

dsPIC33CK1024MP710 Motor Control Plug-In Module (PIM) Information Sheet

The dsPIC33CK1024MP710 Motor Control PIM (P/N: EV57E01A) is designed to demonstrate the motor control capabilities of the dsPIC33CK1024MP710 device. This dsPIC® DSC features a 100 MIPS, single-core 16-bit Digital Signal Controller (DSC) with enhanced on-chip peripherals.

This motor control PIM is designed to take advantage of the high-speed PWM module, four dedicated ADC cores, a single shared ADC core and operational amplifiers in the device to enable various motor control applications. The dedicated ADC cores in the device have a 4:1 input multiplexer. This feature allows switching between internal and external op amp configuration only by setting the input channel selection bits of the dedicated ADCs. Hence, there is only a single variant of the PIM for evaluating internal and external amplifiers' configuration.

The PIM can be used to demonstrate and develop motor control applications by inserting it in the 100-pin PIM interface header provided on the compatible motor control development boards (see [Table 1](#)). The PIM is designed to run a single motor with all the compatible development boards. When operating this PIM on the dsPICDEM™ MCLV-2 Development Board, insert an internal or external op amp configuration matrix board (see [Figure 2](#) and [Figure 3](#)) on the J14 header provided on the board. In the case of the dsPICDEM MCHV-2/ MCHV-3 Development Boards, insert an internal or external op amp configuration matrix board onto the J4 header (as shown in [Figure 2](#) and [Figure 3](#)) on the board. This PIM can be used on the dsPICDEM MCHV-3 Development Board to implement and demonstrate single-stage boost Power Factor Correction (PFC) control, along with Field-Oriented Control (FOC). For additional information regarding development boards, refer to the respective user's guide available on the Microchip website (www.microchip.com). [Table 1](#) provides information on the hardware versions of the motor control boards that are compatible with this PIM.

FIGURE 1: dsPIC33CK1024MP710 MC PIM (P/N: EV57E01A)

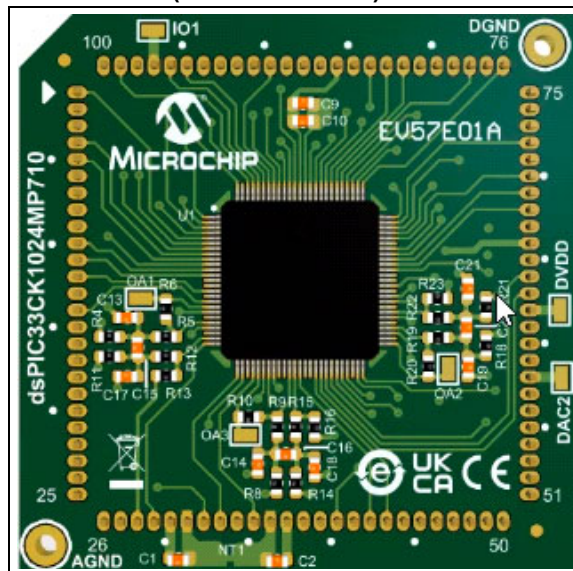


FIGURE 2: INTERNAL OP AMP CONFIGURATION BOARD



FIGURE 3: EXTERNAL OP AMP CONFIGURATION BOARD



dsPIC33CK1024MP710

TABLE 1: HARDWARE COMPATIBILITY

Development Board	Part Number	Compatible Hardware Version(s)
dsPICDEM™ MCHV Development Board	DM330023	Not Compatible
dsPICDEM MCHV-2 Development Board	DM330023-2	All Revisions
dsPICDEM MCHV-3 Development Board	DM330023-3	All Revisions
dsPICDEM MCLV Development Board	DM330021	Not Compatible
dsPICDEM MCLV-2 Development Board	DM330021-2	All Revisions
dsPICDEM MCSM Development Board	DM330022/DM330022-1	All Revisions

WARNING

Do not connect non-isolated oscilloscope probes to the test points on the PIM when inserted and in use with the dsPICDEM™ MCHV-2 or MCHV-3 Development Board. Failure to heed this warning could result in hardware damage.

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Table 2 provides the mapping between the 100-pin dsPIC33CK1024MP710 device and the 100-pin PIM.

TABLE 2: DEVICE TO PIM MAPPING (ORDERED BY DEVICE PIN NUMBER)

Device Pin #	PIM Pin #	dsPIC33CK1024MP710 Device Functional Description	Remarks
1	PIM:94	RP46/PWM1H/PMD5/RB14	Direct Connection
2	PIM:22	AN20/ANC0/CMP5C/RE0	Direct Connection
3	PIM:93	RP47/PWM1L/PMD6/RB15	Direct Connection
4	PIM:21	AN21/ANC1/CMP6B/RE1	Direct Connection
5	PIM:01	RP80/RF0	Direct Connection
6	PIM:09	RP60/PWM8H/PMD7/RC12	Direct Connection
7	PIM:08	RP61/PWM8L/PMA5/RC13	Direct Connection
8	PIM:04	RP62/PWM6H/PMA4/RC14	Direct Connection
9	PIM:05	RP63/PWM6L/PMA3/RC15	Direct Connection
10	PIM:13	MCLR	Direct Connection
11	PIM:10	RP79/PCI22/PMA2/RD15	Direct Connection
12	PIM:11	RP81/RF1	Direct Connection
13	PIM:15, 36, 45, 65, 75 ⁽²⁾	Vss	Digital Ground (DGND)
14	PIM:02, 16, 37, 46, 62, 86 ⁽¹⁾	VDD	Digital Power (DVDD)
15	PIM:12	RP78/PCI21/RD14	Direct Connection
16	—	ANN4/CMP5B/RP77/RD13	No Connection
17	PIM:14	AN12/ANN0/RP48/RC0	Direct Connection
18	—	OA1OUT/AN0/CMP1A/IBIAS0/RA0	The Output of Op Amp 1 (OA1) when Configured and Enabled
19	PIM:25	AN22/ANB3/CMP6C/RE2	Direct Connection
20	—	RP82/RF2	No Connection
21	PIM:66	OA1IN-/ANA1/RA1	Connected via Amplifier Input Resistors
22	PIM:32	AN23/ANN3/RE3	Direct Connection
23	—	RP83/RF3	No Connection
24	PIM:74	OA1IN+/AN9/PMA6/RA2	Connected via Amplifier Input Resistors
25	PIM:29	RP84/RF4	Direct Connection
26	PIM:33	RP85/RF5	Direct Connection
27	PIM:57	DACOUT1/AN3/AN31/CMP1C/RA3	Direct Connection
28	—	RE4	No Connection
29	PIM:35	AN24/RP86/RF6	Direct Connection
30	—	OA3OUT/AN4/ANB1/ANB2/CMP3B/IBIAS3/RA4	The Output of Op Amp 3 (OA3) when Configured and Enabled
31	PIM:34	RE5	Direct Connection
32	PIM:41	AN25/RP87/RF7	Direct Connection
33	PIM:30	AVDD	Analog Power (AVDD)
34	PIM:31	AVss	Analog Ground (AVss)
35	—	RP76/RD12	No Connection
36	PIM:67	OA3IN-/AN13/CMP1B/ISRC0/RP49/PMA7/RC1	Connected via Amplifier Input Resistors
37	PIM:66	OA3IN+/AN14/CMP2B/ISRC1/RP50/PMD13/PMA13/RC2	Connected via Amplifier Input Resistors
38	PIM:42	AN17/ANN1/CMP4B/IBIAS1/RP54/PMD12/PMA12/RC6	Direct Connection
39	PIM:02, 16, 37, 46, 62, 86 ⁽¹⁾	VDD	Digital Power (DVDD)
40	PIM:15, 36, 45, 65, 75 ⁽²⁾	Vss	Digital Ground (DGND)

Note 1: Digital Power (DVDD) pins are shorted together on the PIM.

Note 2: Digital Ground (DGND) pins are shorted together on the PIM.

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TABLE 2: DEVICE TO PIM MAPPING (ORDERED BY DEVICE PIN NUMBER) (CONTINUED)

Device Pin #	PIM Pin #	dsPIC33CK1024MP710 Device Functional Description	Remarks
41	PIM:43	AN15/ANN2/CMP2A/IBIAS2/RP51/PMD11/PMA11/RC3	Direct Connection
42	PIM:63	OSCI/CLKI/AN5/RP32/PMD10/PMA10/RB0	Direct Connection (OSCI)
43	PIM:64	OSCO/CLKO/AN6/RP33/PMA1/PMALH/PSA1/RB1	Direct Connection (OSCO)
44	PIM:56	AN19/ANB0/CMP2C/RP75/PMA0/PMALL/PSA0/RD11	Direct Connection
45	PIM:40	RE6	Direct Connection
46	PIM:49	AN26/RP88/RF8	Direct Connection
47	PIM:20	AN18/ANC2/CMP3C/ISRC3/RP74/PMD9/PMA9/RD10	Direct Connection
48	—	RE7	No Connection
49	PIM:50	RP89/RF9	Direct Connection
50	PIM:58	DACOUT2/AN16/CMP4C/ISRC2/RP55/PMD8/PMA8/RC7	Direct Connection; a Test Point for DAC2 Output is provided on the PIM
51	—	OA2OUT/AN1/AN7/ANA0/ANA2/ANA3/CMP1D/CMP2D/CMP3D/CMP4D/CMP5D/CMP6D/RP34/SCL3/INT0/RB2	The Output of Op Amp 2 (OA2) when Configured and Enabled
52	—	RE8	No Connection
53	PIM:53	RP90/RF10	Direct Connection
54	PIM:66	PGD2/OA2IN-/AN8/CMP4A/RP35/RB3	Connected via Amplifier Input Resistors
55	—	RE9	No Connection
56	PIM:54	RP91/RF11	Direct Connection
57	PIM:73	PGC2/OA2IN+/RP36/RB4	Connected via Amplifier Input Resistors
58	—	RP56/ASDA1/SCK2/RC8	No Connection
59	PIM:59	RP57/ASCL1/SDI2/RC9	Direct Connection
60	PIM:60	RP92/RF12	Direct Connection
61	—	RP73/PCI20/RD9	No Connection
62	PIM:77	RP72/SDO2/PCI19/RD8	Direct Connection
63	PIM:15, 36, 45, 65, 75 ⁽²⁾	Vss	Digital Ground (DGND)
64	PIM:02, 16, 37, 46, 62, 86 ⁽¹⁾	VDD	Digital Power (DVDD)
65	PIM:61	RP71/PMD15/RD7	Direct Connection
66	PIM:68	RP70/PMD14/RD6	Direct Connection
67	PIM:69	RP69/PMA15/PMCS2/RD5	Direct Connection
68	PIM:27	PGD3/RP37/SDA2/PMA14/PMCS1/PSCS/RB5	Direct Connection (PGD)
69	PIM:26	PGC3/RP38/SCL2/RB6	Direct Connection (PGC)
70	—	RE10	No Connection
71	PIM:70	RP93/APWM4H/RF13	Direct Connection
72	PIM:24	TDO/AN2/AN30/CMP3A/RP39/SDA3/RB7	Direct Connection
73	PIM:79	APWM4L/RE11	Direct Connection
74	PIM:72	RP94/APWM3H/RF14	Direct Connection
75	PIM:23	PGD1/AN10/CMP6A/RP40/SCL1/RB8	Direct Connection
76	PIM:76	RP95/APWM3L/RF15	Direct Connection
77	PIM:17	PGC1/AN11/CMP5A/RP41/SDA1/RB9	Direct Connection
78	PIM:84	APWM2H/RE12	Direct Connection
79	PIM:92	RP96/APWM2L/RA5	Direct Connection
80	PIM:78	RP52/PWM5H/ASDA2/RC4	Direct Connection
81	PIM:82	RE13	Direct Connection
82	PIM:83	RP53/PWM5L/ASCL2/PMWR/PMENB/PSWR/RC5	Direct Connection
83	PIM:07	RP58/PWM7H/PMRD/PMWR/PSRD/RC10	Direct Connection
84	PIM:06	RP59/PWM7L/RC11	Direct Connection

Note 1: Digital Power (DVDD) pins are shorted together on the PIM.

2: Digital Ground (DGND) pins are shorted together on the PIM.

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TABLE 2: DEVICE TO PIM MAPPING (ORDERED BY DEVICE PIN NUMBER) (CONTINUED)

Device Pin #	PIM Pin #	dsPIC33CK1024MP710 Device Functional Description	Remarks
85	PIM:48	RP68/ASDA3/RD4	Direct Connection
86	PIM:47	RP67/ASCL3/RD3	Direct Connection
87	PIM:15, 36, 45, 65, 75 ⁽²⁾	VSS	Digital Ground (DGND)
88	PIM:02, 16, 37, 46, 62, 86 ⁽¹⁾	VDD	Digital Power (DVDD)
89	PIM:80	RP66/RD2	Direct Connection
90	PIM:18	RP65/PWM4H/RD1	Direct Connection
91	PIM:19	RP64/PWM4L/PMD0/RD0	Direct Connection
92	PIM:03	TMS/RP42/PWM3H/PMD1/RB10	Direct Connection
93	PIM:100	TCK/RP43/PWM3L/PMD2/RB11	Direct Connection
94	PIM:90	RE14	Direct Connection
95	PIM:95	RP97/APWM1H/RA6	Direct Connection
96	PIM:96	RP98/APWM1L/RA7	Direct Connection
97	PIM:99	TDI/RP44/PWM2H/PMD3/RB12	Direct Connection
98	PIM:97	RE15	Direct Connection; a Test Point (IO1) is provided on the PIM
99	—	RP99/RA8	No Connection
100	PIM:98	RP45/PWM2L/PMD4/RB13	Direct Connection

Note 1: Digital Power (DVDD) pins are shorted together on the PIM.

2: Digital Ground (DGND) pins are shorted together on the PIM.

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Table 3 provides the mapping between the 100-pin PIM and the 100-pin dsPIC33CK1024MP710 device.

TABLE 3: PIM TO DEVICE MAPPING (ORDERED BY PIM PIN NUMBER)

PIM Pin #	Device Pin #	dsPIC33CK1024MP710 Device Functional Description	Remarks
PIM:01	5	RP80/RF0	Direct Connection
PIM:02 ⁽¹⁾	14, 39, 64, 88	VDD	Digital Power (DVDD)
PIM:03	92	TMS/TP42/PWM3H/PMD1/RB10	Direct Connection
PIM:04	8	RP62/PWM6H/PMA4/RC14	Direct Connection
PIM:05	9	RP63/PWM6L/PMA3/RC15	Direct Connection
PIM:06	84	RP59/PWM7L/RC11	Direct Connection
PIM:07	83	RP58/PWM7H/PMRD/PMWR/PSRD/RC10	Direct Connection
PIM:08	7	RP61/PWM8L/PMA5/RC13	Direct Connection
PIM:09	6	RP60/PWM8H/PMD7/RC12	Direct Connection
PIM:10	11	RP79/PCI22/PMA2/RD15	Direct Connection
PIM:11	12	RP81/RF1	Direct Connection
PIM:12	15	RP78/PCI21/RD14	Direct Connection
PIM:13	10	MCLR	Direct Connection
PIM:14	17	AN12/ANN0/TP48/RC0	Direct Connection
PIM:15 ⁽²⁾	13, 40, 63, 87	VSS	Digital Ground (DGND)
PIM:16 ⁽¹⁾	14, 39, 64, 88	VDD	Digital Power (DVDD)
PIM:17	77	PGC1/AN11/CMP5A/TP41/SDA1/RB9	Direct Connection
PIM:18	90	RP65/PWM4H/RD1	Direct Connection
PIM:19	91	RP64/PWM4L/PMD0/RD0	Direct Connection
PIM:20	47	AN18/ANC2/CMP3C/ISRC3/TP74/PMD9/PMA9/RD10	Direct Connection
PIM:21	4	AN21/ANC1/CMP6B/RE1	Direct Connection
PIM:22	2	AN20/ANC0/CMP5C/RE0	Direct Connection
PIM:23	75	PGD1/AN10/CMP6A/TP40/SCL1/RB8	Direct Connection
PIM:24	72	TDO/AN2/AN30/CMP3A/TP39/SDA3/RB7	Direct Connection
PIM:25	19	AN22/ANB3/CMP6C/RE2	Direct Connection
PIM:26	69	PGC3/TP38/SCL2/RB6	Direct Connection (PGC)
PIM:27	68	PGD3/TP37/SDA2/PMA14/PMCS1/PSCS/RB5	Direct Connection (PGD)
PIM:28	—	—	Voltage Reference (VREF)
PIM:29	25	RP84/RF4	Direct Connection
PIM:30	33	AVDD	Analog Power (AVDD)
PIM:31	34	AVSS	Analog Ground (AVSS)
PIM:32	22	AN23/ANN3/RE3	Direct Connection
PIM:33	26	RP85/RF5	Direct Connection
PIM:34	31	RE5	Direct Connection
PIM:35	29	AN24/TP86/RF6	Direct Connection
PIM:36 ⁽²⁾	13, 40, 63, 87	VSS	Digital Ground (DGND)
PIM:37 ⁽¹⁾	14, 39, 64, 88	VDD	Digital Power (DVDD)
PIM:38	—	—	No Connection
PIM:39	—	—	No Connection
PIM:40	45	RE6	Direct Connection
PIM:41	32	AN25/TP87/RF7	Direct Connection

Note 1: Digital Power (DVDD) pins are shorted together on the PIM.

2: Digital Ground (DGND) pins are shorted together on the PIM.

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TABLE 3: PIM TO DEVICE MAPPING (ORDERED BY PIM PIN NUMBER) (CONTINUED)

PIM Pin #	Device Pin #	dsPIC33CK1024MP710 Device Functional Description	Remarks
PIM:42	38	AN17/ANN1/CMP4B/IBIAS1/RP54/PMD12/PMA12/RC6	Direct Connection
PIM:43	41	AN15/ANN2/CMP2A/IBIAS2/RP51/PMD11/PMA11/RC3	Direct Connection
PIM:44	—	—	No Connection
PIM:45 ⁽²⁾	13, 40, 63, 87	Vss	Digital Ground (DGND)
PIM:46 ⁽¹⁾	14, 39, 64, 88	Vdd	Digital Power (DVDD)
PIM:47	86	RP67/ASCL3/RD3	Direct Connection
PIM:48	85	RP68/ASDA3/RD4	Direct Connection
PIM:49	46	AN26/RP88/RF8	Direct Connection
PIM:50	49	RP89/RF9	Direct Connection
PIM:51	—	—	No Connection
PIM:52	—	—	No Connection
PIM:53	53	RP90/RF10	Direct Connection
PIM:54	56	RP91/RF11	Direct Connection
PIM:55	—	—	No Connection
PIM:56	44	AN19/ANB0/CMP2C/RP75/PMA0/PMALL/PSA0/RD11	Direct Connection
PIM:57	27	DACOUT1/AN3/AN31/CMP1C/RA3	Direct Connection
PIM:58	50	DACOUT2/AN16/CMP4C/ISRC2/RP55/PMD8/PMA8/RC7	Direct Connection; a Test Point for DAC2 Output is provided on the PIM
PIM:59	59	RP57/ASCL1/SDI2/RC9	Direct Connection
PIM:60	60	RP92/RF12	Direct Connection
PIM:61	65	RP71/PMD15/RD7	Direct Connection
PIM:62 ⁽¹⁾	10, 25, 41, 57	Vdd	Digital Power (DVDD)
PIM:63	42	OSCI/CLKI/AN5/RP32/PMD10/PMA10/RB0	Direct Connection (OSCI)
PIM:64	43	OSCO/CLKO/AN6/RP33/PMA1/PMALH/PSA1/RB1	Direct Connection (OSCO)
PIM:65 ⁽²⁾	13, 40, 63, 87	Vss	Digital Ground (DGND)
PIM:66	21	OA1IN-/ANA1/RA1	Connected via Amplifier Input Resistors
	37	OA3IN+/AN14/CMP2B/ISRC1/RP50/PMD13/PMA13/RC2	Connected via Amplifier Input Resistors
	54	PGD2/OA2IN-/AN8/CMP4A/RP35/RB3	Connected via Amplifier Input Resistors
PIM:67	36	OA3IN-/AN13/CMP1B/ISRC0/RP49/PMA7/RC1	Connected via Amplifier Input Resistors
PIM:68	66	RP70/PMD14/RD6	Direct Connection
PIM:69	67	RP69/PMA15/PMCS2/RD5	Direct Connection
PIM:70	71	RP93/APWM4H/RF13	Direct Connection
PIM:71	—	—	No Connection
PIM:72	74	RP94/APWM3H/RF14	Direct Connection
PIM:73	57	PGC2/OA2IN+/RP36/RB4	Connected via Amplifier Input Resistors
PIM:74	24	OA1IN+/AN9/PMA6/RA2	Connected via Amplifier Input Resistors
PIM:75 ⁽²⁾	13, 40, 63, 87	Vss	Digital Ground (DGND)
PIM:76	76	RP95/APWM3L/RF15	Direct Connection
PIM:77	62	RP72/SDO2/PCI19/RD8	Direct Connection
PIM:78	80	RP52/PWM5H/ASDA2/RC4	Direct Connection
PIM:79	73	APWM4L/RE11	Direct Connection
PIM:80	89	RP66/RD2	Direct Connection

Note 1: Digital Power (DVDD) pins are shorted together on the PIM.

Note 2: Digital Ground (DGND) pins are shorted together on the PIM.

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TABLE 3: PIM TO DEVICE MAPPING (ORDERED BY PIM PIN NUMBER) (CONTINUED)

PIM Pin #	Device Pin #	dsPIC33CK1024MP710 Device Functional Description	Remarks
PIM:81	—	—	No Connection
PIM:82	81	RE13	Direct Connection
PIM:83	82	RP53/PWM5L/ASCL2/PMWR/PMENB/PSWR/RC5	Direct Connection
PIM:84	78	APWM2H/RE12	Direct Connection
PIM:85	—	—	No Connection
PIM:86 ⁽¹⁾	14, 39, 64, 88	VDD	Digital Power (DVDD)
PIM:87	—	—	No Connection
PIM:88	—	—	No Connection
PIM:89	—	—	No Connection
PIM:90	94	RE14	Direct Connection
PIM:91	—	—	No Connection
PIM:92	79	RP96/APWM2L/RA5	Direct Connection
PIM:93	3	RP47/PWM1L/PMD6/RB15	Direct Connection
PIM:94	1	RP46/PWM1H/PMD5/RB14	Direct Connection
PIM:95	95	RP97/APWM1H/RA6	Direct Connection
PIM:96	96	RP98/APWM1L/RA7	Direct Connection
PIM:97	98	RE15	Direct Connection; a Test Point (IO1) is provided on the PIM
PIM:98	100	RP45/PWM2L/PMD4/RB13	Direct Connection
PIM:99	97	TDI/RP44/PWM2H/PMD3/RB12	Direct Connection
PIM:100	93	TCK/RP43/PWM3L/PMD2/RB11	Direct Connection

Note 1: Digital Power (DVDD) pins are shorted together on the PIM.

Note 2: Digital Ground (DGND) pins are shorted together on the PIM.

INTERNAL AMPLIFIER

Operational amplifiers internal to dsPIC33CK1024MP710 can be configured and enabled for amplifying motor currents. The amplifier circuits are shown in Figure 4. The detailed schematics of the block, “Filter, Feedback and Bias Circuit” used in Figure 4 are shown in Figure 5.

FIGURE 4: dsPIC® DSC INTERNAL AMPLIFIERS

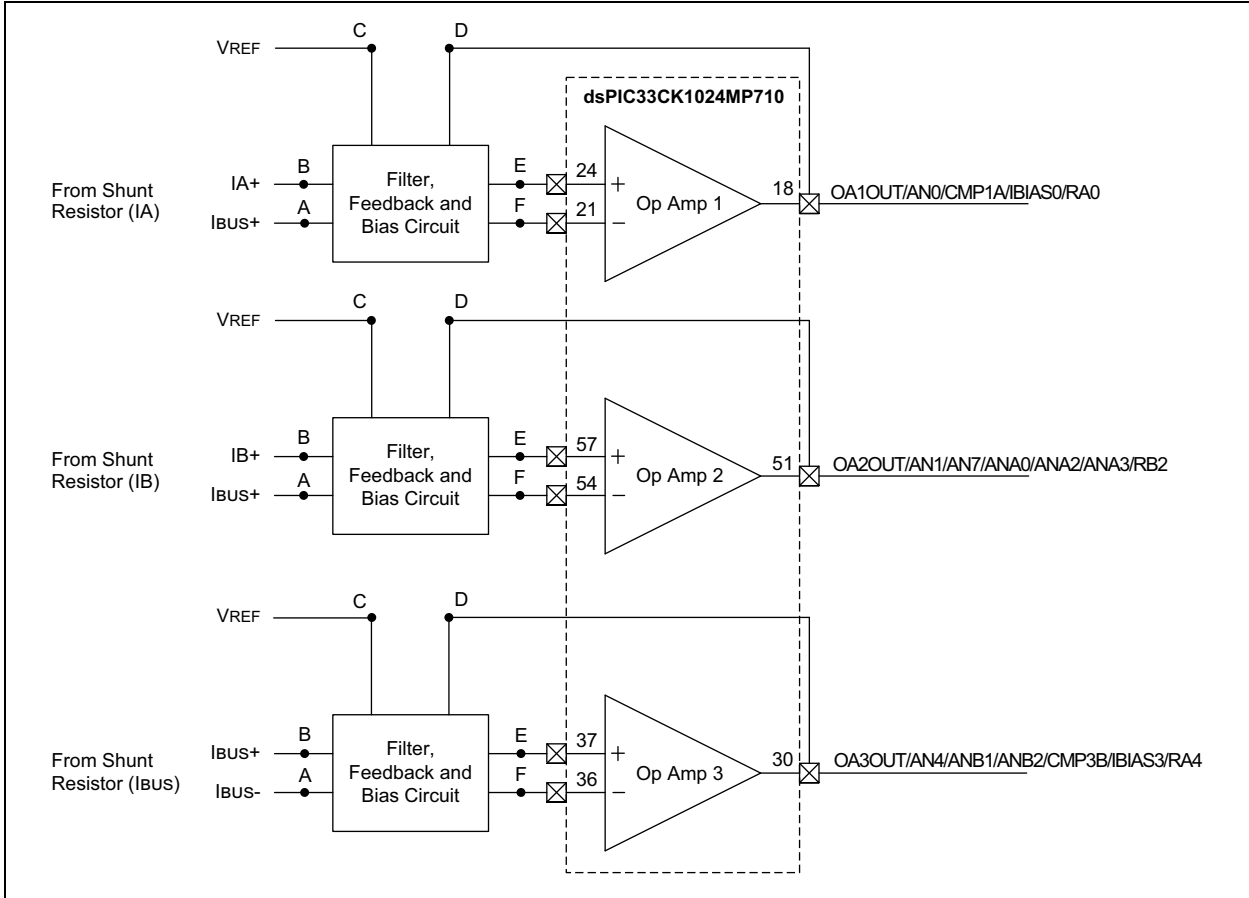
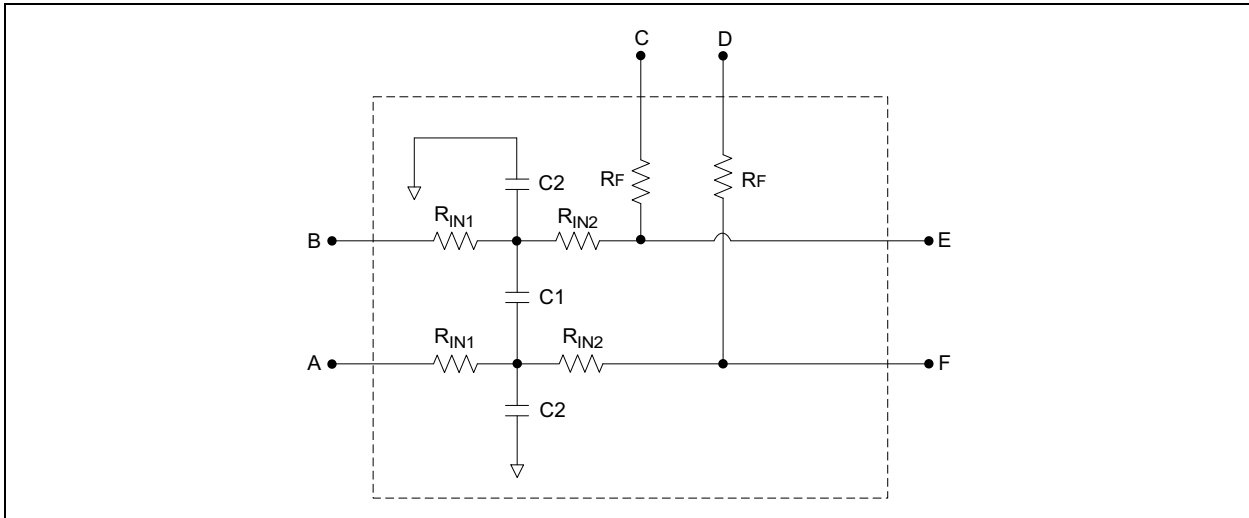


FIGURE 5: FILTER, FEEDBACK AND BIAS CIRCUIT



dsPIC33CK1024MP710

Equation 1 provides the amplifier gain calculations. Equation 2 and Equation 3 are the equations to calculate cutoff frequencies of the Differential-mode and Common-mode filters.

EQUATION 1: AMPLIFIER GAIN

$$\text{Differential Amplifier Gain} = \frac{R_F}{(R_{IN1} + R_{IN2})}$$

EQUATION 2: CUTOFF FREQUENCY DIFFERENTIAL-MODE FILTER

$$\text{Differential-mode } f_{-3dB} \cong \frac{1}{2\pi(R_{IN1} + R_{IN2})\left(\frac{C2}{2} + C1\right)}$$

EQUATION 3: CUTOFF FREQUENCY COMMON-MODE FILTER

$$\text{Common-mode } f_{-3dB} \cong \frac{1}{2\pi(R_{IN1})(C2)}$$

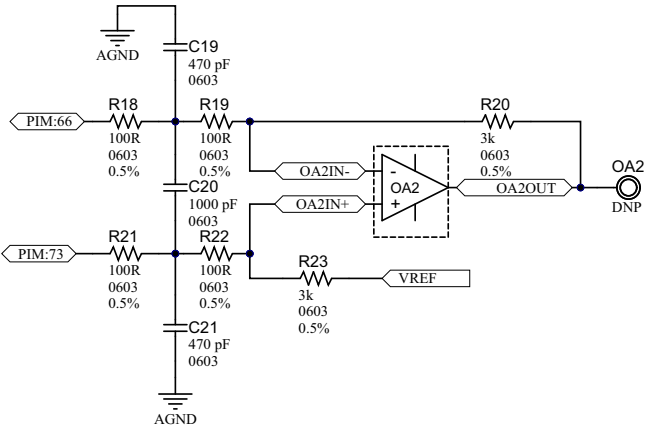
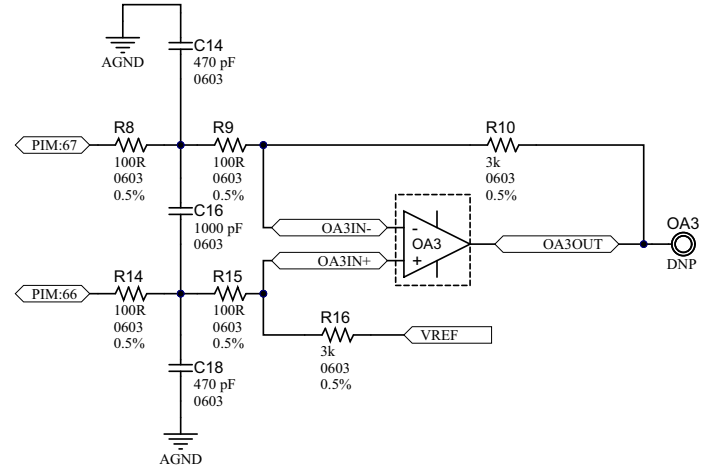
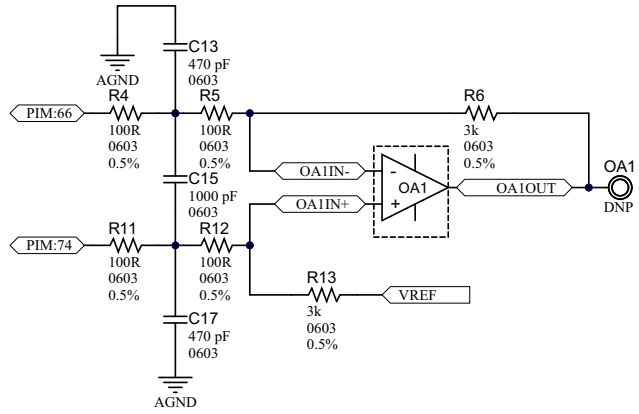
Table 4 summarizes the gain and the filter cutoff frequencies of the amplifiers on the PIM. Customers can select different values for configuring the internal amplifier gain and filter cutoff frequencies based on the application requirements. However, make sure the peak current of the motor control board is within its operating range.

TABLE 4: AMPLIFIER GAIN AND CUTOFF FREQUENCIES

Component Values					Amplifier Gain	Differential-Mode Filter Cutoff Frequency	Common-Mode Filter Cutoff Frequency
R _{IN1}	R _{IN2}	R _F	C1	C2			
100Ω	100Ω	3 kΩ	1000 pF	470 pF	15	644 kHz	3.3 MHz

Schematic Revision 1.0 (Page 2 of 2)

dsPIC33CK1024MP710 Motor Control PIM



The operational amplifiers, OA1, OA2 and OA3, are internal to dsPIC33CK1024MP710

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