

Introduction

The ATSAME54 100-Pin Motor Control Plug-in Module (PIM), MA320207, is designed to demonstrate the capabilities of the ATSAME54 128-pin Motor Control device (ATSAME54P20A) using external op amps with the following hardware:

- The dsPICDEM™ MCLV-2 development board (DM330021-2)
- The dsPICDEM™ MCHV-3 development board (DM330023-3)

Both development boards support 100-pin PIM interfaces. The ATSAME54 Motor Control PIM is designed to use on board external op amps for signal conditioning of analog feedback inputs.

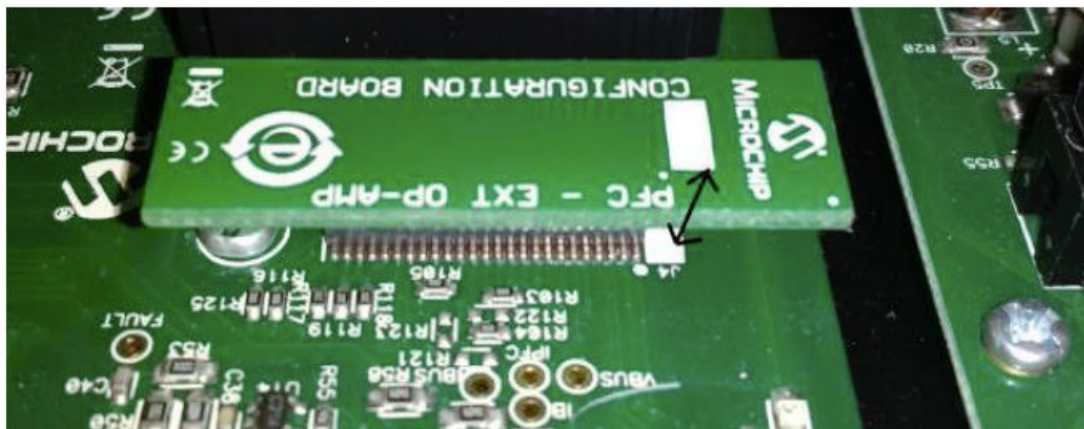
For the dsPICDEM™ MCLV-2 development board, insert the external op amp configuration board (included with the development board) at header J14.

For the dsPICDEM™ MCHV-3 development board, insert the PFC-EXT-OPAMP configuration board (included with the development board) at header J4.

Figure 1. Op amp Configuration Board for dsPICDEM™ MCLV-2



Figure 2. Op amp Configuration Board for dsPICDEM™ MCHV-3



Do not connect non-isolated oscilloscope probes to probe any traces while using the PIM with the dsPICDEM MCHV-3 development boards. Instead, use a high-voltage differential probe, rated in excess of 600 VRMS (Common mode). Failure to heed this warning could result in hardware damage.

Programming and Debugging

Use the following options to program and debug software on the ATSAME54 Motor Control PIM:

- In-Circuit Debugger: The ATSAME54 Motor Control PIM can be programmed and debugged using the following debugging tools, which are connected to the board using the Arm® CoreSight™ 10 connector:
 - MPLAB® ICD 4 In-Circuit Debugger or latest
 - MPLAB ICE 4 In-Circuit Emulator, Programmer, and Debugger
 - Atmel®-ICE
 - SAM-ICE™
- Isolated EDBG Interface (AC320202): This daughter board provides an isolated programming and debugging interface for the ATSAME54 Motor Control PIM. This daughter board is compatible with the dsPICDEM™ MCHV-2/MCHV-3 boards. Refer to the information sheet of this daughter board for additional information.

1. PIM to MCU Mapping

The following table provides the static mapping between the 100-pin PIM pins and the 128-pin device pins.

Table 1-1. PIM to MCU Mapping

PIM Connector PIN	MCLV2 100-pin connection		MCHV3 100-pin connection			SAME54 MCU Pin	MCU Pin
	Pin Name	Functionality	Pin Name	Functionality	100-pin connector signal name		
1	DBG_LED2	Debug LED 2	DBG_LED1	Debug LED 1	LED2	PB26_LED	102
2	VDD	NC	VDD	NC	VDD	-	32,37,46,54, 65,79,91, 97,107,118
3	PWM1H3	PWM Output - 3H	PWM1H3	PWM Output - 3H	PWM1H3	PA10_TCC0_WH	35
4	NC	NC	NC	NC	NC	-	-
5	NC	NC	NC	NC	NC	-	-
6	NC	NC	NC	NC	NC	-	-
7	NC	NC	NC	NC	NC	-	-
8	NC	NC	NC	NC	NC	-	-
9	NC	NC	NC	NC	NC	-	-
10	NC	NC	NC	NC	NC	-	-
11	NC	NC	NC	NC	NC	-	-
12	NC	NC	NC	NC	NC	-	-
13	MCLR	Device Master Clear	MCLR	Device Master Clear	nRESET	nRESET	114
14	NC	NC	NC	NC	NC	-	-
15	VSS	NC	VSS	NC	VSS	-	5,31,38,45, 53,64,78,90, 96,106,116
16	VDD	NC	VDD	NC	VDD	-	32,37,46,54, 65,79,91, 97,107,118
17	NC	NC	NC	NC	NC	-	-
18	FAULT	DC bus Current Fault (active-low logic)	FAULT	DC bus Current Fault (active-low logic)	FAULT_PWM	PB02_EXT2_FAULT_PWM	127
19	TX	UART Transmit	PFC_FLT	IPFC Fault (overvoltage or overcurrent)	PFC_EN_FLT	PB03_EXT3_PFCFLT_PFCEN	128
20	PIM_V_M3	Voltage feedback signal	PIM_IND3/POT/V_M3	Hall Sensor/Current Sense/Voltage Feedback Signal	NA	-	-
21	PIM_V_M2	Voltage feedback signal	PIM_QEB/IB/V_M2	Hall Sensor/Current Sense/Voltage Feedback Signal	NA	-	-
22	PIM_V_M1	Voltage feedback signal	PIM_QEA/IA/V_M1	Hall Sensor/Current Sense/Voltage Feedback Signal	NA	-	-
23	PIM_IMOTOR_SUM	DC bus current signal	PIM_IBUS/VBUS	DC Bus Voltage (downscaled)	VDCBUS2	PA07_ADC0_CH7_VDC_ISHUNT	24
24	PIM_IMOTOR2	Phase current signal	PIM_IB/POT	AC Input Zero Cross/AC Input Voltage (downscaled)/ Potentiometer	NA	-	-

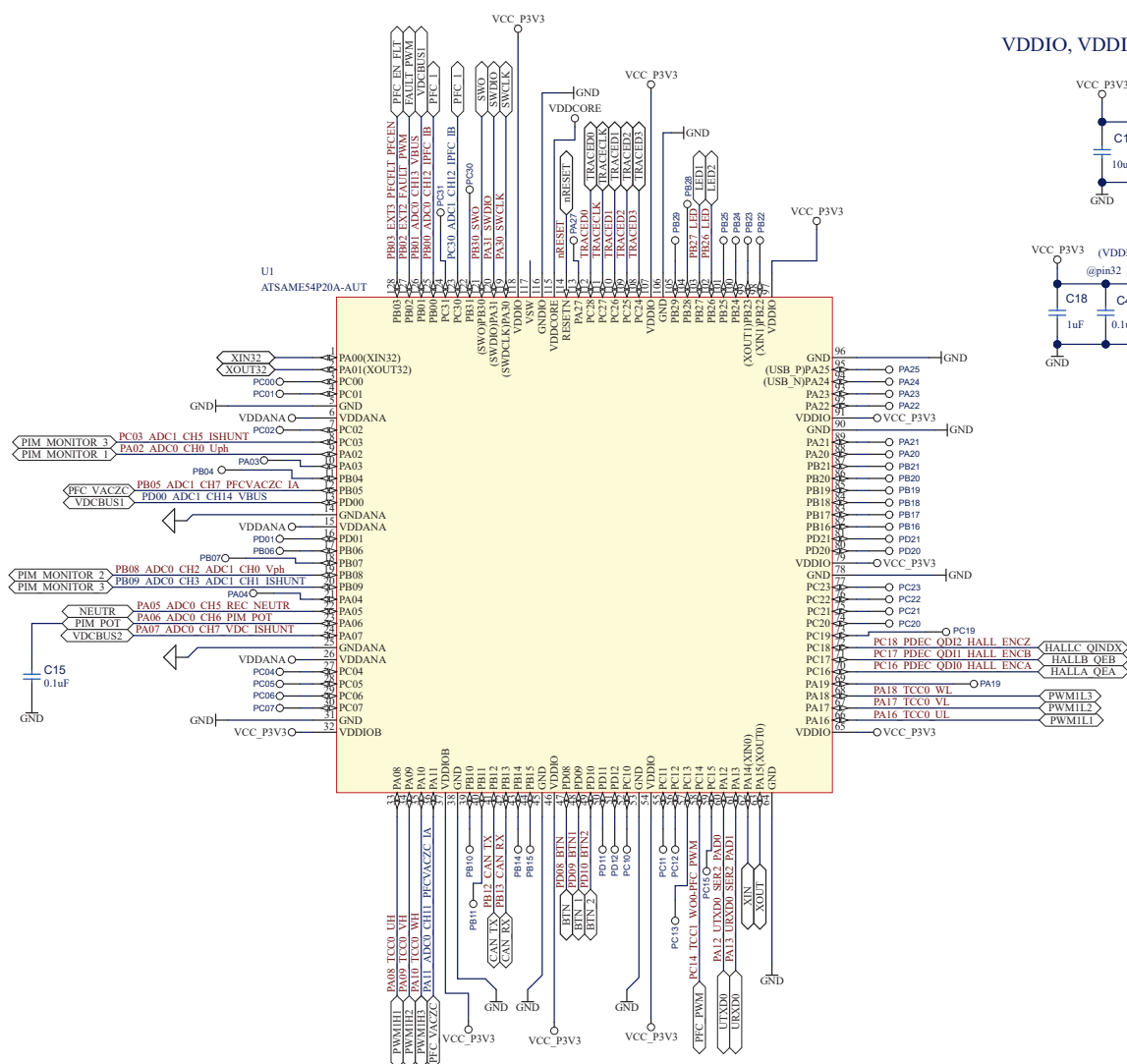
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PIM Connector PIN	MCLV2 100-pin connection		MCHV3 100-pin connection			SAME54 MCU Pin	MCU Pin
	Pin Name	Functionality	Pin Name	Functionality	100-pin connector signal name		
25	PIM_IMOTOR1	Phase current signal	PIM_IA/IPFC	PFC Current (buffered)	NA	-	-
26	PGC	Device programming clock line	PGC	Device programming clock line	SWCLK	PA30_SWCLK	119
27	PGD	Device programming data line	PGD	Device programming data line	SWDIO	PA31_SWDIO	120
28	VREF	Reference voltage (half of AVDD voltage)	AVDD/2	Reference voltage (half of AVDD voltage)	VREF	-	-
29	PIM_REC_NEUTR	Reconstructed motor neutral line voltage	PIM_REC_NEUTR	Reconstructed motor neutral line voltage	NEUTR	PA05_ADC0_CH5_REC_NEUTR	22
30	AVDD	Analog supply	AVDD	Analog supply	AVDD	VDDANA	6,15,26
31	AVSS	Analog supply	AVSS	Analog supply	GND	GNDANA	14,25
32	PIM_POT	Potentiometer signal	PIM_POT	Potentiometer signal	PIM_POT	PA06_ADC0_CH6_PIM_POT	23
33	NC	NC	PIM_POT	Potentiometer signal	NC	-	-
34	PIM_GEN2	General I/O	PIM_GEN2	General I/O	NC	-	-
35	PIM_VBUS	DC bus voltage (downscaled)	PIM_VBUS	DC bus voltage (downscaled)	VDCBUS1	PB01_ADC0_CH13_VBUS PD00_ADC1_CH14_VBUS	126, 13
36	VSS	NC	VSS	NC	VSS	-	5,31,38,45, 53,64,78, 90,96,106,116
37	VDD	NC	VDD	NC	VDD	-	32,37,46,54, 65,79,91, 97,107,118
38	NC	NC	PIM_VAC_VOL2	AC Input Voltage (unbuffered)	NC	-	-
39	NC	NC		PFC Shunt Signal	NC	-	-
40	NC	NC	PIM_PFC_L	PFC Shunt Signal	NC	-	-
41	PIM_MONITOR_1	Hall Sensor/Current Sense/Voltage Feedback Signal	PIM_V_M1/POT	Hall Sensor/Current Sense/Voltage Feedback Signal	PIM_MONITOR_1	PA02_ADC0_CH0_Uph	9
42	PIM_MONITOR_2	Hall Sensor/Current Sense/Voltage Feedback Signal	PIM_V_M2	Hall Sensor/Current Sense/Voltage Feedback Signal	PIM_MONITOR_2	PB08_ADC0_CH2_ADC1_CH0_VPh	19
43	PIM_MONITOR_3	Hall Sensor/Current Sense/Voltage Feedback Signal	PIM_V_M3/IBUS	Hall Sensor/Current Sense/Voltage Feedback Signal	PIM_MONITOR_3	PB09_ADC0_CH3_ADC1_CH1_ISHUNT; PC03_ADC1_CH5_ISHUNT	20, 8
44	NC	NC	NC	NC	NC	-	-
45	VSS	NC	VSS	NC	VSS	-	5,31,38,45, 53,64,78, 90,96,106,116

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PIM Connector PIN	MCLV2 100-pin connection		MCHV3 100-pin connection			SAME54 MCU Pin	MCU Pin
	Pin Name	Functionality	Pin Name	Functionality	100-pin connector signal name		
46	VDD	NC	VDD	NC	VDD	-	32,37,46,54, 65,79,91, 97,107,118
47	HALLB	Hall sensor /QEI input	HB/QEB	Hall sensor /QEI input	HALLB_QEB	PC17_PDEC_QDI1_HALL_ENCB	71
48	HALLC	Hall sensor /QEI input	HC/INDX	Hall sensor /QEI input	HALLC_QINDX	PC18_PDEC_QDI2_HALL_ENCZ	72
49	RX	UART Receive	RX	UART Receive	URXD0	PA13_URXD0_SER2_PAD1	61
50	TX	UART Transmit	TX	UART Transmit	UTXD0	PA12_UTXD0_SER2_PAD0	60
51	USB_TX	UART Transmit (connected directly to U7)	NC	NC	NC	-	-
52	USB_RX	UART Receive (connected directly to U7)	NC	NC	NC	-	-
53	NC	NC	NC	NC	NC	-	-
54	NC	NC	NC	NC	NC	-	-
55	NC	NC	NC	NC	NC	-	-
56	NC	NC	NC	NC	NC	-	-
57	NC	NC	NC	NC	NC	-	-
58	PIM_FLT_OUT2	General I/O	PIM_FLT_OUT2 (VACZC)	General I/O	PFC_VACZC	PA11_ADC0_CH11_;PFCVACZC_IA; PB05_ADC1_CH7_PFCVACZC_IA	36, 12
59	PIM_FLT_OUT1	General I/O	PIM_FLT_OUT1 (IPFC)	General I/O	PFC_I	PB00_ADC0_CH12_IPFC_IB; PC30_ADC1_CH12_IPFC_IB	125, 123
60	DBG_LED1	Debug LED 1	DBG_LED2	Debug LED 2	LED1	PB27_LED	103
61	HOME	Home signal for QEI	HOME	Home signal for QEI	NC	-	-
62	VDD	NC	VDD	NC	VDD	-	32,37,46,54, 65,79,91, 97,107,118
63	OSC1/CLKO	Crystal oscillator in	OSCI	Crystal oscillator in	NC	-	-
64	OSC2/CLKI	Crystal oscillator out	OSCO	Crystal oscillator out	NC	-	-
65	VSS	NC	VSS	NC	VSS	-	5,31,38,45, 53,64,78,90, 96,106,116
66	PIM_IBUS+	Bus current shunt signal	PIM_IBUS+	Bus current shunt signal	NC	-	-
67	PIM_IBUS-	Bus current shunt signal	PIM_IBUS-	Bus current shunt signal	NC	-	-
68	LIN_CS	LIN Chip Select signal	BTN	Push Button	BTN	PD08_BTN	47
69	LIN_FAULT	LIN Fault signal	NC	NC	NC	-	-
70	RX	UART Receive	RX	UART Receive	NC	-	-
71	NC	NC	PIM_PFC_PWM	PFC PWM Output	NC	-	-

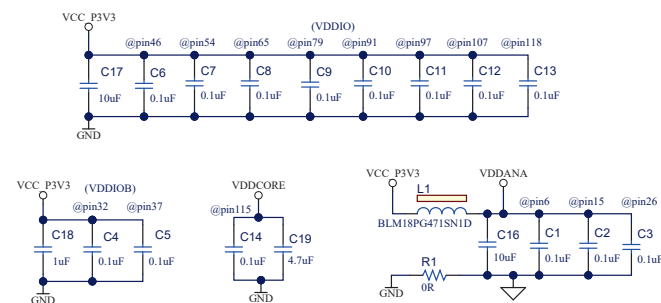
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PIM Connector PIN	MCLV2 100-pin connection		MCHV3 100-pin connection			SAME54 MCU Pin	MCU Pin
	Pin Name	Functionality	Pin Name	Functionality	100-pin connector signal name		
72	USB_RX	UART Receive (connected directly to U7)	HA/QEA	Hall Sensor /QEI Input	NC	-	-
73	PIM_IB+	IMOTOR1 shunt signal	PIM_IB+	IB Shunt Signal	NC	-	-
74	PIM_IA+	IMOTOR2 shunt signal	PIM_IA+	IA Shunt Signal	NC	-	-
75	VSS	NC	VSS	NC	VSS	-	5,31,38, 45,53,64,78, 90,96,106,116
76	USB_TX	UART Transmit (connected directly to U7)	HB/QEB	Hall Sensor /QEI Input	NC	-	-
77	CAN_TX	CAN Transmit	PIM_HALLC/INDX/STP_PWM	Hall Sensor /QEI Input	NC	-	-
78	CAN_RX	CAN Receive	PIM_PFC_PWM	PFC PWM Output	PFC_PWM	PC14_TCC1_WO0_PFC_PWM	58
79	NC	NC	VACZX	AC Input Zero Cross	NC	-	-
80	HALLA	Hall sensor /QEI input	HA/QEA	Hall Sensor /QEI Input	HALLA_QEA	PC16_PDEC_QDI0_HALL_ENCA	70
81	NC	NC	NC	NC	NC	-	-
82	PIM_GEN1	General I/O	PIM_GEN1	General I/O	NC	-	-
83	BTN_1	Push-button S2 input	NC	NC	BTN1	PD09_BTN1	48
84	BTN_2	Push-button S3 input	TX	UART Transmit	BTN2	PD10_BTN2	49
85	NC	NC	NC	NC	NC	-	-
86	VDD	NC	VDD	NC	VDD	-	32,37,46,54, 65,79,91, 97,107,118
87	CAN_RX	CAN Receive	NC	NC	CAN_RX	PB13_CAN_RX	42
88	CAN_TX	CAN Transmit	NC	NC	CAN_TX	PB12_CAN_TX	41
89	NC	NC	NC	NC	NC	-	-
90	NC	NC	NC	NC	NC	-	-
91	NC	NC	NC	NC	NC	-	-
92	NC	NC	NC	NC	NC	-	-
93	PWM1L1	PWM Output - 1L	PWM1L1	PWM Output - 1L	PWM1L1	PA16_TCC0_UL	66
94	PWM1H1	PWM Output - 1H	PWM1H1	PWM Output - 1H	PWM1H1	PA08_TCC0_UH	33
95	NC	NC	NC	NC	NC	-	-
96	NC	NC	NC	NC	NC	-	-
97	NC	NC	NC	NC	NC	-	-
98	PWM1L2	PWM Output - 2L	PWM1L2	PWM Output - 2L	PWM1L2	PA17_TCC0_VL	67
99	PWM1H2	PWM Output - 2H	PWM1H2	PWM Output - 2H	PWM1H2	PA09_TCC0_VH	34
100	PWM1L3	PWM Output - 3L	PWM1L3	PWM Output - 3L	PWM1L3	PA18_TCC0_WL	68

2. Schematics and Assembly Plots

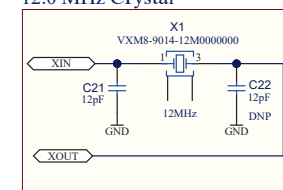
Figure 2-1. ATSAME54 Motor Control PIM Schematic



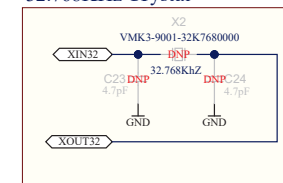
VDDIO, VDDIOB, VDDCORE and VDDANA - Decoupling and Bulk



12.0 MHz Crystal



32.768KHz Crystal

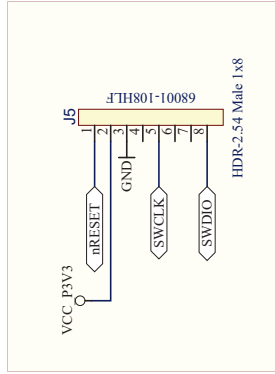


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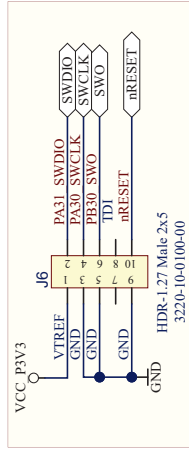
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LABEL Need Help Small

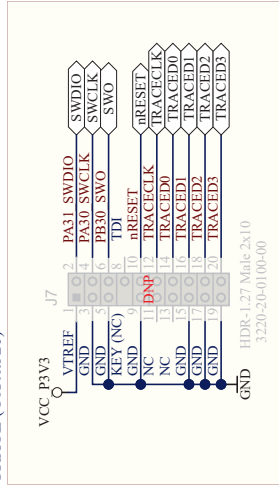
PICkit 4 Connector



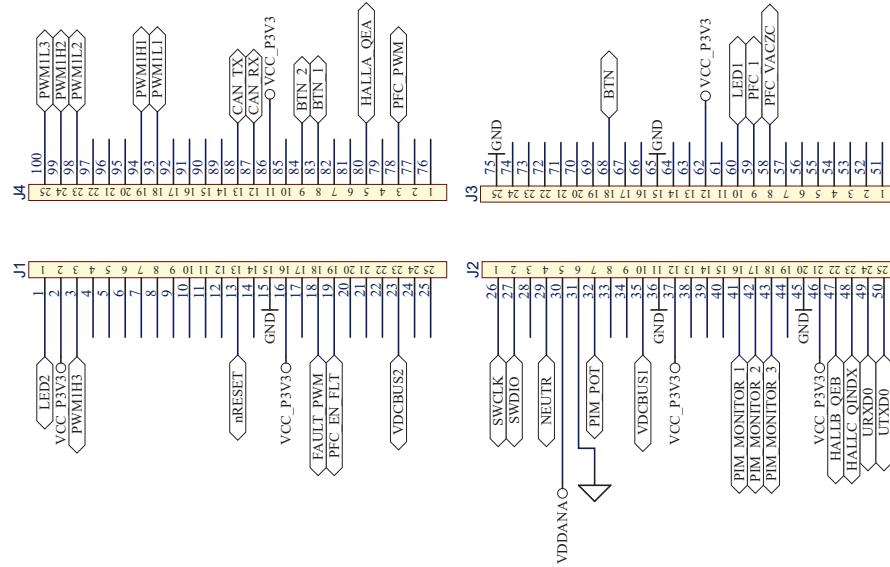
Cortex SWD Connector



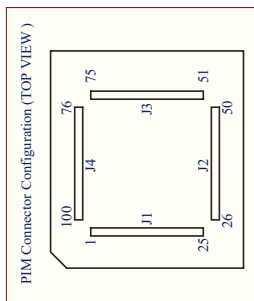
TRACE (Cortex 20)

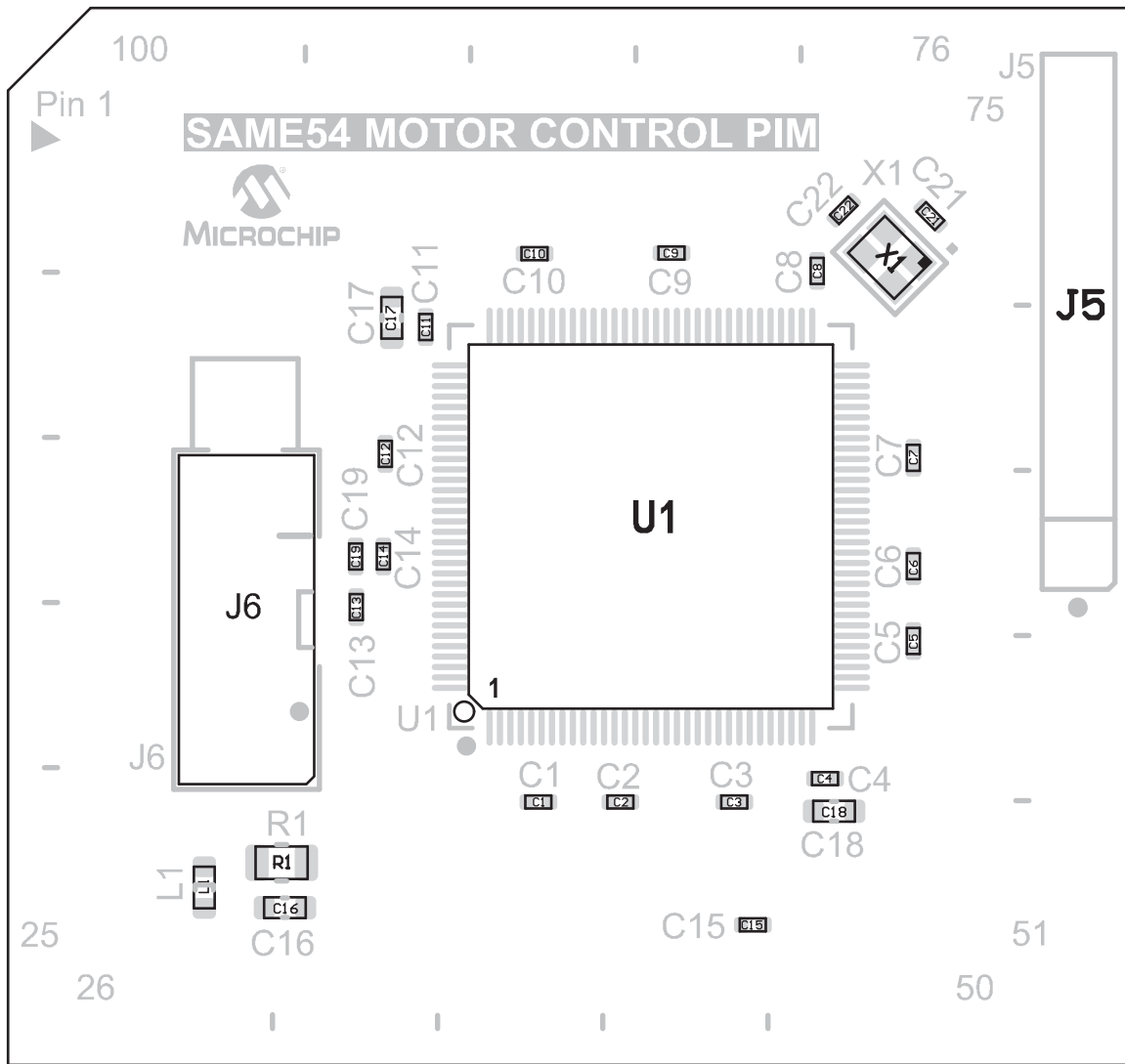


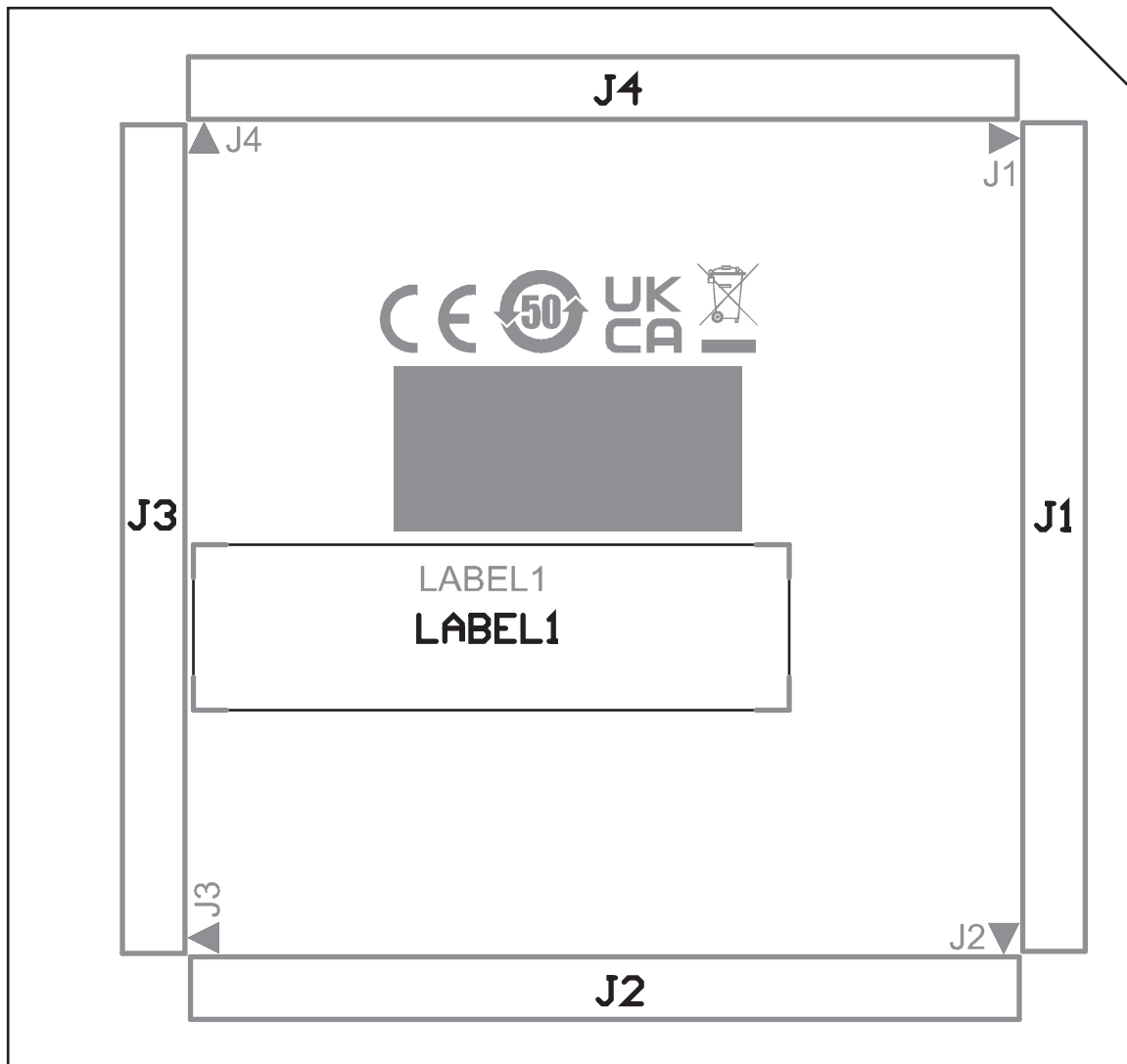
PIM Headers

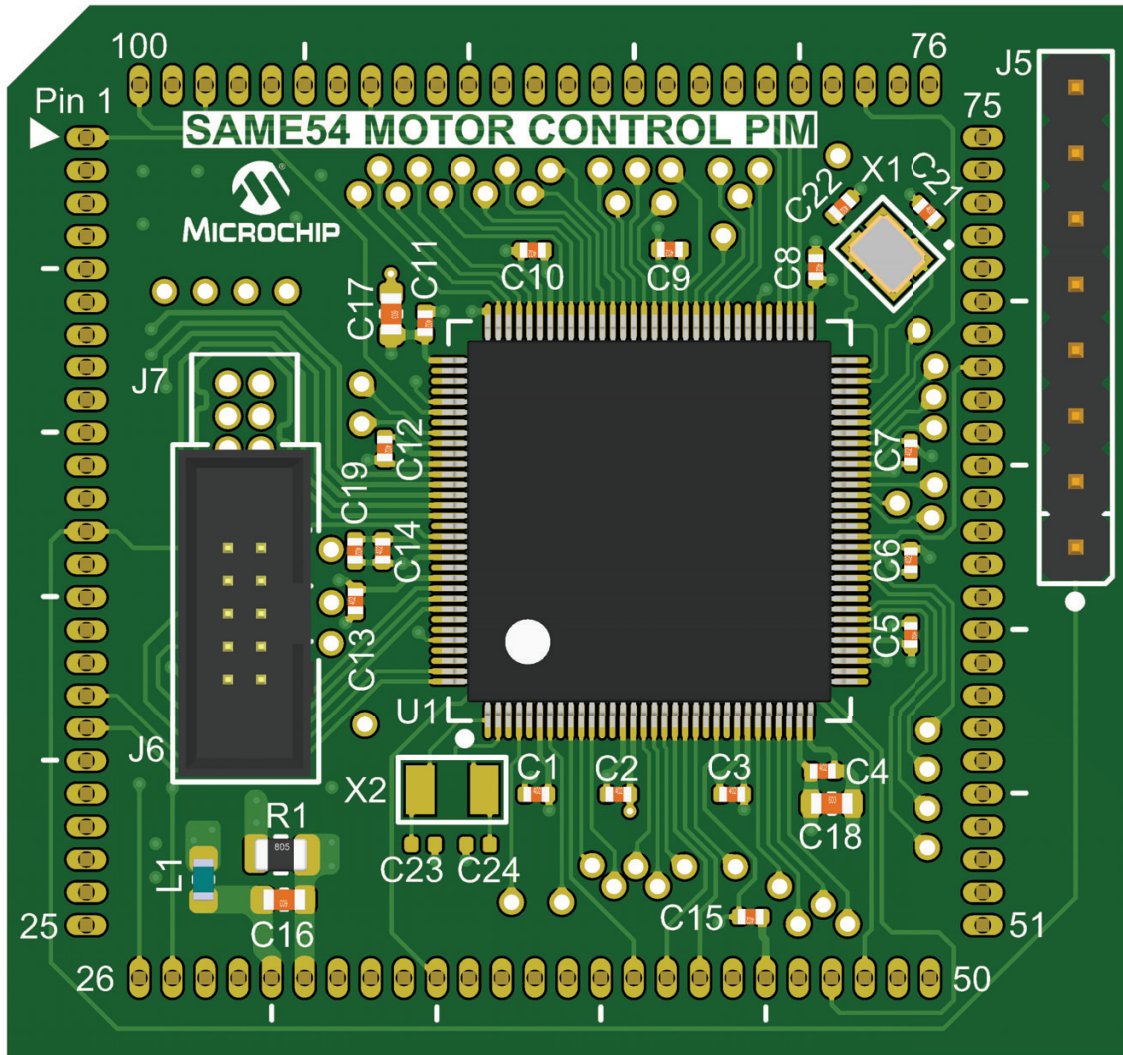


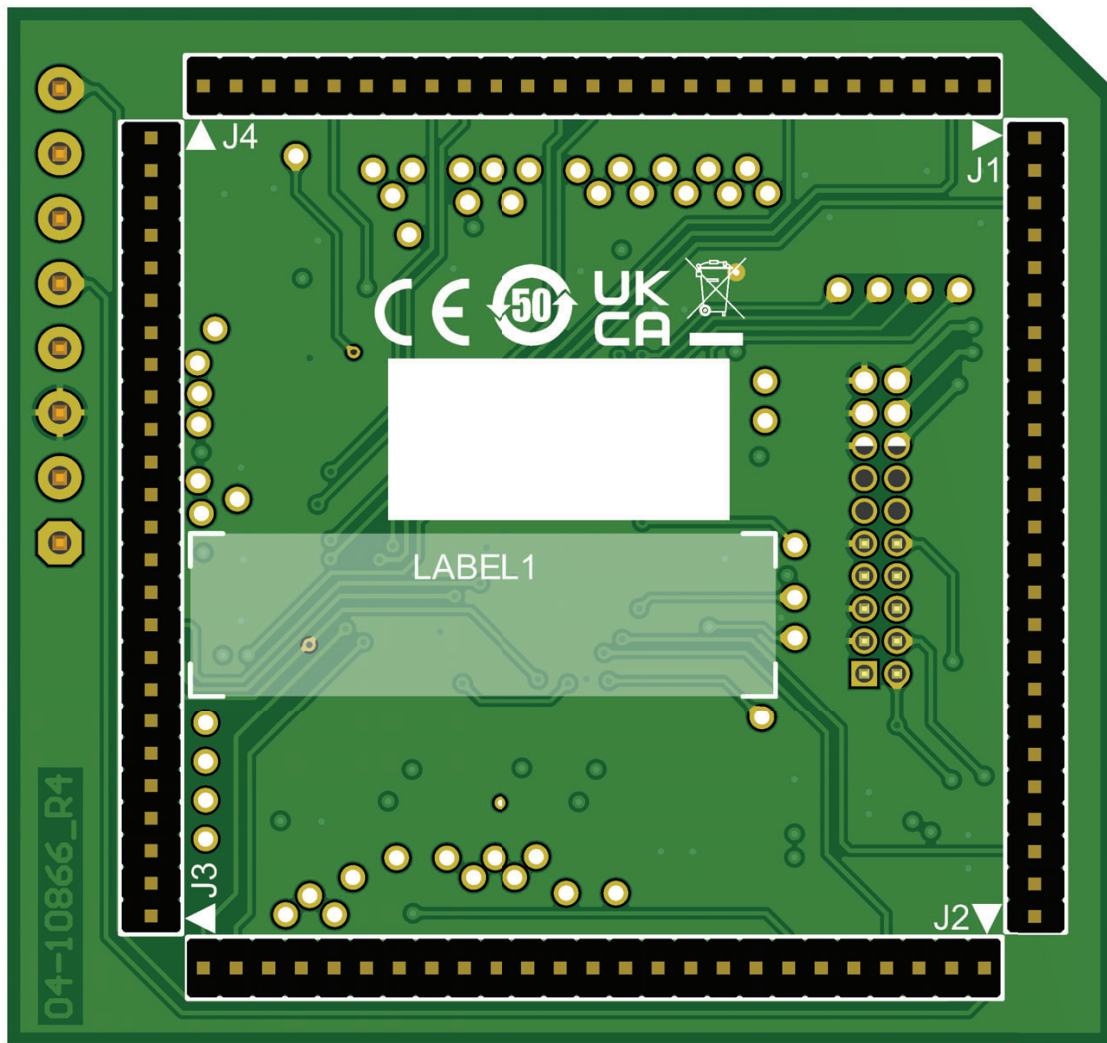
HDR-1.27 Female 1x25 (x4)
2246-1X25G00S











3. Revision History

Revision C - 07/2024

The following updates were performed for this revision:

- Created a new section for Schematics and updated all schematics in [Schematics and Assembly Plots](#)
- Removed erroneous Table of Contents
- Added Revision History

Revision B - 11/2019

The following updates were performed for this revision:

- Updated all Schematics in *PIM to MCU Mapping*
- Updated document formatting

Revision A - 09/2018

This is the initial release of the document.

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