



**MRF24J40MA/MB  
PICtail™/PICtail Plus  
Daughter Board 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in this publication regarding device applications and the like is provided only for your convenience and may be superseded by updates.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, dsPIC, KEELOQ, KEELOQ logo, MPLAB, PIC, PICmicro, PICSTART, rfPIC and UNI/O are registered trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.

FilterLab, Hampshire, HI-TECH C, Linear Active Thermistor, MXDEV, MXLAB, SEEVAL 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, HI-TIDE, In-Circuit Serial Programming, ICSP, Mindi, MiWi, MPASM, MPLAB Certified logo, MPLIB, MPLINK, mTouch, Octopus, Omniclient Code Generation, PICC, PICC-18, PICDEM, PICDEM.net, PICKit, PICtail, PIC<sup>32</sup> logo, REAL ICE, rLAB, Select Mode, Total Endurance, TSHARC, UniWinDriver, 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.

© 2009, 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.*



# MRF24J40MA/MB PICtail™/PICtail PLUS DAUGHTER BOARD USER'S GUIDE

---

## Table of Contents

---

|                                                                                    |           |
|------------------------------------------------------------------------------------|-----------|
| <b>Preface .....</b>                                                               | <b>5</b>  |
| <b>Chapter 1. Overview</b>                                                         |           |
| 1.1 Introduction .....                                                             | 11        |
| 1.2 MRF24J40MA/MB PICtail/PICtail Plus Daughter Board Contents .....               | 11        |
| 1.3 MRF24J40MA/MB PICtail/PICtail Plus Daughter Board .....                        | 11        |
| <b>Chapter 2. Getting Started</b>                                                  |           |
| 2.1 Introduction .....                                                             | 15        |
| 2.2 Plugging into the PIC18 Explorer Board .....                                   | 15        |
| 2.3 Plugging into the Explorer 16 Development Board .....                          | 16        |
| 2.4 Downloading and Running the Demo Program .....                                 | 17        |
| <b>Appendix A. MRF24J40MA/MB PICtail/PICtail Plus<br/>Daughter Board Schematic</b> |           |
| A.1 Introduction .....                                                             | 19        |
| A.2 MRF24J40MA/MB PICtail/PICtail Plus Daughter Board Schematic .....              | 20        |
| A.3 MRF24J40MA/MB PICtail/PICtail Plus Daughter Board PCB Layout .....             | 21        |
| A.4 MRF24J40MA/MB PICtail/PICtail Plus Daughter Board Bill of Materials .....      | 23        |
| <b>Worldwide Sales and Service .....</b>                                           | <b>24</b> |

NOTES:



# MRF24J40MA/MB PICtail™/PICtail PLUS DAUGHTER BOARD USER'S GUIDE

## 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](http://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 MRF24J40MA/MB PICtail™/PICtail Plus Daughter Board. Items discussed in this chapter include:

- Document Layout
- Conventions Used in this Guide
- Warranty Registration
- 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 MRF24J40MA/MB PICtail™/PICtail Plus Daughter Board. The manual layout is as follows:

- **Chapter 1. “Overview”** This chapter provides an overview of the MRF24J40MA/MB PICtail/PICtail Plus Daughter Board, including board contents and features.
- **Chapter 2. “Getting Started”** This chapter describes how to start using your MRF24J40MA/MB PICtail/PICtail Plus Daughter Board.
- **Appendix A. “MRF24J40MA/MB PICtail/PICtail Plus Daughter Board Schematic”** This appendix contains the schematics, PCB information and Bill of Materials for the MRF24J40MA/MB PICtail/PICtail Plus Daughter Board.

## CONVENTIONS USED IN THIS GUIDE

This manual uses the following documentation conventions:

### DOCUMENTATION CONVENTIONS

| Description                                      | Represents                                                                                          | Examples                                                    |
|--------------------------------------------------|-----------------------------------------------------------------------------------------------------|-------------------------------------------------------------|
| <b>Arial font:</b>                               |                                                                                                     |                                                             |
| 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&gt;Save</i></u>                                  |
| Bold characters                                  | A dialog button                                                                                     | Click <b>OK</b>                                             |
|                                                  | A tab                                                                                               | Click the <b>Power</b> 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>                                         |
| <b>Courier New font:</b>                         |                                                                                                     |                                                             |
| 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)<br>{ ...<br>}                              |

## WARRANTY REGISTRATION

Please complete the enclosed Warranty Registration Card and mail it promptly. Sending in the Warranty Registration Card entitles users to receive new product updates. Interim software releases are available at the Microchip web site.

## RECOMMENDED READING

This user's guide describes how to use the MRF24J40MA/MB PICtail/PICtail Plus Daughter Board. Other useful documents are listed below. The following Microchip documents are available and recommended as supplemental reference resources.

**MRF24J40 IEEE 802.15.4 2.4™ GHz RF Transceiver Data Sheet (DS39776)**

**MRF24J40MA IEEE 802.15.4 2.4 GHz RF Transceiver Module Data Sheet (DS70329)**

**MRF24J40MB 2.4 GHz IEEE 802.15.4 20 dBm RF Transceiver Data Sheet (DS70599)**

**PICDEM™ PIC18 Explorer Demonstration Board User's Guide (DS51721)**

**Explorer 16 Development Board User's Guide (DS51589)**

**2K SPI Bus Serial EEPROM with EUI-48™ Node Identity Data Sheet (DS22123)**

## THE MICROCHIP WEB SITE

Microchip provides online support via our web site at [www.microchip.com](http://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

## 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](http://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, 2, and 3 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 (October 2009)

- Initial Release of this Document.

NOTES:

---

## Chapter 1. Overview

---

### 1.1 INTRODUCTION

The MRF24J40MA/MB PICtail™/PICtail Plus Daughter Board is a demonstration and development daughter board for the:

- MRF24J40MA IEEE 802.15.4 2.4 GHz RF Transceiver module, or
- MRF24J40MB 2.4 GHz IEEE 802.15.4 20 dBm RF Transceiver module

The daughter board can plug into multiple Microchip Technology demonstration and development boards. For example, for 8-bit microcontroller development using the PIC18 Explorer Board (DM183032) or for 16-bit microcontroller development using the Explorer 16 Development Board (DM240001).

Supporting software stacks and application notes may be downloaded from the Microchip website <http://www.microchip.com/wireless>.

This chapter discusses:

- MRF24J40MA/MB PICtail/PICtail Plus Daughter Board Contents
- MRF24J40MA/MB PICtail/PICtail Plus Daughter Board

### 1.2 MRF24J40MA/MB PICtail/PICtail PLUS DAUGHTER BOARD CONTENTS

Depending on the development tool ordered, package contents will contain one of the following development boards listed in Table 1-1.

**TABLE 1-1: MRF49XA PICtail™/PICtail PLUS DAUGHTER BOARD**

| Description                                     | Part Number |
|-------------------------------------------------|-------------|
| MRF24J40MA PICtail™/PICtail Plus Daughter Board | AC164134-1  |
| MRF24J40MB PICtail/PICtail Plus Daughter Board  | AC164134-2  |

### 1.3 MRF24J40MA/MB PICtail/PICtail PLUS DAUGHTER BOARD

The MRF24J40MA/MB PICtail/PICtail Plus Daughter Board is a complete IEEE 802.15.4 2.4 GHz wireless transceiver. The features are shown in Figure 1-1 and 1-2.

#### CAUTION

Power to the MRF24J40MA/MB PICtail/PICtail Plus Daughter Board should be in the range of 2.4-3.6V. Ensure that the development/demonstration board that the daughter board is plugged into meets this voltage requirement; otherwise, damage to the MRF24J40 may occur.

FIGURE 1-1: MRF24J40MA PICtail™/PICtail PLUS DAUGHTER BOARD

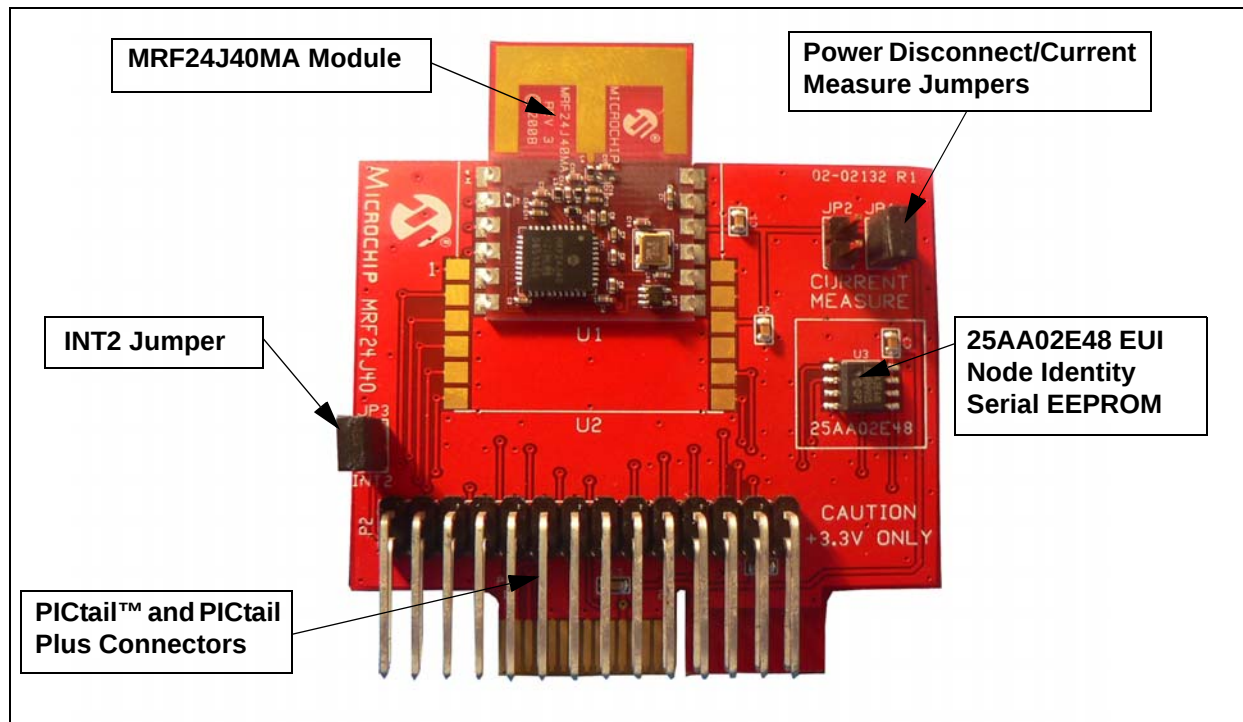
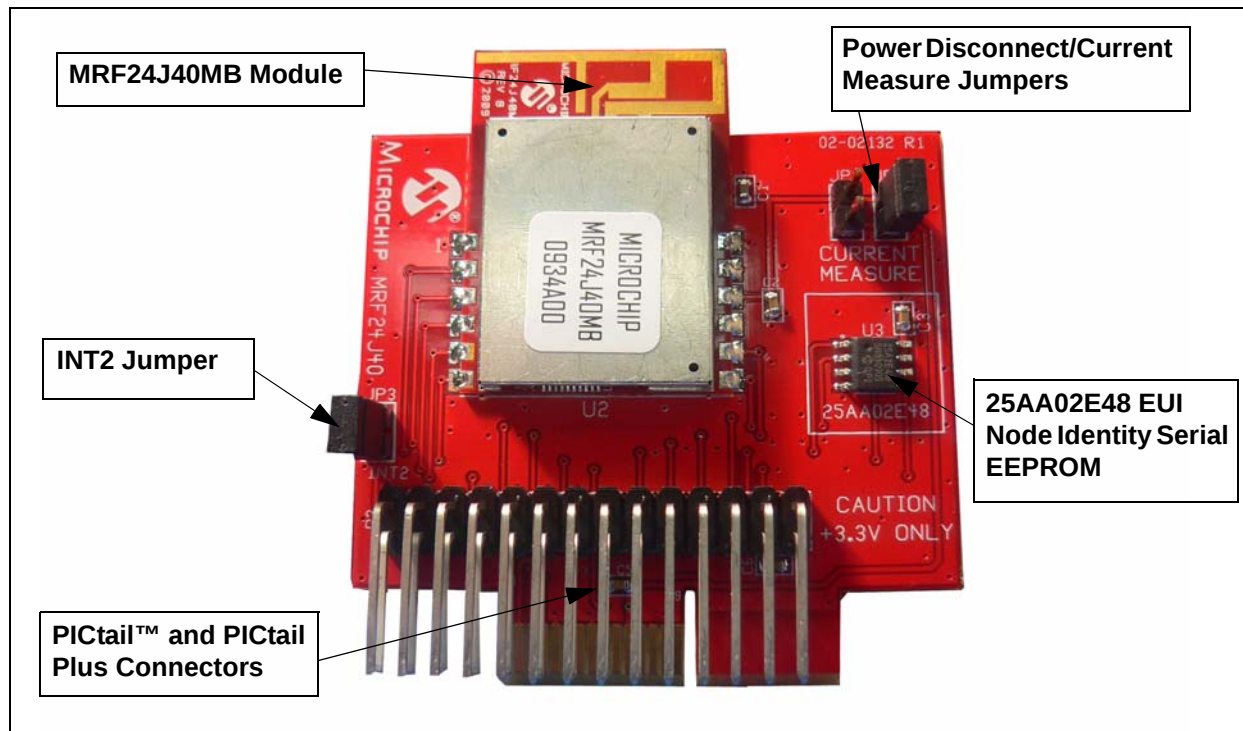


FIGURE 1-2: MRF24J40MB PICtail™/PICtail PLUS DAUGHTER BOARD



**PICtail Plus Connector (P1)** – 30-pin card edge connector for connecting into 16 and 32-bit development boards' PICtail Plus connector.

**PICtail Connector (P2)** – 28-pin right angle connector to connect to 8-bit development boards' PICtail connector.

**MRF24J40MA (U1)** – IEEE 802.15.4 2.4 GHz Transceiver.

**MRF24J40MB (U2)** – IEEE 802.15.4 2.4 GHz 20 dBm Transceiver.

|                                                                                                                                                                 |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><b>Note:</b> Only one MRF24J40 module, U1 or U2, will be populated on the PICtail/PICtail Plus Daughter Board depending on the development tool ordered.</p> |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|

**Power Disconnect/Current Measure Jumpers (JP1/JP2)** – Two 2-pin headers are connected in parallel. A shunt connects power to the MRF24J40 module. A current meter can be placed on the header and the shunt removed to measure current consumption.

**TIP:** To prevent power interruption to the MRF24J40 module, keep the shunt on the header while connecting the current meter. Once connected, remove the shunt to measure current.

**INT2 Jumper (JP3)** – Jumpering JP3 with a shunt allows the connection of RA5 to RB2/INT2 to allow push button switch S2 to trigger an interrupt. See **Section 2.1.1 Configuring Push Button Switch S2 to RB2/INT2** for more information.

**EUI Node Identity Serial EEPROM (U3)** – Contains a unique IEEE EUI address. For more information, refer to “*2K SPI Bus Serial EEPROM with EUI-48™ Node Identity Data Sheet*” (DS22123).

NOTES:

---

## Chapter 2. Getting Started

---

### 2.1 INTRODUCTION

The MRF24J40MA/MB PICtail/PICtail Plus Daughter Board can be plugged into multiple Microchip Technology demonstration and development boards. This allows the developer to choose the microcontroller that best suits the customer's development environment.

The PICtail connector right angle header, P2, can plug into 8-bit demonstration and development boards, such as the PIC18 Explorer Board (DM183032). The PICtail Plus card edge connector, P1, can plug into Explorer 16 Development Board (DM240001).

This chapter shows how the daughter board is plugged into the PIC18 Explorer and Explorer 16 Development Boards.

### 2.2 PLUGGING INTO THE PIC18 EXPLORER BOARD

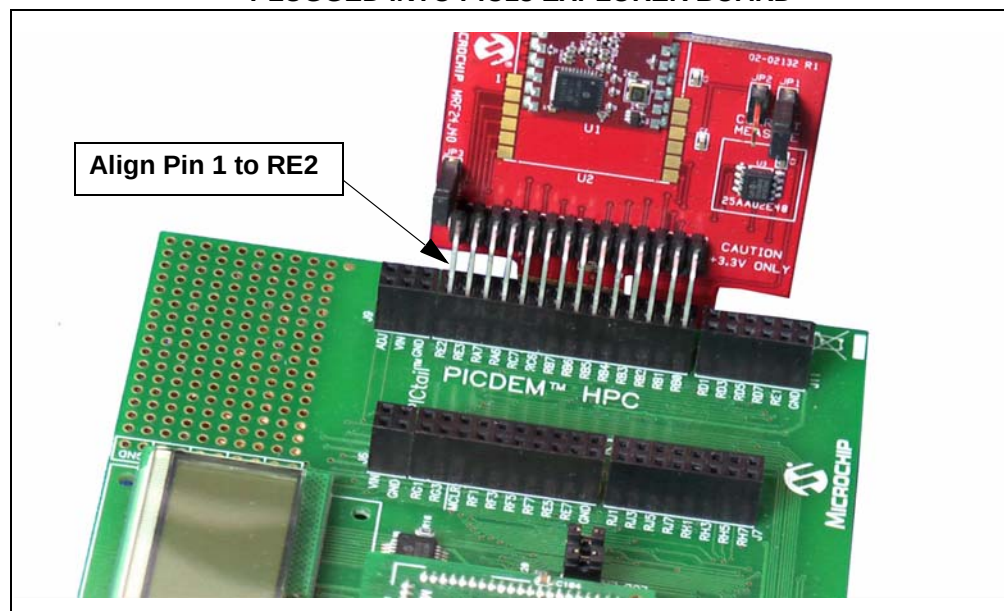
The MRF24J40MA/MB PICtail/PICtail Plus Daughter Board can be plugged into the PIC18 Explorer Board PICtail connector, J3, as shown in Figure 2-1. Make sure to align pin 1 to RE2 as shown.

| CAUTION                                                                                                                                                                                              |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Ensure that the PIC18F87J11 PIM is plugged into the PIC18 Explorer Board. This sets the system VDD voltage to 3.3 volts, which is required by the MRF24J40MA/MB PICtail/PICtail Plus Daughter Board. |

#### 2.2.1 Configuring Push Button Switch S2 to RB2/INT2

On the PIC18 Explorer Board, push button switch S2 is normally connected to I/O port pin RA5. RA5 is not a change on interrupt or external interrupt capable I/O pin. Jumping JP3 with a shunt allows the connection of RA5 to RB2/INT2 to allow push button switch S2 to trigger an interrupt. Keep in mind that RB2 also connects to pin 10 (input) of U6 (RS232 level shifter) which is a Clear-to-Send (CTS) signal on P2 pin 8 (DE9 receptacle).

**FIGURE 2-1: MRF24J40MA/MB PICtail™/PICtail PLUS DAUGHTER BOARD PLUGGED INTO PIC18 EXPLORER BOARD**

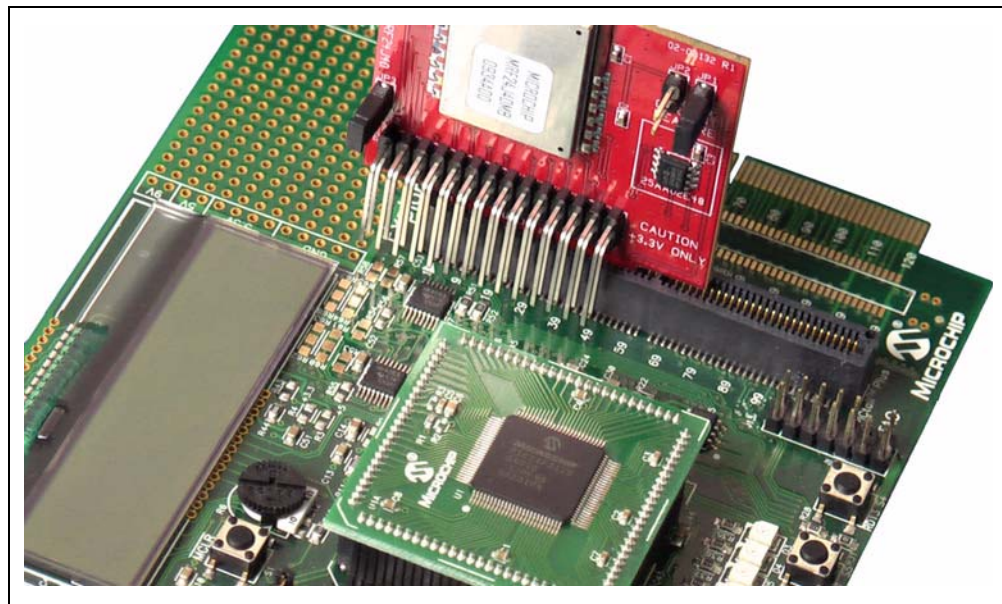


## 2.3 PLUGGING INTO THE EXPLORER 16 DEVELOPMENT BOARD

The MRF24J40MA/MB PICtail/PICtail Plus Daughter Board can be plugged into the Explorer 16 Development Board as shown in Figure 2-2.

The Daughter Board 30-pin card edge connector can be plugged into the top section of the PICtail Plus connector. This will connect to the SPI Port 1 on the PIC® microcontroller plugged into the PIM socket. If the Daughter Board is plugged into the mid-section of the PICtail Plus connector, this will connect to SPI Port 2 on the PIC microcontroller.

**FIGURE 2-2: MRF24J40MA/MB PICtail™/PICtail PLUS DAUGHTER BOARD PLUGGED INTO EXPLORER 16 DEVELOPMENT BOARD**



## 2.4 DOWNLOADING AND RUNNING THE DEMO PROGRAM

Sample source code is available from the Microchip Wireless Design Environment, MiMAC and MiApp. Each is described in application notes AN1283 and AN1284, respectively. A Quick Start Guide is included in the software installation package that explains the installation and operation of the demonstration program. It may be downloaded from the Microchip website <http://www.microchip.com/wireless>.

NOTES:



# MRF24J40MA/MB PICtail™/PICtail PLUS DAUGHTER BOARD USER'S GUIDE

---

## Appendix A. MRF24J40MA/MB PICtail/PICtail Plus Daughter Board Schematic

---

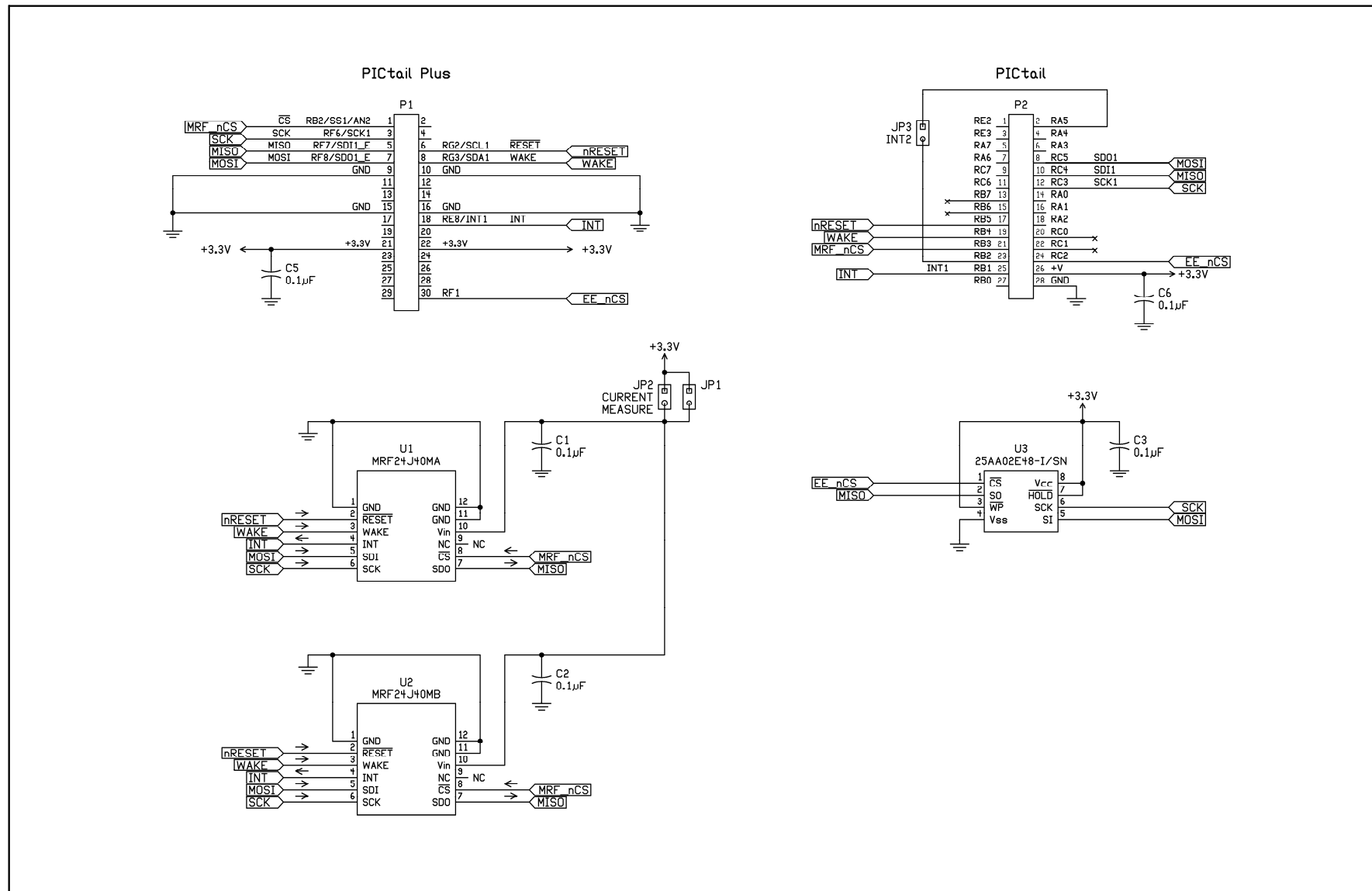
### A.1 INTRODUCTION

This appendix provides the MRF24J40MA/MB PICtail/PICtail Plus Daughter Board schematics, PCB layout and Bill of Materials (BOM).

- MRF24J40MA/MB PICtail/PICtail Plus Daughter Board Schematic
- MRF24J40MA/MB PICtail/PICtail Plus Daughter Board PCB Layout
- MRF24J40MA/MB PICtail/PICtail Plus Daughter Board Bill of Materials

## A.2 MRF24J40MA/MB PICtail/PICtail PLUS DAUGHTER BOARD SCHEMATIC

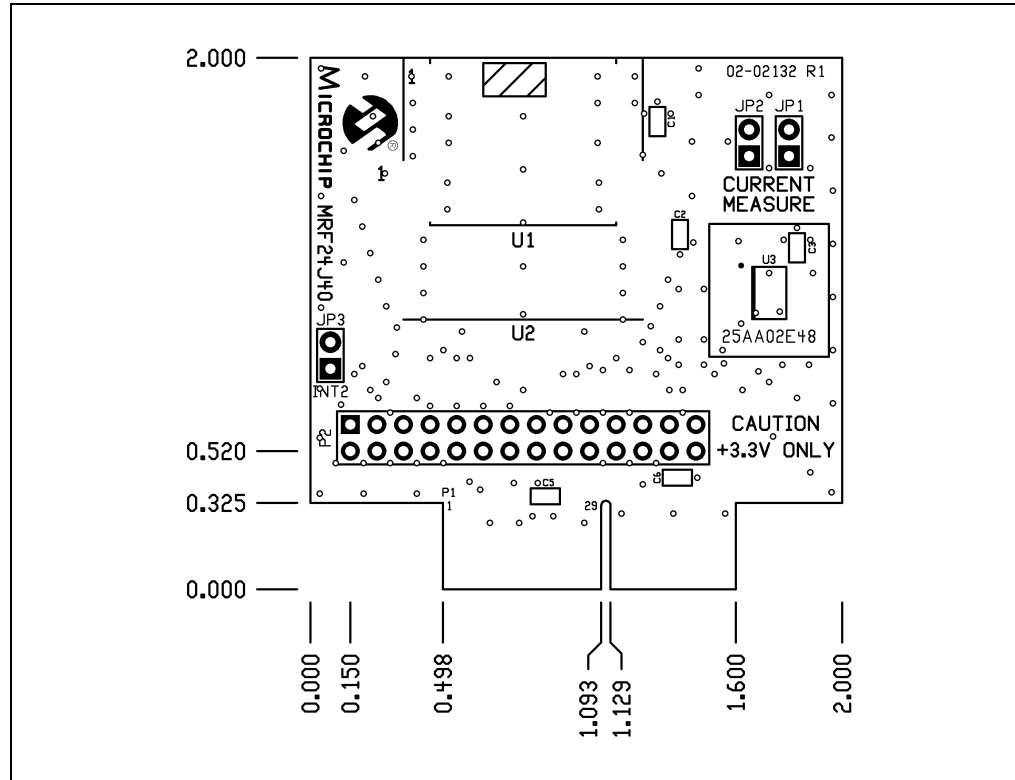
FIGURE A-1: MRF24J40MA/MB PICtail™/PICtail PLUS DAUGHTER BOARD SCHEMATIC



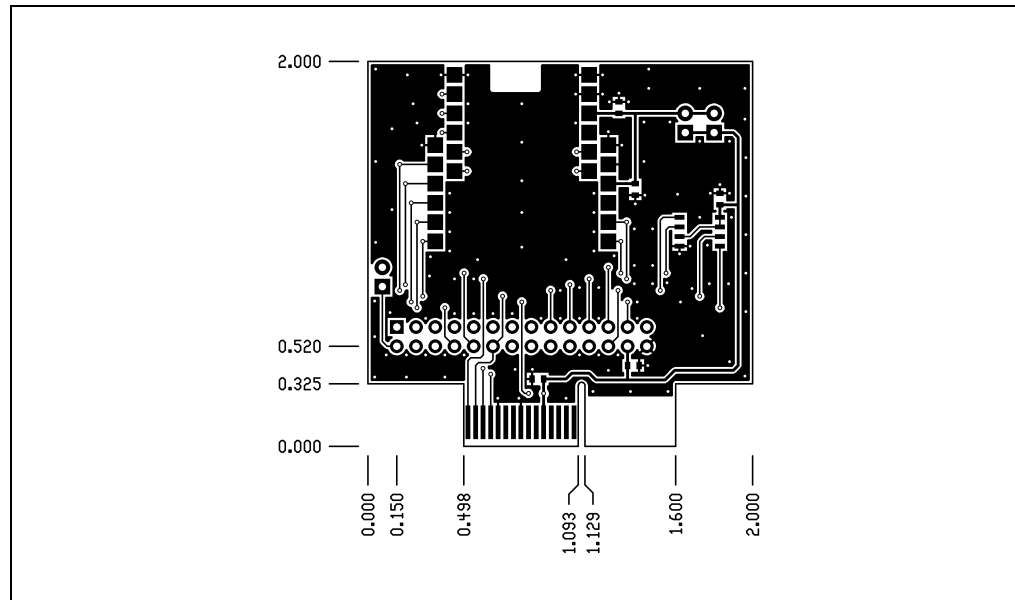
## A.3 MRF24J40MA/MB PICtail/PICtail PLUS DAUGHTER BOARD PCB LAYOUT

The MRF24J40MA/MB PICtail/PICtail Plus Daughter Board is a 2-layer, FR4, 0.062 inch, plated through hole PCB construction.

**FIGURE A-2: MRF24J40MA/MB PICtail™/PICtail PLUS DAUGHTER BOARD SILKSCREEN**



**FIGURE A-3: MRF24J40MA/MB PICtail™/PICtail PLUS DAUGHTER BOARD TOP COPPER**





## A.4 MRF24J40MA/MB PICtail/PICtail PLUS DAUGHTER BOARD BILL OF MATERIALS

TABLE A-1: MRF24J40MA PICtail™/PICtail PLUS DAUGHTER BOARD BILL OF MATERIALS

| Reference          | Value      | Description                                                    | Vendor                      | Vendor P/N      | Comments                                                         |
|--------------------|------------|----------------------------------------------------------------|-----------------------------|-----------------|------------------------------------------------------------------|
| C1, C2, C3, C5, C6 | 0.1 uF     | Capacitor, Ceramic, 50V, C0G, SMT 0603                         | Panasonic                   | ECJ-1VB1C104K   | Bypass capacitor                                                 |
| JP1, JP2, JP3      |            | Connector, Header, 1x2, 0.100" pitch, 0.025" sq post           | SPC TECHNOLOGY              | SPC20481        |                                                                  |
| Shunt              |            | Connector, Shunt, 0.100" pitch                                 | Sullins Connector Solutions | STC02SYAN       | Shunts for JP1 and JP3                                           |
| P2                 |            | Connector, Header, 2x14, 0.100" pitch, right angle 0.390/0.230 | Sullins Connector Solutions | GBC14DBDN       |                                                                  |
| U1                 | MRF24J40MA | MRF24J40MA RF Transceiver Module                               | Microchip Technology        | MRF24J40MA-I/RM | Populated only on MRF24J40MA PICtail/PICtail Plus Daughter Board |
| U2                 | MRF24J40MB | MRF24J40MA 20 dBm RF Transceiver Module                        | Microchip Technology        | MRF24J40MB-I/RM | Populated only on MRF24J40MB PICtail/PICtail Plus Daughter Board |
| U3                 | 25AA02E48  | EUI-48 Node Identity Serial EEPROM                             | Microchip Technology        | 25AA02E48-I/SN  |                                                                  |



---

## 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](http://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

#### Cleveland

Independence, OH  
Tel: 216-447-0464  
Fax: 216-447-0643

#### 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 - Hong Kong SAR

Tel: 852-2401-1200  
Fax: 852-2401-3431

#### China - Nanjing

Tel: 86-25-8473-2460  
Fax: 86-25-8473-2470

#### 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 - Wuhan

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

#### China - Xiamen

Tel: 86-592-2388138  
Fax: 86-592-2388130

#### China - Xian

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

#### China - Zhuhai

Tel: 86-756-3210040  
Fax: 86-756-3210049

### ASIA/PACIFIC

#### India - Bangalore

Tel: 91-80-3090-4444  
Fax: 91-80-3090-4080

#### 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 - Kuala Lumpur

Tel: 60-3-6201-9857  
Fax: 60-3-6201-9859

#### Malaysia - Penang

Tel: 60-4-227-8870  
Fax: 60-4-227-4068

#### 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: 886-3-6578-300  
Fax: 886-3-6578-370

#### 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

03/26/09