PIC18F87J50 FS USB
Plug-In Module
User's Guide

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Preface

NOTICE TO CUSTOMERS

All documentation becomes dated, and this manual is no exception. Microchip tools and documentation are constantly evolving to meet customer needs, so some actual dialogs and/or tool descriptions may differ from those in this document. Please refer to our web site (www.microchip.com) to obtain the latest documentation available.

Documents are identified with a "DS" number. This number is located on the bottom of each page, in front of the page number. The numbering convention for the DS number is "DSXXXXXA", where "XXXXX" is the document number and "A" is the revision level of the document.

For the most up-to-date information on development tools, see the MPLAB® IDE on-line help. Select the Help menu, and then Topics to open a list of available on-line help files.

INTRODUCTION

This chapter contains general information that will be useful to know before using the PIC18F87J50 FS USB Plug-In Module. Items discussed in this chapter include:

- Document Layout
- Conventions Used in this Guide
- Recommended Reading
- The Microchip Web Site
- Development Systems Customer Change Notification Service
- Customer Support
- Document Revision History

DOCUMENT LAYOUT

This document describes how to use the PIC18F87J50 FS USB Plug-In Module. The manual layout is as follows:

- **Chapter 1. "Introduction and Overview"**
- **Chapter 2. "Important Notes and Migration Tips"**
- **Chapter 3. "Hardware Configuration/Jumper Settings"**
- **Chapter 4. "Demo Code/Reference Firmware"**
- **Appendix A. "PIC18F87J50 FS USB Plug-In Module Schematics"**

CONVENTIONS USED IN THIS GUIDE

This manual uses the following documentation conventions:

DOCUMENTATION CONVENTIONS

Description	Represents	Examples
Arial font:		
Italic characters	Referenced books	*MPLAB® IDE User's Guide*
	Emphasized text	...is the *only* compiler...
Initial caps	A window	the Output window
	A dialog	the Settings dialog
	A menu selection	select Enable Programmer
Quotes	A field name in a window or dialog	"Save project before build"
Underlined, italic text with right angle bracket	A menu path	<u>*File>Save*</u>
Bold characters	A dialog button	Click **OK**
	A tab	Click the **Power** tab
N'Rnnnn	A number in verilog format, where N is the total number of digits, R is the radix and n is a digit.	4'b0010, 2'hF1
Text in angle brackets < >	A key on the keyboard	Press <Enter>, <F1>
Courier New font:		
Plain Courier New	Sample source code	`#define START`
	Filenames	`autoexec.bat`
	File paths	`c:\mcc18\h`
	Keywords	`_asm, _endasm, static`
	Command-line options	`-Opa+, -Opa-`
	Bit values	`0, 1`
	Constants	`0xFF, 'A'`
Italic Courier New	A variable argument	*`file`*`.o`, where *`file`* can be any valid filename
Square brackets [ ]	Optional arguments	`mcc18 [options]` *`file`* `[options]`
Curly brackets and pipe character: { | }	Choice of mutually exclusive arguments; an OR selection	`errorlevel {0|1}`
Ellipses...	Replaces repeated text	`var_name [, var_name...]`

	Represents code supplied by user	`void main (void)`
		`{ ...`
		`}`

RECOMMENDED READING

This user's guide describes how to use PIC18F87J50 FS USB Plug-In Module. Other useful documents are listed below. The following Microchip documents are available and recommended as supplemental reference resources.

PIC18F87J50 Family Data Sheet (DS39775)

MCHPFSUSB Firmware User's Guide (DS51679)

PICDEM™ FS USB Demonstration Board User's Guide (DS51526)

USB related application notes, firmware and other resources will be posted at the Microchip full-speed USB design center:

http://www.microchip.com/usb/ (click on the "Full-Speed USB Solutions" link)

Schematics and other support materials for the HPC Explorer board can be obtained at:

http://www.microchip.com/HPCExplorer

In addition to Microchip documents, the official USB 2.0 specifications are of particular interest. These can be obtained from the USB Implementer's Forum:

http://www.usb.org

Chapter 9 of the official USB 2.0 specifications is especially important, as it strongly influences the development of USB firmware.

THE MICROCHIP WEB SITE

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- **General Technical Support** – Frequently Asked Questions (FAQs), technical support requests, online discussion groups, Microchip consultant program member listing
- **Business of Microchip** – Product selector and ordering guides, latest Microchip press releases, listing of seminars and events, listings of Microchip sales offices, distributors and factory representatives

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- **Emulators** – The latest information on Microchip in-circuit emulators.This includes the MPLAB ICE 2000 and MPLAB ICE 4000.
- **In-Circuit Debuggers** – The latest information on the Microchip in-circuit debugger, MPLAB ICD 2.
- **MPLAB® IDE** – The latest information on Microchip MPLAB IDE, the Windows® Integrated Development Environment for development systems tools. This list is focused on the MPLAB IDE, MPLAB SIM simulator, MPLAB IDE Project Manager and general editing and debugging features.
- **Programmers** – The latest information on Microchip programmers. These include the MPLAB PM3 and PRO MATE® II device programmers and the PICSTART® Plus and PICkit™ 1 development programmers.

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- 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. A listing of sales offices and locations is included in the back of this document.

Technical support is available through the web site at: http://support.microchip.com

DOCUMENT REVISION HISTORY

Revision A (July 2007)

- Initial Release of this Document.

Chapter 1. Introduction and Overview

1.1 INTRODUCTION

The PIC18F87J50 FS USB Plug-In Module (PIM) Demonstration Board and Kit is designed as an easy-to-use evaluation platform for Microchip's Full-Speed USB PIC18F87J50 family of microcontrollers. The PIM may be operated either stand-alone, or in conjunction with the HPC Explorer board (microchipDIRECT part number DM183022).

These devices fully support USB 2.0 full-speed and low-speed serial communications at signaling speeds of 12 Mbit/s or 1.5 Mbit/s. The demonstration kit provides all of the hardware and software needed to develop officially compliant USB communication solutions.

1.2 HIGHLIGHTS

Items discussed in this chapter include:

- PIC18F87J50 FS USB Plug-In Module Kit Contents
- Overview of the PIC18F87J50 Family USB Capabilities
- Using the Preprogrammed Firmware

1.3 PIC18F87J50 FS USB PLUG-IN MODULE KIT CONTENTS

The Demonstration Kit contains the following items:

1. The PIC18F87J50 FS USB Plug-In Module demonstration board, preprogrammed with USB Human Interface Device (HID) class mouse demonstration firmware.
2. A standard USB mini-B cable for power and communication.
3. The PICDEM™ FS USB Starter Kit CD-ROM, containing USB firmware projects, Microchip's custom class USB driver and USB-specific documentation, such as this user's guide.

1.4 OVERVIEW OF THE PIC18F87J50 FAMILY USB CAPABILITIES

The PIC18F87J50 microcontroller is the "superset" device in the PIC18F87J50 microcontroller family. The PIC18F87J50 has the highest memory and pin count in the family, but otherwise shares an identical feature set (except features which require pins not present on 64-pin devices) compared to the other devices. All of the devices in the family are code-compatible with each other and share the same USB capabilities:

- USB 2.0 compliance
- Full-speed (12 Mbit/s) and low-speed (1.5 Mbit/s) operation
- Support of control, interrupt, bulk and isochronous transfers
- Support of up to 32 endpoints
- 3.9 Kbytes of dual access RAM for USB or general purpose use
- On-chip features for a single chip USB implementation, including:
    - USB Serial Interface Engine (SIE)
    - USB transceiver
    - USB pull-up resistors
    - D+ and D- driver output impedance matching resistors

1.5 USING THE PREPROGRAMMED FIRMWARE

The PIC18F87J50 FS USB Plug-In Module comes preprogrammed with HID class firmware. Upon plugging in the USB cable to a Windows® operating system based host PC, the device should automatically enumerate as a HID class mouse. The mouse cursor should promptly begin moving around in a continuous circular pattern, and the red LEDs on the PIM should begin blinking in an alternate manner. To stop the mouse cursor from moving, simply press the "S4" push button located in the lower right corner of the PIM. If the LEDs fail to illuminate, the device fails to enumerate or the mouse does not move in a circle, verify that jumpers, JP4 and JP5, are installed. See Figure 3-1 for the locations of these components.

Chapter 2. Important Notes and Migration Tips

2.1 HIGHLIGHTS

This chapter discusses:

- Using the PIM with the HPC Explorer Board
- Programming the Microcontroller
- Migrating to the PIC18F87J50 Family

2.2 USING THE PIM WITH THE HPC EXPLORER BOARD

If the PIM will be used with the HPC Explorer board, be sure to set switch, S3, on the HPC Explorer to the "ICE" position **PRIOR TO INSTALLING THE PIM**. When the switch is in the ICE position, the $\overline{\text{MCLR}}$ line on the PIC18F8722 microcontroller, located on the HPC Explorer, will be held low. Additionally, V_{DD} will not be connected to the PIC18F8722. This is intended to prevent simultaneous code execution on both the microcontroller located on the HPC Explorer board and on the PIM. Almost all of the I/O pins on the PIM are directly connected to the same I/O pins on the PIC18F8722 of the HPC Explorer board. For example, when the two boards are connected together, microcontroller pin, RD0 on the PIC18F87J50 FS USB PIM, is directly connected to the RD0 pin on the PIC18F8722, as well as one of the green LEDs on the HPC Explorer board.

If both microcontrollers could execute code simultaneously, I/O pins configured as outputs could easily result in I/O pin contention and possible device damage. To prevent this potential condition, the S3 switch on the HPC Explorer board should always be in the "ICE" position when a PIM is installed.

The "P4" pin on the PIC18F87J50 FS USB Plug-In Module is intended to physically interfere with switch, S3, on the HPC Explorer board. If the switch is not in the correct position, the PIM will not sit fully seated. To avoid physically damaging the PIM or the HPC Explorer board, never use excessive force when installing the PIM, and always check that switch S3 on the HPC Explorer board is in the correct position.

The PIC18F87J50 FS USB PIM has been specifically designed to work either stand-alone or while plugged into the HPC Explorer board, revision 5. HPC Explorer revision 4 boards will also work, although capacitor, C3, may be too tall to allow the PIM to sit fully seated. The interference should not be enough to prevent electrical connectivity, but if it does, it is recommended to replace C3 with a physically smaller capacitor. The HPC Explorer revision number can be found etched in the copper on the bottom side of the PCB just underneath the 9-pin serial port connector.

2.3 PROGRAMMING THE MICROCONTROLLER

The PIC18F87J50 microcontroller located on the PIM may be reprogrammed in excess of 10,000 cycles. The PIM is too small to feature a full size RJ11 jack used on most Microchip demonstration boards. Instead, the PIM uses a 6-pin right angle male header (J5) which is electrically compatible with common Microchip programmers, such as the MPLAB® ICD 2 and the MPLAB REAL ICE™ in-circuit emulator.

When the PIM is mated to the HPC Explorer board, it may be reprogrammed and debugged directly through the modular RJ11 jack found on the HPC Explorer board.

When operated stand-alone, the PIM can be reprogrammed/debugged with programmers like the ICD 2 or REAL ICE in-circuit emulator via a modular RJ11 to ICSP™ (6-pin female header) adapter board. This adapter board can be ordered online from www.microchipDIRECT.com, part number AC164110. This adapter board also comes as part of the REAL ICE In-Circuit Emulator Performance Pak, microchipDIRECT part number AC244002. When plugging the adapter board into the PIM, the silk screen layer on both boards should face up. On the silk screens of each board, a small square surrounds pin 1 ($\overline{\text{MCLR}}$ pin) on both the adapter board and PIM; these should line up.

2.4 MIGRATING TO THE PIC18F87J50 FAMILY

The PIC18F87J50 family of microcontrollers offers a number of enhancements and new features compared to previous PIC18 devices. Most changes require no modifications to user firmware, however, this section highlights key items that deserve special attention.

2.4.1 Special Function Register Addressing

The PIC18F87J50 family devices are very peripheral rich and consequently have more Special Function Registers (SFRs) than will fit in the access portion of Bank 15. Some of the new SFRs have been placed in the non-access portion of Bank 15 (addresses: F40h to F5Fh inclusive). Some of the USB Control registers are located in the non-access portion of Bank 15. See **Section 5.3 "Data Memory Organization"** in the *"PIC18F87J50 Family Data Sheet"* (DS39775) for more details regarding these changes.

In addition to the new Bank 15 SFRs, some of the new SFRs have been located in a shadow space sharing the same addresses as other access bank SFRs. These shadow space registers are only accessible when the WDTCON<ADSHR> bit has been configured correctly.

When attempting to access the shadow space registers in either assembly or C18, user firmware should be careful to keep track of, and manually control, the WDTCON<ADSHR> bit.

When using Microchip's C18 compiler, no source code changes will be needed to address the non-access Bank 15 SFRs. The C18 compiler has awareness of these new SFR locations and will automatically use the proper addressing modes to access these registers.

The USB module on the PIC18F87J50 family of microcontrollers is compatible with previous full-speed USB products, such as the PIC18F4550 family and PIC18F4450 family. The USB registers and bits within those registers retain the same names across these families, so USB firmware can be ported between the devices with little or no changes.

2.4.2 Oscillator Configuration

The PIC18F87J50 family devices use the same 96 MHz PLL found in prior full-speed USB microcontrollers, such as the PIC18F4550, but the implementation of the surrounding clock structure is slightly different. When migrating up to the PIC18F87J50 family of devices, the most important change is the PLL does not automatically start when the microcontroller is powered on, even if it is programmed to use one of the PLL-enabled modes (e.g., HS+PLL). This allows the microcontroller to start up at less than the maximum operating frequency. This can potentially be advantageous when running from a decaying power source (such as a battery), where the applied voltage may not be adequate for maximum frequency operation. For applications such as these, the WDTCON<LVDSTAT> bit can be polled to determine if firmware can safely switch to maximum frequency operation.

After the Power-up Timer expires and the microcontroller begins code execution, the OSCTUNE<PLLEN> bit must be set by user firmware to activate the PLL (in PLL-enabled modes). The PLL requires up to 2 ms to lock, during which time, the microcontroller continues to execute code at the PLL-disabled frequency. User firmware should not attempt to enable the USB module by setting the UCON<USBEN> bit until after the PLL has locked (unless the PLL is not being used to derive the USB module clock).

2.4.3 Input Buffer Selection

The PIC18F87J50 family of microcontrollers offers more flexibility compared to previous PIC18 devices when selecting which I/O pins should use analog input buffers, and which ones should use digital input buffers. Previous PIC18 microcontrollers used the ADCON1 register to control this function, but the PIC18F87J50 family devices use two new registers, ANCON0 and ANCON1, for this purpose. These new registers allow the PIC18F87J50 family of microcontrollers to individually and independently select which ANx pins should use digital or analog input buffers. See the Analog-to-Digital converter chapter in the device data sheet for more details.

NOTES:

Chapter 3. Hardware Configuration/Jumper Settings

3.1 HIGHLIGHTS

This chapter discusses:

- Hardware Features
- Crystal
- Linear Regulator/Power Management
- LEDs
- Push Buttons
- Jumpers
- Hardware Considerations for Compliance Testing

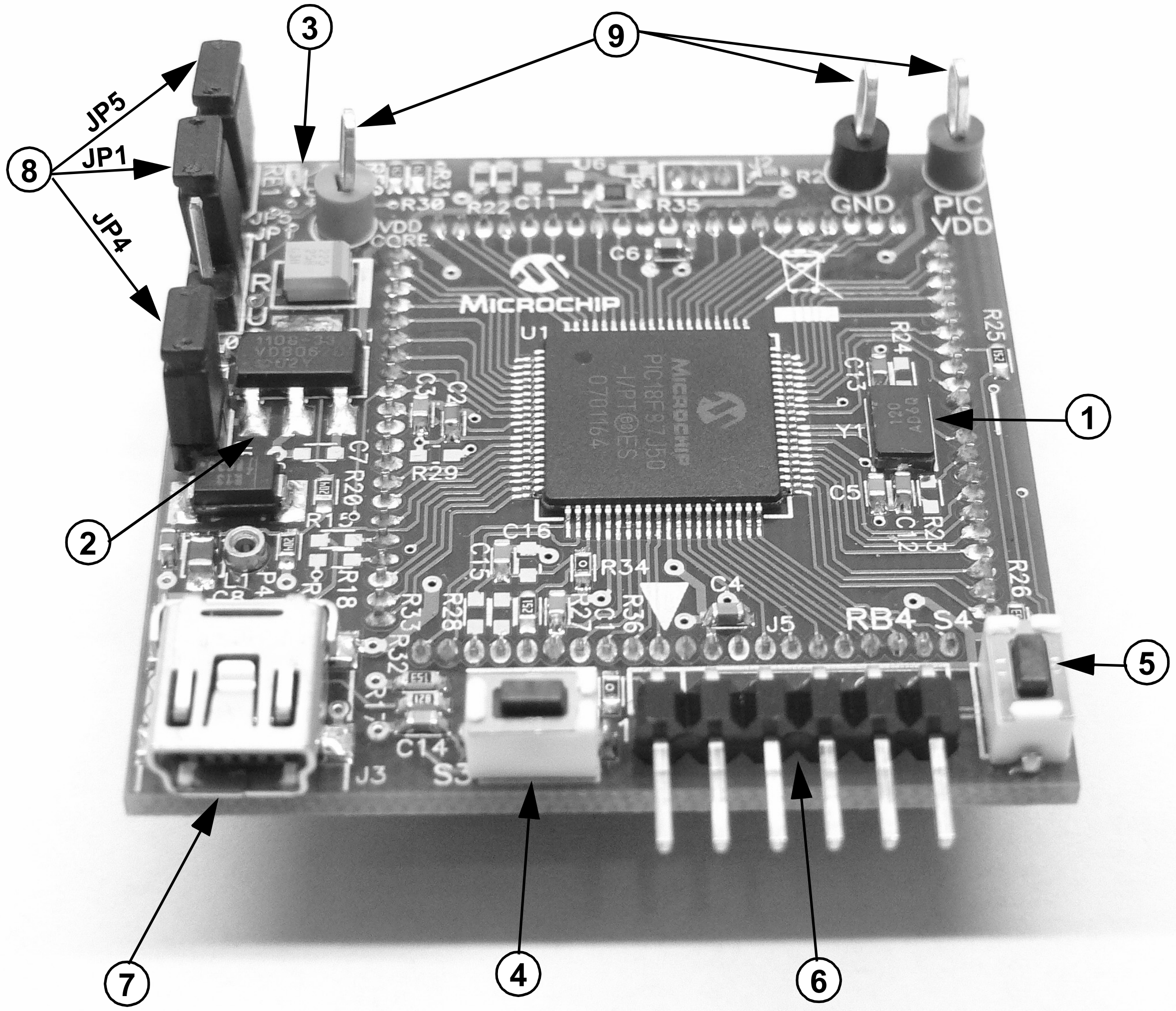
3.2 HARDWARE FEATURES

The PIC18F87J50 FS USB PIM has a number of hardware features intended to make it useful as an initial development platform and demonstration board. Refer to **Appendix A. "PIC18F87J50 FS USB Plug-In Module Schematics"** for schematics of the PIM. The board offers the following hardware features:

1. 12 MHz miniature surface-mounted crystal.
2. 3.3V low IQ LDO linear regulator.
3. 2 bright red miniature LEDs (attached to I/O pins, RE0 and RE1).
4. $\overline{\text{MCLR}}$ push button for convenient device Reset.
5. General purpose push button (attached to I/O pin, RB4).
6. ICSP™ programming and debug 6-pin header.
7. USB mini-B connector.
8. Jumpers for added configurability (JP1, JP4, JP5).
9. Test points for convenient V_{DD}, V_{DDCORE} and GND measurements.

Figure 3-1 shows where these key components are located on the PIM with item numbers corresponding to the above list.

FIGURE 3-1: KEY COMPONENT LOCATIONS



3.3 CRYSTAL

In order to use the USB module on the PIC18F87J50 family of microcontrollers, the module requires a fixed 48 MHz or 6 MHz clock for use in Full-Speed or Low-Speed modes, respectively. These clock frequencies can be derived from the internal 96 MHz PLL, and the microcontroller core need not run at the same frequency as the USB module. In order to use the 96 MHz PLL, a clock source which is an integer multiple of 4 MHz is required. A 12 MHz crystal is included on the board for this purpose.

On the PIC18F87J50 microcontroller, the oscillator pins (RA6 and RA7) route directly to the 12 MHz crystal. Unlike most other I/O pins, these do not route directly to the "ICE Module" female headers. Two resistor pads can be used to connect RA6 and RA7 to the female header pins, but by default, these are left unpopulated. This is done to prevent "crystal contention" between the 12 MHz crystal on the PIM and the 10 MHz crystal on the HPC Explorer board.

3.4 LINEAR REGULATOR/POWER MANAGEMENT

The USB interface provides +5V (nominal) at up to 500 mA (only 100 mA can be ensured) for use by USB peripheral devices. In order to take advantage of this bus provided power, a 3.3V low drop out, low quiescent current linear regulator (TC1108-3.3VDB) has been included on the PIM. This enables the PIM to be purely bus powered, providing power to both the PIM and the HPC Explorer board if connected.

Alternatively, when used in conjunction with the HPC Explorer, the PIM may obtain power from the HPC board. When a suitable power source is connected to power jack, J1 on the HPC Explorer board, the board will natively produce a regulated 5V provided by the on-board adjustable linear regulator. When a PIM requiring 3.3V (such as the PIC18F87J50 FS USB PIM) is plugged in, resistor, R2, located on the PIM alters the feedback circuit of the adjustable linear regulator and configures it to produce 3.3V. Therefore, no soldering or other modification is required to either the HPC Explorer or the PIC18F87J50 FS USB PIM when they are used together.

Jumper, JP4, on the PIM serves two main purposes. JP4 is located in series with the +5V VBUS supply from the USB cable to the rest of the PIM board (see Figure A-1 for exact electrical location). In this location, the jumper cap can be removed, and a digital current meter can be inserted across the posts of the header. This can be quite useful during development, as it offers a means of determining how much current the application (both the PIM and the HPC Explorer board if connected) is actively consuming from the USB port. This is especially important when developing bus powered USB applications that are intended to be fully USB compliant.

All USB devices are supposed to implement a low-power USB Suspend mode. The host PC may, at its own discretion, halt all USB traffic (including Start-of-Frame packets) to your device for more than 3 ms. Upon detecting this condition, the USB peripheral device should drop to a low-power suspend state, whereby it draws no more than 500 μA (or in some cases, 2.5 mA; see the USB 2.0 specifications section 7.2.3) from the +5V VBUS supply. Two USB interrupts, UIR<IDLEIF> and UIR<ACTVIF>, are useful for detecting when the low-power suspend condition is supposed to begin and when it ends. The TC1108-3.3VDB linear regulator was chosen for its low dropout, low quiescent current consumption and good transient response capability.

In addition to providing a convenient location for installing a digital current meter, JP4 also serves another purpose. In some cases, it may be undesirable to consume power from the USB port, for example, when developing end applications that are always self-powered or consume more than 300 mA (the maximum rating for the regulator). In these cases, jumper cap, JP4, can be removed, and the PIM can obtain power from the HPC Explorer board or directly from the test points.

Diode, D2, prevents the PIM from ever sourcing current onto the +5V VBUS pin of the USB cable. The USB 2.0 specifications require that USB peripherals should never source current onto the +5V VBUS line under any condition.

3.5 LEDs

Two high-efficiency, red LEDs have been included on the PIM. The LEDs are connected to I/O pins, RE0 and RE1, and may be used for general purpose indication. The LEDs are connected such that they turn on when the I/O pin controlling them is driven high. Alternatively, if the I/O pin loading is undesirable (each LED consumes approximately 1 mA when turned on), jumper cap covering, JP5, may be removed. This will effectively disconnect both LEDs from their respective I/O pins.

3.6 PUSH BUTTONS

Two miniature push buttons are included on the PIM. Switch, S3 on the PIM, connects to $\overline{\text{MCLR}}$. It may be used to reset the microcontroller when the PIM is used either stand-alone or while connected to the HPC Explorer board.

Pin, RB4 on the PIC18F87J50 microcontroller, is pulled up to VDD through a 15 kOhm resistor (R26 on the PIM). If push button, S4 on the PIM, is pressed, it will pull RB4 low. This push button may be used for any general purpose user interfacing purposes. When the PIM is plugged into the HPC Explorer board, the RB0 push button on the HPC Explorer will also work and can be used for additional general purpose user input.

3.7 JUMPERS

The PIM has three jumper headers on it to provide additional flexibility for experimentation and development purposes.

JP1 – This is a three-pin header with the labels, 'I', 'R' and 'U'. The 'R' is an abbreviation referring to microcontroller pin, RB5. 'I' is an abbreviation referring to the "ICE" female header pin for the RB5 signal. 'U' is an abbreviation for the USB VBUS line.

When the jumper is in the 'R' to 'I' position, the RB5 pin connects only to the ICE female header pin, just like most of the other general purpose I/O pins. When the jumper is in the 'R' to 'U' position, RB5 (which is 5.5V tolerant) can be used to sense when the USB cable has been attached to the host, and when the host is actively providing power to the +5V VBUS line. According to the USB 2.0 specifications, no device should ever pull the D+ or D- lines high (such as with the D+ or D- pull-up resistor) until the host actively powers the +5V VBUS line. This is intended to prevent self-powered peripherals from ever sourcing even small amounts of power to the host when the host is not powered. Small amounts of current could potentially prevent the host (and possibly other USB peripherals connected to that host) from fully becoming depowered, which may cause problems during power-up and initialization.

Self-powered peripherals should periodically monitor the +5V VBUS line and detect when it is driven high. Only when it is powered should user firmware enable the USB module and turn on the D+ (for full speed) or D- (for low speed) pull-up resistor, signaling device attach to the host. The recommended method of monitoring the +5V VBUS line is to connect it to one of the microcontroller's 5.5V tolerant I/O pins through a large value resistor (such as 100 kOhms). The resistor serves to improve the ESD ruggedness of the circuit as well as to prevent microcontroller damage if user firmware should ever unintentionally configure the I/O pin as an output.

Peripherals which are purely bus powered obtain all of their power directly from the +5V VBUS line itself. For these types of devices, it is unnecessary to monitor when the VBUS is powered, as the peripheral will not be able to source current on the D+, D- or VBUS lines when the host is not powered.

JP4 – This jumper is located in series with the +5V VBUS power supply line from the USB connector. When the jumper is removed, a current meter may be placed between the header pins to measure the board current which is being drawn from the USB port. Additionally, by removing the jumper cap altogether, JP4 provides a means of preventing the board from consuming USB power. See **Section 3.4 "Linear Regulator/Power Management"** for more details.

JP5 – This jumper provides a means of removing the LED pin loading on the RE0 and RE1 pins.

3.8 HARDWARE CONSIDERATIONS FOR COMPLIANCE TESTING

When developing USB applications that must pass the official USB compliance testing process, it is recommended to select the USB cable and connector carefully. In order to make a USB compliant application, the USB-IF requires that important USB building blocks, such as cables and connectors, should also be individually compliant. For example, if a standard USB B or mini-B connector is used on the application circuit board, it should be capable of passing compliance tests specific for USB connectors. USB building blocks which have officially gone through the compliance testing process will have a Test ID (TID) number associated with them.

Microchip's USB microcontrollers, such as the PIC18F87J50, have TID numbers associated with them, and these numbers can be found at the USB design center:

http://www.microchip.com/usb (click on the "Full-Speed USB Solutions" link)

When developing products using standard USB cables and connectors, it is recommended to know the TID number for those components prior to including them in the design.

NOTES:

Chapter 4. Demo Code/Reference Firmware

To assist in the development of USB applications, Microchip provides a number of demonstration firmware projects (such as HID, CDC, etc.), and other support materials, such as application notes. The USB demonstration projects use the same basic USB framework, which is referred to as the "MCHPFSUSB Firmware". Documentation for this firmware can be found in the *"MCHPFSUSB Firmware User's Guide"* (DS51679). The firmware projects are contained in an executable setup file which can be found either on the CD-ROM disc, which distributes with the PIM, or at the Microchip USB design center:

http://www.microchip.com/usb

Once the MCHPFSUSB Firmware has been installed, the MPLAB® IDE project containing the source code and hex file for the HID class, mouse like demonstration firmware, that comes preprogrammed on the PIC18F87J50, can be found in the following directory:

`C:\MCHPFSUSB\fw\HID\Mouse`

By default, the MPLAB IDE projects are configured to work with the PICDEM™ FS USB Demo Board, which uses the PIC18F4550 microcontroller. Refer to the MCHPFSUSB Firmware release notes for details on how to switch the projects over for use with the PIC18F87J50.

NOTES:

Appendix A. PIC18F87J50 FS USB Plug-In Module Schematics

A.1 SCHEMATICS

The PIC18F87J50 FS USB Plug-In Module schematics are shown in Figure A-1 and Figure A-2. By default, the PIM ships from the factory with the PIC18F87J50 pre-installed in location U1. The PIC18F87J50 is the superset part in the device family, and is therefore, a good starting point for developing USB applications that will eventually use one of the other devices in the device family.

However, the pads of U1 have been designed to accommodate any of the products in the PIC18F87J50 family of microcontrollers, both the 80-pin TQFP and 64-pin TQFP. For example, if the PIC18F87J50 is carefully desoldered using hot air, and the pads are cleaned using solder wick, it is possible to install the 64-pin TQFP PIC18F65J50 in its place. This is possible since the pin pitch is the same between the 64-pin and 80-pin TQFP packages, and the functionality is the same for pins which share the same locations between the two packages. Effectively, the 80-pin TQFP pads of U1 overlap with the standard 64-pin TQFP pads.

The board revision number can be found etched into the copper on the bottom side of the PCB underneath the programming header. The board revision number is the last number in the line and is located inside the rectangular box.

FIGURE A-1: PIC18F87J50 FS USB PIM REV. 1 SCHEMATICS (SHEET 1 OF 2)

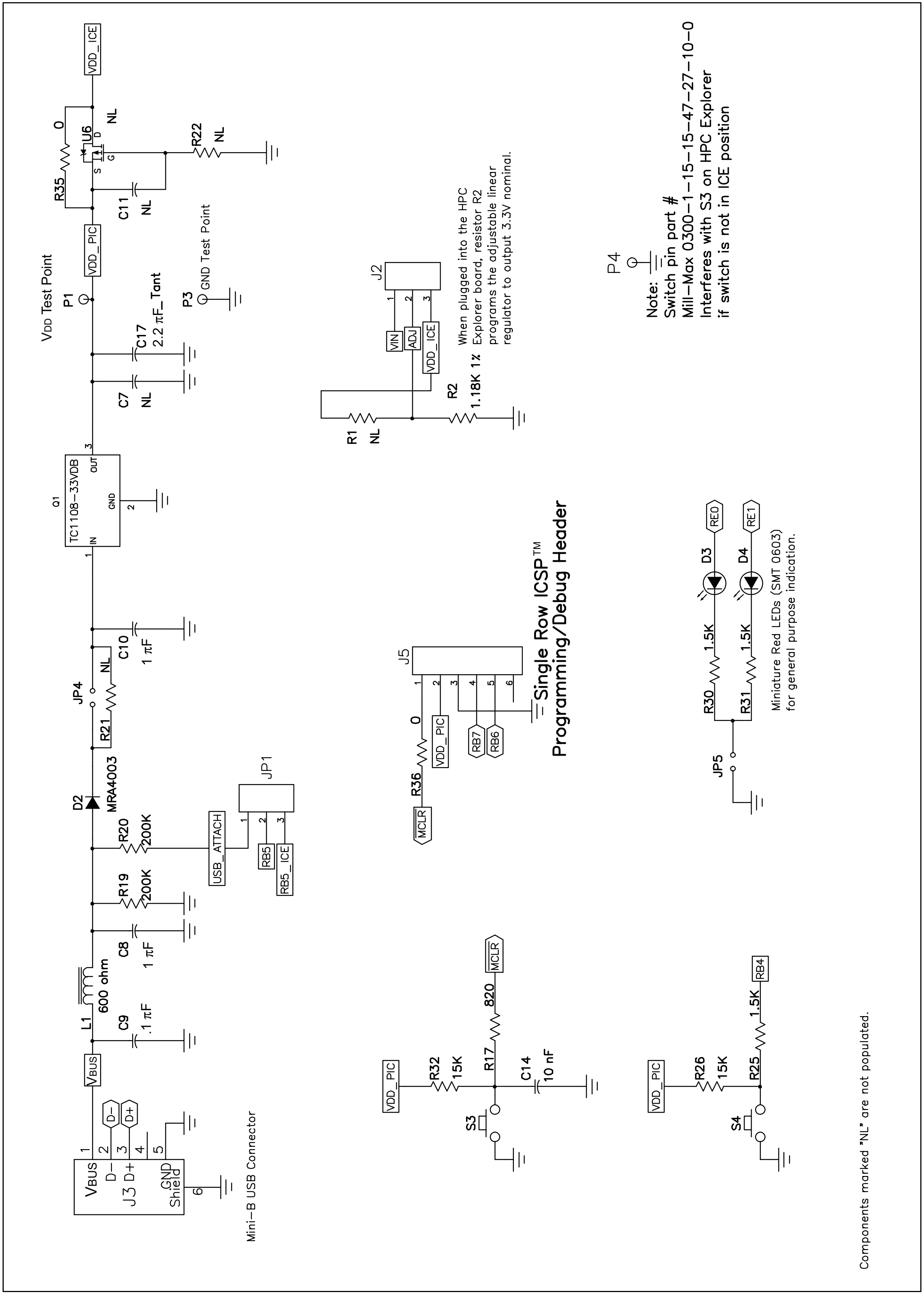
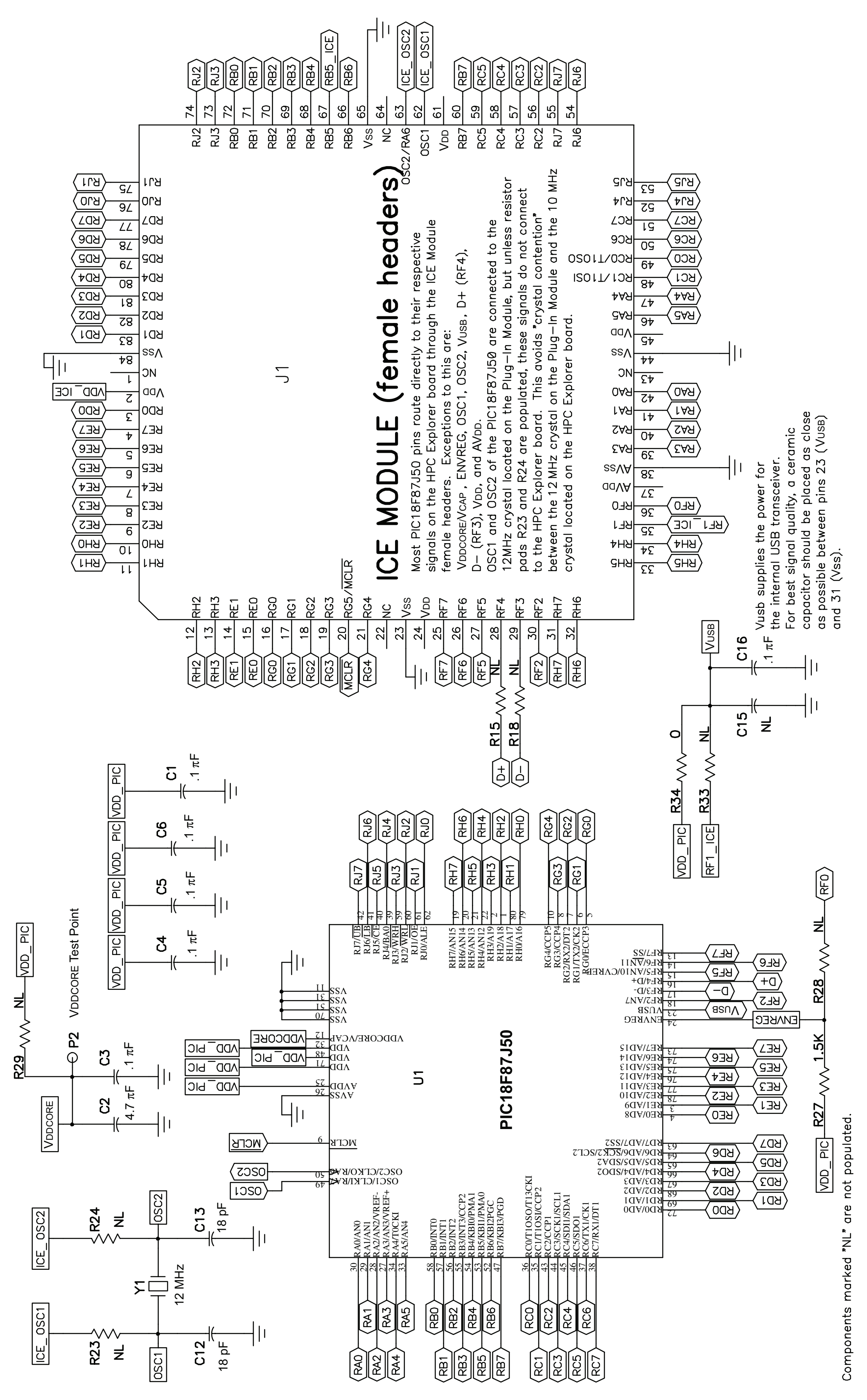

VDD_ICE
R35
0
U6
S
G
D
NL
R22
NL
C11
NL
VDD_PIC
VDD Test Point
P1
P3
GND Test Point
C17
2.2 πF_Tant
C7
NL
Q1
TC1108-33VDB
IN
GND
OUT
1
2
3
C10
1 πF
JP4
R21
NL
D2
MRA4003
R20
200K
R19
200K
C8
1 πF
L1
600 ohm
C9
.1 πF
VBUS
D−
D+
1
2
3
4
5
6
J3
GND
Shield
Mini-B USB Connector
USB_ATTACH
JP1
RB5
RB5_ICE
J2
VIN
ADJ
VDD_ICE
R1
NL
R2
1.18K 1%
When plugged into the HPC Explorer board, resistor R2 programs the adjustable linear regulator to output 3.3V nominal.
J5
R36
0
MCLR
VDD_PIC
RB7
RB6
Single Row ICSP™ Programming/Debug Header
VDD_PIC
R32
15K
R17
820
MCLR
C14
10 nF
S3
P4
Note:
Switch pin part #
Mill-Max 0300-1-15-15-47-27-10-0
Interferes with S3 on HPC Explorer
if switch is not in ICE position
RE0
RE1
D3
D4
R30
1.5K
R31
1.5K
JP5
Miniature Red LEDs (SMT 0603) for general purpose indication.
VDD_PIC
R26
15K
R25
1.5K
RB4
S4
Components marked "NL" are not populated.

FIGURE A-2: PIC18F87J50 FS USB PIM REV. 1 SCHEMATICS (SHEET 2 OF 2)



ICE MODULE (female headers)

Most PIC18F87J50 pins route directly to their respective signals on the HPC Explorer board through the ICE Module female headers. Exceptions to this are: VDDCORE/VCAP, ENVREG, OSC1, OSC2, VUSB, D+ (RF4), D− (RF3), VDD, and AVDD.

OSC1 and OSC2 of the PIC18F87J50 are connected to the 12MHz crystal located on the Plug-In Module, but unless resistor pads R23 and R24 are populated, these signals do not connect to the HPC Explorer board. This avoids "crystal contention" between the 12 MHz crystal on the Plug-In Module and the 10 MHz crystal located on the HPC Explorer board.

Vusb supplies the power for the internal USB transceiver. For best signal quality, a ceramic capacitor should be placed as close as possible between pins 23 (VUSB) and 31 (VSS).

Components marked "NL" are not populated.

J1
U1
PIC18F87J50
VDDCORE Test Point
P2
R29 NL
VDD_PIC
VDDCORE
C1 .1 µF
C2 4.7 µF
C3 .1 µF
C4 .1 µF
C5 .1 µF
C6 .1 µF
C12 18 pF
C13 18 pF
Y1 12 MHz
R23 NL
R24 NL
ICE_OSC1
ICE_OSC2
OSC1
OSC2
MCLR
R15
R18
D+
D−
C15 NL
C16 .1 µF
VUSB
R33 NL
R34 0
RF1_ICE
VDD_ICE
R27 1.5K
R28 NL
ENVREG
RF0

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