

Introduction

The dsPIC33AK128MC106 Digital Power Plug-In Module (DP PIM) is a demonstration board that, in conjunction with different power boards, showcases the Microchip dsPIC33AK128MC106 Digital Signal Controller (DSC) features. The DP PIM provides access to the dsPIC33AK128MC106 analog inputs, the Digital-to-Analog Converter (DAC) output, the Pulse-Width Modulator (PWM) outputs and the General-Purpose Input and Output (GPIO) ports.

All dsPIC33 DP PIMs share the same mating-socket pinout. However, these PIM cards show slightly different performance characteristics.

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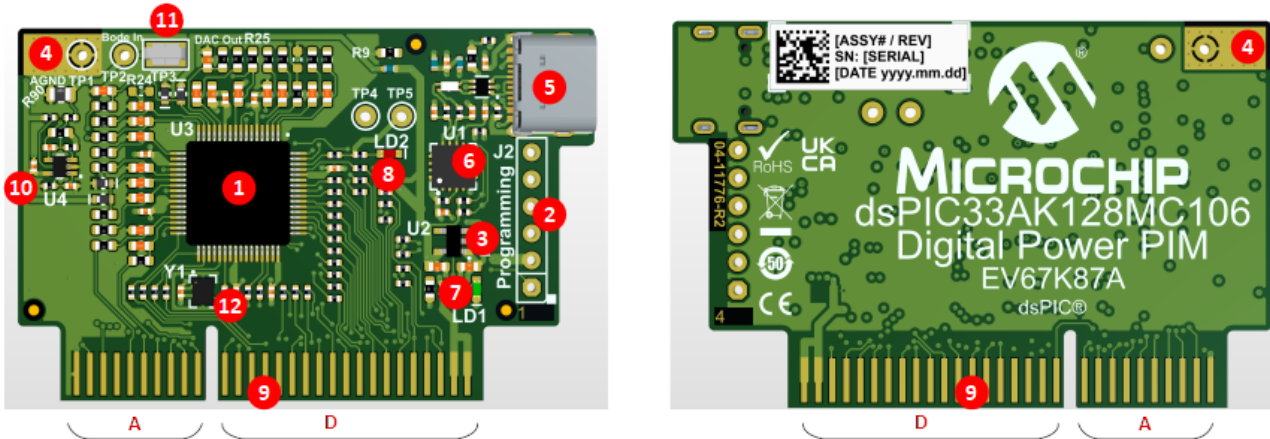
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1. Overview

1.1 Features

Figure 1-1 documents the dsPIC33AK128MC106 DP PIM's features.

Figure 1-1. dsPIC33AK128MC106 DP PIM



1. Microchip dsPIC33AK128MC106 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. USB-C Connector
6. MCP2221A USB to UART/I²C 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. Op amp buffer for Bode input
11. Test point loop for DAC output
12. MEMS oscillator

Board dimensions are: 51 mm (length) x 35 mm (width).

1.1.1 Test Points

Table 1-1 lists the test points on the dsPIC33AK128MC106 DP PIM.

Table 1-1. Test Points

Test Point Name	Function/Description
TP1, TP2	Bode Measurement Signal Insert Point
TP3	RA1_DAC_OUT: Digital-to-Analog Converter Output
TP4	Test Point for Debug (right upper corner of the MCU)

.....continued

Test Point Name	Function/Description
TP5	General Purpose Test Point Connected to Port RD11 together with LD2 (Red LED) (near to TP4, beside LD2)

1.1.2 Electrical Characteristics

Table 1-2 shows the electrical characteristics of the dsPIC33AK128MC106 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 dsPIC33AK128MC106 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 two subsections:

- High-Speed Comparator Inputs: RC filtered with a corner frequency of 10 MHz and a 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 a corner frequency of 1.9 MHz and a maximum signal rise/fall time of 184 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 27 signals, all referenced to digital ground. These lines are split into four subsections:

- High-Speed PWM Outputs: Each line has a 47Ω series resistance.
- GPIOs: Each line has a 47Ω series resistance.
- Programming/Debugging Lines: Each line has a 47Ω series resistance.
- Communication Lines (I²C): Each line has a 47Ω 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 purposed under frequent plug-in/out cycles. This decoupling also increases robustness in case of accidental shorts and EMC issues.

1.1.4 dsPIC33AK128MC106 DP PIM – PCB Edge Connector

The dsPIC33AK128MC106 DP PIM has an edge connector compatible with any application board that provides a mating socket.

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

1.2 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).

2. Appendix A. Board Layout and Schematics

This appendix contains the pinout, schematics, and board layouts for the dsPIC33AK128MC106 DP PIM.

- [2.1. Pinout](#)
- [2.2. Board Schematics](#)
- [2.3. 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	10,18,59	Analog Ground	—
GND_A	2	10,18,59	Analog Ground	—
RA1_DAC_OUT	3	3	DAC Output, Optional RC Filter	560R series resistance
RA6_AD1AN2_IN	4	16	Analog Input, RC Filtered	Fc = 1.9 MHz, tr = 184 ns
RA0_AD2AN6_IN	5	1	Analog Input, RC Filtered	Fc = 1.9 MHz, tr = 184 ns
RA5_AD1AN3_IN	6	15	Analog Input, RC Filtered	Fc = 1.9 MHz, tr = 184 ns
—	7	—	—	—
RA4_AD1AN1_CMP1B_IN	8	14	Analog Input, RC Filtered	Fc = 10 MHz, tr = 33 ns
RB6_AD1AN8_IN	9	29	Analog Input, RC Filtered	Fc = 1.9 MHz, tr = 184 ns
RB5_AD2AN2_IN	10	17	Analog Input, RC Filtered	Fc = 1.9 KHz, tr = 184 ns
RA8_AD2AN9_IN	11	7	Analog Input, RC Filtered	Fc = 1.9 KHz, tr = 184 ns
RB8_AD1AN11_IN	12	23	Analog Input, RC Filtered	Fc = 1.9 KHz, tr = 184 ns
RA9_AD1AN9_IN	13	8	Analog Input, RC Filtered	Fc = 1.9 KHz, tr = 184 ns
RB7_AD2AN8_IN	14	30	Analog Input, RC Filtered	Fc = 1.9 KHz, tr = 184 ns
RA10_AD2AN7_IN	15	9	Analog Input, RC Filtered, Optional Bode Input	Fc = 1.9 KHz, tr = 184 ns
RB1_AD1AN4_IN	16	21	Analog Input, RC Filtered	Fc = 1.9 MHz, tr = 184 ns
RA2_AD1AN0_IN	17	12	Analog Input, RC Filtered	Fc = 1.9 MHz, tr = 184 ns
RB2_AD2AN4_CMP2B_IN	18	22	Analog Input, RC Filtered	Fc = 10 MHz, tr = 33 ns
RA3_AD2AN0_IN	19	13	Analog Input, RC Filtered	Fc = 1.9 MHz, tr = 184 ns
RA7_AD1AN6_IN	20	2	Analog Input, RC Filtered	Fc = 1.9 MHz, tr = 184 ns
slot	21	slot	slot	slot
slot	22	slot	slot	slot
RC0_RP33	23	37	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	—	—	—
—	31	—	—	—

.....continued

Name	Edge Connector Pin	Device Pin	Function/Description	Remark
RB10_SCK2	32	31	Digital General Purpose	47R series resistance
RD7_ASCL2	33	57	Digital General Purpose	47R series resistance
RD8_ASDA2	34	58	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	PWM Output	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	52	PWM Output	47R series resistance
RC4_PWM3L	41	44	PWM Output	47R series resistance
RDO_PWM2H	42	51	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	53	PWM Output	47R series resistance
RB0_RP17	46	20	Digital General Purpose	47R series resistance
RD3_PWM1L	47	54	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
RD9_RP58	52	49	Digital General Purpose	47R series resistance
RD5_ASCL1	53	55	Digital General Purpose	47R series resistance
RD10_RP59	54	50	Digital General Purpose	47R series resistance
RD6_ASDA1	55	56	Digital General Purpose	47R series resistance
RB3_PGD1	56	27	Programing/Debugging	47R series resistance
VDD	57	LDO	VDD Rail	6.3V max, 70 mA max
GND_D	58	4,25,39,47	Digital Ground	—
VDD	59	LDO	VDD Rail	6.3V max, 70 mA max
GND_D	60	4,25,39,47	Digital Ground	—

2.2 Board Schematics

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

Figure 2-1. dsPIC33AK128MC106 Digital Power PIM Schematic Rev. 1.0 (Page 1 of 2)

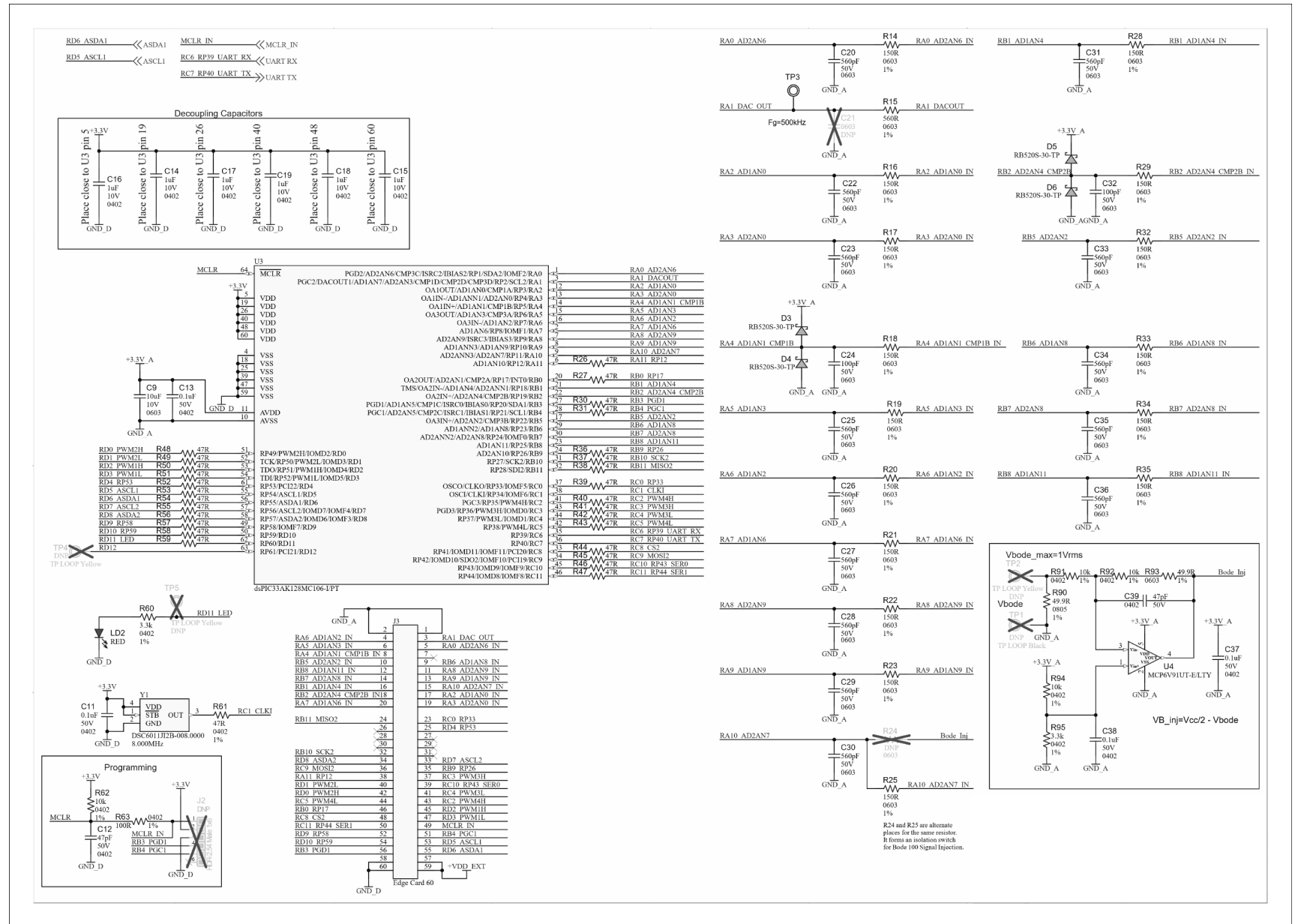
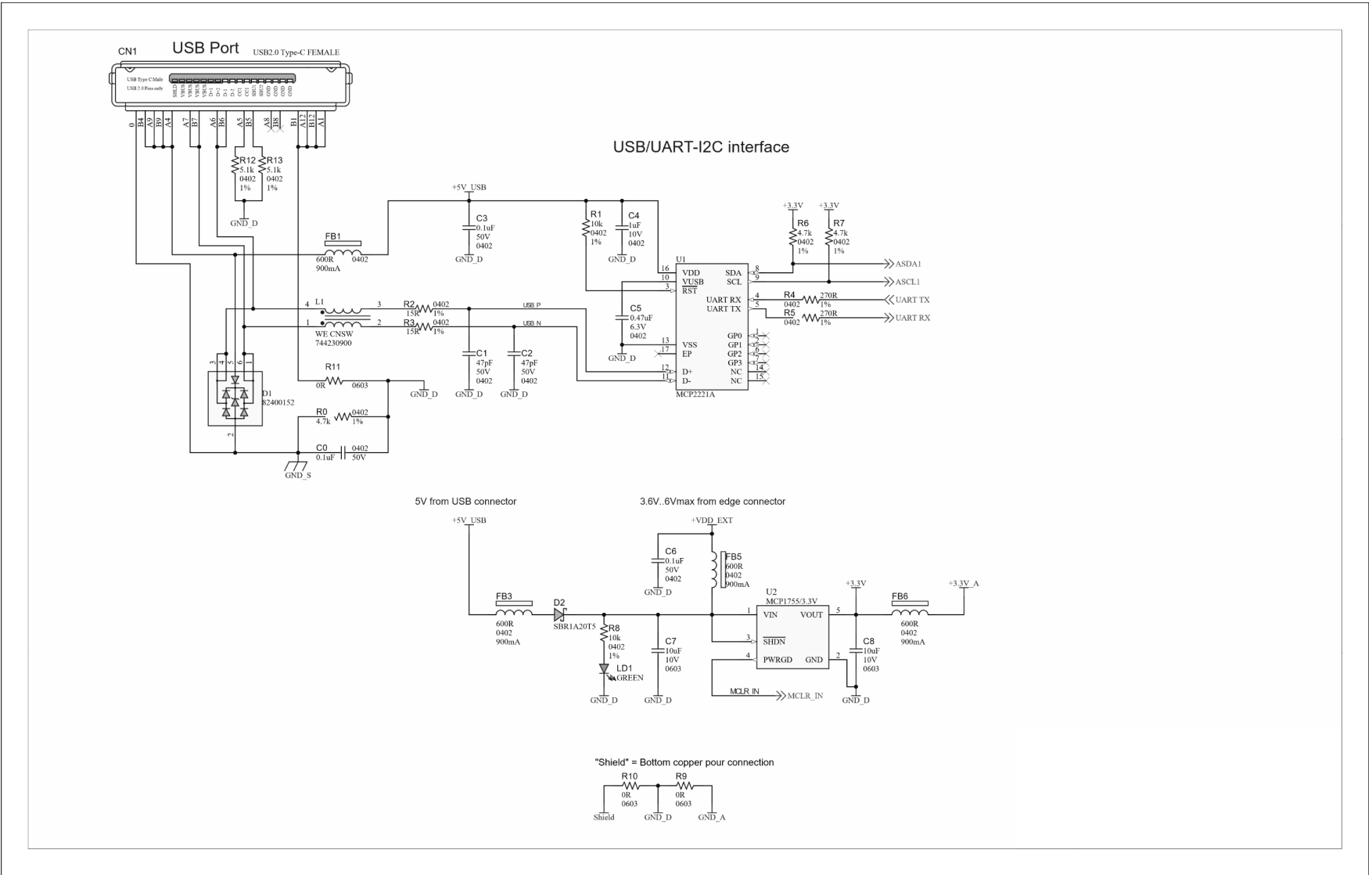


Figure 2-2. dsPIC33AK128MC106 Digital Power PIM Schematic Rev. 1.0 (Page 2 of 2)



2.3 PCB Layout

The dsPIC33AK128MC106 DP PIM is a four-layer FR4, 1.55mm, 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 dsPIC33AK128MC106 DP PIM.

Figure 2-3. dsPIC33AK128MC106 Digital Power PIM Top Silkscreen and Top Copper

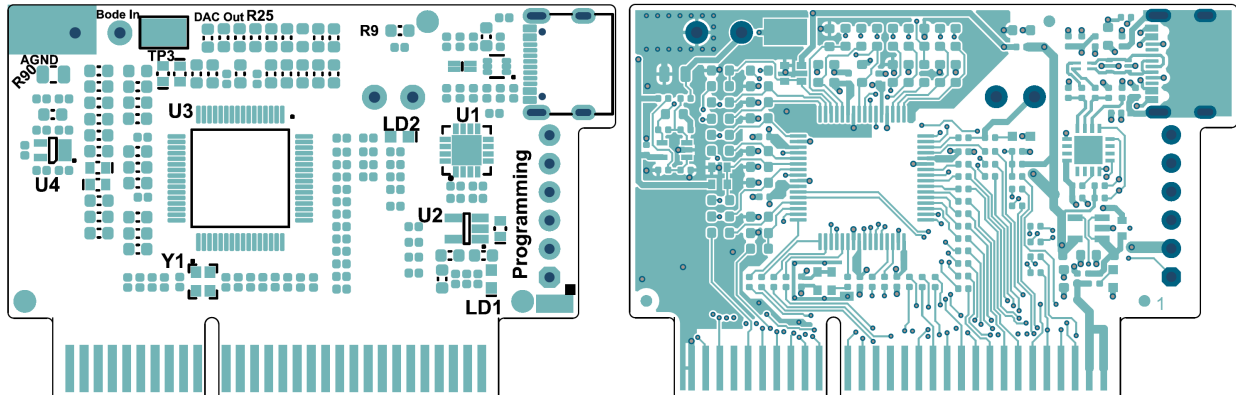


Figure 2-4. dsPIC33AK128MC106 Digital Power PIM MID1 and MID2 Inner Copper (Bottom View)

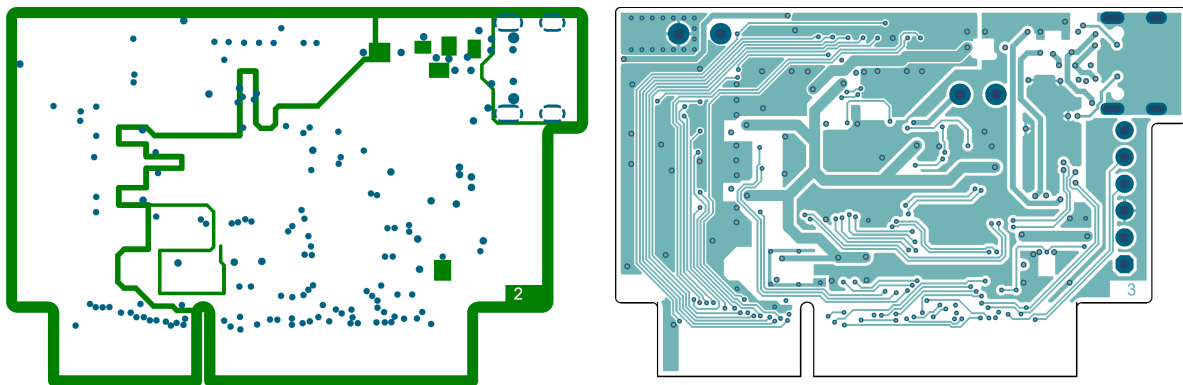


Figure 2-5. dsPIC33AK128MC106 Digital Power PIM Bottom Copper and Bottom Silkscreen (Bottom View)

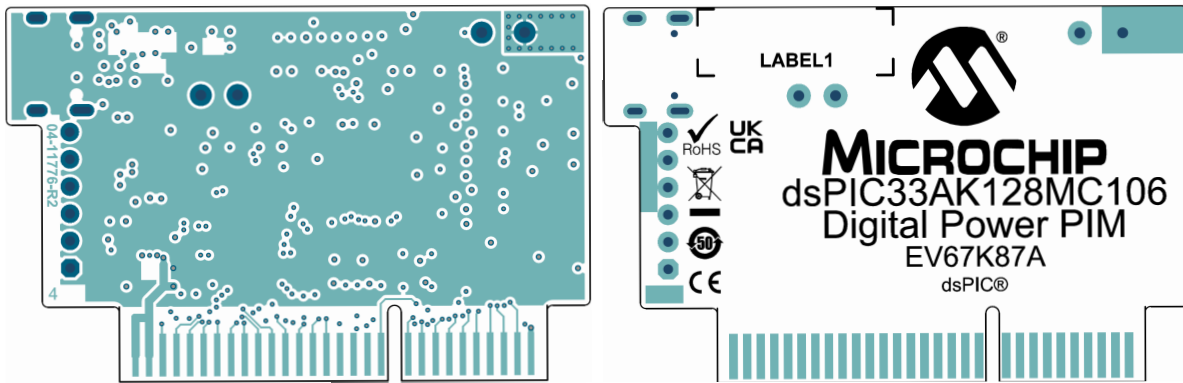
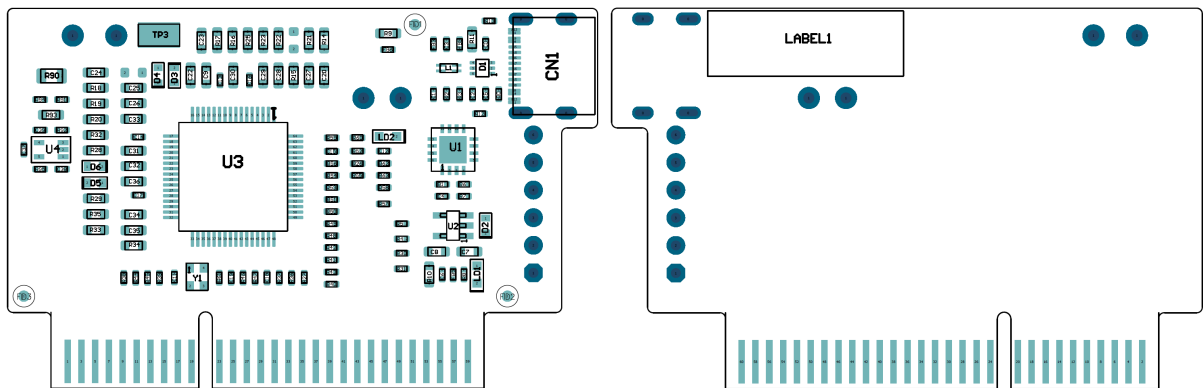


Figure 2-6. dsPIC33AK128MC106 Digital Power PIM Top and Bottom Assembly



3. Appendix B. Bill of Materials (BOM)

This appendix contains the Bill of Materials (BOM) for the dsPIC33AK128MC106 Digital Power PIM.

- [3.1. Bill of Materials](#)

3.1 Bill of Materials

Table 3-1 shows the Bill of Materials for the dsPIC33AK128MC106.

Table 3-1. dsPIC33AK128MC106 Digital Power PIM Bill of Materials (BOM)

Quantity	Designator	Description	Manufacturer	Manufacturer Part Number
7	C0, C3, C6, C11, C13, C37, C38	CAP CER 0.1uF 50V 10% X7R SMD 0402	Murata Electronics®	GRM155R71H104KE14D
4	C1, C2, C12, C39	CAP CER 47pF 50V 5% NP0 SMD 0402	TDK	C1005NP01H470J050BA
7	C4, C14, C15, C16, C17, C18, C19	CAP CER 1uF 10V 10% X7S SMD 0402	Samsung	CL05A105KP5NNNC
1	C5	CAP CER 0.47uF 6.3V 10% X5R SMD 0402	Samsung	CL05A474KQ5NNNC
3	C7, C8, C9	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	Würth Electronics	885012006057
1	CN1	CON USB2.0 Type-C Female SMD R/A	Würth Electronics	629722000214
1	D1	DIO TVS ARRAY 82400152 5V USB2.0 SMD SOT-563	Würth Electronics	82400152
1	D2	DIO SCTKY SBR1A20T5-7 520mV 1A 20V SOD-523	Diodes Incorporated®	SBR1A20T5-7
4	D3, D4, D5, D6	DIODE SCHOTTKY 30V 200MA SOD523	Micro Commercial Components®	RB520S-30-TP
4	FB1, FB3, FB5, FB6	FERRITE 600R@100MHz 0.23R 900mA SMD 0402	Murata	BLM15PX601SN1D
1	L1	CM CHOKE 90R 100MHz 0.145R 550MA SMD 0603	Würth Electronics	744230900
1	LD1	DIO LED GREEN 3.2V 30mA 430mcd Clear SMD 0603	Würth Electronics	150060GS75000
1	LD2	DIO LED RED 2V 20mA 250mcd Clear SMD 0603	Würth Electronics	150060RS75000
3	R0, R6, R7	RES TKF 4.7k 1% 1/10W 0402	KOA Speer®	RK73H1ETTP4701F
6	R1, R8, R62, R91, R92, R94	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	Stackpole Electronics	RMCF0603ZT0R00

.....continued				
Quantity	Designator	Description	Manufacturer	Manufacturer Part Number
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
29	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, R57, R58, R59, R61	RES TKF 47R 1% 1/16W SMD 0402 AEC-Q200	Panasonic	ERJ-2RKF47R0X
2	R60, R95	RES TKF 3.3k 1% 1/10W SMD 0402	Panasonic	ERJ-2RKF3301X
1	R63	RES TKF 100R 1% 1/10W SMD 0402 AEC-Q200	KOA Speer	RK73H1ETTP1000F
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	TP3	CON TP TAB Silver Mini 3.8x2.03 SMD	Keystone Electronics	5019
Microchip Parts listed below				
1	U1	MCHP INTERFACE USB I2C/ UART MCP2221A-I/ML QFN-16	Microchip Technology Inc.	MCP2221A-I/ML
1	U2	MCHP ANALOG LDO 3.3V MCP1755T-3302E/OT SOT-23-5	Microchip Technology Inc.	MCP1755T-3302E/OT
1	U3	MCHP MCU16-BIT 128KB Flash, 16 KB, dsPIC33AK128MC106-I/PT	Microchip Technology Inc.	dsPIC33AK128MC106-I/PT
1	U4	MCHP ANALOG OPAMP 1-Ch 10MHz MCP6V91UT-E/LTY SC-70-5	Microchip Technology Inc.	MCP6V91UT-E/LTY
1	Y1	MCHP CLOCK OSCILLATOR SINGLE 8.000MHz DSC6011J12B-008.0000 VDFN-4	Microchip Technology Inc.	DSC6011J12B-008.0000
Mechanical Parts to be Added in the Package				
1	LABEL1	LABEL PCBA 18x6mm Datamatrix Assy# / Rev / Serial / Date	ACT Logimark AS®	505462
PCB				
1	PCB1	Printed Circuit Board	-	04-1176-R2
Do Not Populate Parts listed below				
0	C21	CAP CER 560pF 50V 5% COG, NPO SMD 0603	KEMET	C0603C561J5GACTU
0	J2	CON HDR-2.54 Male 1x6 Gold 5.84MH TH VERT	Samtec	TSW-106-07-G-S

.....continued

Quantity	Designator	Description	Manufacturer	Manufacturer Part Number
0	R24	RES TKF 150R 1% 1/10W SMD 0603 AEC-Q200	Vishay®	CRCW0603150RFKEA
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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