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The Development of a Microcontroller Circuit Board for Practical Engineering Work

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Abstract: The Embedded System Application is a compulsory course for the Diploma Program in Mechatronic Engineering at Kota Kinabalu Polytechnic, Sabah. The microcontroller used for this course is the PIC16F877A PIC microcontroller. In this course, continuous assessment is tests, quizzes, the end of the chapter, and practical work. The biggest assessment percentage in this course is practical work which is 40 percent. In this course, students begin practical work by assembling all components manually, from the power supply circuit to the microcontroller circuit on the breadboard. It takes a long time for students to prepare the basic circuit each time before starting the practical work. Often, students will face errors in assembling the circuit and take time to troubleshoot and identify the problem. There is also a component failure because of assembling and disassembling the circuit. This paper presented the development of prototype board PIC16F877A to facilitate students to do practical work effectively to save time and energy and lower cost.

Keywords: practical work, embedded system, microcontroller, electronic components

1. Introduction

This development board was designed to allow students to exercise the practical work easily. The development board is designed for general applications and includes hardware connections, I/O programming, LCD interfacing, sensor interfacing, relay interface, and motor control. In some applications, the development of circuit boards that can be programmed in In-Circuit Serial Programming (ICSP) has been used for industrial and educational purposes [1,2].

The microcontroller board used for educational work has been previously presented elsewhere [3]. This board is generally completed with a USB, switches, LEDs, ICSP, reset, and USB power. The programmer that will be used along this board is PICKIT2 and XC8 compiler.

This study aims to develop a microcontroller circuit board system for facilitating the practical work for a student to evaluate their capabilities in preparing the basic circuit for supporting their specific practical work. The board is assembled with a 6-pin berg connector to connect the ICSP programmer kit and may give a convenient way of programming the PIC circuit board without removing the chip from the development board.

2. Materials and Methods

The circuit is designed and simulated using Proteus PCB Design software. Components of the PCB are then placed on board for the PICKIT production. The main components are listed below.

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2.1 Power Supply

The power supply onboard 5Vdc has a current rating of 1A to easily power almost all onboard and external devices. All I/O pins and power pins are available at female header pins to ease the wiring.

2.2 USB Connector

This development board used a B-type USB connector to power the board with a PC or laptop.

2.3 ICSP

ICSP programmers can program the development board. A 6-pin berg connector has been provided to connect the ICSP programmer (PICKIT2 programmer). It gives a convenient way of programming PIC16F877A without removing the chip from the development board. There are six main connections from the PIC ICSP programmer for the development board, presented in Table 1.

Table 1. The six main connections from the PIC ICSP programmer

Vpp (or MCLR)	Programming voltage
VCC	Power (5V)
GND	Ground (0V)
PGD-Data	RB7
PGC-Clock	RB6
PGM-LVP enable	RB3

Vpp signal is a programming action connected to the rest input labeled MCLR. During programming, this signal is raised to the programming voltage VCC +3.5V. That signals to the PIC microcontroller that programming supplies current; in other words, the programming is about to start. VDD /VCC signal (power) supply 5V dc to the board. The GND signal reference to 0V. PGC signal and PGD signals transmit the data to the PIC microcontroller.

2.4 Reset

The reset circuit is externally reset using a momentary open switch activated by pulling the pin low to the ground to offer a manual way to reset the device. When a reset occurs, the program counter will be reset to the top of the program execution or memory location 0x00, which is the start of all program memory.

2.5 Crystal Oscillator

8Mhz high-speed crystal oscillator is connected between OSC1 and OSC2 pins to set the clock frequency to the microcontroller, which controls the speed of program execution. It is important as every instruction is executed in synchronization with the clock.

3. Results and Discussion

3.1 MPLAB X IDE

MPLAB X IDE is the latest edition of MPLAB and is developed on the NetBeans platform. MPLAB X supports project management, code editing, debugging, and programming of Microchip 8-bit, 16-bit, and 32-bit PIC microcontrollers [4].

The circuit using Proteus PCB Design software is presented in Fig. 1.

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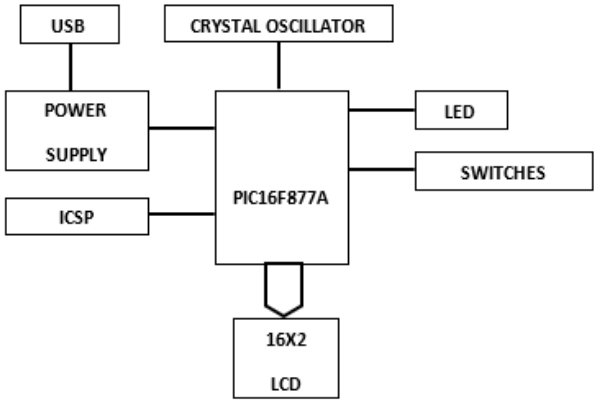

Figure 1. Block Diagram of Development Board PIC16F877A microcontroller

3.2 PICkit2

PICkit2 is a programmer for PIC microcontroller by Microchip Technology. They are used to program and debug microcontrollers, as well as program EEPROM.

The onboard peripherals include a USB interface, 16x2 characters LCD, switches, and LED. The on-chip peripherals and the external hardware on the development board are interconnected using pin headers and jumpers [3,4]. The I/O pins on the microcontroller can be accessed by using a male jumper cable. The board is made from a single-sided PCB board and supports the operating supply voltage between 3V dc and 5v dc, as presented in Fig. 2.

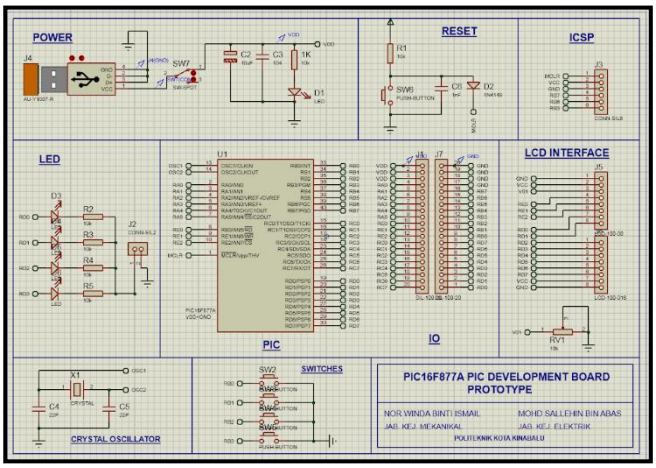

Figure 2. Circuit Diagram

3.3 LCD Programming

The LCD Programming is listed below program.

- - - - -

```
#define _XTAL_FREQ 8000000
#define RS RE0
#define EN RE2
#define D4 RD4
#define D5 RD5
#define D6 RD6
#define D7 RD7
#include <xc.h>
#include "LCD.h";
// BEGIN CONFIG
```

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```
#pragma config FOSC = HS
#pragma config WDTE = OFF
#pragma config PWRTE = OFF
#pragma config BOREN = ON
#pragma config LVP = OFF
#pragma config CPD = OFF
#pragma config WRT = OFF
#pragma config CP = OFF
//END CONFIG
int main()
{
    unsigned int a;
    TRISD = 0x00;
    Lcd_Init();
    while(1)
    {
        Lcd_Clear();
        Lcd_Set_Cursor(1,1);
        Lcd_Write_String("LCD 16x2");
        Lcd_Set_Cursor(2,1);
        Lcd_Write_String("MPLAB XC8");
        __delay_ms(2000);
        Lcd_Clear();
        Lcd_Set_Cursor(1,1);
        Lcd_Write_String("Done by");
        Lcd_Set_Cursor(2,1);
        Lcd_Write_String("AHMAD");
        __delay_ms(2000);
        Lcd_Clear();
        Lcd_Set_Cursor(1,1);
        Lcd_Write_String("Embedded");
        for(a=0;a<15;a++)
        {
            __delay_ms(1000);
            Lcd_Shift_Left();
        }
for(a=0;a<15;a++)
        {
            __delay_ms(1000);
            Lcd_Shift_Right();
        }
        Lcd_Clear();
        Lcd_Set_Cursor(2,1);
        Lcd_Write_Char('e');
        Lcd_Write_Char('S');
        __delay_ms(2000);
    }
    return 0;
}}
```

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The development board PIC16F877A prototype resulted in various potential applications, they are including but not limited as follows:

a. Blinking LED
b. LCD Interfacing
c. Ultrasonic Sensor Interfacing
d. DC Motor Interfacing

The above results are taken through Development Board PIC16F877A prototype for controlling the application as per decoding the codes and executing the same cases previously presented elsewhere [5,6].

4. Conclusions

A simple and cost-effective board is developed in this paper. It implements a low-cost development board based on a PIC16F877A microcontroller with I/O pins and external peripherals. This development board is useful and helps lecturers and students to exercise practical work. This microcontroller board aims to be implemented for teaching and learning for the student's practical work. The programming and components have been successfully assembled on the circuit board with an interchange system that may facilitate students to do the lab work more effectively with time, energy, and cost savings.

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