

dsPICDEM™ MCLV DEVELOPMENT BOARD USER'S GUIDE

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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 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.

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 brackets and pipe character: { | }	Choice of mutually exclusive arguments; an OR selection	`errorlevel {0|1}`
Ellipses...	Replaces repeated text	`var_name [, var_name...]`
	Represents code supplied by user	`void main (void) { ... }`

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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.

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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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.

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

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 sensored 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:

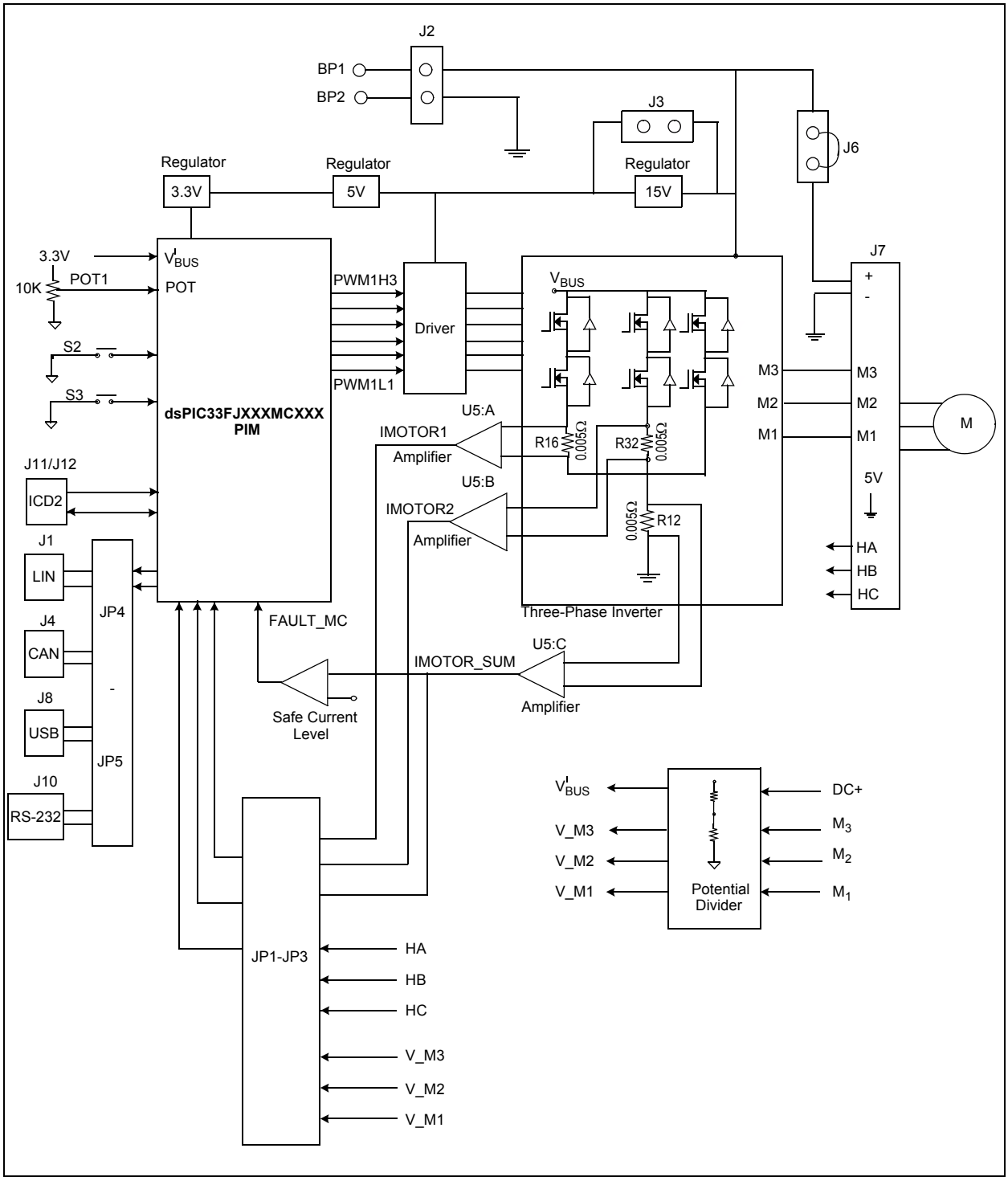
- Devices Supported:
  - 28-pin to 100-pin dsPIC33FJXXXMC202 PIM (MA330014) with a dsPIC33F Motor control device (U9) socket
  - 44-pin to 100-pin dsPIC33FJXXXMCX04 PIM (MA330017 and MA330018) with a dsPIC33F Motor Control device (U9) socket
  - 100-pin to 100-pin dsPIC33FJXXXMCX10 PIM (MA330013) with 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 sensored 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 kΩ 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)

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



NOTES:

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Chapter 2. Hardware Overview

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).

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 V_{BAT} 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.

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	$\overline{\text{MCLR}}$	13	$\overline{\text{MCLR}}$	Not applicable
18	FAULT_MC	18	AN20/$\overline{\text{FLTA}}$/INC1/RE8	Not applicable
19	TX	19	AN21/$\overline{\text{FLTB}}$/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/$\overline{\text{SS1}}$/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/$\overline{\text{U1CTS}}$/CN20/RD14	Not applicable
48	HC	48	IC8/$\overline{\text{U1RTS}}$/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

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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	$\overline{\text{MCLR}}$	26	$\overline{\text{MCLR}}$	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 **Appendix A. "Schematics and Layouts"**)	Not applicable
21	V_M2	—	Restricted Use (see **Appendix A. "Schematics and Layouts"**)	Not applicable
22	V_M1	—	Restricted Use (see **Appendix A. "Schematics and Layouts"**)	Not applicable
23	IMOTOR_SUM	—	Not connected	Not applicable
24	IMOTOR2	—	Restricted Use (see **Appendix A. "Schematics and Layouts"**)	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 (1)	11	ASDA1/RP5/CN27/RB5	Solder R6 and remove R5, R33
69	LIN_FAULT (2)	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.

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	$\overline{\text{MCLR}}$	18	$\overline{\text{MCLR}}$	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 **Appendix A. "Schematics and Layouts"**)	Not applicable
21	V_M2	—	Restricted use (see **Appendix A. "Schematics and Layouts"**)	Not applicable
22	V_M1	—	Restricted use (see **Appendix A. "Schematics and Layouts"**)	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

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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	$\overline{\text{MCLR}}$	18	$\overline{\text{MCLR}}$	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 **Appendix A. "Schematics and Layouts"**)	Not applicable
21	V_M2	—	Restricted use (see **Appendix A. "Schematics and Layouts"**)	Not applicable
22	V_M1	—	Restricted use (see **Appendix A. "Schematics and Layouts"**)	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

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.

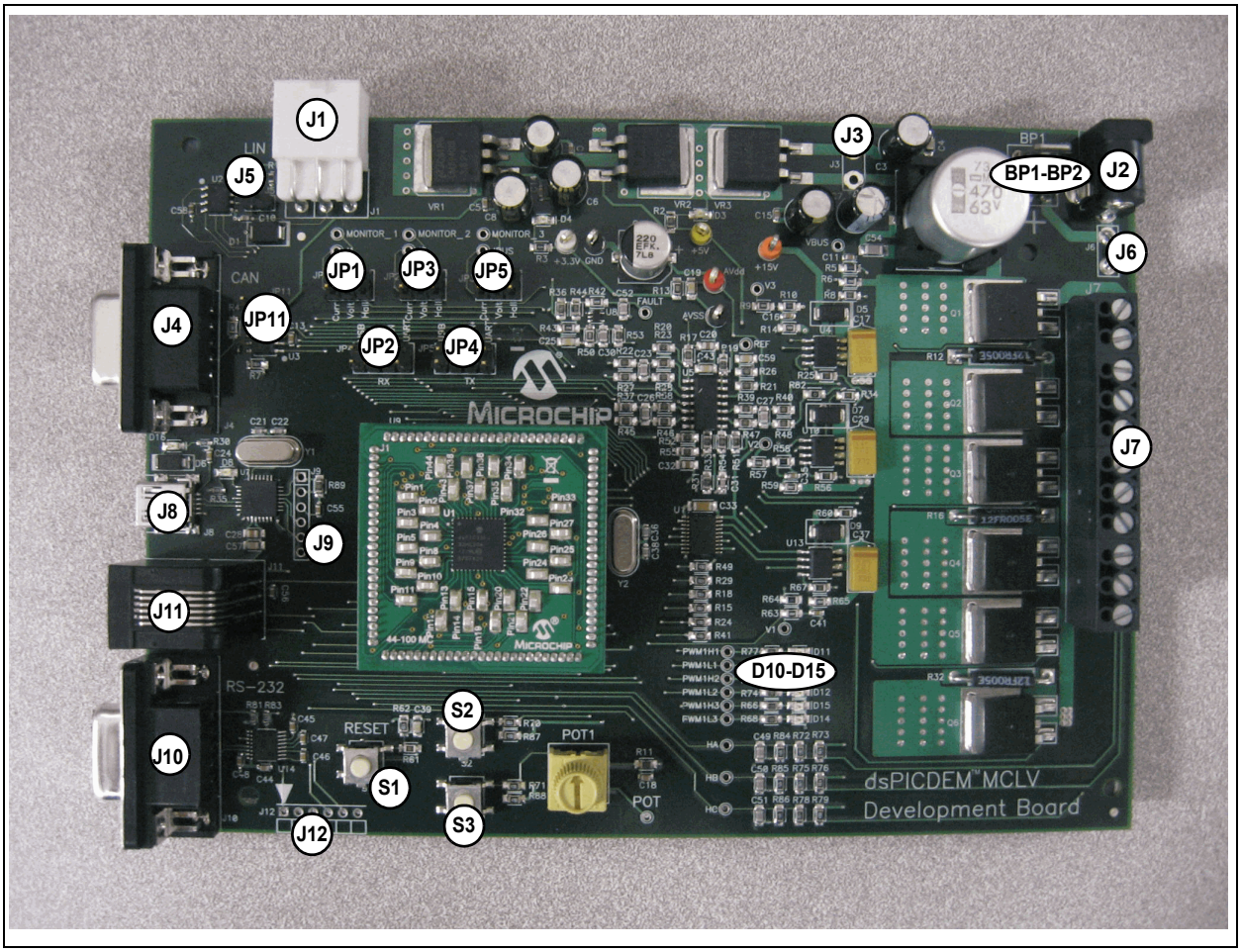
TABLE 2-5: BOARD CONNECTORS

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

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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

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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

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(1)	Remove the jumper	10V to 16V	0V to 48V
Install the jumper(1)	Install the jumper	10V to 16V	Supplied by J2 or BP1-BP2

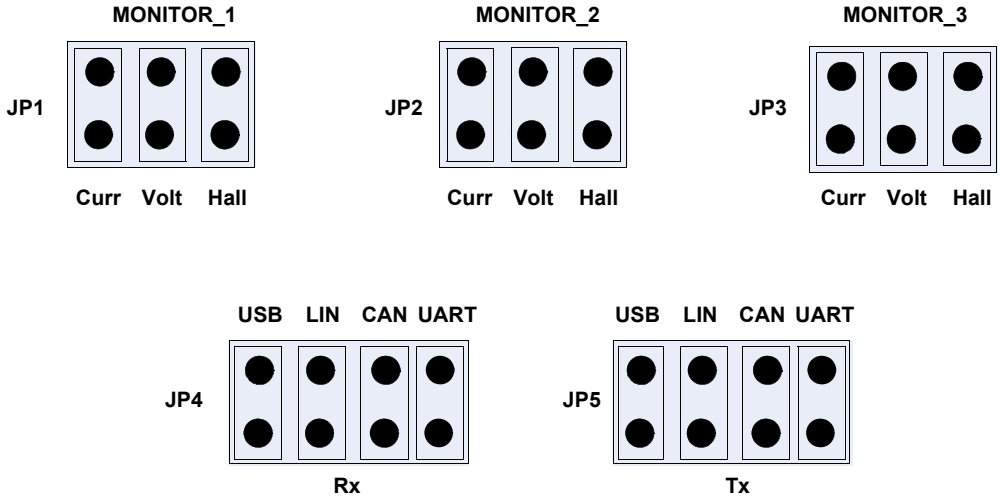
Note 1: When J3 is installed, VR3 must be removed to avoid damage to the 15V regulator.

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



Note 1: The JP1, JP2 and JP3 jumper pairs select the feedback signals required for the motor control algorithm.

2: The JP4 and JP5 jumper pairs select the communication bus for the transmit and receive pin.

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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 kΩ 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

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.

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). 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).

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Appendix A. Schematics and Layouts

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

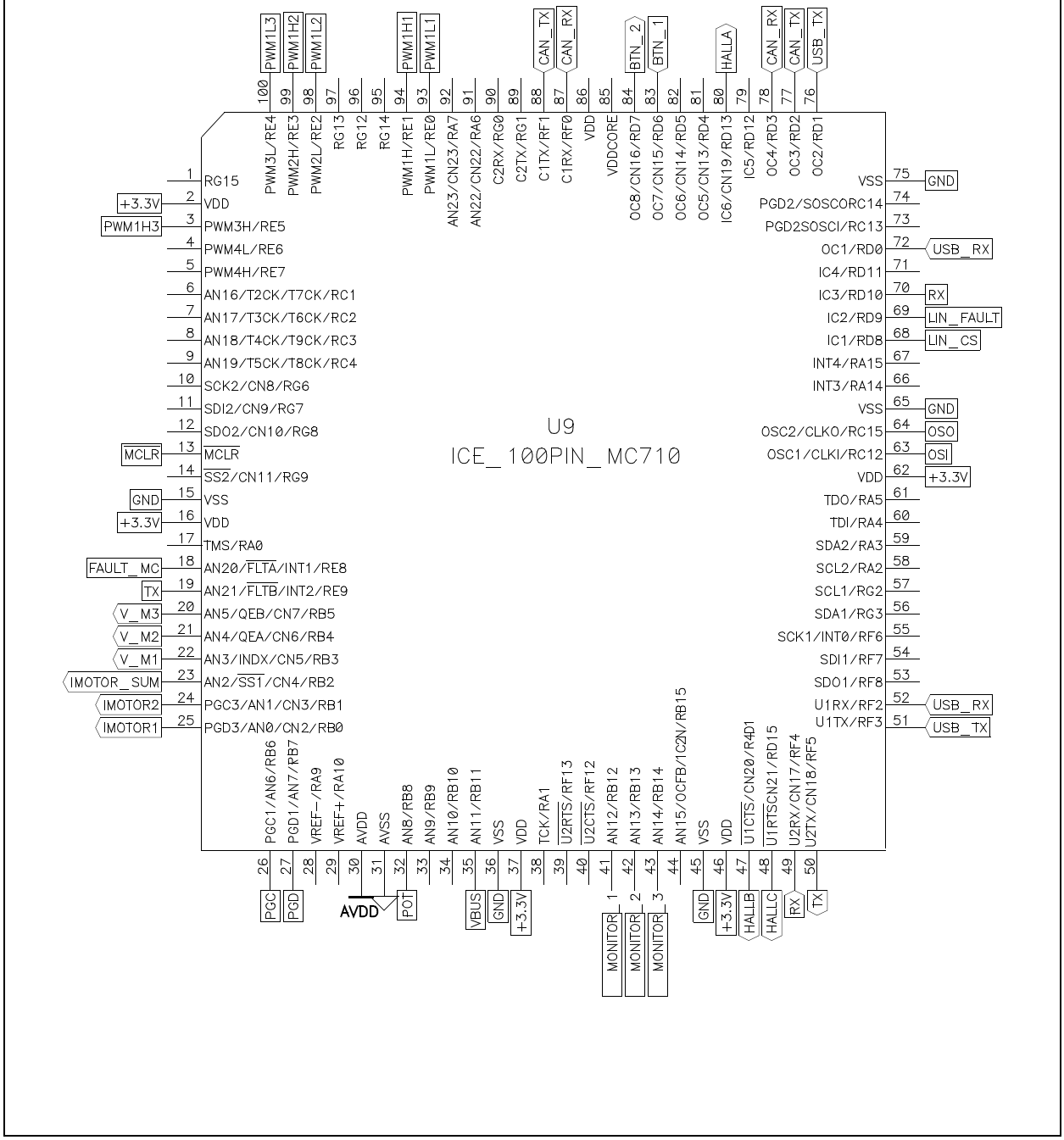
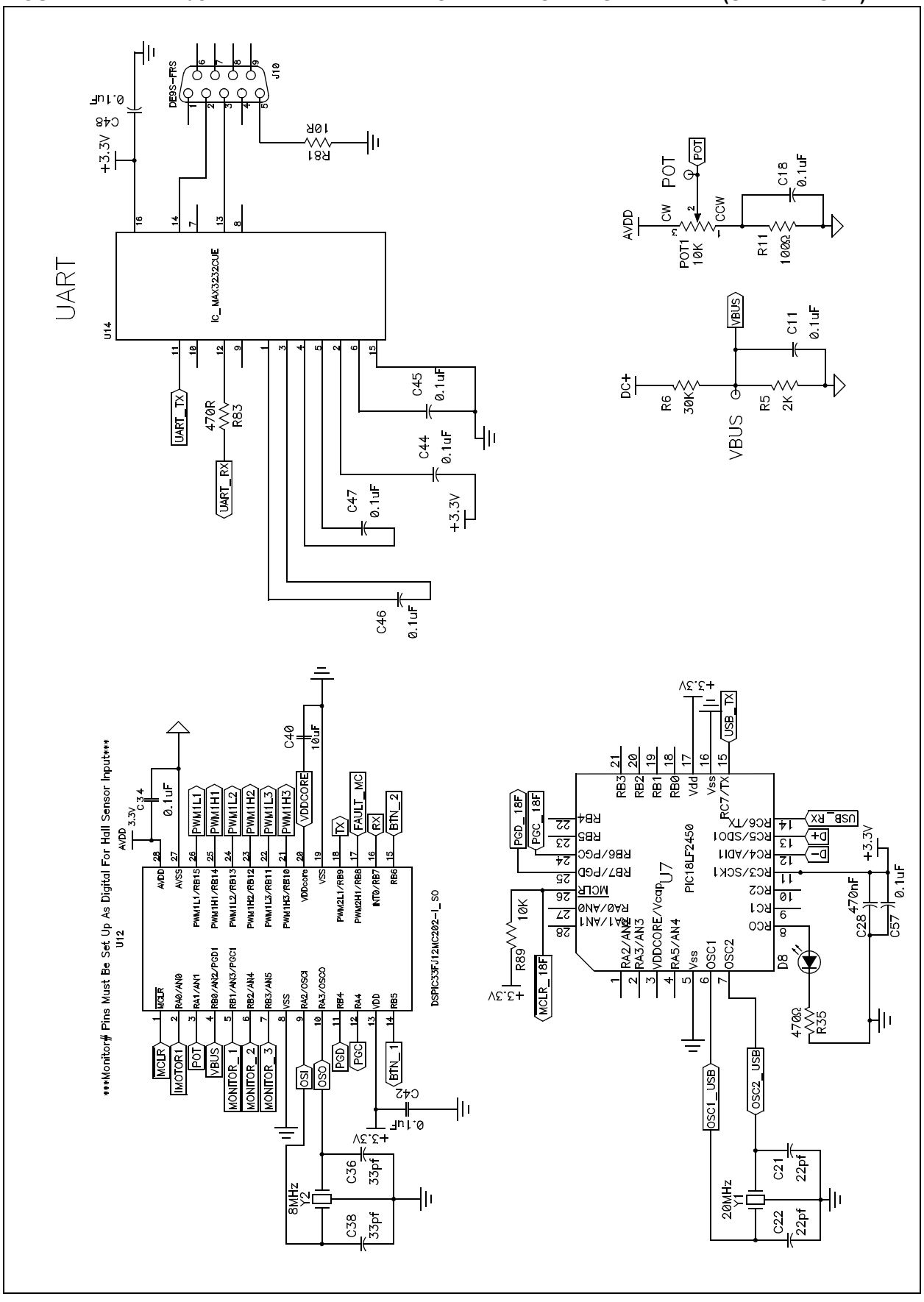


FIGURE A-2: dsPICDEM™ MCLV DEVELOPMENT BOARD SCHEMATIC (SHEET 2 OF 7)



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FIGURE A-3: dsPICDEM™ MCLV DEVELOPMENT BOARD SCHEMATIC (SHEET 3 OF 7)

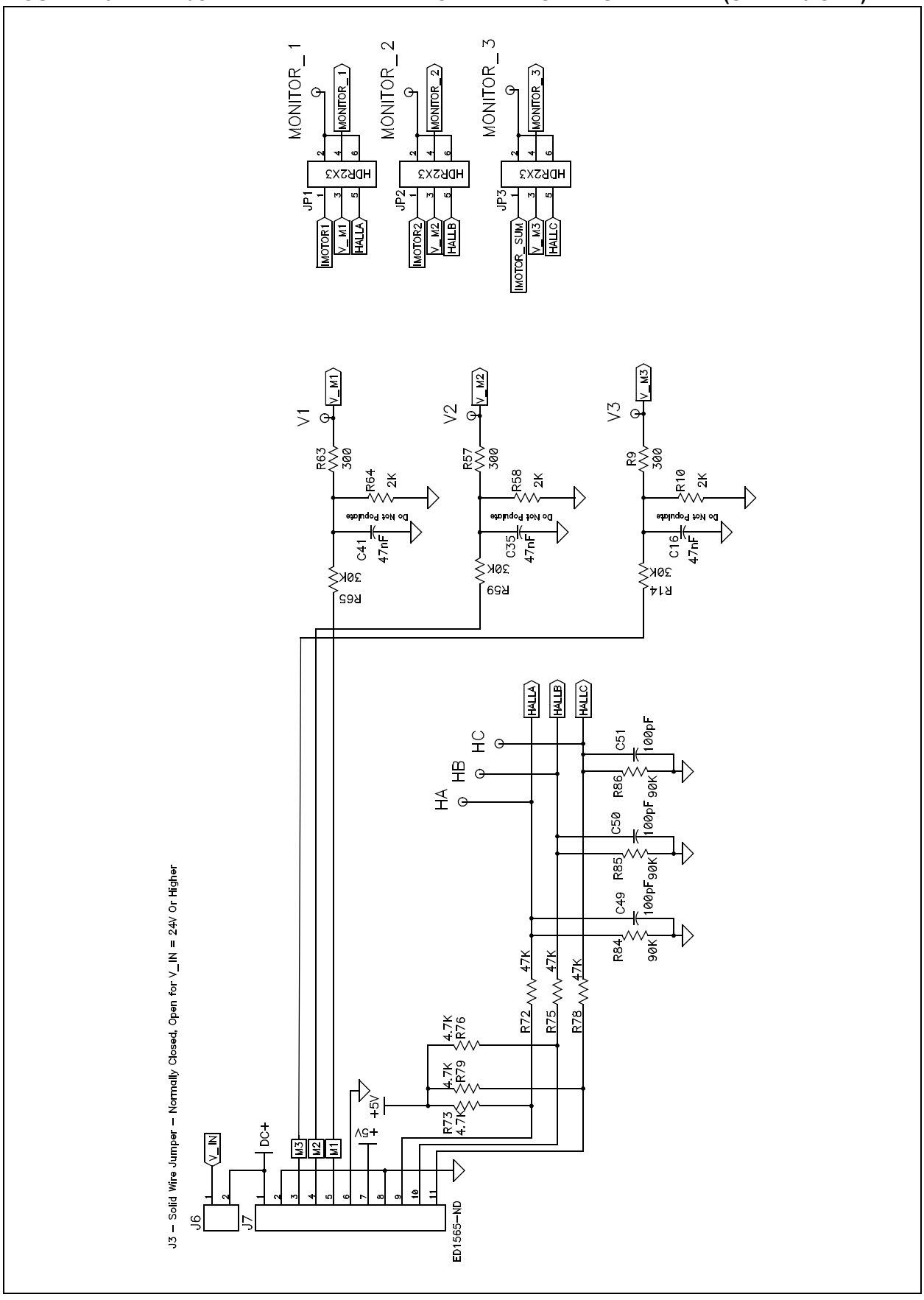
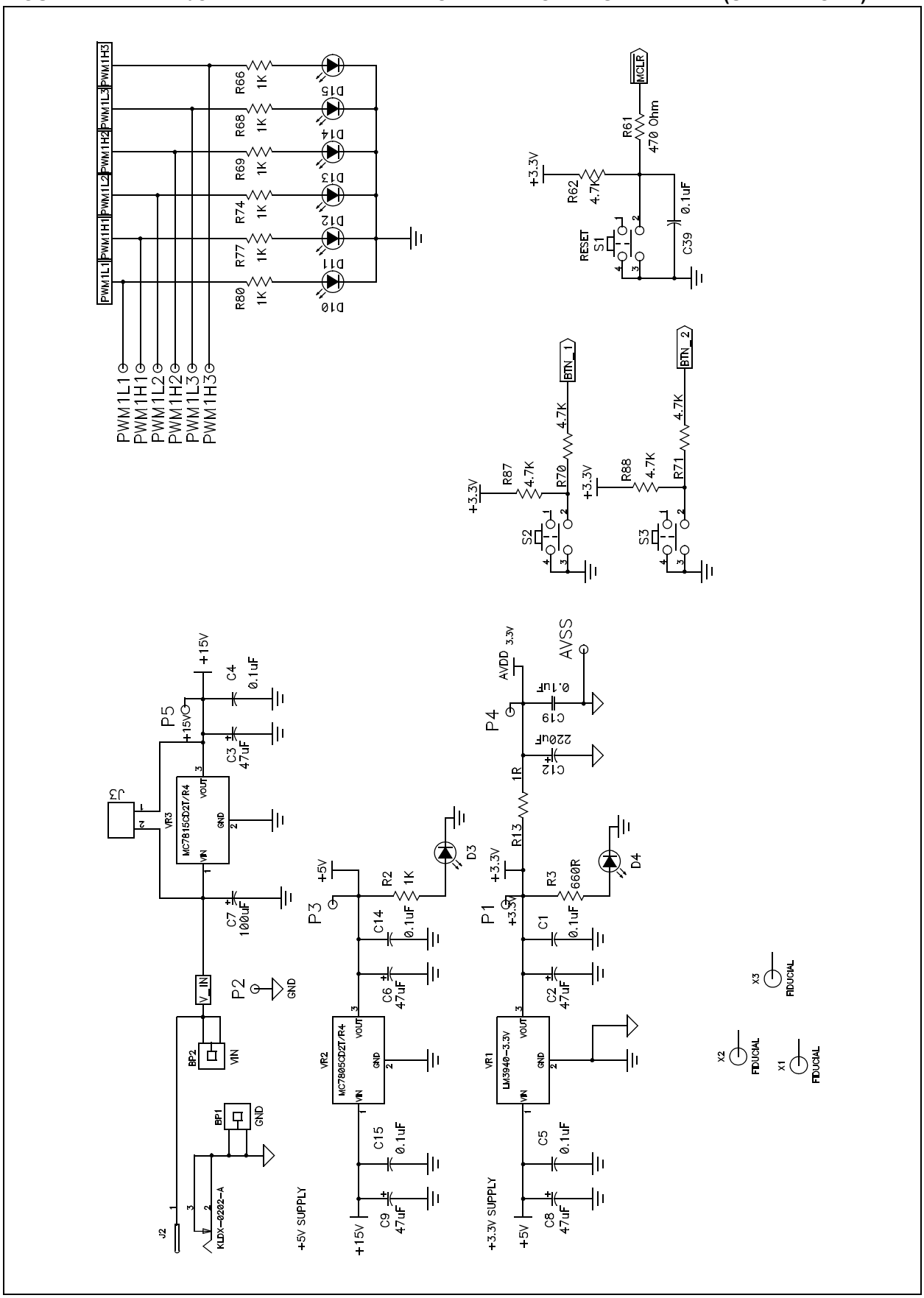


FIGURE A-4: dsPICDEM™ MCLV DEVELOPMENT BOARD SCHEMATIC (SHEET 4 OF 7)



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

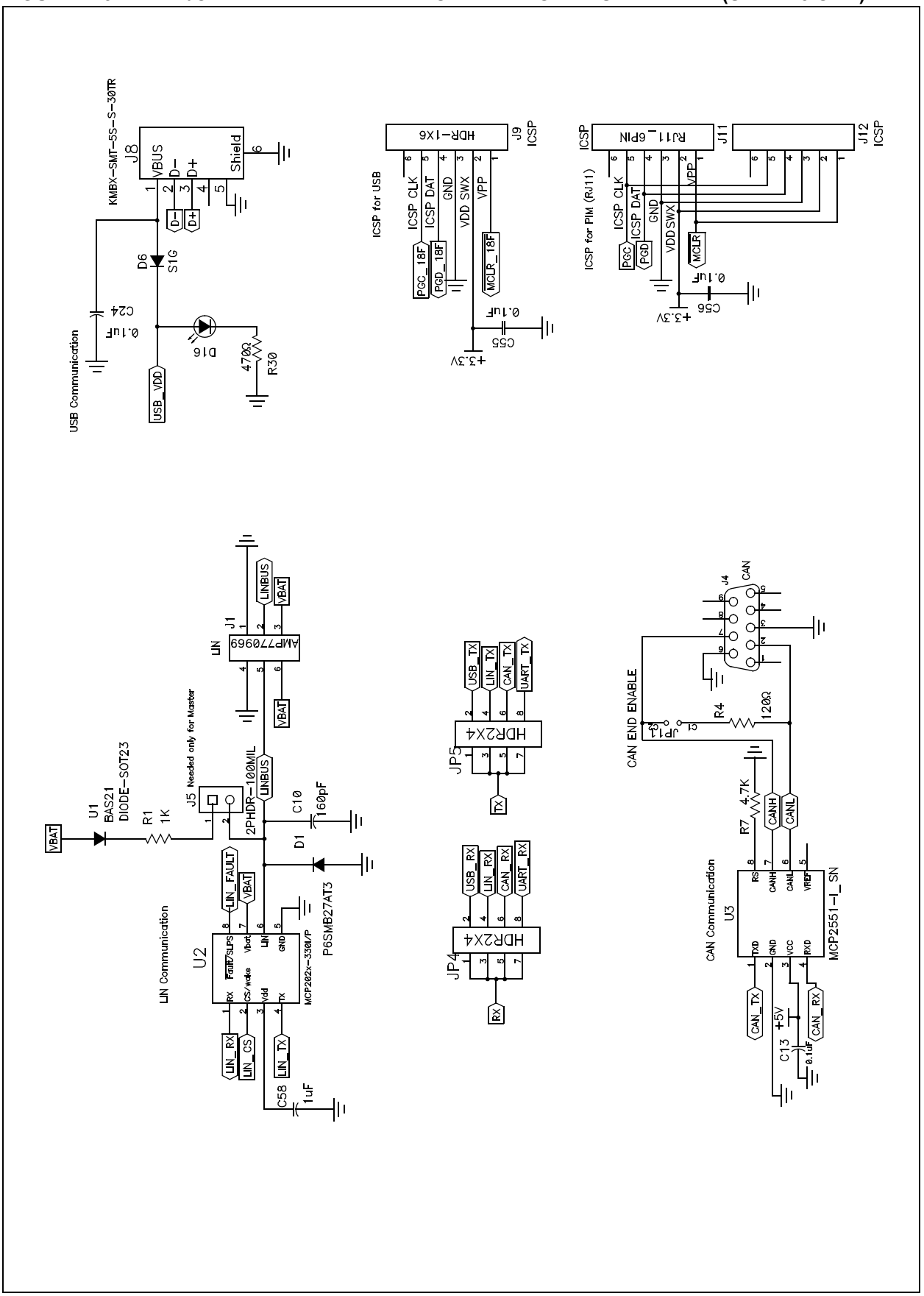
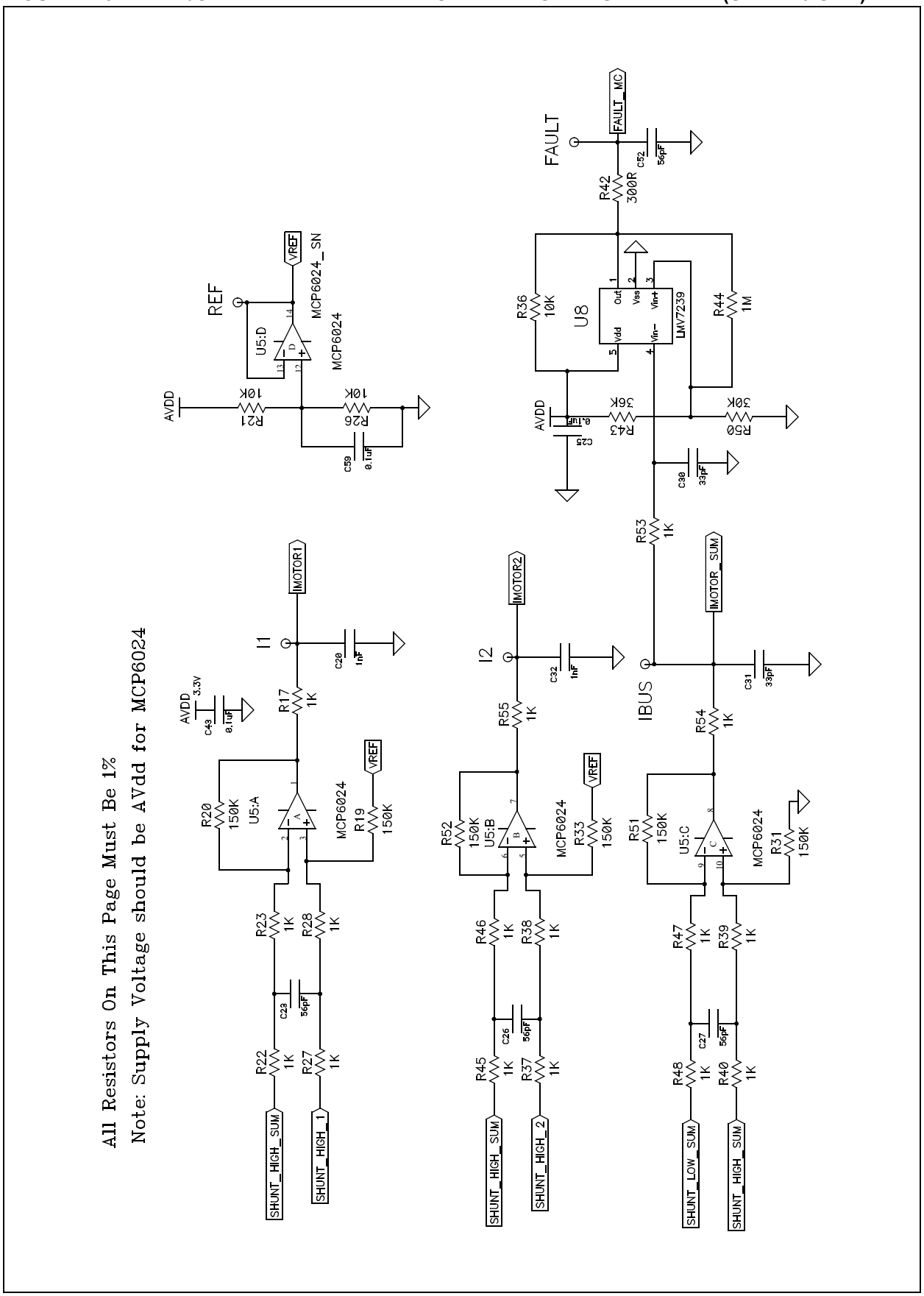


FIGURE A-6: dsPICDEM™ MCLV DEVELOPMENT BOARD SCHEMATIC (SHEET 6 OF 7)



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

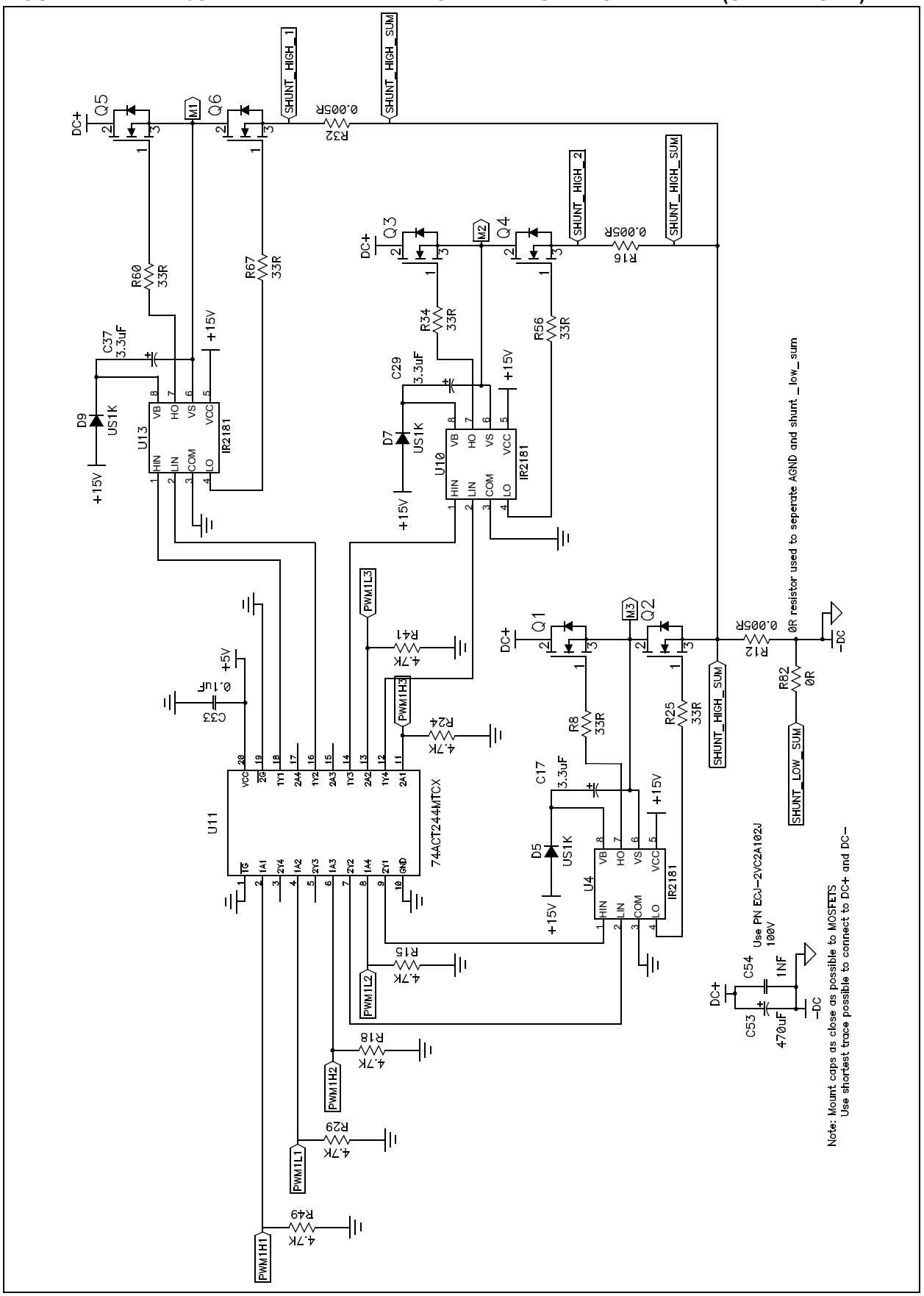
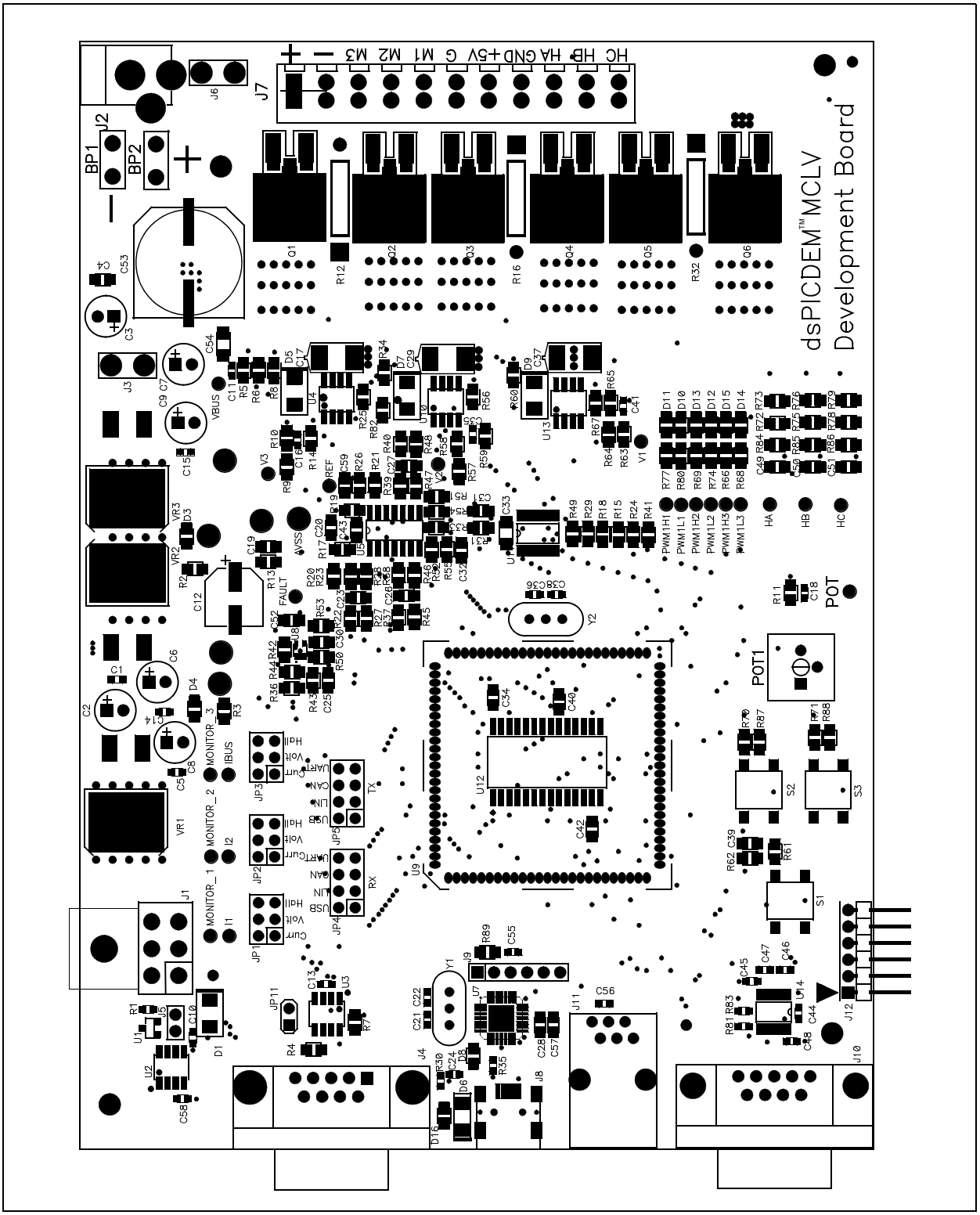


FIGURE A-8: dsPICDEM™ MCLV DEVELOPMENT BOARD LAYOUT



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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(1)	720(2)	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.

NOTES:

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