Microcontroller Development/Training Module

Qik Start

PICmicro Education Board II

(P/N 905173)

Instruction Manual

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1 Overview

The ***Qik Start PIC Education Board*** is designed to assist students with the hands-on portion of learning Microcontrollers. The Board is designed around the *Microchip Technologies Inc. PIC16F874 Microcontroller*. Its features include: an on-board power supply, a 40 pin Zero Insertion Force (ZIF) socket for the PIC Microcontroller; a 4 MHz crystal for its clock; all non dedicated PIC ports brought out to connecting pads; a dedicated socket for I^2C/SPI memory (jumper selectable); 14 momentary push buttons, three potentiometers, eight LEDS with limiting resistors; a 2 x16 LCD display; an encoder emulator (with up/down buttons) and a temperature sensor.

The Board also supports an RS-232 interface, an In-Circuit Debugger Module (ICD) interface and Memory, and all microcontroller pins are easily available on the PCB.

Used as a stand-alone unit or installed into the adapter cradle in the Diversified Engineering ***Design Center*** (P/N 905000), this module provides development systems/components to support experiments and the total lab environment.

2 Power Sources

The ***Qik Start PIC Education Board*** operates on an optional AC Power Pak adapter or on DC power that can deliver 7 to 12 VDC at 200 ma. Input power is regulated down to +5VDC for all supplies to the on-board circuits.

2.1 AC Power Pak Adapter

A Power Pak adapter (DE option # 905530) is available for connection into J1 to provide continuous power to the module. Output is 9–12 VDC at 200 ma. The center pin of J1 is positive (+) and the outer shell is negative (-).

2.2 Battery Power Source

A 9V Panasonic #006PNX battery (or equivalent) installed in the BAT1 connector can be used to power the board.

2.3 DC Power Source

Between 7 and 12 VDC can be supplied to the board by connecting power to J1. The center pin of the connector is positive (+) and the outer shell is negative (-)

3 Microcontroller

The PIC16F874 is an 8-bit CMOS Flash microcontroller manufactured by Microchip. For information about writing software for, loading programs into and erasing this device, please refer to the Microchip PIC16F874 data sheet which can be obtained directly from Microchip at www.microchip.com.

******WARNING******

Power Switch S17 must be in the OFF position before you raise the lever on the microcontroller socket (U3) or you will damage the part.

3.1 Removing the Microcontroller

To remove the microcontroller (U3) turn off Power Switch S17 and lift the lever located near pin 1 of the microcontroller to the vertical position. Lift the microcontroller out of the socket, keeping it level to the surface of the board until all pins have cleared the socket. The microcontroller should lift out with no resistance. If you encounter resistance, reset the lever to horizontal and then back to the vertical position. You should never need a tool to lift out the microcontroller!

3.2 Installing the Microcontroller

To install the microcontroller turn off Power Switch S17 and lift the lever on microcontroller socket in the vertical position. Insert the microcontroller into the socket (U3). Verify that Pin 1 is located in the correct hole and that all pins are placed into all the appropriate holes. Lower the lever 90 degrees into the horizontal position. You should never have to force the microcontroller into the socket!

******WARNING******

Never apply power unless the lever on U3 is in the horizontal position or you will damage the microcontroller.

4 Oscillator (OSC)

The OSC signal, as supplied by Diversified Engineering, is developed from an on-board crystal (X1) running at 4MHz.

5 E^2 Memory

The 25C040 (U5) is a 16k bit serial Electrically Erasable PROM (EEPROM). The memory is accessed through the Serial Peripheral Interface (SPI) controlled by the microcontroller. You can also use the 24C01 series of I^2C memory device by changing the jumper (J8) to the proper location and inserting the part into U5 socket. See Chart 1.

J8 Selector

Jumper	Memory Type	Memory Chip
Pins 1 & 2	I^2C	24CXXX
Pins 2 & 3	SPI	25XXX

Chart 1

******WARNING******

Never install or remove the IC (U5) or change the jumper J8 unless power is removed (S17 is OFF) or you can damage the microcontroller and/or memory IC's.

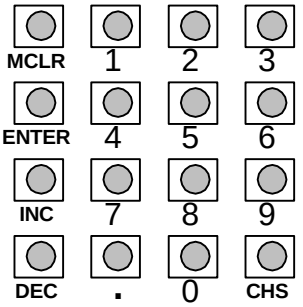
6 MCLR (Reset) Push Button

The MCLR or Master Clear Reset (S14) button is available on the module to manually reset the Microcontroller. The MCLR button is interconnected to VDD (+5V) via a 47K resistor.

7 Enter Push Button

The ***Enter*** button (S13) is connected across GND and Pin RE2 of the microcontroller and has a 10K resistor to +5VDC. Pressing the ***Enter*** button brings RE2 to GND. See Schematic.

8 Push-button Switches (S1 – S12)



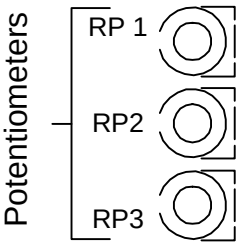
There are 12 momentary N.O. push-button switches (S1-S12) available to the designer. These switches are arranged in keyboard fashion and wired in a matrix of three columns and four rows. (See Schematic for details.) Microcontroller pins RA2, RA5, and RC2 are the driven multiplex output lines (low is a select) to each of the four rows of switches. RB1, RB2 ,RB3 and RB4 are the input lines (pulled high via internal pull-up resistor) of the three columns. Pressing a switch produces a multiplexed output causing the input to go low on its corresponding line.

******NOTE******

Since RB1, RB2, RB3 and RB4 can also be used to drive the LCD display, the software should disable the keyboard inputs when writing to the LCD.

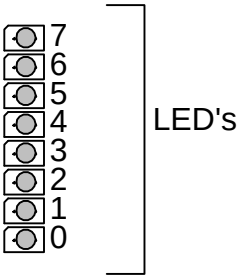
9 Potentiometers (RP1-RP3)

There are three adjustable potentiometers available on the board for control. Each generates an analog 0-5 V signal directly into the microcontroller A/D ports RA0, RA1 and RA3. The potentiometers are 5K ohm. Their ends are tied to the +5VDC (VDD) and GND (circuit common). Rotating the potentiometer clockwise increases the voltage at its wiper from approximately 0 to 5 VDC.



10 LED Indicators (LED0 – LED7)

There are eight LED indicators available on the board. The cathodes are tied to GND (circuit common) and the anodes are connected through a 1K resistor to PORT D pins 0 - 7 respectively. The LED's are rated at 10 ma (Vf=1.0V) to 20 ma (Vf=2.0V).



11 LCD Display (LCD1)

There is a single 2- x 16-character LCD display on the board, with each character a 5x7 dot matrix (FEMA # CG1621-SGR1). The LCD is bus-driven with two 4-bit words outputted on the microcontroller pins RB1, RB2, RB3, and RB4. The alphanumeric display can be used to message a multitude of

things. RE0 is used for Data/Command select and RE1 is used for Signal enable.

Chart 2 gives a brief description of each of the controlling pins. Please refer to the schematic located in the Appendix for further clarification of the hardware interface.

Chart 2

Signal	I/O	Function
RS	I	L: Instructs register (for Write), Busy flag/Address counter (for Read) H: Data Register (for Read & Write)
E	I	Starts Data for Read or Write
DB4	I/O	Bi Directional tristate data bus pin (lsb)
DB5	I/O	Bi Directional tristate data bus pin.
DB6	I/O	Bi Directional tristate data bus pin.
DB7	I/O	Bi Directional tristate data bus pin (msb).

To assist in programming and displaying information, extracts of the data sheet for the LCD display are available in the Appendix. This display uses a Fujitsu FCS2314AK LCD controller and is comparable to the Hitachi HD44780U LCD controller. For an extensive data sheet on this controller, visit

www.diversifiedengineering.net /Standard Products/Embedded Controller/Education Board/Support Info and look for the appropriate PDF file.

You can reach FEMA, the manufacturer of the LCD, by phone at 800-292-3362 or by e-mail at fema@femacorp.com.

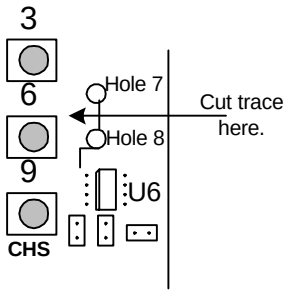
12 Temperature Sensor (U6)

A temperature-sensing integrated circuit (U6) is located on the board for experimental use. It is an Analog Devices TMP-04 and it outputs a Modulated Serial Digital Output proportional to temperature. The temperature is inputted into the microcontroller pin ACI. See Schematic.

The output at 25 °C is 35 Hz. The output scaling factor is:

degrees C = 235 - (400*T1)/T2.

If pin AC1 is needed for other experiments, you can disconnect it from the TMP-04 by cutting the trace located between the two holes labeled TEMPOUT on the top side of the Printed Circuit Board (PCB) near U6. (See layout drawing in the Appendix.) Install a jumper wire if you want to reconnect the temperature sensor at a later date.



To obtain a complete data sheet on this device, call the Analog Devices fax retrieval system at 1-800-446-6212 and request fax code 1850, or visit their world wide web site at

http://www.analog.com/pdf/tmp03_04.pdf

or visit

www.diversifiedengineering.net /Embedded Controller/Education Board/Support Info

and look for the appropriate PDF file.

13 Encoder Emulator (U1)

U1 is used to simulate an encoder whose output is two square waves with a 90-degree phase shift. Pressing button S16 (INC) causes the signal on Pin 4 to lead the signal on Pin 3 of U1. (See Schematic) Pressing button S15 (DEC) causes the signal on Pin 4 to lag the signal on Pin 3 of U1.

******WARNING******
Never install or remove the IC U1 unless power is removed (S17 is OFF).

14 Bread-Boarding Area

There is an area near the power supply that has a series of holes providing a space for bread boarding custom circuits. These holes are .040" plated through on a .10" x .10" matrix. Within this area are holes tided to +5 VDC (Vdd) located just below push button CHS. Another set of holes is tied to GND (circuit common) located just above the Power On LED. For ease of instrument connection, a ground (GND) terminal post is located near pin 4 of U1.

15 Connecting Pads

You can connect the microcontroller to various other circuits easily by interconnecting to its pins by using J5 and J6, which are available for soldering wires. You can also install a standard industry connector (2x10, 0.1" center), available from Samtec (SSW-110-01-T-D) and other manufacturers. (See Schematic for details of pin configuration.)

16 Source Code Utility

A source code utility for the PIC16F874 is available to help support experiments with the ***Qik Start PIC Education II Board.*** This can be downloaded from our web site at

www.diversifiedengineering.net.

Routines for interfacing with the E^2, Serial port, LCD display, 4x4 matrix keypad, A/D and others are included in the utility code. Please feel free to download and use this code for *Qik Start*-ing your project.

17 Serial Port

The RS-232 signal connects through the DB-9 connector (J3) and is converted through the MAX 232 integrated circuit. The signal is then received on RCT

and transmitted on RC6 of the microcontroller. (See Schematic) The DB-9 pin-out configuration is shown in Chart 3.

Pin	Function
1	Open
2	Transmit
3	Receive
4	Connected to 6
5	Circuit Common
6	Connected to 4
7	Connected to 8
8	Connected to 7

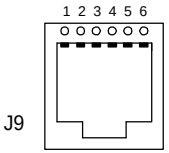
Chart 3

18 In-circuit Debugger (ICD) Interface

Each ***Qik Start PIC Education II Board*** has circuitry for built in access to connector J2 that permits interfacing the ICD Module for emulation capability to a PC. The wiring configuration of J2 is shown in Chart 4.

Pin (RJ)	Connection Point
6	Nc
5	RB6
4	RB7
3	Gnd
2	+5V
1	MCLR

Chart 4

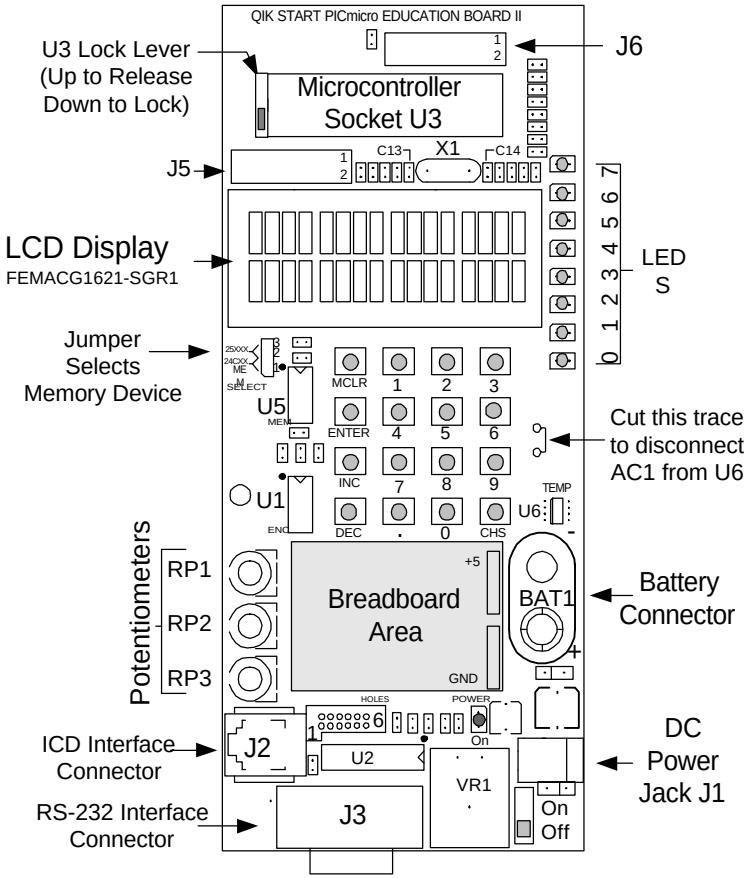


Programming, reprogramming and in-circuit debugging require the use of an interface harness (with built in logic) to your PC. This harness assembly is included in the MPLAB- ICD Kit which can be purchased from an authorized Microchip Distributor. Free MP-LAB software is available from the Microchip web site at www. microchip.com

Appendix A

Board Layout

P/N 905173



Appendix B
LCD Character Set

Appendix C
LCD Instruction Set

Instruction	Code RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	Description	Execution Time (max) (when f_{cp} or f_{OSC} is 270 kHz)
Clear display	0	0	0	0	0	0	0	0	0	1	Clears entire display and sets DDRAM address 0 in address counter.	
Return home	0	0	0	0	0	0	0	0	1	—	Sets DDRAM address 0 in address counter. Also returns display from being shifted to original position. DDRAM contents remain unchanged.	1.52 ms
Entry mode set	0	0	0	0	0	0	0	1	I/D	S	Sets cursor move direction and specifies display shift. These operations are performed during data write and read.	37 µs
Display on/off control	0	0	0	0	0	0	1	D	C	B	Sets entire display (D) on/off, cursor on/off (C), and blinking of cursor position character (B).	37 µs
Cursor or display shift	0	0	0	0	0	1	S/C	R/L	—	—	Moves cursor and shifts display without changing DDRAM contents.	37 µs
Function set	0	0	0	0	1	DL	N	F	—	—	Sets interface data length (DL), number of display lines (N), and character font (F).	37 µs
Set CGRAM address	0	0	0	1	ACG	ACG	ACG	ACG	ACG	ACG	Sets CGRAM address. CGRAM data is sent and received after this setting.	37 µs
Set DDRAM address	0	0	1	ADD	ADD	ADD	ADD	ADD	ADD	ADD	Sets DDRAM address. DDRAM data is sent and received after this setting.	37 µs
Read busy flag & address	0	1	BF	AC	AC	AC	AC	AC	AC	AC	Reads busy flag (BF) indicating internal operation is being performed and reads address counter contents.	0 µs
Write data to CG or DDRAM	1	0	Write data								Writes data into DDRAM or CGRAM.	37 µs t_{ADD} = 4 µs*
Read data from CG or DDRAM	1	1	Read data								Reads data from DDRAM or CGRAM.	37 µs t_{ADD} = 4 µs*

I/D = 1: Increment
I/D = 0: Decrement
S = 1: Accompanies display shift
S/C = 1: Display shift
S/C = 0: Cursor move
R/L = 1: Shift to the right
R/L = 0: Shift to the left
DL = 1: 8 bits, DL = 0: 4 bits
N = 1: 2 lines, N = 0: 1 line
F = 1: 5 × 10 dots, F = 0: 5 × 8 dots
BF = 1: Internally operating
BF = 0: Instructions acceptable

DDRAM: Display data RAM
CGRAM: Character generator RAM
ACG: CGRAM address
ADD: DDRAM address (corresponds to cursor address)
AC: Address counter used for both DD and CGRAM addresses

Execution time changes when frequency changes
Example:
When f_{cp} or f_{OSC} is 250 kHz,
$37\ \mu s \times \frac{270}{250} = 40\ \mu s$

Note: — indicates no effect.

* After execution of the CGRAM/DDRAM data write or read instruction, the RAM address counter is incremented or decremented by 1. The RAM address counter is updated after the busy flag turns off.

Limited Warranty

Diversified Engineering and Manufacturing Inc. (DEM) warrants that the Product(s) will be free from defects in material and workmanship for a period of one (1) year from the date of purchase. Diversified Engineering and Manufacturing Inc. will, at its discretion, repair or replace any part(s) found to be defective in the Product(s) resulting from defective workmanship, material or both. All costs for packaging and transporting *to and from* Orange, CT are the responsibility of the customer. All units returned for repair should have prepaid shipping charges, include a proof of purchase receipt and a detail of the problem/symptom.

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