

dsPIC33CK512MP608 Motor Control Plug-In Module (PIM) Information Sheet for Internal Amplifier Configuration

The dsPIC33CK512MP608 Internal Op Amp Motor Control PIM (P/N: EV33R40A) is designed to demonstrate the motor control capabilities of the dsPIC33CK512MP608 device using the internal op amps of the device.

The dsPIC33CK512MP608 device is a high-performance, 16-bit Digital Signal Controller (DSC). This Motor Control PIM is designed to take advantage of the high-speed PWM module. The PWM, along with other peripherals, such as the ADC, and operational amplifiers in the device enable various motor control applications.

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 op amp configuration matrix board (see [Figure 2](#)) on the J14 header provided on the board. In the case of dsPICDEM MCHV-2/MCHV-3 Development Boards, insert an internal op amp configuration matrix board onto the J4 header (as shown in [Figure 2](#)) 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.

Refer to the specific motor control board user's guide for the hardware version identification information.

FIGURE 1: dsPIC33CK512MP608 INTERNAL OP AMP MOTOR CONTROL PIM (P/N: EV33R40A)

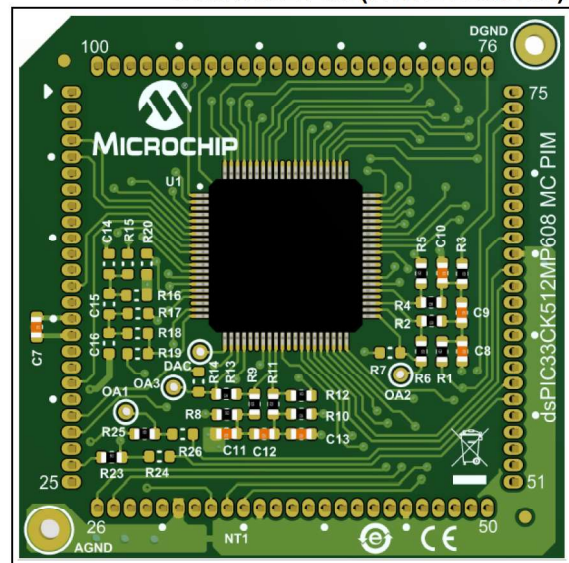


FIGURE 2: INTERNAL OP AMP CONFIGURATION BOARD



dsPIC33CK512MP608

TABLE 1: HARDWARE COMPATIBILITY

| Compatible Development Board | Part Number | Compatible Hardware Revision |
|----------------------------------------------|---------------------|------------------------------|
| 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 |
| Low-Voltage Motor Control Development Bundle | DV330100 | 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 pin mapping from the 80-pin dsPIC33CK512MP608 device to the PIM interface connector.

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

| Device Pin # | PIM Pin # | dsPIC33CK512MP608 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:09 | RP60/PWM8H/PMD7/RC12 | Direct Connection |
| 6 | PIM:08 | RP61/PWM8L/PMA5/RC13 | Direct Connection |
| 7 | PIM:04 | RP62/PWM6H/PMA4/RC14 | Direct Connection |
| 8 | PIM:05 | RP63/PWM6L/PMA3/RC15 | Direct Connection |
| 9 | PIM:13 | MCLR | MCLR |
| 10 | PIM:19 | RP79/PCI22/PMA2/RD15 | Direct Connection |
| 11 | PIM:15, 36, 65, 75 ⁽⁴⁾ | VSS | Digital Ground (DGND) |
| 12 | PIM:02, 16, 37, 62, 86 ⁽³⁾ | VDD | Digital Power (DVDD) |
| 13 | PIM:92 | RP78/PCI21/RD14 | Direct Connection |
| 14 | PIM:89 | ANN4/CMP5B/RP77/RD13 | Direct Connection |
| 15 | PIM:55 | AN12/ANN0/RP48/RC0 | Direct Connection |
| 16 | PIM:25 ⁽¹⁾ | OA1OUT/AN0/CMP1A/IBIAS0/RA0 | Connected via 0R Resistor |
| 16 | PIM:57 ⁽²⁾ | OA1OUT/AN0/CMP1A/IBIAS0/RA0 | Can be connected via 0R Resistor |
| 17 | PIM:20 | AN22/ANB3/CMP6C/RE2 | Direct Connection |
| 18 | PIM:24 ⁽¹⁾ | OA1IN-/ANA1/RA1 | Connected via 0R Resistor |
| 18 | PIM:56 ⁽²⁾ | OA1IN-/ANA1/RA1 | Can be connected via 0 Ohm Resistor |
| 18 | PIM:67 | OA1IN-/ANA1/RA1 | Optional Internal Op Amp Connection |
| 19 | PIM:33 | AN23/ANN3/RE3 | Direct Connection |
| 20 | PIM:66 | OA1IN+/AN9/PMA6/RA2 | Optional Internal Op Amp Connection |
| 21 | PIM:12 | DACOUT1/AN27/AN3/CMP1C/RA3 | Direct Connection |
| 22 | PIM:69 | RE4 | Direct Connection |
| 23 | PIM:21 ⁽²⁾ | OA3OUT/AN4/ANB1/ANB2/CMP3B/IBIAS3/RA4 | Can be connected via 0R Resistor |
| 24 | PIM:68 | RE5 | Direct Connection |
| 25 | PIM:30 | AVDD | Analog Power (AVDD) |
| 26 | PIM:31 | AVSS | Analog Ground (AGND) |
| 27 | PIM:85 | RP76/RD12 | Direct Connection |
| 28 | PIM:66 | OA3IN-/AN13/CMP1B/ISRC0/RP49/PMA7/RC1 | Internal Op Amp Connection |
| 29 | PIM:73 | OA3IN+/AN14/CMP2B/ISRC1/RP50/PMD13/PMA13/RC2 | Internal Op Amp Connection |
| 30 | PIM:43 | AN17/ANN1/CMP4B/IBIAS1/RP54/PMD12/PMA12/RC6 | Direct Connection |
| 31 | PIM:02, 16, 37, 62, 86 ⁽³⁾ | VDD | Digital Power (DVDD) |
| 32 | PIM:15, 36, 65, 75 ⁽⁴⁾ | VSS | Digital Ground (DGND) |
| 33 | PIM:23 | AN15/ANN2/CMP2A/IBIAS2/RP51/PMD11/PMA11/RC3 | Direct Connection |
| 34 | PIM:63 | OSCI/CLKI/AN5/RP32/PMD10/PMA10/RB0 | Direct Connection |

- Note 1:** The PIM pin is directly connected to the device pin through a 0 Ohm resistor (default), which can be removed if desired.
- 2:** The PIM pin can be connected to a device pin through a 0 Ohm resistor, if required. For proper operation, ensure that other 0 Ohm resistors connecting to the same device pin are removed.
- 3:** Digital Power (DVDD) pins are shorted together on the PIM.
- 4:** 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 # | dsPIC33CK512MP608 Device Functional Description | Remarks |
|--------------|---------------------------------------|----------------------------------------------------------------------------|----------------------------------|
| 35 | PIM:64 | OSCO/CLKO/AN6/RP33/PMA1/PMALH/PSA1/RB1 | Direct Connection |
| 36 | PIM:32 | AN19/ANB0/CMP2C/RP75/PMA0/PMALL/PSA0/RD11 | Direct Connection |
| 37 | PIM:11 | RE6 | Direct Connection |
| 38 | PIM:35 | AN18/ANC2/CMP3C/ISRC3/RP74/PMD9/PMA9/RD10 | Direct Connection |
| 39 | PIM:84 | RE7 | Direct Connection |
| 40 | PIM:79 | DACOUT2/AN16/CMP4C/ISRC2/RP55/PMD8/PMA8/RC7 | Direct Connection |
| 41 | PIM:22 ⁽²⁾ | OA2OUT/AN1/AN7/ANA0/CMP1D/CMP2D/CMP3D/CMP4D/CMP5D/CMP6D/RP34/SCL3/INT0/RB2 | Can be connected via 0R Resistor |
| 42 | PIM:60 | RE8 | Direct Connection |
| 43 | PIM:66 | PGD2/OA2IN-/AN8/CMP4A/RP35/RB3 | Internal Op Amp Connection |
| 44 | PIM:01 | RE9 | Direct Connection |
| 45 | PIM:74 | PGC2/OA2IN+/RP36/RB4 | Internal Op Amp Connection |
| 46 | PIM:95 | RP56/ASDA1/SCK2/RC8 | Direct Connection |
| 47 | PIM:96 | RP57/ASCL1/SDI2/RC9 | Direct Connection |
| 48 | PIM:10 | RP73/PCI20/RD9 | Direct Connection |
| 49 | PIM:18 | RP72/SDO2/PCI19/RD8 | Direct Connection |
| 50 | PIM:15, 36, 65, 75 ⁽⁴⁾ | Vss | Digital Ground (DGND) |
| 51 | PIM:02, 16, 37, 62, 86 ⁽³⁾ | VDD | Digital Power (DVDD) |
| 52 | PIM:49 | RP71/PMD15/RD7 | Direct Connection |
| 53 | PIM:50 | RP70/PMD14/RD6 | Direct Connection |
| 54 | PIM:83 | RP69/PMA15/PMCS2/RD5 | Direct Connection |
| 55 | PIM:27 | PGD3/RP37/SDA2/PMA14/PMCS1/PSCS/RB5 | Direct Connection |
| 56 | PIM:26 | PGC3/RP38/SCL2/RB6 | Direct Connection |
| 57 | PIM:40 | RE10 | Direct Connection |
| 58 | PIM:14 | TDO/AN2/AN26/CMP3A/RP39/SDA3/RB7 | Direct Connection |
| 59 | PIM:41 | RE11 | Direct Connection |
| 60 | PIM:17 | PGD1/AN10/CMP6A/RP40/SCL1/RB8 | Direct Connection |
| 61 | PIM:25 | PGC1/AN11/CMP5A/RP41/SDA1/RB9 | Direct Connection |
| 62 | PIM:59 | RE12 | Direct Connection |
| 63 | PIM:76 | RP52/PWM5H/ASDA2/RC4 | Direct Connection |
| 64 | PIM:34 | RE13 | Direct Connection |
| 65 | PIM:54 | RP53/PWM5L/ASCL2/PMWR/PMENB/PSWR/RC5 | Direct Connection |
| 66 | PIM:07 | RP58/PWM7H/PMRD/PMWR/PSRD/RC10 | Direct Connection |
| 67 | PIM:06 | RP59/PWM7L/RC11 | Direct Connection |
| 68 | PIM:61 | RP68/ASDA3/RD4 | Direct Connection |
| 69 | PIM:48 | RP67/ASCL3/RD3 | Direct Connection |
| 70 | PIM:15, 36, 65, 75 ⁽⁴⁾ | Vss | Digital Ground (DGND) |
| 71 | PIM:02, 16, 37, 62, 86 ⁽³⁾ | VDD | Digital Power (DVDD) |
| 72 | PIM:47 | RP66/RD2 | Direct Connection |
| 73 | PIM:80 | RP65/PWM4H/RD1 | Direct Connection |

- Note 1:** The PIM pin is directly connected to the device pin through a 0 Ohm resistor (default), which can be removed if desired.
- 2:** The PIM pin can be connected to a device pin through a 0 Ohm resistor, if required. For proper operation, ensure that other 0 Ohm resistors connecting to the same device pin are removed.
- 3:** Digital Power (DVDD) pins are shorted together on the PIM.
- 4:** 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 # | dsPIC33CK512MP608 Device Functional Description | Remarks |
|--------------|-----------|-------------------------------------------------|-------------------|
| 74 | PIM:78 | RP64/PWM4L/PMD0/RD0 | Direct Connection |
| 75 | PIM:03 | TMS/RP42/PWM3H/PMD1/RB10 | Direct Connection |
| 76 | PIM:100 | TCK/RP43/PWM3L/PMD2/RB11 | Direct Connection |
| 77 | PIM:82 | RE14 | Direct Connection |
| 78 | PIM:99 | TDI/RP44/PWM2H/PMD3/RB12 | Direct Connection |
| 79 | PIM:90 | RE15 | Direct Connection |
| 80 | PIM:98 | RP45/PWM2L/PMD4/RB13 | Direct Connection |

- Note 1:** The PIM pin is directly connected to the device pin through a 0 Ohm resistor (default), which can be removed if desired.
- 2:** The PIM pin can be connected to a device pin through a 0 Ohm resistor, if required. For proper operation, ensure that other 0 Ohm resistors connecting to the same device pin are removed.
- 3:** Digital Power (DVDD) pins are shorted together on the PIM.
- 4:** Digital Ground (DGND) pins are shorted together on the PIM.

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Table 3 provides pin mapping from the PIM interface connector to the 80-pin dsPIC33CK512MP608 device.

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

| PIM Pin # | Device Pin # | Remarks | dsPIC33CK512MP608 Device Functional Description |
|-----------------------|----------------|----------------------------------|--------------------------------------------------------------------------------------|
| PIM:01 | 44 | Direct Connection | RE9 |
| PIM:02 ⁽³⁾ | 12, 31, 51, 71 | Digital Power (DVDD) | — |
| PIM:03 | 75 | Direct Connection | TMS/RP42/PWM3H/PMD1/RB10 |
| PIM:04 | 7 | Direct Connection | RP62/PWM6H/PMA4/RC14 |
| PIM:05 | 8 | Direct Connection | RP63/PWM6L/PMA3/RC15 |
| PIM:06 | 67 | Direct Connection | RP59/PWM7L/RC11 |
| PIM:07 | 66 | Direct Connection | RP58/PWM7H/PMRD/ $\overline{\text{PMWR}}$ /PSRD/RC10 |
| PIM:08 | 6 | Direct Connection | RP61/PWM8L/PMA5/RC13 |
| PIM:09 | 5 | Direct Connection | RP60/PWM8H/PMD7/RC12 |
| PIM:10 | 48 | Direct Connection | RP73/PCI20/RD9 |
| PIM:11 | 37 | Direct Connection | RE6 |
| PIM:12 | 21 | Direct Connection | DACOUT1/AN27/AN3/CMP1C/RA3 |
| PIM:13 | 9 | $\overline{\text{MCLR}}$ | $\overline{\text{MCLR}}$ |
| PIM:14 | 58 | Direct Connection | TDO/AN2/AN26/CMP3A/RP39/SDA3/RB7 |
| PIM:15 ⁽⁴⁾ | 11, 32, 50, 70 | Digital Ground (DGND) | V _{SS} |
| PIM:16 ⁽³⁾ | 12, 31, 51, 71 | Digital Power (DVDD) | V _{DD} |
| PIM:17 | 60 | Direct Connection | PGD1/AN10/CMP6A/RP40/SCL1/RB8 |
| PIM:18 | 49 | Direct Connection | RP72/SDO2/PC119/RD8 |
| PIM:19 | 10 | Direct Connection | RP79/PCI22/PMA2/RD15 |
| PIM:20 | 17 | Direct Connection | AN22/ANB3/CMP6C/RE2 |
| PIM:21 | 4 | Direct Connection | AN21/ANC1/CMP6B/RE1 |
| PIM:21 ⁽²⁾ | 23 | Can be connected via 0R Resistor | OA3OUT/AN4/ANB1/ANB2/CMP3B/IBIAS3/RA4 |
| PIM:22 | 2 | Direct Connection | AN20/ANC0/CMP5C/RE0 |
| PIM:22 ⁽²⁾ | 41 | Can be connected via 0R Resistor | OA2OUT/AN1/AN7/ANA0/ANA2/ANA3/CMP1D/CMP2D/CMP3D/CMP4D/CMP5D/CMP6D/RP34/SCL3/INT0/RB2 |
| PIM:23 | 33 | Direct Connection | AN15/ANN2/CMP2A/IBIAS2/RP51/PMD11/PMA11/RC3 |
| PIM:24 ⁽¹⁾ | 18 | Connected via 0R Resistor | OA1IN-/ANA1/RA1 |
| PIM:25 | 61 | Direct Connection | PGC1/AN11/CMP5A/RP41/SDA1/RB9 |
| PIM:25 ⁽¹⁾ | 16 | Connected via 0R Resistor | OA1OUT/AN0/CMP1A/IBIAS0/RA0 |
| PIM:26 | 56 | Direct Connection | PGC3/RP38/SCL2/RB6 |
| PIM:27 | 55 | Direct Connection | PGD3/RP37/SDA2/PMA14/PMCS1/PSCS/RB5 |
| PIM:28 | — | Not Connected | — |
| PIM:29 | — | Not Connected | — |
| PIM:30 | 25 | Analog Power (AVDD) | AVDD |
| PIM:31 ⁽⁵⁾ | 26 | Analog Ground (AGND) | AV _{SS} |

Note 1: The PIM pin is directly connected to the device pin through a 0 Ohm resistor (default), which can be removed if desired.

2: The PIM pin can be connected to a device pin through a 0 Ohm resistor, if required. For proper operation, ensure that other 0 Ohm resistors connecting to the same device pin are removed.

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

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

5: Analog Ground (AGND) connection via PIM:31 is shorted with Digital Ground (DGND) through 0R resistor, R27, on the PIM.

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

| PIM Pin # | Device Pin # | Remarks | dsPIC33CK512MP608 Device Functional Description |
|-----------------------|----------------|----------------------------------|-------------------------------------------------|
| PIM:32 | 36 | Direct Connection | AN19/ANB0/CMP2C/RP75/PMA0/PMALL/PSA0/RD11 |
| PIM:33 | 19 | Direct Connection | AN23/ANN3/RE3 |
| PIM:34 | 64 | Direct Connection | RE13 |
| PIM:35 | 38 | Direct Connection | AN18/ANC2/CMP3C/ISRC3/RP74/PMD9/PMA9/RD10 |
| PIM:36 ⁽⁴⁾ | 11, 32, 50, 50 | Digital Ground (DGND) | Vss |
| PIM:37 ⁽³⁾ | 12, 31, 51, 71 | Digital Power (DVDD) | VDD |
| PIM:38 | — | Not Connected | — |
| PIM:39 | — | Not Connected | — |
| PIM:40 | 57 | Direct Connection | RE10 |
| PIM:41 | 59 | Direct Connection | RE11 |
| PIM:42 | — | Not Connected | — |
| PIM:43 | 30 | Direct Connection | AN17/ANN1/CMP4B/IBIAS1/RP54/PMD12/PMA12/RC6 |
| PIM:44 | — | Not Connected | — |
| PIM:45 | — | Not Connected | — |
| PIM:46 | — | Not Connected | — |
| PIM:47 | 72 | Direct Connection | RP66/RD2 |
| PIM:48 | 69 | Direct Connection | RP67/ASCL3/RD3 |
| PIM:49 | 52 | Direct Connection | RP71/PMD15/RD7 |
| PIM:50 | 53 | Direct Connection | RP70/PMD14/RD6 |
| PIM:51 | — | Not Connected | — |
| PIM:52 | — | Not Connected | — |
| PIM:53 | — | Not Connected | — |
| PIM:54 | 65 | Direct Connection | RP53/PWM5L/ASCL2/PMWR/PMENB/PSWR/RC5 |
| PIM:55 | 15 | Direct Connection | AN12/ANN0/RP48/RC0 |
| PIM:56 ⁽²⁾ | 18 | Can be connected via 0R Resistor | OA1IN-/ANA1/RA1 |
| PIM:57 ⁽²⁾ | 16 | Can be connected via 0R Resistor | OA1OUT/AN0/CMP1A/IBIAS0/RA0 |
| PIM:58 | — | Not Connected | — |
| PIM:59 | 62 | Direct Connection | RE12 |
| PIM:60 | 42 | Direct Connection | RE8 |
| PIM:61 | 68 | Direct Connection | RP68/ASDA3/RD4 |
| PIM:62 ⁽³⁾ | 12, 31, 51, 71 | Digital Power (DVDD) | VDD |
| PIM:63 | 34 | Direct Connection | OSCI/CLKI/AN5/RP32/PMD10/PMA10/RB0 |
| PIM:64 | 35 | Direct Connection | OSCO/CLKO/AN6/RP33/PMA1/PMALH/PSA1/RB1 |
| PIM:65 ⁽⁴⁾ | 11, 32, 50, 70 | Digital Ground (DGND) | Vss |
| PIM:66 | 20, 28, 43 | Internal Op Amp Connection | Op Amp Inputs |

- Note 1:** The PIM pin is directly connected to the device pin through a 0 Ohm resistor (default), which can be removed if desired.
- Note 2:** The PIM pin can be connected to a device pin through a 0 Ohm resistor, if required. For proper operation, ensure that other 0 Ohm resistors connecting to the same device pin are removed.
- Note 3:** Digital Power (DVDD) pins are shorted together on the PIM.
- Note 4:** Digital Ground (DGND) pins are shorted together on the PIM.
- Note 5:** Analog Ground (AGND) connection via PIM:31 is shorted with Digital Ground (DGND) through 0R resistor, R27, on the PIM.

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

| PIM Pin # | Device Pin # | Remarks | dsPIC33CK512MP608 Device Functional Description |
|-----------------------|----------------|----------------------------|-------------------------------------------------|
| PIM:67 | 18 | Internal Op Amp Connection | Op Amp Inputs |
| PIM:68 | 24 | Direct Connection | RE5 |
| PIM:69 | 22 | Direct Connection | RE4 |
| PIM:70 | — | Not Connected | — |
| PIM:71 | — | Not Connected | — |
| PIM:72 | — | Not Connected | — |
| PIM:73 | 29 | Internal Op Amp Connection | Op Amp Inputs |
| PIM:74 | 45 | Internal Op Amp Connection | Op Amp Inputs |
| PIM:75 ⁽⁴⁾ | 11, 32, 50, 70 | Digital Ground (DGND) | Vss |
| PIM:76 | 63 | Direct Connection | RP52/PWM5H/ASDA2/RC4 |
| PIM:77 | — | Not Connected | — |
| PIM:78 | 74 | Direct Connection | RP64/PWM4L/PMD0/RD0 |
| PIM:79 | 40 | Direct Connection | DACOUT2/AN16/CMP4C/ISRC2/RP55/PMD8/PMA8/RC7 |
| PIM:80 | 73 | Direct Connection | RP65/PWM4H/RD1 |
| PIM:81 | — | Not Connected | — |
| PIM:82 | 77 | Direct Connection | RE14 |
| PIM:83 | 54 | Direct Connection | RP69/PMA15/PMCS2/RD5 |
| PIM:84 | 39 | Direct Connection | RE7 |
| PIM:85 | 27 | Direct Connection | RP76/RD12 |
| PIM:86 ⁽³⁾ | 12, 31, 51, 71 | Digital Power (DVDD) | VDD |
| PIM:87 | — | Not Connected | — |
| PIM:88 | — | Not Connected | — |
| PIM:89 | 14 | Direct Connection | ANN4/CMP5B/RP77/RD13 |
| PIM:90 | 79 | Direct Connection | RE15 |
| PIM:91 | — | Not Connected | — |
| PIM:92 | 13 | Direct Connection | RP78/PCI21/RD14 |
| PIM:93 | 3 | Direct Connection | RP47/PWM1L/PMD6/RB15 |
| PIM:94 | 1 | Direct Connection | RP46/PWM1H/PMD5/RB14 |
| PIM:95 | 46 | Direct Connection | RP56/ASDA1/SCK2/RC8 |
| PIM:96 | 47 | Direct Connection | RP57/ASCL1/SDI2/RC9 |
| PIM:97 | — | Not Connected | — |
| PIM:98 | 80 | Direct Connection | RP45/PWM2L/PMD4/RB13 |
| PIM:99 | 78 | Direct Connection | TDI/RP44/PWM2H/PMD3/RB12 |
| PIM:100 | 76 | Direct Connection | TCK/RP43/PWM3L/PMD2/RB11 |

- Note 1:** The PIM pin is directly connected to the device pin through a 0 Ohm resistor (default), which can be removed if desired.
- Note 2:** The PIM pin can be connected to a device pin through a 0 Ohm resistor, if required. For proper operation, ensure that other 0 Ohm resistors connecting to the same device pin are removed.
- Note 3:** Digital Power (DVDD) pins are shorted together on the PIM.
- Note 4:** Digital Ground (DGND) pins are shorted together on the PIM.
- Note 5:** Analog Ground (AGND) connection via PIM:31 is shorted with Digital Ground (DGND) through 0R resistor, R27, on the PIM.

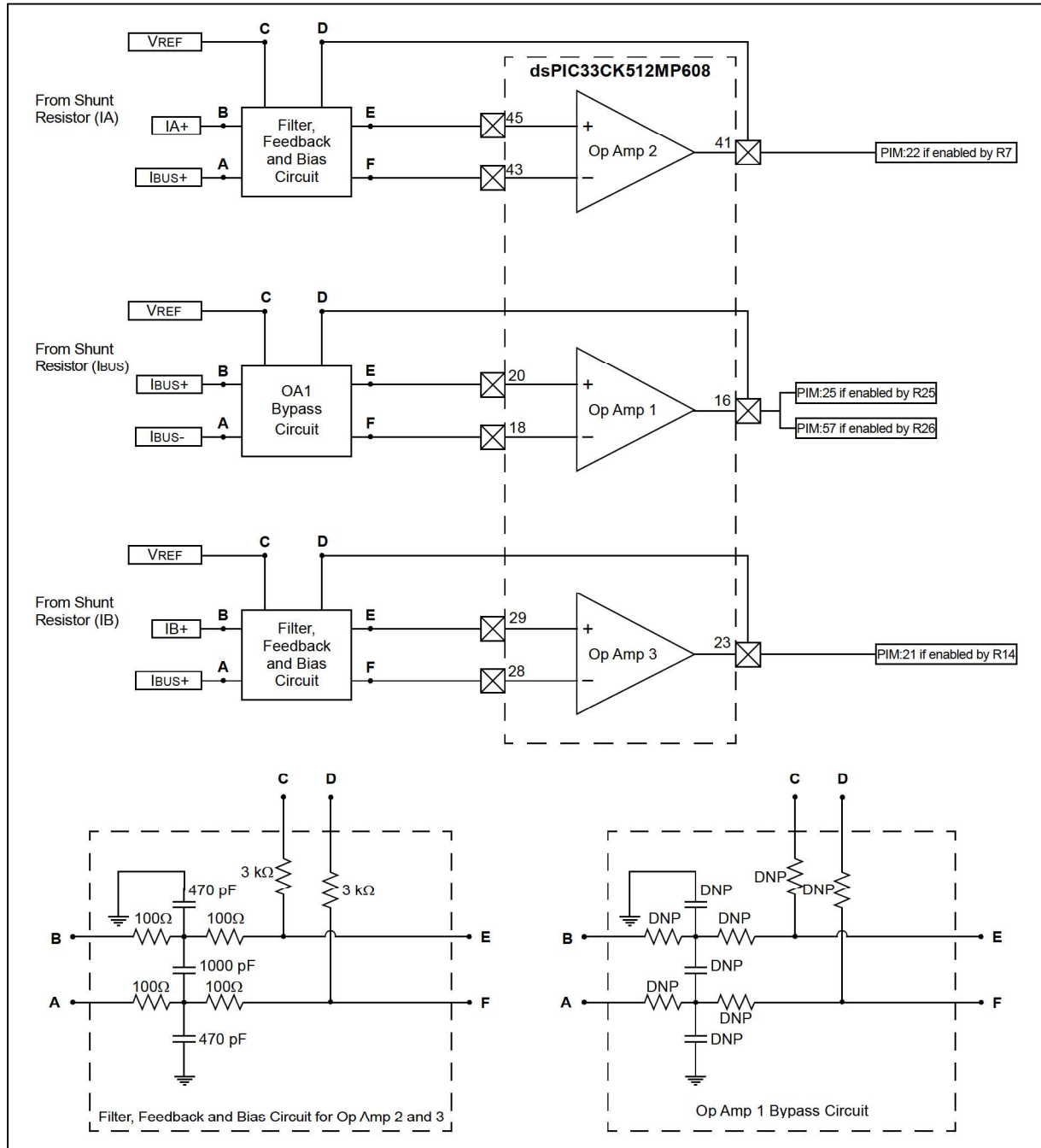
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INTERNAL AMPLIFIER

Operational amplifiers internal to the dsPIC33CK512MP608 can be configured and enabled for amplifying motor currents. The amplifier circuits and their detailed schematics (Filter, Feedback and Bias Circuit) are shown in Figure 3.

Op Amp 1, as seen in Figure 3, is not used by default. If the filter, bias and feedback circuit section is populated and Op Amp 1 is configured in firmware, it can be used to amplify the I_{BUS} current. Prior to using Op Amp 1, the resistor jumpers, R23, R24, R25, R26, should be removed to enable I_{BUS} current use of the Op Amp 1 inputs. As a result, this limits the PFC functionality in case of MCHV-2 or Field-Oriented Control on Inverter B of Low-Voltage Motor Control Development Bundle.

FIGURE 3: dsPIC® DSC INTERNAL AMPLIFIERS



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Equation 1 provides the amplifier gain calculation. Equation 2 and Equation 3 provide calculations for cutoff frequencies of the Differential-mode and Common-mode filters.

EQUATION 1: AMPLIFIER GAIN

$$\text{Differential Amplifier Gain} = \frac{3 \text{ k}\Omega}{2 \times 100\Omega} = 15$$

EQUATION 2: CUTOFF FREQUENCY DIFFERENTIAL-MODE FILTER

$$\text{Differential-mode } f_{-3 \text{ dB}} \cong \frac{1}{2\pi(2 \times 100\Omega) \left(\frac{470 \text{ pF}}{2} + 1000 \text{ pF} \right)} \cong 644 \text{ kHz}$$

EQUATION 3: CUTOFF FREQUENCY COMMON-MODE FILTER

$$\text{Common-mode } f_{-3 \text{ dB}} \cong \frac{1}{2\pi(100\Omega)(470 \text{ pF})} \cong 3.3 \text{ MHz}$$

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Table 4 classifies the passive components according to their functionality and quotes the design equations applicable in each case.

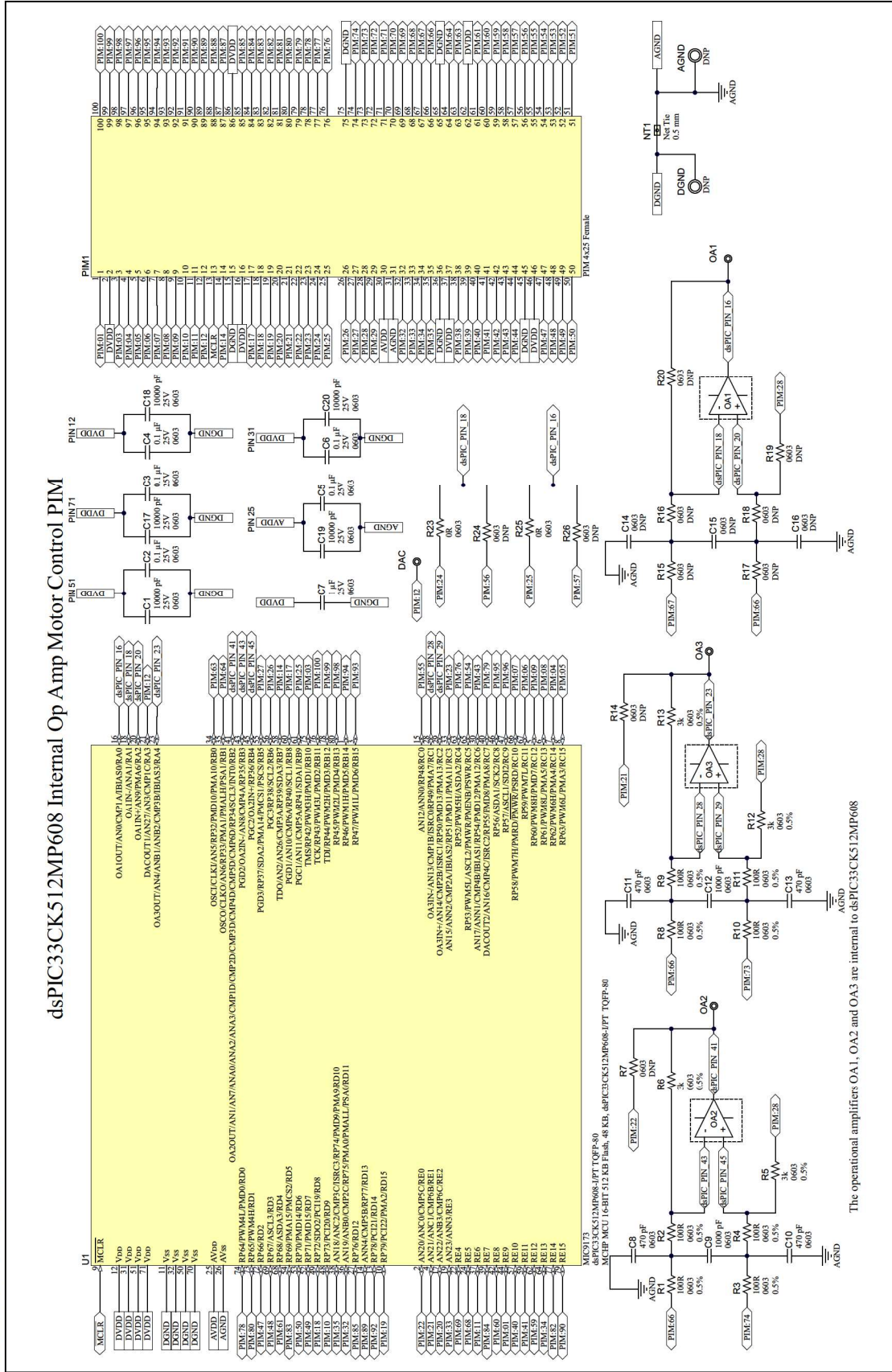
TABLE 4: ANALOG FUNCTIONALITY LISTING

| Op Amp # | Analog Function | Passive Components | Design Equations |
|----------|---------------------------------|-----------------------------------|---------------------------------------------------------------------------------------------------------------------------------------|
| 1 | Low-Pass Filter | R15, R16, R17, R18, C14, C15, C16 | $R15 = R16 = R17 = R18 = R$ $C14 = C15 = C16 = C$ |
| | Reference Voltage Bias | R19 | $R19 = R20$ |
| | Differential Amplifier Input | R15, R16, R17, R18 | $Common-mode f_{-3dB} \cong \frac{1}{2\pi RC}$ |
| | Differential Amplifier Feedback | R20 | $Differential-mode f_{-3dB} \cong \frac{1}{2\pi(2R)\left(\frac{C}{2} + C15\right)}$ $Differential Amplifier Gain = \frac{R20}{2R}$ |
| 2 | Low-Pass Filter | R1, R2, R3, R4, C8, C9, C10 | $R1 = R2 = R3 = R4 = R$ $C8 = C9 = C10 = C$ |
| | Reference Voltage Bias | R5, R6 | $R5 = R6$ |
| | Differential Amplifier Input | R1, R2, R3, R4 | $Common-mode f_{-3dB} \cong \frac{1}{2\pi RC}$ |
| | Differential Amplifier Feedback | R6 | $Differential-mode f_{-3dB} \cong \frac{1}{2\pi(2R)\left(\frac{C}{2} + C9\right)}$ $Differential Amplifier Gain = \frac{R6}{2R}$ |
| 3 | Low-Pass Filter | R8, R9, R10, R11, C11, C12, C13 | $R8 = R9 = R10 = R11 = R$ $C11 = C12 = C13 = C$ |
| | Reference Voltage Bias | R12, R13 | $R12 = R13$ |
| | Differential Amplifier Input | R8, R9, R10, R11 | $Common-mode f_{-3dB} \cong \frac{1}{2\pi RC}$ |
| | Differential Amplifier Feedback | R13 | $Differential-mode f_{-3dB} \cong \frac{1}{2\pi(2R)\left(\frac{C}{2} + C12\right)}$ $Differential Amplifier Gain = \frac{R13}{2R}$ |

dsPIC33CK512MP608

dsPIC33CK512MP608 Motor Control Plug-In Module (PIM) for Internal Op Amp Configuration

Schematic Revision 1.0



The operational amplifiers OA1, OA2 and OA3 are internal to dsPIC33CK512MP608

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