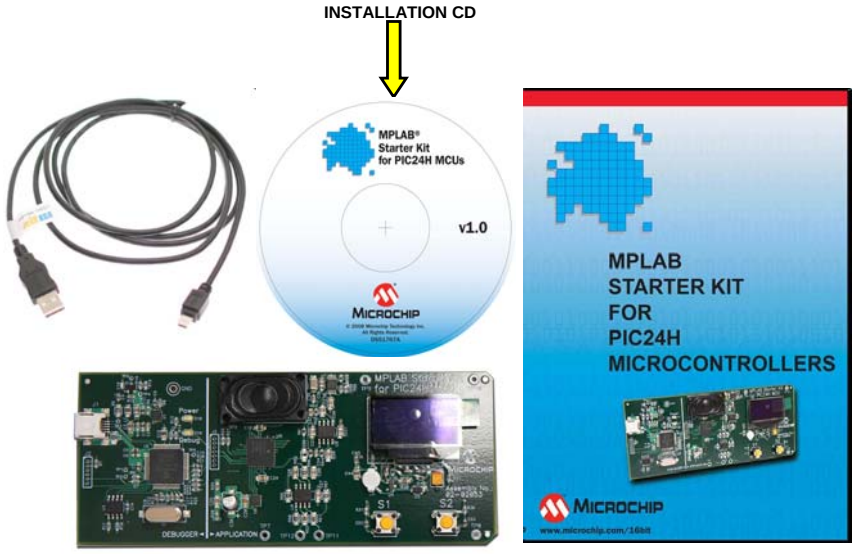
Welcome to the tutorial on Microchip's MPLAB® Starter Kit for PIC24H Microcontrollers. This MPLAB Starter Kit introduces you to Microchip's high-performance 16-bit PIC24H family of microcontrollers while demonstrating its analog and mixed-signal processing capabilities. This tutorial also introduces the various modules on the starter kit and guides you through the demonstrations.

Inside the Starter Kit

MPLAB® Starter Kit for PIC24H Microcontroller

Included inside the starter kit box are a

Inside the Starter Kit



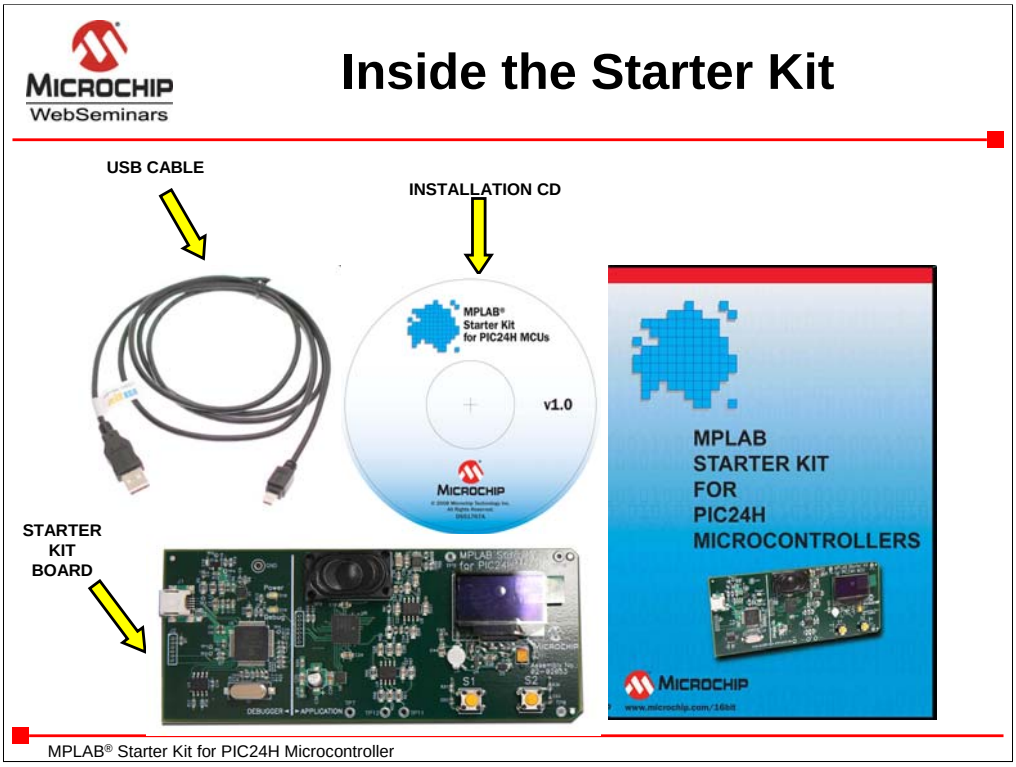
MPLAB® Starter Kit for PIC24H Microcontroller

Included inside the starter kit box are a quick-and-easy single-step installation software disc,

Inside the Starter Kit

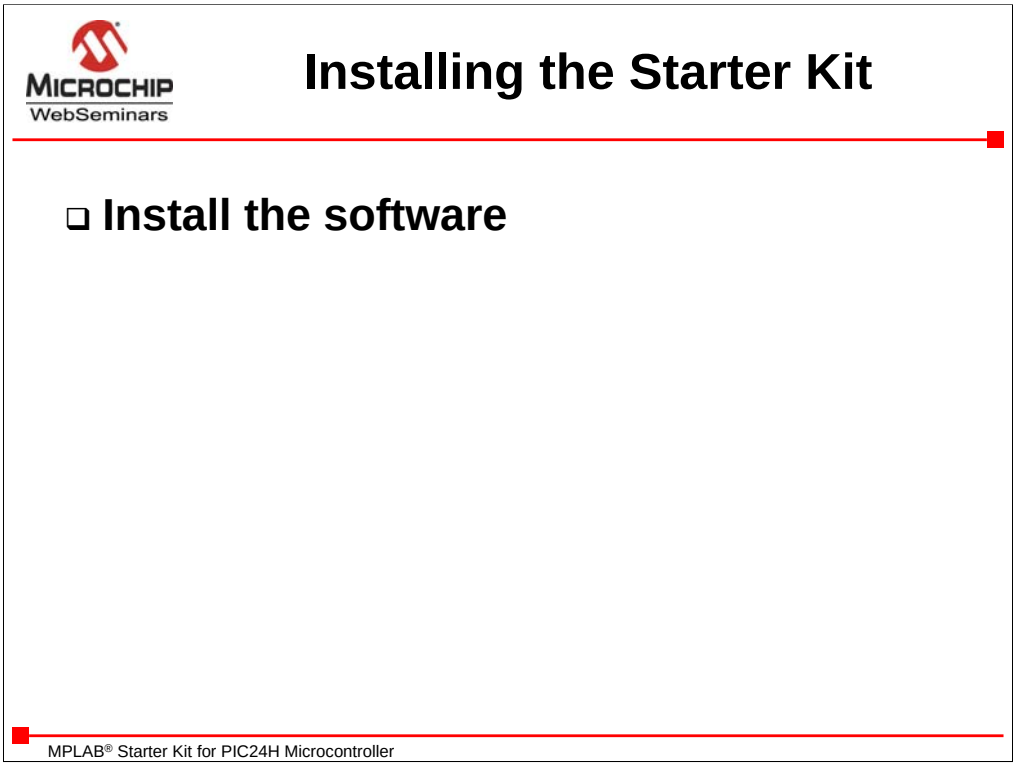
MPLAB® Starter Kit for PIC24H Microcontroller

the starter kit board

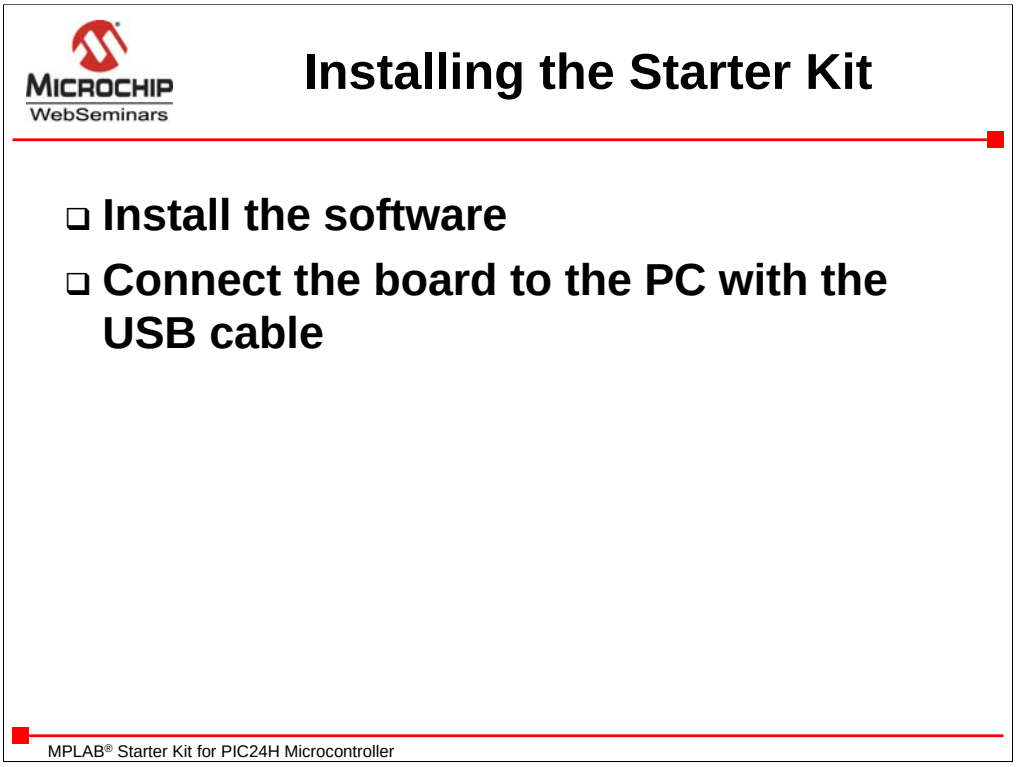


and a USB Mini-B cable for hardware connection. This cable is the debug interface to Microchip's MPLAB® IDE and provides power to the starter kit board.

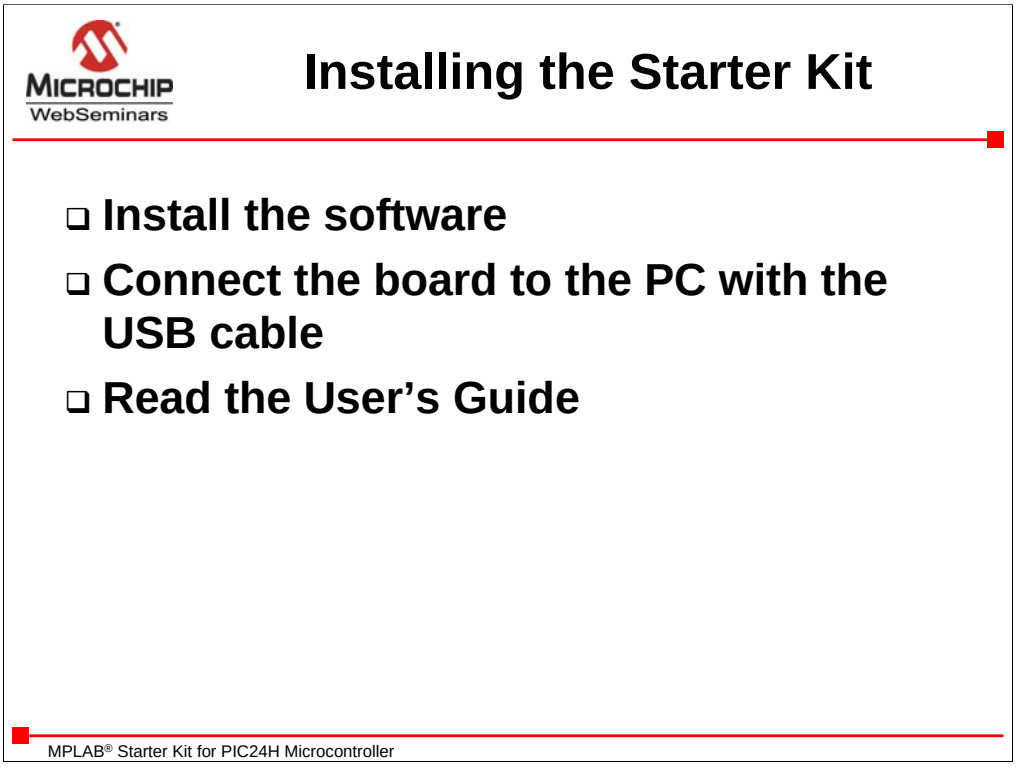
The kit is completely USB-powered, has on-board hardware debugging and programming, a tri-axial analog accelerometer, and separate, dedicated signal conditioning circuitry that enables a wide range of sensors for the kit. An OLED display, a speaker, and two switches are also included on the circuit board, which is fully documented with schematics.



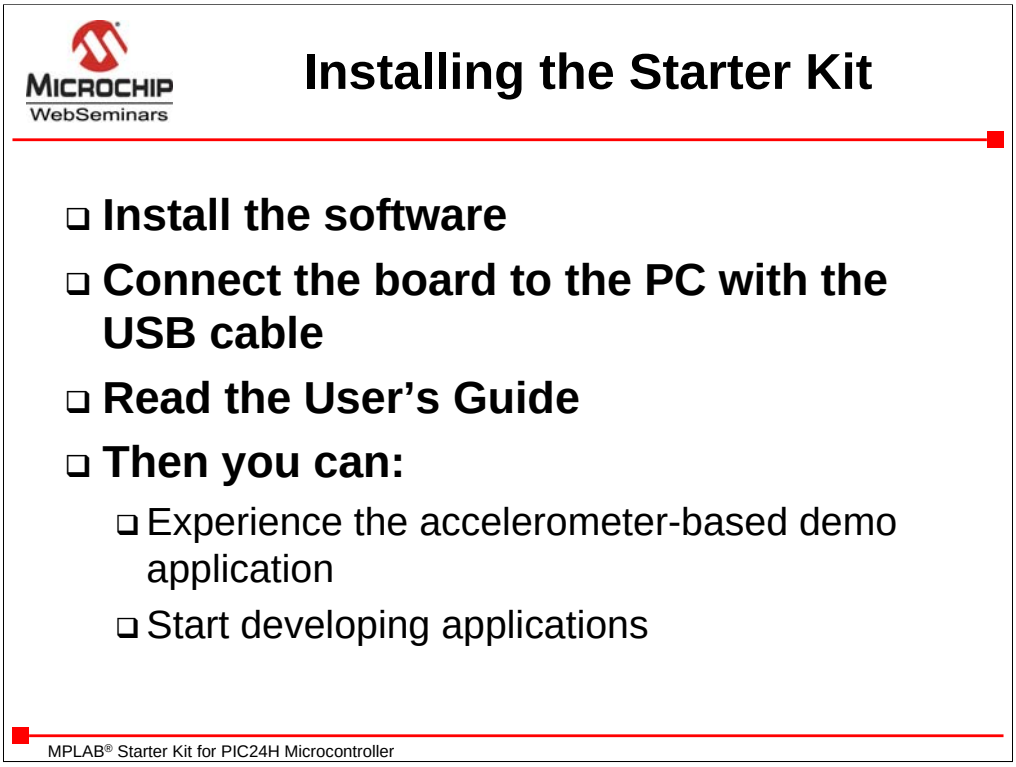
To install the starter kit software, insert the CD and follow the instructions. The installer program will install MPLAB® IDE, a student version of the C30 C compiler, demo applications and the starter kit documentation.



After the software installation is complete, plug the starter kit board into the USB port of the PC.



The entire installation procedure is described in detail in the MPLAB Starter Kit for PIC24H MCUs User's Guide, which is available on the CD.

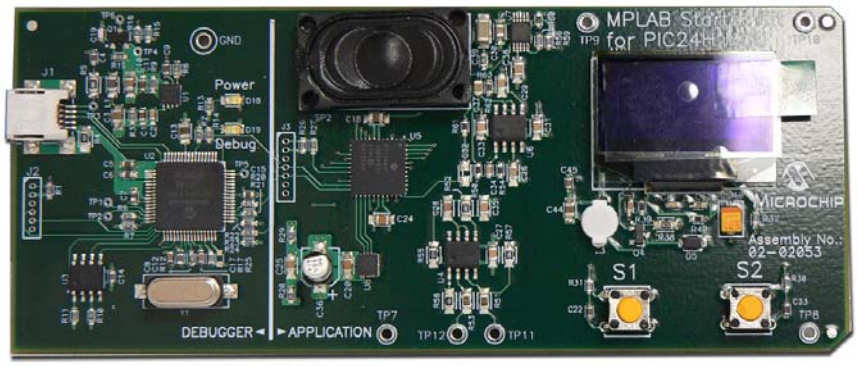


You are now ready to experience the included demo and start developing your own applications. Note that the starter kit does not require an external debugger since it already contains the required hardware on the board.

A demo application is pre-programmed on the PIC24H MCU. Connect the USB cable from the PC to the demo board to start the accelerometer-based demo application. Maneuver the board by tilting to parse through different options on the OLED display and press switches to select the options.

MICROCHIP
WebSeminars

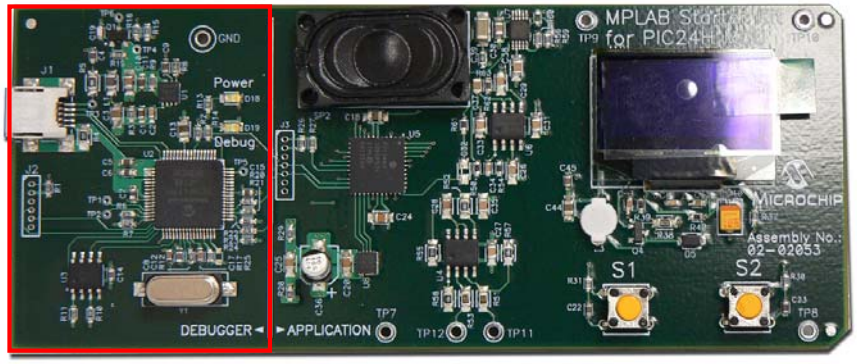
The Starter Kit Board



Let's take a closer look at the starter kit hardware.

MICROCHIP
WebSeminars

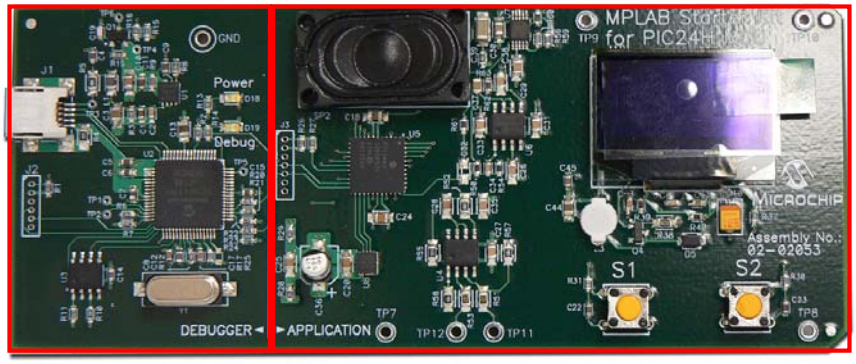
The Starter Kit Board



DEBUG / PROGRAM SECTION

The board has two sections. The debug and programmer section interfaces with the USB port on the PC and provides debug and programming capability.

The Starter Kit Board



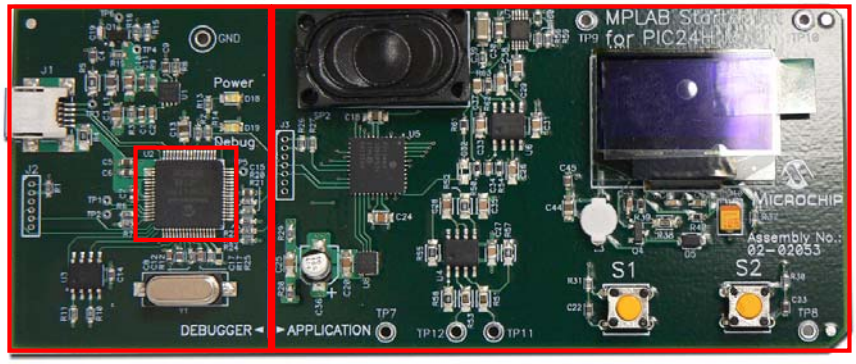
DEBUG / PROGRAM SECTION

APPLICATION SECTION

The application section hosts the PIC24H MCU, an accelerometer, an OLED display, a speaker, switches, and the external sensor conditioning circuitry.

MICROCHIP
WebSeminars

The Starter Kit Board



DEBUG / PROGRAM SECTION

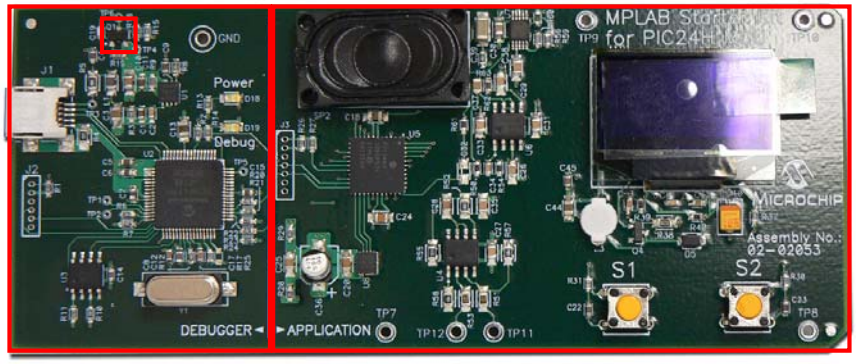
APPLICATION SECTION

The debug/program section has the following features:

•A PIC18F67J50 8-bit microcontroller, which serves as the debugger and programmer for the PIC24H device.

MICROCHIP
WebSeminars

The Starter Kit Board

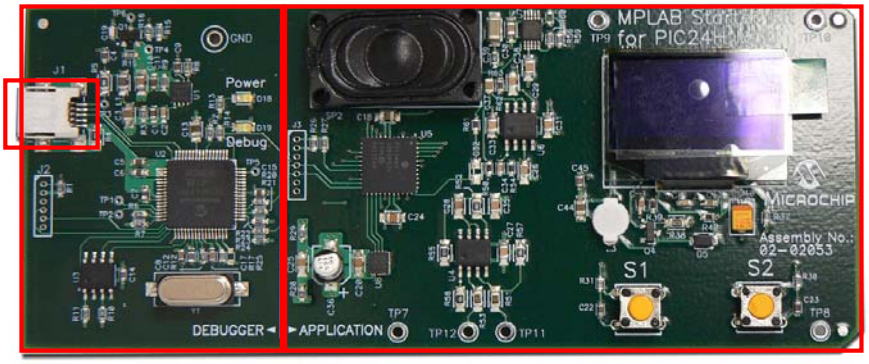


DEBUG / PROGRAM SECTION

APPLICATION SECTION

•A +3.3V regulator that powers the starter kit board via USB

The Starter Kit Board



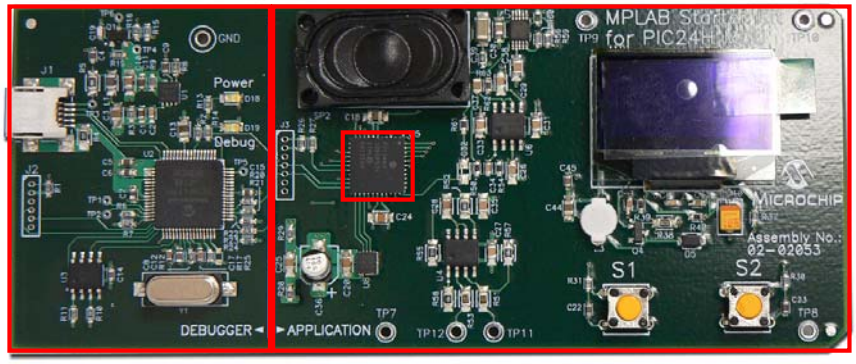
DEBUG / PROGRAM SECTION

APPLICATION SECTION

•Provides the full-speed USB interface required to connect the board to the PC.

MICROCHIP
WebSeminars

The Starter Kit Board



DEBUG / PROGRAM SECTION

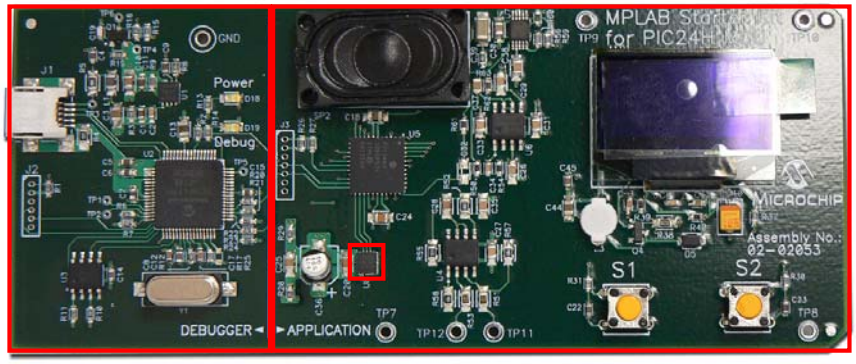
APPLICATION SECTION

•The application section has the following features:

•A PIC24HJ128GP504 16-bit microcontroller with 128 Kbytes of Flash memory, 8 Kbytes of RAM, and a comprehensive set of peripherals. This device serves as the computational device on the board.

MICROCHIP
WebSeminars

The Starter Kit Board



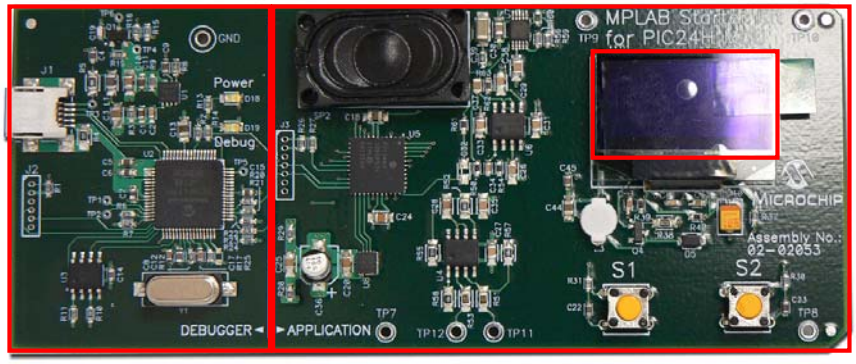
DEBUG / PROGRAM SECTION

APPLICATION SECTION

•A tri-axial accelerometer to interface with the OLED display and browse different options on visual display unit.

MICROCHIP
WebSeminars

The Starter Kit Board



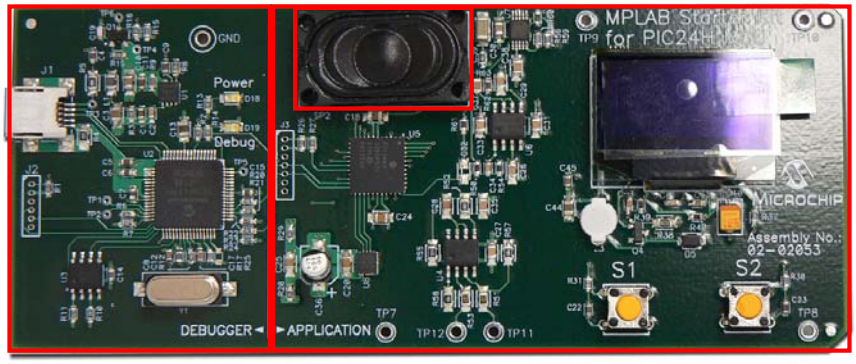
DEBUG / PROGRAM SECTION

APPLICATION SECTION

•An Organic Light Emitting LED Diode (OLED) display as a visual display unit.

MICROCHIP
WebSeminars

The Starter Kit Board



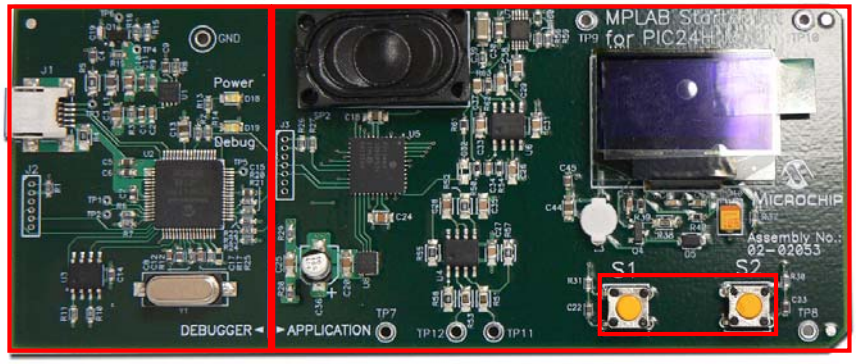
DEBUG / PROGRAM SECTION

APPLICATION SECTION

•A speaker for audio message playback. Associated analog Filters for implementing low-cost speech playback using the pulse width modulation technique.

MICROCHIP
WebSeminars

The Starter Kit Board



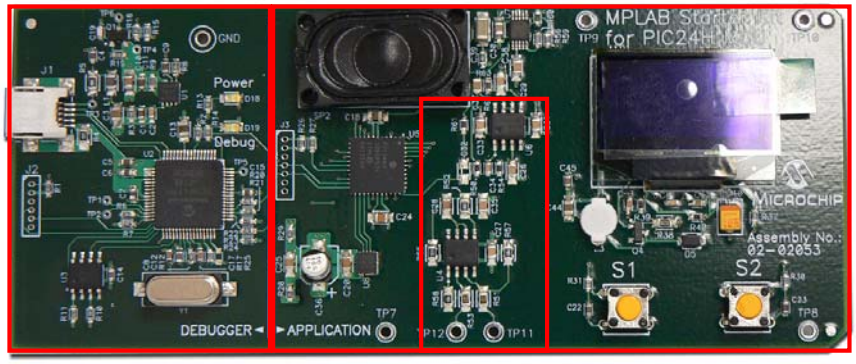
DEBUG / PROGRAM SECTION

APPLICATION SECTION

•Switches to select different options on visual display unit.

MICROCHIP
WebSeminars

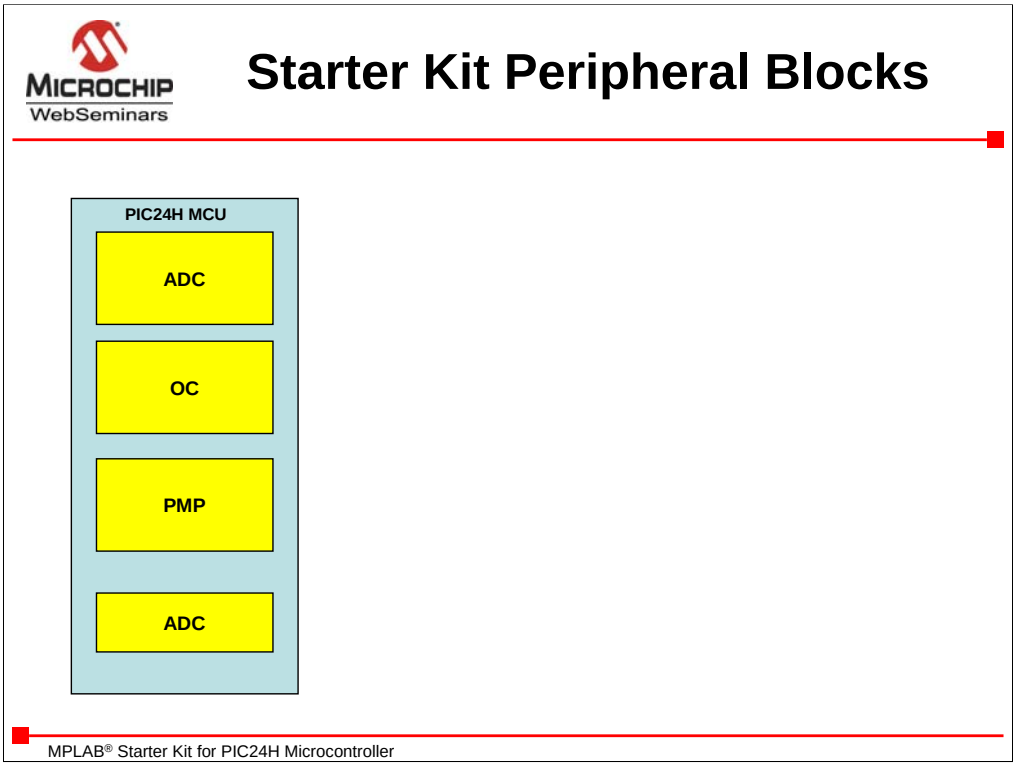
The Starter Kit Board



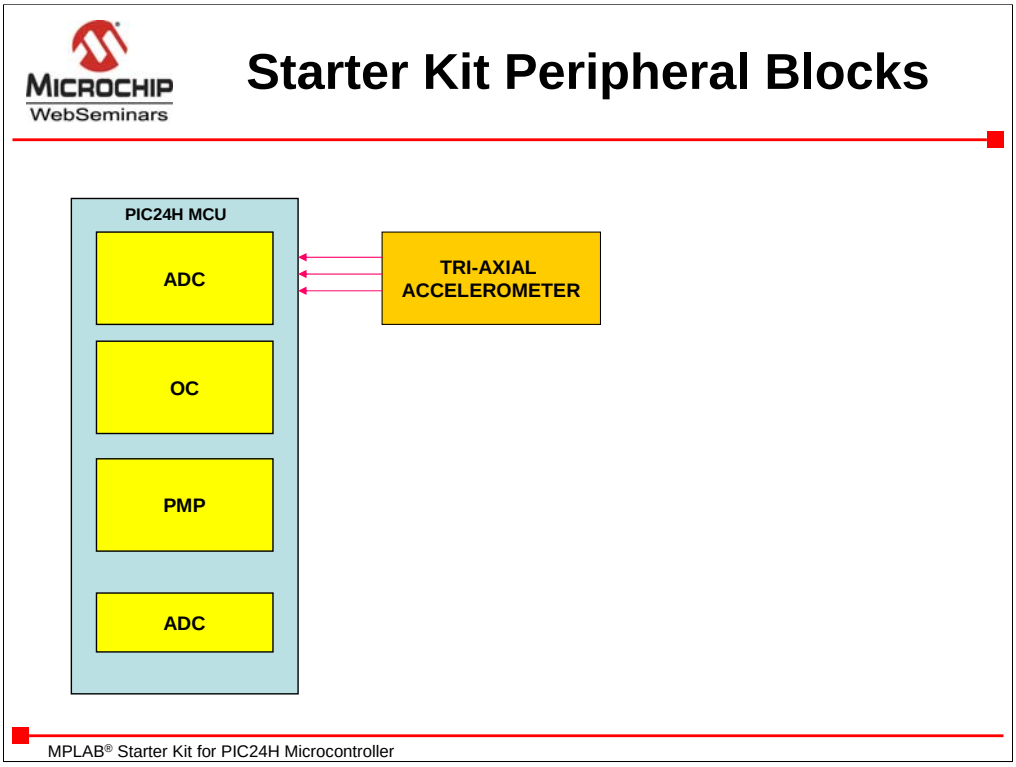
DEBUG / PROGRAM SECTION

APPLICATION SECTION

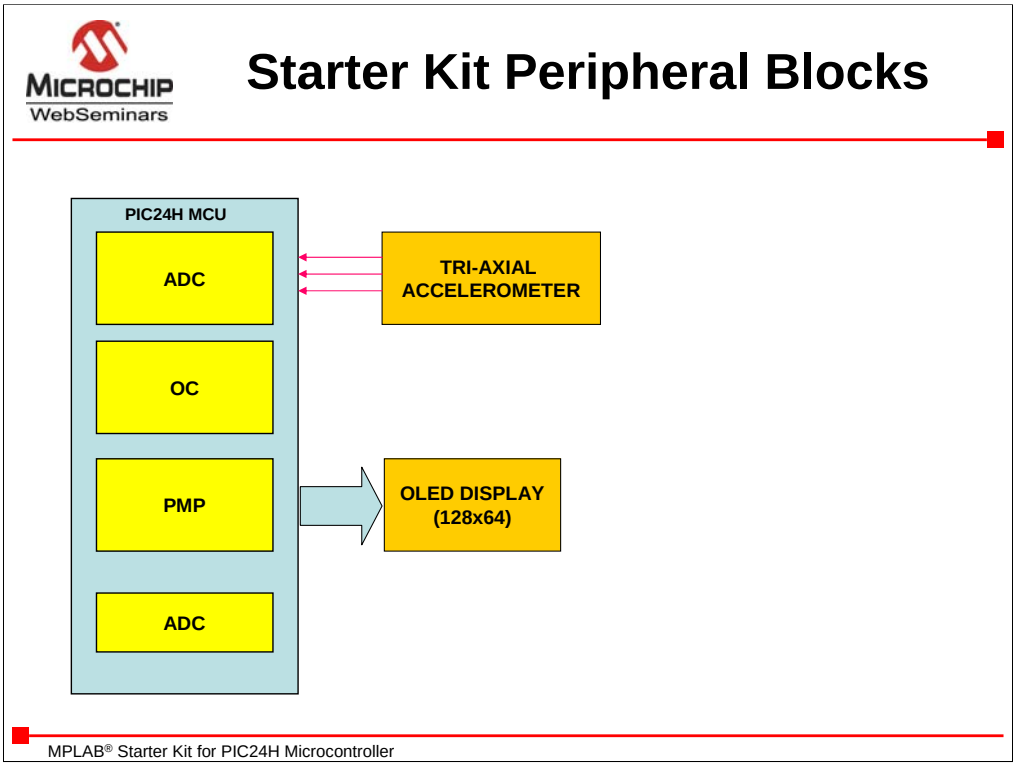
•A signal conditioning circuit with a differential amplifier and a low-pass filter to acquire signals from a wide range of external sensors



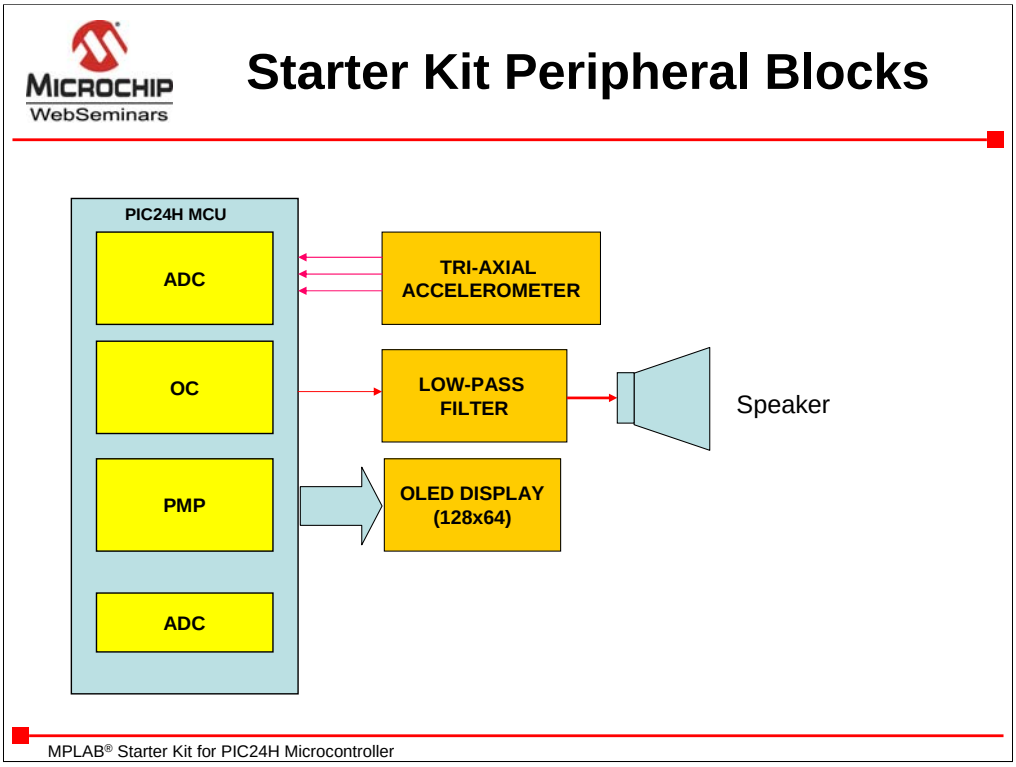
The starter kit has a tri-axial analog accelerometer.



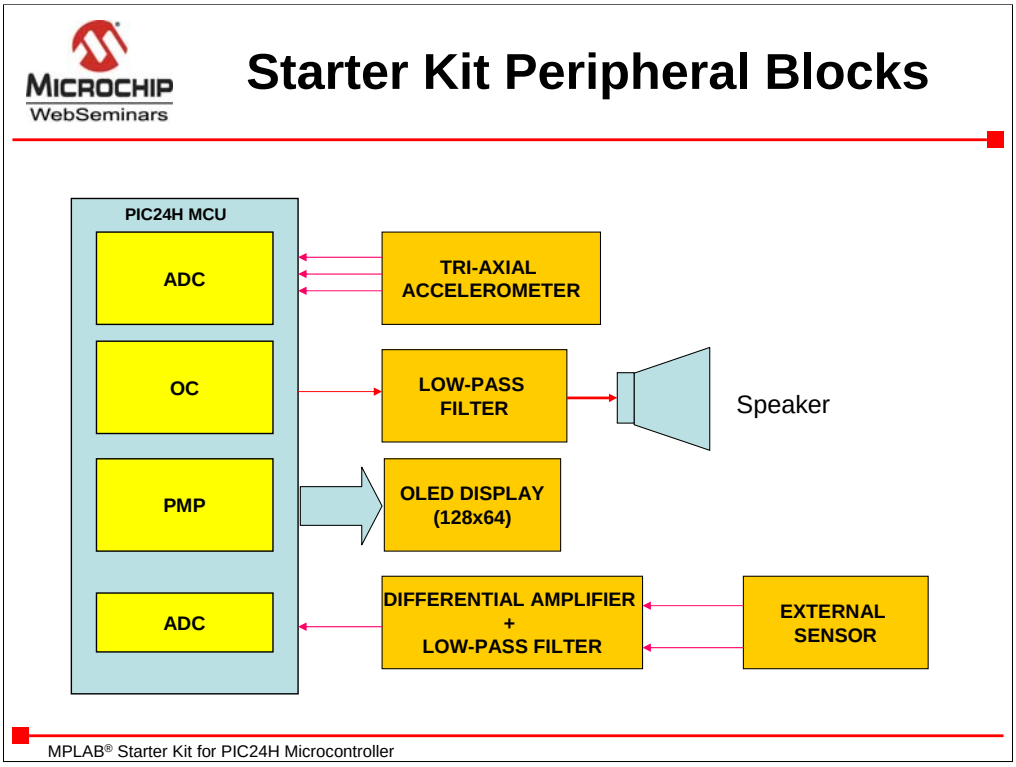
The starter kit has a tri-axial analog accelerometer. It is interfaced through three ADC channels. The three acceleration outputs on the X, Y, and Z axes are captured using the ADC module on the PIC24H MCU. The accelerometer samples captured on the ADC are processed in the PIC24H MCU.



A 128 by 64 OLED display is provided. The OLED is interfaced to the PIC24H through the Parallel Master Port or PMP module. Different screens with different options are displayed for the user to choose from. Depending on the stimulus obtained from the accelerometer and the switches, different screens are displayed, signals are graphed, and games are controlled.



A speaker is provided on the starter kit for message playback. The speech messages are compressed using the G.711 A-law and are stored in the program memory of the PIC24H. The PIC24H decodes the compressed data and generates PWM signals through the Output Compare module, which are demodulated before being output to the speaker.

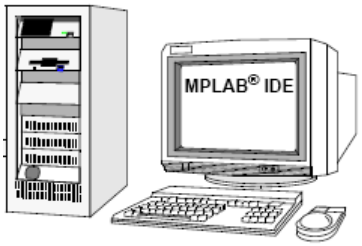


The starter kit also features an analog conditioning circuit, which can be used to plug-in a wide range of external sensors. The differential output of the sensor flows through a differential amplifier and an anti-aliasing filter before being sampled by the on-chip ADC.

MICROCHIP
WebSeminars

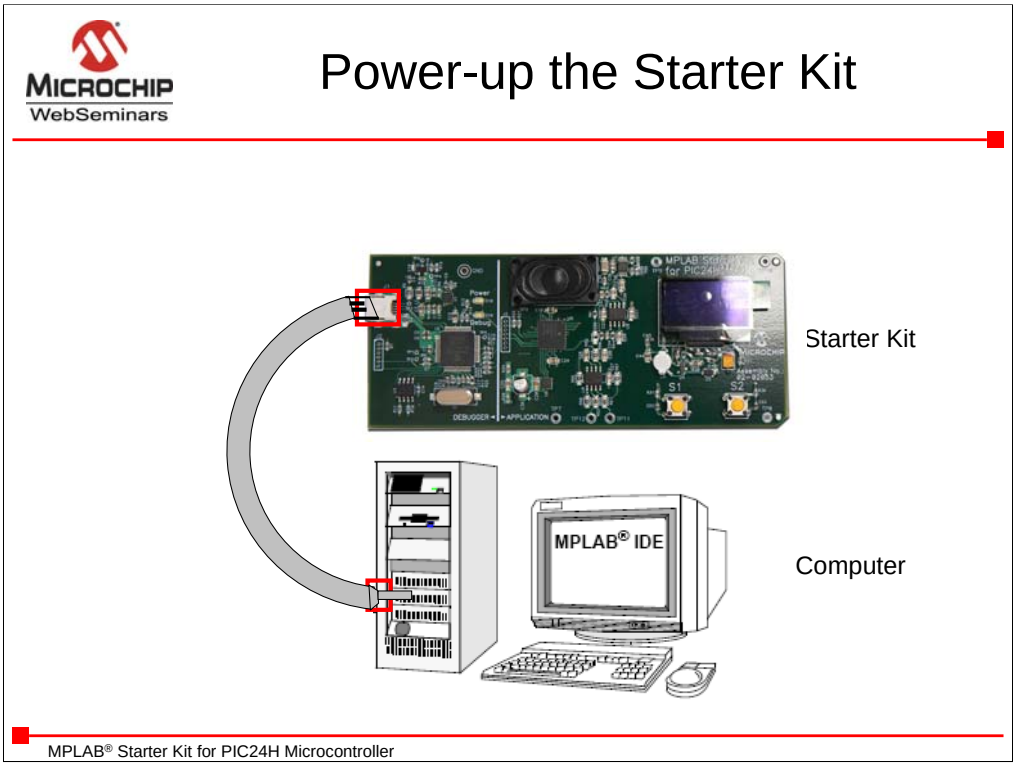
Power-up the Starter Kit

Starter Kit



Computer

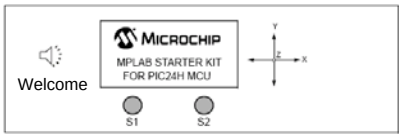
Power up the starter kit



by connecting the board to the USB port of a computer. You should briefly see a pop-up message in the system tray that states new hardware has been found, drivers are being installed, and the new hardware is ready for use. If you do not see these messages and the starter kit does not work, try reconnecting the USB cable. If reconnecting the USB cable does not work, refer to the “Troubleshooting” section in the user’s guide.

Start-Up and Home Screen

- ✓ **The pre-loaded application starts by:**
  - ✓ **Displaying a Start-up screen on OLED**
  - ✓ **Playing a welcome message on the speaker**

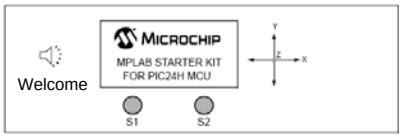


Now let's look at the working of the pre-loaded application and the various options available in the application.

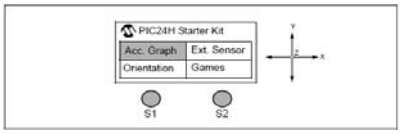
The application will display a Start-up screen on the OLED display and plays out a welcome message through the speaker.

Start-Up and Home Screen

- ✓ **The pre-loaded application starts by:**
  - ✓ **Displaying a Start-up screen on OLED**
  - ✓ **Playing a welcome message on the speaker**



- ✓ **After start-up, the Home screen is displayed**



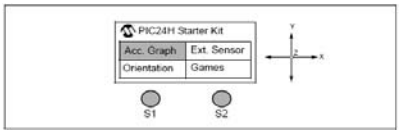
MPLAB® Starter Kit for PIC24H Microcontroller

After the welcome message, the OLED display will display the Home screen. The application uses the Microchip Graphics Library to drive the OLED and create controls such as buttons, pictures, text, and so on.

The accelerometer is used to sense the tilt of the starter kit board in X or Y directions. Based on the tilt, one of the 4 cells is highlighted on the display for selection. Switch S1 or S2 can be pressed to select an option.

Accelerometer Graph

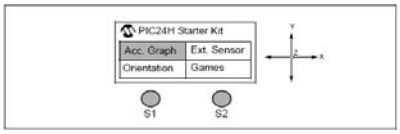
- ✓ **Tilt the starter kit to highlight the Acc. Graph option**
- ✓ **Select it by pressing switch S1 or S2**



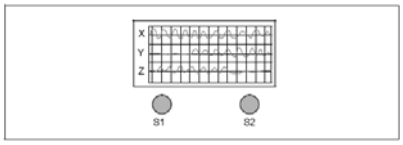
The first option is the Accelerometer Graph. Tilt the starter kit to highlight the Accelerometer Graph option. Press switch S1 or S2 to select the option.

Accelerometer Graph

- ✓ **Tilt the starter kit to highlight the Acc. Graph option**
- ✓ **Select it by pressing switch S1 or S2**



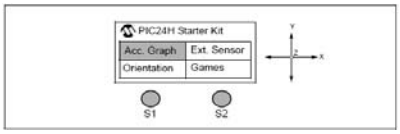
- ✓ **The tri-axial accelerometer outputs are displayed on the OLED**



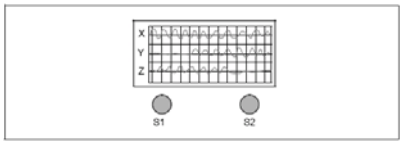
The three outputs X, Y, and Z of the tri-axial accelerometer are displayed on the screen. Maneuver the screen in various directions to see the response of the accelerometer on the screen.

Accelerometer Graph

- ✓ **Tilt the starter kit to highlight the Acc. Graph option**
- ✓ **Select it by pressing switch S1 or S2**



- ✓ **The tri-axial accelerometer outputs are displayed on the OLED**

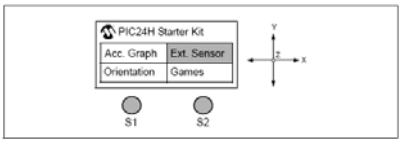


- ✓ **Press switch S1 or S2 at any time to return to the Home screen**

Press switch S1 or S2 at any time to return to the Home screen.

External Sensor

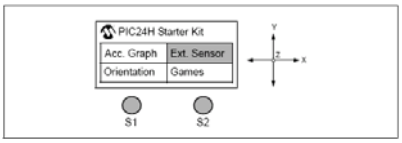
- ✓ **Tilt the starter kit to highlight the Acc. Graph option**
- ✓ **Select it by pressing switch S1 or S2**



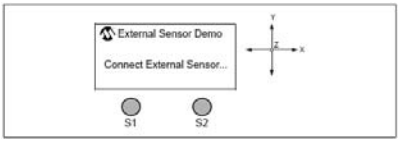
The next option is the External Sensor Graph. Tilt the starter kit to highlight the External Sensor Graph option. Press switch S1 or S2 to select the option.

External Sensor

- ✓ **Tilt the starter kit to highlight the Acc. Graph option**
- ✓ **Select it by pressing switch S1 or S2**



- ✓ **An information screen prompts the user to plug in an external sensor**

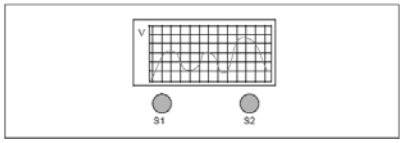


The next option is the External Sensor Graph. Tilt the starter kit to highlight the External Sensor Graph option. Press switch S1 or S2 to select the option.

An information screen is displayed, which prompts you to connect an external sensor.

External Sensor Continued...

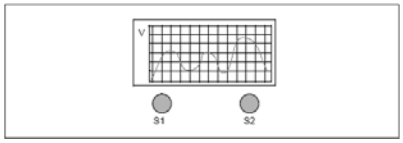
- ✓ **The external sensor signal is displayed on the OLED**



The output of the external sensor which is plugged in at the points TP12 and TP11 is displayed on the screen.

External Sensor Continued...

- ✓ **The external sensor signal is displayed on the OLED**

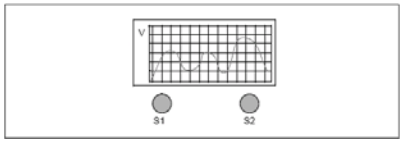


- ✓ **Switch S1 can be pressed to slow down or speed up the display in case the displayed signal is too fast or too slow**

Switch S1 can be pressed to slow down or speed up the display in case the displayed signal is too fast or too slow.

External Sensor Continued...

- ✓ **The external sensor signal is displayed on the OLED**

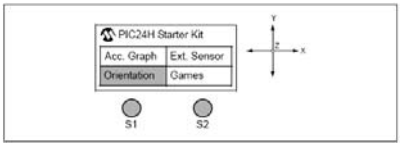


- ✓ **Switch S1 can be pressed to slow down or speed up the display in case the displayed signal is too fast or too slow**
- ✓ **Press switch S2 at any time to return to the Home screen**

Switch S2 can be pressed at any time to return to the Home screen.

Orientation

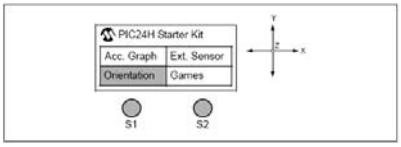
- ✓ **Tilt the starter kit to highlight the Orientation option**
- ✓ **Select it by pressing switch S1 or S2**



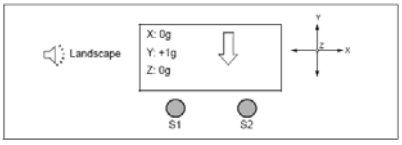
The third option is the Orientation detection. Tilt the starter kit to highlight the Orientation option. Press switch S1 or S2 to select the option.

Orientation

- ✓ **Tilt the starter kit to highlight the Orientation option**
- ✓ **Select it by pressing switch S1 or S2**



- ✓ **The orientation of the board in indicated on the OLED display**
- ✓ **Orientation messages are played through the speaker**
- ✓ **The acceleration in each of the axes is displayed on the left side of the screen as a fraction of gravitational acceleration constant on earth**

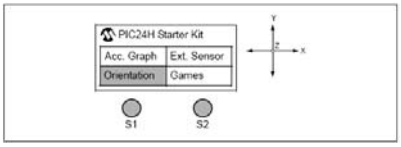


Selecting the Orientation cell starts the application, which indicates the orientation of the starter kit.

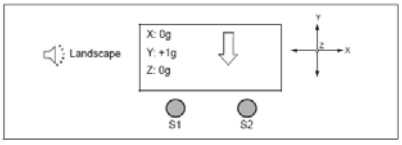
Patterns are displayed on the OLED display and messages are played through the speaker indicating the *Portrait*, the *Landscape*, and the *Plane* orientations. The acceleration in each of the axes is displayed on the left side of the screen as a fraction of gravitational acceleration constant.

Orientation

- ✓ **Tilt the starter kit to highlight the Orientation option**
- ✓ **Select it by pressing switch S1 or S2**



- ✓ **The orientation of the board in indicated on the OLED display**
- ✓ **Orientation messages are played through the speaker**
- ✓ **The acceleration in each of the axes is displayed on the left side of the screen as a fraction of gravitational acceleration constant on earth**

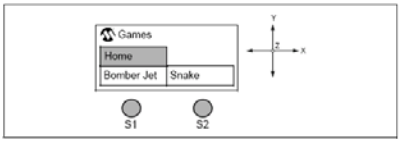


- ✓ **Press switch S1 or S2 at any time to return to the Home screen**

Press S1 or S2 to return to the Home screen

Games

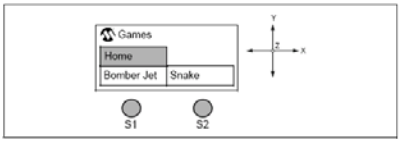
- ✓ **Tilt the starter kit to highlight the Games option**
- ✓ **Select it by pressing switch S1 or S2**



The fourth option is the Games. Tilt the starter kit to highlight the Games option. Press switch S1 or S2 to select the option.

Games

- ✓ **Tilt the starter kit to highlight the Games option**
- ✓ **Select it by pressing switch S1 or S2**

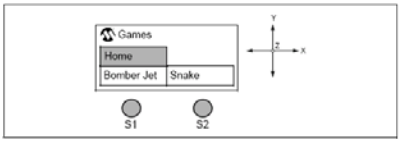


- ✓ **Highlight and select from the two games**

Selecting the Games cell displays a new screen with three cells: *Home*, *Bomber Jet*, and *Snake*.

Games

- ✓ **Tilt the starter kit to highlight the Games option**
- ✓ **Select it by pressing switch S1 or S2**

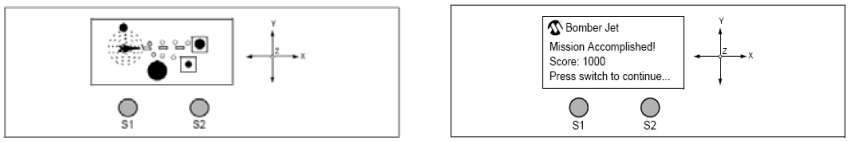


- ✓ **Highlight and select from the two games**
- ✓ **Select the Home option to return to the Home screen**

The Home option can be selected by pressing switch S1 or S2 to return to the Home screen.

Games Continued…

- ✓ **Select the Bomber Jet option to play the Bomber Jet game**



MPLAB® Starter Kit for PIC24H Microcontroller

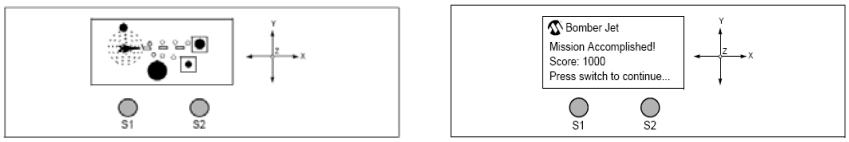
Tilt the starter kit to highlight the Bomber Jet option. Press switch S1 or S2 to select the option.

This starts the Bomber Jet game.

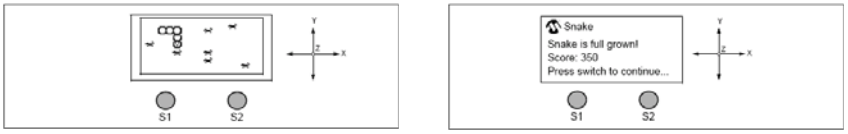
The Jet can be maneuvered on the X and Y planes of the display by tilting the starter kit about the X and Y axes. Asteroids and alien ships are encountered in the game. The jet should be maneuvered to avoid collision with the asteroid and alien ship, and to not be hit by a missile from the alien ship. Pressing switch S1 momentarily turns on a protective shield. The shield will destroy any asteroid or alien ship missile in its path. Pressing S2 releases missiles form the Bomber Jet. The alien ships and the asteroids are destroyed when hit by the missiles from the Bomber Jet. The score increases whenever a missile fired by the Bomber Jet strikes an alien ship or an asteroid. Using the protective shield decreases the score. The game automatically exits to a Score screen after achieving a score of 1000 or when the Bomber Jet is hit by an alien missile, or collides with an alien ship or asteroid. After the Score screen appears, Switch S1 or S2 can be pressed at any time to return to the Games screen.

Games Continued…

- ✓ **Select the Bomber Jet option to play the Bomber Jet game**



- ✓ **Select the Snake option to play the Snake game**



MPLAB® Starter Kit for PIC24H Microcontroller

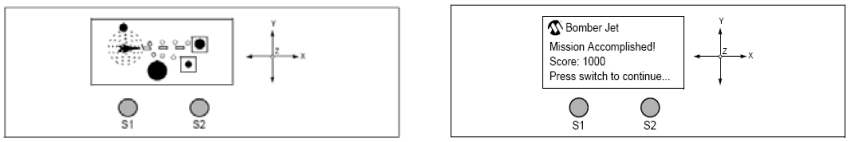
Tilt the starter kit to highlight the Snake option. Press switch S1 or S2 to select the option.

This starts the Snake game.

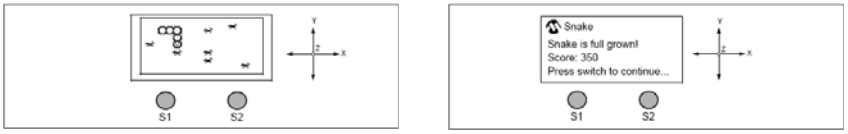
The snake can be maneuvered on the X and Y plane of the display by tilting the starter kit about the X and Y axes. Multiple snake food appears, which the snake must eat. The snake grows in size when it eats. The snake should be maneuvered to eat the food such that it doesn't collide with any of the four walls. The score increases as the snake eats the food. The game automatically exits to a Score screen after the snake grows to a tail length of 25 rings or the snake hits any of the four walls.

Games Continued…

- ✓ **Select the Bomber Jet option to play the Bomber Jet game**

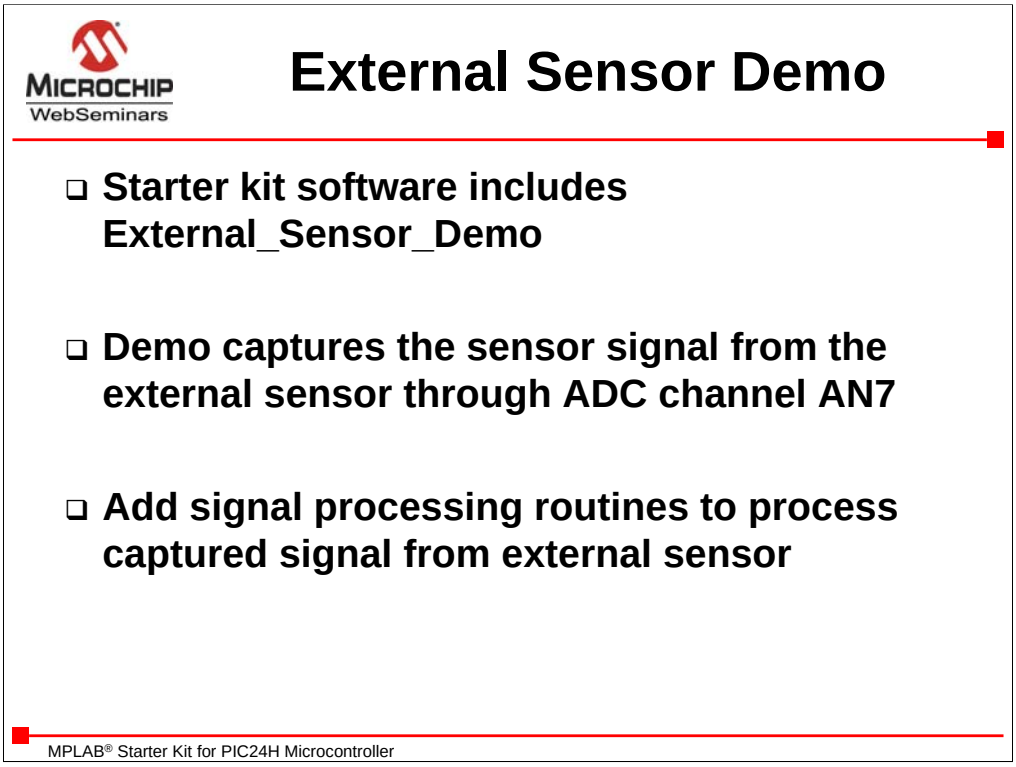


- ✓ **Select the Snake option to play the Snake game**



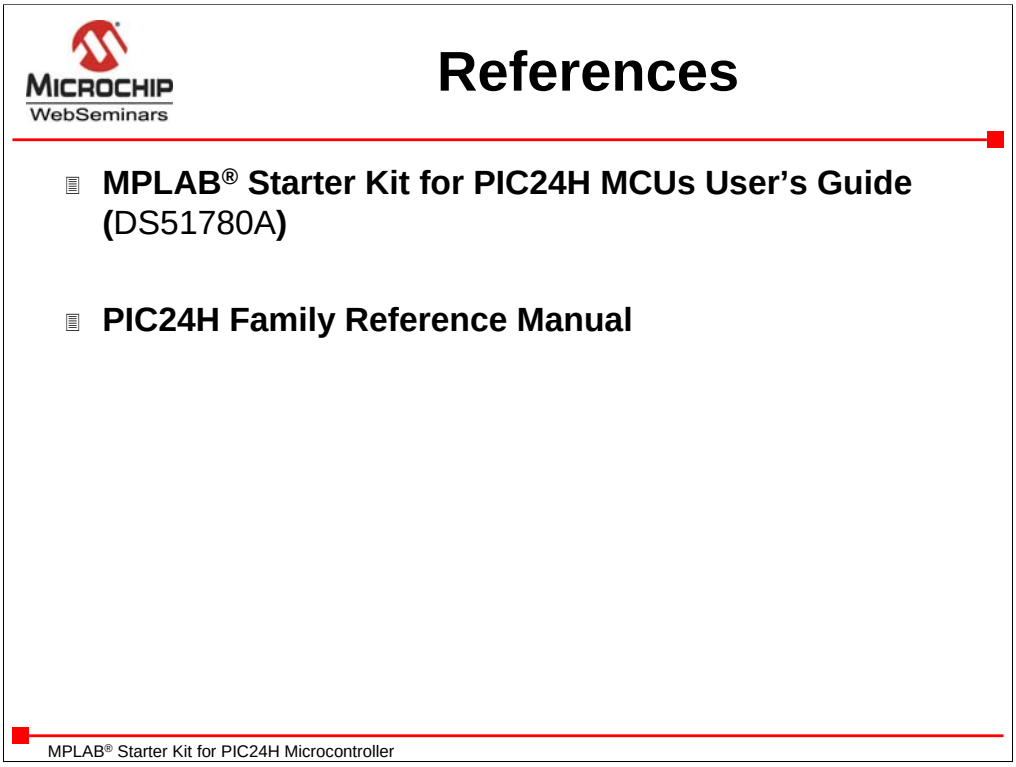
- ✓ **Press switch S1 or S2 at any time while on the Score screen to return to the Game screen**

After the Score screen appears, switch S1 or S2 can be pressed at any time to return to the Games screen.



Also included in the starter kit software is an External Sensor Demo project. This code example demonstrates the low-cost sensor signal capture and processing.

When a sensor is plugged into the analog conditioning circuitry the code example captures the sensor signal through ADC channel AN7. The captured discrete time sensor signal can be processed inside the code example. Instructions are provided in the source file as to where the user desired signal processing routines need to be added to process the sensor signal captured by the ADC.



This brings us to the end of the starter kit tutorial.

Thank you.

Trademarks