

**PIC18F87J50 FS USB
Plug-In Module
User's Guide**

Note the following details of the code protection feature on Microchip devices:

- Microchip products meet the specification contained in their particular Microchip Data Sheet.
- Microchip believes that its family of products is one of the most secure families of its kind on the market today, when used in the intended manner and under normal conditions.
- There are dishonest and possibly illegal methods used to breach the code protection feature. All of these methods, to our knowledge, require using the Microchip products in a manner outside the operating specifications contained in Microchip's Data Sheets. Most likely, the person doing so is engaged in theft of intellectual property.
- Microchip is willing to work with the customer who is concerned about the integrity of their code.
- Neither Microchip nor any other semiconductor manufacturer can guarantee the security of their code. Code protection does not mean that we are guaranteeing the product as "unbreakable."

Code protection is constantly evolving. We at Microchip are committed to continuously improving the code protection features of our products. Attempts to break Microchip's code protection feature may be a violation of the Digital Millennium Copyright Act. If such acts allow unauthorized access to your software or other copyrighted work, you may have a right to sue for relief under that Act.

Information contained in this publication regarding device applications and the like is provided only for your convenience and may be superseded by updates. It is your responsibility to ensure that your application meets with your specifications. MICROCHIP MAKES NO REPRESENTATIONS OR WARRANTIES OF ANY KIND WHETHER EXPRESS OR IMPLIED, WRITTEN OR ORAL, STATUTORY OR OTHERWISE, RELATED TO THE INFORMATION, INCLUDING BUT NOT LIMITED TO ITS CONDITION, QUALITY, PERFORMANCE, MERCHANTABILITY OR FITNESS FOR PURPOSE. Microchip disclaims all liability arising from this information and its use. Use of Microchip devices in life support and/or safety applications is entirely at the buyer's risk, and the buyer agrees to defend, indemnify and hold harmless Microchip from any and all damages, claims, suits, or expenses resulting from such use. No licenses are conveyed, implicitly or otherwise, under any Microchip intellectual property rights.

Trademarks

The Microchip name and logo, the Microchip logo, Accuron, dsPIC, KEELOQ, KEELOQ logo, microID, MPLAB, PIC, PICmicro, PICSTART, PRO MATE, rPIC and SmartShunt are registered trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.


AmPLab, FilterLab, Linear Active Thermistor, Migratable Memory, MXDEV, MXLAB, SEEVAL, SmartSensor and The Embedded Control Solutions Company are registered trademarks of Microchip Technology Incorporated in the U.S.A.

Analog-for-the-Digital Age, Application Maestro, CodeGuard, dsPICDEM, dsPICDEM.net, dsPICworks, dsSPEAK, ECAN, ECONOMONITOR, FanSense, FlexROM, fuzzyLAB, In-Circuit Serial Programming, ICSP, ICEPIC, Mindi, MiWi, MPASM, MPLAB Certified logo, MPLIB, MPLINK, PICkit, PICDEM, PICDEM.net, PICLAB, PICtail, PowerCal, PowerInfo, PowerMate, PowerTool, REAL ICE, rLAB, Select Mode, Smart Serial, SmartTel, Total Endurance, UNI/O, WiperLock and ZENA are trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.

SQTP is a service mark of Microchip Technology Incorporated in the U.S.A.

All other trademarks mentioned herein are property of their respective companies.

© 2007, Microchip Technology Incorporated, Printed in the U.S.A., All Rights Reserved.

 Printed on recycled paper.

QUALITY MANAGEMENT SYSTEM
CERTIFIED BY DNV
== ISO/TS 16949:2002 ==

Microchip received ISO/TS-16949:2002 certification for its worldwide headquarters, design and wafer fabrication facilities in Chandler and Tempe, Arizona; Gresham, Oregon and design centers in California and India. The Company's quality system processes and procedures are for its PIC® MCUs and dsPIC® DSCs, KEELOQ® code hopping devices, Serial EEPROMs, microperipherals, nonvolatile memory and analog products. In addition, Microchip's quality system for the design and manufacture of development systems is ISO 9001:2000 certified.

Table of Contents

Preface	1
Chapter 1. Introduction and Overview	5
1.1 Introduction	5
1.2 Highlights	5
1.3 PIC18F87J50 FS USB Plug-In Module Kit Contents	5
1.4 Overview of the PIC18F87J50 Family USB Capabilities	6
1.5 Using the Preprogrammed Firmware	6
Chapter 2. Important Notes and Migration Tips	7
2.1 Highlights	7
2.2 Using the PIM with the HPC Explorer Board	7
2.3 Programming the Microcontroller	8
2.4 Migrating to the PIC18F87J50 Family	8
Chapter 3. Hardware Configuration/Jumper Settings	11
3.1 Highlights	11
3.2 Hardware Features	11
3.3 Crystal	12
3.4 Linear Regulator/Power Management	13
3.5 LEDs	14
3.6 Push Buttons	14
3.7 Jumpers	14
3.8 Hardware Considerations for Compliance Testing	15
Chapter 4. Demo Code/Reference Firmware	17
Appendix A. PIC18F87J50 FS USB Plug-In Module Schematics	19
A.1 Schematics	19
Index	23
Worldwide Sales and Service	24

PIC18F87J50 FS USB Plug-In Module User's Guide

NOTES:

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 “DSXXXXA”, where “XXXX” 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”**

PIC18F87J50 FS USB Plug-In Module User's Guide

CONVENTIONS USED IN THIS GUIDE

This manual uses the following documentation conventions:

DOCUMENTATION CONVENTIONS

Description	Represents	Examples
Arial font:		
Italic characters	Referenced books	<i>MPLAB[®] IDE User's Guide</i>
	Emphasized text	...is the <i>only</i> 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><i>File>Save</i></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	<i>file.o</i> , where <i>file</i> can be any valid filename
Square brackets []	Optional arguments	mcc18 [options] <i>file</i> [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

Microchip provides online support via our web site at www.microchip.com. This web site is used as a means to make files and information easily available to customers. Accessible by using your favorite Internet browser, the web site contains the following information:

- **Product Support** – Data sheets and errata, application notes and sample programs, design resources, user's guides and hardware support documents, latest software releases and archived software
- **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

PIC18F87J50 FS USB Plug-In Module User's Guide

DEVELOPMENT SYSTEMS CUSTOMER CHANGE NOTIFICATION SERVICE

Microchip's customer notification service helps keep customers current on Microchip products. Subscribers will receive e-mail notification whenever there are changes, updates, revisions or errata related to a specified product family or development tool of interest.

To register, access the Microchip web site at www.microchip.com, click on Customer Change Notification and follow the registration instructions.

The Development Systems product group categories are:

- **Compilers** – The latest information on Microchip C compilers and other language tools. These include the MPLAB C18 and MPLAB C30 C compilers; MPASM™ and MPLAB ASM30 assemblers; MPLINK™ and MPLAB LINK30 object linkers; and MPLIB™ and MPLAB LIB30 object librarians.
- **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.

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. 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.

PIC18F87J50 FS USB Plug-In Module 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 MCLR line on the PIC18F8722 microcontroller, located on the HPC Explorer, will be held low. Additionally, VDD 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.

PIC18F87J50 FS USB Plug-In Module User's Guide

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 (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.

PIC18F87J50 FS USB Plug-In Module User's Guide

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

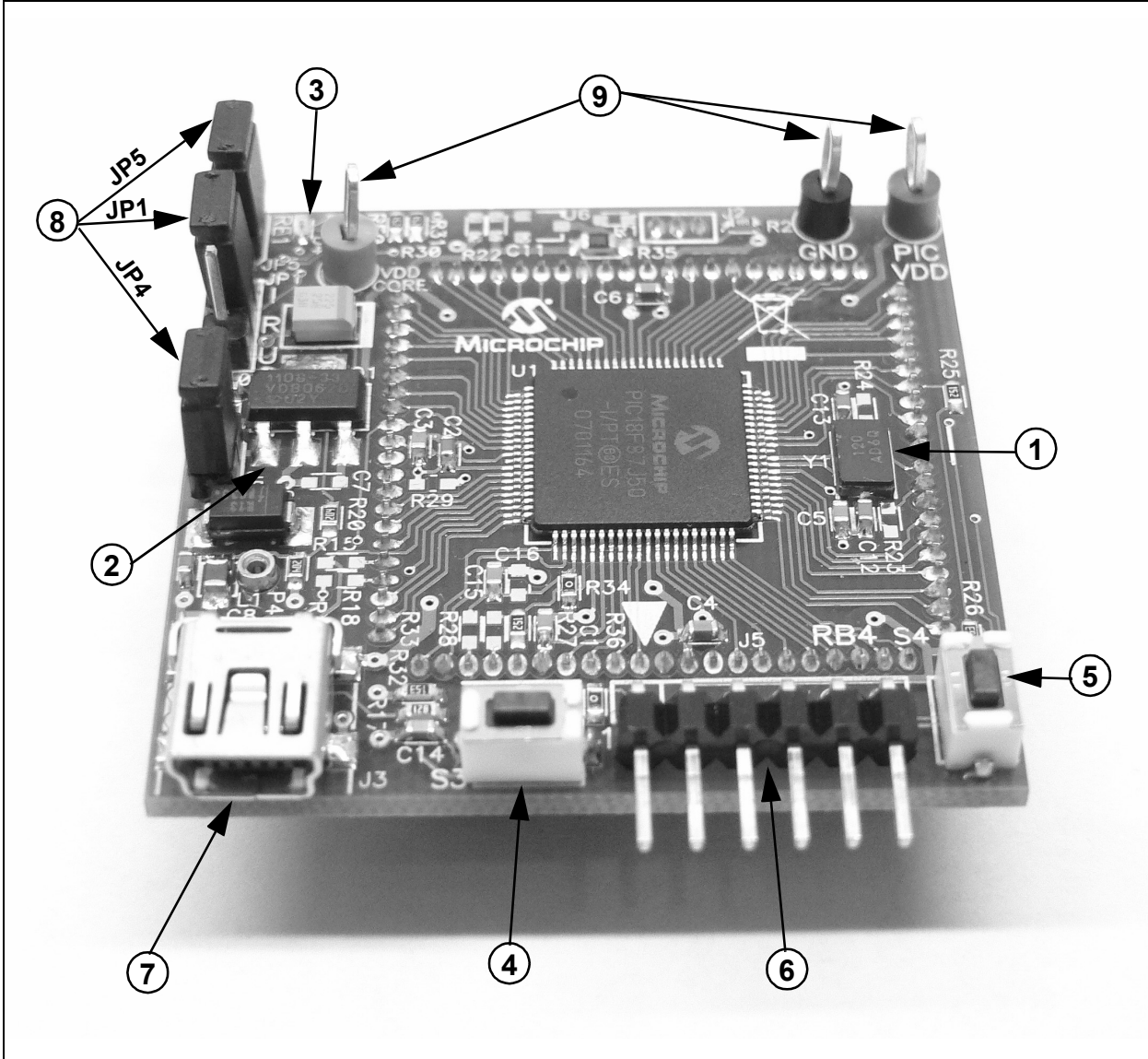
The PIC18F87J50 FS USB PIM has a number of hardware features intended to make it useful as an initial development platform and demonstration board. Refer to **Appendix A. “PIC18F87J50 FS USB Plug-In Module Schematics”** for schematics of the PIM. The board offers the following hardware features:

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. 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 VDD, VDDCORE and GND measurements.

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

PIC18F87J50 FS USB Plug-In Module User's Guide

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 V_{BUS} 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 μ A (or in some cases, 2.5 mA; see the USB 2.0 specifications section 7.2.3) from the +5V V_{BUS} 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.

PIC18F87J50 FS USB Plug-In Module User's Guide

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 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.

PIC18F87J50 FS USB Plug-In Module User's Guide

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.

PIC18F87J50 FS USB Plug-In Module User's Guide

NOTES:

Appendix A. PIC18F87J50 FS USB Plug-In Module Schematics

A.1 SCHEMATICS

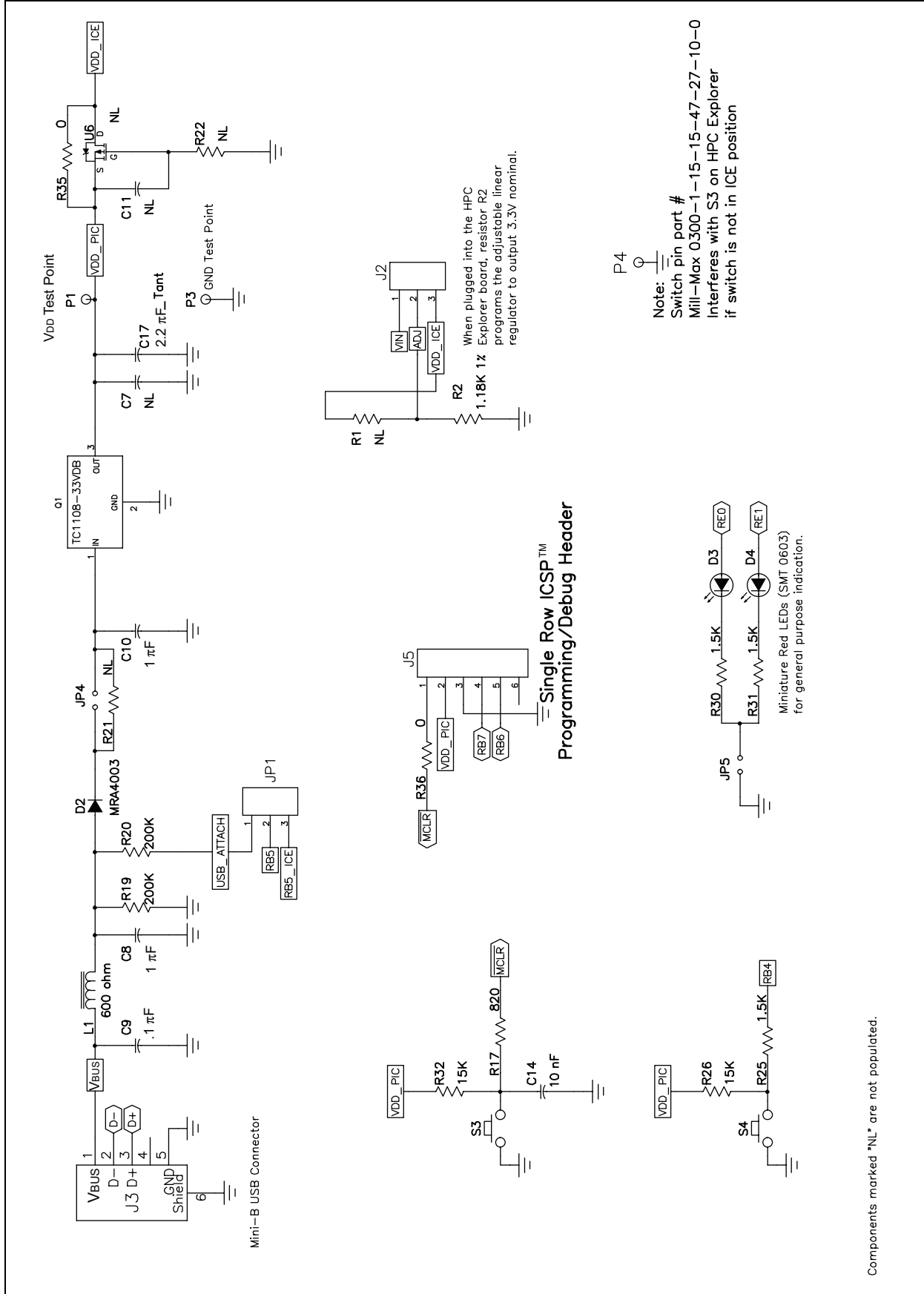
The PIC18F87J50 FS USB Plug-In Module schematics are shown in Figure A-1 and Figure A-2. By default, the PIM ships from the factory with the PIC18F87J50 pre-installed in location U1. The PIC18F87J50 is the superset part in the device family, and is therefore, a good starting point for developing USB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

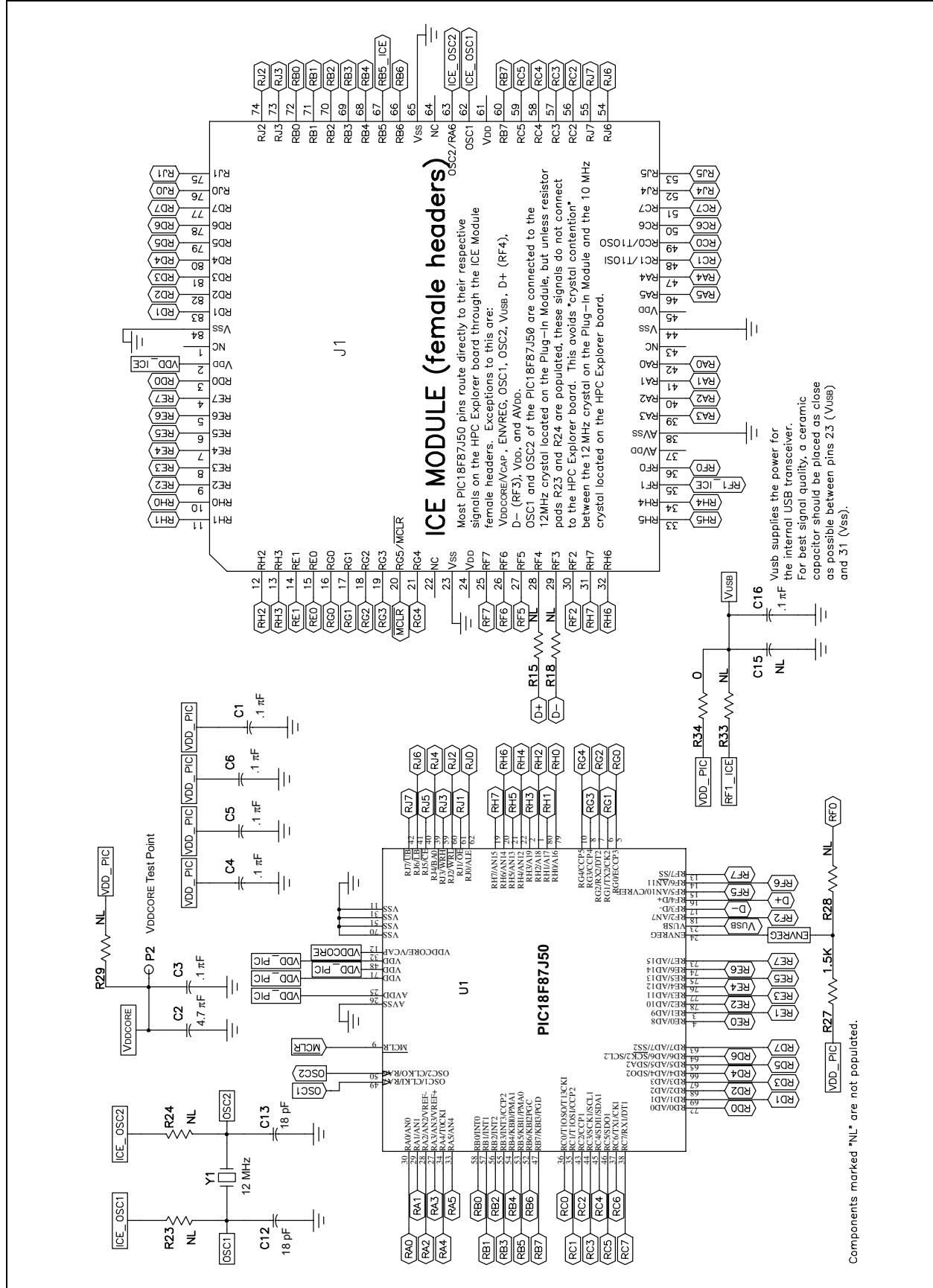
PIC18F87J50 FS USB Plug-In Module User's Guide

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



PIC18F87J50 FS USB Plug-In Module Schematics

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



PIC18F87J50 FS USB Plug-In Module User's Guide

NOTES:

Index

C		L	
Crystal	12	LEDs	14
Customer Notification Service	4	Linear Regulator	13
Customer Support	4	M	
D		Microchip Internet Web Site	3
Demo Code/Reference Firmware	17	Migrating to the PIC18F87J50 Family	8
Documentation		O	
Conventions	2	Oscillator Configuration	9
Layout	1	Overview of PIC18F87J50 USB Capabilities	6
H		P	
Hardware		Power Management	13
Features	11	Programming the MCU	8
Hardware Considerations for		Push Buttons	14
Compliance Testing	15	R	
HPC Explorer Board		Reading, Recommended	3
Use with the PIM	7	S	
I		Schematics	19
Input Buffer Selection	9	Special Function Register Addressing	8
Internet Address	3	U	
J		Using the Preprogrammed Firmware	6
Jumpers	14	W	
JP1	14	WWW Address	3
JP4	15		
JP5	15		
K			
Kit Contents	5		
CD-ROM	5		
PIC18F87J50 FS USB Plug-In Module			
Demo Board	5		
USB mini-B Cable	5		



WORLDWIDE SALES AND SERVICE

AMERICAS

Corporate Office
2355 West Chandler Blvd.
Chandler, AZ 85224-6199
Tel: 480-792-7200
Fax: 480-792-7277
Technical Support:
<http://support.microchip.com>
Web Address:
www.microchip.com

Atlanta

Duluth, GA
Tel: 678-957-9614
Fax: 678-957-1455

Boston

Westborough, MA
Tel: 774-760-0087
Fax: 774-760-0088

Chicago

Itasca, IL
Tel: 630-285-0071
Fax: 630-285-0075

Dallas

Addison, TX
Tel: 972-818-7423
Fax: 972-818-2924

Detroit

Farmington Hills, MI
Tel: 248-538-2250
Fax: 248-538-2260

Kokomo

Kokomo, IN
Tel: 765-864-8360
Fax: 765-864-8387

Los Angeles

Mission Viejo, CA
Tel: 949-462-9523
Fax: 949-462-9608

Santa Clara

Santa Clara, CA
Tel: 408-961-6444
Fax: 408-961-6445

Toronto

Mississauga, Ontario,
Canada
Tel: 905-673-0699
Fax: 905-673-6509

ASIA/PACIFIC

Asia Pacific Office
Suites 3707-14, 37th Floor
Tower 6, The Gateway
Harbour City, Kowloon
Hong Kong
Tel: 852-2401-1200
Fax: 852-2401-3431

Australia - Sydney
Tel: 61-2-9868-6733
Fax: 61-2-9868-6755

China - Beijing
Tel: 86-10-8528-2100
Fax: 86-10-8528-2104

China - Chengdu
Tel: 86-28-8665-5511
Fax: 86-28-8665-7889

China - Fuzhou
Tel: 86-591-8750-3506
Fax: 86-591-8750-3521

China - Hong Kong SAR
Tel: 852-2401-1200
Fax: 852-2401-3431

China - Qingdao
Tel: 86-532-8502-7355
Fax: 86-532-8502-7205

China - Shanghai
Tel: 86-21-5407-5533
Fax: 86-21-5407-5066

China - Shenyang
Tel: 86-24-2334-2829
Fax: 86-24-2334-2393

China - Shenzhen
Tel: 86-755-8203-2660
Fax: 86-755-8203-1760

China - Shunde
Tel: 86-757-2839-5507
Fax: 86-757-2839-5571

China - Wuhan
Tel: 86-27-5980-5300
Fax: 86-27-5980-5118

China - Xian
Tel: 86-29-8833-7252
Fax: 86-29-8833-7256

ASIA/PACIFIC

India - Bangalore
Tel: 91-80-4182-8400
Fax: 91-80-4182-8422

India - New Delhi
Tel: 91-11-4160-8631
Fax: 91-11-4160-8632

India - Pune
Tel: 91-20-2566-1512
Fax: 91-20-2566-1513

Japan - Yokohama
Tel: 81-45-471- 6166
Fax: 81-45-471-6122

Korea - Daegu
Tel: 82-53-744-4301
Fax: 82-53-744-4302

Korea - Seoul
Tel: 82-2-554-7200
Fax: 82-2-558-5932 or
82-2-558-5934

Malaysia - Penang
Tel: 60-4-646-8870
Fax: 60-4-646-5086

Philippines - Manila
Tel: 63-2-634-9065
Fax: 63-2-634-9069

Singapore
Tel: 65-6334-8870
Fax: 65-6334-8850

Taiwan - Hsin Chu
Tel: 886-3-572-9526
Fax: 886-3-572-6459

Taiwan - Kaohsiung
Tel: 886-7-536-4818
Fax: 886-7-536-4803

Taiwan - Taipei
Tel: 886-2-2500-6610
Fax: 886-2-2508-0102

Thailand - Bangkok
Tel: 66-2-694-1351
Fax: 66-2-694-1350

EUROPE

Austria - Wels
Tel: 43-7242-2244-39
Fax: 43-7242-2244-393

Denmark - Copenhagen
Tel: 45-4450-2828
Fax: 45-4485-2829

France - Paris
Tel: 33-1-69-53-63-20
Fax: 33-1-69-30-90-79

Germany - Munich
Tel: 49-89-627-144-0
Fax: 49-89-627-144-44

Italy - Milan
Tel: 39-0331-742611
Fax: 39-0331-466781

Netherlands - Drunen
Tel: 31-416-690399
Fax: 31-416-690340

Spain - Madrid
Tel: 34-91-708-08-90
Fax: 34-91-708-08-91

UK - Wokingham
Tel: 44-118-921-5869
Fax: 44-118-921-5820