PIC32MK

PIC32MK 100-pin Motor Control Plug-In Module (PIM) Information Sheet

The PIC32MK 100-pin Motor Control Plug-in Module (PIM) (MA320024) is designed to demonstrate the capabilities of PIC32MK 100-pin Motor Control devices using external or internal on-chip op amps with the following hardware:

- dsPICDEM™ MCLV-2 Development Board (DM330021-2)
- dsPICDEM™ MCHV-2 Development Board (DM330023-2
- dsPICDEM™ MCHV-3 Development Board (DM330023-3)

All three development boards support 100-pin PIM interfaces. For example, the PIC32MK1024MCF100 is a 32-bit Motor control microcontroller in a 100-pin TQFP package that can be used with all three boards.

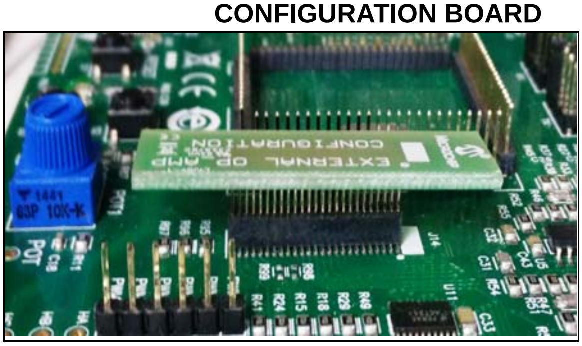
Selecting the External On-board Op Amp Configuration

To operate the PIC32MK 100-pin Motor Control PIM using external on-board op amps, insert the External Op amp Configuration Board, which is included with the development board, into the appropriate header for the hardware in use:

- J14 (dsPICDEM MCLV-2 Development Board)
- J4 (dsPICDEM MCHV-2/MCHV-3 Development Board). In addition, for the MCHV-2/MCHV-3, ensure that jumpers are set at position 1-2 for J12, J13, J14, and position 5-6 for J11.

Figure 1 shows the connection location for the external on-board op amp on the dsPICDEM MCLV-2 Development Board.

FIGURE 1: EXTERNAL OP AMP CONFIGURATION BOARD



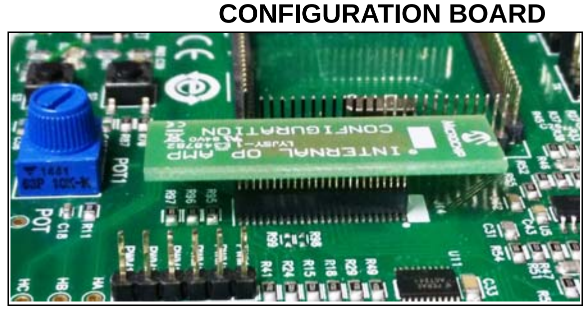
Selecting the Internal On-board Op Amp Configuration

To operate the PIC32MK 100-pin Motor Control PIM using internal on-chip Op Amps, insert the Internal Op Amp Configuration Board, which is included with the development board, into the appropriate header for the hardware in use:

- J14 (dsPICDEM MCLV-2 Development Board)
- J4 (dsPICDEM MCHV-2/MCHV-3 Development Board)

Figure 2 shows the connection location for the internal on-board op amp on the dsPICDEM MCLV-2 Development Board.

FIGURE 2: INTERNAL OP AMP CONFIGURATION BOARD



WARNING:	Do not connect non-isolated oscilloscope probes to probe any traces while using the PIM with the dsPICDEM MCHV-2 or dsPICDEM MCHV-3 Development Boards. Instead, use a high-voltage differential probe, rate in excess of 600 VRMS (Common mode). Failure to heed this warning could result in hardware damage.

Table 1 provides the static mapping between the 100-pin PIM pins and the 100-pin device pins.

Figure 3 shows the 100-pin PIM header schematic.

Figure 4 shows the 100-pin PIM device schematic.

TABLE 1: 100-PIN DEVICE TO 100-PIN PIM MAPPING

Device Pin Number	PIC32MK 100-pin Device Functional Description	PIM Pin Number
1	RG15	1
2	VDD	2
3	RPA7 (U3TX)	51, 76
4	PWM1H	94
5	PWM1L	93
6	PWM5L	4
7	PWM5H	71
8	PWM6L	6
9	PWM6H	7
10	RPG6 (HOME2)	61
11	AN18	29
12	AN17/RPG8 (QEB2)	42
13	$\overline{\text{MCLR}}$	13
14	AN16/RPG9 (QEA2)	41
15	VSS	15
16	VDD	16
17	AN22	8
18	AN21	9
19	AN20	79
20	AN10	35
21	AN9	24
22	OA2OUT	D2
23	OA2IN+ (INDX2)	F2
24	OA2IN-	E2
25	OA1OUT	D1
26	OA1IN+ (QEB2)	F1
27	OA1IN-	E1
28	VREF-	—
29	VREF+	28
30	AVDD	30
31	AVSS	31
32	OA3OUT	D3
33	OA3IN-	E3
34	OA3IN+ (QEA2)	F3
35	RC11	33
36	VSS	36
37	VDD	37
38	RG11	34
39	AN36	38
40	AN37	69
41	AN12	40
42	FLT6	19
43	RPE14 (QEB2)	47
44	AN15	32
45	VSS	45
46	VDD	46
47	RD14	44
48	RD15	—
49	DAC3	85
50	FLT15	18
51	AN24	25
52	RPE0 (C1TX)	77, 88
53	AN41/RPE1 (INDX2)	43
54	VBUS	—
55	VBUS3V3	62
56	D1-	—
57	D1+	—
58	VBUS2	53
59	D2-	54
60	D2+	55
61	RF5	60
62	VDD	62
63	CLKI	—
64	RC15	64
65	VSS	65
66	RPA14 (INDX2)	48
67	RPA15 (U3RX)	52, 72
68	RD8	68
69	PGED2	27
70	PGEC2	26
71	DAC2	H
72	AN25	23
73	RPC13	91
74	RPB8	92
75	VSS	75
76	RPB9 (U2TX)	50
77	USBID2	56
78	RC7	84
79	RD12	69
80	RD13	58
81	RPC8 (U2RX)	49, 70
82	RD5	82
83	RD6	—
84	RPC9	80
85	VSS	85
86	VDD	86
87	RPF0 (C1RX)	78, 87
88	RF1	89
89	RG1	83
90	RG0	90
91	RF6	59
92	RF7	—
93	PWM3H	3
94	PWM3L	100
95	RG14	95
96	RG12	96
97	RG13	97
98	PWM2H	99
99	PWM2L	98
100	TDO	—

FIGURE 3: 100-PIN PIM HEADER SCHEMATIC

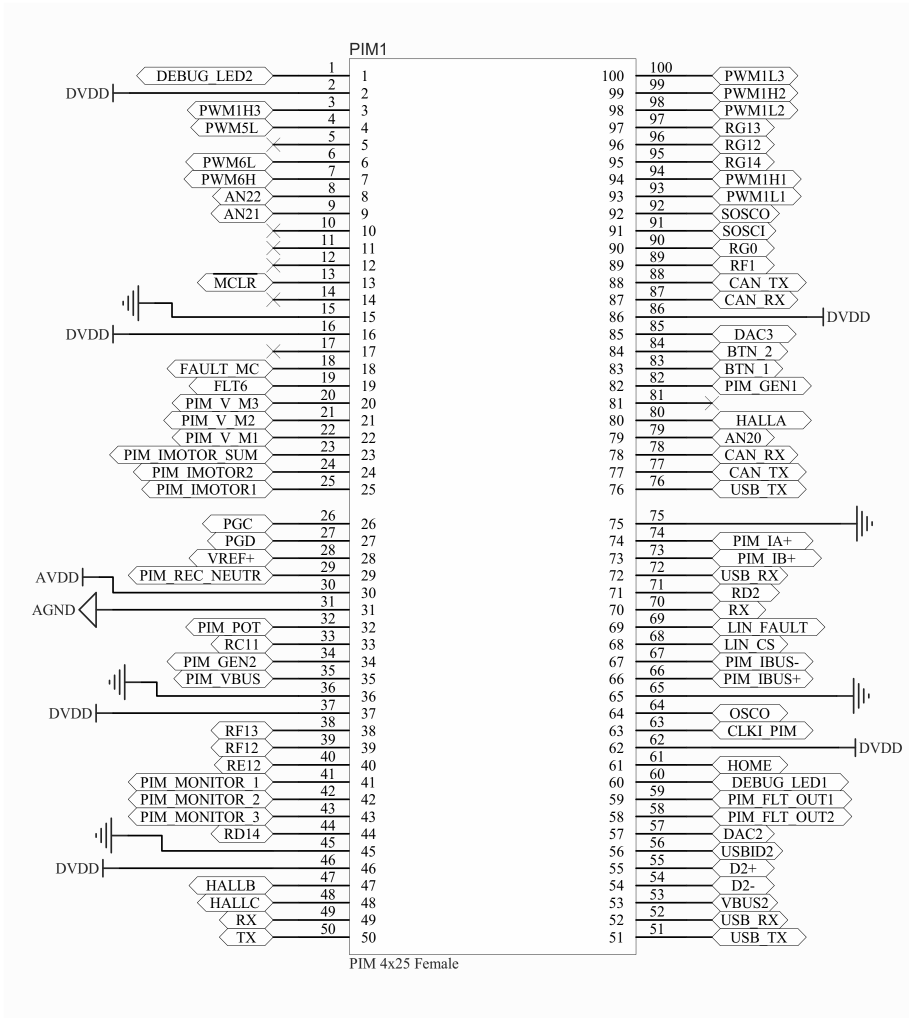
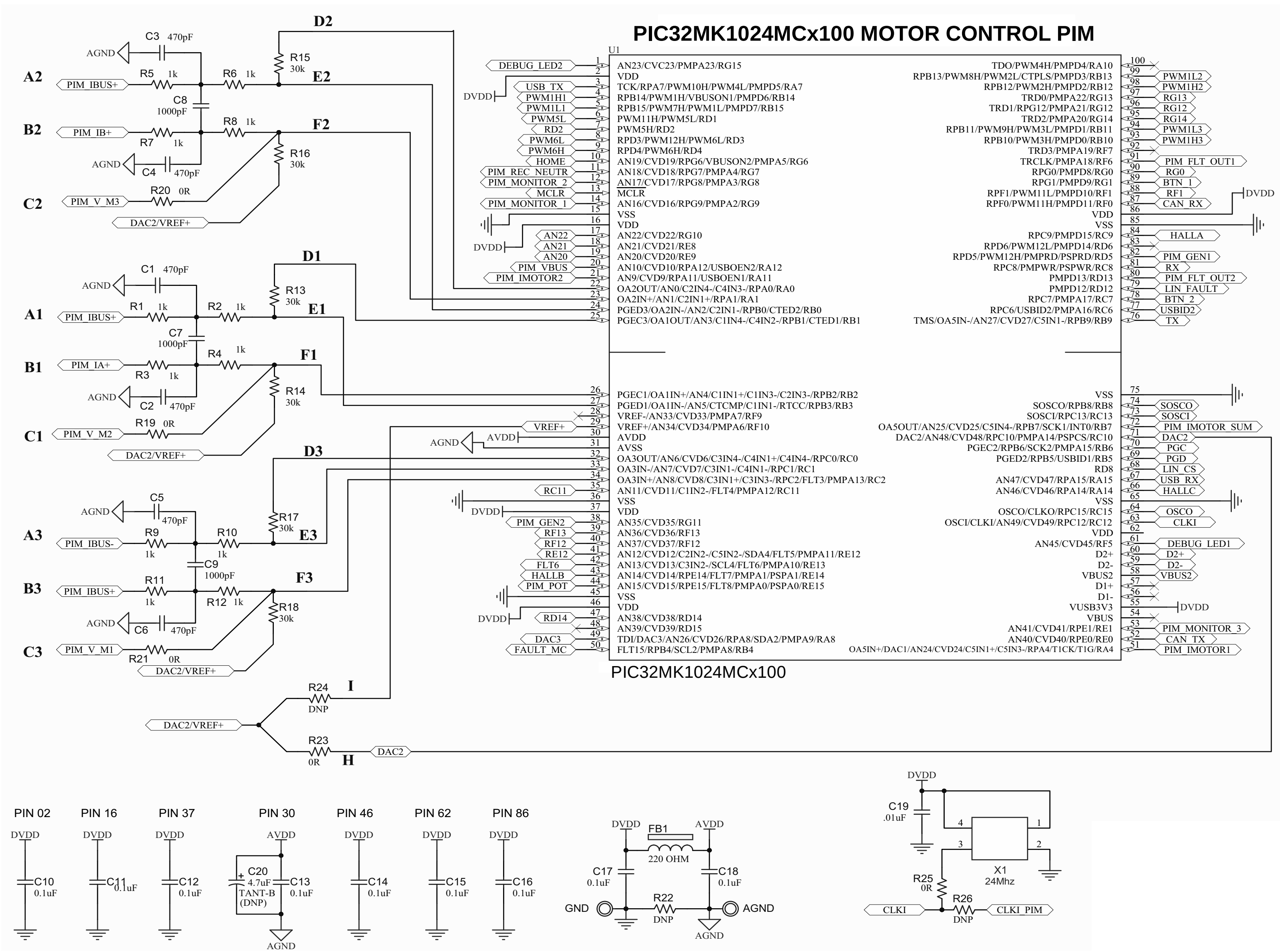


FIGURE 4: 100-PIN PIM DEVICE SCHEMATIC



The reference voltage (VREF) biases the op amps to VDD/2 so that bidirectional motor phase current can be sensed using unipolar op amps. The source of VREF can be selected either from the development board or from the internally generated reference voltage using DAC2 and resistors R23/R24, as shown in Figure 4. By default, the PIM is configured to source the reference voltage, internally generated using DAC2 by populating R23 and keeping R24 depopulated.

To source the reference voltage from Motor Control PIM, R23 needs to be depopulated and R24 must be populated with a zero ohm resistor.

The internal op amp configuration and passive resistor-capacitive network configures the filter bandwidth, op amp bias and op amp gain, as shown in Figure 4.

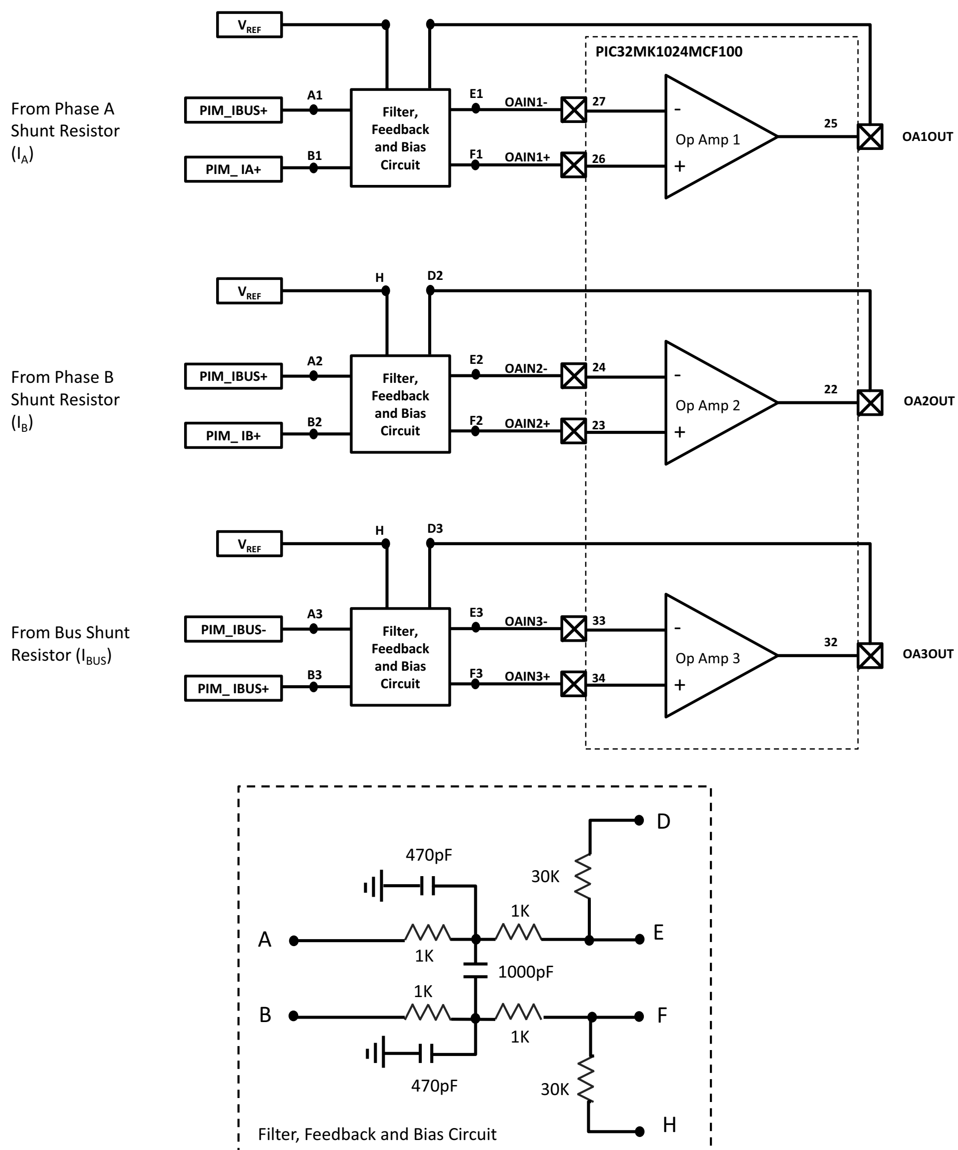
Table 2 classifies the passive components according to their functionality and also specifies the design equations for filter bandwidth and op amp gain.

TABLE 2: ANALOG FUNCTIONALITY LISTING

Op Amp Number	Analog Function	Passive Components	Design Equations
1	Low-Pass Filter	R1, R2, R3, R4, C1, C2, C7	$R1 \quad R2 \quad R3 \quad R4 \quad R$ $C1 \quad C2 \quad C$ $Common\ mode\ f_{-3dB} \cong \frac{1}{2\pi RC}$ $Differential\ mode\ f_{-3dB} \cong \frac{1}{2\pi(2R)\left(\frac{C}{2} \quad C_7\right)}$ $DifferentialAmplifierGain \quad \frac{R_{13}}{2R}$
	Differential Amplifier Input	R1, R2, R3, R4	
	Differential Amplifier Feedback	R13	
2	Low-Pass Filter	R5, R6, R7, R8, C3, C4, C8	$R5 \quad R6 \quad R7 \quad R8 \quad R$ $C3 \quad C4 \quad C$ $Common\ mode\ f_{-3dB} \cong \frac{1}{2\pi RC}$ $Differential\ mode\ f_{-3dB} \cong \frac{1}{2\pi(2R)\left(\frac{C}{2} \quad C_8\right)}$ $DifferentialAmplifierGain \quad \frac{R_{15}}{2R}$
	Differential Amplifier Input	R5, R6, R7, R8	
	Differential Amplifier Feedback	R15	
3	Low-Pass Filter	R9, R10, R11, R12, C5, C6, C9	$R9 \quad R10 \quad R11 \quad R12 \quad R$ $C5 \quad C6 \quad C$ $Common\ mode\ f_{-3dB} \cong \frac{1}{2\pi RC}$ $Differential\ mode\ f_{-3dB} \cong \frac{1}{2\pi(2R)\left(\frac{C}{2} \quad C_9\right)}$ $DifferentialAmplifierGain \quad \frac{R_{17}}{2R}$
	Differential Amplifier Input	R9, R10, R11, R12	
	Differential Amplifier Feedback	R17	

Figure 5 illustrates a typical block diagram of the op amp circuit.

FIGURE 5: OP AMP CIRCUIT BLOCK DIAGRAM



$$\textit{Differential Amplifier Gain} = \frac{30k\Omega}{2 \times 1k\Omega} = 15$$

$$\textit{Differential mode } f_{-3dB} \cong \frac{1}{2\pi(2 \times 1k\Omega)\left(\frac{470pF}{2} + 1000pF\right)} \cong 65kHz$$

$$\textit{Common mode } f_{-3dB} \cong \frac{1}{2\pi(1k\Omega)(470pF)} \cong 340kHz$$

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