

**DESIGN AND ANALYSIS OF AUTOMATED INSPECTION
SYSTEM FOR RELAYS FAULT DETECTION**

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UNIVERSITI TEKNIKAL MALAYSIA MELAKA

**DESIGN AND ANALYSIS OF AUTOMATED INSPECTION
SYSTEM FOR RELAYS FAULT DETECTION**

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**This report is submitted in partial fulfilment of the requirements
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APPROVAL

I hereby declare that I have read this thesis and in my opinion this thesis is sufficient in terms of scope and quality for the award of Bachelor of Electronic Engineering with Honours.

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DEDICATION

Specially dedicated to my beloved family and friends for supporting me to make the work done. Thanks for Mr Michael Lim, supervisor Dr. Norhashimah bte Mohd Saad and co-supervisor Dr. Wira Hidayat bin Mohd Saad to giving the guidance throughout the process to finish my final year project.

ABSTRACT

Relay is an electrical switch that consists of coil and movable iron armature and contactor that act to open and close the switch. Normally the relay will degrade after operated for certain period of time. The conventional way to diagnose the relay condition is a time consuming and difficult. The aim of this project is to provide a solution to overcome the difficulty of testing a relay using the conventional way. The embedded system is designed to be able to perform the functional test and parameter test of the relay. Functional test is done to determine all the relay contacts whether it is function or not. Parameter test is done to find every pick-up and drop out voltage for all contact of the relay. The results obtain from the system need to be precise and accurate, and faster than the conventional way. The project utilize a liquid crystal display (LCD), Arduino board, keypad, device under test (DUT) adapter and interfaced board. The relay is plug into the suitable DUT adapter and then the DUT adapter in plug into the interfaced board. The LCD shows the menu and the result of the test. The keypad is to allow the user to select the options for relay testing. Lastly, the relay tester is successfully construct and able to assist in detect the faulty relay with less time taken and achieve 100% accuracy in functional test and 85% in parameter test.

ABSTRAK

Relay adalah sejenis suis elektrik yang mengandungi gegelung wayar kuprum dan kontak Saklar. Cara konvensional untuk diagnosis keadaan relay rosak yang amat memakan masa dan sukar. Tujuan projek ini adalah untuk menyediakan penyelesaian yang boleh mengatasi kesukaran untuk menguji relay dengan menggunakan cara konvensional. Perkakasan dan perisian perlu direka bentuk dan menghasilkan untuk memberi tumpuan kepada masalah yang dihadapi ketika melakukan ujian manual pada relay. Sistem tertanam perlu direka bentuk untuk dapat melaksanakan ujian fungsi, dan ujian parameter. Ujian fungsi adalah untuk menentukan semua hubungan relay sama ada berfungsi. Ujian parameter adalah untuk mencari setiap voltan pikap dan jatuh untuk semua penyambungan relay. Hasil yang diperolehi dari sistem perlu tepat, dan lebih cepat daripada cara konvensional. Projek ini mengandungi paparan LCD, Arduino, papan kekunci, penyesuai DUT, dan papan perhubungan. Setiap komponen memainkan peranan penting. Relay adalah pasang ke penyesuai DUT yang sesuai dan kemudian penyesuai DUT di pasang ke dalam papan perhubungan. Paparan LCD menunjukkan menu dan hasil ujian. Dengan beberapa butang dalam pad kekunci, ujian akan dilakukan secara automatik. Akhir sekali, alat menguji relay dapat dihasilkan dan dapat mencapai 100% untuk ujian fungsi dan 85% untuk ujian parameter.

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LIST OF SYMBOLS AND ABBREVIATIONS

NO	:	Normally open
NC	:	Normally close
DUT	:	Device under test
PCB	:	Printed circuit board
LCD	:	Liquid crystal display
IC	:	Integrated circuit
TTL	:	Transistor – transistor logic
ATE	:	Automated test equipment
ZIF	:	Zero insertion force
ADC	:	Analog to digital converter.

CHAPTER 1

INTRODUCTION

This chapter discuss about the project's background, objectives, scope of the project, problem statement and project planning.

1.1 Project Background

Relay is an electrical switch that consist of three component which are coil of copper wire wrapped around soft iron core, movable iron armature and contactor as open or close switch [1]. Relays are commonly having one or more poles that act as a switch when it being activated. Other types of relays are commonly come with one or more poles. Each switch in the relay controls contact between one or more circuit poles to provides electrical power between two or more circuits. Common nomenclatures of the relays are single pole-singe throw relays, single pole-double throw relays, multiple pole-single throw relays, and multiple pole-multiple throw relays [2].

Typical construction relay includes a housing cover for dust and moisture protection for the internal circuit consisting of an electromagnetic switch coil [3]. The operation of the relay can be viewed by applying voltage to the coil. When the current flow through the coil, it generates a magnetic field that will attract the contactor to either close or open the gap between iron armature and contactor. The relay offers a very useful function when it comes to controlling the high-power load, such as motor with the low power devices like microcontroller. The relay isolates the microcontroller board from the high voltage circuit to prevent it from burning out.

Pick-up and drop out voltage of the relay are important characteristics to determine certain designs required to function within a certain voltage range. Pick-up voltage is defined as the voltage on a de-energized relay is increasing until a certain value, equal or less till its starts to function. The drop out is defined as the voltage on an operated relay is decreasing until a certain value at or above which all contacts must revert to their unoperated position [4]. To design a proper circuit with the relay in it, pick-up and drop out voltage must be taken into consideration to ensure that the switching mechanisms are working well with the voltage range applied to the coil [5]. It is widely use in the automatic test equipment (ATE) for testing IC in production line [27].

1.2 Project Objectives

The aim of this project is to design a device to provide a convenient way for testing the pick-up and drop out voltage for different types of relay and it shortens the testing time. In order to achieve that, below are the objectives needed to be aligned:

1. To design and analysis of automated inspection system for relay faults detection.
2. To design a plug in and out device under test (DUT) adapter for testing different types of relay.
3. To minimize the time taken for testing the relay's pick-up and drop out voltage.

1.3 Problem Statements

In the event of faulty operation of the electronic equipment, it is custom to locate the printed circuit board, or group of boards, which contain the defect. In circuit boards which carry a limited number of plug-in discrete circuit components, such as diodes, transistors, and relay. Although test equipment is available to identify defective components on a removed board relatively simple, still there are no available equipment's that can test the relay pick-up and drop out voltage accurately with ease and time efficient.

Relay is a very common electronic component, widely used in electronics circuit. In an electromagnetic relay, electric current flows or be interrupted from flowing through an electric circuit by opening and closing a contact [6]. With an ever-increasing use of relays in present day devices, it may be required to test the relays to determine a functioning relay [7]. The electromagnetic relay often needed to be tested its electrical performance parameters, to assess whether it satisfies the requirements before being put into use [8]. Conventionally, testing electrical relays is accomplished with devices incorporating an analog meter. The electromagnetic manufacturer production DC relay needs to produce electromagnetic relays more than a hundred

times of switch tests to verify performance of the electromagnetic relay [9]. Specifically, to test a relay, a source of variable power is connected across the coil of the relay and the source voltage is increased gradually. The analog meter is used to give an indication of the amount of current passing through the coil. When sufficient current is supplied to the coil, the electromagnetic field created by the coil causes the armature of the relay to shift or "pick-up" from its original position, thereby closing the relay switch, as is conventional. Relay's life span is short due to the inconsistent opening and closing the mechanical switch [10]. In result, the parameter pick-up and drop out voltage are often failed by the relay. It could happen when oxidation occur to the switching contact of after relay is operated for certain period [11]. Therefore, the specification and the functionality of the relay will degrade as the time passed, but that could also happen to the new relay too. If one relay pick-up or drop out runs out of its specification, it will either failed to close or open the switch with the desire voltage range supply to its coil. With this failure, the possible issue could be happen are the short circuit or unwanted open circuit and eventually causing the board to fault. Besides, the method to test the pick-up and drop out voltage are not easy and quite time consuming.

The instrument to test the relay pick-up and drop out voltage are just the power supply unit and a multimeter, but the way to test it are very hard to be done alone. Troubleshoot in Load board and DUT board often face problems related to the relay. Load boards typically use relays, such as pin-through-hole relays, to perform switching to minimize signal distortion. These relays are expensive and have a limited life span. Faulty relays are the main cause of load board and test failures, so the load board relays are replaced at regular intervals, whether they are faulty or not. The issue encountered by the relay is that the pick-up and the drop out voltage do not meet the

specification with respect to its datasheet. Usually it takes 3 to 5 minutes to test a 2 form C type relay, and normally there are more than 50 relays in the load board. (Refer to the Figure 1-1 : Load Board) It will take a lot of times to check the entire relay one by one in the manual way.



Figure 1-1 : Load Board

1.4 Scopes of Project

This project cover for two major part which is hardware and software implementation, for the hardware part, the Arduino Uno incorporates with the VI board, interfaced board, DUT adapter to test the pick-up and drop out voltage of the relay. Arduino Uno act as the brain to control and decide the operations of the tester. The DUT adapter is allow the relay fit into the board to perform testing, while the VI

board supply the voltage to the DUT adapter's coil terminal. This tester only cover relay with terminology Single pole double throw and below voltage rating 12Vdc.

For software part, the programming code is developed under Arduino IDE. The test program will only write to cover the pick-up and drop out voltage.

By combining both software and hardware, the tester will not only be able to perform in a faster pace but will also easy to be carried anywhere because of its mobility.

1.5 Project significance

Due to the relay's short life span it is often causing testing process and would have to perform troubleshoot. The duration of troubleshooting must be as fast as possible, because the relay are widely use in the load board of automated test equipment thus company would lose their money if the testing process is stop for a long period of time. Therefore, the relay tester can be help in shortening the troubleshooting time and by that the profit of the company can be increase gradually and reduce the stress of the technician whom perform troubleshooting.

According to [12], the issue about e-waste are getting very serious and the awareness must to be emphasized to everyone. With the help of the relay tester, the rate of load board getting scrap can help in reducing the e-waste and create a greener environment.

1.6 Chapter review

In chapter 1, the content tells about the introduction of the relay fault detection system. It's a short description of the problem statement about the industry that related to the relay faulty issue and the objective scope were listed inside this chapter.

Literature review in chapter 2, briefly tells about what the guidance for are building up the projects. It contents some related material to as the reference that help to achieve the objectives in this project. The topic that will be review are the IC tester using PIC controller, IC tester using 89s52 microcontroller and relay.

In chapter 3, the flow chart of the methodology was shown. It briefly discusses what are the components required to build up the relay tester. The consideration and problem in building the relay test is discussed in this chapter.

Chapter 4 tells about the result and the discussion of the project. The relay tester is made and undergo some experiment to test the performance and the graph of the experiment result show the reliability of the relay test.

Lastly, in chapter tells about conclusion and the future works that can be improve the projects. The improvement can be done by improve the relay tester be more adequate by adding the latest technology features like wireless module, mobile applications to it.

CHAPTER 2

LITERATURE REVIEW

Literature review is a topic that searched of knowledge relate to the project including thesis, article and the methodological contribution. In this chapter, the reviews of an articles and journals to learn and understand the knowledge that needed to complete the project including Arduino, electronic component tester, and relay. And the projects which is having common feature with this project will also discuss in this chapter.

2.1 IC tester using PIC controller

In the field of IC manufacturer, a department called the final test department is responsible for testing the functionality of the IC produce by them. This department needs to make sure every IC they have produced are tested and in good condition before sending it to their customer [13]. The unit price of tester is very