

## DEVELOPMENT TOOLS DESIGN ADVISORY

# **Multi-Tool Design Advisory**

This advisory applies to the following development tools:

- MPLAB<sup>®</sup> REAL ICE<sup>™</sup> In-Circuit Emulator
- MPLAB ICD 3 In-Circuit Debugger
- MPLAB ICD 2 In-Circuit Debugger
- PICkit<sup>™</sup> 3 Programmer/Debug Express
- PICkit 2 Programmer/Debug Express
- MPLAB PM3 Device Programmer

For more on these tools, see Development Tools Overview.

For applications where you intend to use the above tools, you should consider the following guidelines and implementation considerations to ensure proper interfacing.

- In-Circuit Serial Programming<sup>™</sup> (ICSP<sup>™</sup>) Considerations
- Communication Channels
- Grounding and AC Applications
- Oscillator Circuit Setup
- Target Power
- Correcting Crosstalk With dsPIC30FXX Devices
- dsPIC30FXX Devices and Clock Postscaler
- PIC32MX and iFlowtrace<sup>™</sup>
- MPLAB ICD 2 Specific Considerations

<sup>© 2010</sup> Microchip Technology Inc.

### DEVELOPMENT TOOLS OVERVIEW

All development tools that apply to this advisory (see the previous topic) can program a device using In-Circuit Serial Programming (ICSP). All except the MPLAB PM3 dedicated programmer can perform in-circuit debugging on a target device. The MPLAB REAL ICE in-circuit emulator can debug a device as well as perform advanced functions such as trace, which is why it is called an emulator and not a debugger.

### IN-CIRCUIT SERIAL PROGRAMMING<sup>™</sup> (ICSP<sup>™</sup>) CONSIDERATIONS

A debugger, emulator and programmer use a serial signaling scheme to program a target device in-circuit. A debugger and emulator use the same scheme to debug a target device in-circuit. The signals utilized are the clock and data signals defined in some data <u>sheets</u> as PGC and PGD or ICSPCLK and ICSPDAT. Additionally, MCLR/VPP is used as either a high voltage programming signal or an attention indicator to the device.

These signals are not dedicated for programming and debugging only, but are shared with a port pin or alternate peripheral. Generally, most devices use ports RB6 and RB7 as the default primary ports.

For trouble-free in-circuit programming and debugging, you must plan carefully to avoid any problems during the application development or production phase of the product. The proposed implementations are:

- Recommended ICSP Implementation Configuration
- Alternate ICSP Implementation Configuration

#### **Recommended ICSP Implementation Configuration**

The signals PGC and PGD are active bidirectional signals driven by the tool and target device during a typical programming or debugging session. These signals follow the programming specification and device algorithm. To minimize programming times, the signals are clocked at a fast rate of speed. Any additional obstructions or loads can distort the signals sufficiently enough to cause either intermittent or hard failures and prevent programming.

Keep these signals free of any other passive circuits or active logic in the application. This will ensure trouble-free debugging and programming sessions.

Another benefit of this configuration is that cable length and/or type may be negligible as there will be fewer reflections from cable mismatches.

Additionally, the  $\overline{\text{MCLR}}/\text{VPP}$  signal is used by the development tool to provide the voltage used for programming some devices or to signal attention. In instances where the application has a large capacitor, it will cause the signal rise and fall time to degrade. This will hinder the ability of the tool and the device to communicate effectively.

It is recommended to keep the signal pulled up to VDD with a 10K resistor and to utilize the power-on timer features of the device to ensure a proper power-up sequence.

The ICSP power connection from the tool to the target device assembly must use the operating VDD voltage of the device, not the system. For example, if the system voltage is 5V but the device voltage is 3.3V, then the ICSP power connection should be 3.3V.

A matching operating voltage is required so that logic levels remain compatible between both the development tool and target device.

<sup>© 2010</sup> Microchip Technology Inc.

## **Development Tools Design Advisory**

#### Alternate ICSP Implementation Configuration

In some cases, especially with low pin count devices, the pins must be utilized by the application.

If this is the case, as a minimum, a resistive isolation is required between the device and the application active node. This will ensure that both the application circuit and the development tool are able to drive the programming pins (PGC and PGD) to ground and to the proper VDD levels. Figure 1-1 depicts this configuration.

#### FIGURE 1-1: ALTERNATE ICSP™ APPLICATION CIRCUIT



The resistive isolation value will differ depending on the application and how it is being used. Values ranging from 1K to 10K are suggested. In any case, ensure the levels on PGD and PGC can be driven to their appropriate logic voltage levels. For isolating MCLR/VPP, especially when the application uses a voltage supervisor, refer to technical brief TB087 (DS91087) for an in-depth discussion.

## **COMMUNICATION CHANNELS**

Some devices have the flexibility to use one of several communication channels or pins for programming and debugging. These channels are generally referred to in data sheets as PGC *x*/PGD*x*, where *x* is the channel number identifier. As mentioned earlier, these channels are often multiplexed with some peripherals ( $I^2C^{TM}$ , SPI, A/D).

If your application uses those peripherals and pins which are common to the default PGC/PGD pins, you must select a different channel and make provisions for the required ICSP connections. Likewise, when using MPLAB IDE to communicate with the target using this new channel pin assignment, you must ensure that the Configuration bits in MPLAB IDE match the connection channel in your target.

For some devices programming speeds can be slower on PGC3/PGD3 because they cannot make use of certain programming enhancements (i.e., a programming executive). Consult any data sheet errata for details.

### **GROUNDING AND AC APPLICATIONS**

A debugger, emulator or programmer connects to earth ground from the USB connector interface through the PC.

For AC line powered applications which are not referenced to ground, this presents a path where the different system voltage potential can cause damage to both systems. In these instances, the development tool must be isolated. Carefully consider the ground system and signal return connections before connecting the tool to the target. For hot or floating applications, a USB self-powered isolated hub should be used between the PC and the tool to provide isolation from the PC's earth ground through the USB cable (see Figure 1-2).

USB isolated hubs such as the following are suggestions:

- High/Low-Speed 4-port USB HUB, Model UISOHUB 4, B&B Electronics Mfg. Co.
- High-Speed, 7-port USB HUB, Model HUB7i, SEALEVEL Systems, Inc.
- Keterex Inc., Single USB port, Model P/N KXUSB-150.
- IFTOOLS Gbr, Single USB port, Model ISOUSB-HVC.

WARNING	
	Using the development tool without ensuring ground isolation will result in damage to the tool or the target system as the full AC mains voltage will be applied. This condition can be hazardous to the operator in the form of an electric shock. Therefore, take adequate precautions to avoid this situation.

## **Multi-Tool Design Advisory**

#### FIGURE 1-2: EXAMPLE DEBUGGER SETUP FOR NON-ISOLATED AC POWER SYSTEMS





© 2010 Microchip Technology Inc.

## **OSCILLATOR CIRCUIT SETUP**

The following oscillator considerations address proper set up of software and hardware.

### **Primary Oscillator**

Often when starting a new project with a debugger or emulator, there is a high probability that the default settings of MPLAB IDE will not match the specific configuration of the target application since there are a wide range of oscillator variations offered by the device. These differences between the MPLAB IDE default settings and the unique target requirements cause a message to display in the Output window such as "The target device is not ready for debugging. Please check your Configuration bit settings and program the device before proceeding." This is the result of an oscillator configuration mismatch between the target hardware setup and the default Configuration bits in MPLAB IDE. To correct this, set the Configuration bits to match the oscillator settings of the target configuration.

For debugging operations, the application (target) oscillator must be functioning before in-circuit debugging can take place. Ensure the oscillator configuration and the MPLAB IDE Configuration bit setup are configured properly. For example, if your application uses a 20 MHz crystal oscillator, select the HS (High Speed) selection in MPLAB IDE. For any other applicable device oscillator modes, consult the device data sheet.

#### Crystal Oscillator Timer Oscillator/Secondary Oscillator

If a header board or Processor Extension Pak is used to connect to the target, there may be problems with starting the 32 kHz crystal resonator. To avoid potential problems, consider the following:

- 1. Ensure the 32 kHz crystal is connected near the device footprint.
- 2. Keep all lines as short as possible in the target application without unnecessary discontinuities such as PCB interconnect vias and test points.
- 3. Minimize any capacitive loading on these nodes.
- 4. Avoid using a socket for the placement of the crystal and capacitor. Solder the devices directly to PCB pads.

### TARGET POWER

The MPLAB REAL ICE in-circuit emulator cannot power a target board. This makes it different from the other debuggers. Therefore, the target board will need to have its own power supply when using the emulator.

## **Development Tools Design Advisory**

#### CORRECTING CROSSTALK WITH dsPIC30FXX DEVICES

In some cases a crosstalk problem may exist when a dsPIC30 DSC device is being programmed. Due to the locations of the PGC and PGD pins, crosstalk may degrade the signal and cause the debugger or programmer to fail programming the target device.

To correct crosstalk in this situation, try the following:

• Do not use the cable that comes with the debugger. Instead, construct an RJ12 modular cable made from a 6-connector flat satin modular cable such as Interstate WI WICTSS-2206 or equivalent. Keep the length as short as possible, preferably less than 6 inches. Also, remove the jacket from the cable, so that the conductors are far apart from each other (especially the PGC and PGD signals). The standard modular cable is wired as shown in Figure 1-3, that is, RJ12 pin 1 on one end connects to RJ12 pin 6 on the other end. This solves the problem in nearly all cases.



DS51764C-page 10

Note 1:	Noise-inducing equipment (motors, light dimmers, etc.) must be on separate power strips from the target application and the debugger or emulator.
Note 2:	Unless strictly specified for some situations (such as correcting crosstalk for dsPIC30FXX devices), the use of any cable (other material, length, etc.) other than the one provided with the debugger or emulator may result in unreliable device behavior.

### dsPIC30FXX DEVICES AND CLOCK POSTSCALER

In some applications that make use of the clock postscaler, certain precautions need to be taken to ensure that communication with the debugger or emulator is maintained throughout a device interrogation and a programming operation.

With the dsPIC30F series of devices, such as the dsPIC30F60XX, dsPIC30F40XX, dsPIC30F30XX, and dsPIC30F20XX, that have the clock prescalers as an optional clock mode, the ICSP sequence can get out of synchronization and cause programming operations to fail. This happens because the instructions are clocked in a bit at a time and the prescaler also divides the serial data instruction stream.

What further complicates this issue is when applications also use FRC as the clock source and the target power is used. In these situations, the application code that sets up the oscillator postscaler in the OSCCON register begins executing immediately after power-up. Any subsequent MCLR or device Resets do not reset OSCCON, which causes attempts to communicate via the serial channel after this point invalid.

<sup>© 2010</sup> Microchip Technology Inc.

# **Development Tools Design Advisory**

A workaround for this scenario in development is to run from an external crystal or oscillator source. The oscillator needs to be disabled and the target power cycled to clear the OSCCON register to program the device once more.

Additionally, a long delay can be inserted prior to the postscaler configuration setup so the debugger and programmer tool can identify the device and still leave enough time to invoke an erase operation to take place before OSCCON is modified by the application.

Alternatively, consider not using the postscaler during general code development and add the postscaler configuration only as the application development nears completion. For devices in this situation, the MPLAB PM 3 programmer can be used to dynamically switch power and may have enough current (<250 ma) to power up the target completely and keep the OSCCON register cleared.

### PIC32MX AND iFLOWTRACE™

The MPLAB REAL ICE in-circuit emulator can work with PIC32MX device iFlowtrace (if available on the device – consult the device data sheet).

The PIC32MX architecture provides a method of program flow tracing where trace data is compressed and transmitted encoded on 4 data lines and one clock line. This data is transmitted at key points or non-sequential instructions (e.g., branches, jumps) in the program flow. The cycle-by-cycle trace can then be reconstructed by MPLAB IDE and displayed in the trace window.

To take advantage of this feature, some provisions must be made on the target, namely that 5 lines on the device be dedicated for tracing (4 data + 1 clock). These lines cannot be used for other data or a garbled trace may result.

### **MPLAB ICD 2 – SPECIFIC CONSIDERATIONS**

#### **Proper USB Connection**

As a general rule, always connect a powered USB cable to the MPLAB ICD 2 first before connecting any other power source, either directly to the ICD pod or indirectly through a connection to the target board. Also, when powering down, make sure the USB cable maintains power until all other power sources are removed (i.e., do not power down the PC first and then the ICD pod and/or target board).

#### MPLAB ICD 2 USB Driver

Anytime a USB cable is connected to the MPLAB ICD 2, there is a short time (generally a few seconds) before the USB subsystem becomes ready. After connecting the USB cable to the MPLAB ICD 2, allow the USB subsystem to enumerate before invoking the MPLAB IDE software.

To view this process, open the Device Manager window while connecting the USB cable. The window output will display the MPLAB ICD 2 under the MCHP expandable icon.

In some instances when MPLAB ICD 2 is active and enabled during an MPLAB session and USB power is interrupted by a cable disconnect, the MPLAB ICD 2 and PC system may get momentarily out of synchronization.

To allow the system to synchronize once again; select the Simulator as your tool under project properties and remove USB power. Wait 10 seconds or so and reconnect the USB cable and select MPLAB ICD 2 as your tool under project properties.

<sup>© 2010</sup> Microchip Technology Inc.

### MPLAB ICD 2 Unit Upgrade

If you are having problems with ICD operation, please check the revision of your pod, found on the back of the unit. If the part number is 10-00319 R15 through R21 without an "ECO 3013" sticker, please contact your local Microchip FAE or sales office to return the unit for replacement.

#### **Disabling Hibernation**

When using the debugger for prolonged periods of time, especially while the debugger is in emulation mode, disable the Hibernate mode in the Power Options Dialog of the PC's operating system. Click on the **Hibernate** tab and clear (uncheck) the "Enable hibernation" check box. This will ensure that all communication is maintained across all the USB subsystem components.

NOTES:

<sup>© 2010</sup> Microchip Technology Inc.

#### 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. MICRO-CHIP 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, PIC<sup>32</sup> logo, 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, Omniscient Code Generation, PICC, PICC-18, PICDEM, PICDEM.net, PICkit, PICtail, REAL ICE, rfLAB, 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.

 $\textcircled{\mbox{\sc op}}$  2010, Microchip Technology Incorporated, Printed in the U.S.A., All Rights Reserved.

Printed on recycled paper.

<sup>© 2010</sup> Microchip Technology Inc.



#### Worldwide Sales and Service

**Corporate Office** Tel: 480-792-7200 Atlanta Tel: 678-957-9614 Boston Tel: 774-760-0087 Chicago Tel: 630-285-0071 Cleveland Tel: 216-447-0464 Dallas Tel: 972-818-7423 Detroit Tel: 248-538-2250 Kokomo Tel: 765-864-8360 Los Angeles Tel: 949-462-9523 Santa Clara Tel: 408-961-6444 Toronto Tel: 905-673-0699 Asia Pacific Office Tel: 852-2401-1200 Australia - Sydney Tel: 61-2-9868-6733 China - Beijing Tel: 86-10-8528-2100 China - Chengdu Tel: 86-28-8665-5511 China - Chonaging Tel: 86-23-8980-9588 China Hong Kong SAR Tel: 852-2401-1200

China - Nanjing Tel: 86-25-8473-2460 China - Qingdao Tel: 86-532-8502-7355

China - Shanghai Tel: 86-21-5407-5533 China - Shenyang Tel: 86-24-2334-2829 China - Shenzhen Tel: 86-755-8203-2660 China - Wuhan Tel: 86-27-5980-5300 China - Xiamen Tel: 86-592-2388138 China - Xian Tel: 86-29-8833-7252 China - Zhuhai Tel: 86-756-3210040 India - Bangalore Tel: 91-80-3090-4444 India - New Delhi Tel:91-11-4160-8631 India - Pune Tel:91-20-2566-1512 Japan - Yokohama Tel: 81-45-471- 6166 Korea - Daegu Tel: 82-53-744-4301 Korea - Seoul Tel: 82-2-554-7200

Malaysia Kuala Lumpur Tel: 60-3-6201-9857

Malaysia - Penang Tel: 60-4-227-8870 Philippines - Manila Tel: 63-2-634-9065 Singapore Tel: 65-6334-8870 Taiwan - Hsin Chu Tel: 886-3-6578-300 Taiwan - Kaohsiung Tel: 886-7-213-7830 Taiwan - Taipei Tel: 886-2-2500-6610 Thailand - Bangkok Tel: 66-2-694-1351 Austria - Wels Tel: 43-7242-2244-39 Denmark - Copenhagen Tel: 45-4450-2828 France - Paris

Tel: 33-1-69-53-63-20

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

Italy - Milan Tel: 39-0331-742611

Netherlands - Drunen Tel: 31-416-690399

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

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