**COMPUTER APPLICATION FOR INVESTIGATING THE DYNAMIC CHARACTERISTICS OF AC ELECTROMAGNETIC CONTACTORS**

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**18TH NOVEMBER 2005**

"I hereby declare that I have read this report and in my opinion her report is sufficient in terms of scope and quality for the award of the degree of Bachelor of Electrical Engineering (Industry Power)."

Signature : .....

Supervisor's name : Mrs. Aida Fazliana Bt Abd Kadir

Date : 9th November 2005

# COMPUTER APPLICATION FOR INVESTIGATING THE DYNAMIC CHARACTERISTICS OF AN AC ELECTROMAGNETIC CONTACTOR

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This Report Is Submitted In Partial Fulfillment Of Requirements For The Degree Of Bachelor In Electrical Engineering (Industry Power)

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November 2005

"I hereby declare that report is the result of my own work and all sources of references have been clearly acknowledged."

Signature : 

Name : Wirda Bt Abdul Wadus

Date : 9th November 2005

For my beloved parents, En. Abdul Wadus B. Mohd Taib and Pn. Mazenah Bt Hj. Mansor

## ACKNOWLEDGEMENT

I am greatly indebted to Allah swt on His blessing to make this project successful. The preparation of the report is a testimony to overcoming fixed work commitments, continental distances, and widely differing time zones to bring the project to fruition.

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I am sincerely appreciated all the guidance, co-operation and encouragement that they gave to me. I wish them will successful in their life and happy always.

# ABSTRACT

An original computer-controlled measurement system for investigating the dynamic characteristics of Ac electromagnetic contactor is present in this paper. The system was use to examine simultaneously dependencies of time related electromagnet coil current, electromagnet coil voltage, electric power supplied to electromagnet coil, voltage across contacts, acceleration, speed, path and kinetic energy of contactor moving element. Additional software allows diagrams of the following parameters to obtain maximum acceleration, maximum speed, and kinetic energy of contactor moving element, electric energy supplied to electromagnet coil and times typical of alternating current drive for selected values of the coil supply voltages. Results of the investigation enable also to take a view on such parameters of the design equipment as, for example, making time or rebounds of the contactor contacts. The system is very useful to verify the results of investigation of computer simulated contactor closing.

# ABSTRAK

Sistem pengukuran sebenar pengaplikasian komputer untuk mengkaji ciri-ciri dinamik bagi sebuah electromagnet sesentuh Au di persembahkan di dalam laporan ini. Sistem ini digunakan untuk mendapatkan perkaitan masa secara serentak terhadap arus gelung elektromagnet, voltan gelung elektromagnet, kuasa elektrik yang dibekalkan kepada gelung elektromagnet, voltan merintangi sesentuh, daya pecutan, kelajuan, laluan atau bukaan magnet, dan tenaga kinetik oleh elemen gerakan sesentuh. Tambahan perisian membolehkan gambarajah untuk setiap parameter berikut diperolehi: nilai maksimum dan minimum daya pecutan, nilai maksimum kelajuan dan tenaga kinetik elemen gerakan sesentuh, kuasa elektrik dibekalkan kepada gelung elektromagnet dan masa pilihan arus ulang alik pacuan elektromagnetik untuk nilai pilihan daripada sumber voltan gegelung. Hasil kajian juga membolehkan kita mengambil gambaran ke atas beberapa parameter rekaan peralatan seperti, membuat masa atau lantunan pada gerakan sesentuh. Sistem ini amat berguna untuk mengesahkan hasil keputusan kajian ketika simulasi komputer pada litar tutup sesentuh.

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# CHAPTER 1

# INTRODUCTION

This project deals to the development of measurement system in order to investigate more detail the dynamic characteristics of contactor, which operated by AC electromagnetic coil. There are two types of contactor, Ac and Dc contactor, but in this research, consider for Ac contactor. A programming in Labview developed to calculate the dynamic characteristics based on the performances of the contactor that obtained through measuring when it is operating. The measuring can be directly (in real time) read by the developed Labview application.

## 1.1 Background of project

This final project deals to the development of measurement system in order to investigate more details the dynamics characteristics of ac contactor, which operated by AC electromagnetic drive. A programming LabView developed to calculate the dynamic characteristics based on the performances of the contactor that obtained through measuring when it is operating. The measuring can be directly (in real time) read by the developed LabView application. Otherwise, a simulation of the Ac electromagnetic contactor will developed in the LabView application in order to get the performance data. In this project, the system records basic parameters of the

Contactor under test and its driving mechanism versus a value of the supplying voltage when the voltage switching on. Dynamical properties of a driving mechanism and characterized by such quantities as speed and acceleration of the moving element, its motion time, start delay time, which enable use to take a view on such parameters of the designed equipment, as for example, making time or rebounds of the contactor contacts.

Thus, in the project it had been performing the coil voltage, current coil and contact of contactor characteristics.

A program controlling the measurements and currently verifying the correctness of the recorded relationships was prepared. Time-related relationships stored on the disk are then processed and presented in graphical form as diagram following parameters versus time, electromagnetic coil current, electromagnetic coil voltage, and voltage across contacts.

## 1.2 Scope of the project

The project deals to development of measurement system in order to investigate the dynamic characteristics of AC electromagnetic contactor. The LabView software will be used in the project to developed calculation of the dynamic characteristics based on the performances of the data.

## 1.3 Objectives of project

The main objectives of this research is to develop a LabView programming, i.e computerized application in order to get the performance data. There will be small hardware if it is not ready equipment in the laboratory. It also to develop measurement system in order to analyze the characteristics of Ac

electromagnetic contactor. This project was used examine the responses of the contactor contact by using an oscilloscope and to analyze the response of contactor when various voltage supply is applied.

## 1.4 Methodology of the project

In order to finish this project, some methodologies have been use. There are two parts includes the literature study of the dynamic characteristics analysis of Ac contactor based on case study paper work and using the oscilloscope to see the contactor responses for comparing the results from the LabView software.

1. Literature Study

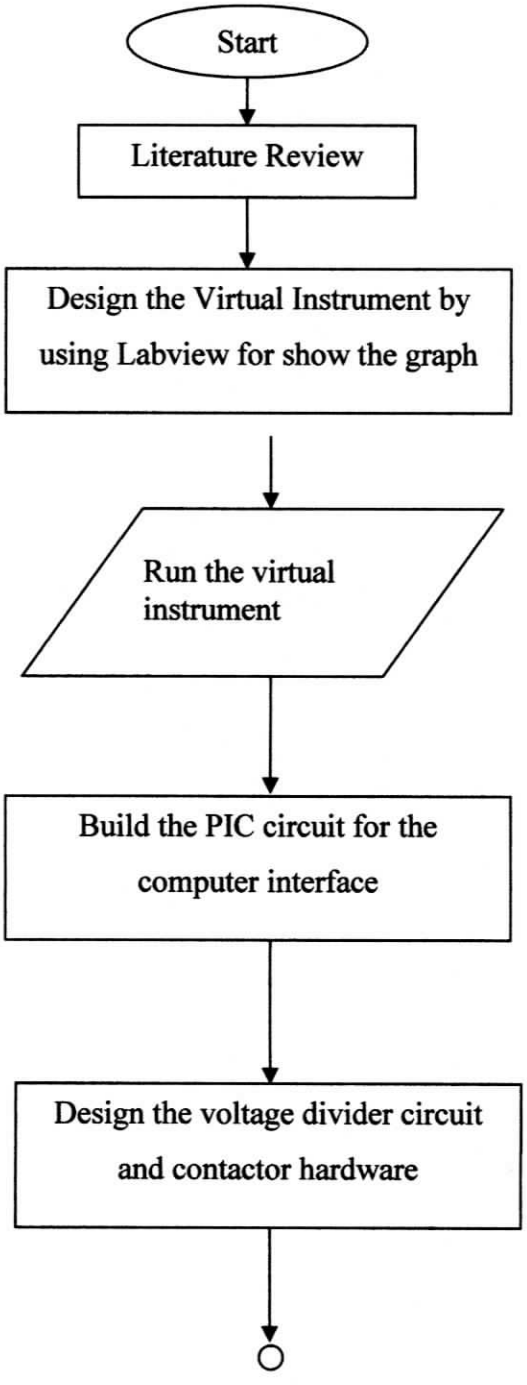
Based of paper work from Institute of Electrical Apparatus, Technical University of Lodz, Poland. In this paper work contains basic part of the measurement system for the contactor and the theoretical the characteristics of contactors with Ac electromagnet drive.

Based of paper work from Department of Electrical Engineering, ETSEIB-UPC, Barcelona, Spain. In this paper, it contains the study of Ac contactors during voltage sags.

Based of paper work by Poulo I. Kolterman, J.P Assumpcao Bastos, Sergio R. Arrudo, Brazil, conatins the model of Ac contactor elements and contactor description.

2. Project's Flowchart

The relevant flow chart or diagram below is the purpose to make the project smooth.



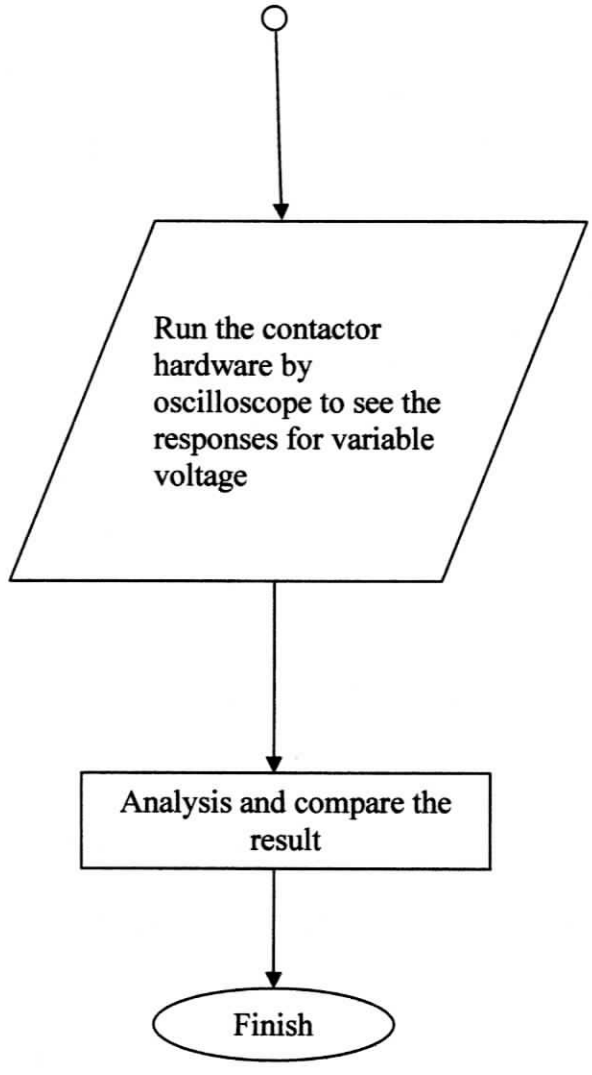



Figure 1-1: Project's Flowchart

## 1.5 Thesis organization

In this project report there have six chapters altogether. Chapter 1 gives some brief introduction and background about this project, the project objectives, scope of this project and the methodology of the project. This chapter also includes the report outline for this project.

The literature review in order to get an idea about the project will discuss in Chapters 2. In this chapter it will describes about the basic theory of dynamic characteristics of Ac contactor. It also briefly explains about the principle operation of the contactor contacts and the equation of the contactor.

In chapter 3, it describes the measuring system that using in the project. Then in chapter 4, it describes about the hardware and software development of the project.

Chapter 5 brings further discussion about the project, the results and analysis based on the results. In this chapter, it contains the experiment module and the results for the responses of the contactor under test.

In chapter 6, it contains the conclusion of the project and the recommendation for the future development.

# CHAPTER 2

# LITERATURE REVIEW

## 2.1 Introduction

Contactors are devices composed by a set of springs and a magnetic circuit. In these devices, mechanical and electrical parts coupled and it is necessary to evaluate with good precision the electrical parameters, specially the inductances. The device is voltage fed through a sinusoidal source, the dynamic force equation considered, and a method for numerical integration adopted. A Finite Element (FE) method used to determine the parameter used in an equivalent circuit. When a voltage applied to the coil, electromagnetic force attracts the mobile part toward the fixed part in order to close the external contacts of the device. Although the structures are well known, an accurate calculation of their movement is difficult, because it is necessary to evaluate the variable reluctances. Ac contactors have copper short-circuit rings, and its magnetic effects have to be composed with the action of the principal coil.

## 2.2 Equations Of Ac Contactor

Figure 2-1 below presents the contactor used. It is composed by the coil, the magnetic circuit, a short-circuit ring, a spring set and the external contacts.

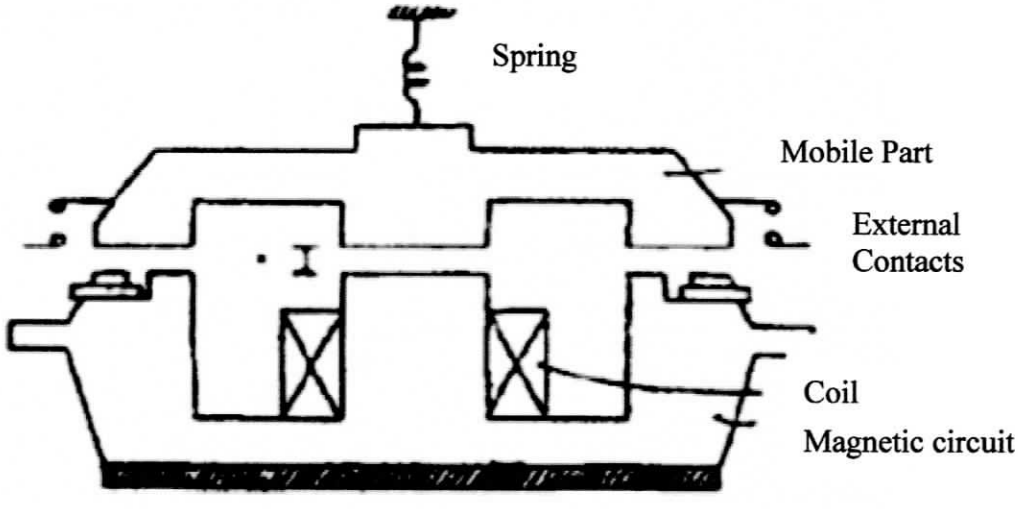



Figure 2-1: Ac Contactor Elements

### 2.2.1 The main equation for the FE method is

The equation of the FE method is

$$\text{Curl } v \text{ curl } A = \text{Je} \qquad (2.1)$$

Where $A$ is the vector potential, $Je$ is the external current and $v$ is the reluctivity.

### 2.2.2 The electrical equations are

The electrical equation of the contactor model is

$$U = r_1 i_1 + N_1 d\varphi_1/dt \ , \quad 2r_2 i_2 + d\varphi_2/dt \qquad (2.2)$$

Where φ1 : flux linkages per turn of the exciting coil,

Φ2 : the addition of the flux linkages per turn corresponding to both shading ring coils.

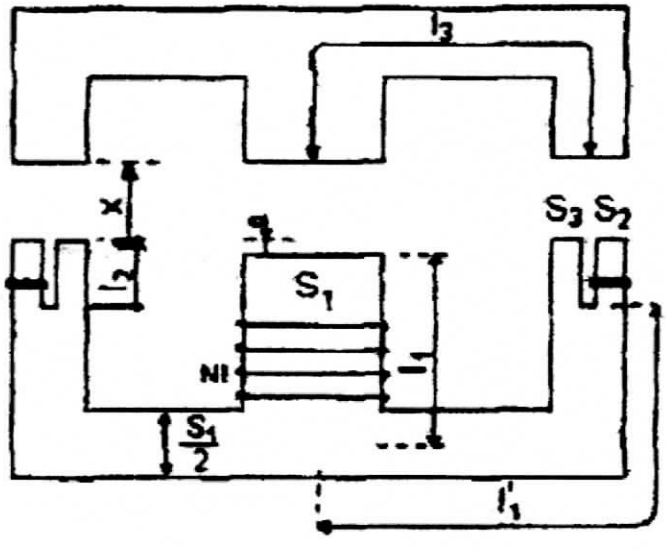



Figure 2-2: Geometry of Contactor

The geometry of the modeled AC contactor shown in Figure2-2. The figure2-3 and figure 2-4 shows the considered magnetic circuit by taking into account the symmetry of the model.

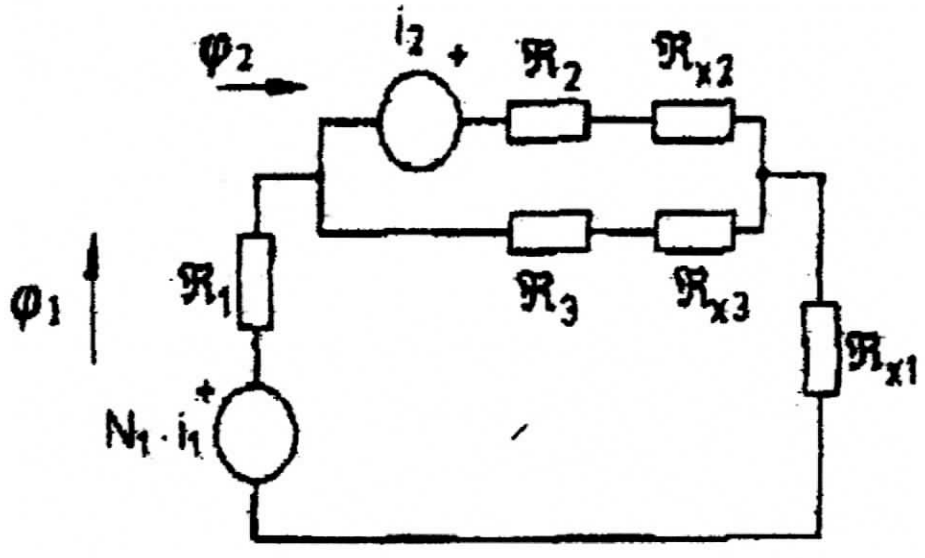



Figure 2-3: Magnetic Circuit

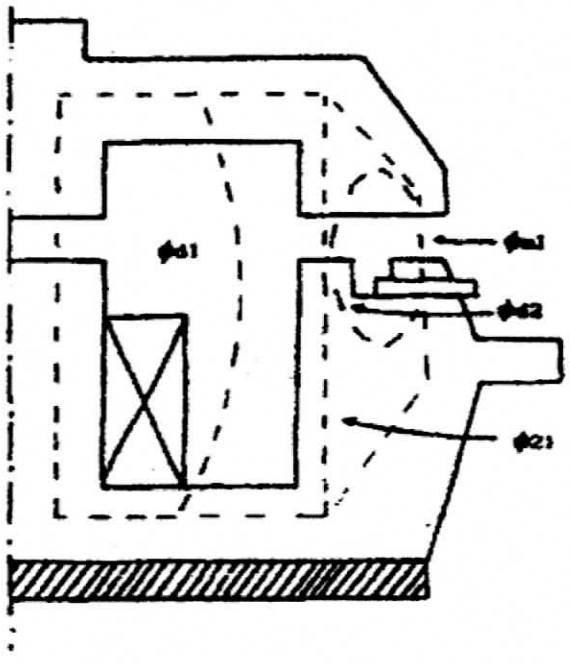


Figure 2-4: Magnetic Circuit