



**dsPICDEM<sup>TM</sup> MCLV  
DEVELOPMENT BOARD  
USER'S GUIDE**

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# dsPICDEM™ MCLV Development Board User's Guide

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## Preface

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### 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 “DSXXXXA”, where “XXXX” is the document number and “A” is the revision level of the document.

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

## INTRODUCTION

This chapter contains general information that will be useful to know before using the dsPICDEM™ MCLV Development 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 user's guide describes how to use the dsPICDEM MCLV Development Board. The document is organized as follows:

- **Chapter 1. “Introduction”** – This chapter introduces the dsPICDEM MCLV Development Board and provides an overview of various features.
- **Chapter 2. “Hardware Overview”** – This chapter describes the hardware components of the dsPICDEM MCLV Development Board.
- **Chapter 3. “Running a BLDC Motor Using Hall Sensors”** – This chapter describes how to run a sensored BLDC motor using a dsPIC® DSC device.
- **Appendix A. “Schematics and Layouts”** – This appendix provides detailed circuit schematics of the dsPICDEM MCLV Development Board.
- **Appendix B. “Electrical Specifications”** – This appendix lists the DC input and output ratings for the dsPICDEM MCLV Development Board.

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## 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><br>[options]                    |
| Curly brackets and pipe character: {   }         | Choice of mutually exclusive arguments; an OR selection  | errorlevel {0 1}  |
| Ellipses...                                      | Replaces repeated text   | var_name [,<br>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 dsPICDEM MCLV 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.

### **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.

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## **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.



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- **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

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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 C17, 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 and MPLAB SIM30 simulators, MPLAB IDE Project Manager and general editing and debugging features.
- **Programmers** – The latest information on Microchip programmers. These include the MPLAB PM3 and PRO MATE® II device programmers and the PICSTART® Plus and PICKit™ 1 development programmers.

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## CUSTOMER SUPPORT

Users of Microchip products can receive assistance through several channels:

- Distributor or Representative
- Local Sales Office
- Field Application Engineer (FAE)
- Technical Support

Customers should contact their distributor, representative or Field Application Engineer (FAE) for support. Local sales offices are also available to help customers. A listing of sales offices and locations is included in the back of this document.

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

## DOCUMENT REVISION HISTORY

### **Revision A (July 2008)**

Initial release of this document.

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## Chapter 1. Introduction

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The dsPICDEM MCLV Development Board is targeted to control a Brushless DC (BLDC) motor or Permanent Magnet Synchronous Motor (PMSM) in sensor or sensorless operation. This flexible and cost-effective board can be configured in different ways for use with Microchip's specialized motor control digital signal controllers. The dsPICDEM MCLV Development Board supports the dsPIC33F motor control device family. It 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 a three-phase inverter bridge circuit. The circuit drives a BLDC or PMSM motor using different control techniques without requiring any additional hardware. Topics covered include:

- Overview of the dsPICDEM MCLV Development Board
- Features Overview

### 1.1 OVERVIEW OF THE dsPICDEM MCLV DEVELOPMENT BOARD

Figure 1-1 shows a simplified block diagram of the dsPICDEM MCLV Development Board. A dsPIC33F device uses the gate driver to drive the three-phase inverter that powers the motor windings. The board includes various circuitry to perform the following functions:

- Measure the feedback signals (e.g., voltage, current, Hall sensors and Fault signals)
- Communicate with a host computer or an external device via CAN, LIN, USB or RS-232 interface
- Drive a three-phase inverter

It also provides the option to interface Hall sensors or a Quadrature Encoder for sensed commutation.

The dsPICDEM MCLV Development Board supports motors with terminal voltage up to 48V and current up to 15A. Refer to **Appendix B. "Electrical Specifications"** for more information on electrical specifications.

### 1.2 FEATURES OVERVIEW

The key features of this board include the following:

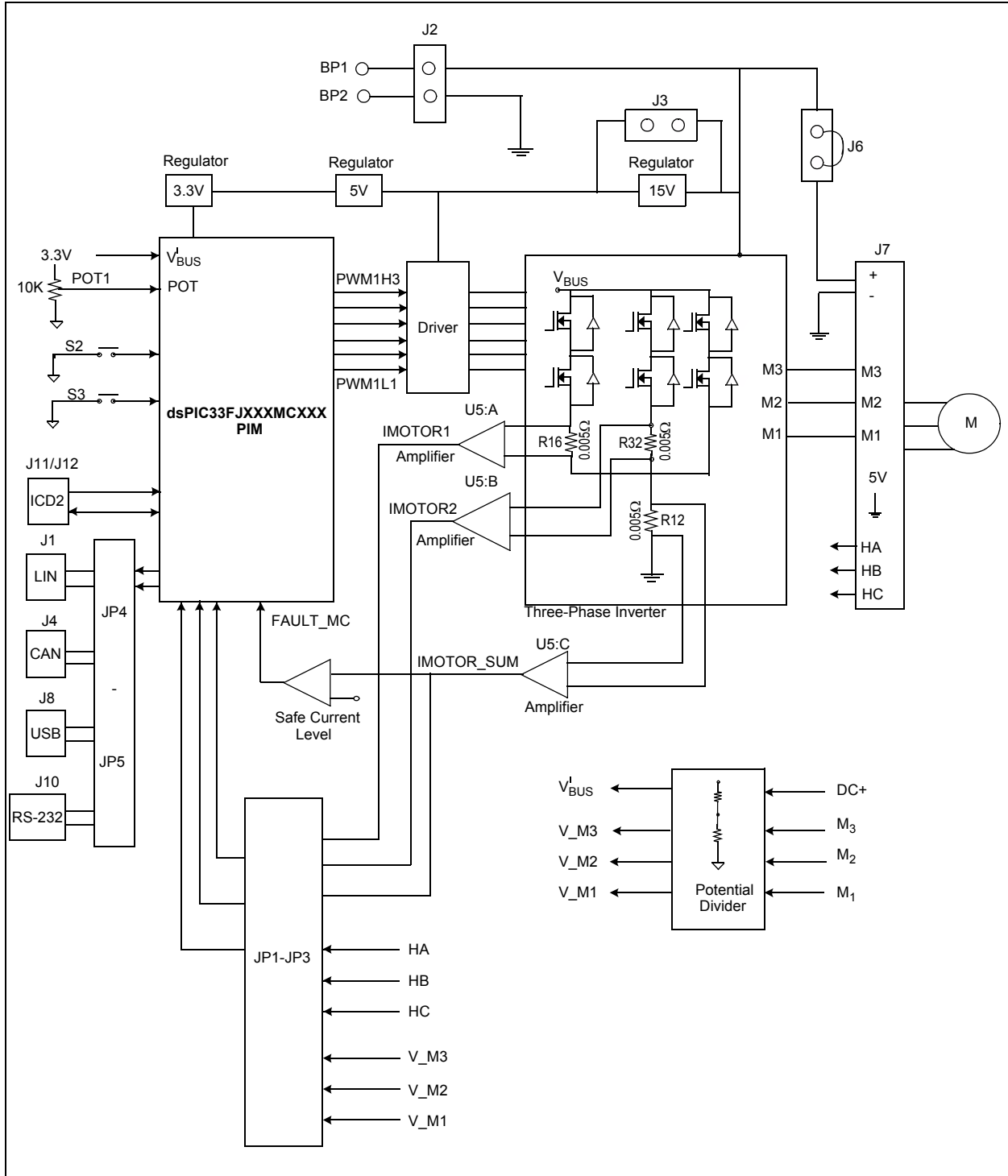
- Devices Supported:
  - 28-pin to 100-pin dsPIC33FJXXXMC202 PIM (MA330014) with a dsPIC33F Motor control device (U9) socket
  - 44-pin to 100-pin dsPIC33FJXXXMCX04 PIM (MA330017 and MA330018) with a dsPIC33F Motor Control device (U9) socket
  - 100-pin to 100-pin dsPIC33FJXXXMCX10 PIM (MA330013) with a dsPIC33F Motor control device (U9) socket
  - The dsPIC33FJ12MC202 Motor Control device in SOIC package (U2) footprint

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- Motor Control Interfaces:
  - Three-phase inverter bridge with a power rating of 48V/15A (J7)
  - Hall sensors/Quadrature encoder interface for sensed motor control (J7)
  - Phase voltage feedback for sensorless BLDC operation
  - DC bus current sense resistor for single shunt vector control
  - Phase current sense resistor for dual shunt vector control
  - Overcurrent protection
- Input/Output Control Switches:
  - Two push buttons (S2 and S3)
  - Reset push button (S1)
  - 10 k $\Omega$  potentiometer (POT1)
  - LED indicator for PWM outputs
- Communication Ports:
  - CAN interface port (J4)
  - LIN interface port (J1)
  - UART communication via USB (J8)
  - UART communication via RS-232 (J10)
- Power Supply Connectors:
  - Auxiliary Power Tab Fast-On connectors (BP1 and BP2) for the controller and power stage
  - 24V power input connector (J2) for the controller
  - Dedicated power input connector (J7) for the power stage
- Programming Connectors:
  - ICSP™ connector for programming a dsPIC DSC device (J12)
  - RJ11 connector for programming a dsPIC DSC device (J11)
  - ICSP connector for programming the PIC18LF2450 USB to UART Bridge (J9)

**FIGURE 1-1: dsPICDEM™ MCLV DEVELOPMENT BOARD BLOCK DIAGRAM**



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## Chapter 2. Hardware Overview

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This chapter describes the hardware components of the dsPICDEM MCLV Development Board. Topics covered include:

- PIM Configuration
- Board Connectors
- User Interface Hardware

A +24V power supply connected to the Power Connector terminal (J2) or Auxiliary Power Tab Fast-On Connector terminals (BP1-BP2) supplies power to the control circuits and DC bus of the board. It is recommended that you use a 24V power supply listed as an accessory (Part Number AC002013) on the Microchip web site ([www.microchip.com](http://www.microchip.com)).

The various components on the board receive the power as follows:

- The Gate drivers receive +15V power from a 15V regulator.
- The CAN driver receives +5V power from a 5V regulator.
- The LIN driver receives VBAT power from the LIN connector J1.
- A dsPIC33F motor control device receives +3.3V power from a +3.3V regulator.
- The RS-232 UART interface receives +3.3V power from a +3.3V regulator.
- The PIC18LF2450 USB to UART Bridge receives +3.3V power from a +3.3V regulator.

**Note 1:** If the input voltage value is less than 16V, remove the 15V voltage regulator and short jumper J3.

- 2:** To use a higher DC voltage bus (24V-48V), complete the following steps:
- a) Connect the power supply to jumper J7, and keep jumper J6 open.
  - b) Power the circuit components, MCU, and the gate drivers using a separate 16V-24V power supply connected to the power connector J2 or BP1-BP2.

### 2.1 PIM CONFIGURATION

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

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

**Note:** When using PIMs, make sure that the 28-pin SOIC dsPIC DSC is removed from the dsPICDEM MCLV Development Board.

The tables that follow describe the PIM configuration details.

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**TABLE 2-1: dsPIC33FJ256MC710 PIM CONFIGURATION DETAILS**

| PIM Pin Number | Labels on the dsPICDEM™ MCLV Development Board | dsPIC33FJ256MC710 |                         | PIM Resistor Configuration |
|----------------|--|-------------------|-------------------------|----------------------------|
|                |  | Pin Number        | Pin Name                |                            |
| 3              | PWM1H3   | 3                 | PWM3H/RE5               | Not applicable             |
| 13             | MCLR   | 13                | MCLR                    | Not applicable             |
| 18             | FAULT_MC                                       | 18                | AN20/FLTA/INC1/RE8      | Not applicable             |
| 19             | TX   | 19                | AN21/FLTB/INT2/RE9      | Not applicable             |
| 20             | V_M3   | 20                | AN5/QEB/CN7/RB5         | Not applicable             |
| 21             | V_M2   | 21                | AN4/QEA/CN6/RB4         | Not applicable             |
| 22             | V_M1   | 22                | AN3/INDX/CN5/RB3        | Not applicable             |
| 23             | IMOTOR_SUM                                     | 23                | AN2/SS1/CN4/RB2         | Not applicable             |
| 24             | IMOTOR2  | 24                | PGC3/EMUC3/AN1/CN3/RB1  | Not applicable             |
| 25             | IMOTOR1  | 25                | PGD3/EMUD3/AN0/CN2/RB0  | Not applicable             |
| 26             | PGC  | 26                | PGC1/EMUC1/AN6/OCFA/RB6 | Not applicable             |
| 27             | PGD  | 27                | PGD1/EMUD1/AN7/RB7      | Not applicable             |
| 32             | POT  | 32                | AN8/RB8                 | Not applicable             |
| 35             | VBUS   | 35                | AN11/R11                | Not applicable             |
| 41             | MONITOR_1                                      | 41                | AN12/RB12               | Not applicable             |
| 42             | MONITOR_2                                      | 42                | AN13/RB13               | Not applicable             |
| 43             | MONITOR_3                                      | 43                | AN14/RB14               | Not applicable             |
| 47             | HB   | 47                | IC7/U1CTS/CN20/RD14     | Not applicable             |
| 48             | HC   | 48                | IC8/U1RTS/CN21/RD15     | Not applicable             |
| 49             | RX   | 49                | U2RX/CN17/RF4           | Not applicable             |
| 50             | TX   | 50                | U2TX/CN18/RF5           | Not applicable             |
| 51             | USB_TX   | 51                | U1TX/RF3                | Not applicable             |
| 52             | USB_RX   | 52                | U1RX/RF2                | Not applicable             |
| 63             | OSI  | 63                | OSC1/CLKIN/RC12         | Not applicable             |
| 64             | OSO  | 64                | OSC2/CLKO/RC15          | Not applicable             |
| 68             | LIN_CS   | 68                | IC1/RD8                 | Not applicable             |
| 69             | LIN_FAULT                                      | 69                | IC2/RD9                 | Not applicable             |
| 70             | RX   | 70                | IC3/RD10                | Not applicable             |
| 72             | USB_RX   | 72                | OC1/RD0                 | Not applicable             |
| 76             | USB_TX   | 76                | OC2/RD1                 | Not applicable             |
| 77             | CAN_TX   | 77                | OC3/RD2                 | Not applicable             |
| 78             | CAN_RX   | 78                | OC4/RD3                 | Not applicable             |
| 80             | HALLA  | 80                | IC6/CN19/RD13           | Not applicable             |
| 83             | BTN_1  | 83                | OC7/CN15/RD6            | Not applicable             |
| 84             | BTN_2  | 84                | OC8/UPDN/CN16/RD7       | Not applicable             |
| 87             | CAN_RX   | 87                | C1RX/RF0                | Not applicable             |
| 88             | CAN_TX   | 88                | C1TX/RF1                | Not applicable             |
| 93             | PWM1L1   | 93                | PWM1L/RE0               | Not applicable             |
| 94             | PWM1H1   | 94                | PWM1H/RE1               | Not applicable             |
| 98             | PWM1L2   | 98                | PWM2L/RE2               | Not applicable             |
| 99             | PWM1H2   | 99                | PWM2H/RE3               | Not applicable             |
| 100            | PWM1L3   | 100               | PWM3L/RE4               | Not applicable             |



**TABLE 2-2: dsPIC33FJ12MC202 PIM CONFIGURATION DETAILS**

| PIM Pin Number | Label on the dsPICDEM™ MCLV Development Board | dsPIC33FJ12MC202 |   | PIM Resistor Configuration   |
|----------------|---|------------------|---|------------------------------|
|                |   | Pin Number       | Pin Name  |                              |
| 3              | PWM1H3  | 18               | TDI/PWM1H3/RP10/CN16/RB10   | Solder R12                   |
| 13             | MCLR  | 26               | MCLR  | Not applicable               |
| 18             | FAULT_MC                                      | 14               | TCK/PWM2H1/SCL1/RP8/CN22/RB8                                      | Solder R11                   |
| 19             | TX  | 15               | TDO/PWM2L1/SDA1/RP9/CN21/RB9                                      | Solder R13 and remove R14    |
| 20             | V_M3  | —                | Restricted Use (see <b>Appendix A. “Schematics and Layouts”</b> ) | Not applicable               |
| 21             | V_M2  | —                | Restricted Use (see <b>Appendix A. “Schematics and Layouts”</b> ) | Not applicable               |
| 22             | V_M1  | —                | Restricted Use (see <b>Appendix A. “Schematics and Layouts”</b> ) | Not applicable               |
| 23             | IMOTOR_SUM                                    | —                | Not connected   | Not applicable               |
| 24             | IMOTOR2                                       | —                | Restricted Use (see <b>Appendix A. “Schematics and Layouts”</b> ) | Not applicable               |
| 25             | IMOTOR1                                       | 27               | PGD2/EMUD2/AN0/VREF+/CN2/RA0                                      | Solder R24 and remove R27    |
| 26             | PGC   | 9                | PGC3/EMUC3/SOSCO/T1CK/CN0/RA4                                     | Not applicable               |
| 27             | PGD   | 8                | PGD3/EMUD3/SOSCI/RP4/CN1/RB4                                      | Not applicable               |
| 32             | POT   | 28               | PGC2/EMUC2/AN1/VREF-/CN3/RA1                                      | Solder R26 and remove R25    |
| 35             | VBUS  | 1                | PGD1/EMUD1/AN2/RP0/CN4/RB0  | Solder R20 and remove R28    |
| 41             | MONITOR_1                                     | 2                | PGC1/EMUC1/AN3/RP1/CN5/RB1  | Solder R21 and remove R31    |
| 42             | MONITOR_2                                     | 3                | AN4/RP2/CN6/RB2   | Solder R22 and remove R30    |
| 43             | MONITOR_3                                     | 4                | AN5/RP3/CN7/RB3   | Solder R23 and remove R29    |
| 47             | HB  | —                | Not connected   | Not applicable               |
| 48             | HC  | —                | Not connected   | Not applicable               |
| 49             | RX  | —                | Not connected   | Not applicable               |
| 50             | TX  | —                | Not connected   | Not applicable               |
| 51             | USB_TX  | —                | Not connected   | Not applicable               |
| 52             | USB_RX  | —                | Not connected   | Not applicable               |
| 63             | OSI   | 6                | OSCI/CLKI/CN30/RA2  | Not applicable               |
| 64             | OSO   | 7                | OSCO/CLKO/CN29/RA3  | Not applicable               |
| 68             | LIN_CS <sup>(1)</sup>                         | 11               | ASDA1/RP5/CN27/RB5  | Solder R6 and remove R5, R33 |
| 69             | LIN_FAULT <sup>(2)</sup>                      | 12               | ASCL1/RP6/CN24/RB6  | Solder R8 and remove R7, R32 |
| 70             | RX  | 13               | INT0/RP7/CN23/RB7   | Solder R10 and remove R9     |
| 72             | USB_RX  | —                | Not connected   | Not applicable               |
| 76             | USB_TX  | —                | Not connected   | Not applicable               |
| 77             | CAN_TX  | —                | Not connected   | Not applicable               |
| 78             | CAN_RX  | —                | Not connected   | Not applicable               |
| 80             | HALLA   | —                | Not connected   | Not applicable               |
| 83             | BTN_1   | 11               | ASDA1/RP5/CN27/RB5  | Solder R33 and remove R5, R6 |
| 84             | BTN_2   | 12               | ASCL1/RP6/CN24/RB6  | Solder R32 and remove R7, R8 |
| 87             | CAN_RX  | —                | Not connected   | Not applicable               |
| 88             | CAN_TX  | —                | Not connected   | Not applicable               |
| 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: If LIN\_CS signal is used, BTN\_1 signal can not be used.  
 2: If LIN\_FAULT signal is used, BTN\_2 signal can not be used.

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**TABLE 2-3: dsPIC33FJ32MC204 PIM CONFIGURATION DETAILS**

| PIM Pin Number | Label on the dsPICDEM™ MCLV Development Board | dsPIC33FJ32MC204 |   | PIM Resistor Configuration |
|----------------|---|------------------|---|----------------------------|
|                |   | Pin Number       | Pin Name  |                            |
| 3              | PWM1H3  | 8                | PGD2/EMUD2/PWM1H3/RP10/CN16/RB10                                  | Solder R6                  |
| 13             | MCLR  | 18               | MCLR  | Not applicable             |
| 18             | FAULT_MC                                      | 44               | SCL1/RP8/CN22/RB8   | Solder R4                  |
| 19             | TX  | 1                | SDA1/RP9/CN21/RB9   | Solder R1                  |
| 20             | V_M3  | —                | Restricted use (see <b>Appendix A. "Schematics and Layouts"</b> ) | Not applicable             |
| 21             | V_M2  | —                | Restricted use (see <b>Appendix A. "Schematics and Layouts"</b> ) | Not applicable             |
| 22             | V_M1  | —                | Restricted use (see <b>Appendix A. "Schematics and Layouts"</b> ) | Not applicable             |
| 23             | IMOTOR_SUM                                    | —                | Not connected   | Not applicable             |
| 24             | IMOTOR2                                       | 20               | AN1/VREF-/CN3/RA1   | Solder R13                 |
| 25             | IMOTOR1                                       | 19               | AN0/VREF+/CN2/RA0   | Solder R12                 |
| 26             | PGC   | 42               | PGC3/EMUC3/ASCL1/RP6/CN24/RB6                                     | Not applicable             |
| 27             | PGD   | 41               | PGD3/EMUD3/ASDA1/RP5/CN27/RB5                                     | Not applicable             |
| 32             | POT   | 27               | AN8/RP18/CN10/RC2   | Solder R16                 |
| 35             | VBUS  | 21               | PGD1/EMUD1/AN2/C2IN-/RP0/CN4/RB0                                  | Solder R14                 |
| 41             | MONITOR_1                                     | 22               | PGC1/EMUC1/AN3/C2IN+/RP1/CN5/RB1                                  | Solder R22                 |
| 42             | MONITOR_2                                     | 23               | AN4/RP2/CN6/RB2   | Solder R25                 |
| 43             | MONITOR_3                                     | 24               | AN5/RP3/CN7/RB3   | Solder R21                 |
| 47             | HALLB   | —                | Not connected   | Not applicable             |
| 48             | HALLC   | —                | Not connected   | Not applicable             |
| 49             | RX  | —                | Not connected   | Not applicable             |
| 50             | TX  | —                | Not connected   | Not applicable             |
| 51             | USB_TX  | —                | Not connected   | Not applicable             |
| 52             | USB_RX  | —                | Not connected   | Not applicable             |
| 63             | OSI   | 30               | OSCI/CLKI/CN30/RA2  | Not applicable             |
| 64             | OSO   | 31               | OSCO/CLKO/CN29/RA3  | Not applicable             |
| 68             | LIN_CS  | 4                | RP24/CN20/RC8   | Solder R2 and remove R18   |
| 69             | LIN_FAULT                                     | 5                | RP25/CN19/RC9   | Solder R5 and remove R27   |
| 70             | RX  | 43               | INT0/RP7/CN23/RB7   | Solder R3 and remove R26   |
| 72             | USB_RX  | 37               | RP20/CN25/RC4   | Solder R29                 |
| 76             | USB_TX  | 38               | RP21/CN26/RC5   | Solder R30                 |
| 77             | CAN_TX  | 2                | PWM2H1/RP22/CN18/RC6  | Solder R32                 |
| 78             | CAN_RX  | 3                | PWM2L1/RP23/CN17/RC7  | Solder R31                 |
| 80             | HALLA   | —                | Not connected   | Not applicable             |
| 83             | BTN_1   | 32               | TDO/RA8   | Solder R19                 |
| 84             | BTN_2   | 33               | SOSCI/RP4/CN1/RB4   | Solder R20                 |
| 87             | CAN_RX  | —                | Not connected   | Not applicable             |
| 88             | CAN_TX  | —                | Not connected   | Not applicable             |
| 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                | PGC2/EMUC2/PWM1L3/RP11/CN15/RB11                                  | Solder R8                  |

**TABLE 2-4: dsPIC33FJ128MC804 PIM CONFIGURATION DETAILS**

| Pin Number | Label on the dsPICDEM™ MCLV Development Board | dsPIC33FJ128MC804 |   | PIM Resistor Configuration |
|------------|---|-------------------|---|----------------------------|
|            |   | Pin Number        | Pin Name  |                            |
| 3          | PWM1H3  | 8                 | PGD2/EMUD2/PWM1H3/RP10/CN16/RB10                                  | Solder R6                  |
| 13         | MCLR  | 18                | MCLR  | Not applicable             |
| 18         | FAULT_MC                                      | 44                | SCL1/RP8/CN22/RB8   | Solder R4                  |
| 19         | TX  | 1                 | SDA1/RP9/CN21/RB9   | Solder R1                  |
| 20         | V_M3  | —                 | Restricted use (see <b>Appendix A. "Schematics and Layouts"</b> ) | Not applicable             |
| 21         | V_M2  | —                 | Restricted use (see <b>Appendix A. "Schematics and Layouts"</b> ) | Not applicable             |
| 22         | V_M1  | —                 | Restricted use (see <b>Appendix A. "Schematics and Layouts"</b> ) | Not applicable             |
| 23         | IMOTOR_SUM                                    | —                 | Not Connected   | Not applicable             |
| 24         | IMOTOR2                                       | 20                | AN1/VREF-/CN3/RA1   | Solder R13                 |
| 25         | IMOTOR1                                       | 19                | AN0/VREF+/CN2/RA0   | Solder R12                 |
| 26         | PGC   | 42                | PGC3/EMUC3/ASCL1/RP6/CN24/RB6                                     | Not applicable             |
| 27         | PGD   | 41                | PGD3/EMUD3/ASDA1/RP5/CN27/RB5                                     | Not applicable             |
| 32         | POT   | 27                | AN8/RP18/CN10/RC2   | Solder R16                 |
| 35         | VBUS  | 21                | PGD1/EMUD1/AN2/C2IN-/RP0/CN4/RB0                                  | Solder R14                 |
| 41         | MONITOR_1                                     | 22                | PGC1/EMUC1/AN3/C2IN+/RP1/CN5/RB1                                  | Solder R22                 |
| 42         | MONITOR_2                                     | 23                | AN4/RP2/CN6/RB2   | Solder R25                 |
| 43         | MONITOR_3                                     | 24                | AN5/RP3/CN7/RB3   | Solder R21                 |
| 47         | HALLB   | —                 | Not connected   | Not applicable             |
| 48         | HALLC   | —                 | Not connected   | Not applicable             |
| 49         | RX  | —                 | Not connected   | Not applicable             |
| 50         | TX  | —                 | Not connected   | Not applicable             |
| 51         | USB_TX  | —                 | Not connected   | Not applicable             |
| 52         | USB_RX  | —                 | Not connected   | Not applicable             |
| 63         | OSI   | 30                | OSCI/CLKI/CN30/RA2  | Not applicable             |
| 64         | OSO   | 31                | OSCO/CLKO/CN29/RA3  | Not applicable             |
| 68         | LIN_CS  | 4                 | RP24/CN20/RC8   | Solder R2 and remove R18   |
| 69         | LIN_FAULT                                     | 5                 | RP25/CN19/RC9   | Solder R5 and remove R27   |
| 70         | RX  | 43                | INT0/RP7/CN23/RB7   | Solder R3 and remove R26   |
| 72         | USB_RX  | 37                | RP20/CN25/RC4   | Solder R29                 |
| 76         | USB_TX  | 38                | RP21/CN26/RC5   | Solder R30                 |
| 77         | CAN_TX  | 2                 | PWM2H1/RP22/CN18/RC6  | Solder R32                 |
| 78         | CAN_RX  | 3                 | PWM2L1/RP23/CN17/RC7  | Solder R31                 |
| 80         | HALLA   | —                 | Not connected   | Not applicable             |
| 83         | BTN_1   | 32                | TDO/RA8   | Solder R19                 |
| 84         | BTN_2   | 33                | SOSCI/RP4/CN1/RB4   | Solder R20                 |
| 87         | CAN_RX  | —                 | Not connected   | Not applicable             |
| 88         | CAN_TX  | —                 | Not connected   | Not applicable             |
| 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  | 0                 | PGC2/EMUC2/PWM1L3/RP11/CN15/RB11                                  | Solder R8                  |

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## 2.2 BOARD CONNECTORS

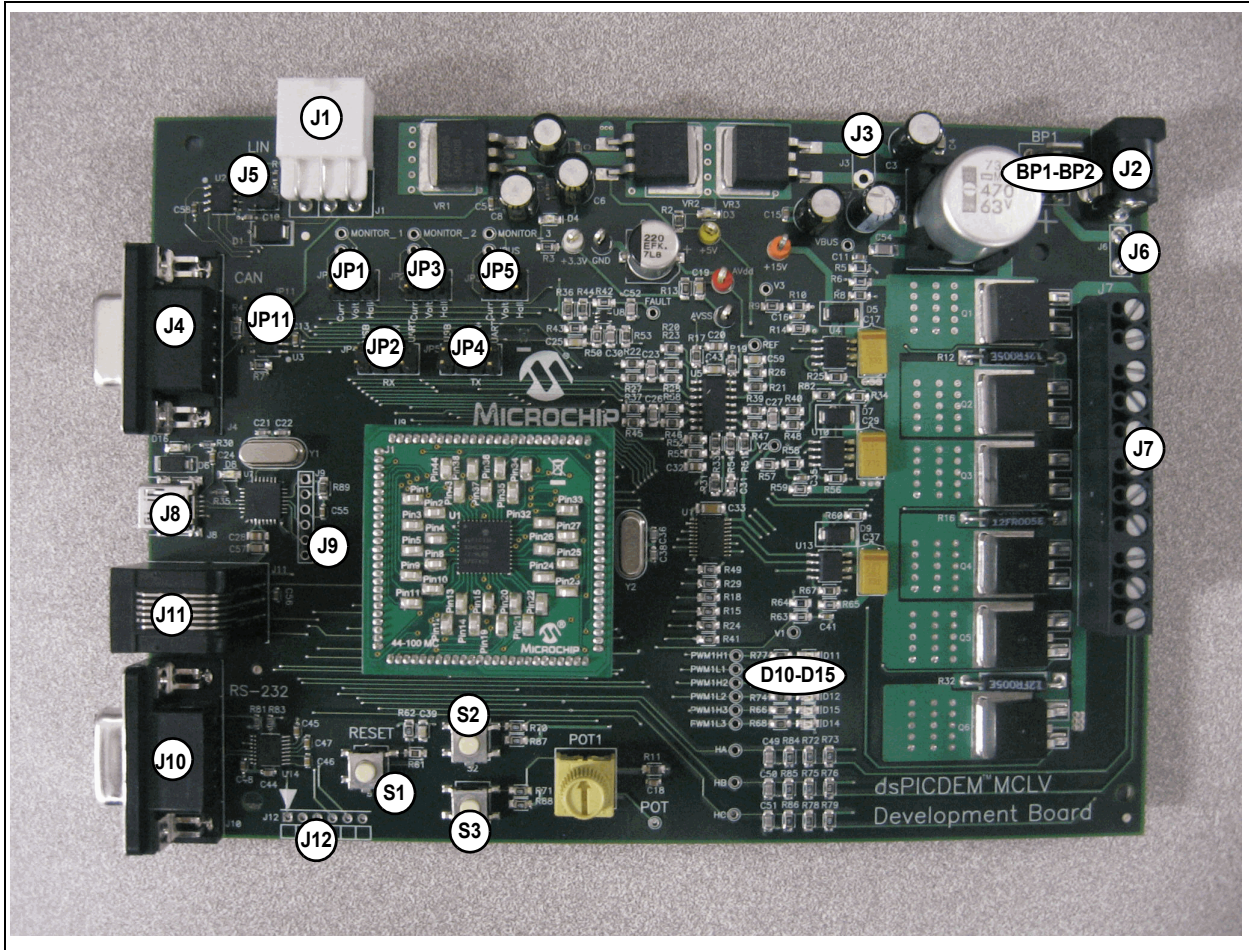
Table 2-5 describes the hardware connection between MPLAB ICD 2 or MPLAB REAL ICE™ In-Circuit Emulator, the power supply, and the dsPICDEM MCLV Development Board connectors.

**TABLE 2-5: BOARD CONNECTORS**

| Number | Designator | Description  |
|--------|------------|--|
| 1      | BP1-BP2    | Auxiliary power supply connector   |
| 2      | J1         | LIN interface port   |
| 3      | J2         | Input power supply connector   |
| 4      | J4         | CAN interface port   |
| 5      | J7         | Motor power connector, Hall sensors/Quadrature encoder connector and DC bus power supply connector |
| 6      | J8         | USB interface port   |
| 7      | J9         | ICSP™ programmer interface connector for programming the PIC18LF2450 USB to UART Bridge            |
| 8      | J10        | RS-232 interface port  |
| 9      | J11        | RJ11, 6-pin connector for programming a dsPIC® DSC device  |
| 10     | J12        | ICSP connector for programming a dsPIC DSC device  |

Figure 2-1 shows various connectors and jumpers available on the dsPICDEM MCLV Development Board.

**FIGURE 2-1: dsPICDEM™ MCLV DEVELOPMENT BOARD CONNECTORS AND JUMPERS**



## 2.2.1 Input Power Connector (J2, BP1-BP2)

The dsPICDEM MCLV Development Board receives the power for control circuits and the DC bus from a +24V power supply. It is connected to the board through J2 or BP1-BP2 points.

## 2.2.2 DC Bus Power Supply Connector (J6 and J7)

By default, jumper J6 is short, and the +24V input power supply connected to J2 or BP1-BP2 supplies the DC bus voltage to the board.

## 2.2.3 CAN Interface (J4)

The board has a MCP2551 High-Speed CAN Transceiver, which is connected to the dsPIC33F device through jumpers JP4 and JP5. The CAN transceiver converts the differential signal on the CAN bus to a digital signal for the ECAN™ module. It also converts the ECAN output digital signal to a differential signal for the CAN bus. In Sleep mode, the CAN transmitter is turned off, and the receiver operates at a lower current level. The control device monitors the CAN activity and switches the transceiver back to normal operation when needed. For more information, refer to the data sheet, *MCP2551 “High-Speed CAN Transceiver”* (DS21667).

## 2.2.4 LIN Interface (J1)

The board has a MCP2021 High-Speed LIN Transceiver, which is connected to the dsPIC33F device through jumpers JP4 and JP5. The LIN transceiver monitors the LIN bus, conditions the incoming signal, and passes it to the UART module on the control device. The LIN transceiver responds to a "Transmit Enable" from the control device by conditioning an output signal and placing it on the LIN bus. A power-down mode turns the transmitter and voltage regulator off, leaving only the receiver and wake-up circuits in operation. The LIN circuit includes a Master/Slave jumper to accommodate a Master node on the LIN bus. For more information, refer to the data sheet, *MCP202X "LIN Transceiver with Voltage Regulator"* (DS22018).

## 2.2.5 USB Interface (J8)

The board uses an on-board PIC18 interface as a bridge between the UART and USB. The PIC18 UART pins are connected to the dsPIC33F device through jumpers JP4 and JP5.

## 2.2.6 ICD 2 Connector (J11- J12)

The ICD 2 Connector is an RJ11 female connector (J11) that connects the MPLAB ICD 2 In-Circuit Debugger to the dsPIC33F device for programming and debugging purposes. The ICD 2 can be connected to the board using 6-pin ICSP connector (J12).

## 2.2.7 ICSP for PIC18 (J9)

The jumper J9 is a 6-pin connector that connects the PICkit™ 2 development programmer to the PIC18F device. The board uses the on-board PIC18 interface as a bridge between the UART and USB. The PIC18F can be programmed for USB communication.

## 2.2.8 RS-232 Connector (J10)

The connector J10 is an RS-232 interface port. The board uses the UART connector to pass the UART signals from the dsPIC33F device to the dedicated UART IC MAX3232CUE. The output of U14 is provided to the connector J10.

## 2.2.9 Motor Connector (J7)

The motor connector (J7) has 11 terminals. Table 2-6 shows the functionality of each terminal.

**TABLE 2-6: MOTOR CONNECTOR DETAILS**

| Pin | Terminal Name | Function                                     |
|-----|---------------|--|
| 1   | +             | External DC bus power supply                 |
| 2   | -             | Ground                                       |
| 3   | M1            | Motor winding phase 1                        |
| 4   | M2            | Motor winding phase 2                        |
| 5   | M3            | Motor winding phase 3                        |
| 6   | G             | Ground                                       |
| 7   | +5V           | Hall sensors/Quadrature encoder power supply |
| 8   | GND           | Hall sensors ground                          |
| 9   | HALLA         | Hall A/QEA feedback                          |
| 10  | HALLB         | Hall B/QEB feedback                          |
| 11  | HALLC         | Hall C/INDEX feedback                        |

Table 2-7 lists the test points that can be used to check various signals.

**TABLE 2-7: TEST POINTS**

| Test Points | Description                         |
|-------------|-------------------------------------|
| HA          | Hall A/QEA feedback                 |
| HB          | Hall B/QEB feedback                 |
| HC          | Hall C/INDEX feedback               |
| PWM1H1      | PWM output for leg 1 top switch     |
| PWM1L1      | PWM output for leg 1 bottom switch  |
| PWM1H2      | PWM output for leg 2 top switch     |
| PWM1L2      | PWM output for leg 2 bottom switch  |
| PWM1H3      | PWM output for leg 3 top switch     |
| PWM1L3      | PWM output for leg 3 bottom switch  |
| Fault       | Fault pin                           |
| V1          | Motor phase 1 voltage feedback      |
| V2          | Motor phase 2 voltage feedback      |
| V3          | Motor phase 3 voltage feedback      |
| Ref         | 2.5V reference for current feedback |
| POT1        | POT signal                          |
| MONITOR_1   | Motor feedback signal 1             |
| MONITOR_2   | Motor feedback signal 2             |
| MONITOR_3   | Motor feedback signal 3             |
| I1          | Phase 1 current                     |
| I2          | Phase 2 current                     |
| IBUS        | Bus current                         |
| P1          | +3.3V                               |
| P2          | GND                                 |
| P3          | +5V                                 |
| P4          | AVss                                |
| P5          | +15V                                |

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## 2.3 SELECTING A POWER SUPPLY FOR THE dsPICDEM MCLV DEVELOPMENT BOARD

The following connectors and power jumpers, when configured, offer multiple power supply configuration options for the dsPICDEM MCLV Development Board.

- Input Power Connector (J2 or BP1-BP2)
- Bypass 15V Regulator (J3)
- DC Bus Power Supply Jumper (J6)
- Motor Power Connector with pins, '+' and '-' (J7)

To locate these components, refer to Figure 1-1. Table 2-8 describes how to select the required power supply configuration option by setting jumper J3 and J6:

**TABLE 2-8: JUMPER SETTINGS FOR SELECTING A POWER SUPPLY**

| J3                                | J6                 | J2 or BP1-BP2 | J7: Pins '+' and '-'      |
|-----------------------------------|--------------------|---------------|---------------------------|
| Remove the jumper                 | Remove the jumper  | 16V to 24V    | 0V to 48V                 |
| Remove the jumper                 | Install the jumper | 16V to 24V    | Supplied by J2 or BP1-BP2 |
| Install the jumper <sup>(1)</sup> | Remove the jumper  | 10V to 16V    | 0V to 48V                 |
| Install the jumper <sup>(1)</sup> | Install the jumper | 10V to 16V    | Supplied by J2 or BP1-BP2 |

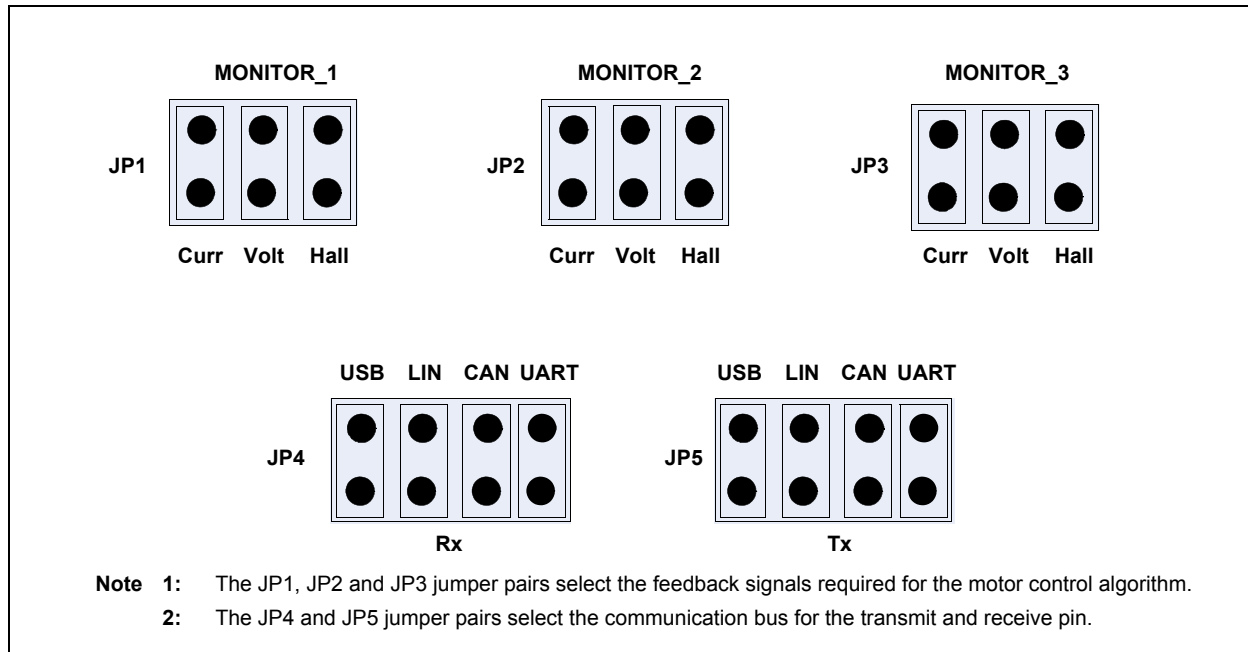
**Note 1:** When J3 is installed, VR3 must be removed to avoid damage to the 15V regulator.

## 2.4 USER INTERFACE HARDWARE

### 2.4.1 Jumpers

The dsPICDEM MCLV Development Board has nine jumpers that configure the functionality of the board. Figure 2-2 shows the jumper settings and Table 2-9 lists these jumpers and their functions.

**FIGURE 2-2: JUMPER SETTINGS**





**TABLE 2-9: JUMPER DESCRIPTIONS**

| No. | Designator | Position | Description                                    |
|-----|------------|----------|--|
| 1   | JP1        | 1-2      | Connects current sense phase 1 to MONITOR_1    |
|     |            | 3-4      | Connects voltage sense phase 1 to MONITOR_1    |
|     |            | 5-6      | Connects Hall sensor interface HA to MONITOR_1 |
| 2   | JP2        | 1-2      | Connects current sense phase 2 to MONITOR_2    |
|     |            | 3-4      | Connects voltage sense phase 2 to MONITOR_2    |
|     |            | 5-6      | Connects Hall sensor interface HB to MONITOR_2 |
| 3   | JP3        | 1-2      | Connects current sense DC Bus to MONITOR_3     |
|     |            | 3-4      | Connects voltage sense phase 3 to MONITOR_3    |
|     |            | 5-6      | Connects Hall sensor interface HC to MONITOR_3 |
| 4   | JP4        | 1-2      | Connects USB receive line to Rx                |
|     |            | 3-4      | Connects LIN receive line to Rx                |
|     |            | 5-6      | Connects CAN receive line to Rx                |
|     |            | 7-8      | Connects UART receive line to Rx               |
| 5   | JP5        | 1-2      | Connects USB transmit line to Tx               |
|     |            | 3-4      | Connects LIN transmit line to Tx               |
|     |            | 5-6      | Connects CAN transmit line to Tx               |
|     |            | 7-8      | Connects UART transmit line to Tx              |

**TABLE 2-10: ADDITIONAL JUMPERS**

| Designator | Functions   |
|------------|---|
| J3         | Bypass 15V regulator connector for gate driver IC |
| J5         | LIN master select                                 |
| J6         | Connects BP1-BP2/J2 to motor connector block J7   |
| JP11       | CAN end enable                                    |

## 2.4.2 Push Buttons, LEDs, Bus Resistors and Potentiometers

The dsPICDEM MCLV Development Board consists of the following items:

- Two push buttons
- One potentiometer
- Six LEDs
- Two power-on status LEDs
- Two USB LEDs
- Device Reset push button

**TABLE 2-11: INDICATORS AND HUMAN INTERFACES**

| Label   | Hardware Element Description  |
|---------|---|
| S2, S3  | Push buttons; these push buttons are connected to port pins. When momentarily pressed, the switch connects the respective port pin to Ground. |
| POT     | 10 k $\Omega$ potentiometer; it is connected to analog input pin.   |
| D3      | Power-on status LED, which indicates the status of the 5V regulator.  |
| D4      | Power-on status LED, which indicates the status of the +3.3V regulator.   |
| D8      | USB communication indicator, which indicates the device has been detected.  |
| D10-D15 | LEDs, which indicate the PWM pin status.  |
| D16     | USB bus indicator, which indicates that the device is connected to the USB bus.   |

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## Chapter 3. Running a BLDC Motor Using Hall Sensors

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This chapter describes how to set up the dsPICDEM MCLV Development Board to run a BLDC motor using Hall sensors.

Refer to the application note, AN957 “*Sensored BLDC Motor Control Using dsPIC30F2010*” (DS00957), for more information about running the BLDC motor control using Hall sensors. Topics covered include:

- Hardware Requirements
- dsPICDEM MCLV Development Board Setup

### 3.1 HARDWARE REQUIREMENTS

To set up and run the board, the following items are recommended:

- dsPICDEM MCLV Development Board (DM330021)
- 24V power supply (AC002013) or equivalent
- 10 pole Hurst motor (AC300020)
- dsPIC33FJ32MC204 PIM (MA330017)

### 3.2 dsPICDEM MCLV DEVELOPMENT BOARD SETUP

The following procedure describes how to set up the dsPICDEM MCLV Development Board:

#### WARNING

**Note 1:** The dsPICDEM MCLV Development Board is intended to drive the three-phase BLDC or PMSM motor. 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 jumper settings are correct for the firmware programmed into the target 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.

**2:** 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.

1. Place the dsPICDEM MCLV Development Board on a sturdy insulated platform.
2. Make sure that the dsPIC33FJ32MC204 device or an appropriate PIM is mounted in the respective socket.

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3. Connect the 24V power supply to J2 or BP1-BP2.  
If the supply voltage is not equal to 24V, refer to Table 2-8 to configure the power supply for the board.
4. Set JP1, JP2 and JP3 in the 5-6 position to select Hall sensors feedback.
5. Connect MPLAB ICD 2 or MPLAB REAL ICE In-Circuit Emulator to the computer, and the board to J11 or J12.
6. Connect the three-phase, 10 pole, 24V Hurst motor (AC300020) to J7. Connect motor phases and Hall sensors as described in Table 3-1.

**TABLE 3-1: PHASES AND HALL SENSORS CONNECTION**

| Color Coding                              | J7 Connection | Component          | Hurst Motor Connection                      |
|---|---------------|--------------------|---|
| 4-pin power (white connector) wires       | —             | —                  | Power connector on the Hurst motor          |
| Red wire                                  | M1            | Motor phase 1      | Pin 3                                       |
| Black wire                                | M2            | Motor phase 2      | Pin 2                                       |
| White wire                                | M3            | Motor phase 3      | Pin 1                                       |
| Green wire                                | G             | Body Ground        | Pin 4                                       |
| 8-pin Hall sensor (black connector) wires | —             | —                  | Hall interface connector on the Hurst motor |
| Red wire                                  | +5V           | Hall sensor power  | Pin 1                                       |
| Black wire                                | Gnd           | Hall sensor return | Pin 2                                       |
| White wire                                | HA            | Hall A output      | Pin 4                                       |
| Brown wire                                | HB            | Hall B output      | Pin 3                                       |
| Green wire                                | HC            | Hall C output      | Pin 5                                       |

7. Download the code for the dsPIC33FJ32MC204 from the Microchip web site ([www.microchip.com](http://www.microchip.com)). It is available with the application note AN957.
8. Unzip the file and open the project using MPLAB IDE. Refer to the “MPLAB® ICD 2 In-Circuit Debugger User's Guide” (DS51331) for more information about how to generate a project and run a program using the MPLAB ICD 2 In-Circuit Debugger.
9. Build the project and download the program into the processor.
10. Press the **Run** icon when in Debug mode.
11. Press S2 to run the motor.
12. Vary the motor's speed with POT1.
13. Press S2 again to stop the motor.

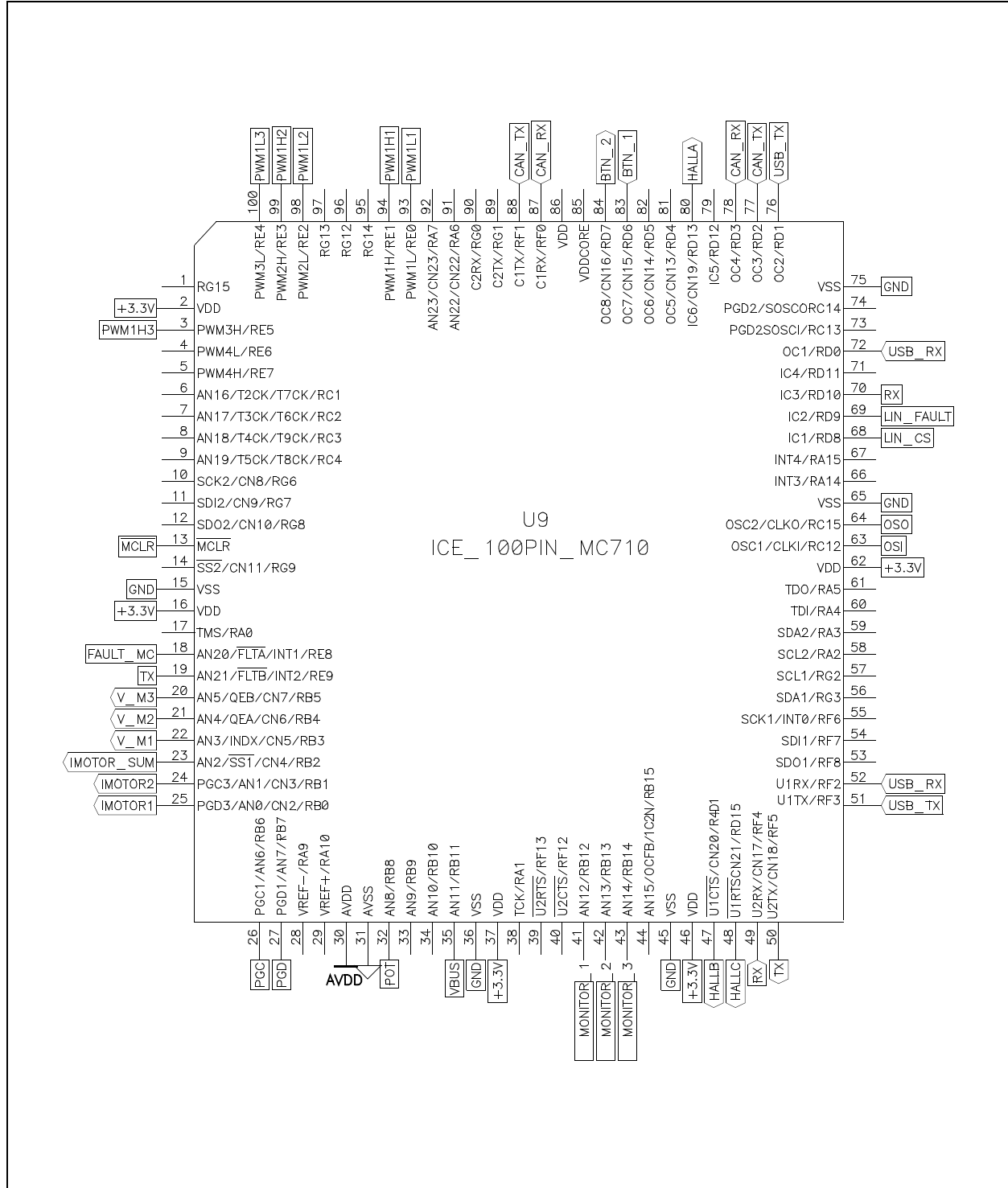
**Note:** For more information on running BLDC motors using dsPIC DSC devices, refer to the following application notes, which are available from the Microchip web site:

- AN957, “Sensored BLDC Motor Control Using dsPIC30F2010” (DS00957)
- AN1160, “Sensorless BLDC Control with Back-EMF Filtering Using a Majority Function” (DS01160)
- AN1078, “Sensorless Field Oriented Control of PMSM Motors using dsPIC30F or dsPIC33F Digital Signal Controllers” (DS01078)
- AN1017, “Sinusoidal Control of PMSM Motors with dsPIC30F DSC” (DS01017)

The source code referred in these application notes is also available from the Microchip web site ([www.microchip.com](http://www.microchip.com)).

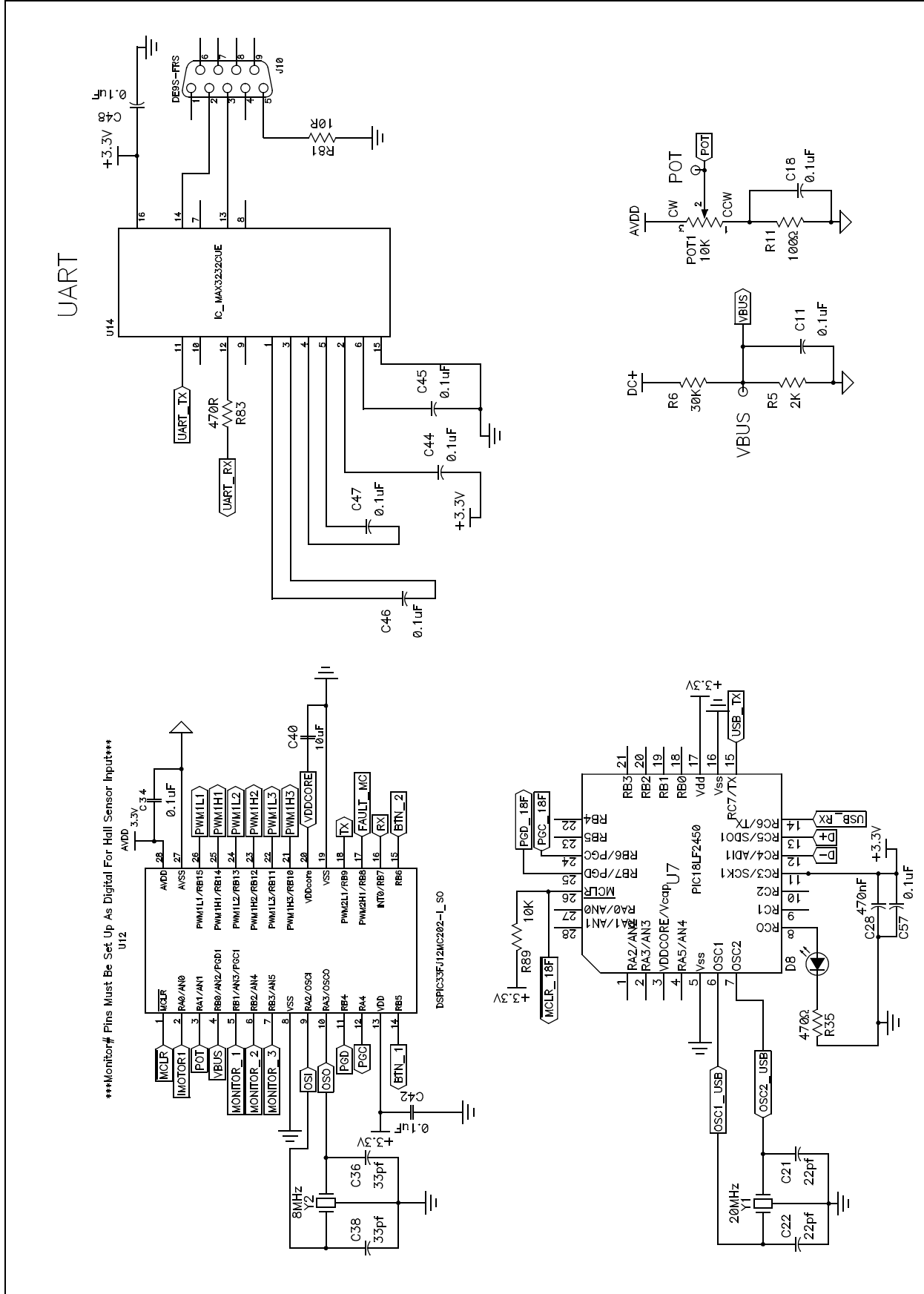
**Appendix A. Schematics and Layouts**

**FIGURE A-1: dsPICDEM™ MCLV DEVELOPMENT BOARD SCHEMATIC (SHEET 1 OF 7)**



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FIGURE A-2: dsPICDEM™ MCLV DEVELOPMENT BOARD SCHEMATIC (SHEET 2 OF 7)





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FIGURE A-4: dsPICDEM™ MCLV DEVELOPMENT BOARD SCHEMATIC (SHEET 4 OF 7)

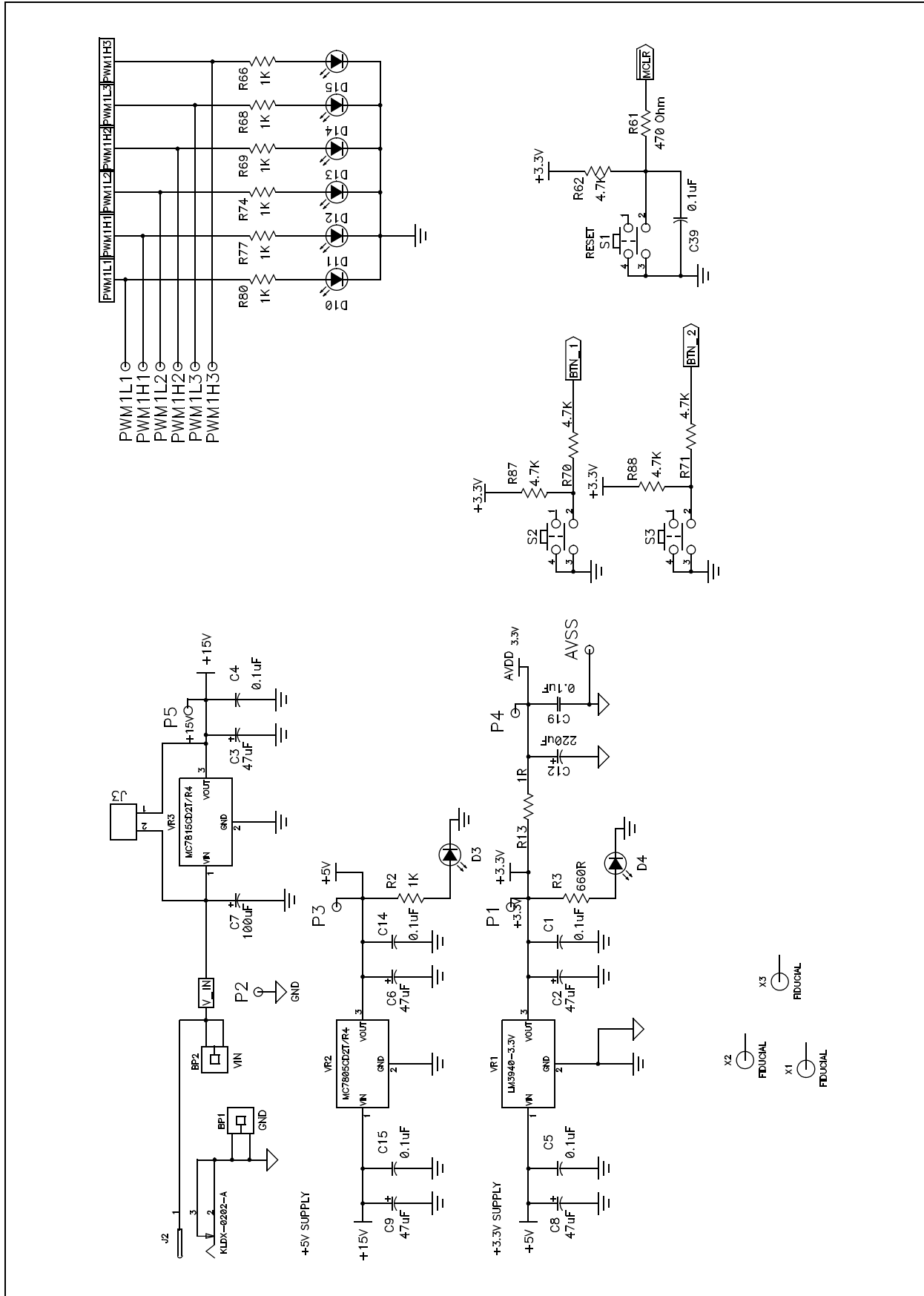
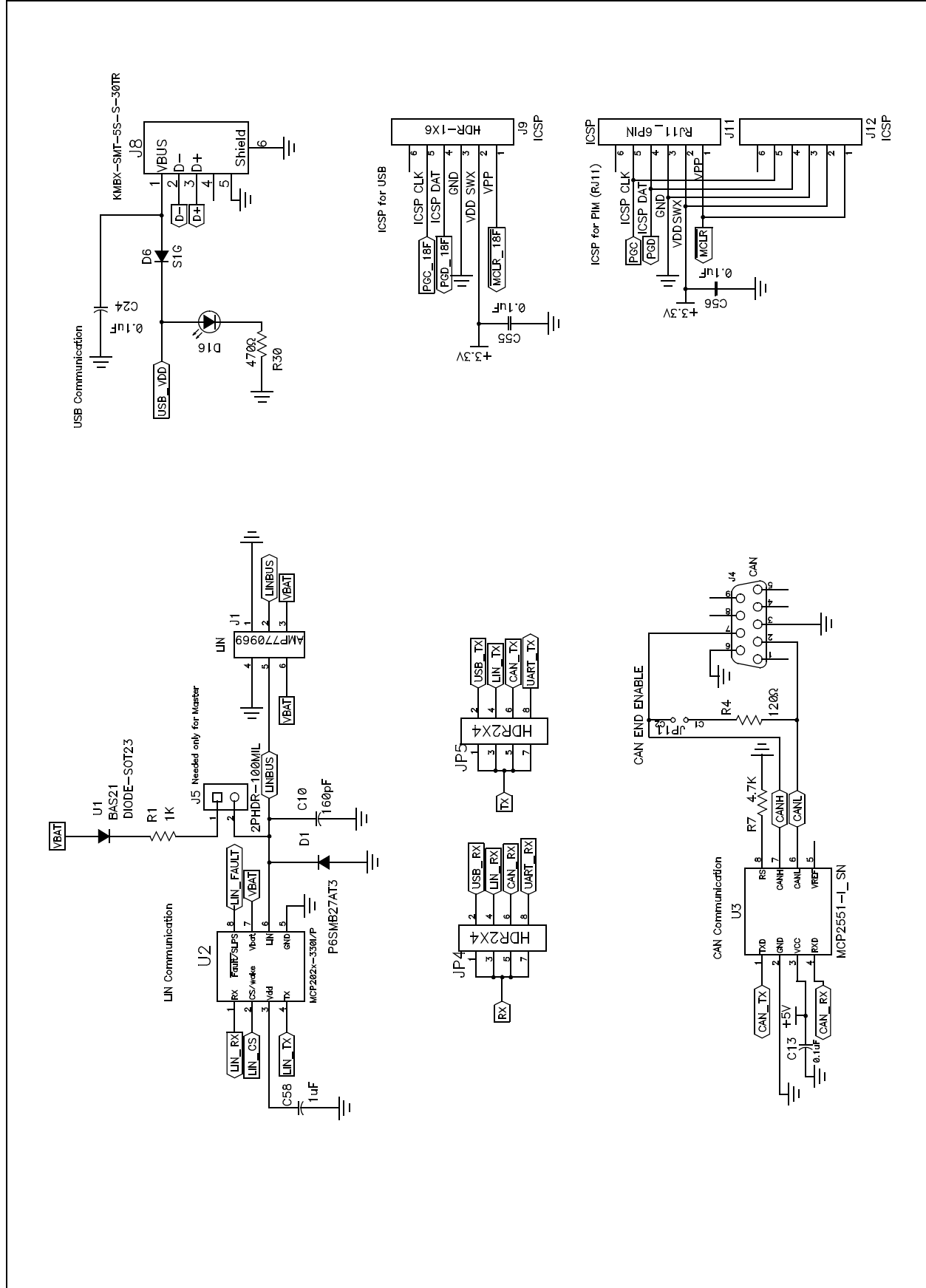




FIGURE A-5: dsPICDEM™ MCLV DEVELOPMENT BOARD SCHEMATIC (SHEET 5 OF 7)



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FIGURE A-6: dsPICDEM™ MCLV DEVELOPMENT BOARD SCHEMATIC (SHEET 6 OF 7)

All Resistors On This Page Must Be 1%  
 Note: Supply Voltage should be AVDD for MCP6024

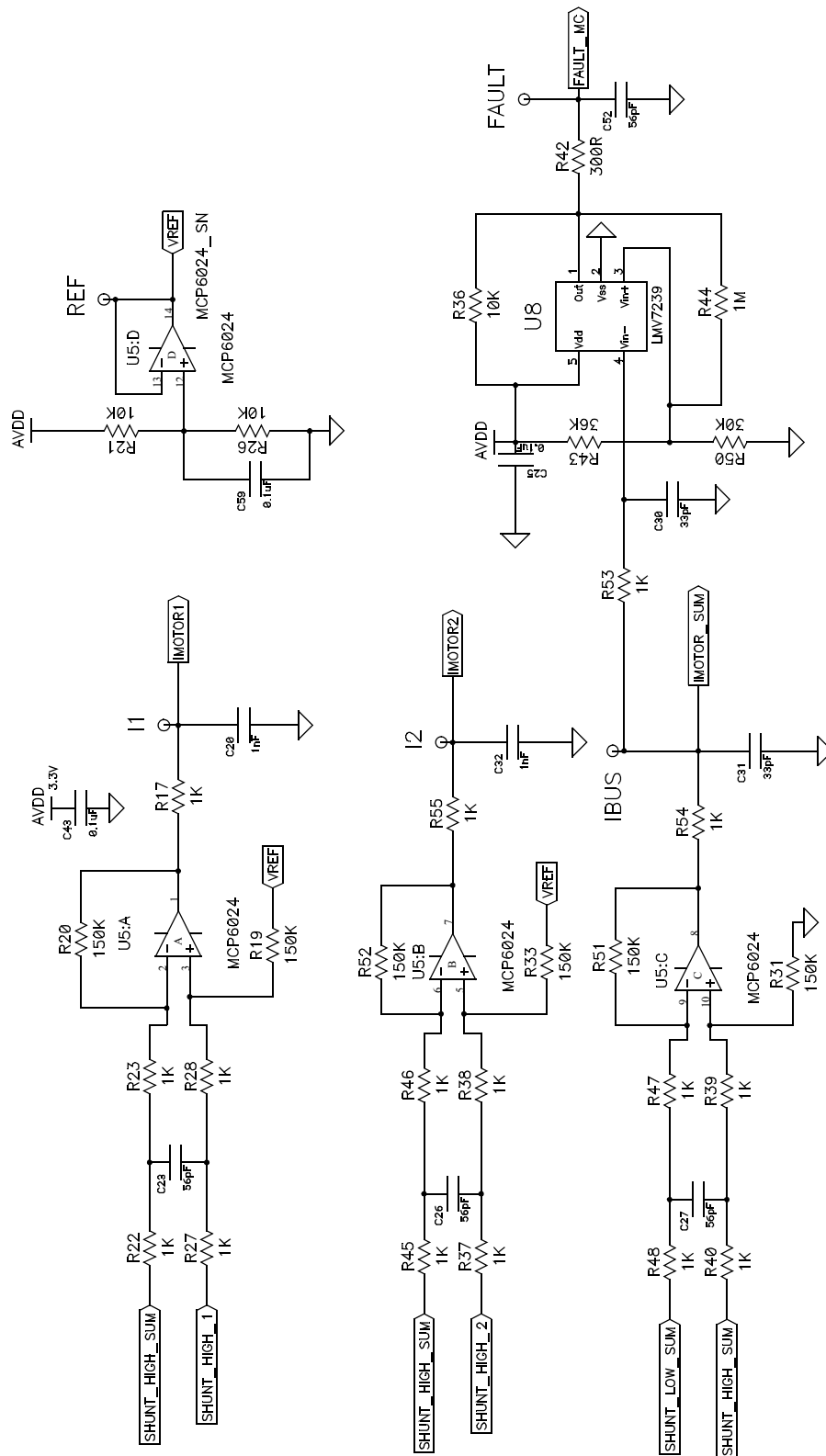
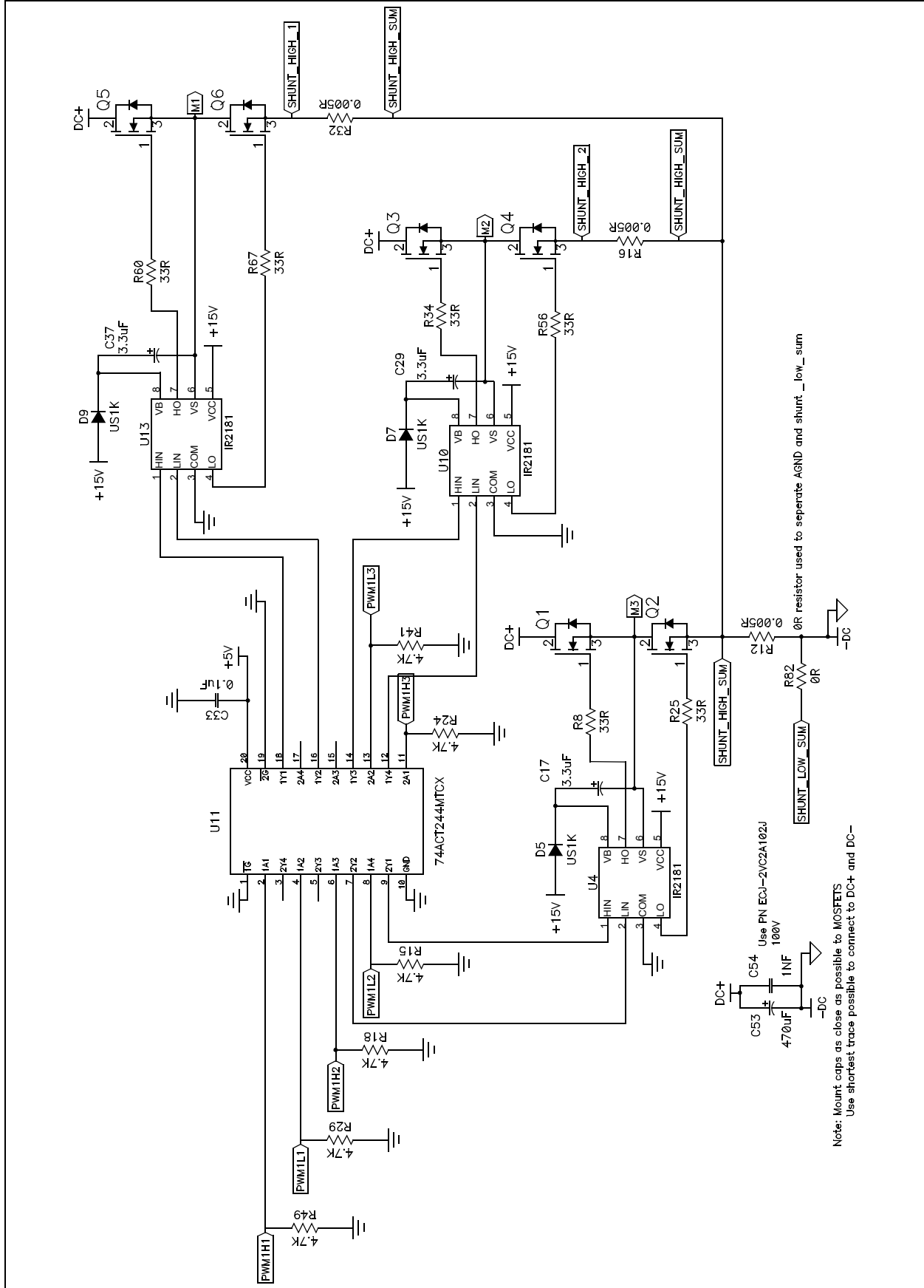
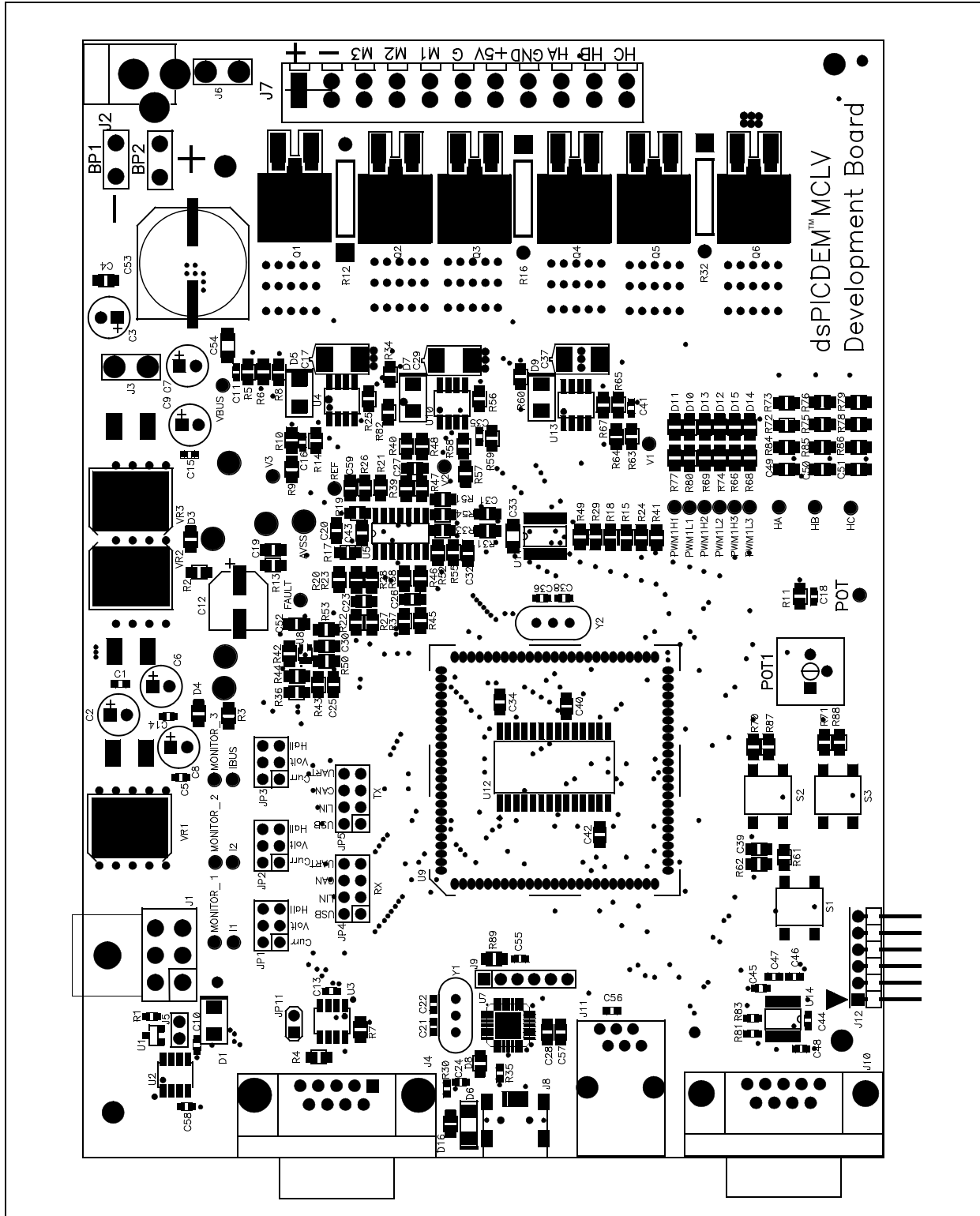


FIGURE A-7: dsPICDEM™ MCLV DEVELOPMENT BOARD SCHEMATIC (SHEET 7 OF 7)



# dsPICDEM™ MCLV Development Board User's Guide

FIGURE A-8: dsPICDEM™ MCLV DEVELOPMENT BOARD LAYOUT



## Appendix B. Electrical Specifications

**TABLE B-1: DC INPUT RATING**

| Parameter                               | Condition                          | Min. | Max. | Unit |
|---|------------------------------------|------|------|------|
| Power supply connected to J7            | J6 is open                         | 0    | 48   | VDC  |
| Power supply connected to J2 or BP1-BP2 | J3 is open and VR3 is installed    | 16   | 24   | VDC  |
| Power supply connected to J2 or BP1-BP2 | J3 is installed and VR3 is removed | 10   | 16   | VDC  |

**TABLE B-2: DC OUTPUT RATING**

| Parameter    | Min. | Typical            | Max.               | Unit  |
|--------------|------|--------------------|--------------------|-------|
| Voltage      | 0    | 24                 | 48                 | VDC   |
| Current      | 0    | 10                 | 15                 | A     |
| Power Rating | 0    | 240 <sup>(1)</sup> | 720 <sup>(2)</sup> | Watts |

**Note 1:** If the output power exceeds 240W, the power MOSFETs (Q1-Q6) may need additional heat sink.

**2:** By default, the board uses D2-PAK Power MOSFETs. It also supports the TO-220 packages. If the TO-220 Power MOSFETs are used, additional heat sink can be mounted on the MOSFETs, if required.

# dsPICDEM™ MCLV Development Board User's Guide

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