Chipsmall Limited consists of a professional team with an average of over 10 year of expertise in the distribution of electronic components. Based in Hongkong, we have already established firm and mutual-benefit business relationships with customers from,Europe,America and south Asia,supplying obsolete and hard-to-find components to meet their specific needs.

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Processor Extension Pak and Header Specification

This chapter contains the following:

- Processor Extension Pak and Header Defined
- Why Do I Need A Header To Debug?
- Debug Details
- Programming Details
- General Header Setup
- Device vs. Optional Header Features
- MPLAB IDE and MPLAB X IDE Use with Headers
- Calibration Bits
- Performance Issues
- Related Debug Tools
- Customer Support

PROCESSOR EXTENSION PAK AND HEADER DEFINED

A header (or debug header) is a circuit board that allows an emulator or debugger to debug code for a specific device. A special version of the device with on-board debug circuitry is located on the header. Connectors on the side of the header allow it to connect directly or through an adaptor to the debug tool. Connectors on the bottom of the header allow it to connect directly, or through a transition socket, to a target board.

A processor extension pak contains a header, adaptor board, and stand-offs.

Processor Extension Pak and Header Specification

WHY DO I NEED A HEADER TO DEBUG?

Some PIC® microcontrollers, particularly low pin count devices (with 20 pins or less), generally must use a header for debugging. This is done to free up I/O lines for your application and to make production parts more affordable. Optional headers are also available for high pin count devices (with 64 pins or higher).

Debugging requires a two-line connection (plus V_{DD}, V_{SS} and V_{PP}) to communicate with the device. In a high pin count device, losing a few I/O lines is generally not a problem for most designs. But in a low pin count device, it can be a critical problem. Imagine having to do an 8-pin design where there are only 5 I/Os, having used up 2 I/Os just for debugging!

Headers are also used to save you money. In high pin count devices, adding debugging to the silicon can generally be done at little or no cost since the silicon is already fairly large. However, low pin count devices are low cost specifically because they use very little silicon. So, adding debugging circuitry on-board these parts would add significant cost since it would raise the amount of silicon used by a considerable percentage. The header places the cost for debugging up front and frees your production parts from the extra cost of an unused debug module.

Microchip also makes optional debug modules, usually for high pin count devices. The module is optional because you can still do basic debugging without a header, but if you use one, you get back I/O lines, and may also gain additional debugging features. Only certain devices can use an optional header, see the device page on our website for details.

Microchip lists what header must be ordered to work with your device, if one is required. Simply consult the device page on our website, or our other ordering guides.

Note that in all cases, devices can be programmed "in circuit" (called ICSP™) with very few exceptions. Even devices without an internal debug feature can still be programmed by connecting the programming/debugging tool to the in-circuit programming lines. These devices simply cannot perform debugging without a header.

**FIGURE 1:   PRODUCTION DEVICE VS. HEADER DEVICE (-ICE/-ICD)**
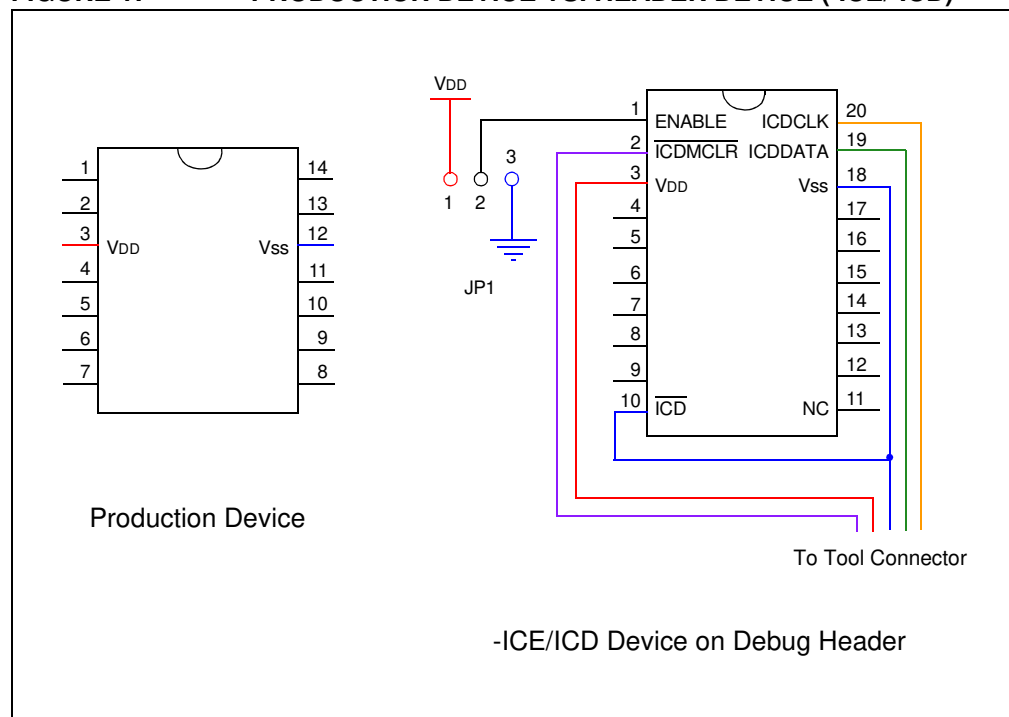
DEBUG DETAILS

Next generation in-circuit emulators (such as the MPLAB® REAL ICE™ In-Circuit Emulator) and in-circuit debuggers work with devices that have on-chip debug circuitry. Sometimes the actual production device will have this circuitry and sometimes a special version of this device is required or available for code debugging. This special version of the chip, with the suffix -ICD or -ICE, is mounted on a debug header (Figure 2).

> **Note:** ICE/ICD devices are only used on the header; they are not sold separately.

FIGURE 2: **DEBUG OPTIONS**
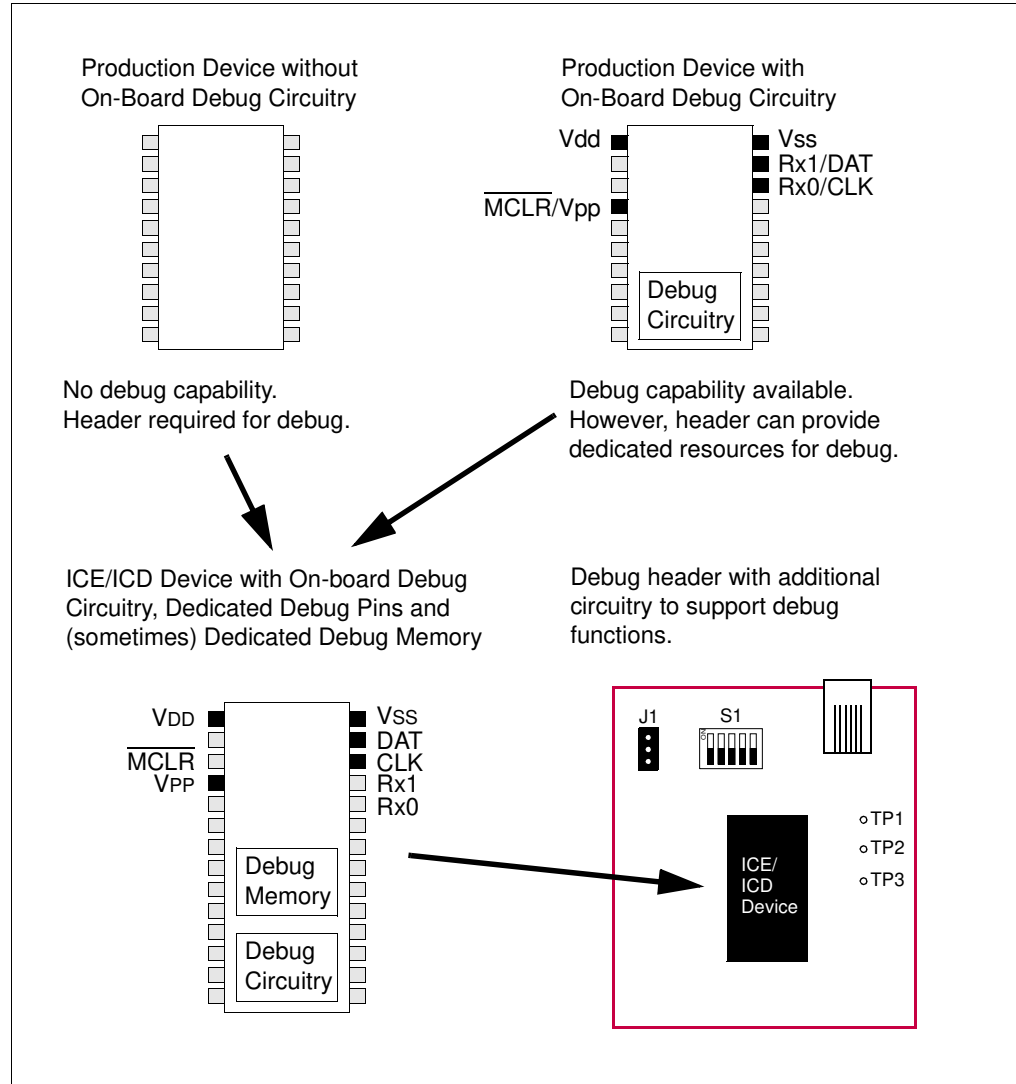
In general, ICE devices are designed for next-generation in-circuit emulator use and ICD devices are designed for in-circuit debugger use. However, ICE devices may be used with an in-circuit debugger and ICD devices may be used with a next-generation in-circuit emulator, but will provide only basic ICD functionality.

To determine what device resources must be dedicated to debugging for either a device with on-board debug capability or the special ICE/ICD device, see the "Resources used by ..." section of the in-circuit emulator or in-circuit debugger online Help file.

Processor Extension Pak and Header Specification

PROGRAMMING DETAILS

The debug header is designed to be used with the in-circuit emulator or the in-circuit debugger selected as a debugger, not a programmer, in MPLAB IDE or MPLAB X IDE. Any programming of the ICE/ICD device on the header is for debug purposes and includes the debug executive. See your related debug tool documentation for details on using it as a debugger.

To program production (non-ICE/ICD) devices with your debug tool, use the Universal Programming Module (AC162049) or design a modular interface connector on the target. See the appropriate specification for connections. For the most up-to-date device programming specifications, see the Microchip website (www.microchip.com).

Also, production devices may be programmed with the following tools:

• MPLAB PM3 device programmer
• PICSTART® Plus development programmer
• PICkit™ 1, 2 or 3 development programmer
• MPLAB ICD 3 in-circuit debugger (select as a programmer)
• MPLAB REAL ICE in-circuit emulator (select as a programmer)

GENERAL HEADER SETUP

To set up your header, do the following:

1. Check the debug header for any stickers and the header box for any paper inserts that may specify special operating instructions (Figure 3). Follow these instructions before doing anything else.

FIGURE 3: SPECIAL HEADER INSTRUCTIONS
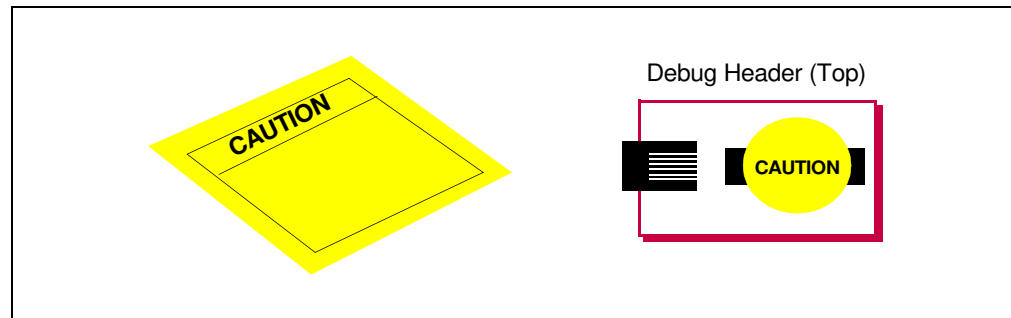
2. Set any jumpers or switches on the header to determine device functionality or selection as specified for that header. See the sections "Optional Debug Headers" or "Required Debug Headers" for information on how to set up individual headers.

3. Connect the header to your desired debug tool by consulting the tool documentation for connection options. An example connection is shown in Figure 4.

   The special ICE/ICD device is mounted on the top of a header and its signals are routed to the emulator or debugger connector. These special device versions are labeled with the appropriate suffix (i.e., either *Device*-ICE or *Device*-ICD).

**FIGURE 4:**   **CONNECT HEADER TO DEBUG TOOL**
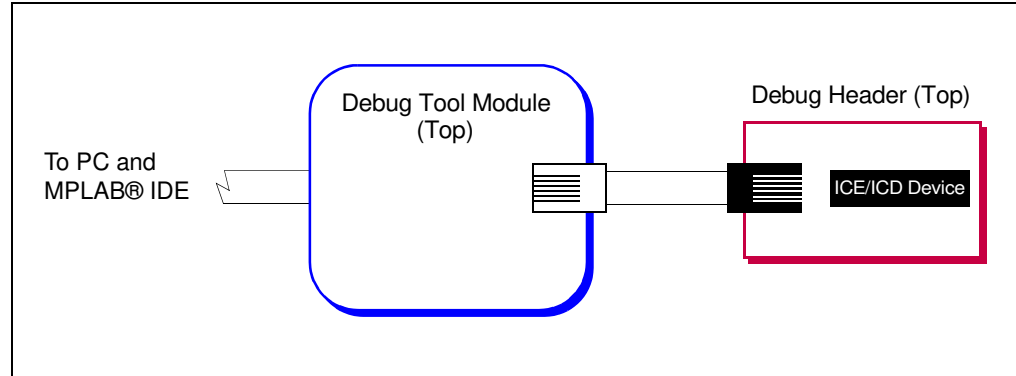
4. Connect the header to the target board. On the bottom of the header is a socket that is used to connect to the target board. The header may be connected to the target board as follows:

    a) PDIP header socket to PDIP target socket with a stand-off (male-to-male) connector
    b) Header socket to plug on the target board
    c) Header socket to target socket with a transition socket (see the "*Transition Socket Specification*", DS51194)

    An example connection is shown in Figure 5.

    The header socket will have the same pin count as your selected device. The ICE/ICD device on the top of the header usually has a larger pin count because it has additional pins that are dedicated to debug.

FIGURE 5:   **CONNECT HEADER TO TARGET**
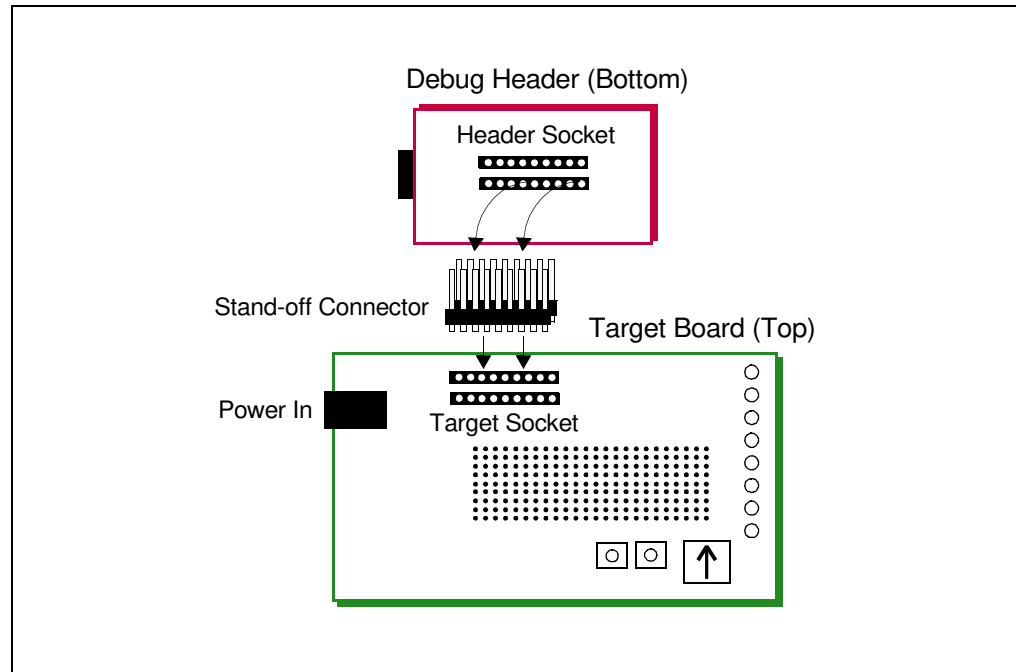
5. If using a debug tool that can power the target, power that tool now.
6. Power the target, if needed.

Processor Extension Pak and Header Specification

DEVICE VS. OPTIONAL HEADER FEATURES

For some devices that have on-board debug capability, the optional header provides more debug features than the device itself. To determine if your device and optional header differ in their debug features, go to the DTS to look up your device:

1. In a web browser, go to: http://www.microchip.com/dtsapp/
2. Enter your device and click the **Search** button.
3. Select the package you will use.
4. Compare the device features under "Debug Features" to the header features under "Header Debug Features".

FIGURE 6: DTS DEVICE INFORMATION

MPLAB IDE AND MPLAB X IDE USE WITH HEADERS

MPLAB IDE v8

Perform the following steps to use the debug header:

1. Set up the debug header as specified in "General Header Setup".
2. Create a project for a device supported by your debug header using the Project wizard (*Project>Project Wizard*). See MPLAB IDE v8 documentation for more on Projects.
3. Under *Debugger>Select Tool*, select the debug tool to which your header is attached.

> **Note:** A debug header can be used only in debug mode, not in programming mode. See "Programming Details".

4. Write code for your project and build it until there are no errors.
5. Select *Debugger>Program* and then *Debugger>Run* to run your debug code.

MPLAB X IDE

Perform the following steps to use the debug header:

1. Set up the debug header as specified in "General Header Setup".
2. Begin creating a project for a device supported by your debug header using the Projects wizard (*File>New Project*). See MPLAB X IDE documentation for more on Projects.
3. In one step of the wizard you will have an opportunity to specify the header.
4. In another step you will specify the hardware (debug) tool to which your header is attached.
5. Once the wizard is complete, write code for your project.
6. Select *Debug>Debug Project* to run and debug your code.

> **Note:** A debug header can be used only to debug (Debug menu), not to program (Run menu). See "Programming Details".

CALIBRATION BITS

The calibration bits for the band gap and internal oscillator are always preserved to their factory settings.

PERFORMANCE ISSUES

The PIC® MCU devices do not support partial program memory erase; therefore, users may experience slower performance than with other devices.

Also, see either the in-circuit emulator or the in-circuit debugger Help file for information on specific device limitations that may affect performance.

RELATED DEBUG TOOLS

The following tools support the use of headers:

- MPLAB REAL ICE In-Circuit Emulator
- MPLAB ICD 2 or 3 In-Circuit Debugger
- PICkit 2 or 3 Debug Express

See the Microchip website for the latest documentation:

http://www.microchip.com

Processor Extension Pak and Header Specification

CUSTOMER SUPPORT

Users of Microchip products can receive assistance through several channels:

• Distributor or Representative
• Local Sales Office
• Field Application Engineer (FAE)
• Technical Support

Customers should contact their distributor, representative or field application engineer (FAE) for support. Local sales offices are also available to help customers.

Technical support is available through the web site at:

http://support.microchip.com

Documentation errors or comments may be sent to docerrors@microchip.com.

Required Debug Headers

INTRODUCTION

Some devices have no built-in debug circuitry. Therefore, special ICE/ICD versions of these devices are required for debug tool operation.

Currently available debug headers and their associated ICE/ICD devices are shown below, sorted by supported device.

TABLE 1:   REQUIRED DEBUG HEADERS BY DEVICE

Device	Pin Count	Header Part Number	ICE/ICD Device Used	V$_{DD}$ Max
PIC10F200/2/4/6	8/14	AC162059	PIC16F505-ICD	5.5V
PIC10F220/2	8/14	AC162070	PIC16F506-ICD	5.5V
PIC10F320/322	6/8	AC244045	PIC10F320-ICE	5.5V
PIC10LF320/322	6/8	AC244045	PIC10F320-ICE	3.6V
PIC12F508/509	8/14	AC162059	PIC16F505-ICD	5.5V
PIC12F510	8/14	AC162070	PIC16F506-ICD	5.5V
PIC12F519	8/14	AC162096	PIC16F526-ICD	5.5V
PIC12F609/HV609	28	AC162083	PIC16F616-ICD	5.5V
PIC12F615/HV615	28	AC162083	PIC16F616-ICD	5.5V
PIC12F617	28	AC162083	PIC16F616-ICD	5.5V
PIC12F629	8	AC162050	PIC12F675-ICD	5.5V
PIC12F635	14	AC162057	PIC16F636-ICD	5.5V
PIC12F675	8	AC162050	PIC12F675-ICD	5.5V
PIC12F683	8	AC162058	PIC12F683-ICD	5.5V
PIC12F1501[1]	8	AC244051	PIC16F1509-ICE	5.5V
PIC12LF1501[1]	8	AC244052	PIC16LF1509-ICE	3.6V
PIC16F505	8/14	AC162059	PIC16F505-ICD	5.5V
PIC16F506	8/14	AC162070	PIC16F506-ICD	5.5V
PIC16F526	8/14	AC162096	PIC16F526-ICD	5.5V
PIC16F610/HV610	14/16	AC162083	PIC16F616-ICD	5.5V
PIC16F616/HV616	14/16	AC162083	PIC16F616-ICD	5.5V
PIC16F627A/628A	18	AC162053	PIC16F648A-ICD	5.5V
PIC16F630	14	AC162052	PIC16F676-ICD	5.5V

Note   1:   Header optional for other devices

2:   V$_{DDCORE}$ Max

3:   Dual die

Processor Extension Pak and Header Specification

TABLE 1: REQUIRED DEBUG HEADERS BY DEVICE (CON'T)

Device	Pin Count	Header Part Number	ICE/ICD Device Used	V_{DD} Max
PIC16F631	20	AC162061	PIC16F690-ICD	5.5V
PIC16F636	14	AC162057	PIC16F636-ICD	5.5V
PIC16F639[3]	20	AC162066	PIC16F636-ICD	5.5V
PIC16F648A	18	AC162053	PIC16F648A-ICD	5.5V
PIC16F676	14	AC162052	PIC16F676-ICD	5.5V
PIC16F677	20	AC162061	PIC16F690-ICD	5.5V
PIC16F684	14	AC162055	PIC16F684-ICD	5.5V
PIC16F685/687	20	AC162061	PIC16F690-ICD	5.5V
PIC16F688	14	AC162056	PIC16F688-ICD	5.5V
PIC16F689/690	20	AC162061	PIC16F690-ICD	5.5V
PIC16F716	18	AC162054	PIC16F716-ICD	5.5V
PIC16F785/HV785	20	AC162060	PIC16F785-ICD	5.5V
PIC16F1503[1] PIC16F1507[1]	14 20	AC244051	PIC16F1509-ICE	5.5V
PIC16LF1503[1] PIC16LF1507[1]	14 20	AC244052	PIC16LF1509-ICE	3.6V
PIC18F13K50 PIC18F14K50	20	AC244023	PIC18F14K50-ICE	5.5V
PIC18LF13K50 PIC18LF14K50	20	AC244024	PIC18LF14K50-ICE	3.6V 2.75V[2]
PIC24F04KA200[1] PIC24F04KA201[1]	14 20	AC244028	PIC24F16KA102-ICE	3.6V

Note 1: Header optional for other devices

2: V_{DDCORE} Max

3: Dual die

AC162050, AC162058

Header Identification

The header AC number is used for ordering the header. However, this number is not on the debug header, as the board is often used for multiple headers by inserting different ICE/ICD devices. To identify these debug headers, use the following information.

Header	ICE/ICD Device	Board Assembly Number
AC162050	PIC12F675-ICD	02-01662
AC162058	PIC12F683-ICD	

Header Setup and Operation

For these headers, device peripherals need to be selected by setting jumper J1 to the appropriate position. For AC162050, this will have the effect of selecting the device.

Header	Jumper J1	Function	Device Selected
AC162050	2-3	A/D Disabled	PIC12F629
	1-2	A/D Enabled	PIC12F675
AC162058	1-2	A/D Enabled	PIC12F683

Header Limitations

See the "Limitations" section in your debug tool online Help file for details.

Processor Extension Pak and Header Specification

Header Dimensions

The figure below lists the dimensions for the debug header. Dimensions are design values in inches.

If the length and/or width of the debug header is too large a footprint for the target board, consider using stand-offs, transition sockets or other extenders in the header connection socket to raise the header above the target.

FIGURE 1:   DIMENSIONS – AC162050, AC162058

Dimensions are in inches

1.275

0.700

8-Pin MPLAB ICD 2 Header
ASSEMBLY NO. 02-01662
Microchip Technology Inc.
© 2002

1 J1

P1

1.000

Top

0.525

J2

6-pin Modular Connector
See **"Debug Header Connec-
tions"** for details.

Target Pin 1 Located on
Bottom side of Header

ICE
Device

0.165 Typical

0.560
Typical

Side

0.062 Typical

AC162052, AC162055, AC162056, AC162057

Header Identification

The header AC number is used for ordering the header. However, this number is not on the debug header, as the board is often used for multiple headers by inserting different ICE/ICD devices. To identify these debug headers, use the following information.

Header	ICE/ICD Device	Board Assembly Number
AC162052	PIC16F676-ICD	02-01686
AC162055	PIC16F684-ICD	
AC162056	PIC16F688-ICD	
AC162057	PIC16F636-ICD	

Header Setup and Operation

For these headers, device peripherals need to be selected by setting jumper J1 to the appropriate position. For AC162052 and AC162057, this will have the effect of selecting the device.

Header	Jumper J1	Function	Device Selected
AC162052	2-3	A/D Disabled	PIC16F630
	1-2	A/D Enabled	PIC16F676
AC162055	Don't care	N/A	PIC16F684
AC162056	Don't care	N/A	PIC16F688
AC162057	2-3	PORTC, Comparator 2 Disabled	PIC12F635
	1-2	PORTC, Comparator 2 Enabled	PIC16F636

Header Limitations

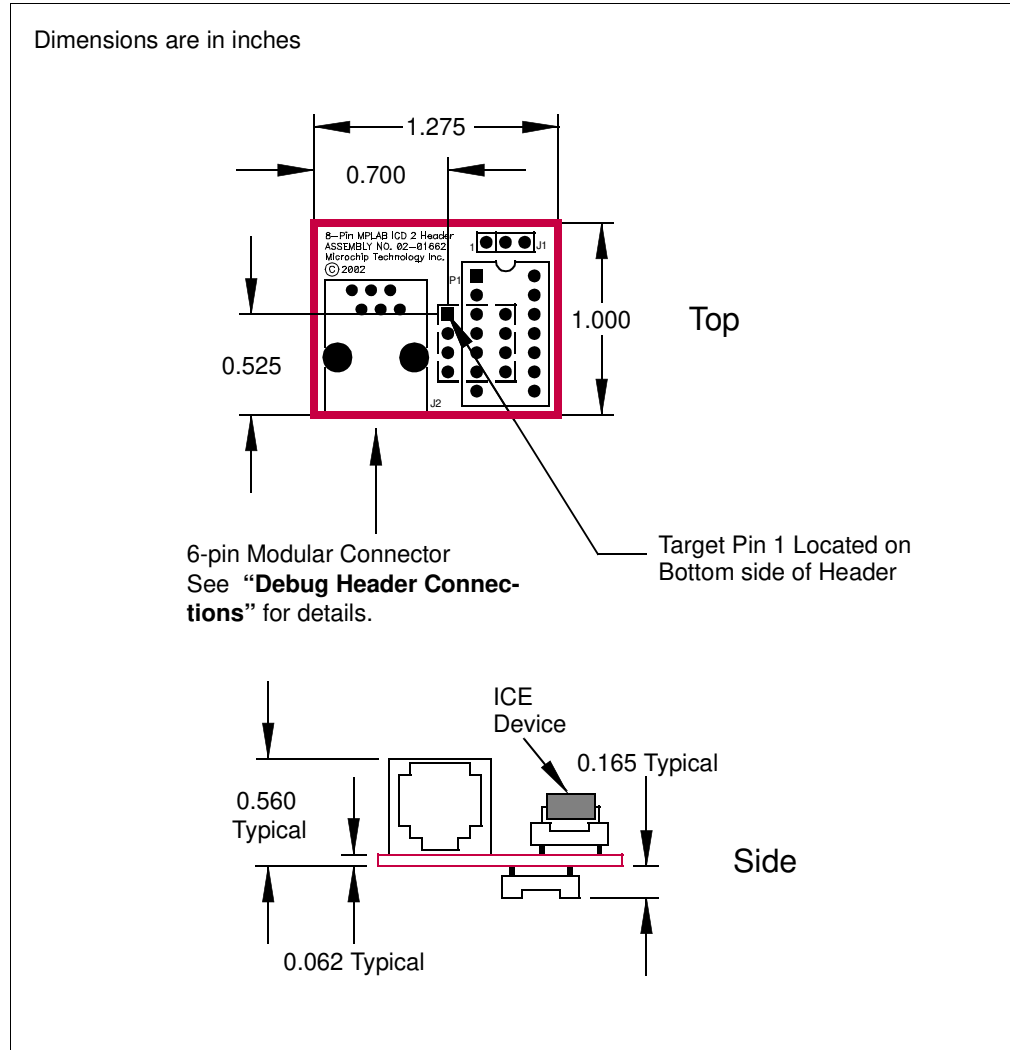See the "Limitations" section in your debug tool online Help file for details.

Processor Extension Pak and Header Specification

Header Dimensions

The figure below lists the dimensions for the debug header. Dimensions are design values in inches.

If the length and/or width of the debug header is too large a footprint for the target board, consider using stand-offs, transition sockets or other extenders in the header connection socket to raise the header above the target.

FIGURE 2:   DIMENSIONS – AC162052, AC162055, AC162056, AC162057
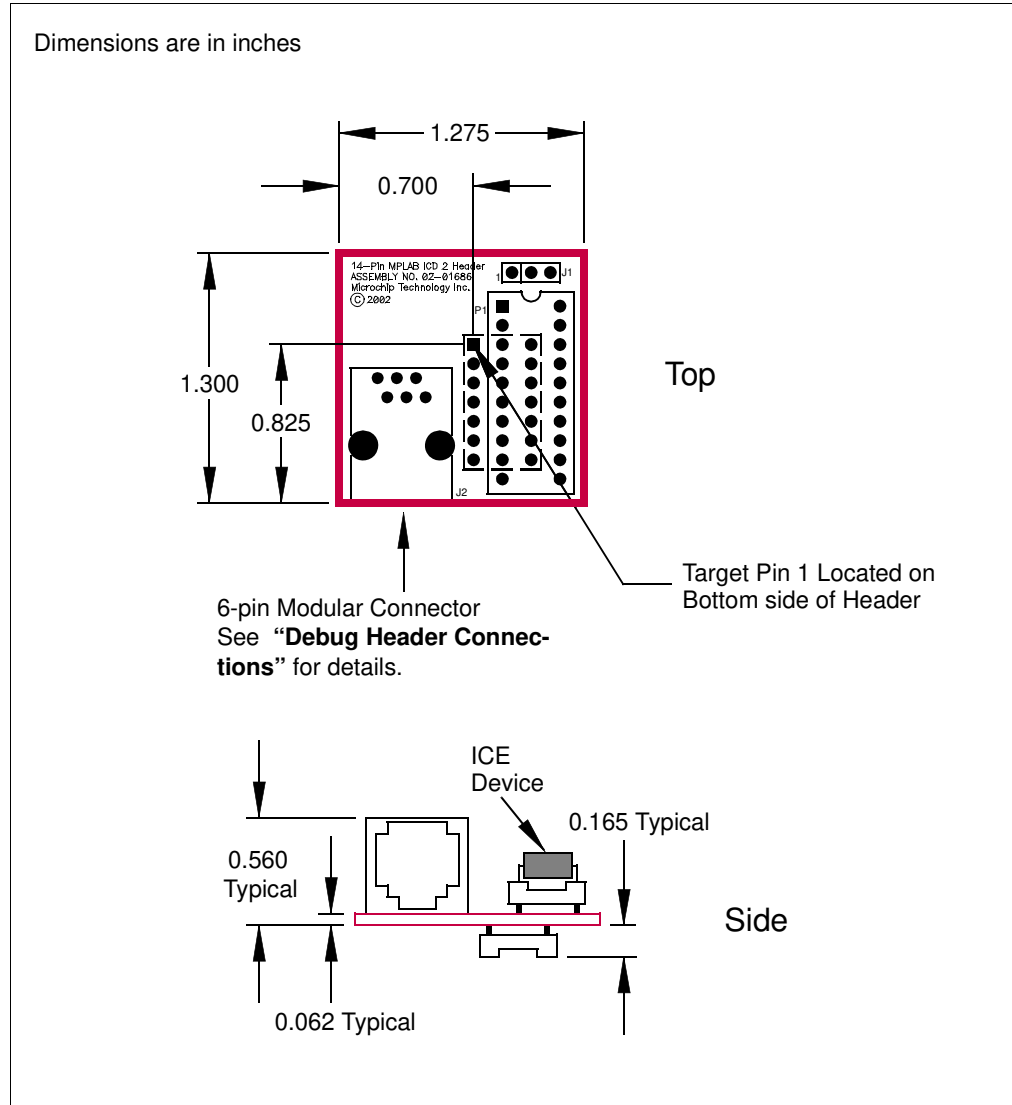
AC162053, AC162054

Header Identification

The header AC number is used for ordering the header. However, this number is not on the debug header, as the board is often used for multiple headers by inserting different ICE/ICD devices. To identify these debug headers, use the following information.

Header	ICE/ICD Device	Board Assembly Number
AC162053	PIC16F648A-ICD	02-01695
AC162054	PIC16F716-ICD	

Header Setup and Operation – AC162053

For this headers, there are no jumpers/switches. The device with the most program memory is always selected.

If PIC16F627A or PIC16F628A devices are selected for development in MPLAB IDE or MPLAB X IDE, the warning "Invalid target device ID" may be received in the build window and as a dialog. The reason is the PIC16F648A-ICD device supports PIC16F648A, PIC16F627A and PIC16F628A, but only reports the device ID for the PIC16F648A.

Ignore this warning or disable it under the **Warnings** tab on the ICD Programming dialog.

Header Setup and Operation – AC162054

This header supports one device (PIC16F716) so there are no jumpers or switches.

Header Limitations

See the "Limitations" section in your debug tool online Help file for details.

Processor Extension Pak and Header Specification

Header Dimensions

The figure below lists the dimensions for the debug header. Dimensions are design values in inches.

If the length and/or width of the debug header is too large a footprint for the target board, consider using stand-offs, transition sockets or other extenders in the header connection socket to raise the header above the target.

FIGURE 3:   **DIMENSIONS – AC162053, AC162054**

Dimensions are in inches

Target Pin 1 Located on Bottom side of Header

0.150

0.150

0.750

18-Pin MPLAB ICD 2 Header Microchip Technology Inc. © 2002
ASSEMBLY NO. 02-01695

2.350

6-pin Modular Connector See **"Debug Header Connections"** for details.

Top

ICE Device

0.165 Typical

0.560 Typical

0.062 Typical

Side

AC162059, AC162070, AC162096

Header Identification

The header AC number is used for ordering the header. However, this number is not on the debug header, as the board is often used for multiple headers by inserting different ICE/ICD devices. To identify these debug headers, use the following information.

Header	ICE/ICD Device	Board Assembly Number
AC162059	PIC16F505-ICD	02-01803
AC162070	PIC16F506-ICD	
AC162096	PIC16F526-ICD	

Header Setup and Operation

The ICD devices on these headers are specifically designed to select a device without the use of additional jumpers or switches.

These headers support 8 and 14-pin devices (see Figure 4.) For the AC162059 and AC162070, there is an 8-pin and a 14-pin connector. For the AC162096, there is only a 14-pin connector. (The 8-pin connector is not populated.) Use the 14-pin connector for 8-pin devices, but make sure device pin 1 is placed at the 14-pin connector pin 1.

Header Limitations

See the "Limitations" section in your debug tool online Help file for details.

Processor Extension Pak and Header Specification

Header Dimensions

The figure below lists the dimensions for the debug header. Dimensions are design values in inches.

If the length and/or width of the debug header is too large a footprint for the target board, consider using stand-offs, transition sockets or other extenders in the header connection socket to raise the header above the target.

FIGURE 4: **DIMENSIONS – AC162059, AC162070, AC162096**
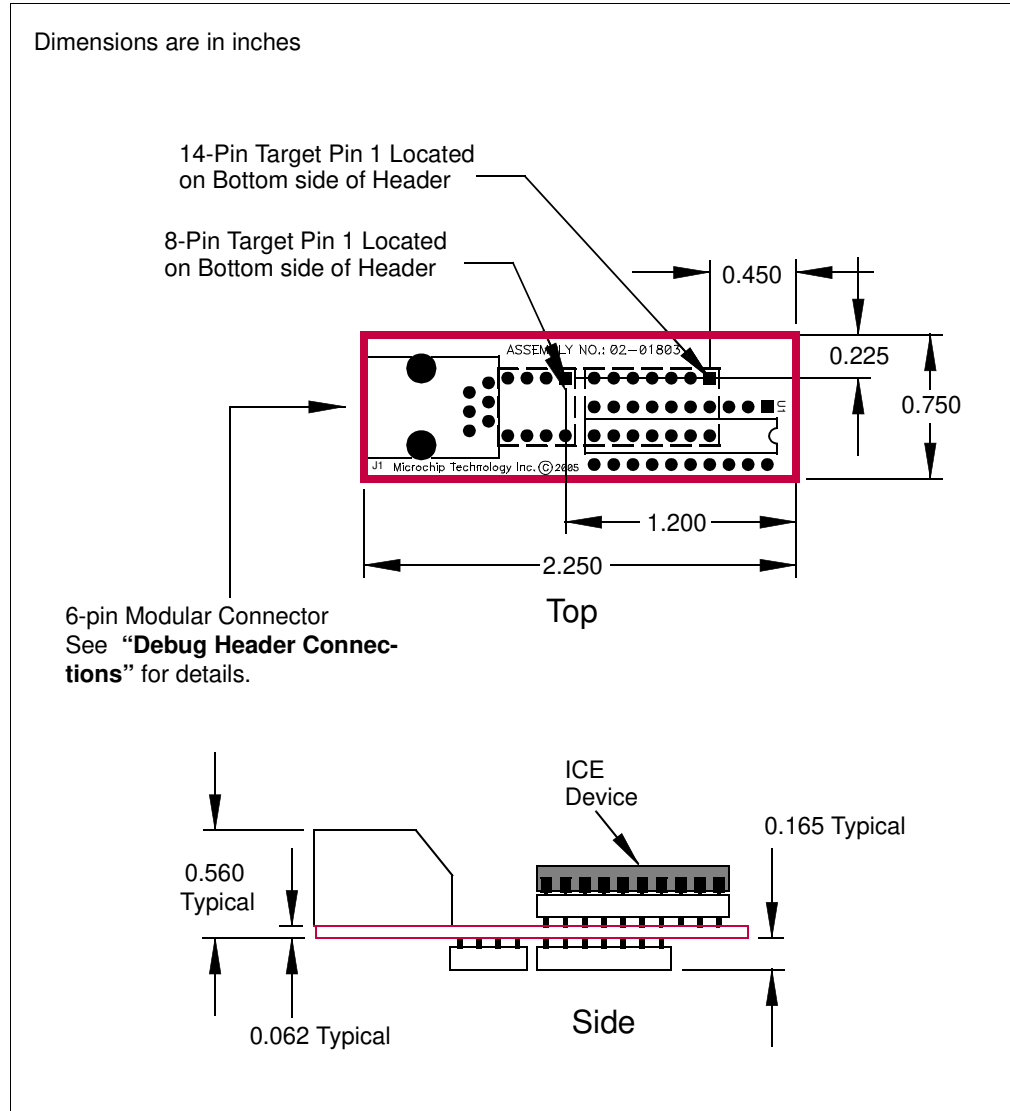
AC162060

Header Identification

The header AC number is used for ordering the header. However, this number is not on the debug header, as the board is often used for multiple headers by inserting different ICE/ICD devices. To identify this debug header, use the following information.

Header	ICE/ICD Device	Board Assembly Number
AC162060	PIC16F785-ICD	02-01820

Header Setup and Operation

For the PIC16F785 20-pin header, you will need to connect the jumper J2 to enable the shunt regulator.

Device	Device Type	Jumper J2	Function
PIC16F785	F	1-2	Disable shunt regulator
PIC16HV785	HV	2-3	Enable shunt regulator

Header Limitations

See the "Limitations" section in your debug tool online Help file for details.

Processor Extension Pak and Header Specification

Header Dimensions

The figure below lists the dimensions for the debug header. Dimensions are design values in inches.

If the length and/or width of the debug header is too large a footprint for the target board, consider using stand-offs, transition sockets or other extenders in the header connection socket to raise the header above the target.

FIGURE 5:   DIMENSIONS – AC162060
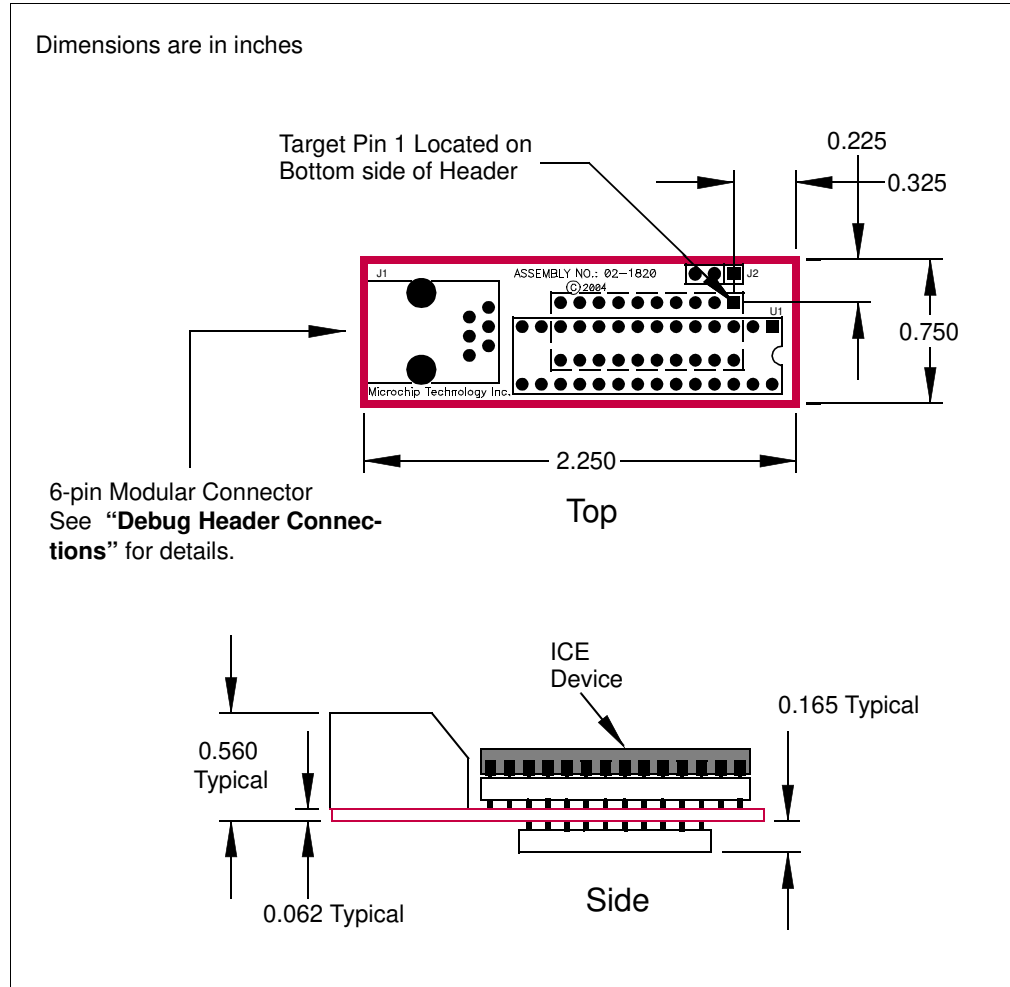
AC162061

Header Identification

The header AC number is used for ordering the header. However, this number is not on the debug header, as the board is often used for multiple headers by inserting different ICE/ICD devices. To identify this debug header, use the following information.

Header	ICE/ICD Device	Board Assembly Number
AC162061	PIC16F690-ICD	02-01835

Header Setup and Operation

For the PIC16F690 20-pin header, you will need to set the S1 switches (Figure 6) to enable peripherals and choose devices (Table 2).
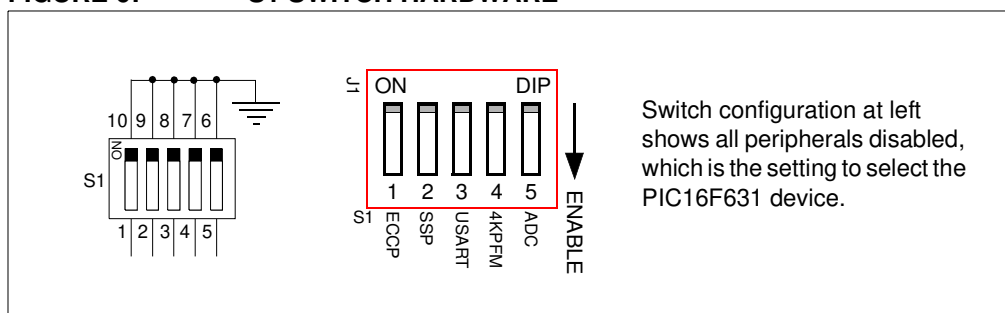
FIGURE 6:   S1 SWITCH HARDWARE

Switch configuration at left shows all peripherals disabled, which is the setting to select the PIC16F631 device.

TABLE 2:   S1 SWITCH DEVICE SELECTION

Device	Switches				
	1 ECCP	2 SSP	3 USART	4 4k PFM	5 ADC
PIC16F631	0	0	0	0*	0
PIC16F677	0	1	0	0**	1
PIC16F685	1	0	0	1	1
PIC16F687	0	1	1	0**	1
PIC16F689	0	1	1	1	1
PIC16F690	1	1	1	1	1

Legend: 1 = Enabled   0 = Disabled   * = 1k PFM   ** = 2k PFM

Header Limitations

See the "Limitations" section in your debug tool online Help file for details.

Processor Extension Pak and Header Specification

Header Dimensions

The figure below lists the dimensions for the debug header. Dimensions are design values in inches.

If the length and/or width of the debug header is too large a footprint for the target board, consider using stand-offs, transition sockets or other extenders in the header connection socket to raise the header above the target.

FIGURE 7:   DIMENSIONS – AC162061
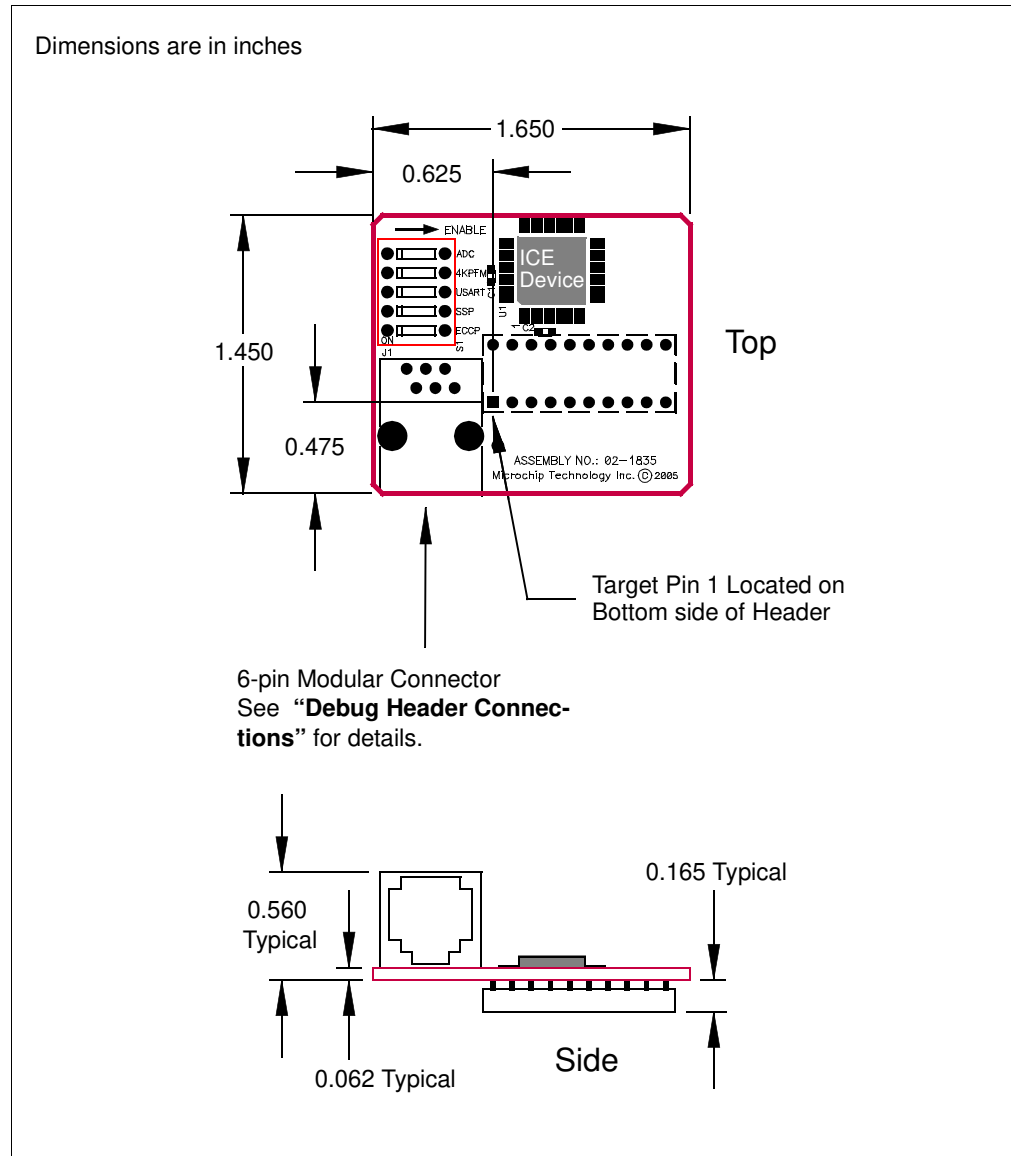
AC162066

Header Identification

The header AC number is used for ordering the header. However, this number is not on the debug header, as the board is often used for multiple headers by inserting different ICE/ICD devices. To identify this debug header, use the following information.

Header	ICE/ICD Device	Board Assembly Number
AC162066	PIC16F636-ICD	02-01832

Header Setup and Operation

For the PIC16F639 20-pin header, you will need to connect the jumper J3 as specified below.

Tool	Jumper J3	Function
MPLAB® ICE 2000	1-2	Run/program as production device
In-circuit debuggers, next generation in-circuit emulators	2-3	Run/program as ICD device

In addition to being used with debug tools that normally use headers, this header is used with the PCM16YM0 processor module to emulate a PIC16F639 on the MPLAB ICE 2000 in-circuit emulator. Plug the end of the processor module into the header, and then plug the header into the transition socket or directly onto the target board.

Header Limitations

See the "Limitations" section in your debug tool online Help file for details.

Header Dimensions

The figure below lists the dimensions for the debug header. Dimensions are design values in inches.

If the length and/or width of the debug header is too large a footprint for the target board, consider using stand-offs, transition sockets or other extenders in the header connection socket to raise the header above the target.

FIGURE 8:   DIMENSIONS – AC162066
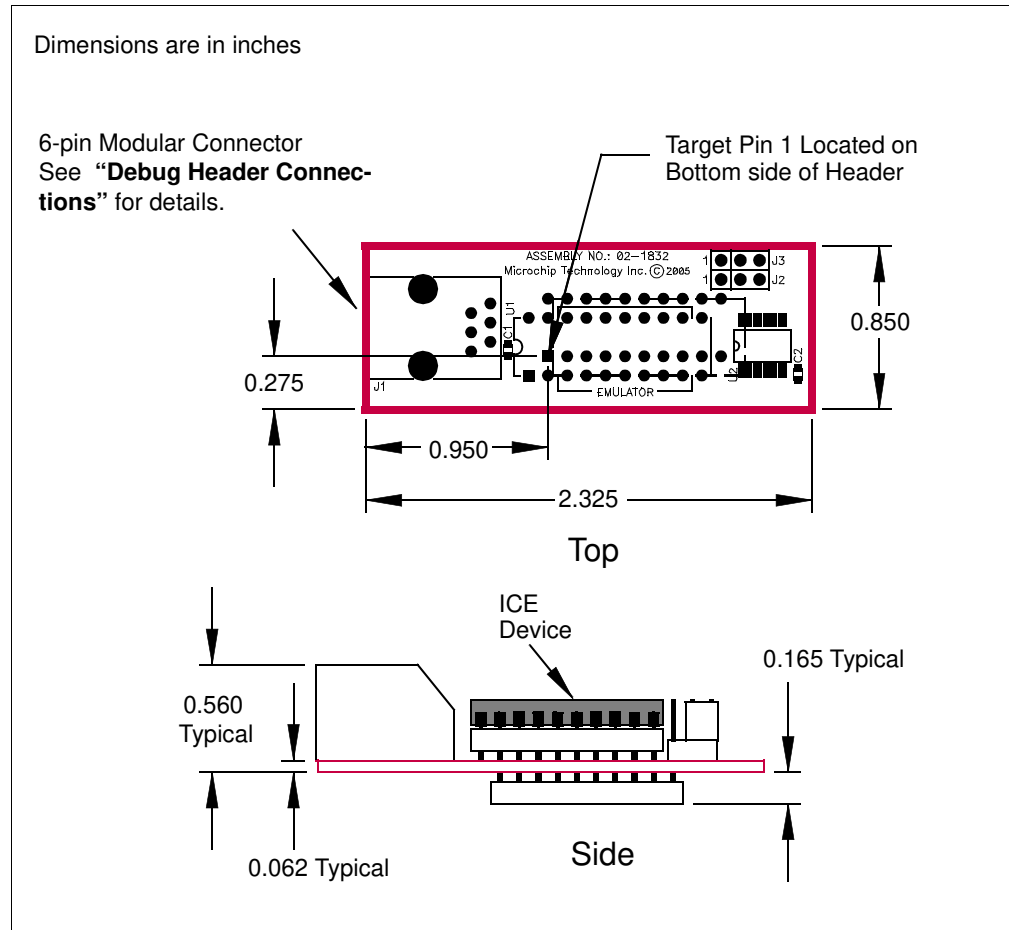
AC162083

Header Identification

The header AC number is used for ordering the header. However, this number is not on the debug header, as the board is often used for multiple headers by inserting different ICE/ICD devices. To identify this debug header, use the following information.

Header	ICE/ICD Device	Board Assembly Number
AC162083	PIC16F616-ICD	02-01976

Header Setup and Operation

CAUTION
Incorrect rotary switch (Figure 9) settings may irreparably damage the header.
Ensure rotary switch settings are correct (Table 3) before powering or connecting the header.
Do not change the rotary switch setting while the header is powered or connected to a debug tool.
Do not power shunt regulator (HV) devices from the debug tool.

Test points are available on this header to check the following: Ground (TP1), V_{DD} (TP2), ICD Clock (TP3), ICD Data (TP4) and ICD MCLR/V_{PP} (TP5).

TABLE 3: ROTARY SWITCH SETTINGS

Switch Position	Device	Switch Position	Device
0	**PIC12HV609**	8	**PIC12F609**
1	**PIC12HV615**	9	**PIC12F615**
2	Reserved HV	A	**PIC12F617**
3	**PIC16HV610**	B	**PIC16F610**
4	**PIC16HV616**	C	**PIC16F616**
5	Reserved HV	D	Reserved F
6	Reserved HV	E	Reserved F
7	Reserved HV	F	Reserved F

Also, see the AC162083 Insert (DS51693).