dsPIC33CK256MP506 Digital Power Plug-In Module (PIM) 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 website (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 "DSXXXXXXXXA", where "XXXXXXXX" 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 online help. Select the Help menu, and then Topics to open a list of available online help files.

INTRODUCTION

This chapter contains general information that will be useful to know before using the dsPIC33CK256GS806 Digital Power Plug-In Module (PIM). Items discussed in this chapter include:

- Document Layout
- Conventions Used in this Guide
- Recommended Reading
- The Microchip Website
- Product Change Notification Service
- Customer Support
- Document Revision History

DOCUMENT LAYOUT

This document describes how to use the dsPIC33CK256MP506 Digital Power PIM as a development tool to emulate and debug firmware on a target board. The document is organized as follows:

- **Chapter 1. "Overview"** — This chapter introduces the dsPIC33CK256MP506 Digital Power PIM and provides a brief overview of its various features.
- **Appendix A. "Board Layout and Schematics"** — This appendix presents the schematics and the board layouts for the dsPIC33CK256MP506 Digital Power PIM.
- **Appendix B. "Bill of Materials (BOM)"** — This appendix presents the Bill of Materials for the dsPIC33CK256MP506 Digital Power PIM.

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) { ... }`

RECOMMENDED READING

This user's guide describes how to use the dsPIC33CK256MP506 Digital Power PIM. Other useful document(s) are listed below. The following Microchip document(s) are recommended as supplemental reference resources.

- ***"dsPIC33EPXXXGS70X/80X Family Data Sheet"*** (DS70005258) is available for download from the Microchip website (www.microchip.com)

THE MICROCHIP WEBSITE

Microchip provides online support via our website at www.microchip.com. This website is used as a means to make files and information easily available to customers. Accessible by using your favorite Internet browser, the website contains the following information:

- **Product Support** – Data sheets and errata, application notes and sample programs, design resources, user's guides and hardware support documents, latest software releases and archived software
- **General Technical Support** – Frequently Asked Questions (FAQs), technical support requests, online discussion groups, Microchip consultant program member listing
- **Business of Microchip** – Product selector and ordering guides, latest Microchip press releases, listing of seminars and events; and listings of Microchip sales offices, distributors and factory representatives

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- Local Sales Office
- Corporate Application Engineer (CAE)
- Embedded Solutions Engineer (ESE)

Customers should contact their distributor, representative or Embedded Solutions Engineer (ESE) 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 website at:

http://www.microchip.com/support.

DOCUMENT REVISION HISTORY

Revision A (October 2018)

This is the initial release of this document.

NOTES:

Chapter 1. Overview

1.1 INTRODUCTION

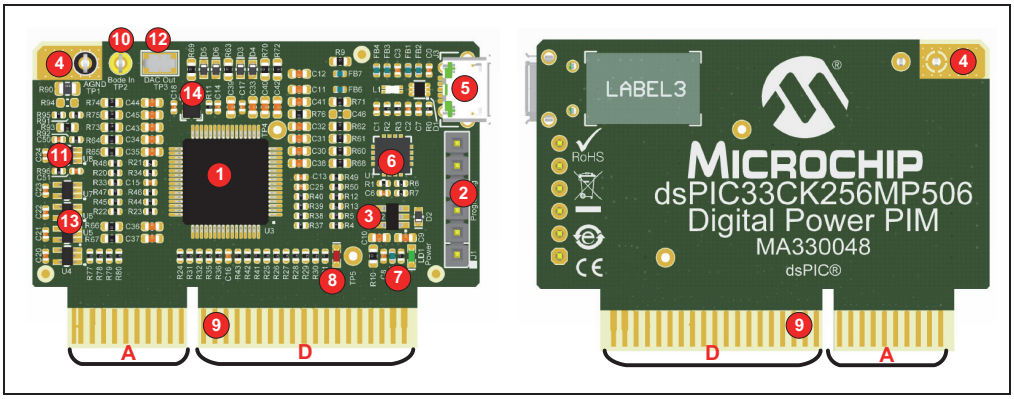
The dsPIC33CK256MP506 Digital Power Plug-In Module (DP PIM) is a demonstration board that, in conjunction with different power boards, showcases the Microchip dsPIC33CK256MP506 16-bit Digital Signal Controller (DSC) features. The DP PIM provides access to the dsPIC33CK256MP506 analog inputs, the Digital-to-Analog Converter (DAC) output, the Pulse-Width Modulator (PWM) outputs and the General Purpose Input and Output (GPIO) ports.

The Microchip series of DP PIMs for digital power share the same pinout at the mating socket. However, these PIM cards show slightly different performing characteristics.

1.2 FEATURES

The dsPIC33CK256MP506 DP PIM has the following features, as shown in Figure 1-1:

FIGURE 1-1: dsPIC33CK256MP506 DP PIM



1. Microchip dsPIC33CK256MP506 16-Bit Digital Signal Controller (64-pin TQFP package).
2. ICSP™ programming header (6-pin, 2.54 mm header).
3. On-board LDO with Power Good (PG) function.
4. Solder pad for ground connection.
5. Micro USB connector.
6. MCP2221A USB to UART/I^{2}C serial converter.
7. Power indicator LED (Green).
8. User LED (Red).
9. Board edge connection interface for analog inputs/outputs, PWM outputs and GPIO ports.
10. Analog input with op amp buffer via test point loop connector; can be used for Bode plot measurements.
11. Op amp buffer for Bode input.
12. Test point loop for DAC output.
13. Op amp buffers for shared ADC inputs.
14. MEMS oscillator.

Board dimensions are: 51 mm (length) x 38.5 mm (width).

1.2.1 Test Points

Table 1-1 lists the test points on the dsPIC33CK256MP506 DP PIM.

TABLE 1-1: TEST POINTS

Test Point Name	Function/Description
TP1, TP2	Bode Measurement Signal Insert Point
TP3	RA3_DAC1_OUT: Digital-to-Analog Converter Output
TP4	Test Point for Debug (right upper corner of the MCU)
TP5	General Purpose Test Point Connected to Port RD15 together with LD2 (Red LED) (near to the right bottom corner beside LD2)

1.2.2 Electrical Characteristics

Table 1-2 shows the electrical characteristics of the dsPIC33CK256MP506 DP PIM.

TABLE 1-2: ELECTRICAL CHARACTERISTICS

Parameter	Value
Input Voltage Range	3.6 VDC to 6.3 VDC
Current Consumption	<100 mA
Power Dissipation	<0.6W max.
Operating Temperature Range	-40°C to +85°C

1.2.3 Analog and Digital Signals

The dsPIC33CK256MP506 DP PIM ensures good signal integrity and provides all signals needed to control a power train. These signals are divided into two main sections: Analog, marked with A; Digital, marked with D (see Figure 1-1).

1. Analog Section
   The analog section is located at the left connector side (smaller section in Figure 1-1). It consists of 17 signals, all referenced to analog ground. These lines are split into four subsections:
   - High-Speed Comparator Inputs: RC filtered with corner frequency of 10 MHz and maximum signal rise/fall time of 33 ns. These lines are designed to be used with on-chip comparators for signal zero-cross detections, etc.
   - High-Speed ADC Inputs: RC filtered with corner frequency of 2 MHz and maximum signal rise/fall time of 180 ns. These lines are connected to the Track-and-Hold (T&H) circuitry of the dedicated ADC inputs and to the Sample-and-Hold (S&H) circuitry of the shared ADC inputs.
   - High-Speed ADC Inputs: Buffered through operational amplifiers. RC filtered with corner frequency of 1 MHz and maximum signal rise/fall time of 347 ns. These lines are connected to the Sample-and-Hold (S&H) circuitry of the shared ADC inputs.
   - Medium Speed ADC Inputs: RC filtered with corner frequency of 190 kHz and maximum signal rise/fall time of 1.8 µs. These lines are connected to the Sample-and-Hold (S&H) circuitry of the shared ADC inputs. The different RC filtering is needed because of the significant difference between T&H and S&H circuitry, and the sampling times.

2. Digital Section
   The digital section is located at the right connector side (larger section in Figure 1-1). It consists of 31 signals, all referenced to digital ground. These lines are split into four subsections:
   - High-Speed PWM Outputs: Each line has a 75Ω series resistance.
   - Medium Speed GPIO: Each line has a 270Ω series resistance.
   - Programing/Debugging Lines: Each line has a 100Ω series resistance.
   - Communication Lines (I^2C): Each line has a 100Ω series resistance.

Note:	RC filtering and series resistance are needed for good signal integrity, and for reducing EMI issues. Hence, the board can be used for development purposes under frequent plug-in/out cycles. This decoupling also increases robustness in case of accidental shorts and EMC issues.

1.2.4 dsPIC33CK256MP506 DP PIM – PCB Edge Connector

The dsPIC33CK256MP506 DP PIM has an edge connector compatible with any application board that provides a mating socket.

The mating socket type is Samtec, Inc.: MECF-30-01-L-DV-WT.

1.3 UART COMMUNICATION

The on-board USB to UART serial bridge enables easy serial connection to PCs. The USB port can provide power to the digital power PIM and allows the user to communicate with the dsPIC® Digital Signal Controller (DSC).

1.4 LOW-FREQUENCY BODE PLOT MEASUREMENTS

The dsPIC33CK256MP506 device, with the additional on-board circuitry, is able to perform Bode plot measurements without the need for an isolation transformer. The transformer might be difficult to use if the injecting signal tends to be at a very low frequency (for instance, in case of Power Factor Correction (PFC) applications).

Perform the following steps:

1. Solder the 150Ω resistor from position R74 to R94.
2. Run the power stage in Open-Loop mode with a fixed duty cycle.
3. Connect the Bode 100 AC output across TP2 and TP1. The on-board operational amplifier is adding a $V_{DD}/2$ (1.65V) offset. In this case, no injection transformer is needed.
4. Connect RA3_DAC1_OUT to CH2 of the Bode 100.
5. Use the AN18 input to sample the signal from Bode 100 in every PWM cycle at Frequency Switching (FSW) (action in firmware is needed).
6. Remove the $V_{DD}/2$ offset to regain a signal with no DC value (action in firmware is needed).
7. Add sampled AC signal to the nominal duty cycle (PDCx) (action in firmware is needed).
8. Use a second dedicated ADC core input (ANx) to sample the output of the plant at FSW. The output can be:
   - Output voltage
   - Average coil current sampled at $T_{ON}/2$, where T_{ON} is the switch-on time.
9. Duty cycle input and plant output are converted into an analog signal using RA3_DAC1_OUT.

Measured transfer function is the plant (Power Stage + Digital Modulator), after scaling and ADC sampling, versus digital duty cycle input (PDCx).

Note: Due to run-time delays of Sample-and-Hold circuits and conversion time of ADC and DAC, this measurement is only recommended for low-frequency measurements (a maximum of two decades below sampling frequency).

Figure 1-2 and Figure 1-3 show measuring procedure examples for plant and closed-loop measurements.

FIGURE 1-2: MEASURING PROCEDURE FOR PLANT MEASUREMENT

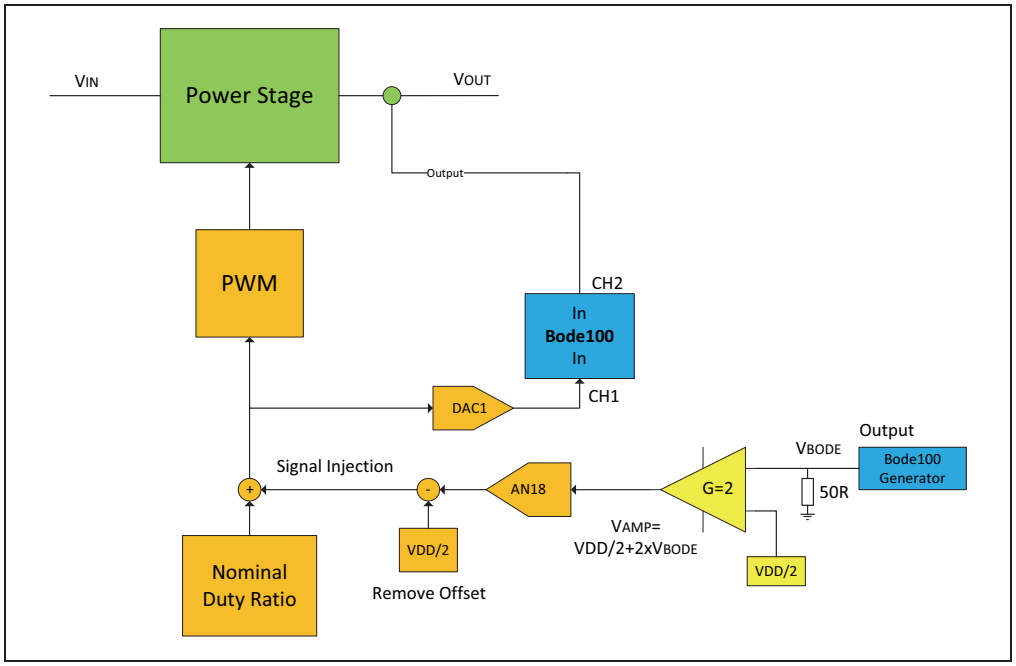
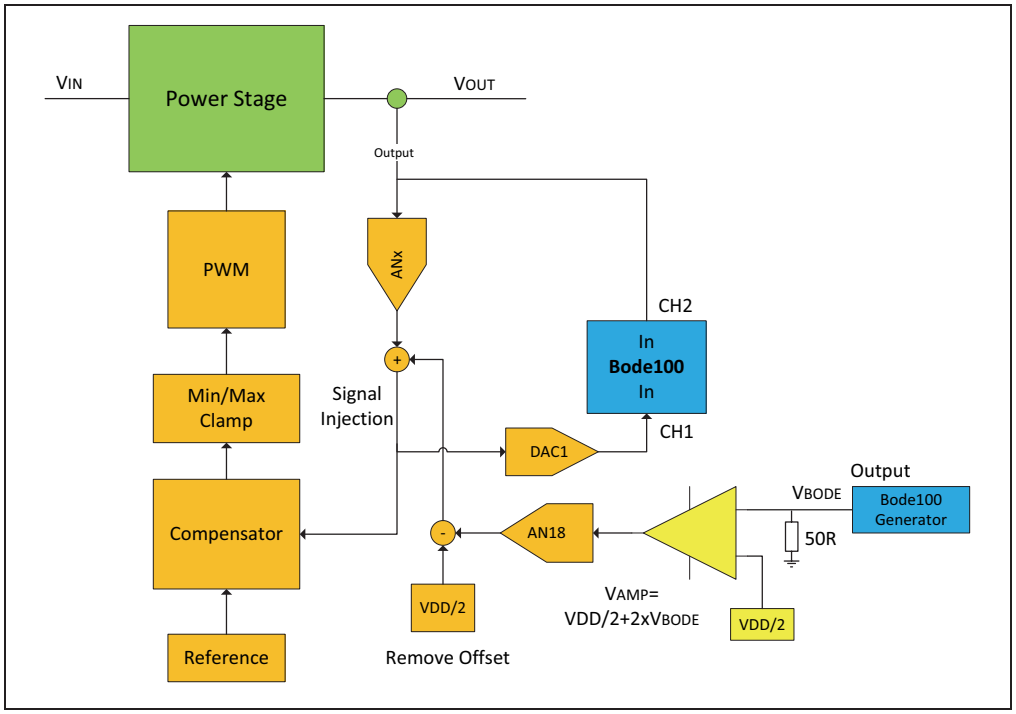


FIGURE 1-3: MEASURING PROCEDURE FOR CLOSED-LOOP MEASUREMENT



Appendix A. Board Layout and Schematics

This appendix contains the pinout, the schematics and the board layouts for the dsPIC33CK256MP506 DP PIM.

- Pinout
- Board Schematics
- PCB Layout

A.1 PINOUT

Pinout and electrical parameters are shown in Table A-1.

TABLE A-1: PINOUT AND ELECTRICAL PARAMETERS

Name	Edge Connector Pin	Device Pin	Function/Description	Remark
GND_A	1	20	Analog Ground	—
GND_A	2	20	Analog Ground	—
RA3_DAC1_OUT	3	17	DAC Output, Optional RC Filter	560R series resistance
RC3_AN15_IN	4	27	Analog Input, RC Filtered	Fc = 190 kHz, tr = 1.8 µs
RB8_AN10_IN	5	48	Analog Input, RC Filtered, Buffered	Fc = 1 MHz, tr = 347 ns
RB2_AN1_IN	6	33	Analog Input, RC Filtered	Fc = 1.9 MHz, tr = 180 ns
—	7	—	—	—
RA4_CMP3B_IN	8	18	Analog Input, RC Filtered	Fc = 10 MHz, tr = 33 ns
RC6_AN17_IN	9	24	Analog Input, RC Filtered, Buffered	Fc = 1 MHz, tr = 347 ns
RB7_AN2_IN	10	47	Analog Input, RC Filtered, Buffered	Fc = 1 MHz, tr = 347 ns
RA1_ANA1_IN	11	15	Analog Input, RC Filtered	Fc = 1.9 MHz, tr = 180 ns
RA0_AN0_IN	12	14	Analog Input, RC Filtered	Fc = 1.9 MHz, tr = 180 ns
RD11_AN19_IN	13	30	Analog Input, RC Filtered	Fc = 1.9 MHz, tr = 180 ns
RC7_AN16_IN	14	32	Analog Input, RC Filtered, Buffered	Fc = 1 MHz, tr = 347 ns
RD10_AN18_IN	15	31	Analog Input, RC Filtered, Optional Bode Input	Fc = 1.9 MHz, tr = 180 ns
RC0_AN12_IN	16	13	Analog Input, RC Filtered	Fc = 190 kHz, tr = 1.8 µs
RC2_AN14_IN	17	23	Analog Input, RC Filtered	Fc = 190 kHz, tr = 1.8 µs
RC1_CMP1B_IN	18	22	Analog Input, RC Filtered	Fc = 10 MHz, tr = 33 ns
RA2_AN9_IN	19	16	Analog Input, RC Filtered	Fc = 190 kHz, tr = 1.8 µs
RB1_AN6_IN	20	29	Analog Input, RC Filtered	Fc = 190 kHz, tr = 1.8 µs
slot	21	slot	slot	slot
slot	22	slot	slot	slot
RB9_RP41	23	49	Digital General Purpose	270R series resistance

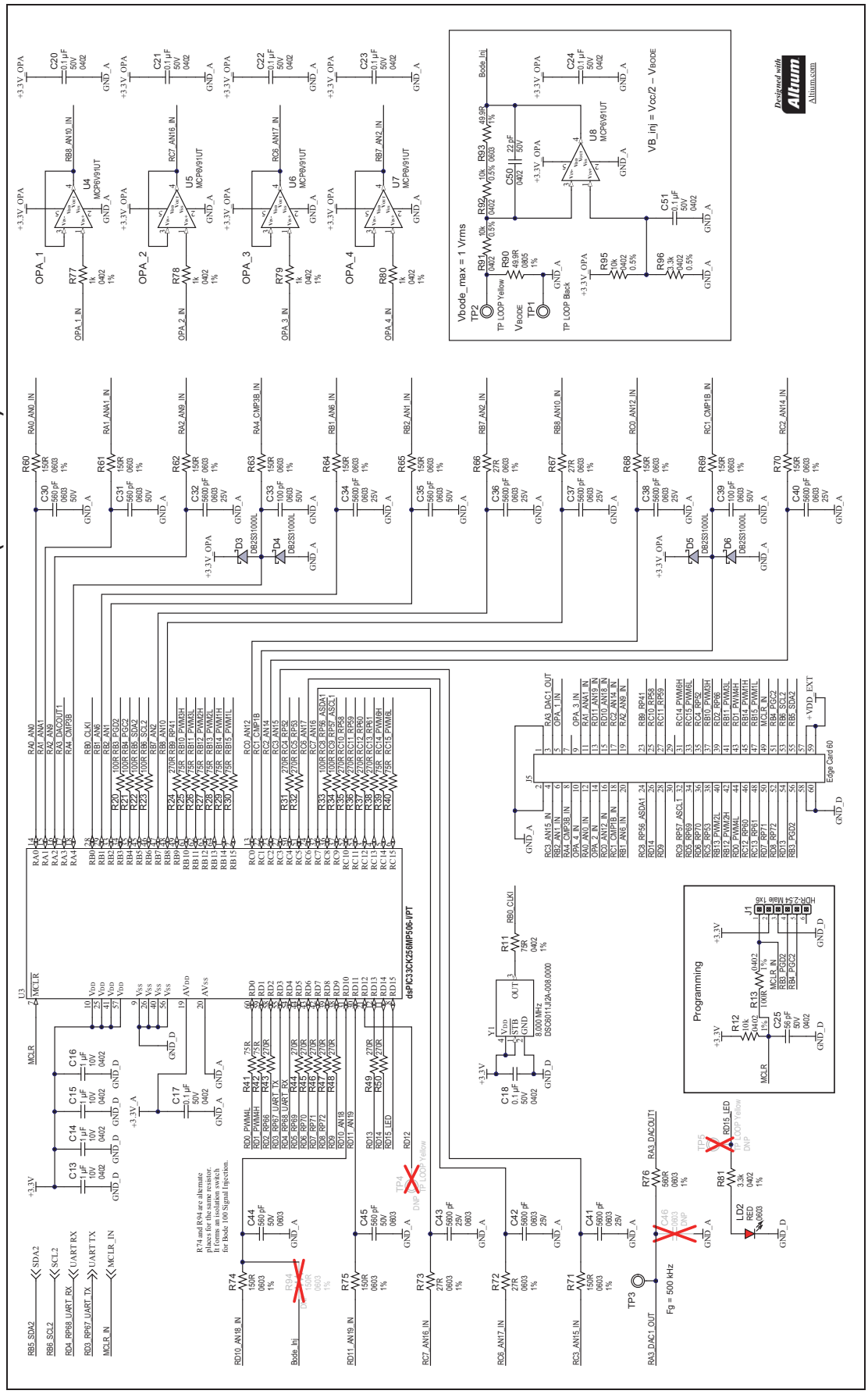
TABLE A-1: PINOUT AND ELECTRICAL PARAMETERS (CONTINUED)

Name	Edge Connector Pin	Device Pin	Function/Description	Remark
RC8_RP56_ASDA1	24	36	Digital General Purpose	100R series resistance
RC10_RP58	25	52	Digital General Purpose	270R series resistance
RD14	26	11	Digital General Purpose	270R series resistance
RC11_RP59	27	53	Digital General Purpose	270R series resistance
RD9	28	38	Digital General Purpose	270R series resistance
—	29	—	—	—
—	30	—	—	—
RC14_PWM6H	31	5	PWM Output	75R series resistance
RC9_RP57_ASCL1	32	37	Digital General Purpose	100R series resistance
RC15_PWM6L	33	6	PWM Output	75R series resistance
RD5_RP69	34	44	Digital General Purpose	270R series resistance
RC4_RP52	35	50	Digital General Purpose	270R series resistance
RD6_RP70	36	43	Digital General Purpose	270R series resistance
RB10_PWM3H	37	61	Digital General Purpose	75R series resistance
RC5_RP53	38	51	Digital General Purpose	270R series resistance
RD2_RP66	39	58	Digital General Purpose	270R series resistance
RB13_PWM2L	40	64	PWM Output	75R series resistance
RB11_PWM3L	41	62	PWM Output	75R series resistance
RB12_PWM2H	42	63	PWM Output	75R series resistance
RD1_PWM4H	43	59	PWM Output	75R series resistance
RD0_PWM4L	44	60	PWM Output	75R series resistance
RB14_PWM1H	45	1	PWM Output	75R series resistance
RC12_RP60	46	3	Digital General Purpose	270R series resistance
RB15_PWM1L	47	2	PWM Output	75R series resistance
RC13_RP61	48	4	Digital General Purpose	270R series resistance
MCLR_IN	49	7	Device Reset	100R series resistance
RD7_RP71	50	42	Digital General Purpose	270R series resistance
RB4_PGC2	51	35	Programing/Debugging	100R series resistance
RD8_RP72	52	39	Digital General Purpose	270R series resistance
RB6_SCL2	53	46	Digital General Purpose	100R series resistance
RD13	54	12	Digital General Purpose	270R series resistance
RB5_SDA2	55	45	Digital General Purpose	100R series resistance
RB3_PGD2	56	34	Programing/Debugging	100R series resistance
VDD	57	LDO	VDD Rail	6.3V max, 70 mA max
GND_D	58	9,26,40,56	Digital Ground	—
VDD	59	LDO	VDD Rail	6.3V max, 70 mA max
GND_D	60	9,26,40,56	Digital Ground	—

A.2 BOARD SCHEMATICS

Figure A-1 and Figure A-2 show the board schematics.

FIGURE A-1: dsPIC33CK256MP506 DIGITAL POWER PIM SCHEMATIC REV. 1.0 (PAGE 1 OF 2)



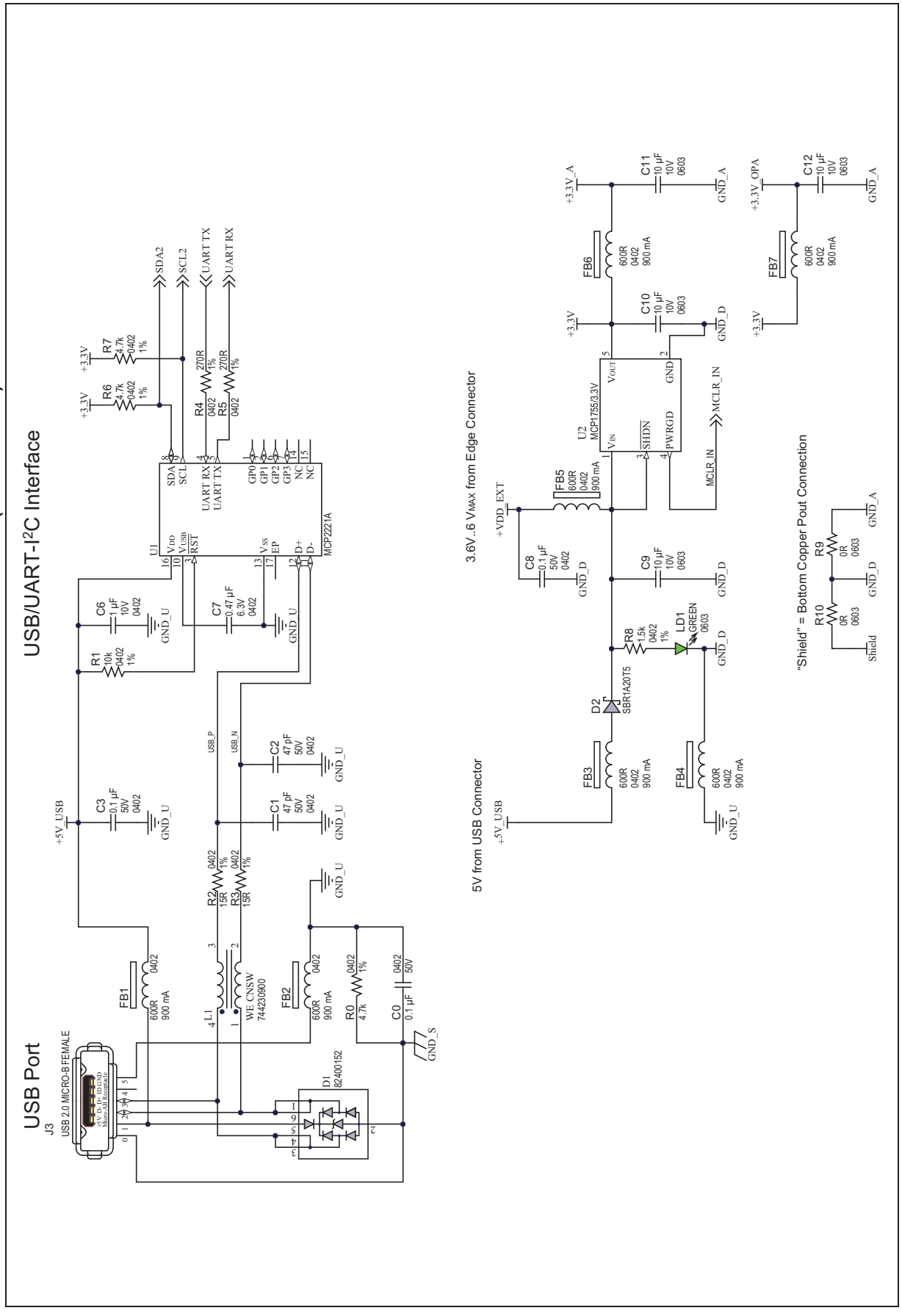
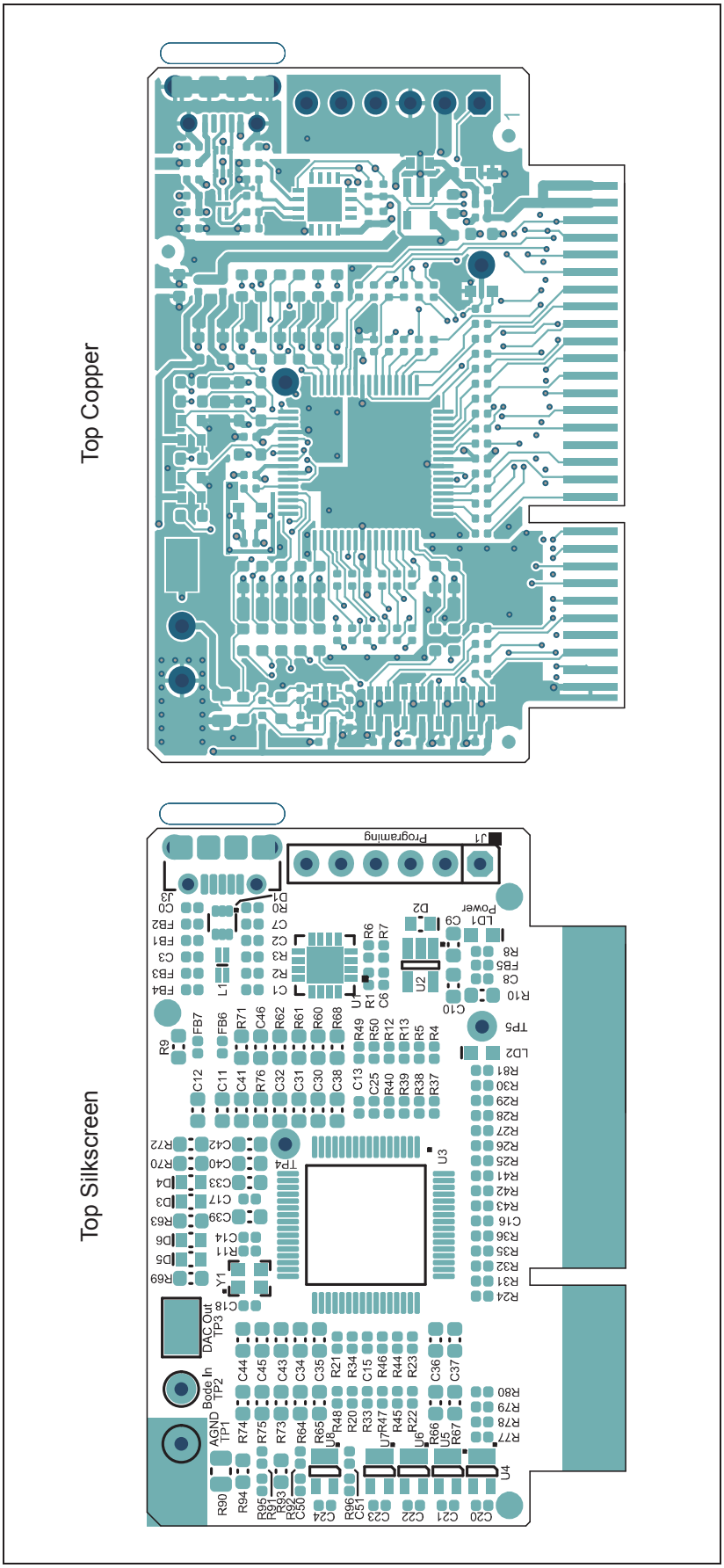


FIGURE A-2: dsPIC33CK256MP506 DIGITAL POWER PIM SCHEMATIC REV. 1.0 (PAGE 2 OF 2)

A.3 PCB LAYOUT

The dsPIC33CK256MP506 DP PIM is a four-layer FR4, 1.55 mm, Plated-Through-Hole (PTH) PCB construction. Figure A-3 through Figure A-5 illustrate the PCB layers and Figure A-6 shows the assembly drawings of the dsPIC33CK256MP506 DP PIM.

FIGURE A-3: dsPIC33CK256MP506 DIGITAL POWER PIM TOP SILKSCREEN AND TOP COPPER



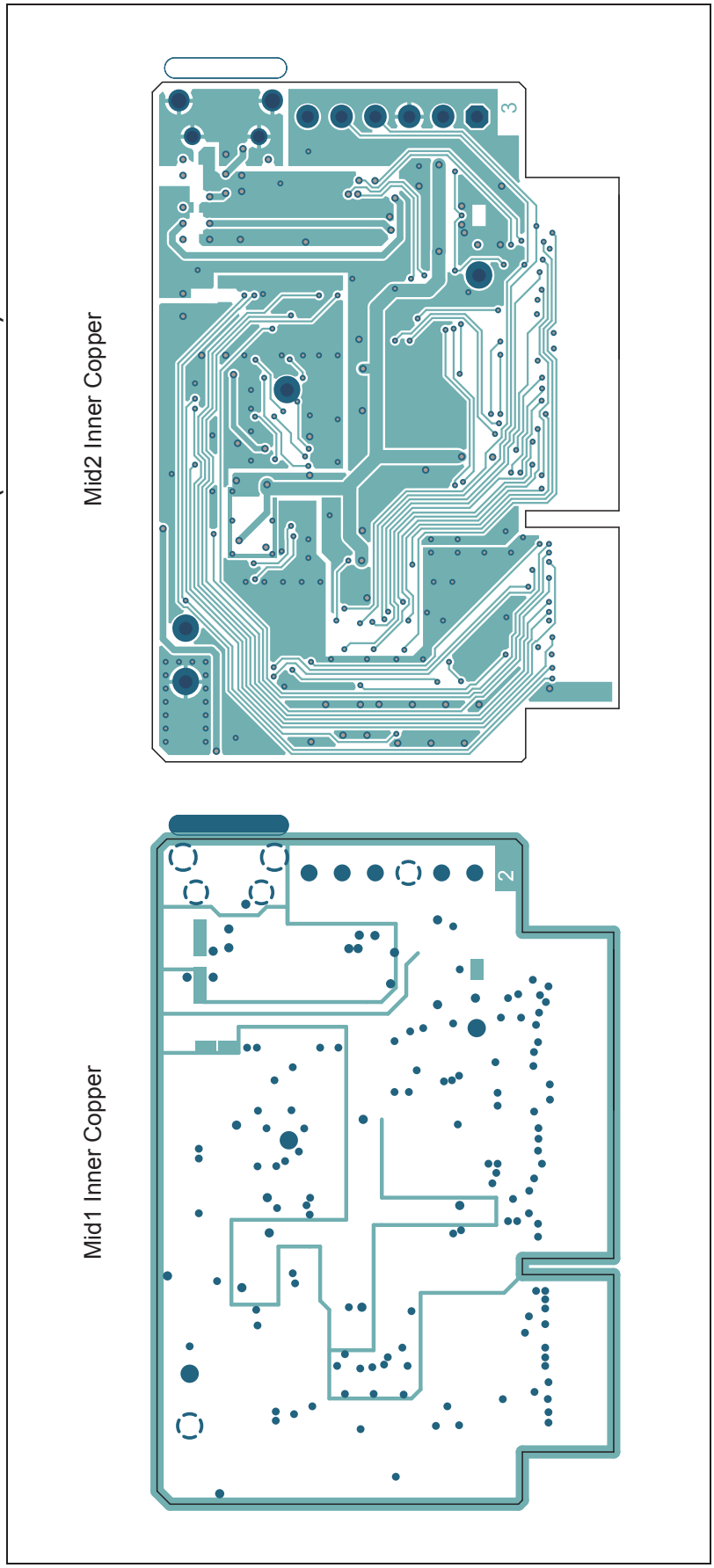


FIGURE A-4: dsPIC33CK256MP506 DIGITAL POWER PIM MID1 AND MID2 INNER COPPER (BOTTOM VIEW)

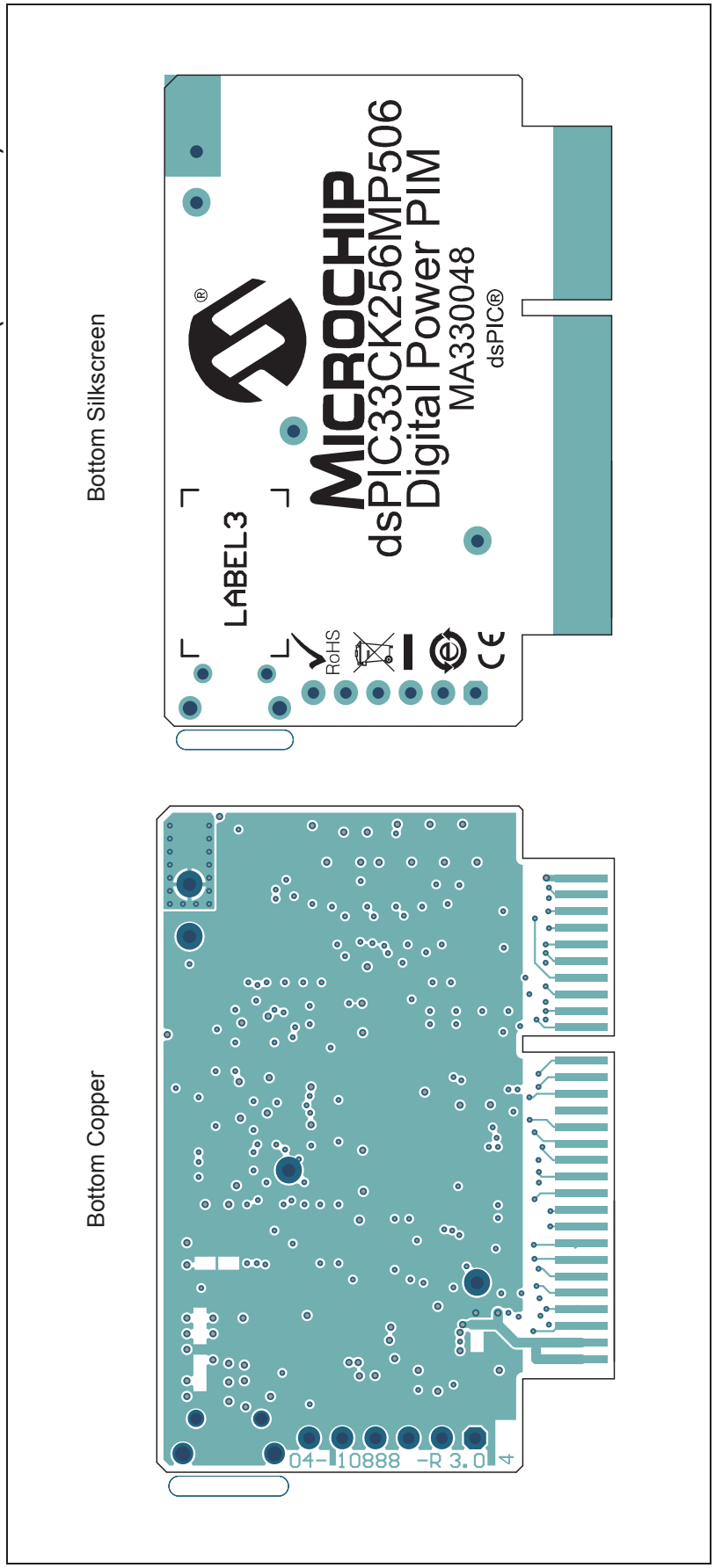


FIGURE A-5: dsPIC33CK256MP506 DIGITAL POWER PIM BOTTOM COPPER AND BOTTOM SILKSCREEN (BOTTOM VIEW)

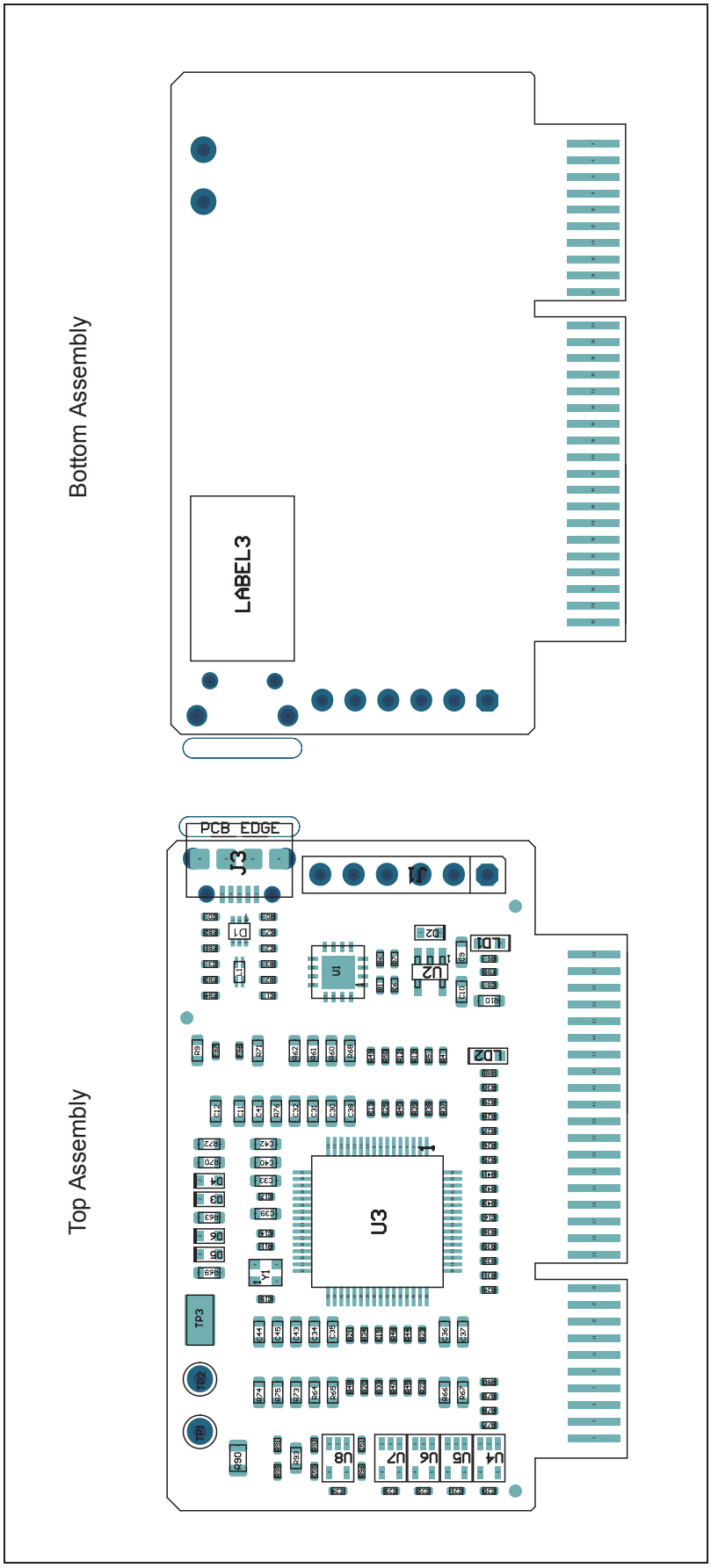


FIGURE A-6: dsPIC33CK256MP506 DIGITAL POWER PIM TOP AND BOTTOM ASSEMBLY

Appendix B. Bill of Materials (BOM)

This appendix contains the Bill of Materials (BOM) for the dsPIC33CK256MP506 Digital Power PIM.

- Bill of Materials

B.1 BILL OF MATERIALS

Table B-1 shows the Bill of Materials for the dsPIC33CK256MP506.

TABLE B-1: dsPIC33CK256MP506 DIGITAL POWER PIM BILL OF MATERIALS (BOM)

Qty.	Designator	Description	Manufacturer	Manufacturer Part Number
11	C0, C3, C8, C17, C18, C20, C21, C22, C23, C24, C51	Capacitor, Ceramic, 0.1 µF, 50V, 10%, X7R, SMD, 0402	TDK Corporation	C1005X7R1H104K050BB
2	C1, C2	Capacitor, Ceramic, 47 pF, 50V, 5%, NP0, SMD, 0402	Murata Electronics®	GRM1555C1H470JA01D
5	C6, C13, C14, C15, C16	Capacitor, Ceramic, 1 µF, 10V, 10%, X7S, SMD, 0402	TDK Corporation	C1005X7S1A105K050BC
1	C7	Capacitor, Ceramic, 0.47 µF, 6.3V, 10%, X5R, SMD, 0402	Murata Electronics	GRM155R60J474KE19D
4	C9, C10, C11, C12	Capacitor, Ceramic, 10 µF, 10V, 20%, X5R, SMD, 0603	Samsung Group	CL10A106MP8NNNC
1	C25	Capacitor, Ceramic, 56 pF, 50V, 5%, C0G, SMD, 0402	TDK Corporation	C1005C0G1H560J050BA
5	C30, C31, C35, C44, C45	Capacitor, Ceramic, 560 pF, 50V, 5%, C0G, NP0, SMD, 0603	KEMET	C0603C561J5GACTU
9	C32, C34, C36, C37, C38, C40, C41, C42, C43	Capacitor, Ceramic, 5600 pF, 25V, 5%, C0G, SMD, 0603	TDK Corporation	C1608C0G1E562J080AA
2	C33, C39	Capacitor, Ceramic, 100 pF, 50V, 5%, NP0, SMD, 0603	Cal-Chip Electronics Inc.	GMC10CG101J50NTLF
1	C50	Capacitor, HiQ, 22 pF, 50V, 5%, NP0, 1.95 GHz, SMD, 0402	Johanson Technology Inc.	500R07S220JV4T
1	D1	Diode, TVS Array, 82400152, 5V, USB 2.0, SMD, SOT-563	Wurth Elektronik	82400152
1	D2	Diode Schottky, SBR1A20T5-7, 520 mV, 1A, 20V, SOD-523	Diodes Incorporated®	SBR1A20T5-7
4	D3, D4, D5, D6	Diode Schottky, DB2S31000L, 470 mV, 200 mA, 30V, SMD, SOD-523	Panasonic® - ECG	DB2S31000L
7	FB1, FB2, FB3, FB4, FB5, FB6, FB7	Ferrite, 600R at 100 MHz, 0.23R, 900 mA, SMD, 0402	Murata Electronics	BLM15PX601SN1D

TABLE B-1: dsPIC33CK256MP506 DIGITAL POWER PIM BILL OF MATERIALS (BOM) (CONTINUED)

Qty.	Designator	Description	Manufacturer	Manufacturer Part Number
1	J1	Connector Header-2.54 Male, 1x6, Gold, 5.84MH, TH, Vertical	FCI	68000-106HLF
1	J3	Connector, USB 2.0 micro-B, Female, TH/SMD, R/A	FCI	10118194-0001LF
1	L1	Common-Mode Choke, 90R, 100 MHz, 0.145R, 550 mA, SMD, 0603	Wurth Elektronik	744230900
1	LD1	Diode LED Green, 2V, 30 mA, 35 mcd, Clear, SMD, 0603	Lite-On®, Inc.	LTST-C190KGKT
1	LD2	Diode LED Red, 1.8V, 40 mA, 10 mcd, Clear, SMD, 0603	Lite-On, Inc.	LTST-C190KRKT
3	R0, R6, R7	Resistor TKF, 4.7k, 1%, 1/10W, 0402	KOA Speer Electronics, Inc.	RK73H1ETTP4701F
2	R1, R12	Resistor TKF, 10k, 1%, 1/10W, SMD, 0402	Panasonic® - ECG	ERJ-2RKF1002X
2	R2, R3	Resistor TKF, 15R, 1%, 1/10W, SMD, 0402	Panasonic - ECG	ERJ-2RKF15R0X
17	R4, R5, R24, R31, R32, R35, R36, R37, R38, R43, R44, R45, R46, R47, R48, R49, R50	Resistor TKF, 270R, 1%, 1/10W, SMD, 0402	Panasonic - ECG	ERJ-2RKF2700X
1	R8	Resistor TKF, 1.5k, 1%, 1/16W, SMD, 0402	Yageo Corporation	RC0402FR-0775RL
2	R9, R10	Resistor TKF, 0R, 1/10W, SMD, 0603	NIC Components Corp.	NRC06Z0TRF
11	R11, R25, R26, R27, R28, R29, R30, R39, R40, R41, R42	Resistor TKF, 75R, 1%, 1/16W, SMD, 0402	Yageo Corporation	RC0402FR-0775RL
7	R13, R20, R21, R22, R23, R33, R34	Resistor TKF, 100R, 1%, 1/10W, SMD, 0402	Panasonic - ECG	ERJ-2RKF1000X
12	R60, R61, R62, R63, R64, R65, R68, R69, R70, R71, R74, R75	Resistor TKF, 150R, 1%, 1/10W, SMD, 0603	Stackpole Electronics, Inc.	RMCF0603FT150R
4	R66, R67, R72, R73	Resistor TKF, 27R, 1%, 1/10W, SMD, 0603	Yageo Corporation	RC0603FR-0727RL
1	R76	Resistor TKF, 560R, 1%, 1/10W, SMD, 0603	Yageo Corporation	RC0603FR-07560RL
4	R77, R78, R79, R80	Resistor TKF, 1k, 1%, 1/10W, SMD, 0402	Panasonic - ECG	ERJ-2RKF1001X
1	R81	Resistor TKF, 3.3k, 1%, 1/10W, SMD, 0402	Panasonic - ECG	ERJ-2RKF3301X
1	R90	Resistor TKF, 49.9R, 1%, 1/8W, SMD, 0805	Panasonic - ECG	ERJ-6ENF49R9V
3	R91, R92, R95	Resistor TF, 10k, 0.5%, 1/16W, SMD, 0402	Susumu Co., Ltd.	RR0510P-103-D
1	R93	Resistor TKF, 49.9R, 1%, 1/10W, SMD, 0603	Panasonic - ECG	ERJ-3EKF49R9V

TABLE B-1: dsPIC33CK256MP506 DIGITAL POWER PIM BILL OF MATERIALS (BOM) (CONTINUED)

Qty.	Designator	Description	Manufacturer	Manufacturer Part Number
1	R96	Resistor TKF, 3.3k, 0.5%, 1/16W, SMD, 0402	Panasonic® - ECG	ERA-2AED332X
1	TP1	Misc, Test Point Multipurpose Mini, Black	Keystone Electronics Corp.	5001
1	TP2	Misc, Test Point PC Mini, 0.040", D, Yellow	Keystone Electronics Corp.	5004
1	TP3	Connector, Test Point, TAB, Silver, Mini, 3.8x2.03, SMD	Keystone Electronics Corp.	5019
1	U1	Microchip Interface, USB, I^2C/UART, MCP2221A-I/ML, QFN-16	Microchip Technology Inc.	MCP2221A-I/ML
1	U2	Microchip Analog LDO, 3.3V, MCP1755T-3302E/OT, SOT-23-5	Microchip Technology Inc.	MCP1755T-3302E/OT
1	U3	Microchip MCU, 16-Bit, 100 MIPS, 256k, 24k, dsPIC33CK256MP506-I/PT, TQFP-64	Microchip Technology Inc.	dsPIC33CK256MP506-I/PT
5	U4, U5, U6, U7, U8	Microchip Analog Op Amp, 1-Ch, 10 MHz, MCP6V91UT-E/LTYCT-ND, SC-70-5	Microchip Technology Inc.	MCP6V91UT-E/LTY
1	Y1	Microchip Clock Oscillator, Single, 8.000 MHz, DSC6011JI2A-008.0000, VDFN-4	Microchip Technology Inc.	DSC6011JI2A-008.0000

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