"I declare that I have read this thesis and in my opinion, it is suitable in terms of scope and quality for the purpose of awarding a Bachelor Degree in Electronic Engineering (Industrial Electronic)."

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Date: 18TH MAY 2006

DIGITAL IC TESTER DRIVEN BY PIC16F877A IMPLEMENTING EXHAUSTIVE TEST METHOD

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This project report is submitted in part fulfillment of the requirements of the award of a degree in Bachelor of Electronic Engineering (Industrial Electronic)

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"Hereby, I declare that this thesis is a result of my own research and idea except for works that have been cited clearly in the references."

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Dedicated to those remembered and beloved...

Especially for parents, brothers and sisters.

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ABSTRACT

Testing is a critical part in IC manufacturing. The purposes of IC testing are to ensure IC components and connections between them are in good condition for uses. Hence the output yield from it's as well as had estimated theoritically. This tester is uses the flexible programmable features of PIC16F877A microcontroller for many applications. The microcontroller was using as a central processing unit for 1 keypad, 4 7-segments displays, and input and output IC under test via a ZIF socket. Keypad was function as a medium for entering IC series number. 7-segment display was function as a platform for displaying IC under test series numbers and results of tests. ZIF socket was function as a platform to place IC under test, and as a channel for input and output IC under test to be connected to microcontroller as central processing unit. The testing method used is exhaustive method. Through this method, all input combinations are considered for tests. For this project, IC might be tested have 2 inputs so that 4 input combinations been considered for each test.

ABSTRAK

Pengujian ialah satu proses yang kritikal dalam pembuatan IC. Tujuan pengujian ialah untuk memastikan komponen-komponen IC dan sambungan-sambungan diantara komponen adalah dalam keadaan baik untuk digunakan dalam aplikasi tertentu. Dari itu, keluaran bagi IC tersebut dapat dipastikan seperti yang dijangka secara teori. Penguji IC ini menggunakan ciri-ciri fleksibel pengawal mikro PIC16F877A yang boleh diprogramkan untuk pelbagai aplikasi. Pengawal mikro ini digunakan sebagai pusat pemproses bagi 1 papan kekunci, 4 paparan 7-segmen, dan masukan serta keluaran IC diuji melalui 1 soket ZIF. Papan kekunci berfungsi untuk masukan nombor siri IC. Paparan 7-segmen berfungsi untuk memaparkan nombor IC dan keputusan ujian. Soket ZIF berfungsi sebagai tempat IC yang hendak diuji diletakkan, dan sebagai saluran untuk masukan dan keluaran dihubungkan kepada pengawal mikro. Kaedah pengujian yang digunakan ialah kaedah meletihkan. Melalui kaedah ini, semua kombinasi masukan dipertimbangkan untuk ujian. Untuk projek ini, IC diuji mempunyai 2 masukan jadi, terdapat 4 kombinasi masukan dipertimbangkan untuk setiap ujian.

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LIST OF ABBREVIATIONS

PIC16F877A	-	Microchip Microcontroller 16F87x Series
IC	-	Integrated Circuit
TTL	-	Transistor-Transistor Logic
I/O	-	Input/Output
ZIF	-	Zero Insertion Force
PC	-	Personal Computer
DTL	-	Diode Transistor Logic
GND	-	Ground
R	-	Resistor
ATE	-	Automatic Test Equipment
CMOS	-	Complementary Metal-Oxide Semiconductor
MCU	-	Microcontroller Unit
RAM	-	Random Access Memory
XT	-	Crystal Oscillator
SFR	-	Special Function Register
MCLR	-	Master Clear
EEPROM	-	Electrical Erasable Programmable Read Only Memory
CPU	-	Central Processing Unit
ALU	-	Arithmetic Logic Unit
H	-	High
L	-	Low
PCB	-	Printed Circuit Board

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CHAPTER 1

INTRODUCTION

This chapter will explores about project introduction, project objectives, problem statement and scope of project.

1.1 BACKGROUND

In IC manufacturing process, testing is the most critical part in determining digital circuit efficiency. There are continuous efforts to effect cost reductions, upgrade quality and improve overall efficiencies. In the electronics industry, with a dramatic increase in circuit complexity and the need for higher levels of reliability, a major contributory cost of any product can be in the testing. However, in the real world we have to recognize that no process can be perfect, so that testing.

This IC tester system has been designed to carry out exhaustive tests. There are a lot of common chips used in nowadays projects but in particular project, the PIC16F877A micro controller is used. This microchip microcontroller unit is used as well as to support the pins number need to construct the IC tester that have a keypad,

4 7-segments display, a 14 pins ZIF socket, and 4 switching transistor to controlling 4 7-segments displays as peripheral devices needed to completes the tester.

For IC testing process using this tester, the user needed to place the IC would be tests on ZIF socket, apply the power to the tester, and key-in the IC under tests series numbers. IC series numbers will be displayed on 7-segments displays devices. To start the testing, the user needed to press the start button. Wait for a moment for built in test process, and finally the result of test will be displayed on the 7-segments displays devices. The testing end and to start another session, steps above are repeated.

1.2 PROBLEM STATEMENTS

Bipolar TTL IC is useful in industry causes optimum capabilities for more applications such as in telecommunication systems, traffic lights, computers, individual projects etc. Thus, the uses of good IC are so important so that all those systems will functions as needed, fulfill the purposes of its manufacturing goals and yields as targeted theoretically.

By design and accomplish this digital IC tester, hopes all problems and goals as stated will be overcomes and achieved respectively.

1.3 PROJECT OBJECTIVES

The objectives of this project are to design a digital IC tester with specifications as follows:

i. A PIC16F877A microcontroller-based tester. Using the advantages of PIC16F877A features to ensure this tester is beneficial.
ii. Using the exhaustive test method. This method of tests makes sure all possible faults are tested. Thus, the result of tests is higher acceptability.
iii. Capable to test in purely functional manner the 7400, 7403, 7408, 7409, 7432, 7437, 7438, 7486, and all their compatible logic families IC respectively.

1.4 SCOPE OF PROJECT

This project will focus on implementing exhaustive test method by using PIC16F877A as central processing unit. This project consists of two components that are the development of hardware of the IC tester, and the development of software that is an IC testing program.

For the hardware development of this tester, a circuit comprise of a 3x4 keypad used by user to enter the IC series number, 4 7-segments displays to display the IC series numbers that have been entered by user and also to display the test result, a ZIF socket to place IC under test, a circuit for the microcontroller in expanded mode is developed and others component like capacitors and transistor needed for this project stabilize and function properly.

For the software development of this tester, the program written would be able to control all the hardware parts. Meaning that, all the I/O being used in this tester is totally software controlled. The program written will also be able to generate Exhaustive Test Vector pattern to test the IC. The fault-free output look up table of all ICs included in this project scope will be parts of the program also. The look up table is used for the purpose of comparing the test result to determine whether the IC under test is function properly or defects.

This IC tester will functional to operate in frequency range of 1MHz till 4MHz depends on the microcontroller peripheral set up and programming. This IC tester is capable to tests functionality a lot of TTL IC. The IC types have been tested by this tester are:

i. 7400 – Quad 2-input NAND gates
ii. 7403 – Quad 2-input open collector NAND gates
iii. 7408 – Quad 2-inputs AND gates
iv. 7409- Quad 2-input open collector AND gate
v. 7432 – Quad 2-input OR gates
vi. 7437- Quad 2-input NAND buffer
vii. 7438- Quad 2-input open collector NAND buffer
viii. 7486 – Quad 2-input XOR gates
ix. TTL 74 series compatible with all have been listed– 74, 74LS, 74S, 74ALS, 74AS.

Figure 1.1 shows a basic block diagram of designed IC tester in this project. That Figure depicts the combination of hardware developments and software developments of this IC tester project.

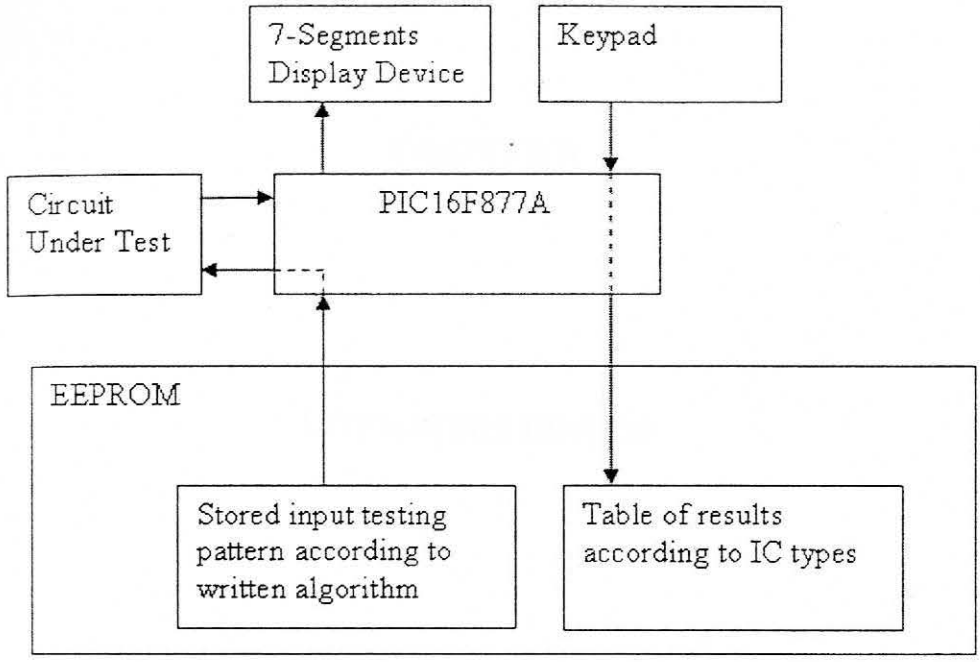

Figure 1.1: Basic block diagram of the designed IC tester

CHAPTER II

LITERATURE REVIEW

This chapter will discuss about transistor-transistor logic, types of faults, types of testing method those considered for this project, and about the PIC16F877A microcontroller features and architectures.

2.1 TRANSISTOR-TRANSISTOR LOGIC

Transistor-Transistor Logic, TTL refers to the technology for designing and fabricating digital integrated circuits that employ logic gates consisting primarily of bipolar transistors. It overcomes the main problem associated with Diode Transistor Logic, DTL i.e. lack of speed. [5]

Basic gate logic used for TTL IC is a NAND gate. Figure 2.1 is the schematic diagram for TTL NAND gate. The input A and B to a TTL circuit is always through the emitter of the input transistor, which exhibits a low input resistance. The base of the input transistor is connected to the +5V, which causes the input transistor to pass an amount of current when the input voltage to the emitter is logic '0'. Letting a TTL

input 'float' (left unconnected) will usually make it go to logic '1', but such a state is vulnerable to stray signals, which is why it is good practice to connect TTL inputs to Vcc using 1 k? pull-up resistors. [5]

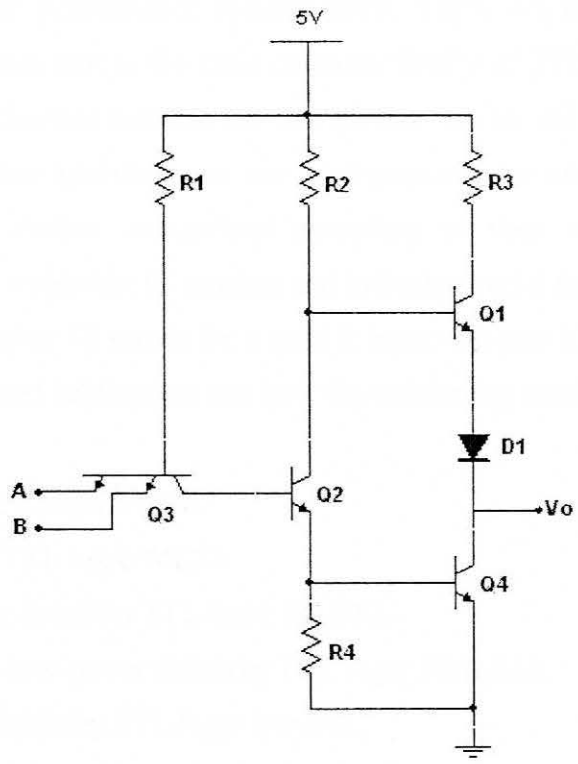

Figure 2.1: Basic 2 input TTL NAND gate with totem pole [2].

2.1.1 TTL Subfamilies

TTL ICs are grouped according to families. ICs that belong to the same family contain similar performance specifications. There are two major TTL IC families: the 7400 series that is the most common family of TTL ICs and the 5400 series of ICs. The difference between the two IC families is: the 5400 series of ICs are fabricated to higher specifications are used primarily in military applications. Most TTL ICs are further categorized according to their subfamilies. These subfamilies are listed within the IC number and indicate special features that the chip may contain. The number 32 stands for a quad 2 input OR gate IC. Listed below are the most commonly used subfamilies and how the numbering would appear on an IC.

i. S=Schottky TTL logic 74S32.
ii. L=low-power TTL logic 74L32.
iii. LS=low-power Schottky TTL logic 74LS32.
iv. ALS=advance low-power Schottky TTL logic 74ALS32.
v. AS=advance Schottky TTL logic 74AS32.
vi. F=FAST Fairchild Advanced Schottky TTL logic 74F32.
vii. H=high speed TTL logic 74H32.

Schottky TTL IC is fabricated using Schottky transistors and diodes. These devices normally do not go into saturation and therefore provide faster switching times. The low-power power ICs operate at less of a power drain than the normal IC's.