dsPIC33AK512MPS506 Digital Power Plug-In Module (PIM) User Guide

Introduction

The dsPIC33AK512MPS506 Digital Power Plug-In Module (DP PIM) is a demonstration board that, in conjunction with different power boards, showcases the Microchip dsPIC33AK512MPS506 Digital Signal Controller (DSC) features. The DP PIM provides access to the dsPIC33AK512MPS506 High-Speed 12-Bit Resolution Analog-to-Digital Converter (ADC) inputs, the Digital-to-Analog Converter (DAC) output, the High-Speed Pulse-Width Modulator (PWM) with Fine Edge Placement outputs and the General-Purpose Input/Output (GPIO) ports.

All dsPIC33 DP-PIMs share the same socket pinout. However, these PIM may vary in performance characteristics.

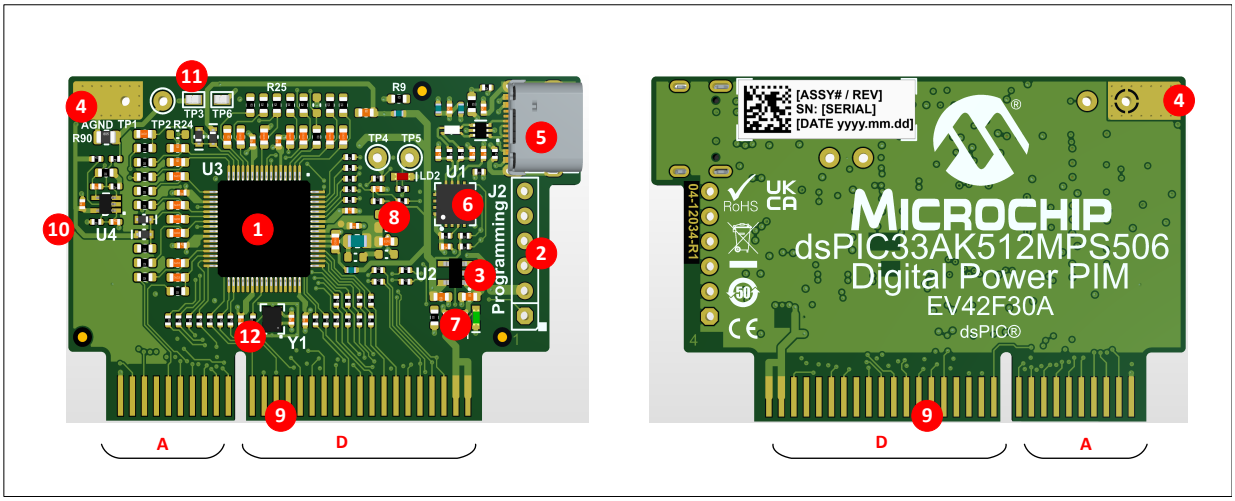
Table of Contents

1. Overview

1.1. Features

The dsPIC33AK512MPS506 DP PIM has the following subcomponents, as shown in Figure 1-1:

Figure 1-1. dsPIC33AK512MPS506 DP PIM



1. Microchip dsPIC33AK512MPS506 32-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. USB-C Connector
6. MCP2221A USB to UART/I^{2}C Serial Converter
7. Power Indicator LED (Green)
8. User LED (Red)
9. PCB Edge Connector for Analog Inputs/Outputs, PWM Outputs and GPIO Ports
10. Op Amp Buffer for Bode Input
11. Test Point Loop for DAC Output
12. Op Amp Buffers for Shared ADC Inputs
13. MEMS Oscillator

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

1.1.1. Test Points

Table 1-1 lists the test points on the dsPIC33AK512MPS506 DP PIM.

Table 1-1. Test Points

Test Point Name	Function/Description
TP1, TP2	Bode measurement signal insert point
TP3	RC7_DAC2_OUT: Digital-to-Analog converter output
TP4	Test point for debug (right upper corner of the MCU)

Table 1-1. Test Points (continued)	
Test Point Name	**Function/Description**
TP5	General purpose test point connected to Port RD15 together with LD2 (Red LED) (near to the right bottom corner beside LD2)

1.1.2. Electrical Characteristics

Table 1-2 shows the electrical characteristics of the dsPIC33AK512MPS506 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

1.1.3. Analog and Digital Signals

The dsPIC33AK512MPS506 DP PIM ensures good signal integrity and provides all signals necessary to control a power stage. These signals are divided into two main sections: Analog, marked with A and 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 two subsections:
   - High-Speed Comparator Inputs: RC filtered with a 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 multiple applications such as zero-cross detection, Peak Current Mode (PCMC) and more.
   - High-Speed ADC Inputs: RC filtered with a corner frequency of 1.9 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.
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 47Ω series resistance.
   - GPIO: Each line has a 47Ω series resistance.
   - Programing/Debugging Lines: Each line has a 47Ω series resistance.
   - Communication Lines (I^2C): Each line has a 47Ω series resistance.

Note: RC filtering and series resistance are needed for good signal integrity and for reducing EMI issues. Therefore, the board can be used for development purposes under frequent plug-in cycles. The series resistance also limits MCU pin source/sink current in case of accidental shorts.

1.1.4. dsPIC33AK512MPS506 DP PIM – PCB Edge Connector

The dsPIC33AK512MPS506 DP PIM has an edge connector compatible with many Microchip demonstrator application boards, which offer the following mating connector for DP PIMs.

Manufacturer and Part Number: Samtec, Inc.: MECF-30-01-L-DV-WT

1.2. UART Communication

The on-board USB to UART serial bridge enables an 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).

2. Appendix A. Board Layout and Schematics

This appendix contains the pinout, schematics and board layout for the dsPIC33AK512MPS506 DP PIM.

- Pinout
- Board Schematics
- PCB Layout

2.1. Pinout

Pinout and electrical parameters are shown in Table 2-1.

Table 2-1. Pinout and Electrical Parameters

Name	Edge Connector Pin	Device Pin	Function/Description	Remark
GND_A	1	10	Analog Ground	—
GND_A	2	10	Analog Ground	—
RA1_DAC_OUT1	3	3	DAC Output, Optional RC Filter	560R series resistance
RA6_AD3AN2_IN	4	16	Analog Input, RC Filtered	Fc = 1.9 MHz, tr = 180 ns
RA0_AD3AN5_IN	5	1	Analog Input, RC Filtered	Fc = 1.9 MHz, tr = 180 ns
RA5_AD3AN0_IN	6	15	Analog Input, RC Filtered	Fc = 1.9 MHz, tr = 180 ns
—	7	—	—	—
RA4_AD1AN1_CMP1B_IN	8	14	Analog Input, RC Filtered	Fc = 10 MHz, tr = 33 ns
RB6_AD4AN1_IN	9	29	Analog Input, RC Filtered, Buffered	Fc = 1.9 MHz, tr = 180 ns
RB5_AD3AN1_IN	10	17	Analog Input, RC Filtered, Buffered	Fc = 1.9 MHz, tr = 180 ns
RA8_AD5AN3_IN	11	7	Analog Input, RC Filtered	Fc = 1.9 MHz, tr = 180 ns
RB8_AD2AN4_IN	12	23	Analog Input, RC Filtered	Fc = 1.9 MHz, tr = 180 ns
RA9_AD1AN3_IN	13	8	Analog Input, RC Filtered	Fc = 1.9 MHz, tr = 180 ns
RB7_AD4AN2_IN	14	30	Analog Input, RC Filtered	Fc = 1.9 MHz, tr = 180 ns
RA10_AD1AN4_IN	15	9	Analog Input, RC Filtered	Fc = 1.9 MHz, tr = 180 ns
RB1_AD2AN2_IN	16	21	Analog Input, RC Filtered	Fc = 1.9 MHz, tr = 180 ns
RA2_AD1AN0_IN	17	12	Analog Input, RC Filtered	Fc = 1.9 MHz, tr = 180 ns
RB2_AD2AN1_CMP2B_IN	18	22	Analog Input, RC Filtered	Fc = 10 MHz, tr = 33 ns
RA3_AD1AN2_IN	19	13	Analog Input, RC Filtered	Fc = 1.9 MHz, tr = 180 ns
RA7_AD5AN0_IN	20	2	Analog Input, RC Filtered	Fc = 1.9 MHz, tr = 180 ns
slot	21	slot	slot	slot
slot	22	slot	slot	slot
RC0_RP33	23	39	Digital General Purpose	47R series resistance
RB11_MISO2	24	32	Digital General Purpose	47R series resistance
RD4_RP53	25	61	Digital General Purpose	47R series resistance
—	26	—	—	—
—	27	—	—	—
—	28	—	—	—
—	29	—	—	—
—	30	—	—	—

Table 2-1. Pinout and Electrical Parameters (continued)

Name	Edge Connector Pin	Device Pin	Function/Description	Remark
RB0_RP17	31	20	Digital General Purpose	47R series resistance
RB10_SCK2	32	31	Digital General Purpose	47R series resistance
RD7_ASCL2	33	62	Digital General Purpose	47R series resistance
RD8_ASDA2	34	63	Digital General Purpose	47R series resistance
RB9_RP26	35	24	Digital General Purpose	47R series resistance
RC9_MOSI2	36	34	Digital General Purpose	47R series resistance
RC3_PWM3H	37	43	Digital General Purpose	47R series resistance
RA11_RP12	38	6	Digital General Purpose	47R series resistance
RC10_RP43_SER0	39	45	Digital General Purpose	47R series resistance
RD1_PWM2L	40	50	PWM Output	47R series resistance
RC4_PWM3L	41	44	PWM Output	47R series resistance
RD0_PWM2H	42	49	PWM Output	47R series resistance
RC2_PWM4H	43	41	PWM Output	47R series resistance
RC5_PWM4L	44	42	PWM Output	47R series resistance
RD2_PWM1H	45	51	PWM Output	47R series resistance
—	46	—	—	—
RD3_PWM1L	47	52	PWM Output	47R series resistance
RC8_CS2	48	33	Digital General Purpose	47R series resistance
MCLR_IN	49	64	Device Reset	100R series resistance
RC11_RP44_SER1	50	46	Digital General Purpose	47R series resistance
RB4_PGC1	51	28	Programing/Debugging	47R series resistance
—	52	—	—	—
RD5_ASCL1	53	59	Digital General Purpose	47R series resistance
—	54	—	—	—
RD6_ASDA1	55	60	Digital General Purpose	47R series resistance
RB3_PGD1	56	27	Programing/Debugging	47R series resistance
VDD_EXT	57	—	VDD Rail	6.3V max, 70 mA max
GND_D	58	4, 18, 25, 37, 47, 57	Digital Ground	—
VDD_EXT	59	—	VDD Rail	6.3V max, 70 mA max
GND_D	60	4, 18, 25, 37, 47, 57	Digital Ground	—

2.2. Board Schematics

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

Figure 2-1. dsPIC33AK512MPS506 Digital Power PIM Schematic Rev. 1.0 (Page 1 of 2)

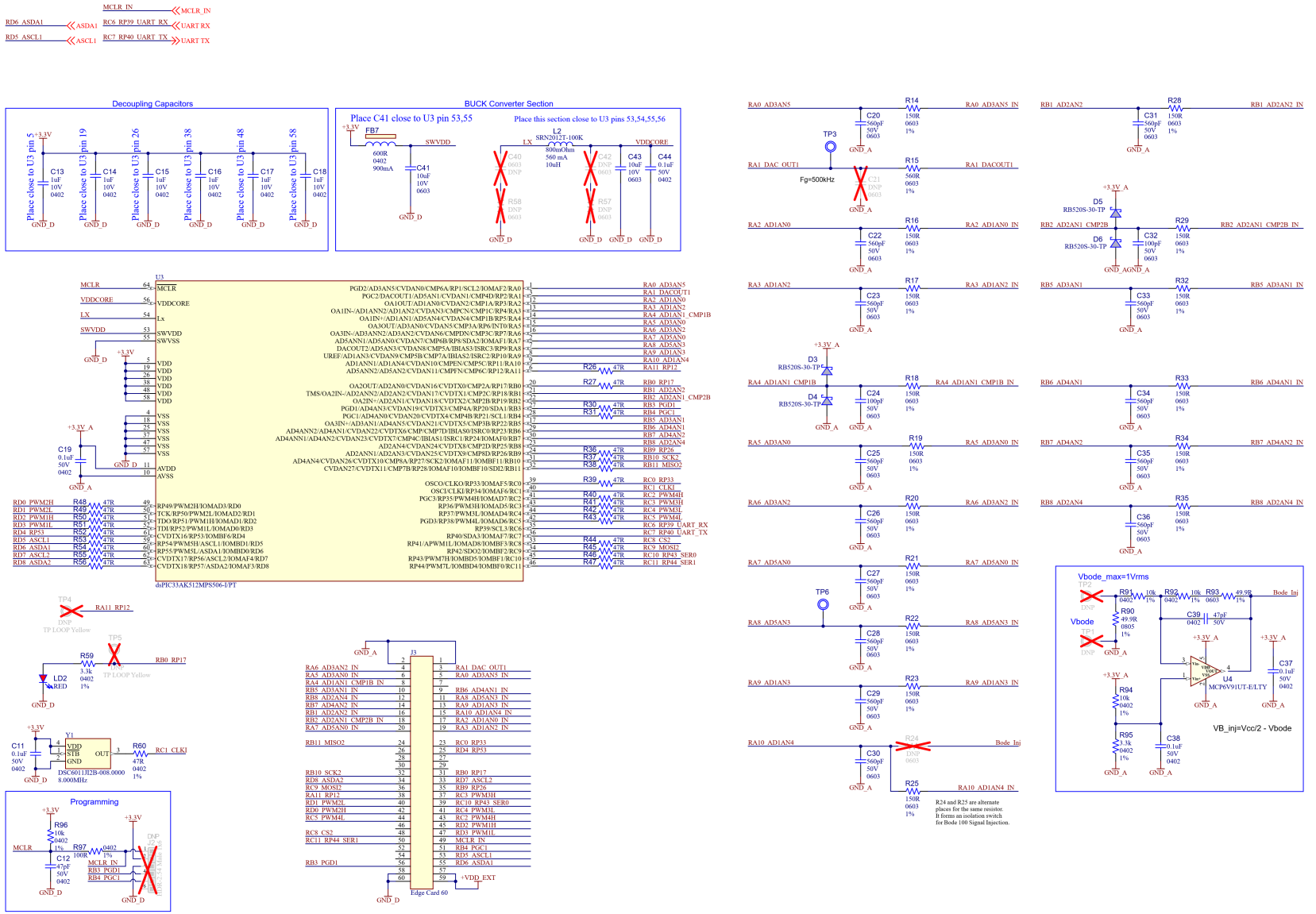
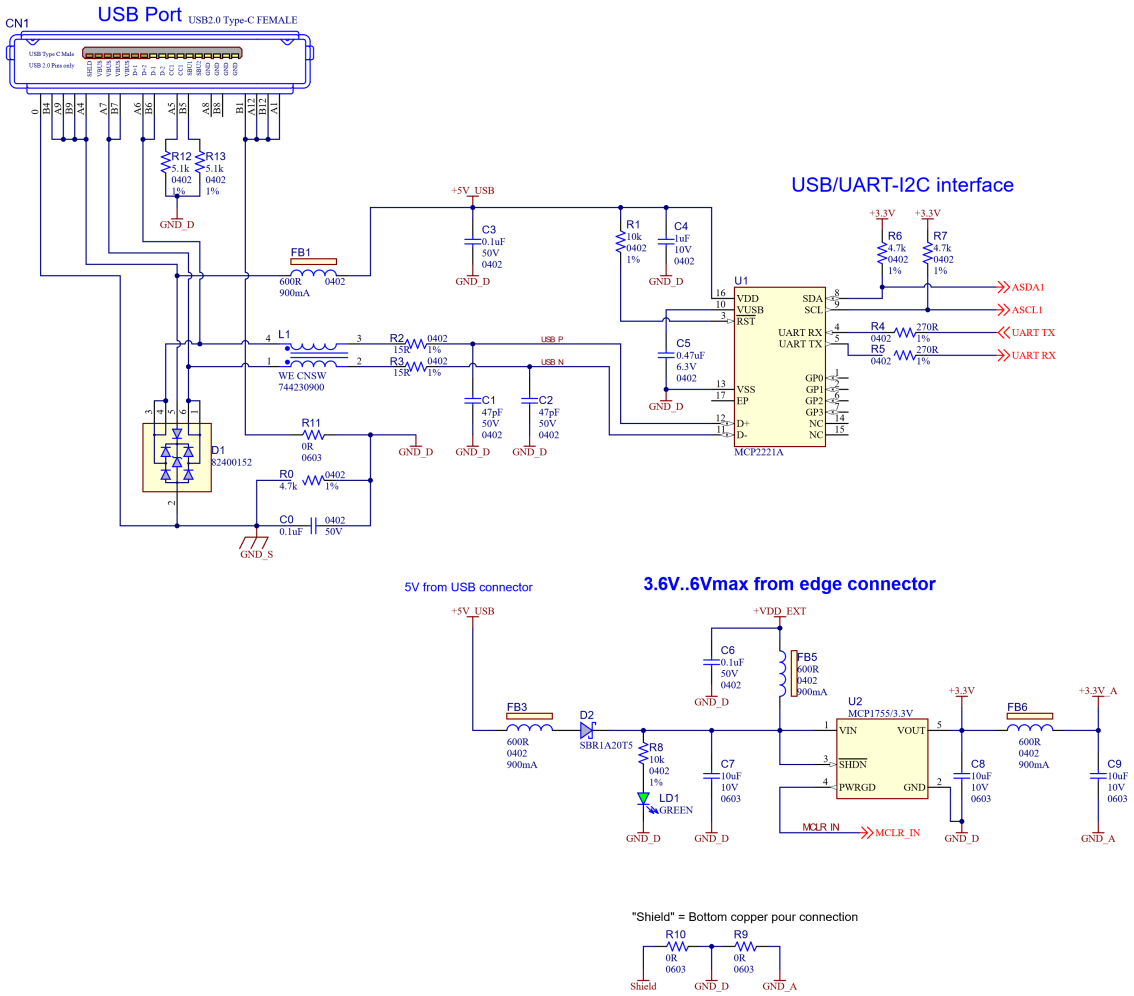


Figure 2-2. dsPIC33AK512MPS506 Digital Power PIM Schematic Rev. 1.0 (Page 2 of 2)



2.3. PCB Layout

The dsPIC33AK512MPS506 DP PIM is a four-layer FR4, 1.55 mm, Plated-Through-Hole (PTH) PCB construction. Figure 2-3 through Figure 2-5 illustrate the PCB layers and Figure 2-6 shows the assembly drawings of the dsPIC33AK512MPS506 DP PIM.

Figure 2-3. dsPIC33AK512MPS506 Digital Power PIM Top Silkscreen and Top Copper

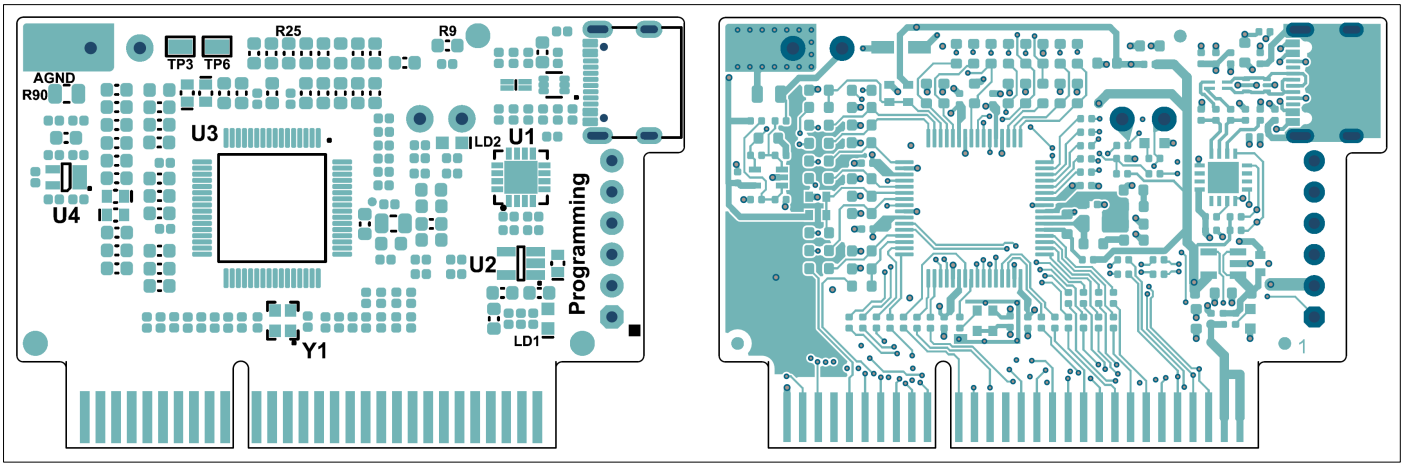


Figure 2-4. dsPIC33AK512MPS506 Digital Power PIM MID1 and MID2 Inner Copper (Bottom View)

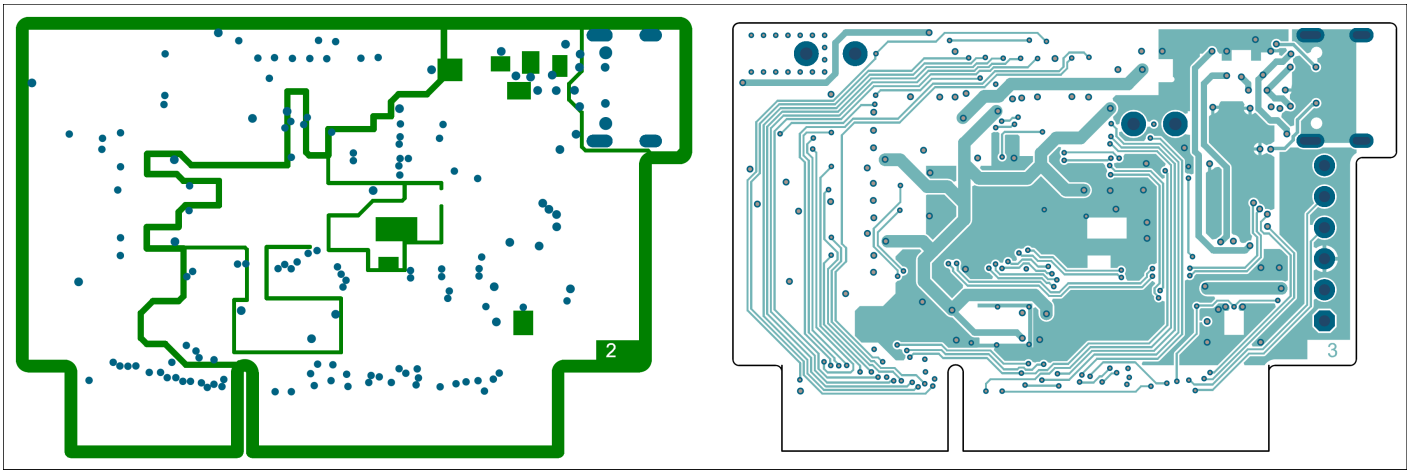


Figure 2-5. dsPIC33AK512MPS506 Digital Power PIM Bottom Silkscreen and Bottom Copper (Bottom View)

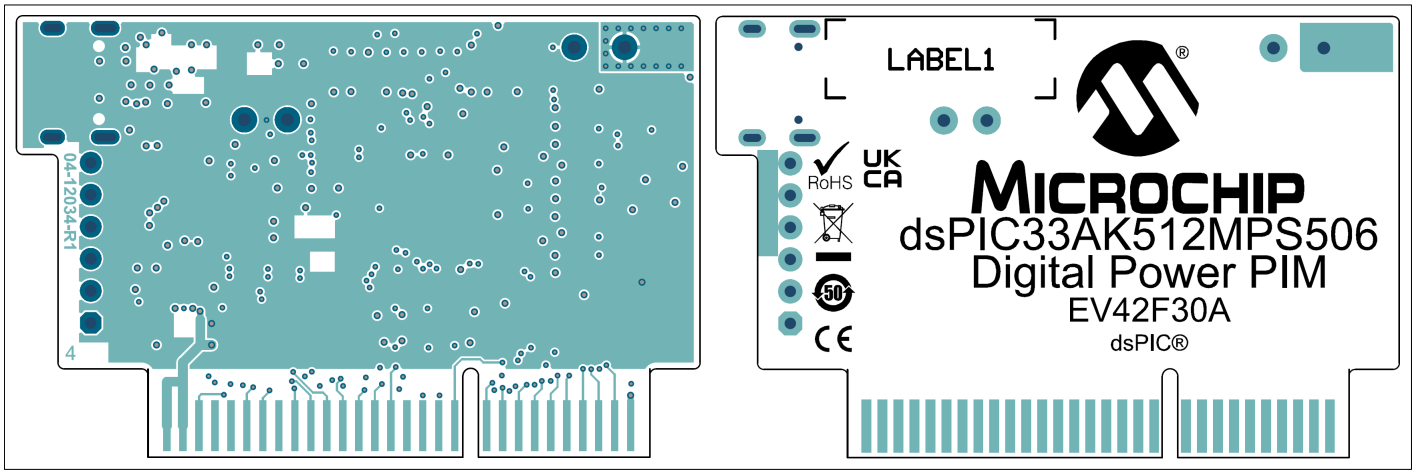
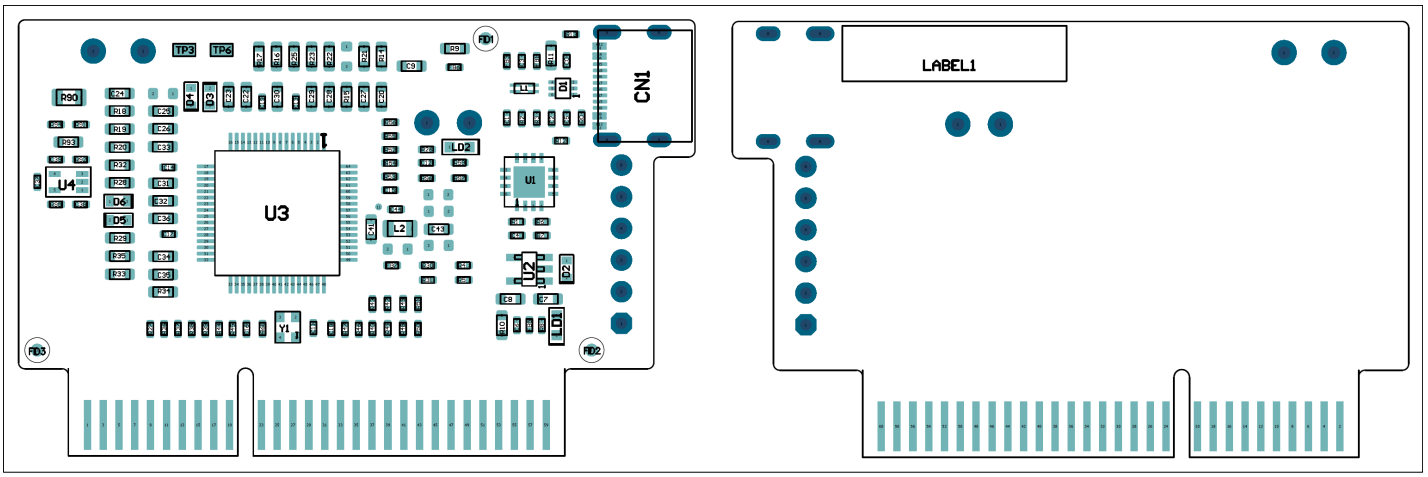


Figure 2-6. dsPIC33AK512MPS506 Digital Power PIM Top and Bottom Assembly



3. Appendix B. Bill of Materials (BOM)

This appendix contains the Bill of Materials (BOM) for the dsPIC33AK512MPS506 Digital Power PIM.

- Bill of Materials

3.1. Bill of Materials

Table 3-1 shows the Bill of Materials for the dsPIC33AK512MPS506.

Table 3-1. dsPIC33AK512MPS506 Digital Power PIM Bill of Materials

Quantity	Designator	Description	Manufacturer	Manufacturer Part Number
8	C0, C3, C6, C11, C19, C37, C38, C44	CAP CER 0.1uF 50V 10% X7R SMD 0402	TDK	C1005X7R1H104K050BB
4	C1, C2, C12, C39	CAP CER 47pF 50V 5% NP0 SMD 0402	TDK	C1005NP01H470J050BA
7	C4, C13, C14, C15, C16, C17, C18	CAP CER 1uF 10V 10% X7S SMD 0402	Samsung	CL05A105KP5NNNC
1	C5	CAP CER 0.47uF 6.3V 10% X5R SMD 0402	Samsung	CL05A474KQ5NNNC
5	C7, C8, C9, C41, C43	CAP CER 10uF 10V 20% X5R SMD 0603	Samsung	CL10A106MP8NNNC
14	C20, C22, C23, C25, C26, C27, C28, C29, C30, C31, C33, C34, C35, C36	CAP CER 560pF 50V 5% C0G, NP0 SMD 0603	KEMET	C0603C561J5GACTU
2	C24, C32	CAP CER 100pF 50V 5% NP0 SMD 0603	Yageo	CC0603JRNPO9BN101
1	CN1	CON USB2.0 Type-C Female SMD R/A	Wurth Electronics	629722000214
1	D1	DIO TVS ARRAY 82400152 5V USB2.0 SMD SOT-563	Würth Elektronik	82400152
1	D2	DIO SCTKY SBR1A20T5-7 520mV 1A 20V SOD-523	Diodes®	SBR1A20T5-7
4	D3, D4, D5, D6	DIODE SCHOTTKY 30V 200MA SOD523	MCC®	RB520S-30-TP
5	FB1, FB3, FB5, FB6, FB7	FERRITE 600R@100MHz 0.23R 900mA SMD 0402	Murata	BLM15PX601SN1D
1	L1	CM CHOKE 90R 100MHz 0.145R 550MA SMD 0603	Wurth Electronics	744230900
1	L2	Inductor 10uH 800 mOhms 560 mA 10% SMD 2mmx1.2mm	Bourns®	SRN2012T-100K
1	LD1	DIO LED GREEN 3.2V 20mA 430mcd Clear SMD 0603	Wurth Electronics	150060GS75000
1	LD2	DIO LED RED 2V 20mA 250mcd Clear SMD 0603	Wurth Electronics	150060RS75000
3	R0, R6, R7	RES TKF 4.7k 1% 1/10W 0402	KOA Speer®	RK73H1ETTP4701F

Table 3-1. dsPIC33AK512MPS506 Digital Power PIM Bill of Materials (continued)

Quantity	Designator	Description	Manufacturer	Manufacturer Part Number
6	R1, R8, R91, R92, R94, R96	RES TKF 10k 1% 1/10W SMD 0402	Panasonic®	ERJ-2RKF1002X
2	R2, R3	RES TKF 15R 1% 1/10W SMD 0402	Panasonic	ERJ-2RKF15R0X
2	R4, R5	RES TKF 270R 1% 1/10W SMD 0402	Panasonic	ERJ-2RKF2700X
3	R9, R10, R11	RES TKF 0R 1/10W SMD 0603	Yageo	RC0603JR-070RL
2	R12, R13	RES TKF 5.1k 1% 1/10W SMD 0402	Panasonic	ERJ-2RKF5101X
16	R14, R16, R17, R18, R19, R20, R21, R22, R23, R25, R28, R29, R32, R33, R34, R35	RES TKF 150R 1% 1/10W SMD 0603 AEC-Q200	Stackpole Electronics	RMCF0603FT150R
1	R15	RES TKF 560R 1% 1/10W SMD 0603	Yageo	RC0603FR-07560RL
26	R26, R27, R30, R31, R36, R37, R38, R39, R40, R41, R42, R43, R44, R45, R46, R47, R48, R49, R50, R51, R52, R53, R54, R55, R56, R60	RES TKF 47R 1% 1/16W SMD 0402 AEC-Q200	Panasonic	ERJ-2RKF47R0X
2	R59, R95	RES TKF 3.3k 1% 1/10W SMD 0402	Panasonic	ERJ-2RKF3301X
1	R90	RES TKF 49.9R 1% 1/8W SMD 0805	Panasonic	ERJ-6ENF49R9V
1	R93	RES TKF 49.9R 1% 1/10W SMD 0603	Panasonic	ERJ-3EKF49R9V
1	R97	RES TKF 100R 1% 1/10W SMD 0402 AEC-Q200	KOA Speer	RK73H1ETTP1000F
2	TP3, TP6	CON TP TAB Silver Mini 1.6x0.8 SMD	Harwin	S2761-46R
Microchip Parts Listed Below				
1	U1	MCHP INTERFACE USB I2C/UART MCP2221A-I/ML QFN-16	Microchip®	MCP2221A-I/ML
1	U2	MCHP ANALOG LDO 3.3V MCP1755T-3302E/OT SOT-23-5	Microchip	MCP1755T-3302E/OT
1	U3	MCHP MCU 16-BIT 100MIPS 512k 64k dsPIC33AK512MPS506-I/PT TQFP-64	Microchip	DSPIC33AK512MPS506-I/PT
1	U4	MCHP ANALOG OPAMP 1-Ch 10MHz MCP6V91UT-E/LTY SC-70-5	Microchip	MCP6V91UT-E/LTY
1	Y1	MCHP CLOCK OSCILLATOR SINGLE 8.000MHz DSC6011JI2B-008.0000 VDFN-4	Microchip	DSC6011JI2B-008.0000

Table 3-1. dsPIC33AK512MPS506 Digital Power PIM Bill of Materials (continued)

Quantity	Designator	Description	Manufacturer	Manufacturer Part Number
Do Not Populate Parts Listed Below				
0	C21	CAP CER 560pF 50V 5% C0G, NP0 SMD 0603	KEMET	C0603C561J5GACTU
0	C40, C42	CAP CER 10uF 10V 20% X5R SMD 0603	Samsung	CL10A106MP8NNNC
0	J2	CON HDR-2.54 Male 1x6 Gold 5.84MH TH VERT	Samtec	TSW-106-07-G-S
0	R24	RES TKF 150R 1% 1/10W SMD 0603	Stackpole Electronics	RMCF0603FT150R
0	R57, R58	RES TKF 3.3R 1% 1/10W SMD 0603	Panasonic	ERJ-3RQF3R3V
0	TP1	MISC, TEST POINT MULTI PURPOSE MINI BLACK	Keystone Electronics®	5001
0	TP2, TP4, TP5	MISC, TEST POINT PC MINI, 0.040" D YELLOW	Keystone Electronics	5004

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