dsPIC33EP512GM706 Plug-In Module (PIM) Information Sheet for Internal Op Amp Configuration

The dsPIC33EP512GM706 Internal Op Amp Motor Control PIM is designed to demonstrate the capabilities of the dsPIC33EP512GM706 motor control device using internal op amps with development boards, such as the dsPICDEM™ MCLV-2 Development Board (DM330021-2) and the dsPICDEM MCHV-2 Development Board (DM330023-2), which support 100-pin PIM interfaces.

The dsPIC33EP512GM706 is a high-performance, 16-bit Digital Signal Controller (DSC) in a 64-pin TQFP package. This device is equipped with four op amp/comparators, plus one dedicated comparator. The dsPIC33EP512GM706 Internal Op Amp Motor Control PIM takes advantage of these analog peripherals, configured using on-board passive components (resistors and capacitors) to support motor control applications, without requiring external op amps or comparators.

To operate this PIM with the dsPICDEM MCLV-2 and dsPICDEM MCHV-2 Development Boards, please insert the Internal Op Amp Configuration Board into the header, J4 (for the dsPICDEM MCHV-2 Development Board), or header, J14 (for the dsPICDEM MCLV-2 Development Board). Future development boards will not use the Internal Op Amp Configuration Matrix Board.

Figure 1 shows the connection location for the dsPICDEM MCHV-2 Development Board.

FIGURE 1: INTERNAL OP AMP CONFIGURATION BOARD

Hardware Compatibility

Table 1 provides information on the hardware versions of the motor control boards that are compatible with this PIM. Refer to the user's guide for the specific motor control board for hardware version identification information.

TABLE 1: HARDWARE COMPATIBILITY

Development Board	Part Number	Compatible Hardware Version(s)
dsPICDEM™ MCHV Development Board	DM330023	Not compatible
dsPICDEM™ MCLV Development Board	DM330021	Not compatible
dsPICDEM™ MCSM Development Board	DM330022	Not compatible
dsPICDEM™ MCHV-2 Development Board	DM330023-2	All revisions
dsPICDEM™ MCLV-2 Development Board	DM330021-2	All revisions

Warning:

Do not connect non-isolated oscilloscope probes to the test points on the dsPIC33EP512GM706 Internal Op Amp Motor Control PIM while using the PIM with the dsPICDEM™ MCHV-2 Development Board. Use a high-voltage differential probe, rated in excess of 600 VRMS (Common-mode). Failure to heed this warning could result in hardware damage.

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

TABLE 2: 64-PIN DEVICE TO 100-PIN PIM MAPPING

Device Pin #	dsPIC33EP512GM706 Device Functional Description	PIM Pin #
1	TDI/PWM1L4/PMPD5/RA7	NC
2	RPI46/PWM1H1/T3CK/T7CK/PMPD6/RB14	94
3	RPI47/PWM1L1/T5CK/T6CK/PMPD7/RB15	93
4	AN19/RP118/PMPA5/RG6	84
5	AN18/ASCL1/RPI119/PMPA4/RG7	83
6	AN17/ASDA1/RP120/PMPA3/RG8	76
7	$\overline{\text{MCLR}}$	13
8	AN16/RPI121/PMPA2/RG9	72
9	VSS	15, 36, 45, 65, 75
10	VDD	2, 16, 37, 46, 62, 86
11	AN10/RPI28/RA12	35
12	AN9/RPI27/RA11	25
13	OA2OUT/AN0/C2IN4-/C4IN3-/RPI16/RA0	42
14	OA2IN+/AN1/C2IN1+/RPI17/RA1	22, 41
15	PGED3/VREF-/OA2IN-/AN2/C2IN1-/$\overline{\text{SS1}}$/RPI32/CTED2/RB0	43
16	PGEC3/VREF+/(CVREF+)/OA1OUT/AN3/C1IN4-/C4IN2-/RPI33/CTED1/PMPA6/RB1	59
17	PGEC1/OA1IN+/AN4/C1IN3-/C1IN1+/C2IN3-/RPI34/RB2	21
18	PGED1/OA1IN-/AN5/C1IN1-/(CTMUC)/RP35/RTCC/RB3	Used by op amp circuit
19	AVDD	30
20	AVSS	31
21	OA3OUT/AN6/C3IN4-/C4IN4-/C4IN1+/RP48/OCFB/RC0	58
22	OA3IN-/AN7/C3IN1-/C4IN1-/RP49/PMPA7/RC1	Used by op amp circuit
23	OA3IN+/AN8/C3IN3-/C3IN1+/RPI50/$\overline{\text{U1RTS}}$/BCLK1/$\overline{\text{FLT3}}$/PMPA13/RC2	20
24	AN11/C1IN2-/$\overline{\text{U1CTS}}$/$\overline{\text{FLT4}}$/PMPA12/RC11	24
25	VSS	15, 36, 45, 65, 75
26	VDD	2, 16, 37, 46, 62, 86
27	AN12/C2IN2-/C5IN2-//$\overline{\text{U2RTS}}$/BCLK2/$\overline{\text{FLT5}}$/PMPA11/RE12	Reconstructed motor neutral input
28	AN13/C3IN2-/$\overline{\text{U2CTS}}$/$\overline{\text{FLT6}}$/PMPA10/RE13	32, 33
29	AN14/RPI94/$\overline{\text{FLT7}}$/PMPA1/RE14	23
30	AN15/RPI95/$\overline{\text{FLT8}}$/PMPA0/RE15	34
31	SDA2/RPI24/PMPA9/RA8	80
32	$\overline{\text{FLT32}}$/SCL2/RP36/PMPA8/RB4	18

Device Pin #	dsPIC33EP512GM706 Device Functional Description	PIM Pin #
33	OA5IN+/AN24/C5IN3-/C5IN1+/SDO1/RP20/T1CK/RA4	Used by op amp circuit
34	AN28/SDI1/RPI25/RA9	77
35	AN29/SCK1/RPI51/RC3	79
36	AN30/SDA1/RPI52/RC4	69
37	AN31/SCL1/RPI53/RC5	49
38	VDD	2, 16, 37, 46, 62, 86
39	AN49/OSC1/CLKI/RPI60/RC12	63
40	OSC2/CLKO/RPI63/RC15	64
41	VSS	15, 36, 45, 65, 75
42	RPI72/RD8	Debug test point
43	PGED2/ASDA2/RP37/RB5	27
44	PGEC2/ASCL2/RP38/PMPCS2/RB6	26
45	AN48/CVREF20/RPI58/PMPCS1/RC10	61
46	OA5OUT/AN25/C5IN4-/RP39/INT0/RB7	19
47	SOSCI/RPI61/RC13	82
48	TCK/AN26/CVREF1O/SOSCO/RP40/T4CK/RB8	68
49	TMS/OA5IN-/AN27/C5IN1-/RP41/RB9	78
50	RP54/PWM1H6/RC6	47
51	RP55/PWM1L6/PMBE/RC7	70
52	RP56/PWM1H5/PMPWR/RC8	88
53	RP69/PMPRD/RD5	60
54	RP70/RD6	1
55	RP57/PWM1L5/RC9/RC9	87
56	VCAP	NC
57	VDD	2, 16, 37, 46, 62, 86
58	RPI96/RF0	48
59	RP97/RF1	50
60	RP42/PWM1H3/PMPD0/RB10	3
61	RP43/PWM1L3/PMPD1/RB11	100
62	RPI44/PWM1H2/PMPD2/RB12	99
63	RPI45/PWM1L2/CTPLS/PMPD3/RB13	98
64	TDO/PWM1H4/PMPD4/RA10	NC

FIGURE 2: 100-PIN HEADER SCHEMATIC

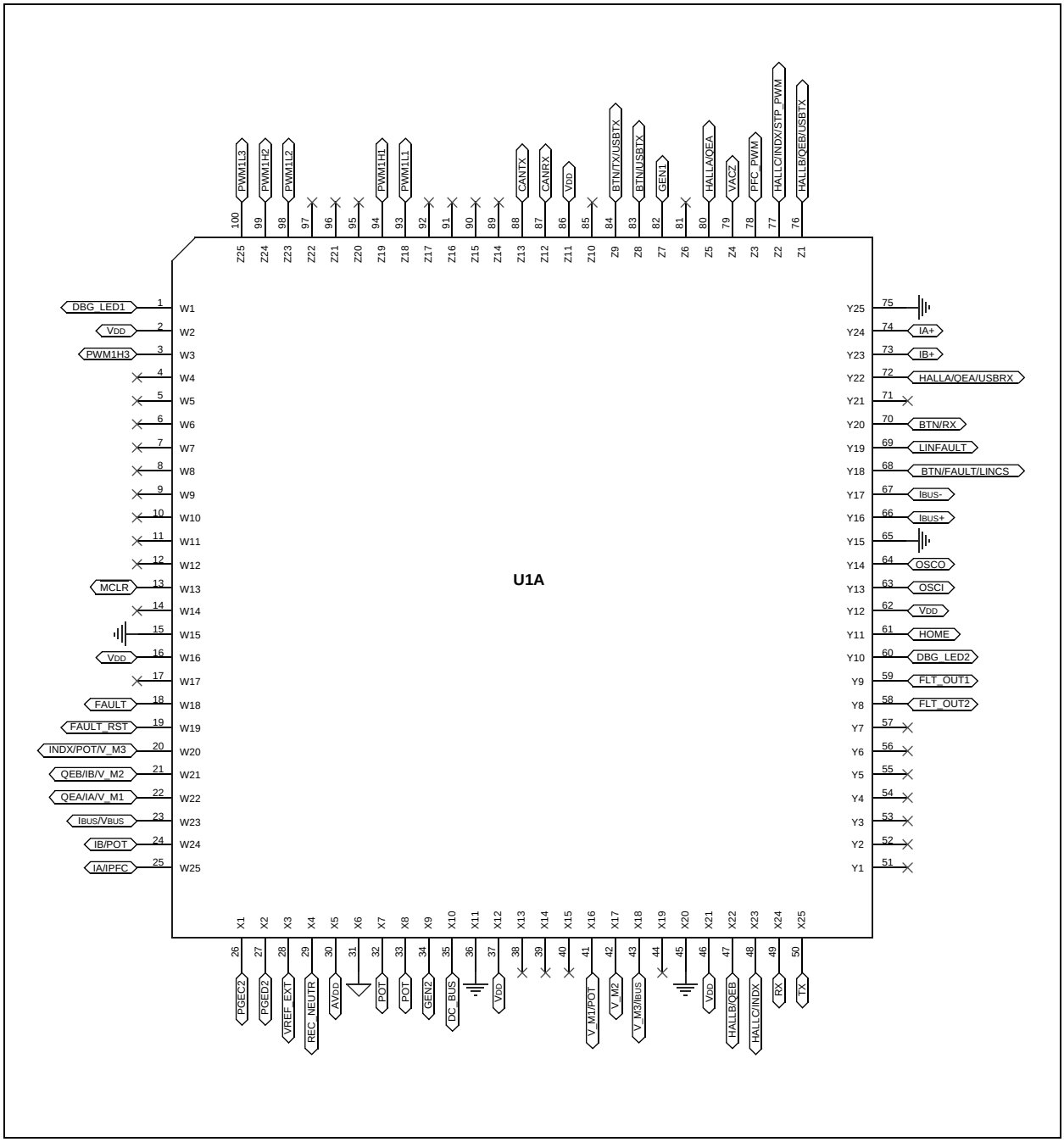
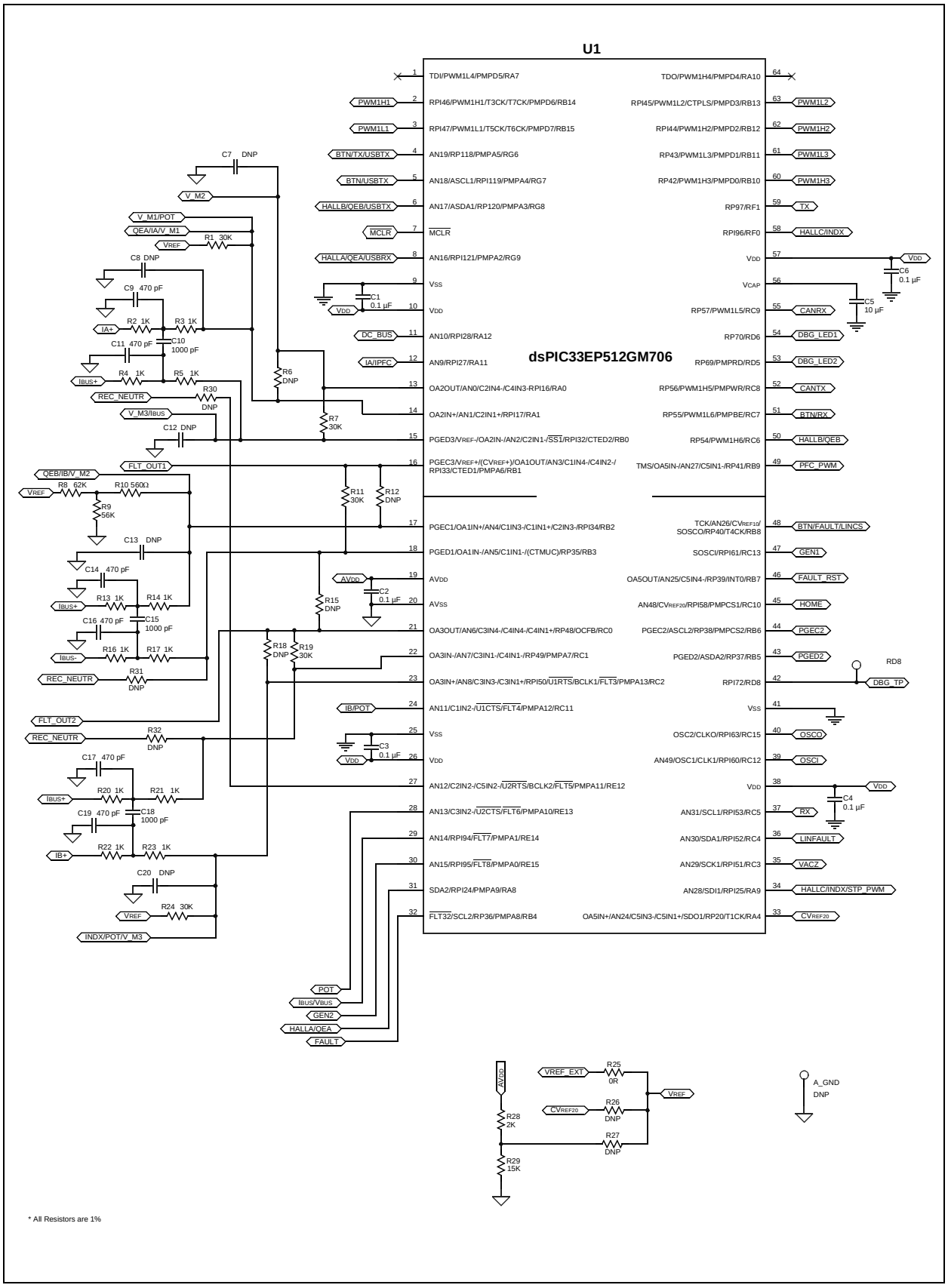


FIGURE 3: 64-PIN DEVICE SCHEMATIC



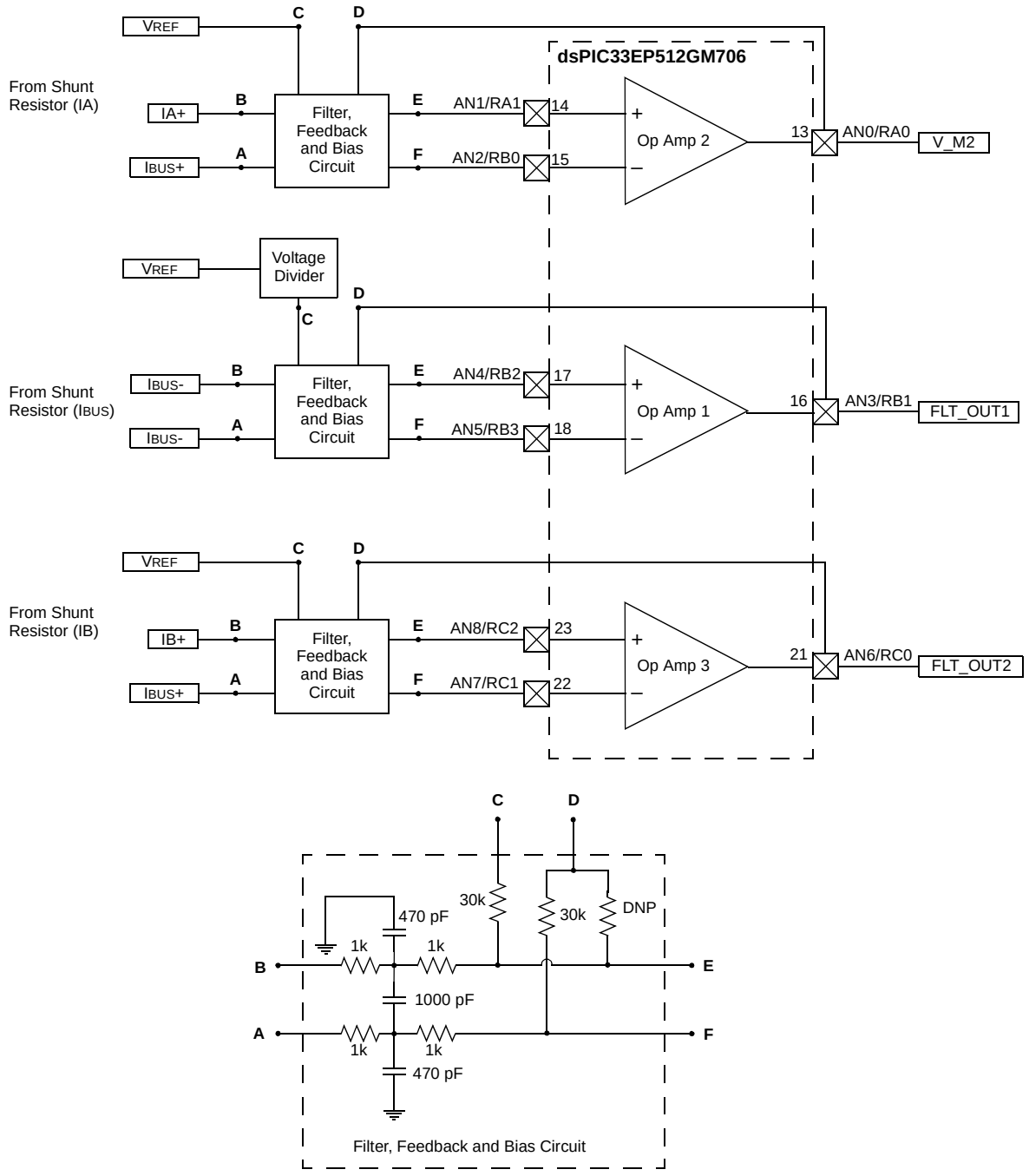
In the schematic shown in Figure 3, resistors, R25 and R27, are used to choose the reference voltage (VREF) from the motor control board (VREF_EXT) or a simple voltage divider (R28-R29), respectively. By default, the PIM is configured to source the reference voltage from the motor control board.

Table 3 classifies the passive components according to their functionality and also quotes the design equations applicable in each case.

TABLE 3: ANALOG FUNCTIONALITY LISTING

Op Amp #	Analog Function	Passive Components	Design Equations
1	Low-Pass Filter	R13, R14, R16, R17, C14, C15, C16	$R13 = R14 = R16 = R17 = R$ $C14 = C16 = C$ $R10 = R11$ $Common\ mode\ f_{-3dB} \cong \frac{1}{2\pi RC}$ $Differential\ mode\ f_{-3dB} \cong \frac{1}{2\pi(2R)\left(\frac{C}{2}+C_{15}\right)}$ $DifferentialAmplifierGain = \frac{R_{11}}{2R}$
	Reference Voltage Bias	R10, R11	
	Voltage Divider	R8, R9	
	Differential Amplifier Input	R13, R14, R16, R17	
	Differential Amplifier Feedback	R11	
2	Low-Pass Filter	R2, R3, R4, R5, C9, C10, C11	$R2 = R3 = R4 = R5 = R$ $C9 = C11 = C$ $R1 = R7$ $Common\ mode\ f_{-3dB} \cong \frac{1}{2\pi RC}$ $Differential\ mode\ f_{-3dB} \cong \frac{1}{2\pi(2R)\left(\frac{C}{2}+C_{10}\right)}$ $DifferentialAmplifierGain = \frac{R_7}{2R}$
	Reference Voltage Bias	R1, R7	
	Differential Amplifier Input	R2, R3, R4, R5	
	Differential Amplifier Feedback	R7	
3	Low-Pass Filter	R20, R21, R22, R23, C17, C18, C19	$R20 = R21 = R22 = R23 = R$ $C17 = C19 = C$ $R24 = R19$ $Common\ mode\ f_{-3dB} \cong \frac{1}{2\pi RC}$ $Differential\ mode\ f_{-3dB} \cong \frac{1}{2\pi(2R)\left(\frac{C}{2}+C_{18}\right)}$ $DifferentialAmplifierGain = \frac{R_{19}}{2R}$
	Reference Voltage Bias	R24, R19	
	Differential Amplifier Input	R20, R21, R22, R23	
	Differential Amplifier Feedback	R19	

FIGURE 4: 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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