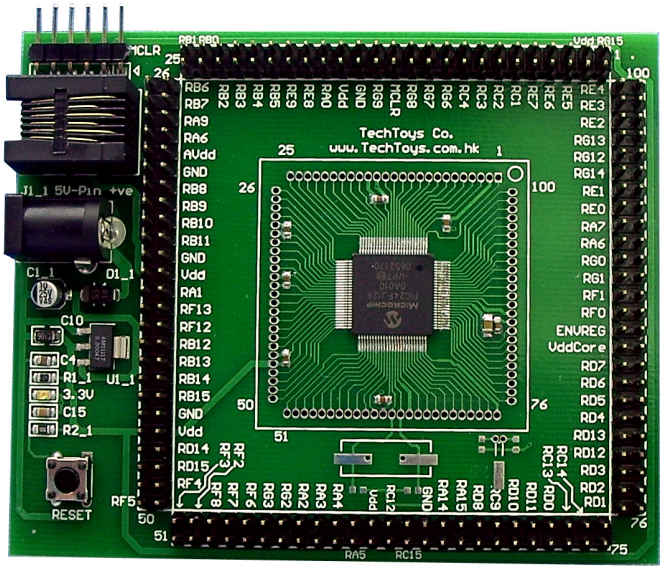
Development board for PIC24xx128GA010



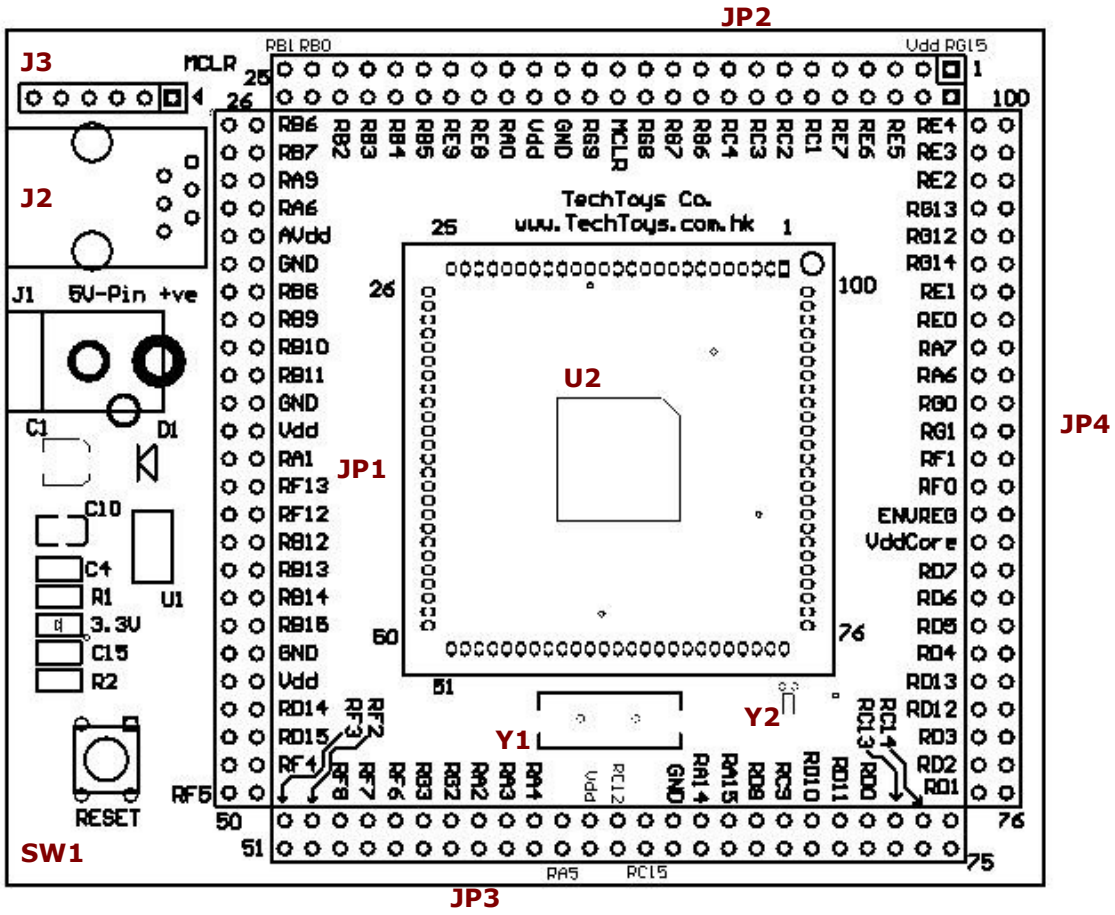
INTRODUCTION

Development board for PIC24xx128GA010 provides a low cost platform to evaluate the high pin-count 16-bit microcontrollers from Microchip. 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-series from the previous PIC16 and PIC18 microcontroller series.

However, prototyping with PIC24 series especially for 100-pin microcontrollers PIC24FJ128GA010 / PIC24HJ128GA010 could be difficult because they have been offered in 100/TQFP package only. A tiny lead pitch of merely 0.50mm of these devices makes it almost impossible for hand-solder job. Our development board for PIC24xx128GA010 offers a handy way to evaluate this 100-pin microcontroller with the following features

1. Onboard AMS1117-3.3V linear regulator for a clean and regulated 3.3V
2. ICD2 compatible socket
3. PICKit2 compatible header
4. Double row 2.54mm PCB headers for 0.100” (2.54) cables plus DOS/Logic Analyzer probes
5. Free 20 pieces single position 0.100” (2.54) cables for speedy prototyping

ANNOTATION : BOARD LAYOUT



	Function	Designator
1	Microcontroller – PIC24FJ128GA010 or PIC24HJ128GA010 as they are pin-compatible.	U2
2	AMS1117-3.3V linear voltage regulator.	U1
3	2.1mm DC power supply jack. Pin positive and the shell is ground. A supply voltage of 5V-9V maximum recommended.	J1
4	ICSP connector directly compatible with Microchip PICKit2 programmer. Triangular mark indicates the MCLR pin.	J3
5	ICSP connector directly compatible with Microchip ICD2 debugger and programmer.	J2
6	RESET switch connected to MCLR pin of the microcontroller.	SW1
7	Crystal pad for the Primary Oscillator. Only a land pattern has been provided for freedom of crystal choice. Internal Fast RC Oscillator has been used for examples in this manual therefore this crystal pad has been left empty.	Y1
8	Crystal pad for the Secondary Oscillator, typically a 32.768kHz would be used there for Real Time Clock applications.	Y2
9	Double row 2.54mm PCB headers for strip wires, and DSO/Logic Analyzer probes	JP1 – JP4

SOFTWARE : MPLAB C30 COMPILER

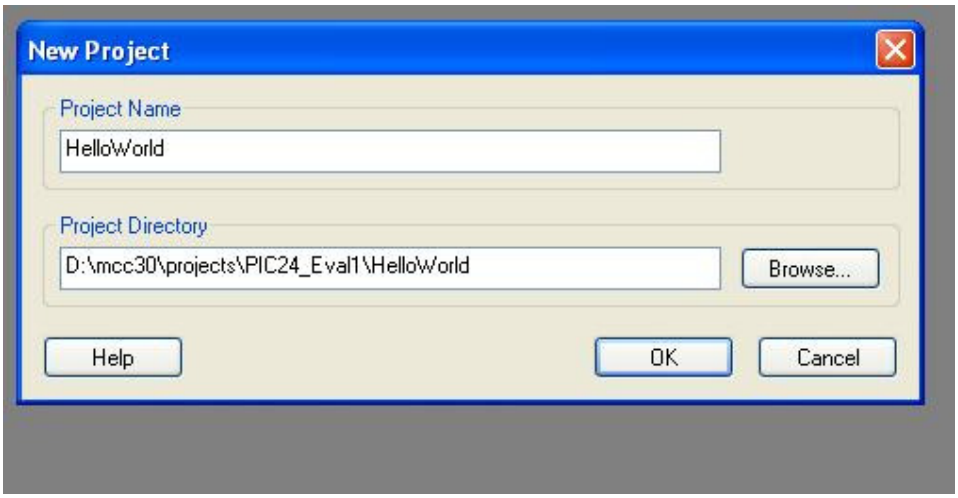
The MPLAB®C C30 compiler is a full-featured ANSI compliant C compiler for the Microchip 16-bit devices. MPLAB C30 v3.xx Student Edition is free and thus this is used for examples in this manual. Microchip is generous to offer this full-featured compiler for the first 60 days, and after 60 days only its optimization levels would be limited.

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

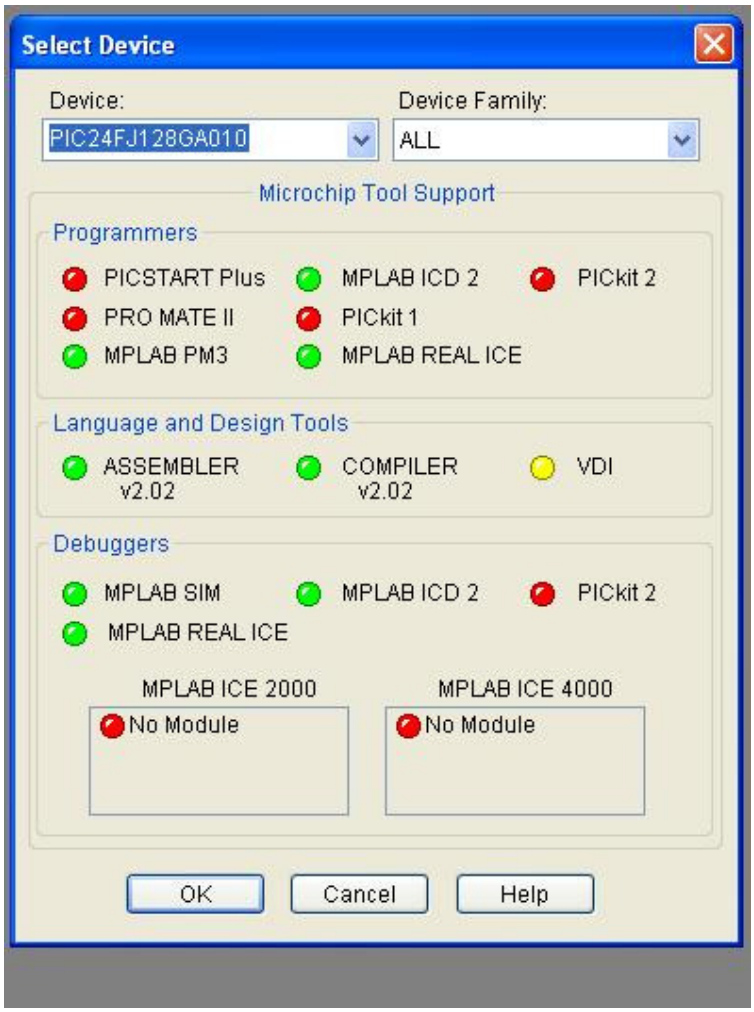
http://www.microchip.com/stellent/idcplg?IdcService=SS_GET_PAGE&nodeId=1406&dDocName=en010065&part=SW006012

If you accept the default installation path, you will get a **bin** directory under the folder **C:\Program Files\Microchip\mcc30**. This **bin** folder contains the execute file. It is just a matter of individual preference for the installation and my path to mcc30 is simply **D:**; therefore the bin folder is located under **D:\mcc30** and the project folder has been set to **D:\mcc30\ projects\PIC24_Eval1**.

It is assumed that MPLAB version 7.60 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_Eval1\HelloWorld**) and the first project being the **HelloWorld** as the Project Name.



From **Configure→Select Device**… menu of the MPLAB, select PIC24FJ128GA010 as the microcontroller to use (or PIC24HJ128GA010 if you have ordered this part number). Click **OK**.

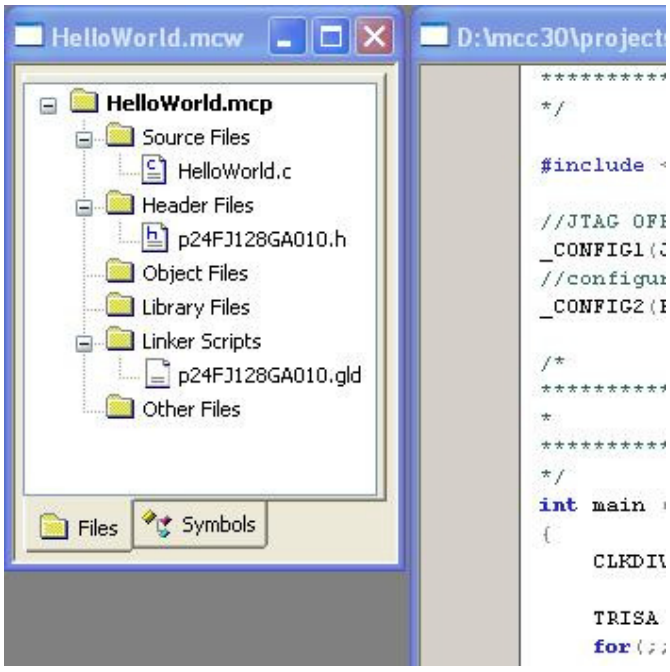


Click **Project→Select Language Toolsuite** to select Microchip C30 Toolsuite. Point locations of all MPLAB ASM30 Assembler (pic30-as.exe), C30 C Compiler (pic30-gcc.exe), LINK30 Object Linker (pic30-ld.exe), and LIB30 Archiver (pic30-ar.exe) to the right path of the compiler. In my case, it is D:\mcc30\bin\. Click **OK** to exit upon finish.

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

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

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


int main (void)
{
        CLKDIV = 0x0000; //FRC postscaler divided by 1 (8MHz from internal RC) (4)

        TRISA = 0;                                                            (5)

        for(;;){
                PORTA = 0xC5;                                                 (6)
                PORTA = 0x38;                                                 (7)
                PORTA = 0x47;                                                 (8)
        }

        return (0);
}
```

Right click on **Source Files** at the project workspace at the left Panel and add HelloWorld.c to the Source Files. Then we need to add the linker script p24FJ128GA010.gld (located under ..\mcc30\support\gld\). Optionally we may put p24FJ128GA010.h (under mcc30\support\h\) to Header Files section for reference purpose. That is all we need! Under **Project**, press **Build** to compile this simple program.



The **Output Window** shows that we have at least successfully compiled a program, even though this program will not do anything yet. 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 PIC24FJ128 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.

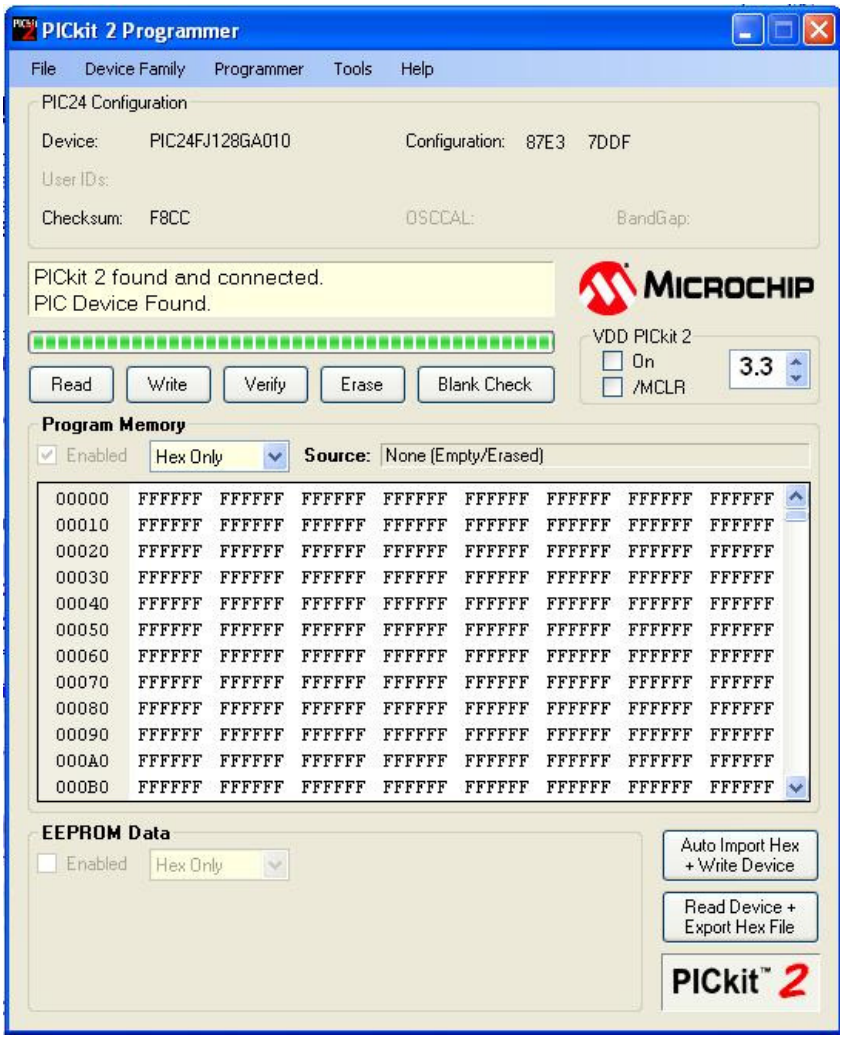
- PICKit2 operation
PIC24-Eval-B1 board is compatible with PICKit2. Match the triangular mark on PICKit2 with the white triangular mark on board as shown below.

Download the latest version (it was V2.40 at the time of writing) from Microchip web site.

Downloads

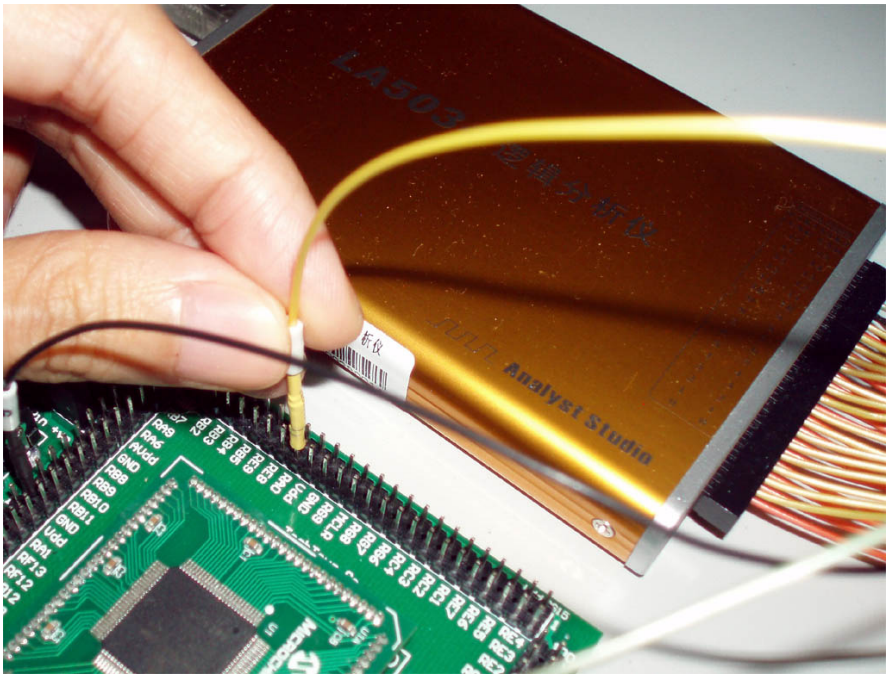
Software Firmware	Size
PICkit 2 V2.40 Install	1.99 MB
PICkit 2 V2.40 Install with .NET Framework	28.3MB
Readme for PICkit 2 V2.40	30 KB
PICkit 2 Firmware V2.10	22 KB
Device File Update V1.41.00 for PICkit 2 V2.40	17 KB
PK2CMD V1.00 PICkit 2 Command Line Interface	52 KB

Launch PICKit 2 v2.40 from the Desktop and select the correct microcontroller. After power up with a 5V-9V DC supply you will see the following screen. Under **File→Import Hex,** browse to the project folder and select HelloWorld.hex. Click on the **Write** button then you will see a successful message.



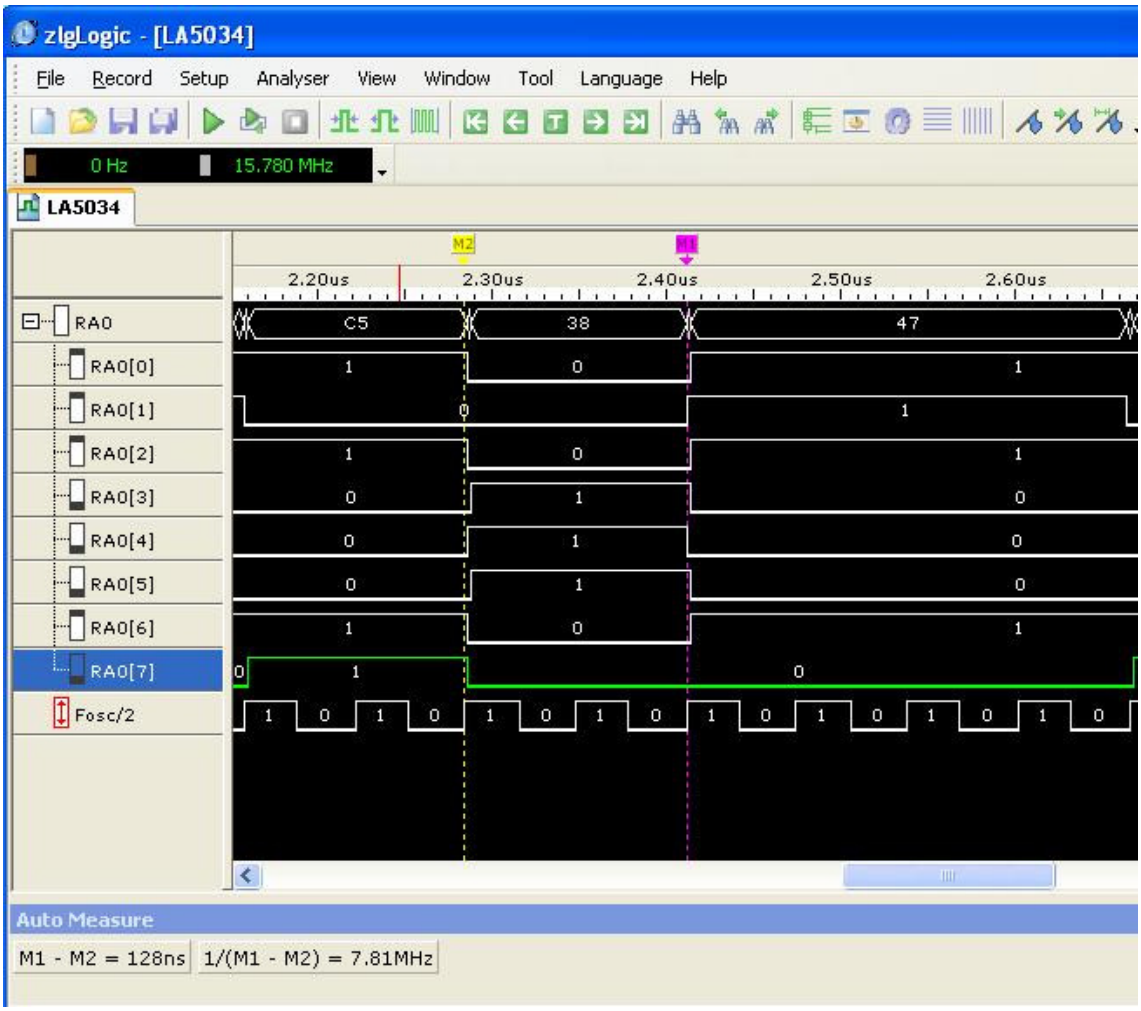
The problem is: how can we tell from such simple application if it is really working? There is no LED, no push button, nor serial port; not to say a color LCD. Here comes an interesting tool from my own collection. It is a low-cost PC-based Logic Analyzer. Picture in the next page shows my setup.

An extract from Wikipedia: A Logic Analyzer is an electronic instrument that displays signals in a digital circuit that are too fast to be observed and presents it to a user so that the user can more easily check correct operation of the digital system. They are typically used for capturing data in systems that have too many channels to be examined with an oscilloscope. Software running on the logic analyzer can convert the captured data into timing diagrams, protocol decodes, state machine traces, assembly language, or correlate assembly with source-level software. Without a Logic Analyzer, one may stick to a DSO for timing diagrams but the number of traces would be limited.



From Wikipedia data, Agilent and Tektronix make up over 95% of the industry's revenue for such device! However, offer from these two giants could be daunting to most hobbyists, students, and even individual engineers too. Mine one is only a made-in-China PC-based Logic Analyzer. This yellowish, aluminum extruded casing device make jobs done for most cases. The next page shows a screen capture of what I found out from the timing diagram.

Not bad, really! At least it shows our first "helloworld" project is working as expected. The microcontroller is using the Fast Internal RC Oscillator as the clock source.



It is time to go through the code line-by-line:

Line (1) includes the header file for PIC24FJ128GA010.

Line (2), (3), & (4) 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. The configuration word 2 is more important for us in this example. 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 post scaler 8). The full speed of the mcu can be achieved by setting RCDIV2:RCDIV0 to 000 (divide by 1). Thus Fosc would be 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.

From a frequency window near the top of the user interface, a value of 15.780MHz is displayed! This is exactly the cpu clock, being Fosc/2 with Fosc set to 32MHz by internal Fast RC Oscillator!

Line (5) sets PORTA to an output

Line (6) assigns the lower byte of PORTA to 0xC5. This is displayed by the timing diagram with annotation C5 on the waveforms. Then, hex values of 0x38, and then 0x47 displayed as we step through the code.

One interesting thing to watch out is the time required to step through one code line. Two cpu cycles has been spent for 0xC5, and two cpu cycles have been spent for 0x38 as well. This is contrary to our expectation that, simple value assignment to a physical port like

PORTA = 0xC5
PORTA = 0x38

should take a single instruction for each. At least this was true for our experience with PIC16 and PIC18 series. Why this time we have a more powerful microcontroller but the speed is halved?

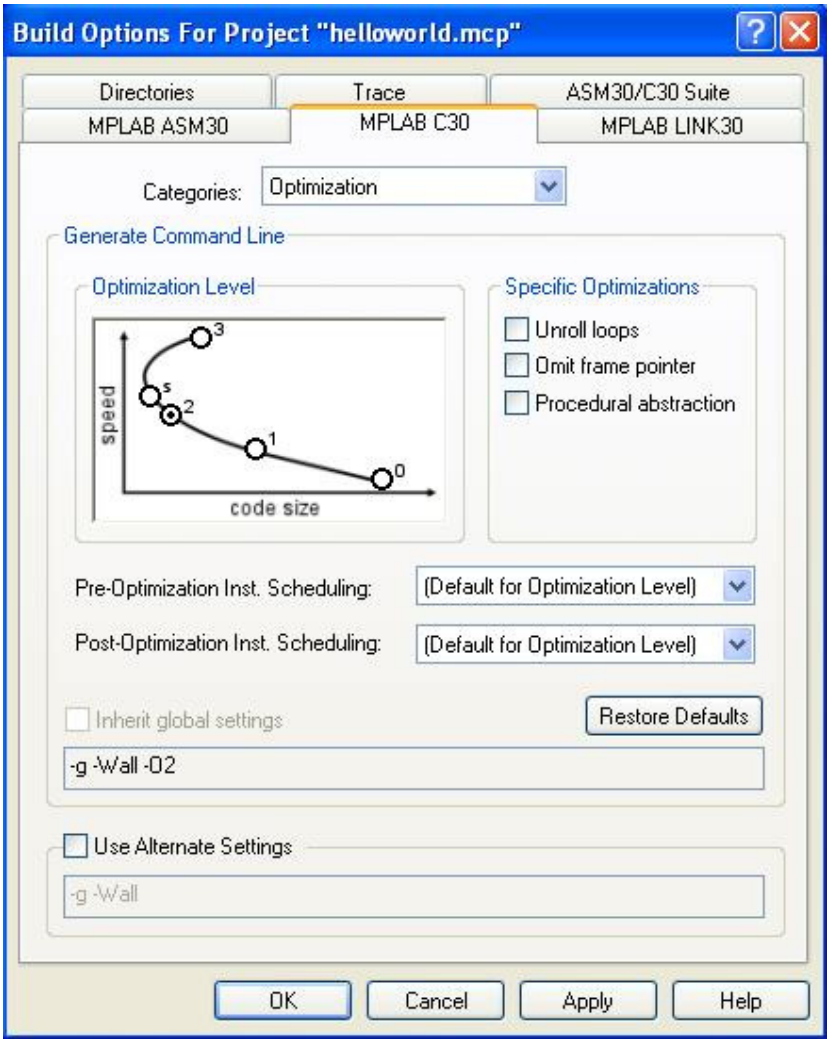
It is the compiler option we need to take care! Look closely at the program by dis-assembly listing shows the following. If we don't care about optimization and do a blind compile, the complier gave us two instructions each for all three assignments

PORTA = 0xC5;
PORTA = 0x38;
PORTA = 0x47;

As a result, there are two instruction cycles per line and hence the time it took for each code was 128ns (7.81MHz) instead of what we expected it to be a 16MHz device!

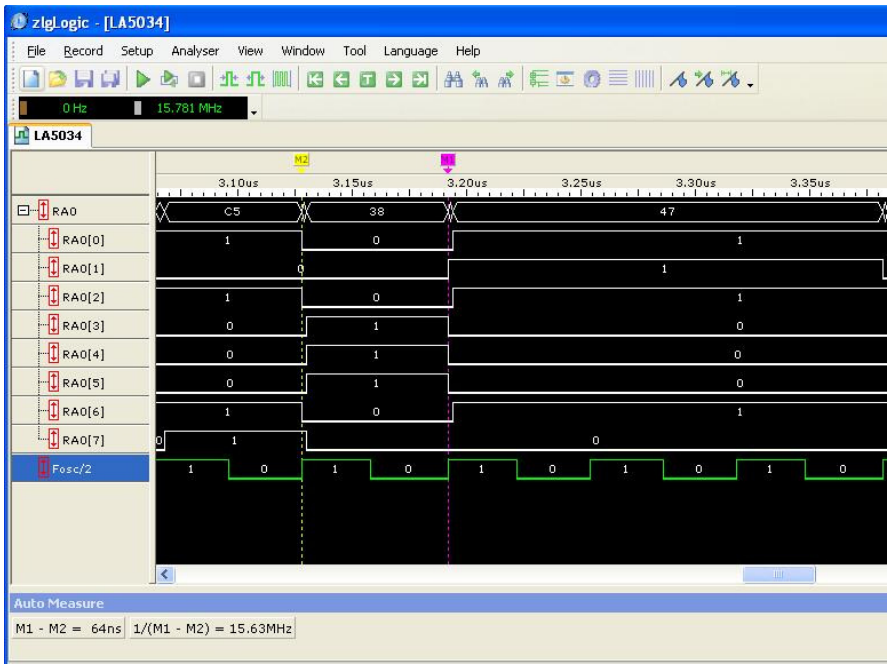
```
44:                 ***********************
45:                 */
46:                 int main (void)
47:                 {
 00280  FA0000      lnk #0x0
48:                  CLKDIV = 0x0000;
 00282  EB0000      clr.w 0x0000
 00284  883A20      mov.w 0x0000,0x0744
49:
50:                  TRISA = 0;
 00286  EB0000      clr.w 0x0000
 00288  881600      mov.w 0x0000,0x02c0
51:                  for(;;){
52:                       PORTA = 0xC5;
 0028A  200C50      mov.w #0xc5,0x0000
 0028C  881610      mov.w 0x0000,0x02c2
53:                       PORTA = 0x38;
 0028E  200380      mov.w #0x38,0x0000
 00290  881610      mov.w 0x0000,0x02c2
54:                       PORTA = 0x47;
 00292  200470      mov.w #0x47,0x0000
 00294  881610      mov.w 0x0000,0x02c2
55:                  }
 00296  37FFF9      bra 0x00028a
```

Now go to the compiler option to see if there is any change upon a different compiler option is chosen.

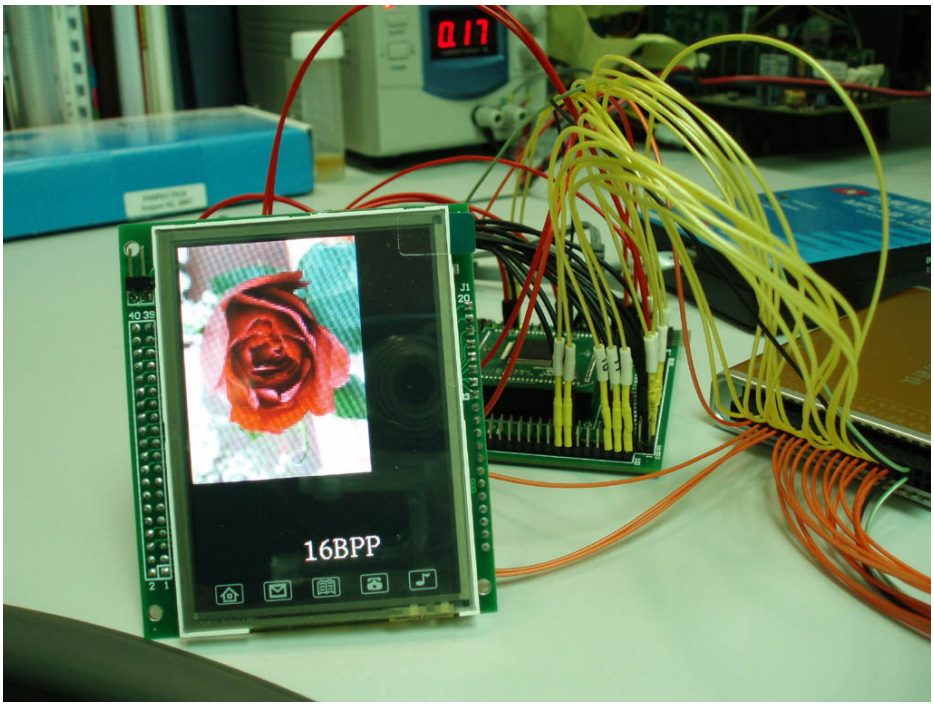


A recompile gives us the following dis-assembly listing. Display from the Logic analyzer showed a 16MHz device now! The time taken for a value of 0x38 at PORTA takes 64ns (15.63MHz) and so fro.

```
46:                 int main (void)
47:                 {
48:                  CLKDIV = 0x0000;
 00280  EB0000      clr.w 0x0000
 00282  883A20      mov.w 0x0000,0x0744
49:
50:                  TRISA = 0;
 00284  881600      mov.w 0x0000,0x02c0
 00286  200C52      mov.w #0xc5,0x0004
 00288  200381      mov.w #0x38,0x0002
 0028A  200470      mov.w #0x47,0x0000
51:                  for(;;){
52:                      PORTA = 0xC5;
 0028C  881612      mov.w 0x0004,0x02c2
53:                      PORTA = 0x38;
 0028E  881611      mov.w 0x0002,0x02c2
54:                      PORTA = 0x47;
 00290  881610      mov.w 0x0000,0x02c2
 00292  37FFFC      bra 0x00028c
```



A simple "helloworld" project makes me know a bit better on this new PIC24 device. This debugging technique applies for other complex programs such as a low-level driver for color LCD displays with PMP module, which is one of the new features of PIC24 devices. Below please find a picture of my setup for a 3.2" TFT color LCD module. No expensive development board required. Instead, a simple breakout board plus several 0.100" (2.54) cables that fly from the board's header to the LCD are enough for development.



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