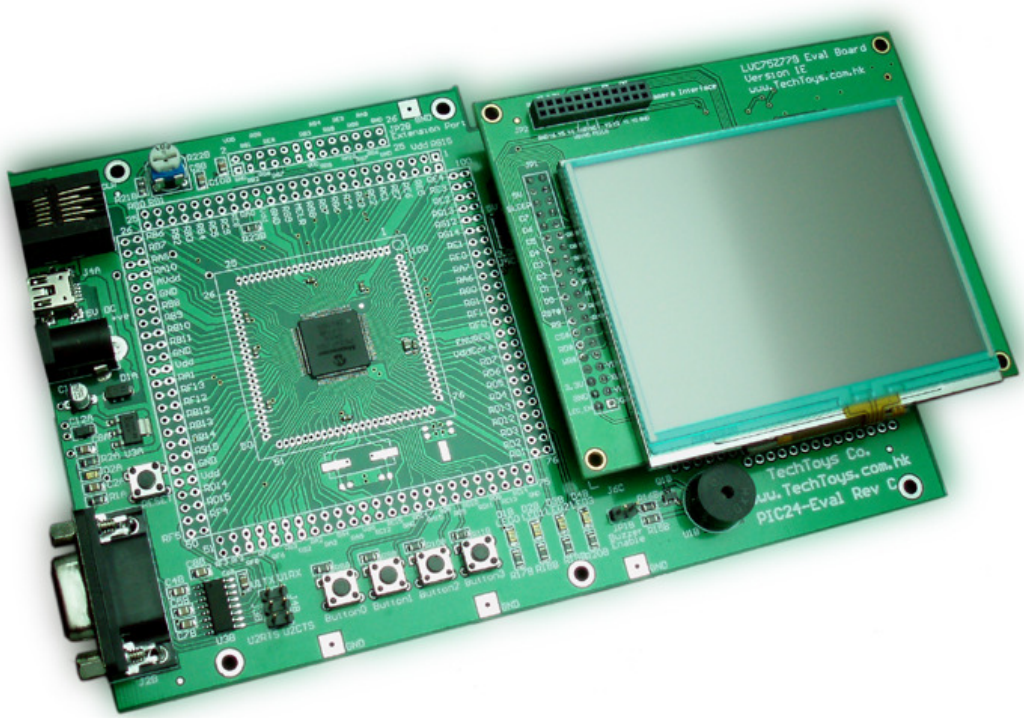
Evaluation board for Microchip 100-Pin General Purpose Microcontrollers



Board shown with a PIC24FJ128GA010 soldered onboard with an optional 3.5” TFT LCD module stacked

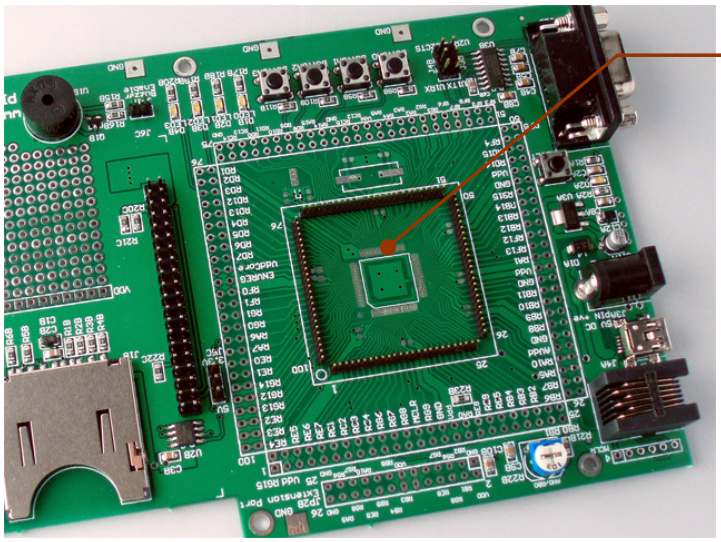
Written by: John Leung

INTRODUCTION

The part number PIC24/32-Eval-Rev C2 provides a low-cost platform to evaluate high pin-count 16-bit/32-bit microcontrollers of Microchip. There are four ordering options available:

(1) PIC24/32-Eval-Rev C2 - Option for Plug-In-Module (w/o MCU)

This option omits the microcontroller onboard (designator U1A on schematic) leaving only 100-pin Plug-in-module socket (designator U2A) therefore different microcontrollers can be used for development.

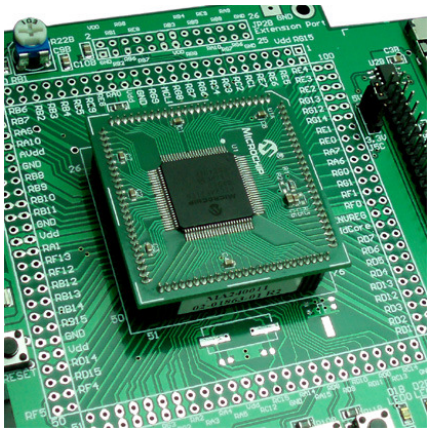


No mcu soldered here, leaving only 1.27mm 100-pin header for PIM

Processor Plug-In Modules (PIM) are small circuit boards to be used with the various Microchip Development Boards, e.g. Explorer 16. Further information can be found from Microchip web site at the following hyperlink.

http://www.microchip.com/stellent/idcplg?IdcService=SS_GET_PAGE&nodeId=1406&dDocName=en531260

Microchip is offering its PIM at incredible low cost of US$25.00, I would recommend customers going directly to Microchip online if the target microcontroller model is available in PIM format. However, we do offer innovative PIM for some of the Microchip products to remap a lower MCU (e.g. PIC18F67J50) to 100-Pin PIM socket. The idea of remap is to fully utilize peripherals of the PIC24/32 evaluation board and at the same time, minimize production cost to keep selling price lower than US$25.00. Please check our company web site for details. Below please find a picture with a Microchip PIM for 16-bit PIC24FJ128GA010 in place.



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(2) PIC24/32-Eval-Rev C2 - Option PIC24FJ128GA010 onboard

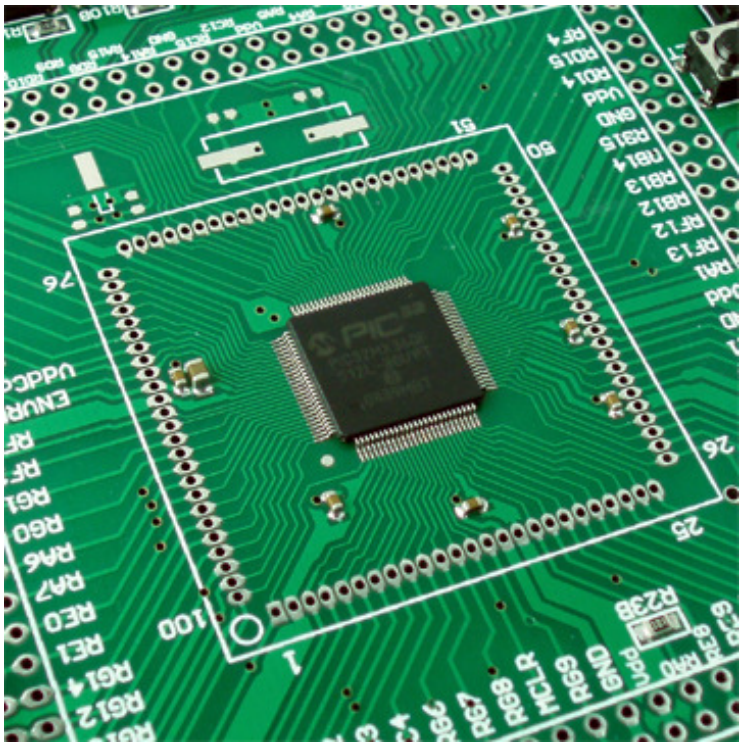
With just US$5.00 added to option 1, this board has got the PIC24FJ128GA010 16-bit microcontroller soldered onboard to designator U1A in form of 12x12mm 100-lead TQFP package.

(3) PIC24/32-Eval-Rev C2 – Option PIC24FJ256GA110 onboard

If you are still not comfortable with 128kb Flash/8kb SRAM of PIC24FJ128GA010, you may consider the third option with PIC24FJ256GA110. This powerful microcontroller provides an ample Flash space of 256kb Flash/16kb SRAM. Besides, on top of all features of PIC24FJ128GA010 family, there are the Peripheral Pin Select feature and Charge Time Measurement Unit (CTMU) that open up new applications to this mcu. The Peripheral Pin Select feature provides an alternative to user's choice of peripheral functions (such as UART and SPI) on a wide range of I/O pins. Therefore it is not restricted to use only pin 49 and pin 50 for U2RX and U2TX for UART. It is possible to map these pins to other I/O pins for more hardware design flexibility. The Charge Time Measurement Unit is a flexible analog module that provides accurate differential time measurement between pulse sources as well as pulse generation, which is good for interface with capacitive-based sensors, for example the Touch Sensing human interface.

(4) PIC24/32-Eval-Rev C2 – Option PIC32MX360F512L onboard

Thanks to the compatibility design among PIC32 to PIC24 series, it is possible for us to use the same footprint of 12x12mm TQFP-100 across these 16-bit to 32-bit MCU. This option uses the same motherboard for Microchip 32-bit microcontroller of MIPS32 M4K core running as high as 80MHz! The picture below shows a PIC32MX360F512L microcontroller soldered. The same footprint would be used for PIC24FJ128GA010 or PIC24FJ256GA110 as they are pin-compatible.



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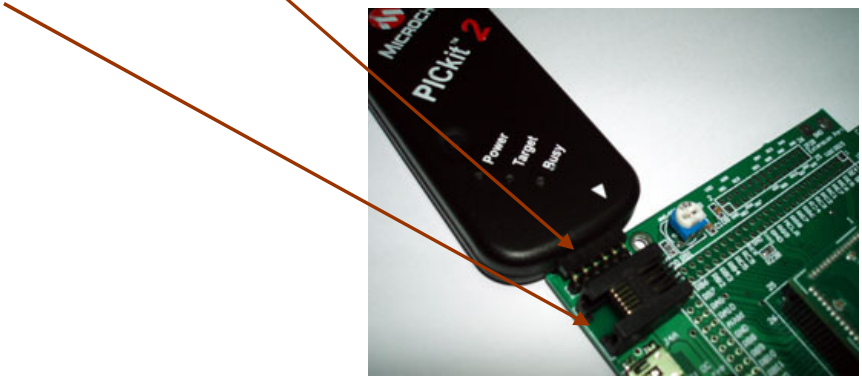
FEATURES

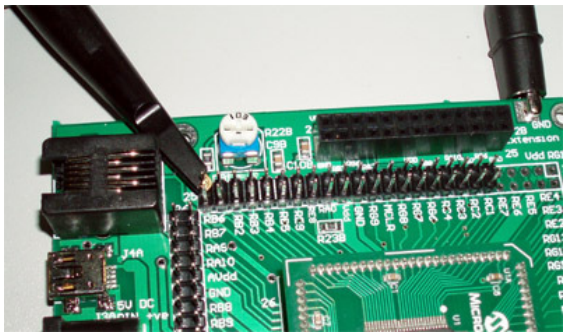
A rich set of on-chip peripherals such as Fast RC Oscillator, Real Time Clock & Calendar, flexible Output Compare, & Parallel Master Port module (just to name a few of them) differentiates PIC24/PIC32-series from previous PIC16 microcontrollers.

However, prototyping with PIC24/PIC32 series especially for 100-pin microcontrollers could be difficult as they are offered in TQFP-100 package only. A tiny lead pitch of merely 0.40mm makes it almost impossible for hand-solder. Our development board offers a handy way to evaluate these 100-pin microcontrollers with the following features

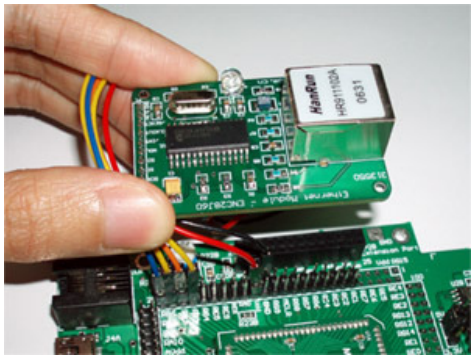
1. Onboard AMS1117-3.3V linear regulator for a clean and regulated 3.3V
2. PICKit2 compatible header
3. ICD2/3 compatible socket



4. Double row 2.54mm headers for 0.100” (2.54) cables or DSO/Logic Analyzer probes.



These headers are also useful for prototyping with any third-party modules that don’t fit with our board readily. One may use 0.100” jumper cables for this purpose. Each board comes with 20 pieces free 0.100” jumper cables. Picture below shows how an Ethernet module could be wired up with our board by joining few jumper cables for the SPI interface and power.



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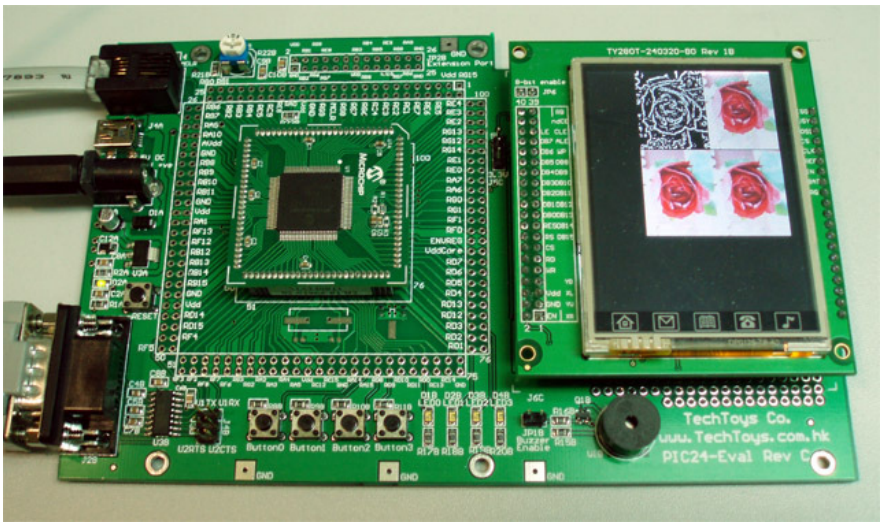
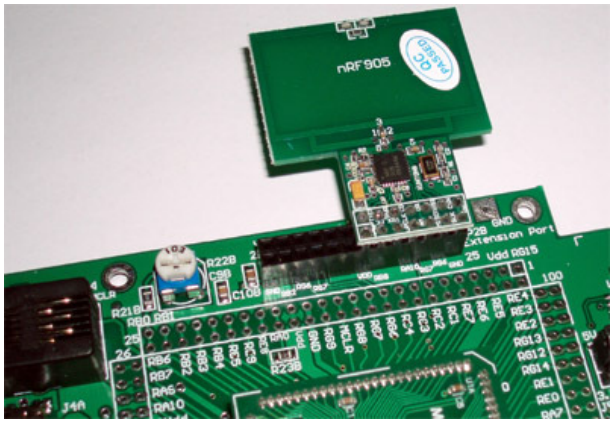
5. 2.54mm pin headers compatible with all our color LCD modules:
    a. 3.5” QVGA TFT LCD with Touch Panel and external Solomon SSD1928 Image Processor
    b. 2.8” QVGA TFT LCD with Touch Panel
    c. 2.4” QVGA TFT LCD module

    Picture below shows the result running a primitive demo for 2.8” TFT LCD module with Touch Panel. The same headers can be used for both 2.4” and 3.5” LCD modules.



6. SD Card socket
7. UART interface via SIPEX SP3232
8. SPI eeprom (Atmel AT25256A) for storage of critical board information such as calibration data for Touch Panel
9. 2x13 2.54mm receptacle for more *“TechToy”* such as nRF905 433 MHz wireless module (shown below), nRF24L01 2.4GHz wireless module, and SHT1X digital temperature/humidity sensor module. Because this receptacle has got several important peripherals including SPI2 module, interrupt pins, Analog-to-digital converter, and a few general purpose IO pins from the microcontroller, it would be just a matter of imagination to use this evaluation board for any real-life applications.
10. Buzzer, LED, trimmer (for ADC experiment), and tact switches for user interface.



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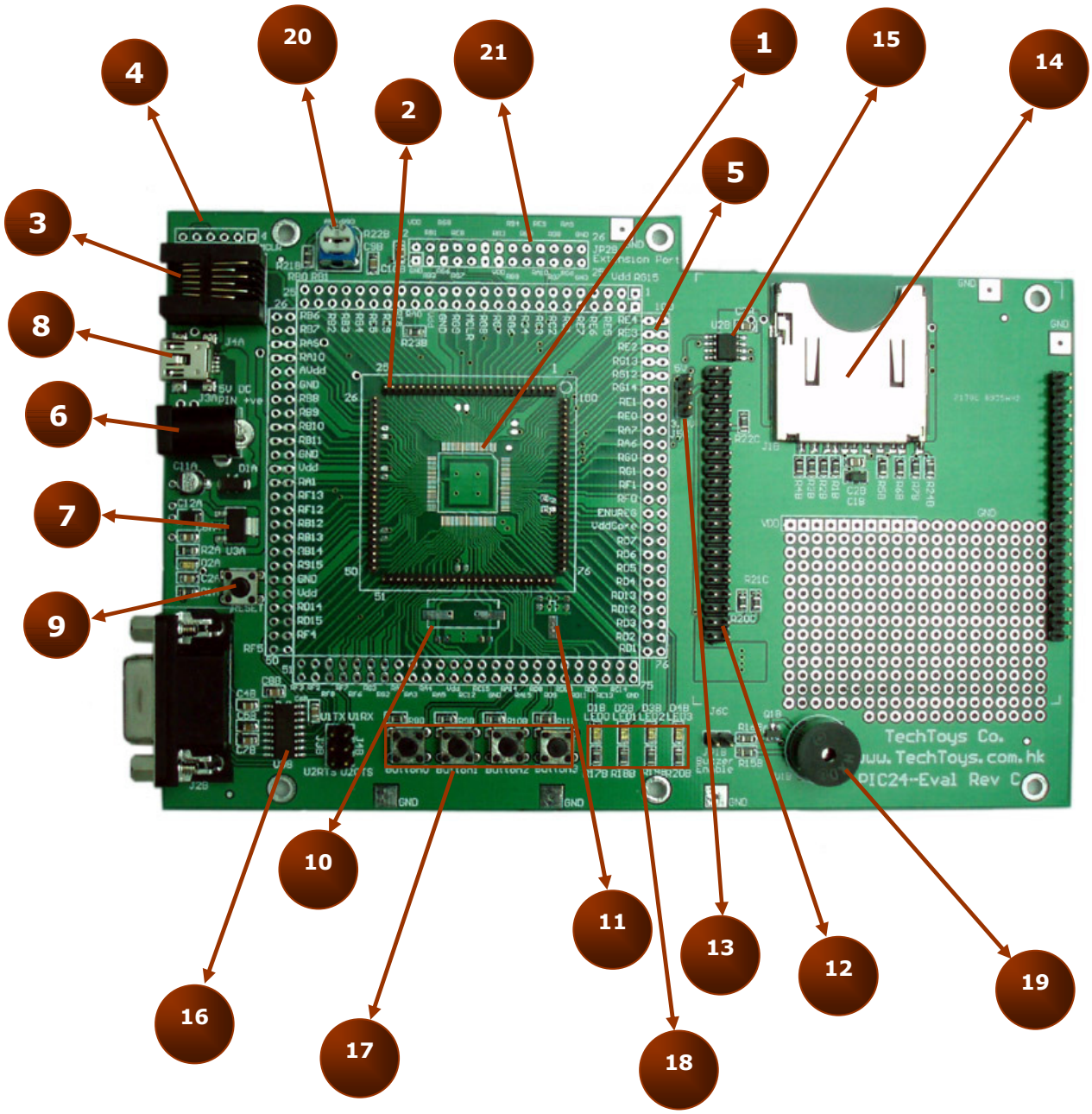
ANNOTATION: BOARD LAYOUT (board shown for 100-pin PIM header)



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	Function	Designator
1	Land pattern for 12x12mm 100-lead TQFP package. Microcontroller – PIC24FJ128GA010 or PIC24FJ256GA110 or PIC32MX360F512L, or no mcu soldered for PIM	U1A
2	Pads for pin header in 1.27mm pitch. These pads are compatible with Plug-In Module (PIM) released by Microchip	U2A
3	ICSP connector compatible with Microchip ICD2 debugger	J1A
4	ICSP connector (pads only) compatible with Microchip PICKit2 programmer. Triangular mark indicates the MCLR pin	J2A
5	Double row 2.54mm PCB headers for jumper cables, and/or DSO/Logic Analyzer probes	JP1A-JP4A
6	2.1mm DC power supply jack. Pin positive and the shell is ground. A supply voltage of 5V recommended	J3A
7	AMS1117-3.3V linear voltage regulator supplies a stable 3.3V as Vdd for the whole board	U3A
8	Mini-B type USB connector for 5V power supply from a PC. NO USB D+/D- connection with this USB connector yet.	J4A
9	RESET switch connected to MCLR pin of the microcontroller.	SW1A
10	Solder pads for the Primary Oscillator. Only a land pattern has been provided for your choices of crystal frequency. Internal Fast RC Oscillator has been used for examples in this manual therefore this land pattern has been left empty.	Y1A
11	Solder pads for the Secondary Oscillator, typically a 32.768kHz would be used there for Real Time Clock applications.	Y2A
12	Module header for TFT LCD modules released by TechToys.	J6C
13	Jumper select between 5V / 3.3V for backlight to LCD module. This jumper is necessary for 2.4” or 3.5” LCD modules, but not required for 2.8” LCD module from us.	J5C
14	SD Card Socket wired to the SPI2 module of the microcontroller	J1B
15	Atmel 25256A SPI eeprom for data storage, wired to SPI2 module of the microcontroller	U2B
16	Sipex SP3232*, for UART connection with PC COMPORT. The following signals have been routed to SP3232 transceiver: (a) U2Tx and U2Rx of UART2 for transmit and receive (b) U2RTS and U2CTS for handshake control. These signals are optional. So, these control lines have been wired to two selection jumpers J3B and J4B just next to SP3232 to share with U1Tx and U1Rx. As a result, user may choose dual UART, handshake control for UART2, or simply leave the jumpers open for pure, single UART2 without any handshake * Please refer to schematic page 3 for details	U3B
17	Input control by four tact switches, wired to interrupt pins INT3, INT4, and RD8, RD9.	Button0 – Button3
18	Simple output to four LEDs to RD0:RD3	LED0 – LED3
19	Buzzer, wired to RD0. It is multiplexed with LED0 with a jumper JP1B.	Q1B
20	10k trimmer for ADC experiments, wired to RB0 port	R22B
21	2*13 2.54mm headers compatible with TechToys modules incl. nRF905 433MHz wireless module, nRF24L01 2.4GHz module, SHT1x digital sensor module, etc.	JP2B

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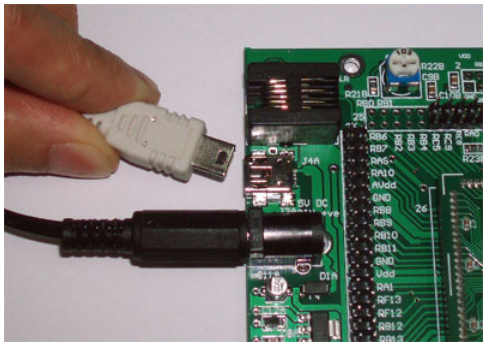
GET STARTED

Most probably the first concern is the power supply. There are two options, either a USB mini cable or 5V DC power supply. There is a current limit of 500mA from a PC's USB port. Power supply from a USB port is a convenient way; however, it is advised to get an idea of current requirement prior to USB power especially if you are using a heavy duty module such as motor drive, MOSFET applications, etc.



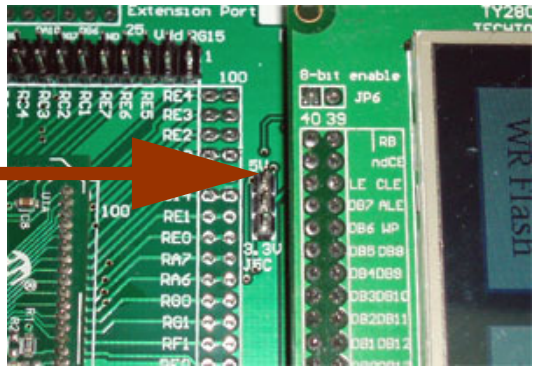
A good indication of current ratings is shown below:

Microcontroller: PIC24FJ128GA010 at 32MHz	Current Ratings @ 5V D.C.
AN1136 Demo for a 2.8" TFT LCD with backlight ON	180mA
CMOS camera life video application with a 3.5" TFT LCD with backlight OFF	120mA
CMOS camera life video application with a 3.5" TFT LCD with backlight ON	210mA
Simple LED blinky project	50mA

Every board we shipped would be preloaded with demo application for out-of-box testing. The exact demo application would be different subject to different ordering option.

The last thing about power supply is the voltage level required. Because it is the AMS1117-3.3V linear regulator onboard, the theoretical absolute maximum for input voltage is 15V. However, it is recommended to limit the supply voltage to a regulated 5V D.C. supply because the external input voltage is wired directly to backlight input of our LCD modules as well. If one applied 9V D.C. (say) to the board and short the jumper J5C to the upper two leads by mistake, one would be applying 9V D.C. to the backlight module of the LCD, too. *This will damage the LCD module's backlight circuit for sure.* Therefore, it is advised to apply only a regulated 5V D.C. if you are not using a USB cable. Reader is advised to consult the schematic for how J5C is wired to external input.

External input directly fed to backlight supply for jumper J5C



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SOFTWARE: MPLAB C30 COMPILER

The MPLAB®C C30 compiler is a full-featured ANSI compliant C compiler for the Microchip 16-bit PIC24 MCUs and dsPIC DSCs. MPLAB C30 v3.11b (or later) Student Edition is free and thus this is used for examples in this manual. Microchip is generous to offer this full-featured compiler for the first 60 days, and after 60 days only its optimization levels would be limited.

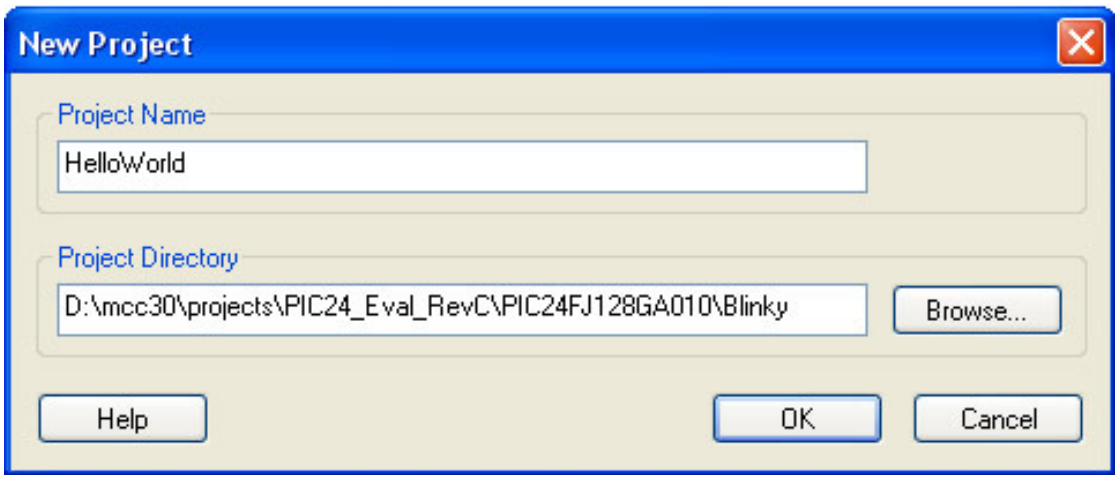
Click the link below to download and see a full description of the compiler.

http://www.microchip.com/stellent/idcplg?IdcService=SS_GET_PAGE&nodeId=1406&dDocName=en010065&part=SW006012

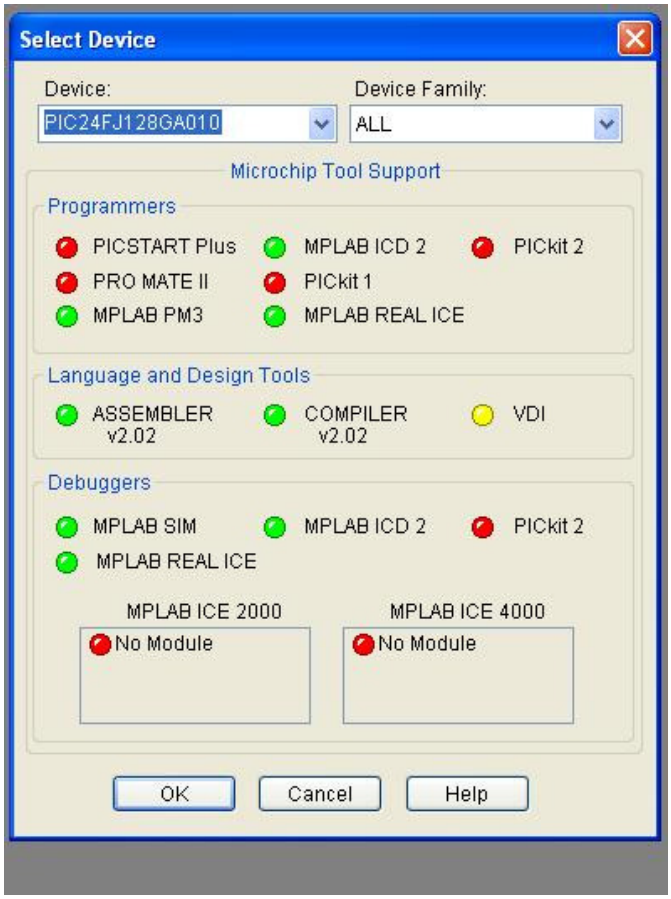
If you accept the default installation path, you will get a **bin** directory under the folder **C:\Program Files\Microchip\MPLAB C30**. This **bin** folder contains the execute file.

It is assumed that MPLAB version 8.20 or later has been installed in your development workstation. First create a new project under **Project→New…**in MPLAB. A New Project window will pop up with **Project Directory** and **Project Name** information that you need to fill in. Just create a directory of your convenience (my case being **D:\mcc30\projects\PIC24_Eval_RevC\PIC24FJ128GA010\Blinky**) and the first project being the **HelloWorld** as the Project Name. If you don't want to type it all over, please download the full source code under Doc 04 at the following html link.

http://www.techtoys.com.hk/PIC_boards/PIC24-Eval-C/PIC24-Eval-RevC.htm



From **Configure→Select Device**… menu of the MPLAB, select PIC24FJ128GA010 as the microcontroller to use (or PIC24FJ256GA110 if you have ordered this part number). Click **OK**.



Click **Project→Select Language Toolsuite** to select Microchip C30 Toolsuite. Point locations of all MPLAB ASM30 Assembler (pic30-as.exe), C30 C Compiler (pic30-gcc.exe), LINK30 Object Linker (pic30-ld.exe), and LIB30 Archiver (pic30-ar.exe) to the right path of the compiler. Click **OK** to exit upon finish.

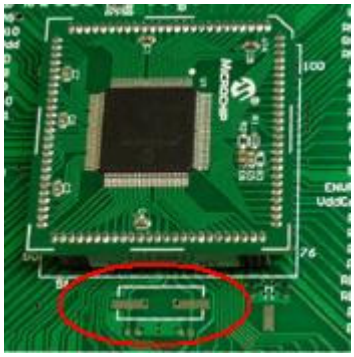
Written by: John Leung

All we have to do now is to create a new document and start programming. Under **File**, click on **New**. A new document will be created with an empty template. Type in the following code and save it as HelloWorld.c.

```
#include <p24fj128ga010.h>                                  //(1)

_CONFIG1(JTAGEN_OFF & FWDTEN_OFF)                           //(2)
_CONFIG2(FNOSC_FRCPLL & OSCIOFNC_OFF)                       //(3)

void delay(void)                                            //(4)
{
        int i=0;

        while(i++<20000);
}

int main (void)
{
        char i;
        //FRC postscaler divided by 1 (8MHz from internal RC)
        CLKDIV = 0x0000;                                    //(5)

        LATD  = 0xFFFF;                                     //(6)
        TRISD = 0xFFF0;                                     //(7)
        for(;;){
                for (i=0; i<16; i++)
                {
                        LATD = i;                           //(8)
                        delay();
                }
        }
        return (0);
}
```

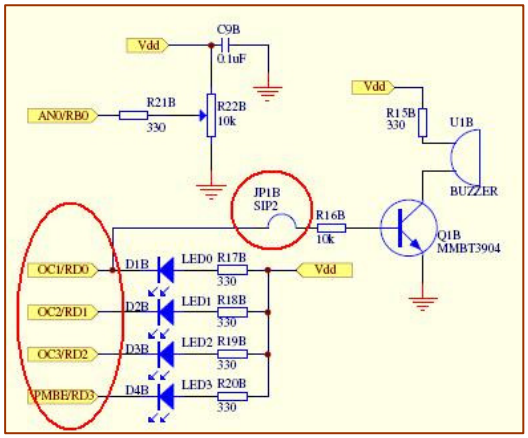
Line (1) includes the header file for PIC24FJ128GA010. Change it to PIC24FJ256GA110 if you are using this option.

Line (2), (3), & (5) define the Configuration bit settings and clock postscaler of the microcontroller. The oscillator source that is used at a device power-on reset is selected using Configuration bit settings. This is very important for our development board because there is no external crystal by default (OSC1 and OSC2 pins empty). The default configuration for FNOSC2:FNOSC0 is 1:1:1 (Fast RC Oscillator with Postscaler). The postscaler value is configured in register CLKDIV, with default value RCDIV2:RCDIV0 = 0:1:1. This gives a clock speed of 1MHz (divided by 8). Therefore, if we didn't configure the FNOSC values, the clock source of the mcu would be given by FRC oscillator at 8MHz with a postscaler divided by 8, giving a Fosc value of 1MHz with cpu peripheral clock ratio set to 1:1. If we want to set a faster cpu speed without using an external crystal, we need to use the PLL (x4). This can be done by using the configuration marco _CONFIG2(FNOSC_FRCPLL) provided by mcc30 compiler. The result is a cpu clock speed of 4MHz (8MHz*4 divided by the postscaler 8). The full speed of the mcu can be achieved by setting RCDIV2:RCDIV0 to 000 (divide by 1). Thus Fosc becomes 32MHz. There is an easy way to monitor the cpu clock speed by setting RC15 pin to OSCO (Fosc/2). This can be done by using the _CONFIG2 configuration macro with an argument OSCIOFNC_OFF. If RC15 digital IO function is required, we just use the complementary argument OSCIOFNC_ON to get it back.



Line (4) declares a simple delay function for visual inspection. No accurate timing feature applied yet.

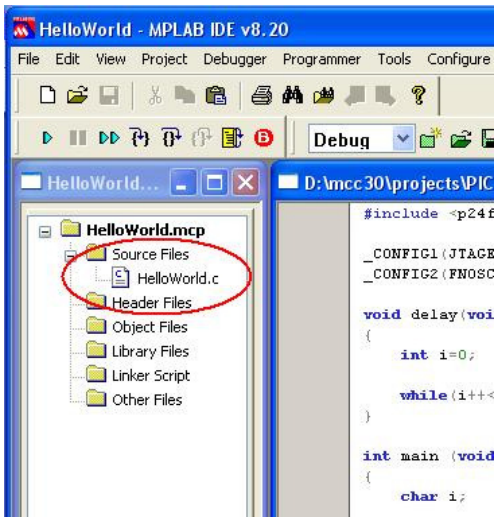
Line (6) assigns LATD to 0xFFFF in which only pins RD[3:0] are useful for driving LED3:LED0 onboard. One may also short jumper JP1B for audio signal because RD0 is multiplexed with LED0 and BUZZER.



Line (7) assigns TRISD register to 0xFFF0 which in turns assigns PORTD to output for pins RD[3:0].

Line (8) is the body of this program, simply set LATD to a counter "*i*" running from 0 to 15.

Right click on **Source Files** at the project workspace at the left Panel and add HelloWorld.c to the Source Files. Optionally we may put p24FJ128GA010.h (under C:\Program Files\Microchip\MPLAB C30\support\PIC24F\h\) to Header Files section for reference purpose. That is all we need! Under **Project**, press **Build** to compile this simple program.



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The **Output Window** will show at least the project successfully compiled. Browse to the project folder you will see there is a HelloWorld.hex file created. This is the hex file we need to download to PIC24FJ128GA010 to build an embedded system.

PROGRAM SECTION

- ICD2 operation
The first choice is to use an ICD2 if you have one because it allows single code stepping for program debug.

- PICKit2 operation
PIC24-Eval-Board C board is compatible with PICKit2. Match the triangular mark on PICKit2 with the white triangular mark on board as shown below. The latest version is V2.60 at time of writing, and its web site is:

http://www.microchip.com/stellent/idcplg?IdcService=SS_GET_PAGE&nodeId=1406&dDocName=en027813

RESULT

No matter what programming device or debugger you are using, the result is the same for such simple program. You will find LED[3:0] blink in sequence and an audio beep generated if the jumper JP1B short. Picture below also shows a DSO probe for RC15 to monitor the clock speed, which was found to be 15.76 MHz by a Tektronix DSO.