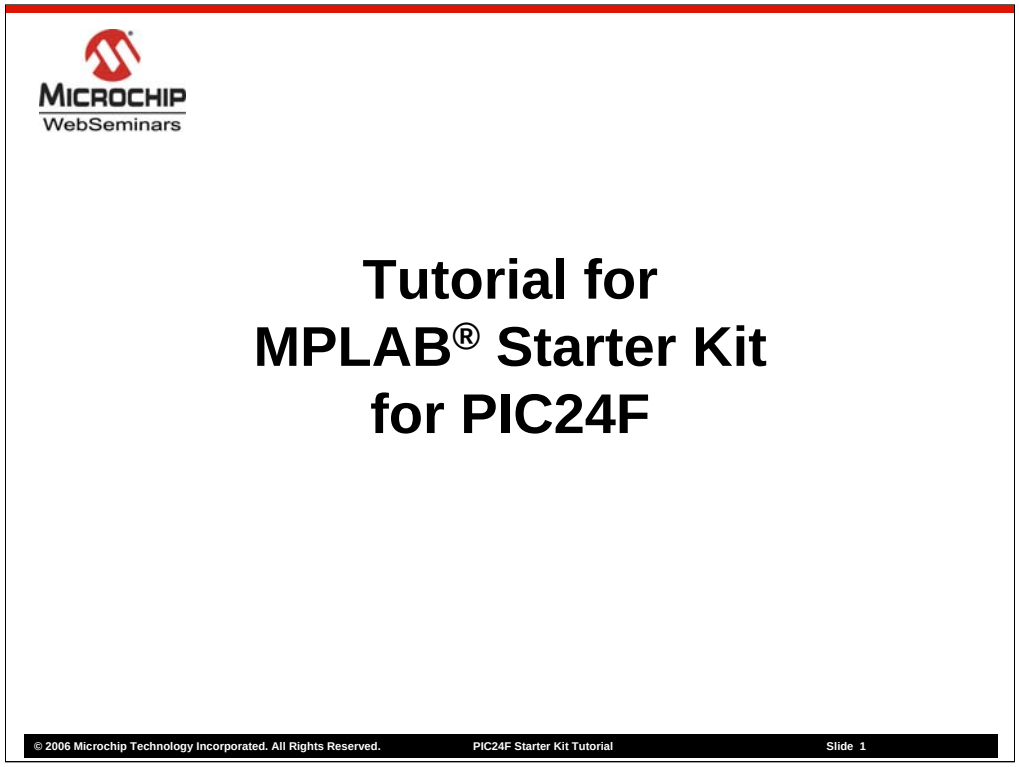
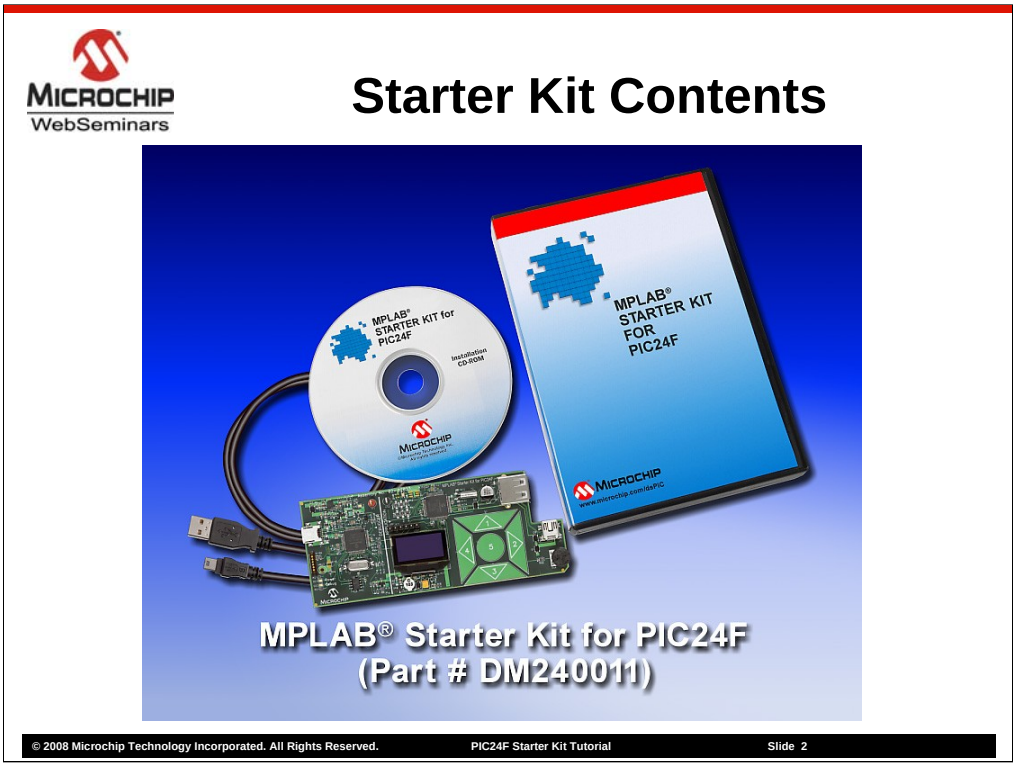


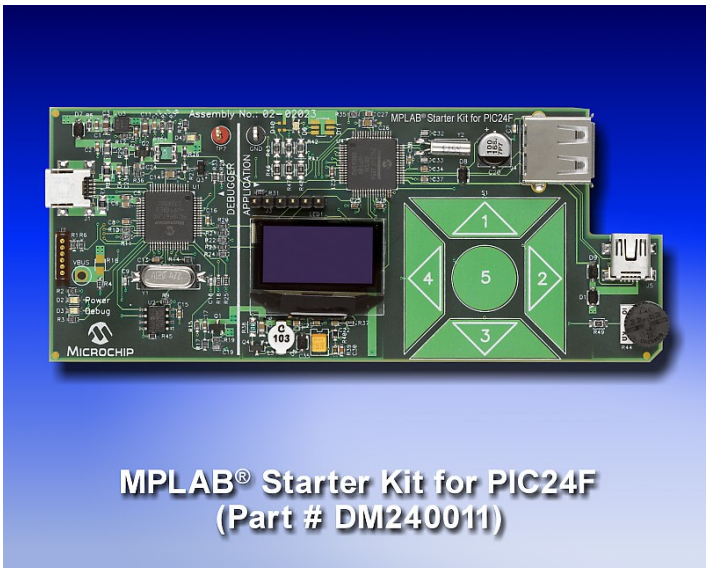
Welcome to the tutorial for the MPLAB® Starter Kit for PIC24F. My name is Kim Otten, and I am an Applications Engineer at Microchip's headquarters in Chandler, Arizona. In this tutorial, I will be guiding you through the PIC24F Starter Kit's demonstration project, and showing you the powerful features of the PIC24F microcontroller that you can utilize in your own application.



The starter kit consists of a software installation disk, the starter kit board, and a USB mini-B cable to connect the starter kit to a PC.

Before connecting the starter kit to the PC, install the starter kit software by inserting the CD and following the instructions. The installer program will install the MPLAB® IDE, a student version of the MPLAB C30 C compiler, the demo application, and the starter kit documentation.

PIC24F Starter Kit



Let’s take a look at the starter kit board.

MICROCHIP
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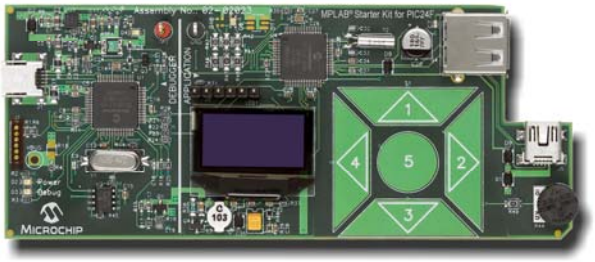
PIC24F Starter Kit



Note the vertical white line on the board.

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PIC24F Starter Kit

Debugger

The circuitry to the left of this line is an in-circuit debugger. This circuitry allows you to debug an application on the starter kit without an external debugger.

MICROCHIP
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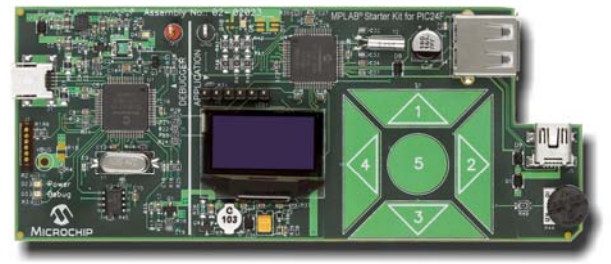
PIC24F Starter Kit



Debugger

Application

The circuitry to the right of the white line is the demonstration application.

MICROCHIP
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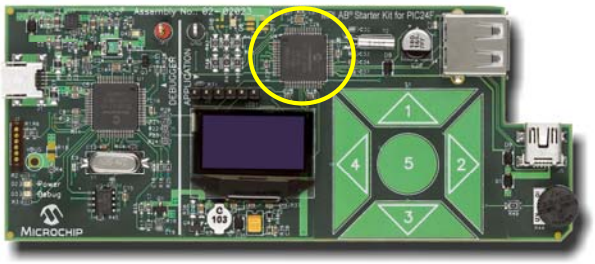
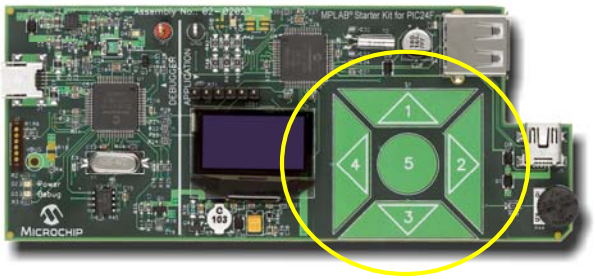
PIC24F Starter Kit



At the heart of the application is a PIC24FJ256GB106, the 64-pin member of the PIC24FJ256GB1 microcontroller family with USB On-The-Go capability.

PIC24F Starter Kit



Five capacitive touchpads provide user input to the application.

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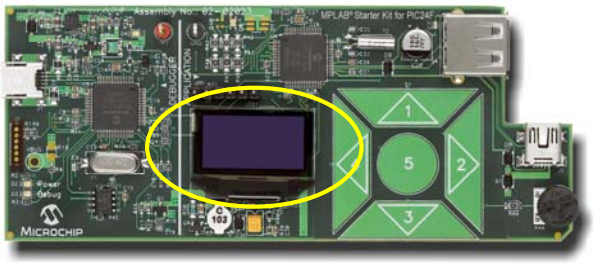
PIC24F Starter Kit



A 128 by 64 pixel organic LED display provides graphical feedback to the user.

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PIC24F Starter Kit

The RGB LED can produce nearly any color by varying the red, green, and blue components of the emitted light.

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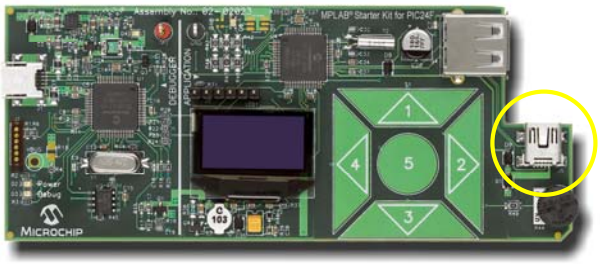
PIC24F Starter Kit

The USB Type-A receptacle is utilized when exercising the USB Embedded Host capability, …

PIC24F Starter Kit



… and the mini-B receptacle is utilized when exercising the USB Device capability of the microcontroller.

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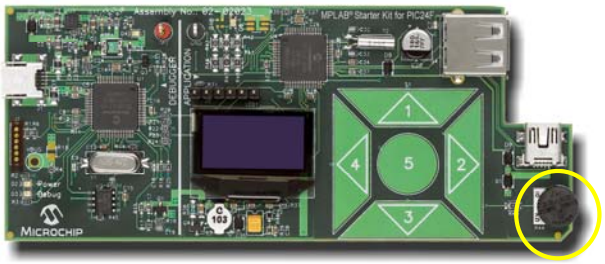
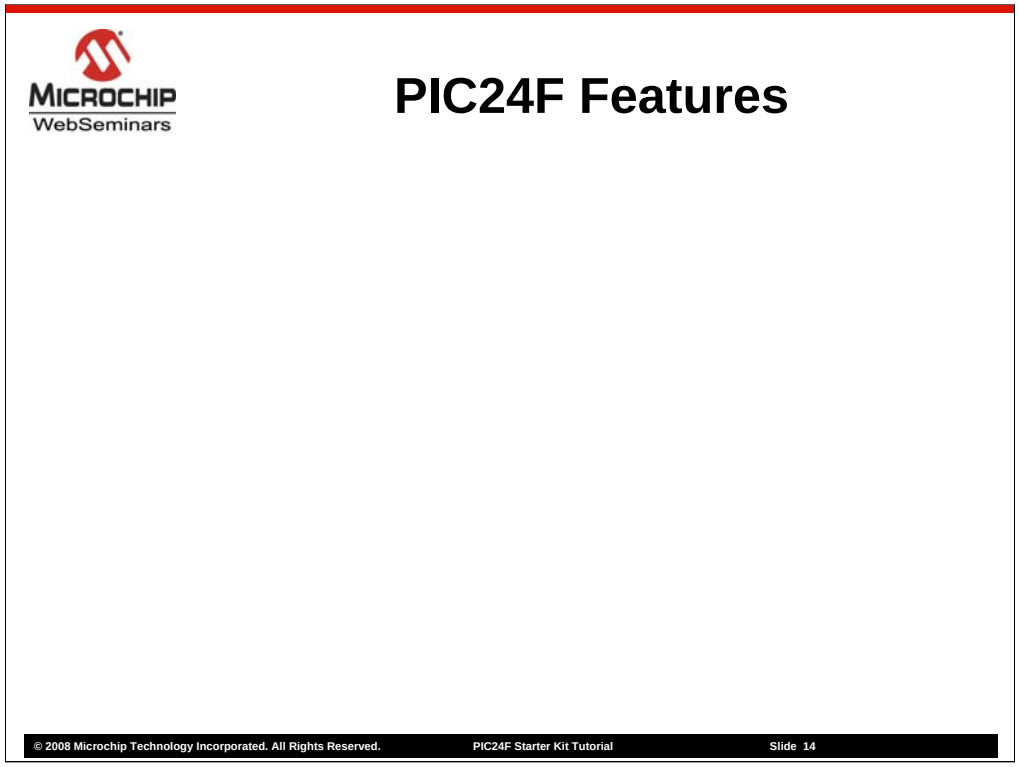
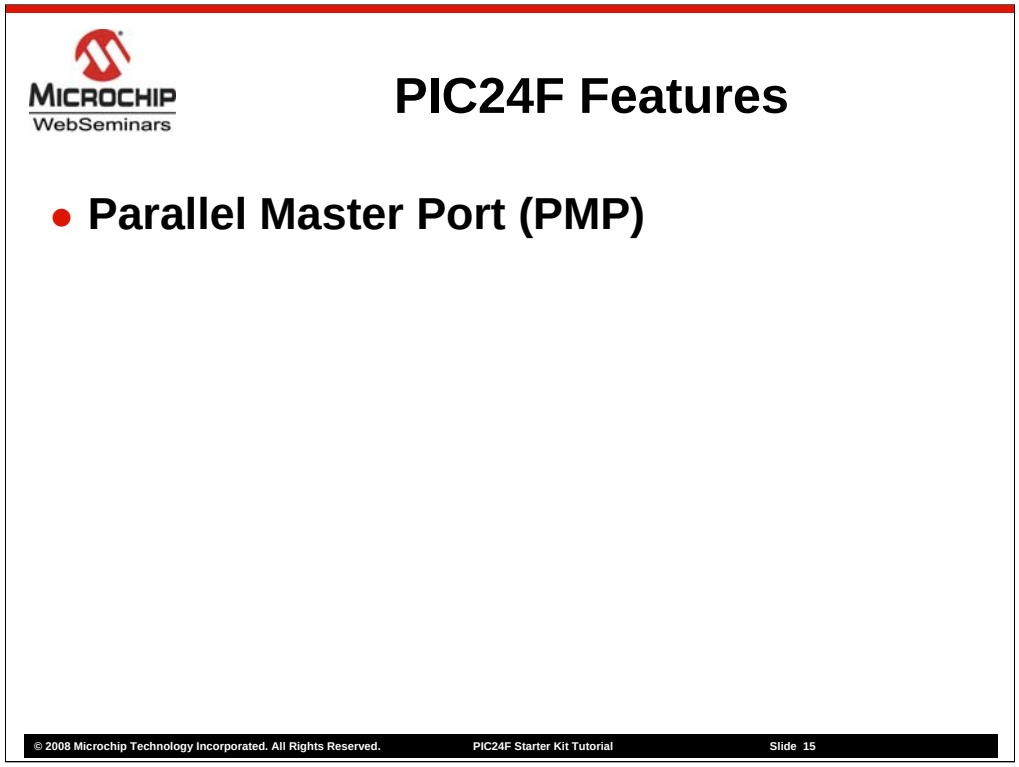
PIC24F Starter Kit



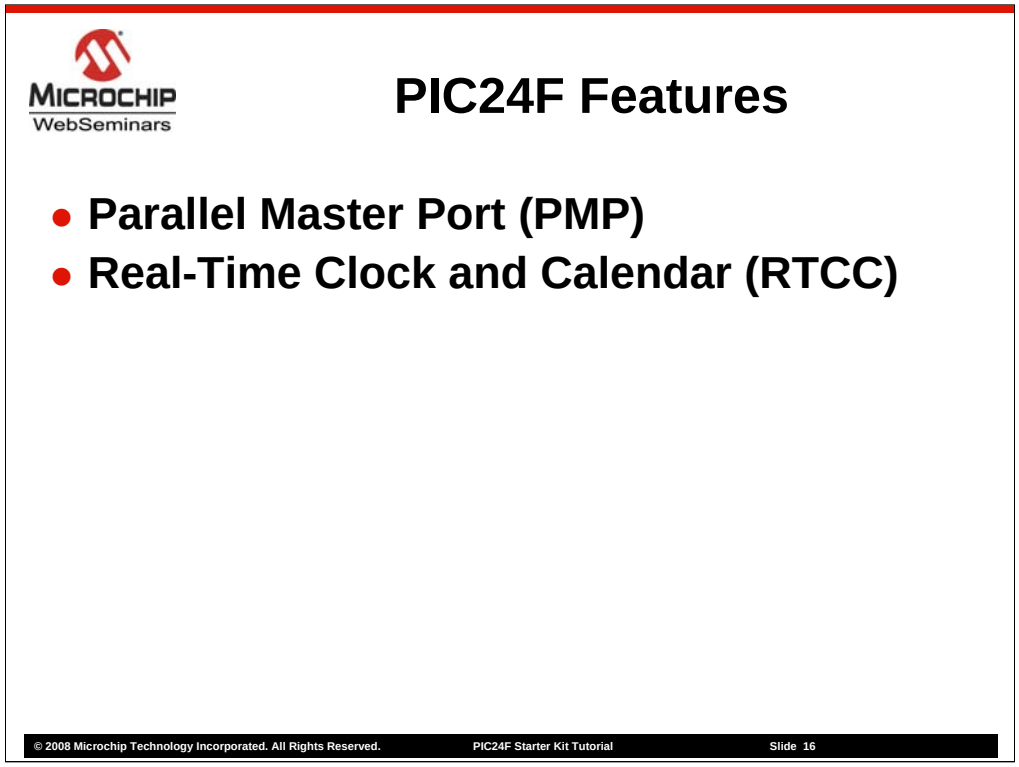
A potentiometer is also provided for input.



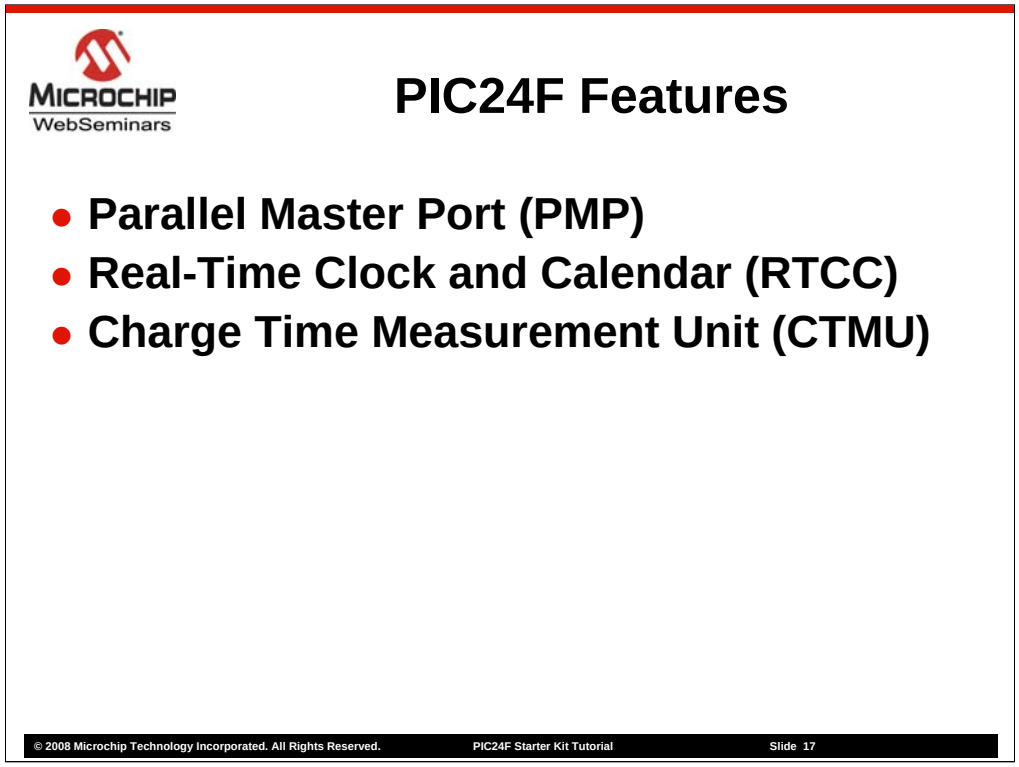
The PIC24F microcontrollers have many features and peripherals that make them powerful, versatile platforms for embedded projects.



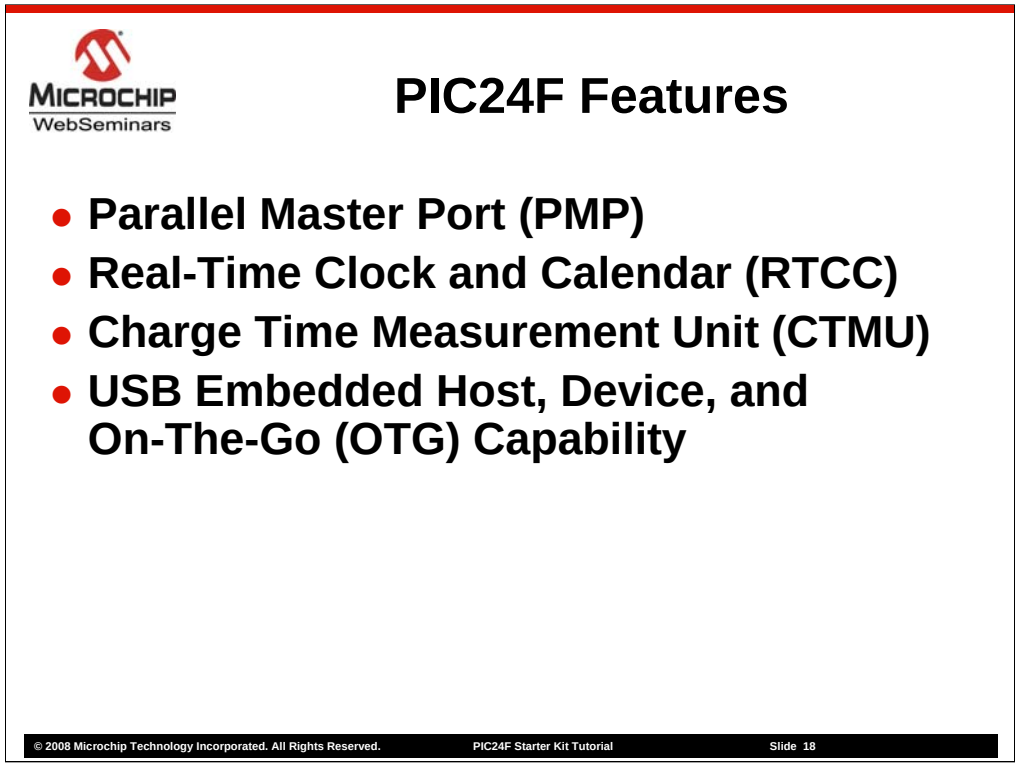
The Parallel Master Port, or PMP, is a parallel 8-bit I/O module specifically designed to communicate with a wide variety of parallel devices, such as communications peripherals, LCDs, external memory devices, and microcontrollers. Because the interface to parallel peripherals varies significantly, the PMP module is highly configurable.



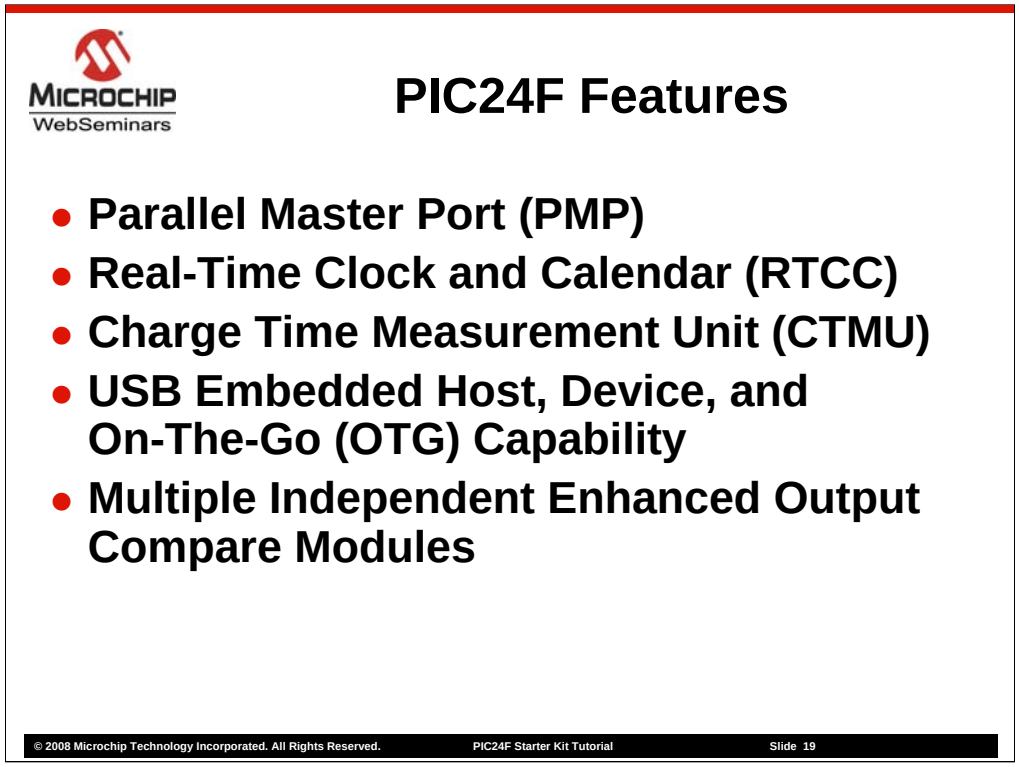
The Real-Time Clock and Calendar module is a 100-year clock and calendar with automatic leap year detection. It runs off a 32.768 kHz input from the secondary oscillator, and is optimized for low-power usage in battery powered applications.



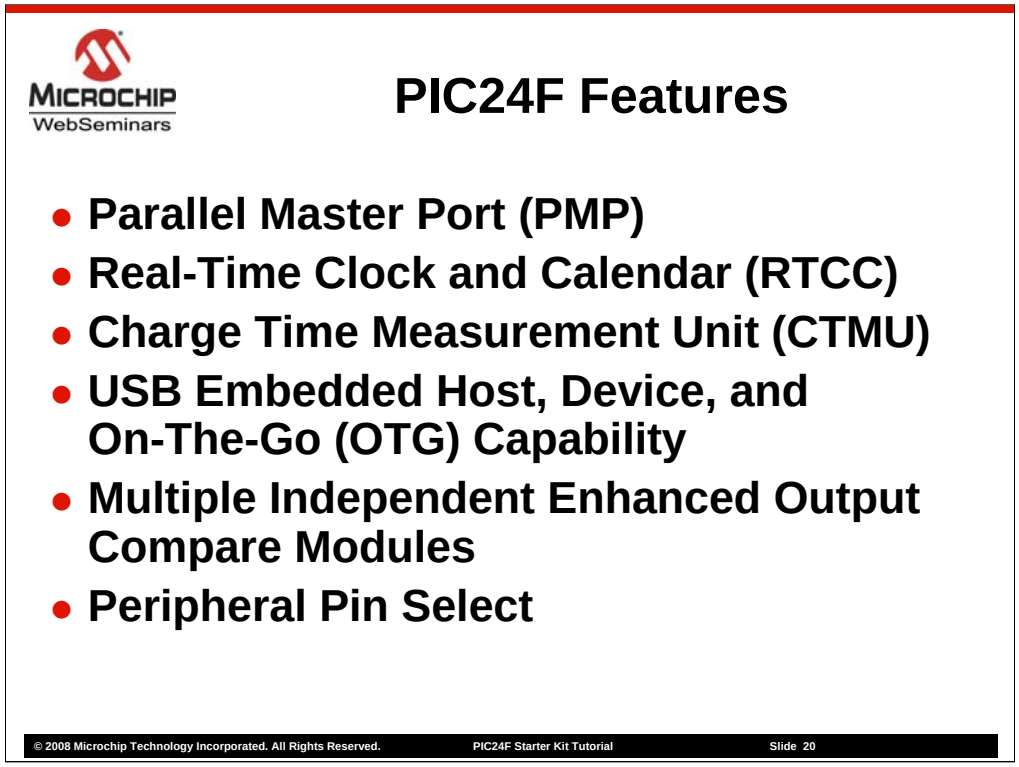
The Charge Time Measurement Unit is a flexible analog module that provides accurate differential time measurement between pulse sources, as well as asynchronous pulse generation. The CTMU allows an application like the starter kit to utilize capacitive touch sensors for user input.



The Universal Serial Bus module contains the analog and digital components to provide a USB 2.0 full-speed and low-speed host, full-speed device or On-The-Go implementation with a minimum of external components. USB Device mode support allows an application to easily interface to a PC, while the USB Embedded Host capability allows an embedded application to utilize the wide array of available USB devices.



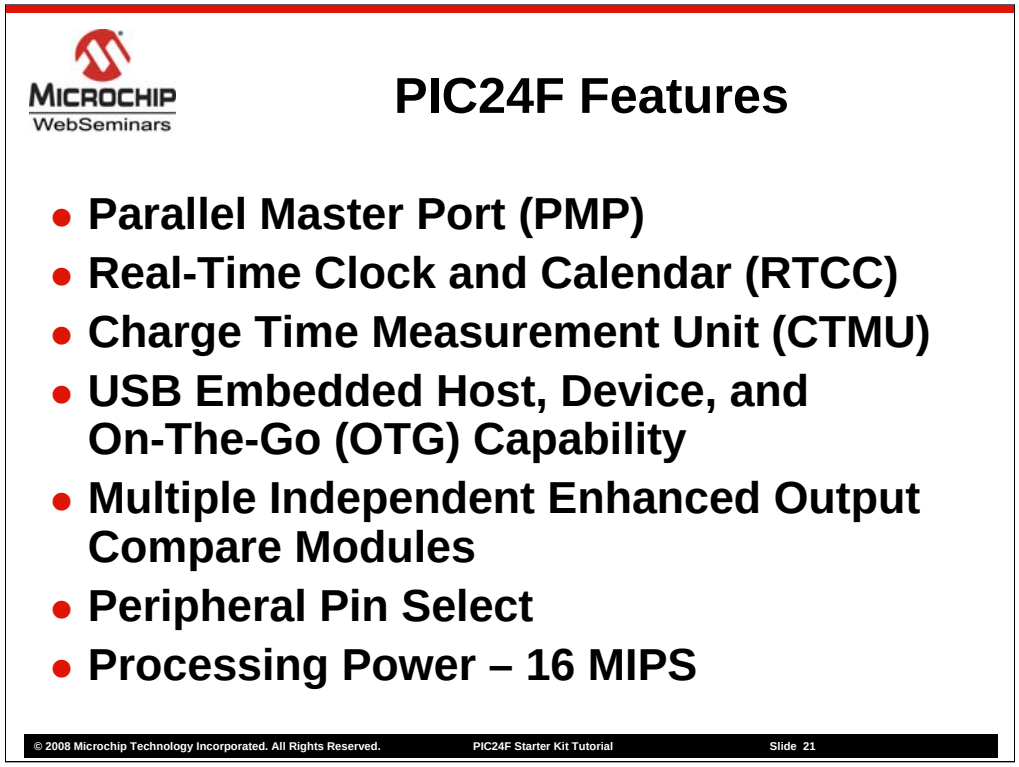
An output compare module has the ability to compare the value of a selected time base with the value of one or two compare registers, depending on the operation mode selected. Furthermore, it has the ability to generate a single output pulse, or a train of output pulses, on a compare match event. The PIC24FJ256GB106 has nine independent output compare modules.



Many of the PIC24F devices have the Peripheral Pin Select feature. On many microcontrollers, especially the lower pin count devices, pins are often shared between device peripherals. For example, a UART module may share pins with an SPI module. If an application wanted to use both the UART and the SPI, it would require either special hardware and software multiplexing, or a larger pin count device that does not share those pins. Peripheral Pin Select allows a user to remap certain digital signals to optimally utilize the peripherals and the available pins on a device.

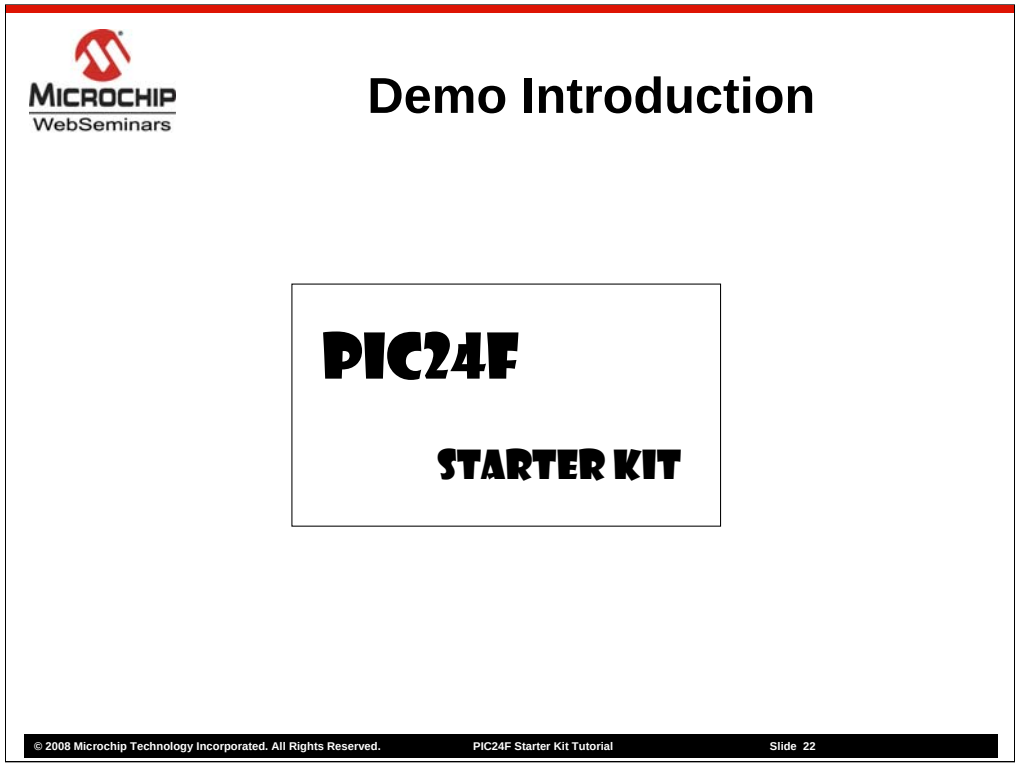
Peripheral Pin Select also allows peripherals to overlay each other. For example, mapping an interrupt on change input onto a UART receive pin allows the device to wake up from Sleep when a character is received.

In addition, Peripheral Pin Select allows multiple pins to be used for a single output function, increasing the drive strength.

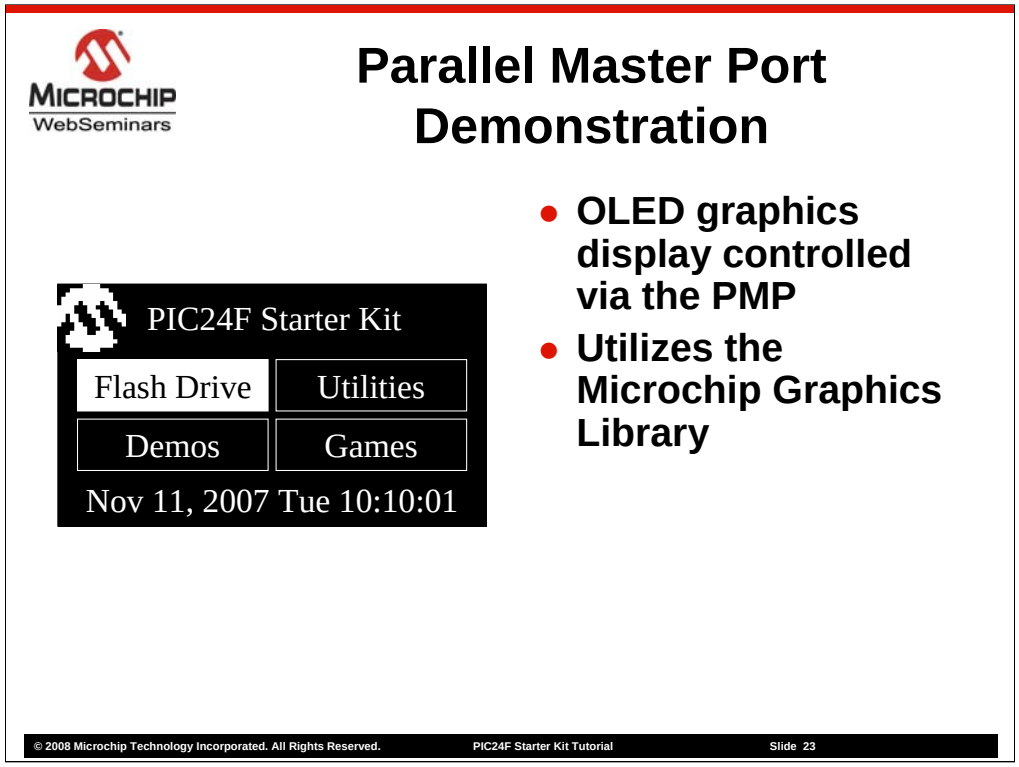


All of these features are available on a device with a processing power of up to 16 MIPS, with an architecture where the majority of instructions are executed in a single cycle.

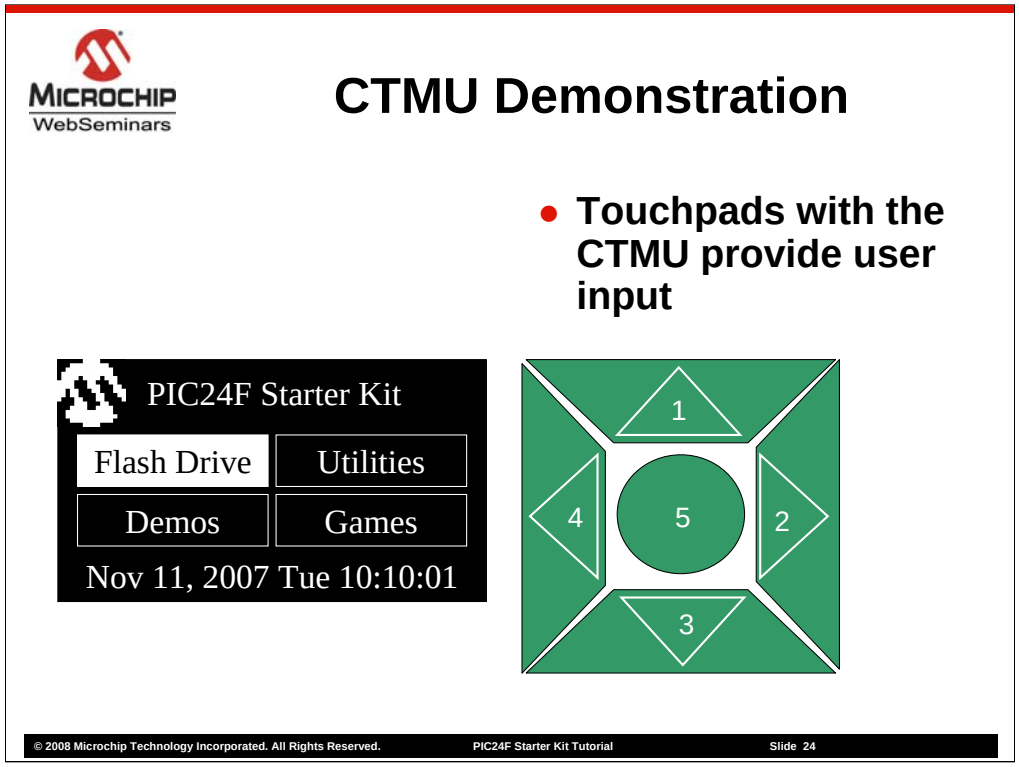
Now, let's take a look at the demonstration program already loaded on the PIC24F Starter Kit.



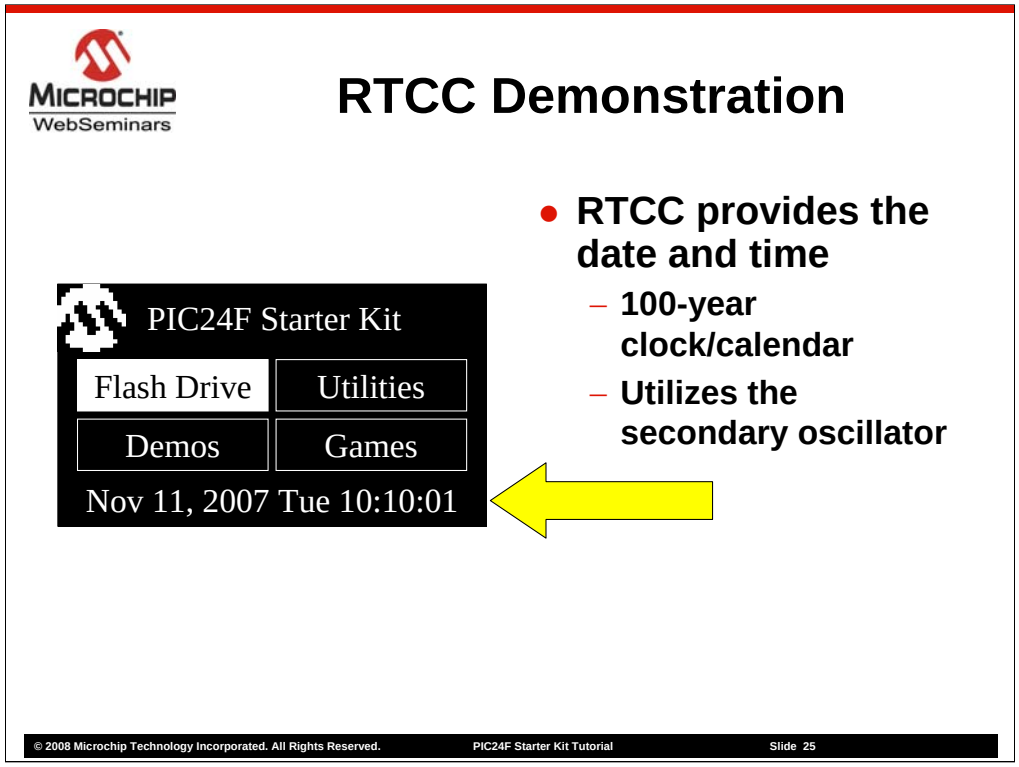
After installing the software on the CD, plug the Starter Kit board into a USB port of the PC by plugging the mini-B cable into the receptacle on the left side of the starter kit board. Allow the preprogrammed demonstration program to run. The starter kit will display a splash screen and set the RGB LED to a series of different colors.



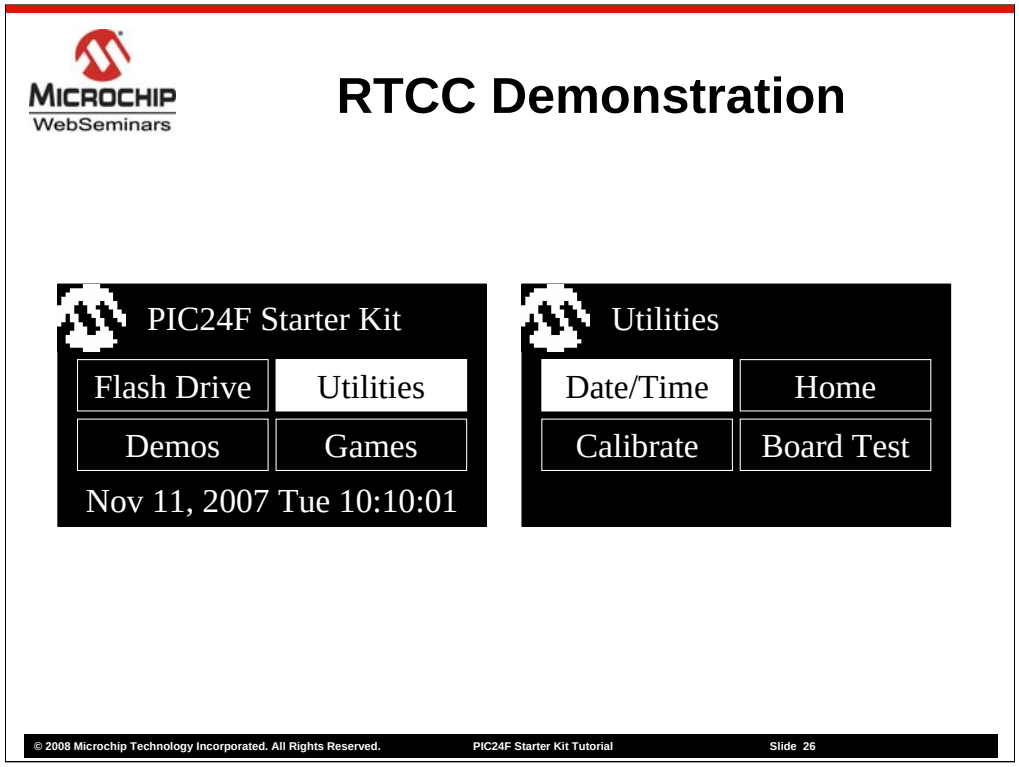
After the introduction, the organic LED graphics display will appear as shown. The OLED is controlled via the Parallel Master Port. The demo utilizes the Microchip Graphics Library to control the OLED and create various controls on the display, such as buttons, pictures, text, and sliders.



The touchpads to the right of the display implement capacitive touch sensing for user input. The touchpads are connected to analog inputs to utilize the Capacitive Time Measurement Unit to detect a touch. Use the arrow touchpads to change the highlighted button, and use the center touchpad to select it.



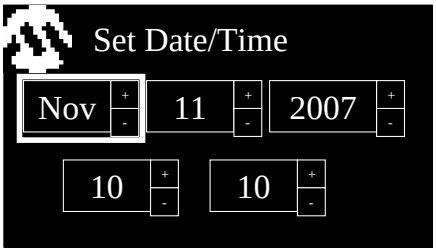
The date and time at the bottom of the display are obtained by utilizing the Real-Time Clock and Calendar. Since the starter kit has no battery back-up, the initial starting time is hard coded. You can change the date and time through the demo application.



Use the left/right and up/down touchpads to highlight the Utilities option, and then touch the center touchpad to select it.

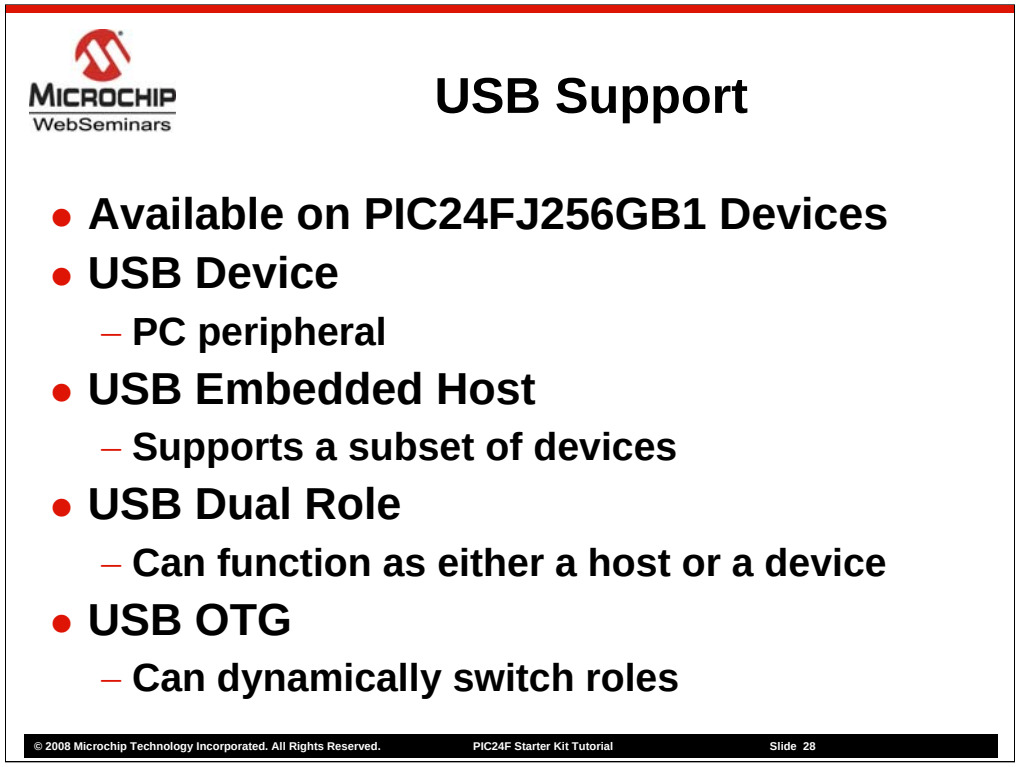
The different utility functions of the demo are displayed. Use the touchpads to highlight and select the Date/Time option.

RTCC Demonstration

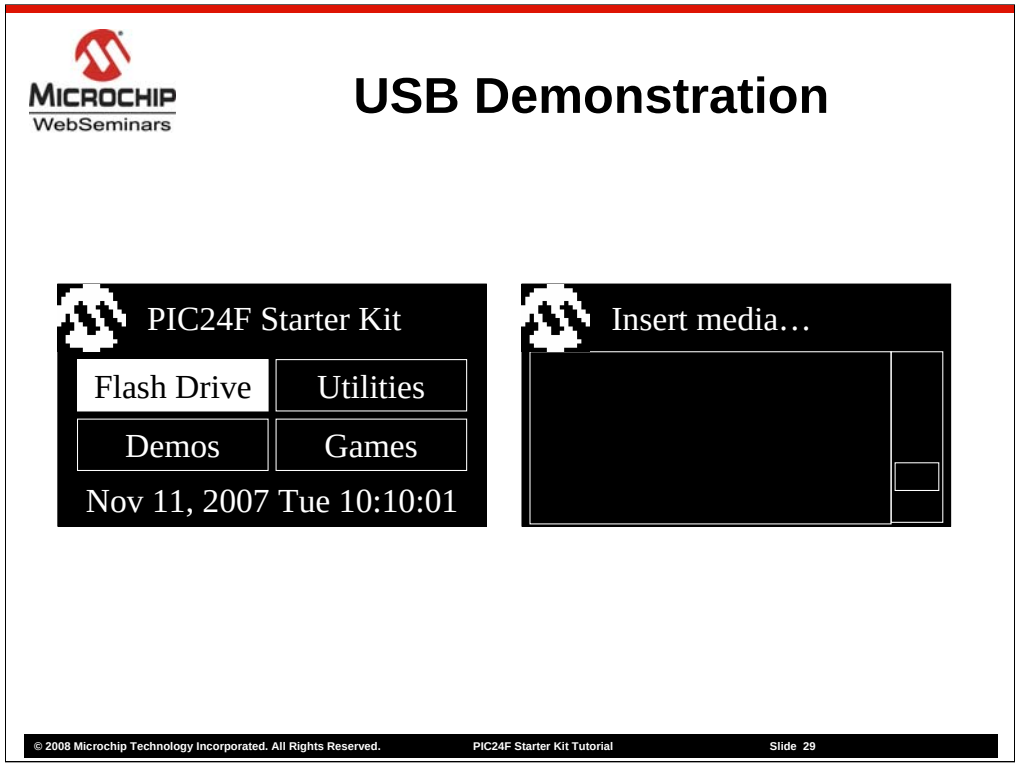


- Current parameter is highlighted
- Left/right – select parameter
- Up/down – Increase/decrease parameter value
- Center – exit

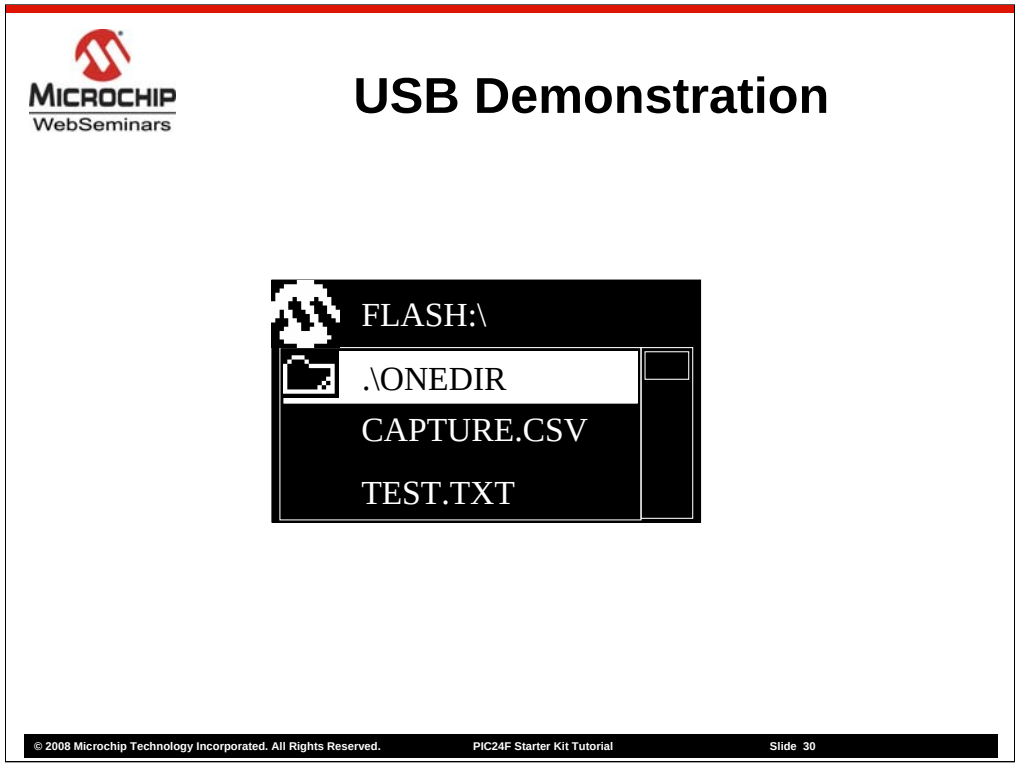
This portion of the demo allows you to set the current date and time of the RTCC. The current parameter is indicated by a thick outline. Use the left and right arrows to select which parameter you want to change. Touch the up arrow to increase the value, and touch the down arrow to decrease the value. When all parameters are set, touch the center touchpad to return to the name menu.



Microchip has expanded its USB offerings with the PIC24FJ256GB1 microcontrollers. Like the PIC18F devices, these microcontrollers provide USB device functionality, allowing an application to have easy connectivity to a PC. In addition, the PIC24F family also offers USB Embedded Host capability, allowing an application to utilize a selected subset of widely available PC peripherals or to interface with a custom device. An advanced application can be a USB Dual Role Device by acting as either a Device or an Embedded Host. In addition, the PIC24F devices support USB On-The-Go, which allows an application to switch roles on the fly, without manually changing cables.



The starter kit's demo application shows the USB Embedded Host capability of the PIC24FJ256GB1. From the demo's main menu, select the Flash option. You will then be prompted to insert a Flash drive into the Type-A receptacle. If you have a Flash drive available, insert it into the receptacle.

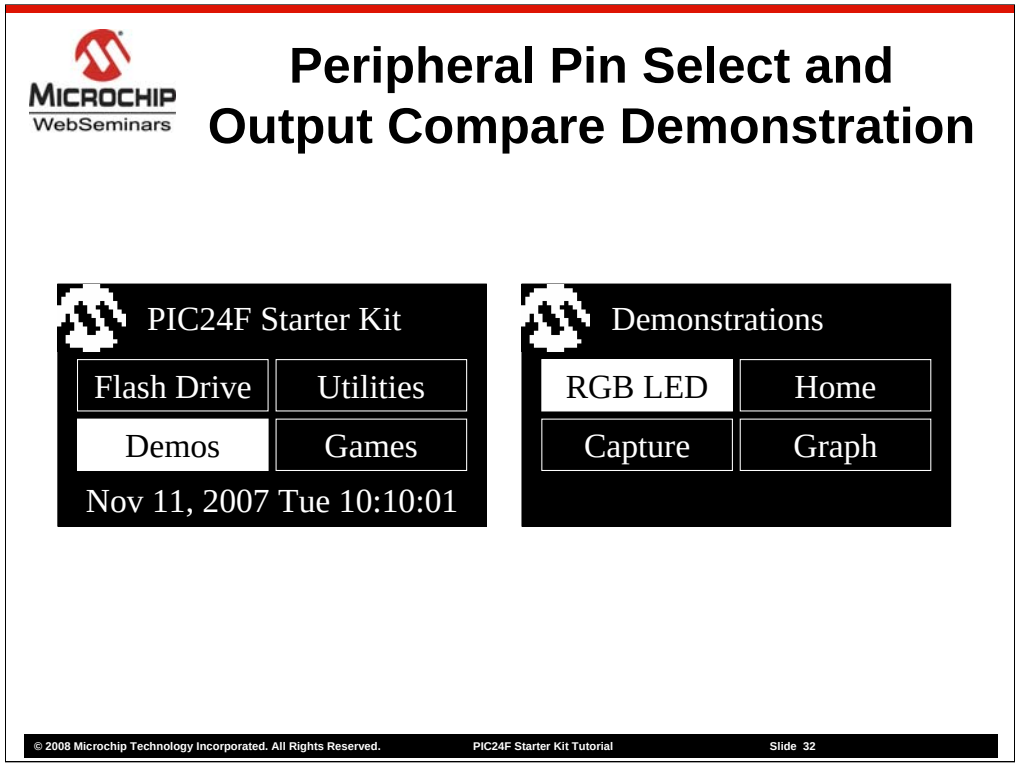


When you insert a Flash drive, the demo will read the volume label and the root directory of the Flash drive. It will display the volume label at the top of the display, and the contents of the directory in a listbox below. Subdirectories are displayed first, as indicated by a preceding folder icon, followed by a list of files. Use the up and down touchpads to scroll through the file list.

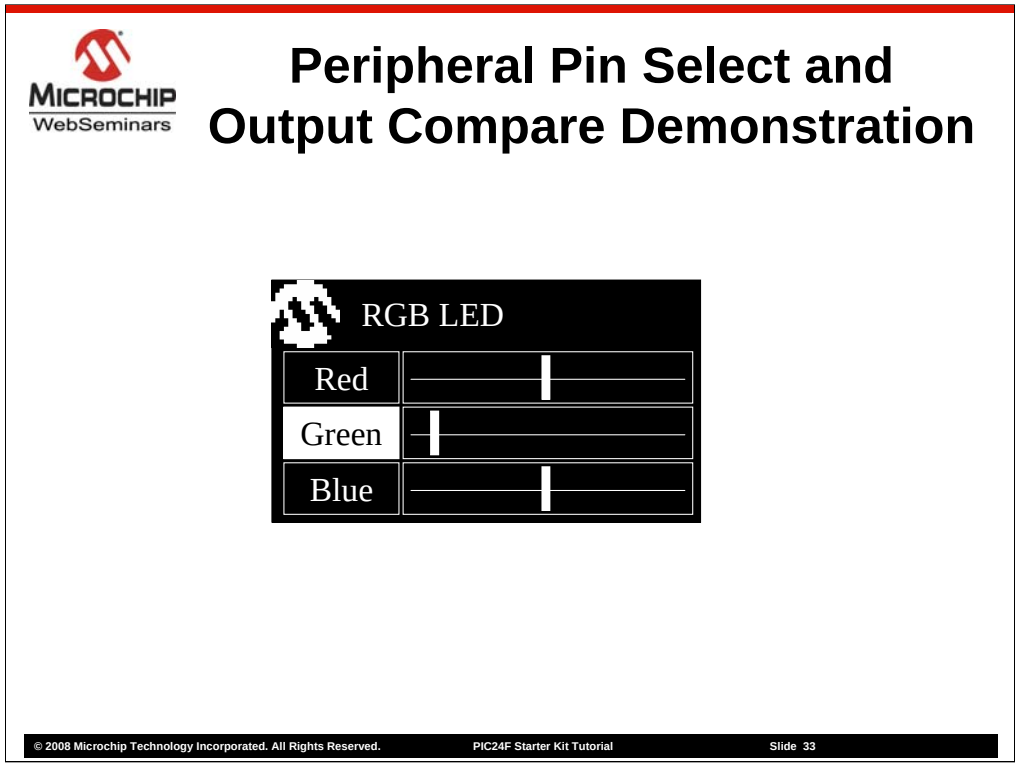
To explore the directory structure of the Flash drive, select a directory using the up and down touchpads, and then touch the center touchpad.

USB Demonstration

The current working directory will change to that directory, and the files in that directory will be displayed. To go up to the previous directory, select the dot-dot directory and touch the center touchpad. When you are finished, touch the left arrow touchpad to exit this portion of the demo and return to the main menu.



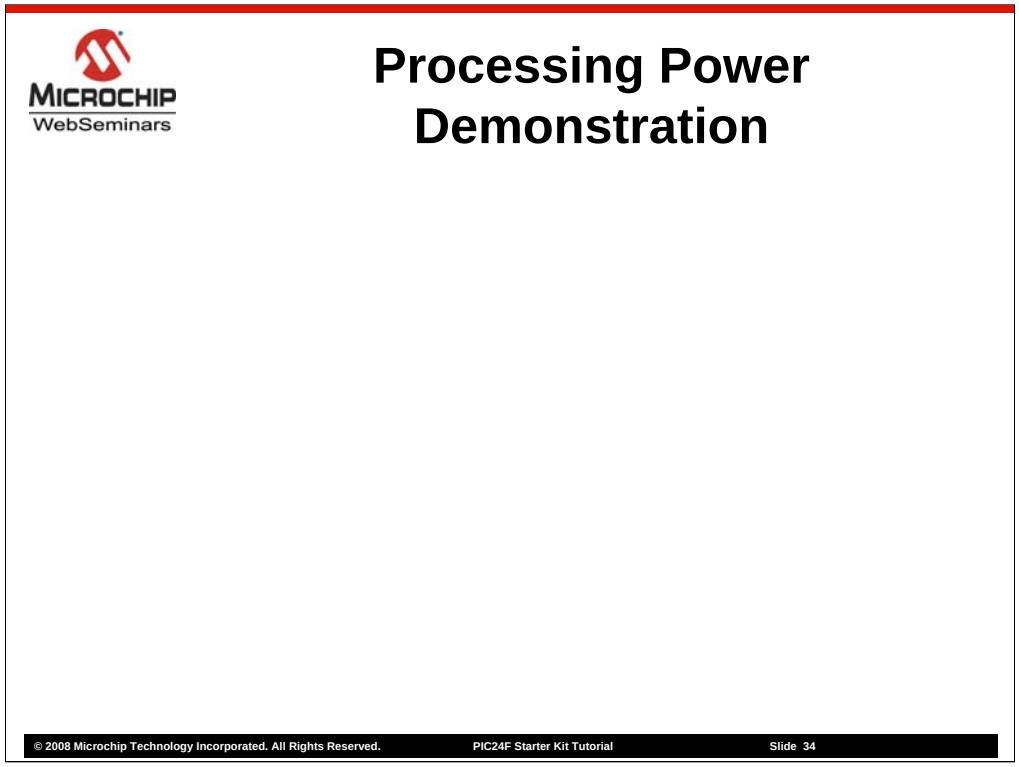
The PIC24F Starter Kit includes a demonstration of using three output comparators and Peripheral Pin Select to control an RGB LED. From the demo's main menu, select Demos. Then select RGB LED from the Demonstration menu.



The demonstration program will enable the RGB LED at the top of the demo board, and allow you to configure the red, green, and blue components of the color. Each component is controlled by an output comparator configured as a PWM output. Each PWM output is mapped to two output pins using Peripheral Pin Select, increasing the drive strength and therefore the brightness of the LED.

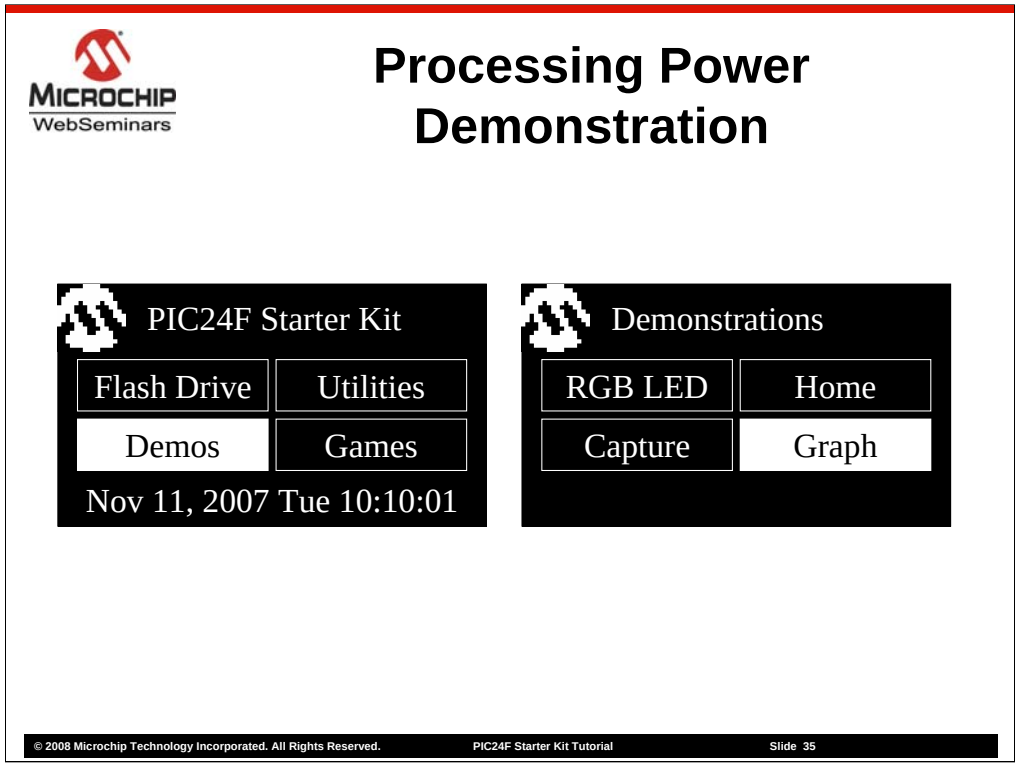
Use the up and down touchpads to select which color to modify. Use the left touchpad to reduce the color content by increasing the PWM duty cycle. Use the right touchpad to increase the color content by decreasing the PWM duty cycle.

When you are finished with this demonstration, touch the center touchpad.

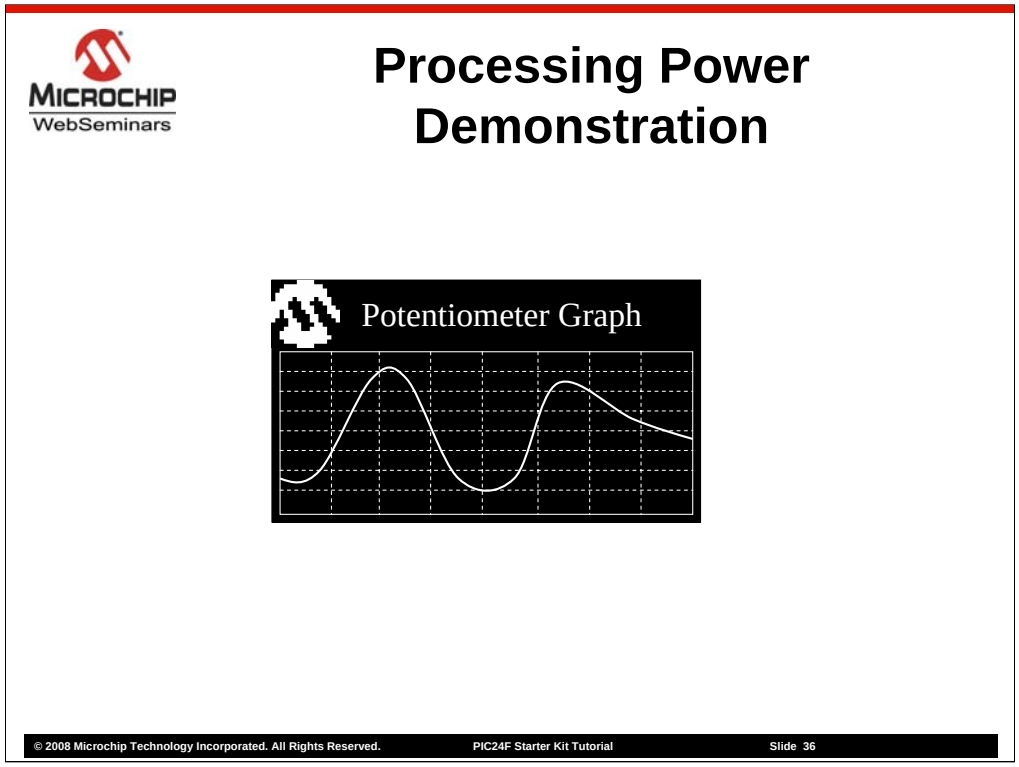


Most PIC24F instructions execute in a single instruction clock cycle, with branches and comparisons requiring only two or three cycles. With a top speed of 16 MIPS, the PIC24F has plenty of processing power for a wide variety of applications.

For example, graphics output is a very CPU intensive operation. But the PIC24F simultaneously can monitor the user touchpads plus an additional input channel, and display the additional reading in graphical format.

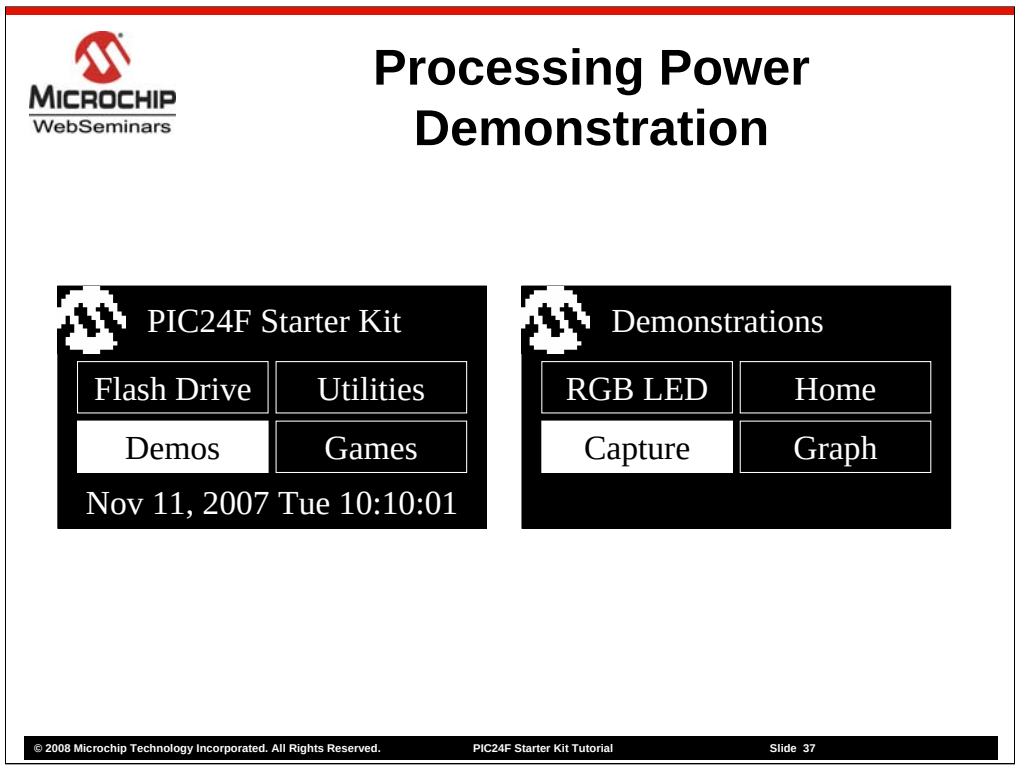


From the main menu, select Demos. Then, from the Demonstrations menu, select Graph.

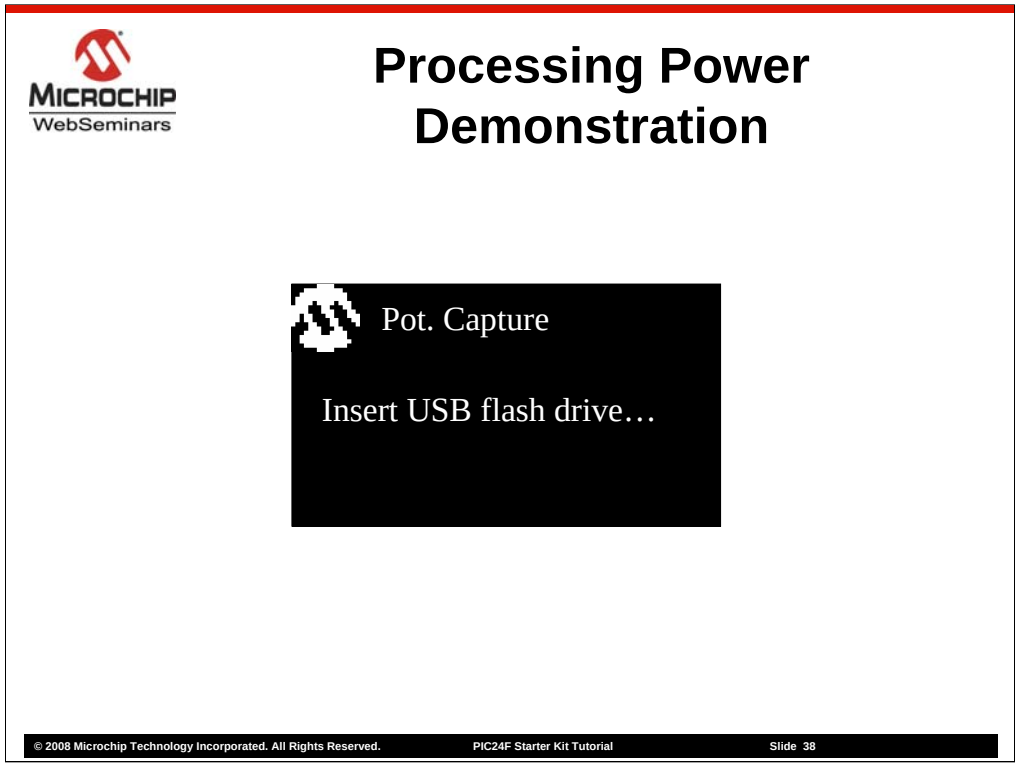


The demo will monitor the potentiometer at 10 millisecond intervals, while monitoring the touchpads and displaying a scrolling graph of the potentiometer readings. Twist the potentiometer on the right side of the demo board and watch as the readings are reflected on the display. To increase the display speed, touch the right touchpad. To decrease the display speed, touch the left touchpad.

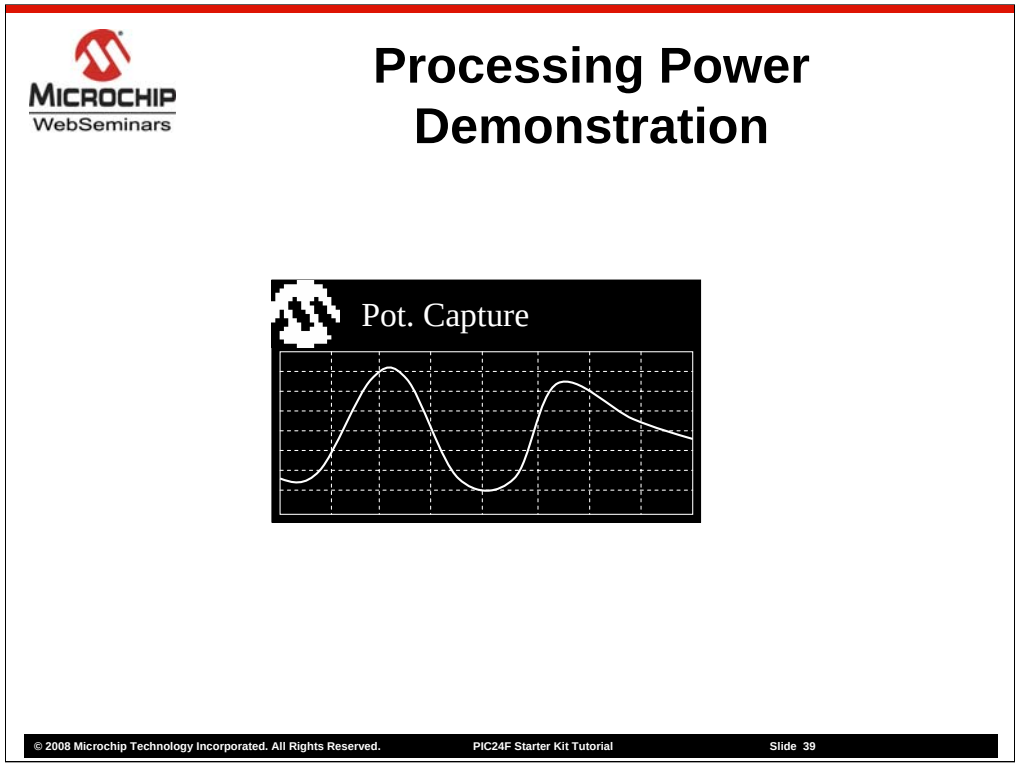
When you are finished with this demonstration, touch the center touchpad.



Often, an application wants not only to monitor data, but to store the data for later analysis. By using the PIC24F's USB Embedded Host capability, an application can store data to a USB Flash drive for easy transfer to a PC for analysis. To see this capability in action, select Demos from the main menu. At the Demonstrations menu, select Capture.



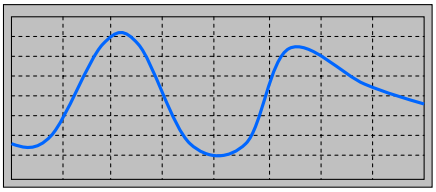
You will be prompted to insert a USB Flash drive into the Type-A receptacle on the right side of the demo board. Insert a Flash drive to begin data monitoring and capturing.



Except for the title, the display looks identical to the graphing demonstration. The touchpad controls are identical: the left arrow slows the display, the right arrow speeds the display, and the center touchpad exits the demo. The difference is that while the graphics display is being updated, the potentiometer readings are also being stored to the file CAPTURE.CSV in the root directory of the Flash drive. Let the demo run while twisting the potentiometer to view the display. Then press the center touchpad to terminate the demonstration. Do not remove the Flash drive while this portion of the demo is in progress. If the Flash drive is removed while the application is writing to it, the Flash drive will be corrupted.

Processing Power Demonstration

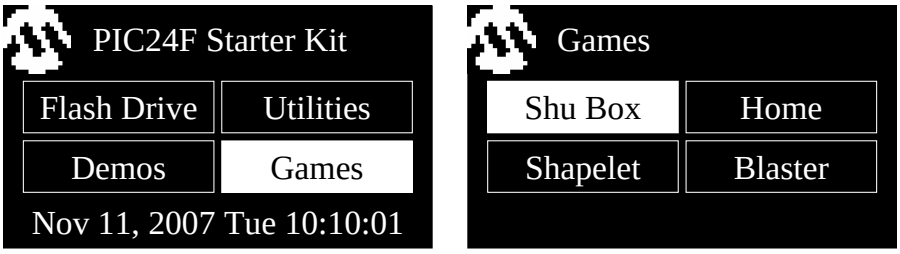
	A	B
1	1540	422
2	1541	418
3	1542	415



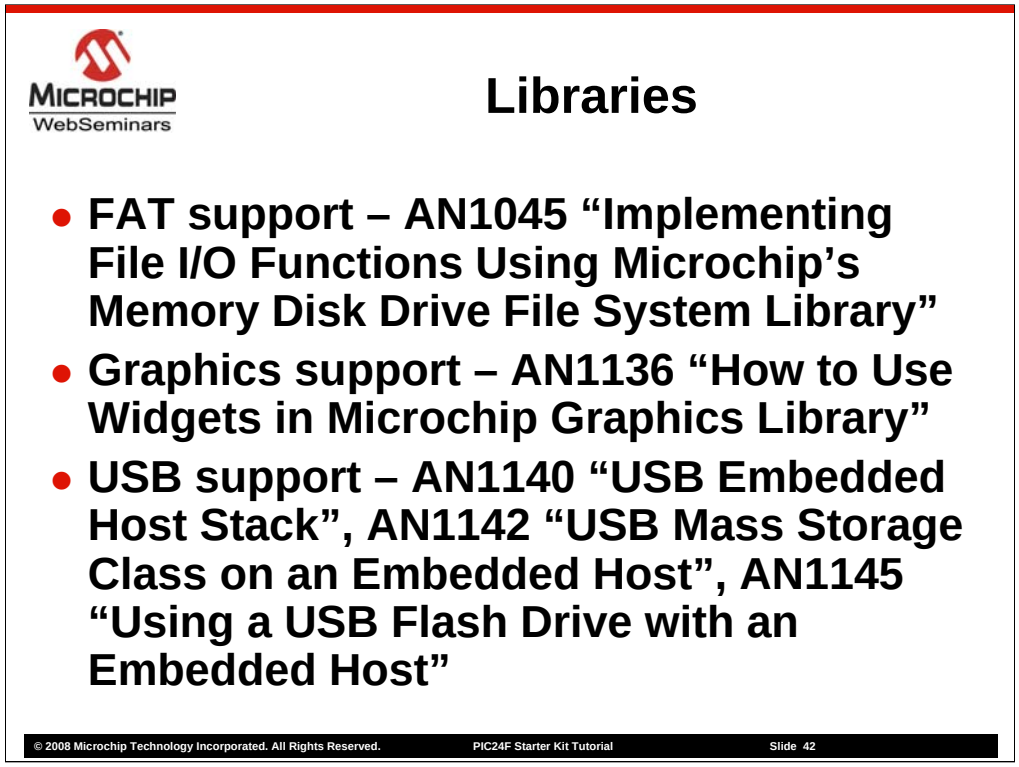
After exiting the demo, remove the Flash drive, and insert it into a PC. Use a spreadsheet program to open CAPTURE.CSV. The beginning of the file will look something like this. The first column is the timestamp of the data. Each number represents one 10 millisecond interval, and is the number of intervals since the demo began execution. The second column is the raw potentiometer reading. Use the spreadsheet program to graph the data column. You should get a graph that looks very similar to the one displayed real-time during data collection.

Note that the data displayed on the starter kit's graph is not guaranteed to be at a fixed interval, but is for indication only. The data captured to the Flash drive, however, is guaranteed to be at a fixed interval, and can be used for analysis.

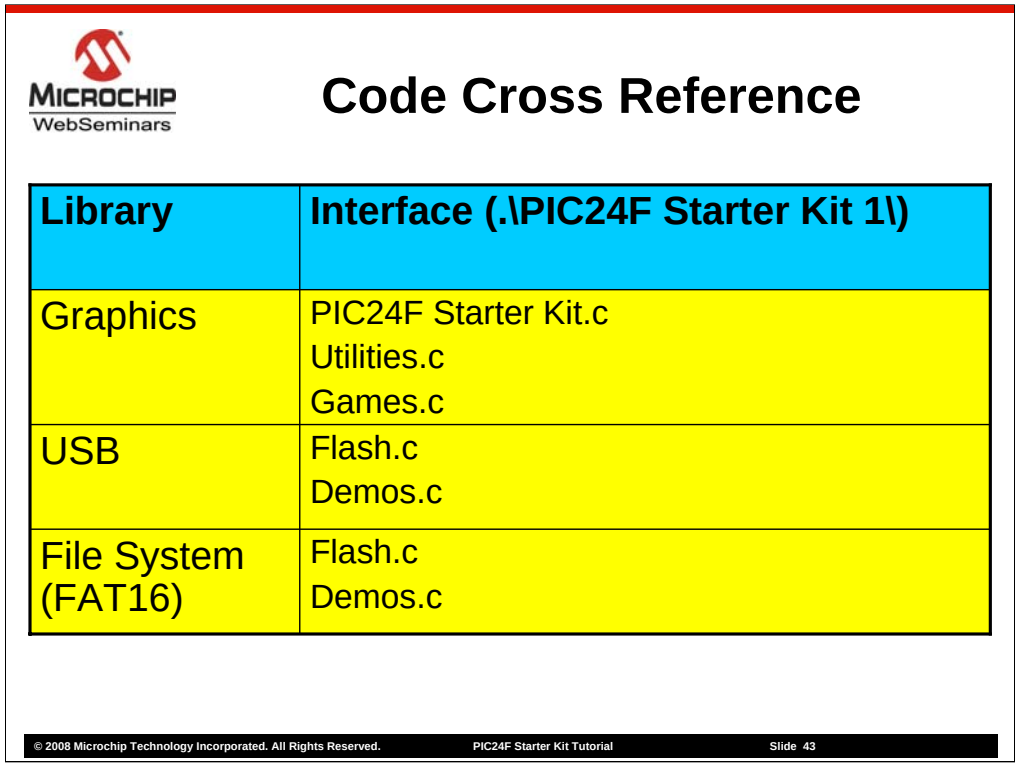
Other Application Ideas



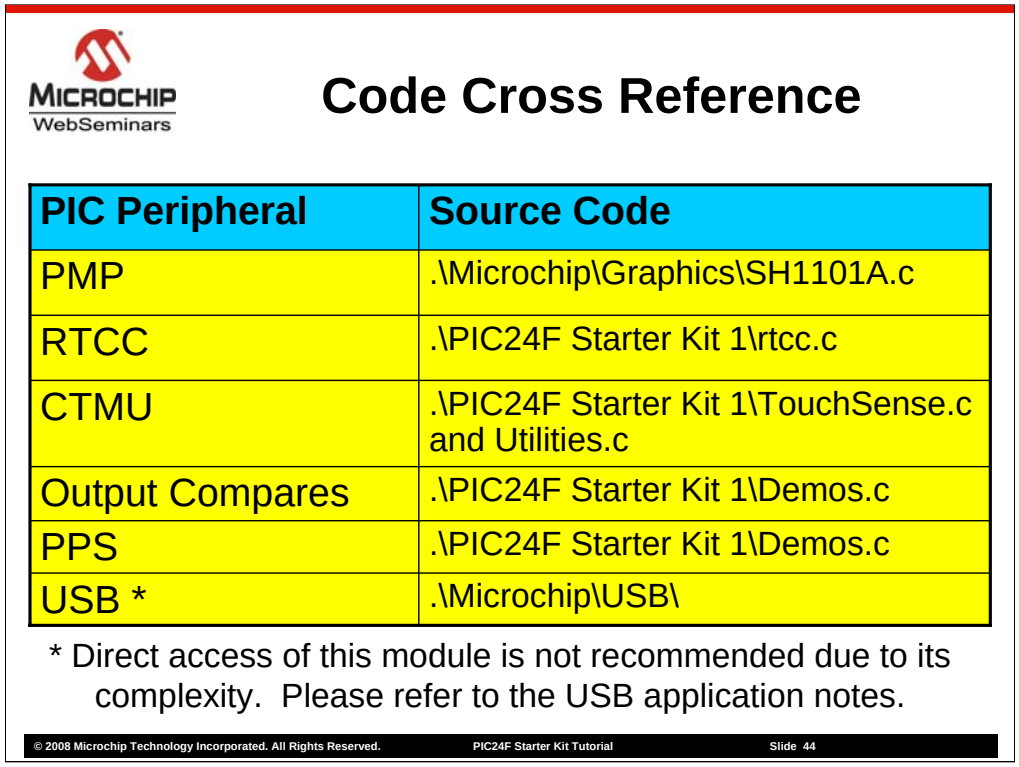
For other interesting applications for the PIC24F, be sure to investigate the other available menu options.



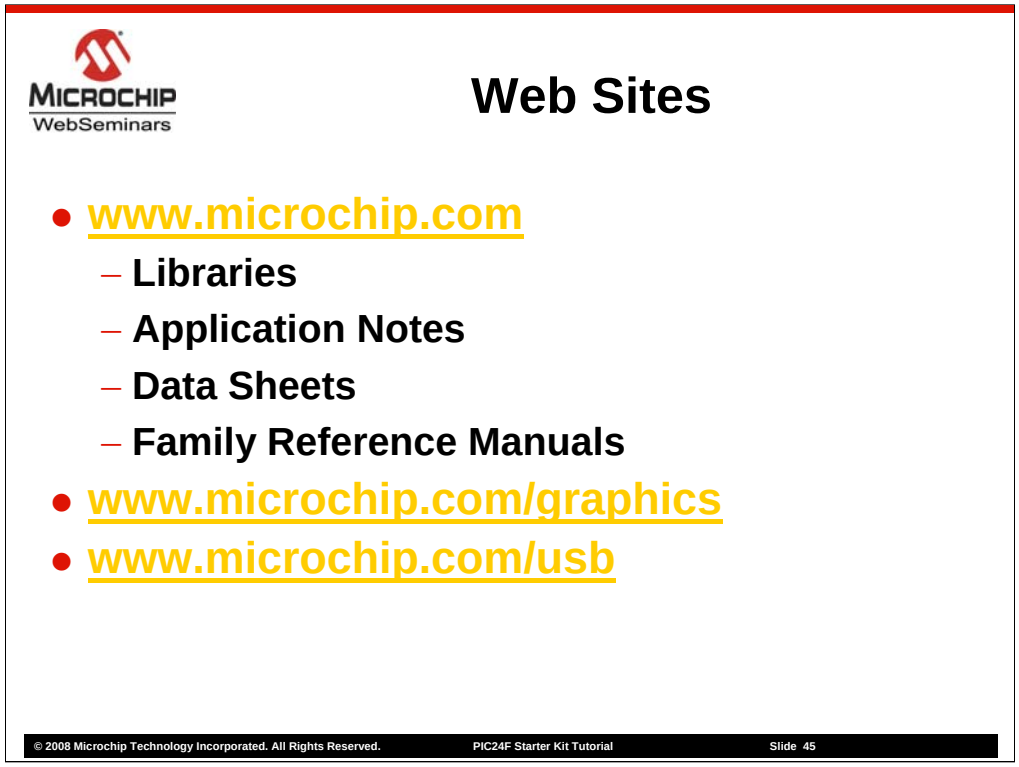
The demonstration program on the PIC24F Starter Kit uses several freely available libraries. Portions of those libraries are included with the starter kit demo code, which is installed as part of the Starter Kit installation. Application Note 1045 provides support for the FAT16 file system used on many Flash drives. Application Note 1136 describes in more detail how to use the Graphics Library. USB support is described by several application notes. The key application notes for this demo are Application Note 1140, which is the USB Embedded Host Stack; Application Note 1142, which describes the Mass Storage Class on an Embedded Host; and Application Note 1145, which describes how to interface to a USB Flash drive.



If you would like to see examples of how to interface with the various libraries, please refer to the following source files in the project directory. The files PIC24F Starter Kit.c, Utilities.c, and Games.c provide the best examples of interfacing with the graphics library. The files Flash.c and Demos.c show how to utilize the USB and the Microchip Memory Disk Drive File System with FAT16 support.



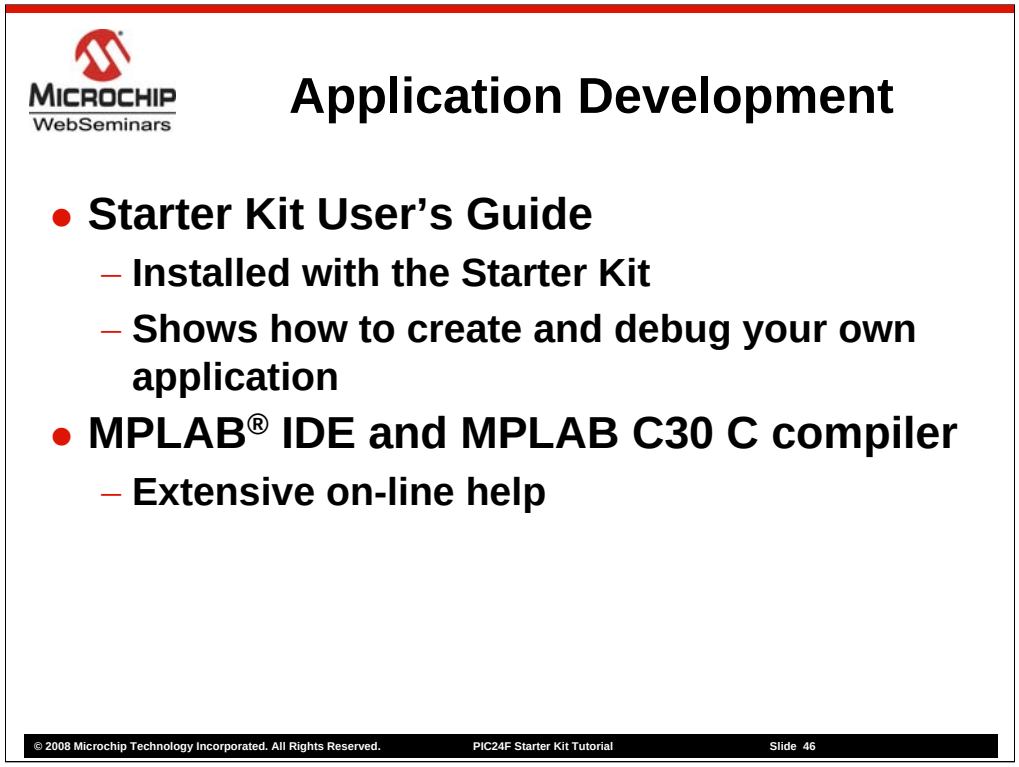
If you would like to see examples of how to interface with the various PIC® MCU peripherals, please refer to these files used to create the demonstration project. The Parallel Master Port interface can be found in the Graphics Library directory, in the file SH1101A.c. The Real-Time Clock and Calendar interface can be found in the file rtcc.c in the project directory. The CTMU interface is in two files. TouchSense.c performs the keypad scan and interpretation, and Utilities.c contains the calibration routine. Three output comparators are used in PWM mode in the RGB LED demonstration, which is found in the file Demos.c. The PWM outputs are configured with Peripheral Pin Select, also located in the Demos.c file. The USB peripheral is used by the various files in the USB library directory. Due to the complexity of the USB module and the USB specification, we recommend that you not access the module directly, but use the provided Embedded Host and Peripheral Device libraries.



Go to the Microchip website, www.microchip.com, for the full, most recent version of the libraries and application notes used in this demonstration. You can also find the appropriate data sheets and Family Reference Manual chapters at this site.

For more information about the Graphics Library, go to www.microchip.com/graphics.

For more information about the USB Library, go to www.microchip.com/usb.



When you are ready to try your own application, or simply modify the demonstration project, refer to the starter kit's User's Guide, which is installed in the Starter Kit's Documentation directory. You can also refer to the extensive on-line help available for the MPLAB® IDE and the MPLAB C30 C compiler.

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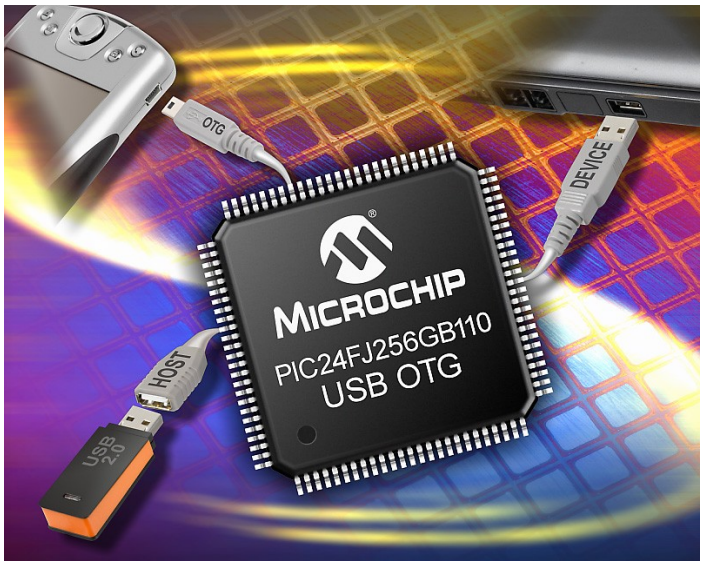
Thank you!



Thank you for taking the time to view this tutorial.

You are now ready to explore the capabilities of the PIC24F microcontroller!