MC68HC11 MICROCONTROLLER BASED UNIVERSAL MEMORY PROGRAMMER

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"I hereby acknowledge that the scope and quality of this thesis is qualified for the award of the Bachelor Degree of Electrical Engineering (Electronics)"

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ABSTRACT

Memory product is an essential component for all microcontroller and microprocessor system. The high demand towards memory product has tremendously promoted the development of various types of memory product in the market such as the EPROM, EEPROM, and NVRAM. All these memory products require a programming stage in order to be used in the microprocessor and microcontroller system. The programming stage involves the storage of object file codes onto the memory devices using a memory programmer and these codes can be retrieved and read by the microprocessor and microcontroller during its operation. Therefore, memory programmer is a crucially important device for all microprocessor and microcontroller users. However, most memory programmers are limited to program non volatile ROM such as PROM, EPROM and EEPROM only. Thus, NVRAM users need to develop their own programming coding to program NVRAM. This, undoubtedly, is a setback to potential NVRAM users. For this reason, a universal memory programmer is designed to support various types of memory products including the fast emerging NVRAM. In addition, the programmer can support various object file loading to support a wide range of microprocessor system available in the market. As a result, the MC68HC11 microcontroller based universal memory programmer (UMP11) can provide an all-in-one solution to the users for the programming of their memory products.

ABSTRAK

Produk ingatan adalah satu komponen utama dalam sistem mikro pemproses dan pengawal terbenam. Permintaan yang tinggi terhadap produk ingatan meningkatkan perkembangan produk ingatan serta pengeluaran produk baru seperti EPROM, EEPROM dan NVRAM. Semua produk ingatan perlu melalui proses pengaturcaraan sebelum digunapakai dalam sistem mikro pemproses dan pengawal terbenam. Proses pengaturcaraan ini melibatkan penyimpanan kod fail objek ke dalam produk ingatan dengan menggunakan pengatucara ingatan. Kod tersebut akan dibaca dan diproses oleh mikro pemproses dan pengawal terbenam semasa operasi. Oleh itu, pengaturcara ingatan adalah perkakas yang amat penting kepada semua pengguna mikro pemproses dan pengawal terbenam. Walaubagaimanapun, kebanyakan pengaturcara ingatan hanya terhad kepada pengaturcaraan produk ingatan ROM seperti PROM, EPROM dan EEPROM. Ini menyebabkan pengguna NVRAM perlu menyediakan kod program tersendiri untuk mengaturcara produk ingatan NVRAM. Ini pastinya menjadi satu halangan kepada bakal pengguna NVRAM. Oleh sebab itu, satu pengaturcara universal dibina untuk memberikan sokongan pengaturcaraan kepada pelbagai jenis produk ingatan termasuk NVRAM yang hangat di pasaran. Selain itu, pengaturcara tersebut mampu membaca pelbagai jenis kod fail objek untuk menyediakan sokongan kepada pelbagai jenis mikro pemproses dan pengawal terbenam yang berlainan dalam pasaran. Secara keseluruhan, “MC68HC11 microcontroller based universal memory programmer” (UMP11) boleh menyediakan satu penyelesaian keseluruhan bagi pengguna dalam pengaturcaraan produk ingatan mereka.

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LIST OF ABBREVIATIONS

UMP11	MC68HC11 Microcontroller Based Universal Memory Programmer
ROM	Read Only Memory
PROM	Programmable Read Only Memory
EPROM	Erasable Programmable Read Only Memory
EEPROM	Electrically Erasable Programmable Read Only Memory
RAM	Random Access Memory
NVRAM	Non Volatile Random Access Memory
Rx	Receiving Signal
Tx	Transmitting Signal
DIP	Dual In-Line Package
PLCC	Plastic Leaded Chip Carrier
I/O	Input and Output
GND	Ground
MOS	Main Operating System
VB	Visual Basic
GUI	Graphical User Interface
CPU	Central Processing Unit
LED	Light Emitting Diode
ASCII	American Standard Code for Information Interchange
CMOS	Complementary Metal Oxide Semiconductor
PCB	Printed Circuit Board
DC	Direct Current

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CHAPTER 1

INTRODUCTION

1.1 Background

In this era of advanced technology, the computers have taken their place in many sectors of our daily life, such as the telecommunication devices, automobile and home entertainment system. A computer composes from a microprocessor, and a memory, in which the microprocessor executes instructions and read data from the memory [1]. The notion of computers usually categorizes them as 'data processor', to perform numerical operations with inexhaustible competence.

The computers of different breed in a more subtle context performing tasks in an efficient, quiet, and even humble manner, their presence are often unnoticed. As a central component in many consumer products, the computer is used in supermarket inside cash registers and electronic scales; at domestic houses in microwave ovens, alarm clocks, and washing machines; and in play toys, cell phones, and home entertainment system. The computers are performing 'control' function by interfacing with the 'real world' to monitor the conditions and to turn the devices on and off [2].

In general, computer can be classified into various categories. One of the most widely used are the microprocessor and microcontroller. Microprocessors and microcontrollers are often found in many applications. It is difficult to imagine the absent of microprocessor and microcontroller in the present world full of electronic tools. Both the microcontroller and microprocessors require memory products in order to perform their task efficiently. The non-volatile memory product is crucially important as it is specially designed to withhold the data stored even during power failure. In order to fulfill the demand and needs of the market, various types of non-volatile memory products have been developed, such as Read Only Memory (ROM), Programmable Read Only Memory (PROM), Erasable Programmable Read Only Memory (EPROM), Electrically Erasable Programmable Read Only Memory (EEPROM), Non Volatile Random Access Memory (NVRAM), and FLASH Memory.

All these non-volatile memory products require a programming stage in order to be used in the microprocessor and microcontroller system. The programming stage involves the storage of object file or data onto the memory devices and this data can be retrieved and read by the microprocessor and microcontroller during operation. As a result, a memory programmer is crucially important device for all microprocessor and microcontroller user to program the data onto their memory products.

1.2 Problem Statement

The non-volatile memory products need to be programmed with the object files which contains all the instructions before capable to perform in the microprocessor or microcontroller system. Unfortunately, the current programmers are unable to program NVRAM devices. For this reason, NVRAM users need to develop their own programming coding to program NVRAM. This undoubtedly is a

tedious task and serves as the major setback for the potential NVRAM users. Therefore, the high demand towards non-volatile memory products especially NVRAM shows the needs of a universal memory programmer which can provide an all-in-one solution to the non-volatile memory products including the fast rising and high demand NVRAM.

1.3 Objectives

The objective of the project is to design a prototype of MC68HC11 microcontroller based universal memory programmer (UMP11). The aim of the project is to develop a system that capable of downloading various object code files into various types of memory product including NVRAM. The design must be cost-effective and easy to operate. For this reason, the project is designed in graphical-oriented mode to provide a user-friendly environment.

1.4 Scope of Project

In order to achieve the objective of the project, several scopes have been outlined which covers both hardware and software implementation:

- Develop a MC68HC11 microcontroller based system that capable to download the object file from the PC into the memory product.

- Design the programmer that able to support different type of memory products.

- Design the programmer to support various object files such as Intel Hex and Motorola S-Record.

- Develop GUI based programming tool to be used with the programmer.

- Develop a test bed for the programmed memory devices.

1.5 Thesis Outline

This thesis consists of six chapters. The contents of each chapter are summarized as followed.

In Chapter 1, the background of the project is introduced. It is followed by the introduction of memory products in market. The objectives of project will be elaborated and the scopes of project that covered throughout the project will be listed.

In Chapter 2, the literature review which covers all the research and studies contributed in related area are elaborated and explained in details.

In Chapter 3, the hardware design and circuitry of the project will be explained in a technical approach. This includes detailed explanation on hardware design for each module.

Chapter 4 discusses the software development of the project. This includes the introduction on the Visual Basic. The software operations of the project will be explained with support of flow chart.

In Chapter 5, the result for the project is discussed. All the output result obtained or achieved will be established in this chapter. This covers the result from both hardware and software of the project.

Chapter 6 concludes the project achievement. The result of the project will be reviewed and recommendations and improvements that are applicable to the project are discussed for future development.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter discusses on several researches and studies contributed in the related area. Thoroughly research and continuous studies have been done to implement the appropriate ideas on the design and development of MC68HC11 microcontroller based universal memory programmer (UMP11). The various types of non-volatile memory product in the market will be discussed in term of features and programming methods required. The object code file of Intel Hex file and Motorola S-Record will be discussed and the data arrangement in the object file will be explained in detail.

2.2 Non-Volatile Memory Products

A non-volatile memory refers to memory that can retain the stored information even when not powered or during a power failure. Non-volatile memory products are crucially important in microcontroller and microprocessor system as

they provide the required storage space for the system. The permanent data required for the operation of the microcontroller or microprocessor such as the system program will be stored in non-volatile memory to ensure that the system can operate as usual after a shutdown of the system or when power failure occurs.

2.2.1 ROM

Read Only Memory (ROM) is non volatile memory which used as a storage memory for the microcontroller system. It consists of an array of core cells whose contents or states are preprogrammed by using the presence or absence of a single transistor as the storage mechanism during the fabrication process. It contains permanent data which does not lose its data state when power is turned off [3]. Therefore, it is normally used to store firmware or boot loader program for the system which required the data to maintain its state for a prolonged period even when the power is turned off. There are many type of memory which evolutes from the ROM family such as PROM, EPROM, and EEPROM.

The differences between those products are the method used to write data onto the memory and their ability to be rewritten. PROM (Programmable ROM) can only be written once, it usually ships in an unwritten state and once it is written with data, the data cannot be erased. EPROM (Erasable Programmable ROM) is similar to PROM but with an improvement to its rewrite ability. After a data is written on EPROM, it can be erased by exposure of the EPROM window to Ultraviolet (UV) light.

EEPROM (Electrically Erasable PROM) is the successor of EPROM, it has the same characteristic of EPROM but the erase operation can be done electrically by applying of a high voltage. The advantages of EEPROM are high number of Write and Erase cycles, ability to erase small amount of memory (word size) and fast write time [4]. This makes EEPROM one of the most successful and renowned memory

products in the market. All the while, the primary drawback of the EEPROM is the higher implementation cost compare to EPROM. However, with the advancement in technologies and mass production of EEPROM due to the high market demand, the price of EEPROM has greatly reduced and it is currently the non volatile memory product with the highest demand in the semiconductor market.

2.2.2 RAM

Random Access Memory (RAM) is a form of memory which can provides access in any order and usually serves as a type of temporary storage between the processor and the storage memory. RAM can access each location in memory in the same amount of time regardless of its physical location which differs from position dependent storage such as ROM [5]. This enable RAM to provide a faster write and read time in compare to storage memory. However, RAM is a type of Volatile memory which will lose its data state once the power is disconnected [5]. There are 2 types of RAM mainly in the market which is SRAM (Static RAM) and DRAM (Dynamic RAM). SRAM is the successor of DRAM where SRAM provides a better memory retention time compare to DRAM.

The evolution continues and recently, the Non-Volatile RAM (NVRAM) is introduced where it inherits the advantage of speed on RAM and improved with non volatile characteristic. The NVRAM actually consists of SRAM with alternative supply such as Lithium cell which can provides the necessary power to retain its data state even when the power is disconnected. In addition, NVRAM has a better rewrite cycle and easily compatible with current EPROM or EEPROM system. This makes it an ideal replacement for the EPROM or EEPROM to provide greater speed advantage to the system. In addition, its capability to write during normal operation and random access to the stored data, without doubt, has provided additional advantages of the device.

The latest NVRAM implements various type of technology to provide the universal memory characteristics such as high-density (low-cost), high-speed (for both read and write operation), low-power (both access and standby powers), random-accessibility, non-volatile and unlimited endurance [6]. Some of the technologies used in NVRAM are phase change memory, magnetic memory, spin-transfer torque memory, resistive memory and memristor [7].

2.2.3 EPROM, EEPROM, and NVRAM

EPROM, EEPROM and NVRAM are compatible non-volatile storage solutions but accidentally choosing the poor choice for particular application can cause failure to the system design [8]. The main criteria that will impose on memory choices are availability of densities, access rate, number of reliable write cycles, ability to block writes, and erase time.

Table 2.1: Comparison Table for Non-volatile Memory

Memory	**Density**	**Read Access (ns)**	**Write Access Time**	**Write Cycle Lifetime**	**Block Writes**	**UV Erase**
EPROM	2k to 4M x 8	45 to 200	100µs/byte After part erased Vcc=6.5V, Vpp=13V	100 write cycles	No	Yes
EEPROM	2k to 512k x 8	70 to 200	200µs to 1ms/byte	10k to 100k write cycles	No	No
FLASH	128k to 8M x 8	45 to 200	Non standard write time, fastest at 10µs/byte, require block write, Vpp=13V	10k write cycles	Y/N	No
NVRAM	2k to 2M x 8	70 to 200	70 to 200µs/byte	Unlimited cycles for up to 10 years	No	No