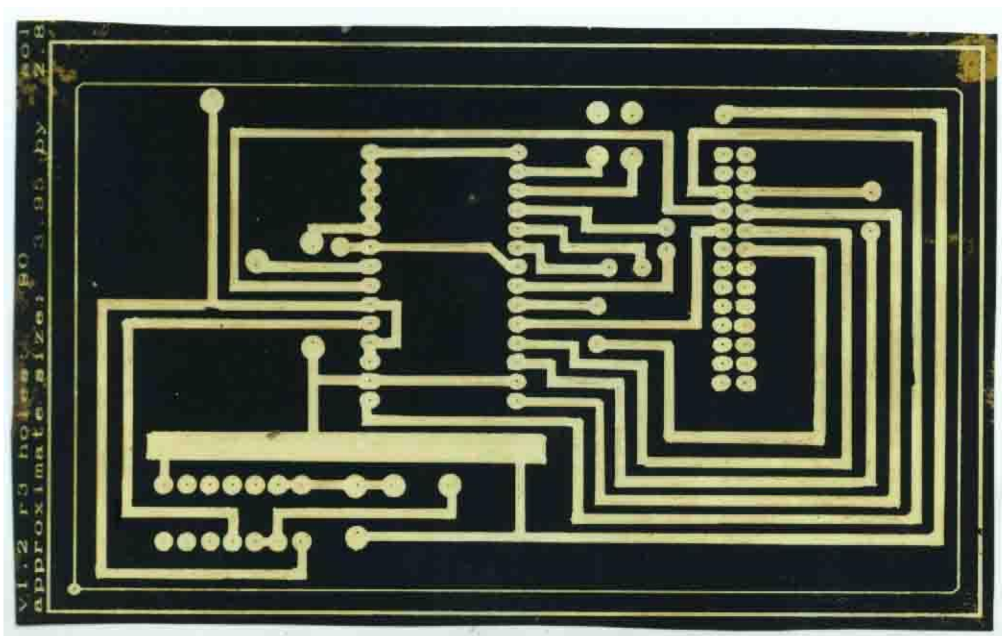

Figure 3: PCB layout design

Figure 3 provides one circuit board design used for holding the power transformers and Peripheral interface chip. Details of the components used for this PCB described in below sections.

General Electrical theory used:
Electrical energy is the total power delivered over a specific time interval.

W = VI Cos Ø dt
Where,

V= Voltage, I = Current, Ø = Phase angle between V and I

The power is then digitized using electronics and stored in memory of Microprocessor over a period interval of time. Suitable computation is managed by the Software module based on the voltage and current measured at particular instance of time.

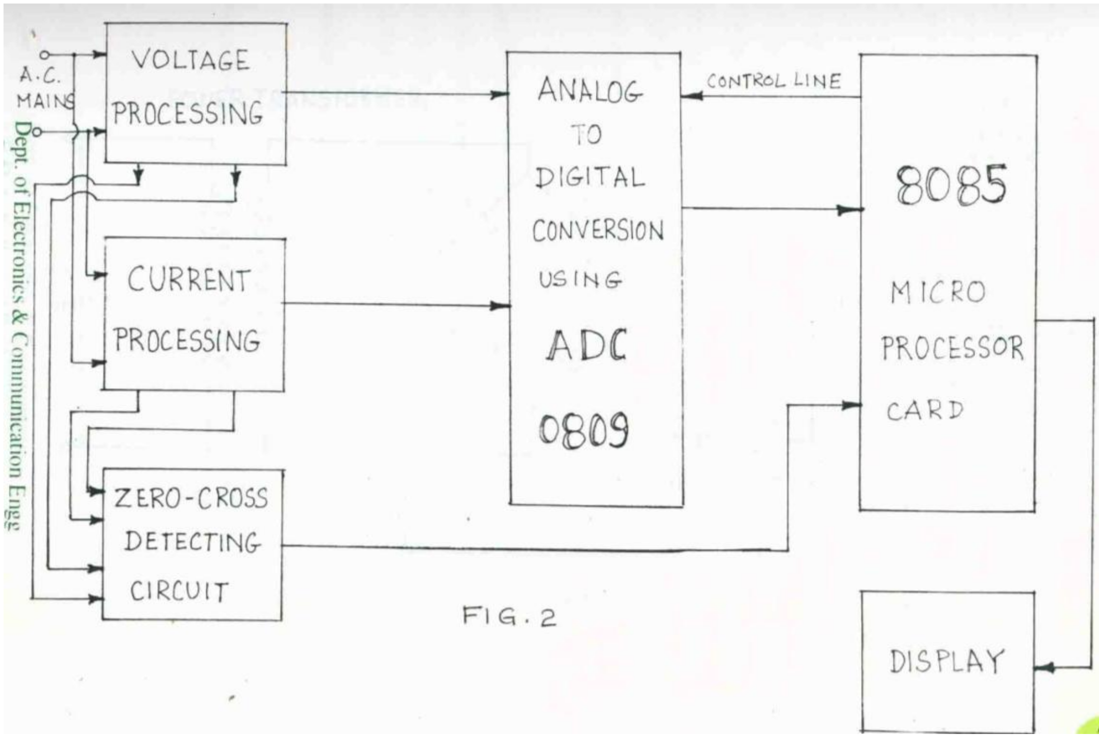

Figure 4: Basic modules of the Digital Energy meter

CE 1.3.2.1 DESIGN OF VOLTAGE PROCESSING MODULE:

With reference to Figure 4 the voltage processing module has been developed as described below.

Supply voltage can be measured by stepping down to a low value using a voltage power transformer and is then rectified using full wave bridge to remove any ripples. This is further attenuated using potentiometer and amplified to suit the signal requirements to 8085 chip. This is then converted to digital counter using Analog to Digital Converter (ADC)

CE 1.3.2.2 DESIGN OF CURRENT PROCESSING MODULE:

With reference to Figure 4 the current processing module has been developed as described below.

To measure the load current a current power transformer is used to step down in ratio of 12: 5. To make this suitable for further processing suitable resistor is used to convert the current to voltage equivalent. This provides the simulated voltage equivalent of the current.

CE 1.3.2.3 DESIGN OF POWER FACTOR PROCESSING MODULE:

With reference to Figure 4 the power factor processing module has been developed as described below.

The power factor can be measured by measuring the angle between the voltage and current and finding the cosine of the angle. This is done using zero crossing detectors. Suitable lookup table in software module is used to obtain the right cosine of the measured angle.

CE 1.3.3 DESIGN AND DEVELOP SOFTWARE

Software is basically to store the digitized values of the respective Voltage, Current and Phase in particular memory areas.

Suitable registers are used and assembly language is used to provide the necessary computations.

Typical registers, interrupt subroutines are used to obtain the V and I values and the equivalent Hex values are stored. Computed power is aggregated as per the provided time interval and the sum is displayed.

One typical flow chart used in the project is shown in Figure 5.

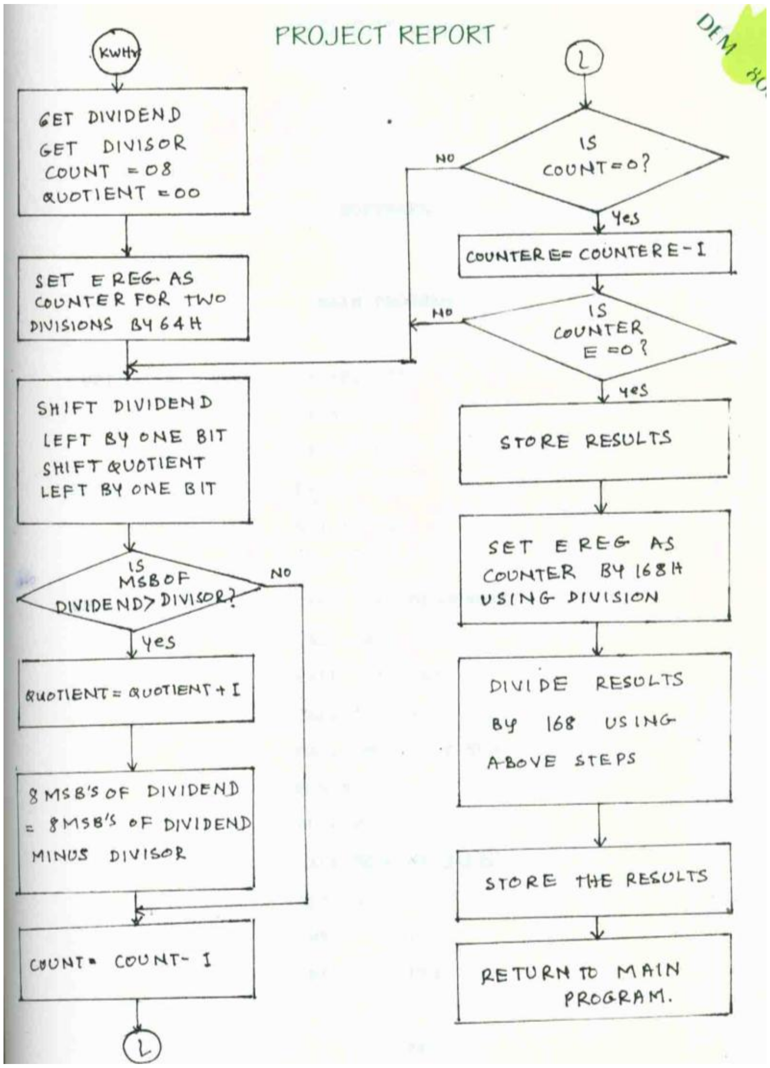

Figure 5: Flow chart demonstrating use of registers for KwHr subroutine

I used assembly language for the project and the sample steps are shown in figure 5. One code snippet I wrote is as below:

```
UP1     LXISP 1FE0
        LXIH, 0000
        LXIB, 0000
        LXID, 0000
        EI
        MVI A, 02
        SIM

UP      CALL 'KEY DEBOUNCE'
        CALL 'Ø' SUB
        CALL 'V' SUB
```

```
CALL 'I' SUB
CALL 'MULTIPLY SUB'
MOV M, A
PUSH H
CALL 'KWHR SUB'
CPI 99
JNZ UP
JMP UP1
```

Above code shows the main routine calling other routines and obtaining and storing results in the registers.

CE 1.3.4 MY TECHNIQUES AND STRATEGIES

1. Technical contribution: I had to study IEEE guides, analyze the current trends in Energy devices. I had to go through a dozen books from library and get the technical requirements of the needed chips and electronic components, their make and specifications.

2. Group involvement: Being responsible for overall success of the project I had to interact with Electrical and Mechanical department Heads and get the guidance and validation of the methodology used in arriving at accurate limitations in Electro Mechanical systems.

3. Knowledge sharing: I was involved in brainstorm sessions and had team involved in getting the best of each member. One example is working on the Microprocessor pins that needed good theoretical understanding of the chip pins and their significance.

4. Challenges faced: I had to persuade team to carry on experimenting and not to give up at any stage. I did face challenges in the project like at times I had to debug and find the root cause of non availability of outputs and no show of results during the trial runs. Also I had to re-etch the PCB and burn the EEPROM.

5. Reporting to Guide: I had been assigned to interact with guide and convey the recommendations to team. I did get expert guidance from our college staff especially the lab staff who were cooperative while we overstretched

6. Guiding team: I had to guide the team in certain areas like use of Printed circuit board design software. I had to spend few extra hours to learn it.

7. Time and cost management: I used the team funds reasonably and avoided costly remakes and purchases of chips like Processor chip. I had to finish the project in time and I did the planning and micro planning to retain the project on the right track. We did have an incident where a team member had overused the components and we had to share and pay for the excess bills we got.

8. Presentation in report format: I had to personally sit with the team and content writers to bring up the text, images and special symbols used in science formulas like Beta, Theta etc. I had to use Word processors and Engineering drawing materials to come up with good images

9. Demo to other teams: I had to practice internally and practice delivering a product demo to review team and external teams. I had to learn ways of presentation in limited time period.

CE 1.4 SUMMARY

My responsibility of design and implementation of the Digital energy meter was completed successfully. This provided me the confidence to face the real world and provide suitable design and solution to real world problems using Electronics**.**