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# dsPICDEM™ MCSM Development Board User's Guide

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# dsPICDEM™ MCSM DEVELOPMENT BOARD USER'S GUIDE

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**NOTES:**

# dsPICDEM™ MCSM DEVELOPMENT 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) 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 preface contains general information that will be useful to know before using the dsPICDEM™ Motor Control Stepper Motor (MCSM) Development Board. Topics discussed in this preface 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 user's guide describes how to use the dsPICDEM MCSM Development Board. The document is organized as follows:

• **Chapter 1. "Introduction"** – This chapter introduces the dsPICDEM MCSM Development Board and provides a brief overview of its features.
• **Chapter 2. "Getting Started"** – This chapter provides information on getting started with the dsPICDEM MCSM Development Board.
• **Chapter 3. "Hardware"** – This chapter describes the hardware on the dsPICDEM MCSM Development Board.
• **Chapter 4. "Troubleshooting"** – This chapter provides information for troubleshooting problems encountered while using the dsPICDEM MCSM Development Board.

- **Appendix A. "Board Layout and Schematics"** – This appendix provides diagrams of the hardware layout, as well as schematic diagrams for the dsPICDEM MCSM Development Board.
- **Appendix B. "Electrical Specifications"** – This appendix provides pertinent electrical specifications for the dsPICDEM MCSM Development Board.

# Preface

## CONVENTIONS USED IN THIS GUIDE

This manual uses the following documentation conventions:

### DOCUMENTATION CONVENTIONS

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

# dsPICDEM™ MCSM Development Board User's Guide

## 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 dsPICDEM MCSM Development Board. The device-specific data sheets contain current information on programming the specific microcontroller or digital signal controller devices. Other useful documents are listed below. The following Microchip documents are available and recommended as supplemental reference resources:

**MPLAB® IDE Simulator, Editor User's Guide (DS51025)**

This user's guide is a comprehensive guide that describes installation and features of Microchip's MPLAB Integrated Development Environment (IDE), as well as the editor and simulator functions in the MPLAB IDE environment.

**Readme Files**

For the latest information on using other tools, read the tool-specific Readme files in the Readme subdirectory of the MPLAB IDE installation directory. The Readme files contain updated information and known issues that may not be included in this user's guide.

**MPASM™ Assembler, MPLINK™ Object Linker, MPLIB™ Object Librarian User's Guide (DS33014)**

This user's guide describes how to use the Microchip MPASM Assembler, the MPLINK Object Linker and the MPLIB Object Librarian.

**dsPIC33FJ12MC202 PIM Information Sheet (DS70314)**

This document provides device-specific information for the dsPIC33FJ12MC202 PIM device. The dsPIC33FJ12MC202 is a high-performance 16-bit digital signal controller within a small 28-pin 6x6 mm QFN package.

**dsPIC33FJ32MC204 PIM Information Sheet (DS70316)**

This document provides device specific information for the dsPIC33FJ32MC204 PIM device. The dsPIC33FJ32MC204 is a high-performance 16-bit digital signal controller within a small 44-pin QFN package.

**dsPIC33FJ128MC804 PIM Information Sheet (DS70326)**

This document provides device specific information for the dsPIC33FJ128MC804 PIM device. The dsPIC33FJ128MC804 is a high-performance 16-bit digital signal controller within a small 44-pin QFN package.

**dsPIC33FJ256MC710 PIM Information Sheet (DS70564)**

This document provides device specific information for the dsPIC33FJ256MC710 PIM device. The dsPIC33FJ256MC710 is a high-performance 16-bit digital signal controller within a small 100-pin TQFP package.

**dsPIC33FJ12MC201/202 Data Sheet (DS70265)**

This data sheet contains device specific information for the dsPIC33FJ12MC201/202 Digital Signal Controller (DSC) devices. The dsPIC33F devices contain extensive Digital Signal Processor (DSP) functionality with a high performance 16-bit microcontroller (MCU) architecture.

**dsPIC33FJ32MC202/204 and dsPIC33FJ16MC304 Data Sheet (DS70283)**

This data sheet provides device specific information for the dsPIC33FJ32MC202/204 and dsPIC33FJ16MC304 motor control family of devices.

**dsPIC33FJ32MC302/304, dsPIC33FJ64MCX02/X04, and dsPIC33FJ128MCX02/ X04 Data Sheet (DS70291)**

This data sheet contains device specific information for the dsPIC33FJ32MC302/304, dsPIC33FJ64MCX02/ X04 and dsPIC33FJ128MCX02/X04 motor control family of devices.

**dsPIC33FJXXXMCX06/X08/X10 Data Sheet (DS70287)**

This data sheet contains device specific information for the dsPIC33FJXXXMCX06/ X08/X10 motor control family of devices.

To download these documents, visit Microchip web site at www.microchip.com.

## 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. 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, 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, MPLAB ICE 4000, and MPLAB REAL ICE™.
- **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™ 1development programmers.

# dsPICDEM™ MCSM Development Board User's Guide

## CUSTOMER SUPPORT

Users of Microchip products can receive assistance through several channels:

- Distributor or Representative
- Local Sales Office
- Field Application Engineer (FAE)
- Technical Support
- Development Systems Information Line

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 (September 2009)

This is the initial released revision of this document.

# Chapter 1.  Introduction

The dsPICDEM MCSM Development Board is targeted to control both unipolar and bipolar stepper motors with no hardware configuration changes. This flexible and cost-effective board can be configured in different ways for use with Microchip's specialized dsPIC33F Motor Control Digital Signal Controllers (DSCs).

The dsPICDEM MCSM Development Board offers a mounting option to connect either a 28-pin SOIC device or a generic 100-pin Plug-In Module (PIM). The board also has two full-bridge inverters. The hardware is designed in such a way that no hardware changes are necessary for 8-, 6- or 4-wire stepper motors in either bipolar or unipolar configurations. Topics covered include:

• Overview
• Features
• What's Included
• Reference Documents and Webinars

## 1.1    OVERVIEW

Figure 1-1 shows a photograph of the dsPICDEM MCSM Development Board. A dsPIC33F device uses the MOSFET driver to drive the two full-bridge inverters that power the motor windings. The board includes various circuitries to perform the following functions:

• Drive two motor windings with the two on-board full-bridge inverters
• Measure feedback and other analog signals (i.e., current, DC voltage, Potentiometer and Fault signals)
• Communicate with a host computer or an external device via USB

The dsPICDEM MCSM Development Board supports terminal voltages up to 80V and currents up to 3A. Refer to **Appendix B. "Electrical Specifications"** for more information.

# dsPICDEM™ MCSM Development Board User's Guide

**FIGURE 1-1:**      **dsPICDEM MCSM DEVELOPMENT BOARD**
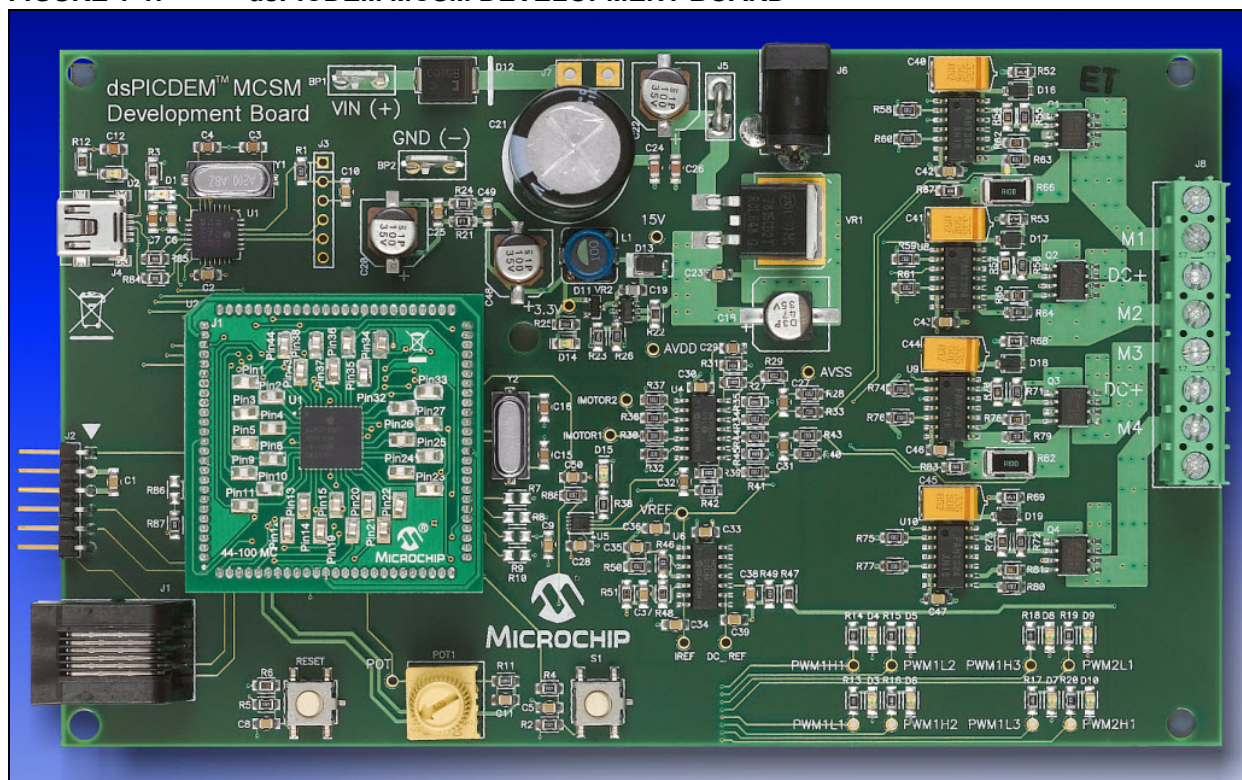
## 1.2 FEATURES

The key features of this board include the following:

- Devices supported:
  - 28-pin to 100-pin dsPIC33FJ12MC202 PIM (MA330014) with a dsPIC33F
  - 44-pin to 100-pin dsPIC33FJ32MC204 PIM (MA330017) and dsPIC33FJ128MC804 PIM (MA330018) with a dsPIC33F motor control device (U2) socket
  - 100-pin to 100-pin dsPIC33FJ256MC710 PIM (MA330013) with a dsPIC33F
- Motor control device (U2) socket
  - The dsPIC33FJ12MC202 Motor Control device in SOIC package (U3) footprint
- Motor control interfaces:
  - Two full-bridge inverters
  - Two phase current sense resistors
  - DC bus voltage sense resistor
  - Overcurrent protection
- Input/output control switches:
  - One push button (S1)
  - Reset push button (RESET)
  - 10 kΩ potentiometer (POT)
  - LED indicators for PWM outputs arranged in a full-bridge format
  - LED indicator for overcurrent
- Communication Ports:
  - UART communication via USB (J4)
- Built-in power supplies
  - 15V power supply, maximum power available 11 W
  - 3.3V power supply, maximum power available 2 W
- Power supply connectors:
  - 24V power input connector (J6) for the controller and power stage
  - Auxiliary Power Tab Fast-On connectors (BP1 and BP2) for the power stage
- Programming Connectors:
  - ICSP™ connector for programming a dsPIC DSC device (J2)
  - RJ11 connector for programming a dsPIC DSC device (J1)
  - ICSP connector for programming the PIC18LF2450 USB-to-UART Bridge (J3)

## 1.3 WHAT'S INCLUDED

> **Note:** The MCSM Development Board is available in two configurations:
> - dsPICDEM MCSM Development Board
> - dsPICDEM MCSM Development Board Kit

The dsPICDEM MCSM Development Board with the part number DM330022 contains the following:

• dsPICDEM MCSM Development Board

• dsPIC33FJ32MC204 Plug-In-Module

• USB-to-mini-USB cable

• Screwdriver

• dsPICDEM MCSM Development Board CD ROM, which includes:

   - This user's guide

   - Data sheets for dsPIC families

   - Example programs for use with the dsPIC DSC devices

The dsPICDEM MCSM Development Board Kit with part number DV330021 contains the following:

• dsPICDEM MCSM Development Board

• dsPIC33FJ32MC204 Plug-In-Module (PIM)

• USB-to-mini-USB cable

• Screwdriver

• dsPICDEM MCSM Development Board CD ROM, which includes:

   - This user's guide

   - Data sheets for dsPIC DSC families

   - Example programs for use with the dsPIC DSC devices

• 24V Power Supply

• Leadshine Stepping Motor (P/N 42HS03)

•  use the following link:

    http://www.leadshine.com

If you are missing any part of the kit, please contact your nearest Microchip sales office, which is listed on the last page of this manual.

## 1.4    REFERENCE DOCUMENTS AND WEBINARS

In addition to the documents listed in the **"**Recommended Reading**"** section, the following are also available from Microchip to support the use of the dsPICDEM MCSM Development Board.

•  AN907 *"Stepping Motors Fundamentals"*

•  AN906 *"Stepper Motor Control Using the PIC16F684"*

•  AN822 *"Motor Microstepping with PIC18C452"*

•  Stepper motor webinars are available at:
  http://techtrain.microchip.com/webseminars/Archived.aspx

   -  Stepper Motors Part 1: Types of Stepper Motors

   -  Stepper Motors Part 2: Stepper Motor Control

You can obtain these reference documents from your nearest Microchip sales office (listed in the last page of this document) or by downloading them from the Microchip web site.

# Chapter 2. Getting Started

This chapter describes how to set up the dsPICDEM MCSM Development Board hardware and software; and how to run the included demonstration software. Refer to **Chapter 3. "Hardware"** for detailed information on the board and its components.

Topics in this chapter include:

• Board Setup
• Programming and Debugging Application Code

## 2.1 BOARD SETUP

<table>
<tr><td align="center"><strong>WARNING</strong></td></tr>
<tr><td>

**The dsPICDEM MCSM Development Board is intended to drive bipolar or unipolar step-per motors. Before connecting the motor, make sure that the power rating of the motor is equal to or less than the power rating of the board, as shown in Appendix B. "Electrical Specifications". Also, make sure the configuration resistors are correct for the firmware and the specific dsPIC DSC device mounted on the socket. Failure to comply with this warning could lead to malfunction of the board and the motor, and could result in physical harm.**

**Before beginning the start-up procedure, complete a visual check of the board and the motor for connectivity and mechanical damage. If damage is found, DO NOT power-up the board. Otherwise, you may further damage the equipment. Contact Microchip's local office or distributor immediately.**

</td></tr>
</table>

The following procedure describes how to set up the dsPICDEM MCSM Development Board to run with the demonstration software. The stepper motor used for the demonstration is the Leadshine Stepping Motor (P/N 42HS03).

1. Place the dsPICDEM MCSM Development Board on a sturdy insulated platform.
2. Make sure that the dsPIC33FJ32MC204 device or an appropriate PIM is mounted in the respective socket.
3. Connect the stepper motor (42HS03) to J8. Connect the motor phases in a bipolar series connection as described in Table 2-1.

**TABLE 2-1: MOTOR CONFIGURATION TABLE**

| J8 Pin Number J8 Pin Name | Bipolar Series | Bipolar Parallel | Bipolar Half-winding | Unipolar | |
|---|---|---|---|---|---|
| 1 | NC | Green+Yellow | — | Yellow | — |
| 2 | M1 | Black | Black+Yellow | Black | Black |
| 3 | DC+ | — | — | Orange | Green+Yellow |
| 4 | M2 | Orange | Green+Orange | Green | Orange |
| 5 | M3 | Red | Red+White | Red | Red |
| 6 | DC+ | — | — | White | Blue+White |
| 7 | M4 | Brown | Blue+Brown | Blue | Brown |
| 8 | NC | Blue+White | — | Brown | — |

4. Connect the 24V power supply to J6.

5. Press S1 to run the motor.

6. Vary the motor's speed with the potentiometer.

7. Press S1 to switch to full-step wave mode, full-step, half-step and various microstepping modes. Pushing S1 after the 256$^{th}$ microstep step setting stops the motor. Press S1 again to repeat the cycle.

Operating the dsPICDEM MCSM Development Board using the on-board POT and switch button cannot offer the flexibility required in most applications and it is only intended as a quick start demonstration. To have more control over the motor using a real-time communication tool, please refer to the next section.

## 2.2    PROGRAMMING AND DEBUGGING APPLICATION CODE

The following procedure describes how to program the dsPICDEM MCSM Development Board in Debug mode:

1. Place the dsPICDEM MCSM Development Board on a sturdy insulated platform.

2. Make sure that the dsPIC33FJ32MC204 device or an appropriate PIM is mounted in the respective socket.

3. Connect the stepper motor (42HS03) to J8. Connect motor phases in a bipolar series connection as described in Table 2-1.

4. Connect the 24V power supply to J6.

5. Connect PICkit™ 3 In-Circuit Debugger/Programmer, MPLAB® ICD 3 or MPLAB REAL ICE™ In-Circuit Emulator to the computer and to the board at J1 or J2.

6. Connect the USB cable to J4 and to the computer.

7. Download the code for the dsPIC33FJ32MC204 from the Microchip web site .

8. Build the project and download the program into the processor.

9. Click the **Run** icon when in Debug mode.

> **Note:** For more information on running stepper motors, refer to **Section 1.4 "Reference Documents and Webinars"**.

# Chapter 3. Hardware

This chapter describes the hardware used in the dsPICDEM MCSM Development Board. Topics covered include:

- Hardware Architecture
- PIM Configuration
- Board Connectors
- User Interface Hardware

## 3.1 HARDWARE ARCHITECTURE

The dsPIC DSC devices feature an 8-channel, high-speed PWM with Complementary mode output, a programmable ADC trigger on the PWM reload cycle, digital dead time control, internal shoot-through protection and hardware fault shutdown.

These features make the dsPIC DSC an ideal solution for high-performance stepper motor control applications where full control of the full-bridge inverter is required.

Figure 3-1 provides a simplified block diagram of the development board hardware.

**FIGURE 3-1: dsPICDEM MCSM DEVELOPMENT BOARD BLOCK DIAGRAM**
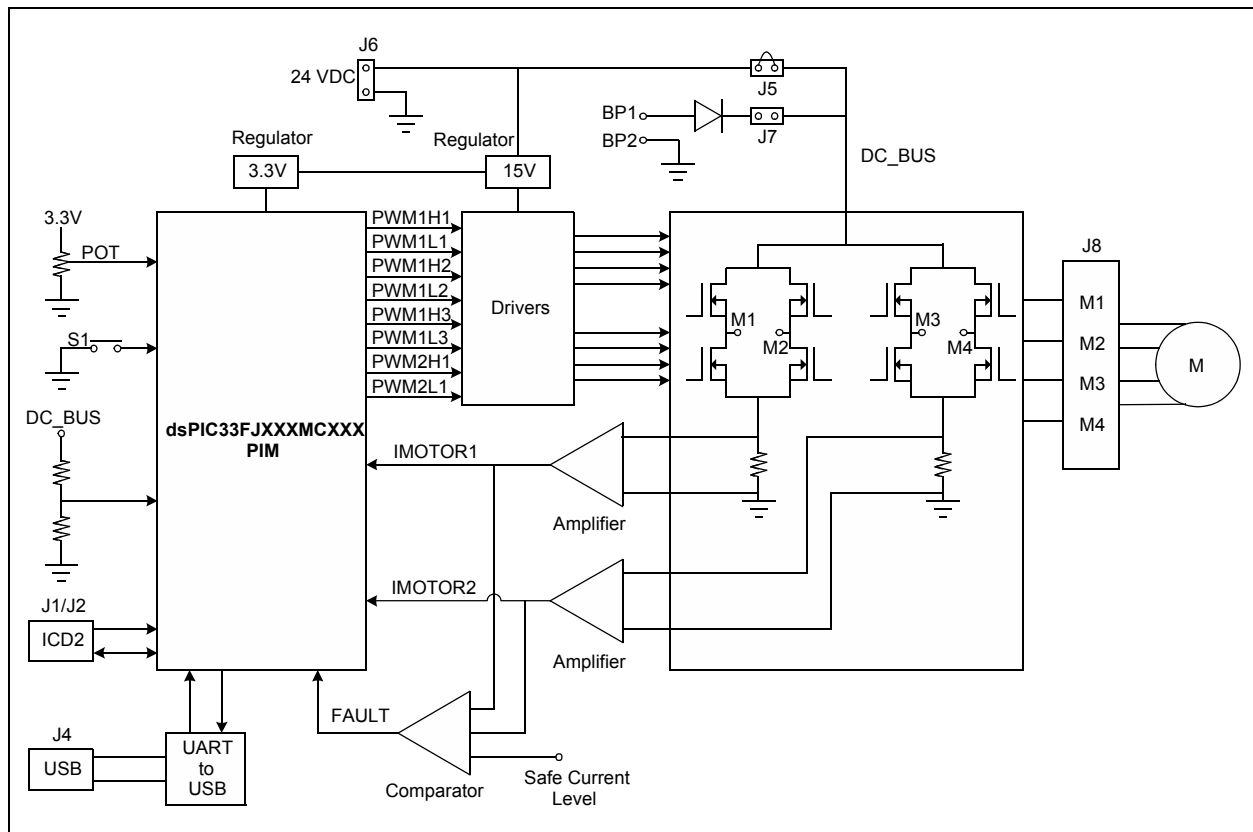
### 3.1.1 Power Stage

The dsPICDEM MCSM Development Board features two full-bridge inverters to accommodate a bipolar stepper motor. MOSFET gate signals are powered from a 15V permanent supply while the full-bridge inverters can be powered from a supply up to 80V.

#### 3.1.1.1 MOSFET DRIVER

Although the dsPIC DSC devices can operate in Complementary PWM mode, Independent PWM mode is still possible. In this case, internal dead time control and shoot-through protection circuits are disabled. In order to protect the power stage from high shoot-through currents in Independent PWM mode, the chosen MOSFET driver also has a built-in shoot-through protection and a small fixed dead time. In Independent PWM mode, the development board is suitable for controlling two brushed DC motors with full direction control, or up to four DC motors with a single turning direction.

#### 3.1.1.2 SWITCHING TOPOLOGY

Driving a stepper motor in a full-bridge topology requires switching the opposite diagonal MOSFETs on and off at the same time in order to reverse the drive current and to accommodate all possible decay modes. Since all PWMxHx pins are on at the same time (for example, PWM1H1 and PWM1H2), it is not possible to drive all of the high-side MOSFETs with the PWMxHx signals. Figure 3-2 shows the PWM and MOSFET assignment.

Driving the high PWM pins active will run the current through a motor winding in one direction, while driving the low PWM pins active will run the current through the winding in the opposite direction. By using this topology in addition to the dsPIC PWM Override feature, all decay modes for the winding current can be achieved.

Refer to **Appendix A. "Board Layout and Schematics"** for the complete schematic and PWM pin assignments.

FIGURE 3-2:       MOSFET PWM ASSIGNMENT
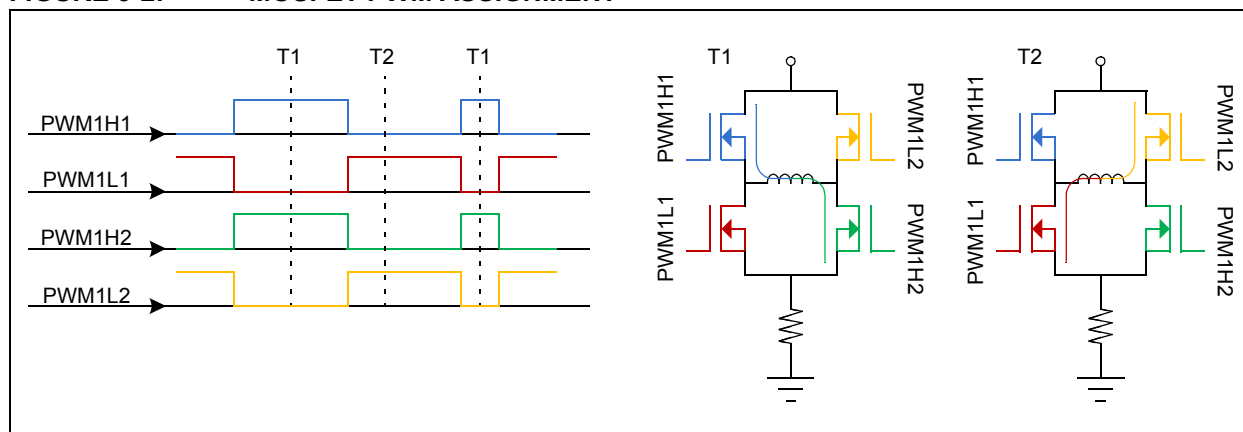
## 3.1.2 Current Sensing

Two shunt resistors are available for current sensing, one for each of the two motor windings. In order to read both positive and negative currents, the amplifier circuit is designed with an offset of $V_{REF}$ = AVDD/2. The amplifier gain allows for a maximum current range of ±2.2A.

To calculate the amplifier gain, use the formula provided in Equation 3-1:

**EQUATION 3-1:    AMPLIFIER GAIN CALCULATION FORMULA**

$$Gain = R_{SHUNT} \cdot \frac{R_{27}}{R_{28} + R_{29}}$$

**Note:** The default gain value is 0.75 V/A, allowing a resolution of 67 μA/bit with a 10-bit ADC.

The formula shown in Equation 3-1 is a simplified version of the complete formula and is only valid when $R_{28} = R_{29} = R_{33} = R_{34}$ and $R_{27} = R_{35}$. If changes to the amplifier gain are needed, use the above formula to calculate $R_{27}$ corresponding to the desired gain, and then replace both $R_{27}$ and $R_{35}$ with the calculated resistor value. Make the same changes for $R_{39}$ and $R_{45}$.

The DC voltage supplied to the power stage is measured with a simple resistor divider. To calculate the DC_REF signal used for this purpose use the formula provided in Equation 3-2:

**EQUATION 3-2:    DC_REF SIGNAL CALCULATION FORMULA**

$$DC\_REF = \frac{1}{28}DC\_BUS$$

This measurement is needed in the PI loop calculation and for algorithms such as automatic motor induction and resistance identification.

## 3.1.3 Fault Protection

The dsPICDEM MCSM Development Board features an overcurrent fault detection, which triggers a PWM shutdown. Each phase current is amplified and then compared with a fixed "safe" current value. A value of 1.7A is set for the dsPICDEM MCSM Development Board; however, the user can change this limit by changing the resistor divider made by R48 and R51. When either of the two phase currents is above the "safe" current level, a Fault signal is triggered and the dsPIC DSC hardware module automatically switches off all PWM outputs.

The Fault LED (D15) is active only when an overcurrent is present in the motor windings. It will go inactive immediately after the internal dsPIC Fault circuit shuts down the PWM pins. In this case, the LED will not be visible as the on-time is very short. The Fault LED will only be visible if the Fault is persistent, that is when the software fault shutdown is disabled.

For details about the PWM module Fault feature, please refer to **Section 14. "Motor Control PWM"** (DS70187) in the *"dsPIC33F Family Reference Manual"*.

**WARNING**

If the Fault LED is permanently active, power off the board immediately to avoid damage to the power Mosfets.

## 3.2    PIM CONFIGURATION

This section summarizes the resistor configurations required to connect the PIM pins to the dsPIC DSC pins. The following PIMs can be configured on the dsPICDEM MCSM Development Board:

- dsPIC33FJ256MC710 PIM (MA330013)
- dsPIC33FJ12MC202 PIM (MA330014)
- dsPIC33FJ32MC204 PIM (MA330017)
- dsPIC33FJ128MC804 PIM (MA330018)

Table 3-1, Table 3-2 and Table 3-3 describe the PIM configuration details. The dsPIC33FJ32MC204 and dsPIC33FJ128MC804 PIMs are pin-compatible and share the same table.

**TABLE 3-1:** **dsPIC33FJ256MC710 CONFIGURATION DETAILS**[1]

| PIM Pin Number | Labels on the MCSM Board | dsPIC33FJ256MC710 | | Comment/Board Resistor Configuration |
|---|---|---|---|---|
| | | Pin Number | Pin Name | |
| 3 | PWM1H3 | 3 | PWM3H/RE5 | — |
| 4 | PWM2L1 | 4 | PWM4L/RE6 | — |
| 5 | PWM2H1 | 5 | PWM4H/RE7 | — |
| 13 | MCLR | 13 | MCLR | — |
| 18 | PWM2H1 | — | AN20/FLTA/INT1/RE8 | Not used, set pin as input |
| 19 | FAULT_1 | 19 | AN21/FLTB/INT2/RE9 | Solder R86, remove R87 |
| 20 | POT | 20 | AN5/QEB/CN7/RB5 | Not used, set pin as input |
| 22 | POT | 22 | AN3/INDX/CN5/RB3 | — |
| 23 | DC_REF | 23 | AN2/SS1/CN4/RB2 | — |
| 24 | IMOTOR2 | 24 | PGEC3/AN1/CN3/RB1 | — |
| 25 | IMOTOR1 | 25 | PGED3/AN0/CN2/RB0 | — |
| 26 | PGC | 26 | PGEC1/AN6/OCFA/RB6 | — |
| 27 | PGD | 27 | PGED1/AN7/RB7 | — |
| 35 | DC_REF | 35 | AN11/RB11 | Not used, set pin as input |
| 41 | POT | 41 | AN12/RB12 | Not used, set pin as input |
| 49 | USB_RX | 49 | U2RX/CN17/RF4 | — |
| 50 | USB_TX | 50 | U2TX/CN18/RF5 | — |
| 51 | USB_TX | 51 | U1TX/RF3 | — |
| 52 | USB_RX | 52 | U1RX/RF2 | — |
| 54 | USB_VBUS | — | SDI1/RF7 | Not used, set pin as input |
| 55 | USB_3.3V | — | SCK1/INT0/RF6 | Not used, set pin as input |
| 56 | USB_D- | — | SDA1/RG3 | Not used, set pin as input |
| 57 | USB_D+ | — | SCL1/RG2 | Not used, set pin as input |
| 63 | OSCI | 63 | OSC1/CLKIN/RC12 | — |
| 64 | OSCO | 64 | OSC2/CLKO/RC15 | — |
| 68 | FAULT_1 | 68 | IC1/RD8 | Not used, set pin as input |
| 70 | BTN_1 | 70 | IC3/RD10 | — |
| 76 | USB_TX | 76 | OC2/RD1 | Not used, set pin as input |
| 77 | PWM2H1 | 77 | OC3/RD2 | Not used, set pin as input |
| 78 | PWM2L1 | 78 | OC4/RD3 | Not used, set pin as input |
| 83 | USB_TX | — | OC7/CN15/RD6 | Not used, set pin as input |
| 84 | USB_RX | — | OC8/UPDN//CN16/RD7 | Not used, set pin as input |
| 93 | PWM1L1 | 93 | PWM1L/RE0 | — |
| 94 | PWM1H1 | 94 | PWM1H/RE1 | — |
| 98 | PWM1L2 | 98 | PWM2L/RE2 | — |
| 99 | PWM1H2 | 99 | PWM2H/RE3 | — |
| 100 | PWM1L3 | 100 | PWM3L/RE4 | — |

**Note 1:** When using a dsPIC33FJ256MC710 it is necessary to set PIM pin 19 as FAULT_1. PIM Pin 19 can be configured for FAULT_1 or PWM2L1 signals by soldering the appropriate resistor as follows:

- For FAULT_1 : Remove R87 and Solder R86
- For PWM2L1 : Remove R86 and Solder R87 (Default)

**TABLE 3-2: dsPIC33FJ12MC202 CONFIGURATION DETAILS[1,2]**

| PIM Pin Number | Labels on the MCSM Board | dsPIC33FJ12MC202 | | PIM Resistor Configuration |
| --- | --- | --- | --- | --- |
| | | Pin Number | Pin Name | |
| 3 | PWM1H3 | 18 | TDI/PWM1H3/RP10/CN16/RB10 | Solder R12 |
| 4 | PWM2L1 | — | — | — |
| 5 | PWM2H1 | — | — | — |
| 13 | MCLR | 26 | MCLR | — |
| 18 | PWM2H1 | 14 | TCK/PWM2H1/SCL1/RP8/CN22/RB8 | Solder R11 |
| 19 | PWML1 | 15 | TDO/PWM2L1/SDA1/RP9/CN21/RB9 | Solder R14, solder R13 |
| 20 | POT | 2 | PGC1/EMUC1/AN3/RP1/CN5/RB1 | Solder R31, remove R21 |
| 22 | POT | — | — | Remove R9 |
| 23 | DC_REF | — | — | — |
| 24 | IMOTOR2 | 28 | PGC2/EMUC2/AN1/VREF-/CN3/RA1 | Solder R25, remove R26 |
| 25 | IMOTOR1 | 27 | PGD2/EMUD2/AN0/VREF+/CN2/RA0 | Solder R24, remove R27 |
| 26 | PGC | 9 | PGC3/EMUC3/SOSCO/T1CK/CN0/RA4 | — |
| 27 | PGD | 8 | PGD3/EMUD3/SOSCI/RP4/CN1/RB4 | — |
| 35 | DC_REF | 1 | PGD1/EMUD1/AN2/RP0/CN4/RB0 | Solder R20, remove R28 |
| 41 | POT | — | — | — |
| 49 | USB_RX | — | — | — |
| 50 | USB_TX | — | — | — |
| 51 | USB_TX | — | — | — |
| 52 | USB_RX | — | — | — |
| 54 | USB_VBUS | — | — | — |
| 55 | USB_3.3V | — | — | — |
| 56 | USB_D- | — | — | — |
| 57 | USB_D+ | — | — | — |
| 63 | OSCI | 6 | OSCI/CLKI/CN30/RA2 | — |
| 64 | OSCO | 7 | OSCO/CLKO/CN29/RA3 | — |
| 68 | FAULT_1 | 11 | ASDA1/RP5/CN27/RB5 | Solder R6, remove R5, R33 |
| 70 | BTN_1 | 13 | INT0/RP7/CN23/RB7 | Solder R10, remove R9 |
| 76 | USB_TX | — | — | — |
| 77 | PWM2H1 | — | — | — |
| 78 | PWM2L1 | — | — | — |
| 83 | USB_TX | 3 | AN4/RP2/CN6/RB2 | Solder R30, remove R22 |
| 84 | USB_RX | 4 | AN5/RP3/CN7/RB3 | Solder R29, remove R23 |
| 93 | PWM1L1 | 23 | PWM1L1/RP15/CN11/RB15 | Solder R19 |
| 94 | PWM1H1 | 22 | PWM1H1/ RP14/CN12/RB14 | Solder R18 |
| 98 | PWM1L2 | 21 | PWM1L2/RP13/CN13/RB13 | Solder R17 |
| 99 | PWM1H2 | 20 | PWM1H2/RP12/CN14/RB12 | Solder R16 |
| 100 | PWM1L3 | 19 | TMS/PWM1L3/RP11/CN15/RB11 | Solder R15 |

**Note 1:** No hardware changes are needed if the standard dsPICDEM MCSM Development Board is used with a standard dsPIC33FJ12MC202 PIM.

**2:** PIM Pin 19 can be configured for FAULT_1 or PWM2L1 signals by soldering the appropriate resistor as follows:

- For FAULT_1 : Remove R87 and Solder R86
- For PWM2L1 : Remove R86 and Solder R87 (Default)

**TABLE 3-3:** **dsPIC33FJ32MC204 AND dsPIC33FJ128MC804 CONFIGURATION DETAILS**

| PIM Pin Number | Labels on the MCSM Board | dsPIC33FJ32MC204 dsPIC33FJ128MC804 | | PIM Resistor Configuration |
| --- | --- | --- | --- | --- |
| | | Pin Number | Pin Name | |
| 3 | PWM1H3 | 8 | PGED2/EMUD2/PWM1H3/RP10/CN16/RB10 | Solder R6 |
| 4 | PWM2L1 | — | — | — |
| 5 | PWM2H1 | — | — | — |
| 13 | MCLR | 18 | $\overline{MCLR}$ | — |
| 18 | PWM2H1 | 44 | SCL1/RP8/CN22/RB8 | Not used, set pin as input |
| 19 | PWM2L1 | 1 | SDA1/RP9/CN21/RB9 | Not used, set pin as input |
| 20 | POT | 26 | AN7/RP17/CN9/RC1 | Not used, set pin as input |
| 22 | POT | — | — | — |
| 23 | DC_REF | — | — | — |
| 24 | IMOTOR2 | 20 | AN1/V$_{REF}$-/CN3/RA1 | Solder R13 |
| 25 | IMOTOR1 | 19 | AN0/V$_{REF}$+/CN2/RA0 | Solder R12 |
| 26 | PGC | 42 | PGEC3/EMUC3/ASCL1/RP6/CN24/RB6 | — |
| 27 | PGD | 41 | PGED3/EMUD3/ASDA1/RP5/CN27/RB5 | — |
| 35 | DC_REF | 21 | PGED1/EMUD1/AN2/C2IN-/RP0/CN4/RB0 | Solder R14 |
| 41 | POT | 22 | PGEC1/EMUC1/AN3/C2IN+/RP1/CN5/RB1 | Solder R22 |
| 49 | USB_RX | — | — | — |
| 50 | USB_TX | — | — | — |
| 51 | USB_TX | — | — | — |
| 52 | USB_RX | — | — | — |
| 54 | USB_VBUS | — | — | — |
| 55 | USB_3.3V | — | — | — |
| 56 | USB_D- | — | — | — |
| 57 | USB_D+ | — | — | — |
| 63 | OSCI | 30 | OSCI/CLKI/CN30/RA2 | — |
| 64 | OSCO | 31 | OSCO/CLKO/CN29/RA3 | — |
| 68 | FAULT_1 | 4 | RP24/CN20/RC8 | Solder R2, remove R18 |
| 70 | BTN_1 | 43 | INT0/RP7/CN23/RB7 | Solder R3, remove R26 |
| 76 | USB_TX | 38 | RP21/CN26/RC5 | Solder R30 |
| 77 | PWM2H1 | 2 | PWM2H1/RP22/CN18/RC6 | Solder R32 |
| 78 | PWM2L1 | 3 | PWM2L1/RP23/CN17/RC7 | Solder R31 |
| 83 | USB_TX | 32 | TDO/RA8 | Not used, set pin as input |
| 84 | USB_RX | 33 | SOSCI/RP4/CN1/RB4 | Solder R20 |
| 93 | PWM1L1 | 15 | PWM1L1/RP15/CN11/RB15 | Solder R11 |
| 94 | PWM1H1 | 14 | PWM1H1/RP14/CN12/RB14 | Solder R10 |
| 98 | PWM1L2 | 11 | PWM1L2/RP13/CN13/RB13 | Solder R9 |
| 99 | PWM1H2 | 10 | PWM1H2/RP12/CN14/RB12 | Solder R7 |
| 100 | PWM1L3 | 9 | PGEC2/EMUC2/PWM1L3/RP11/CN15/RB11 | Solder R8 |

**Note 1:** No hardware changes are needed if the standard dsPICDEM MCSM Development Board is used with a standard dsPIC33FJ12MC204 or dsPIC33FJ128MC804 PIM.

**2:** PIM Pin 19 can be configured for FAULT_1 or PWM2L1 signals by soldering the appropriate resistor as follows:
- For FAULT_1 : Remove R87 and Solder R86
- For PWM2L1 : Remove R86 and Solder R87 (Default)

## 3.3    BOARD CONNECTORS

Figure 3-3 shows the various user interface components available on the dsPICDEM MCSM Development Board. Table 3-4 describes the hardware connection between the PICkit™ 3, MPLAB® ICD 3 or MPLAB REAL ICE™ In-Circuit Emulator, the power supply, and the dsPICDEM MCSM Development Board connectors.

**FIGURE 3-3:**    **dsPICDEM MCSM DEVELOPMENT BOARD USER INTERFACE COMPONENTS**
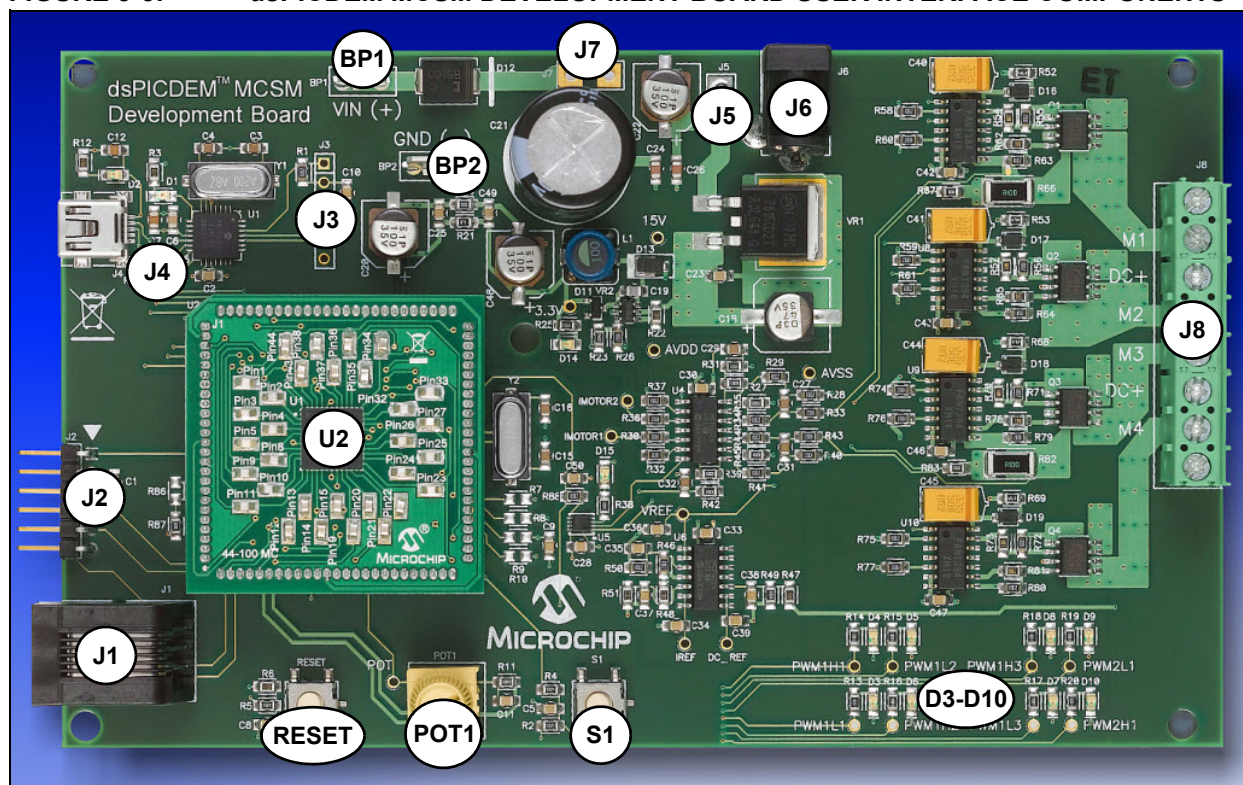


**TABLE 3-4:**    **dsPICDEM MCSM DEVELOPMENT BOARD USER INTERFACE COMPONENTS**

| Designator | Description |
|---|---|
| BP1-BP2 | Auxiliary power supply connector |
| D3-D10 | PWM LEDs |
| S1 | Push button switch 1 |
| RESET | Device Reset switch |
| POT1 | Potentiometer |
| U2 | Plug-in Module (PIM) adaptor |
| J1 | RJ11, 6-pin connector for programming a dsPIC® DSC device |
| J2 | ICSP connector for programming a dsPIC DSC device |
| J3 | ICSP™ programmer interface connector for programming the PIC18LF2450 USB-to-UART bridge |
| J4 | USB interface port |
| J5 | 24V power supply select jumper |
| J6 | 24V Input power supply connector |
| J7 | Auxiliary power supply select jumper |
| J8 | Motor power connector |

### 3.3.1    Input Power Connector (J6, BP1-BP2)

The dsPICDEM MCSM Development Board receives the power for control circuits from a +24V power supply. The 24V supply is always needed as it supplies 15V and 3.3V necessary for the dsPIC DSC and for the interface between the dsPIC DSC and the power stage. The power stage DC bus voltage can be connected to the development board through the J6 or BP1-BP2 connectors.

### 3.3.2    DC Bus Power Supply Connector (J5 and J7)

By default, jumper J5 is short and jumper J7 is open, and the +24V input power supply connected to J6 supplies both the control circuits and the DC bus voltage to the development board. If jumper J7 is short and jumper J5 is open, the BP1-BP2 connectors supply the DC bus voltage to the development board power stage and J6 supplies the control circuits.

The 0-80V ADC power supply can be connected between BP1-BP2.

### 3.3.3    USB Interface (J4)

The development board uses an on-board PIC18 interface as a bridge between the UART and the USB. The PIC18 UART pins are connected to the dsPIC33F devices on different ports depending on the specific dsPIC33F device used. For the specific devices that do not have remappable peripherals, additional UART RX/TX are available on the device designated port for UART communication.

For dsPIC DSC devices that have an embedded USB port, populate R7, R8, R9 and R10 with 0Ω resistors, and disable the PIC18 USB communication by removing R84 and R85.

### 3.3.4    ICSP Connector for dsPIC DSC (J1/J2)

The MPLAB ICD 3 and MPLAB REAL ICE Connector is an RJ11 female connector (J1) that connects the MPLAB ICD 3 or MPLAB REAL ICE In-Circuit Debugger to the dsPIC33F device for programming and debugging purposes. The PICkit 3 In-Circuit Debugger/Programmer can be connected to the board using a 6-pin ICSP connector (J2).

### 3.3.5    ICSP for PIC18 (J3)

J3 is a 6-pin connector that connects the PICkit 3 In-Circuit Debugger/Programmer to the PIC18F device. The development board uses the on-board PIC18 interface as a bridge between the UART and USB. The PIC18F can be programmed for USB communication.

### 3.3.6    Motor Connector (J8)

The motor connector has eight terminals. Table 3-5 lists the functionality of each terminal.

**TABLE 3-5:    MOTOR CONNECTOR DETAILS**

| Terminal Number | Designator | Description |
|---|---|---|
| 1 | NC | Not connected |
| 2 | M1 | Motor wire 1 (phase 1) |
| 3 | DC+ | DC bus voltage |
| 4 | M2 | Motor wire 2 (phase 1) |
| 5 | M3 | Motor wire 3 (phase 2) |
| 6 | DC+ | DC bus voltage |
| 7 | M4 | Motor wire 4 (phase 2) |
| 8 | NC | Not connected |