

## dsPIC33CK256MP508 Motor Control Plug-In Module (PIM) Information Sheet for Internal Op Amp Configuration

The dsPIC33CK256MP508 Internal Op Amp Motor Control PIM (P/N: MA330041-2) is designed to demonstrate the motor control capabilities of the dsPIC33CK256MP508 device using the internal op amps of the device.

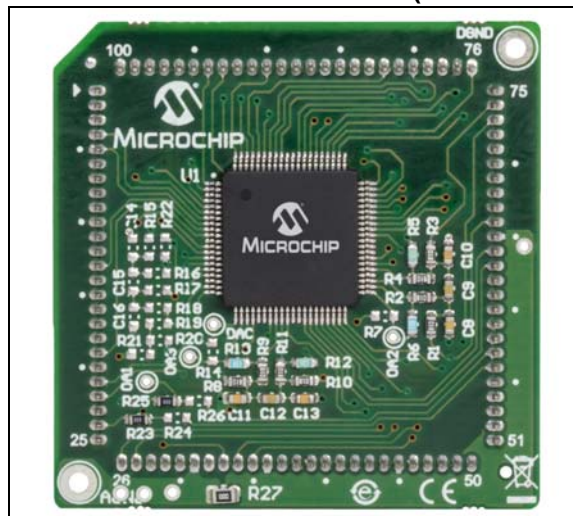
The dsPIC33CK256MP508 device is a high-performance, 16-bit Digital Signal Controller (DSC). This Motor Control PIM is designed to take advantage of the high-resolution PWM (with fine edge placement) peripheral in the device. The PWM, along with other peripherals, such as the ADC, enable motor control 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 on to the J4 header (as shown in [Figure 2](#)) on the board. The PIM design also supports dual motor control on the Low-Voltage Motor Control Bundle (DV330100).

For additional information regarding development boards, refer to the respective user's guides available on the Microchip web site ([www.microchip.com](http://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: dsPIC33CK256MP508 INTERNAL OP AMP MOTOR CONTROL PIM (MA330041-2)**



**FIGURE 2: INTERNAL OP AMP CONFIGURATION BOARD**



**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-3 Development Board            | DM330023-3  | All Revisions                  |
| dsPICDEM MCHV-2 Development Board            | DM330023-2  | All Revisions                  |
| dsPICDEM MCLV-2 Development Board            | DM330021-2  | All Revisions                  |
| Low-Voltage Motor Control Development Bundle | DV330100    | All Revisions                  |

**Warning:** Do not connect non-isolated oscilloscope probes to the test points on the PIM while using 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 80-pin device pinout and the 100-pin PIM.

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

| Device Pin # | dsPIC33CK256MP508 Device Functional Description | PIM Pin #                             | Remarks  |
|--------------|---|---------------------------------------|--|
| 1            | RP46/PWM1H/RB14                                 | PIM:94                                | Direct Connection  |
| 2            | AN20/RE0  | PIM:22                                | Direct Connection  |
| 3            | RP47/PWM1L/PMD6/RB15                            | PIM:93                                | Direct Connection  |
| 4            | AN21/RE1  | PIM:21                                | Direct Connection  |
| 5            | RP60/PWM8H/PMD7/RC12                            | PIM:09                                | Direct Connection  |
| 6            | RP61/PWM8L/PMA5/RC13                            | PIM:08                                | Direct Connection  |
| 7            | RP62/PWM6H/PMA4/RC14                            | PIM:04                                | Direct Connection  |
| 8            | RP63/PWM6L/PMA3/RC15                            | PIM:05                                | Direct Connection  |
| 9            | MCLR  | PIM:13                                | MCLR   |
| 10           | RP79/PCI22/PMA2/RD15                            | PIM:19                                | Direct Connection  |
| 11           | Vss   | PIM:15, 36, 65, 75 <sup>(4)</sup>     | Digital Ground (DGND)  |
| 12           | VDD   | PIM:02, 16, 37, 62, 86 <sup>(3)</sup> | Digital Power (DVDD)   |
| 13           | RP78/PCI21/RD14                                 | PIM:92                                | Direct Connection  |
| 14           | ANN2/RP77/RD13                                  | PIM:89                                | Direct Connection  |
| 15           | AN12/ANN0/RP48/RC0                              | PIM:55                                | Direct Connection  |
| 16           | OA1OUT/AN0/CMP1A/IBIAS0/RA0                     | PIM:25 <sup>(1)</sup>                 | Connected via 0 Ohm Resistor   |
| 16           | OA1OUT/AN0/CMP1A/IBIAS0/RA0                     | PIM:57 <sup>(2)</sup>                 | Can be Connected via 0 Ohm Resistor                                    |
| 17           | AN22/RE2  | PIM:20                                | Direct Connection  |
| 18           | OA1IN-/ANA1/RA1                                 | PIM:24 <sup>(1)</sup>                 | Connected via 0 Ohm Resistor   |
| 18           | OA1IN-/ANA1/RA1                                 | PIM:56 <sup>(2)</sup>                 | Can be Connected via 0 Ohm Resistor                                    |
| 18           | OA1IN-/ANA1/RA1                                 | PIM:67                                | Optional Internal Op Amp Connection can be Connected to Op Amp 1 Input |
| 19           | AN23/RE3  | PIM:33                                | Direct Connection  |
| 20           | OA1IN+/AN9/PMA6/RA2                             | PIM:66                                | Optional Internal Op Amp Connection                                    |
| 21           | DACOUT1/AN3/CMP1C/RA3                           | PIM:12                                | Direct Connection  |
| 22           | RE4   | PIM:69                                | Direct Connection  |
| 23           | OA3OUT/AN4/CMP3B/IBIAS3/RA4                     | PIM:21 <sup>(2)</sup>                 | Can be Connected via 0 Ohm Resistor                                    |
| 24           | RE5   | PIM:68                                | Direct Connection  |
| 25           | AVDD  | PIM:30                                | Analog Power (AVDD)  |
| 26           | AVss  | PIM:31 <sup>(5)</sup>                 | Analog Ground (AGND)   |
| 27           | RP76/RD12                                       | PIM:85                                | Direct Connection  |
| 28           | OA3IN-/AN13/CMP1B/ISRC0/RP49/PMA7/RC1           | PIM:66                                | Internal Op Amp Connection   |
| 29           | OA3IN+/AN14/CMP2B/ISRC1/RP50/PMD13/PMA13/RC2    | PIM:73                                | Internal Op Amp Connection   |
| 30           | AN17/ANN1/IBIAS1/RP54/PMD12/PMA12/RC6           | PIM:43                                | Direct Connection  |
| 31           | VDD   | PIM:02, 16, 37, 62, 86 <sup>(3)</sup> | Digital Power (DVDD)   |
| 32           | Vss   | PIM:15, 36, 65, 75 <sup>(4)</sup>     | Digital Ground (DGND)  |
| 33           | AN15/CMP2A/IBIAS2/RP51/PMD11/PMA11/RC3          | PIM:23                                | Direct Connection  |
| 34           | OSCI/CLKI/AN5/RP32/PMD10/PMA10/RB0              | PIM:63                                | Direct Connection  |
| 35           | OSCO/CLKO/AN6/RP33/PMA1/PMALH/PSA1/RB1          | PIM:64                                | Direct Connection  |
| 36           | AN19/CMP2C/RP75/PMA0/PMALL/PSA0/RD11            | PIM:32                                | 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 desired. 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 0 Ohm resistor, R27, on the PIM.

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

| Device Pin # | dsPIC33CK256MP508 Device Functional Description          | PIM Pin #                             | Remarks                             |
|--------------|--|---------------------------------------|-------------------------------------|
| 37           | RE6  | PIM:11                                | Direct Connection                   |
| 38           | AN18/CMP3C/ISRC3/RP74/PMD9/PMA9/RD10                     | PIM:35                                | Direct Connection                   |
| 39           | RE7  | PIM:84                                | Direct Connection                   |
| 40           | AN16/ISRC2/RP55/PMD8/PMA8/RC7                            | PIM:79                                | Direct Connection                   |
| 41           | OA2OUT/AN1/AN7/ANA0/CMP1D/CMP2D/CMP3D/RP34/SCL3/INT0/RB2 | PIM:22 <sup>(2)</sup>                 | Can be Connected via 0 Ohm Resistor |
| 42           | RE8  | PIM:60                                | Direct Connection                   |
| 43           | PGD2/OA2IN-/AN8/RP35/RB3                                 | PIM:66                                | Internal Op Amp Connection          |
| 44           | RE9  | PIM:1                                 | Direct Connection                   |
| 45           | PGC2/OA2IN+/RP36/RB4                                     | PIM:74                                | Internal Op Amp Connection          |
| 46           | RP56/ASDA1/SCK2/RC8                                      | PIM:95                                | Direct Connection                   |
| 47           | RP57/ASCL1/SDI2/RC9                                      | PIM:96                                | Direct Connection                   |
| 48           | RP73/PCI20/RD9   | PIM:10                                | Direct Connection                   |
| 49           | RP72/SDO2/PCI19/RD8                                      | PIM:18                                | Direct Connection                   |
| 50           | Vss  | PIM:15, 36, 65, 75 <sup>(4)</sup>     | Digital Ground (DGND)               |
| 51           | VDD  | PIM:02, 16, 37, 62, 86 <sup>(3)</sup> | Digital Power (DVDD)                |
| 52           | RP71/PMD15/RD7   | PIM:49                                | Direct Connection                   |
| 53           | RP70/PMD14/RD6   | PIM:50                                | Direct Connection                   |
| 54           | RP69/PMA15/PMCS2/RD5                                     | PIM:83                                | Direct Connection                   |
| 55           | PGD3/RP37/SDA2/PMA14/PMCS1/PSCS/RB5                      | PIM:27                                | Direct Connection                   |
| 56           | PGC3/RP38/SCL2/RB6                                       | PIM:26                                | Direct Connection                   |
| 57           | RE10   | PIM:40                                | Direct Connection                   |
| 58           | TDO/AN2/CMP3A/RP39/SDA3/RB7                              | PIM:14                                | Direct Connection                   |
| 59           | RE11   | PIM:41                                | Direct Connection                   |
| 60           | PGD1/AN10/RP40/SCL1/RB8                                  | PIM:17                                | Direct Connection                   |
| 61           | PGC1/AN11/RP41/SDA1/RB9                                  | PIM:25                                | Direct Connection                   |
| 62           | RE12   | PIM:59                                | Direct Connection                   |
| 63           | RP52/PWM5H/ASDA2/RC4                                     | PIM:76                                | Direct Connection                   |
| 64           | RE13   | PIM:34                                | Direct Connection                   |
| 65           | RP53/PWM5L/ASCL2/PMWR/PMENB/PSWR/RC5                     | PIM:54                                | Direct Connection                   |
| 66           | RP58/PWM7H/PMRD/PMWR/PSRD/RC10                           | PIM:07                                | Direct Connection                   |
| 67           | RP59/PWM7L/RC11  | PIM:06                                | Direct Connection                   |
| 68           | RP68/ASDA3/RD4   | PIM:61                                | Direct Connection                   |
| 69           | RP67/ASCL3/RD3   | PIM:48                                | Direct Connection                   |
| 70           | Vss  | PIM:15, 36, 65, 75 <sup>(4)</sup>     | Digital Ground (DGND)               |
| 71           | VDD  | PIM:02, 16, 37, 62, 86 <sup>(3)</sup> | Digital Power (DVDD)                |
| 72           | RP66/RD2   | PIM:47                                | Direct Connection                   |
| 73           | RP65/PWM4H/RD1   | PIM:80                                | Direct Connection                   |
| 74           | RP64/PWM4L/PMD0/RD0                                      | PIM:78                                | Direct Connection                   |
| 75           | TMS/RP42/PWM3H/PMD1/RB10                                 | PIM:03                                | Direct Connection                   |
| 76           | TCK/RP43/PWM3L/PMD2/RB11                                 | PIM:100                               | Direct Connection                   |
| 77           | RE14   | PIM:82                                | 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.

**Note 2:** The PIM pin can be connected to a device pin through a 0 Ohm resistor, if desired. 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 0 Ohm resistor, R27, on the PIM.

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

| Device Pin # | dsPIC33CK256MP508 Device Functional Description | PIM Pin # | Remarks           |
|--------------|---|-----------|-------------------|
| 78           | TDI/RP44/PWM2H/PMD3/RB12                        | PIM:99    | Direct Connection |
| 79           | RE15  | PIM:90    | Direct Connection |
| 80           | RP45/PWM2L/PMD4/RB13                            | PIM:98    | 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 desired. 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 0 Ohm resistor, R27, on the PIM.

# dsPIC33CK256MP508

Table 3 provides the mapping between the 80-pin device pinout and the 100-pin PIM.

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

| PIM Pin #             | Device Pin #   | dsPIC33CK256MP508 Device Functional Description          | Remarks                             |
|-----------------------|----------------|--|-------------------------------------|
| PIM:01                | 44             | RE9  | Direct Connection                   |
| PIM:02 <sup>(3)</sup> | 12, 31, 51, 71 | VDD  | Digital Power (DVDD)                |
| PIM:03                | 75             | TMS/RP42/PWM3H/PMD1/RB10                                 | Direct Connection                   |
| PIM:04                | 7              | RP62/PWM6H/PMA4/RC14                                     | Direct Connection                   |
| PIM:05                | 8              | RP63/PWM6L/PMA3/RC15                                     | Direct Connection                   |
| PIM:06                | 67             | RP59/PWM7L/RC11  | Direct Connection                   |
| PIM:07                | 66             | RP58/PWM7H/PMRD/PMWR/PSRD/RC10                           | Direct Connection                   |
| PIM:08                | 6              | RP61/PWM8L/PMA5/RC13                                     | Direct Connection                   |
| PIM:09                | 5              | RP60/PWM8H/PMD7/RC12                                     | Direct Connection                   |
| PIM:10                | 48             | RP73/PCI20/RD9   | Direct Connection                   |
| PIM:11                | 37             | RE6  | Direct Connection                   |
| PIM:12                | 21             | DACOUT1/AN3/CMP1C/RA3                                    | Direct Connection                   |
| PIM:13                | 9              | MCLR   | MCLR                                |
| PIM:14                | 58             | TDO/AN2/CMP3A/RP39/SDA3/RB7                              | Direct Connection                   |
| PIM:15 <sup>(4)</sup> | 11, 32, 50, 70 | VSS  | Digital Ground (DGND)               |
| PIM:16 <sup>(3)</sup> | 12, 31, 51, 71 | VDD  | Digital Power (DVDD)                |
| PIM:17                | 60             | PGD1/AN10/RP40/SCL1/RB8                                  | Direct Connection                   |
| PIM:18                | 49             | RP72/SDO2/PCI19/RD8                                      | Direct Connection                   |
| PIM:19                | 10             | RP79/PCI22/PMA2/RD15                                     | Direct Connection                   |
| PIM:20                | 17             | AN22/RE2   | Direct Connection                   |
| PIM:21                | 4              | AN21/RE1   | Direct Connection                   |
| PIM:21 <sup>(2)</sup> | 23             | OA3OUT/AN4/CMP3B/IBIAS3/RA4                              | Can be Connected via 0 Ohm Resistor |
| PIM:22                | 2              | AN20/RE0   | Direct Connection                   |
| PIM:22 <sup>(2)</sup> | 41             | OA2OUT/AN1/AN7/ANA0/CMP1D/CMP2D/CMP3D/RP34/SCL3/INT0/RB2 | Can be Connected via 0 Ohm Resistor |
| PIM:23                | 33             | AN15/CMP2A/IBIAS2/RP51/PMD11/PMA11/RC3                   | Direct Connection                   |
| PIM:24 <sup>(1)</sup> | 18             | OA1IN-/ANA1/RA1  | Connected via 0 Ohm Resistor        |
| PIM:25                | 61             | PGC1/AN11/RP41/SDA1/RB9                                  | Direct Connection                   |
| PIM:25 <sup>(1)</sup> | 16             | OA1OUT/AN0/CMP1A/IBIAS0/RA0                              | Connected via 0 Ohm Resistor        |
| PIM:26                | 56             | PGC3/RP38/SCL2/RB6                                       | Direct Connection                   |
| PIM:27                | 55             | PGD3/RP37/SDA2/PMA14/PMCS1/PSCS/RB5                      | Direct Connection                   |
| PIM:28                | —              | —  | Not Connected                       |
| PIM:29                | —              | —  | Not Connected                       |
| PIM:30                | 25             | AVDD   | Analog Power (AVDD)                 |
| PIM:31 <sup>(5)</sup> | 26             | AVSS   | Analog Ground (AGND)                |
| PIM:32                | 36             | AN19/CMP2C/RP75/PMA0/PMALL/PSA0/RD11                     | Direct Connection                   |
| PIM:33                | 19             | AN23/RE3   | Direct Connection                   |
| PIM:34                | 64             | RE13   | Direct Connection                   |
| PIM:35                | 38             | AN18/CMP3C/ISRC3/RP74/PMD9/PMA9/RD10                     | 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.

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

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

| PIM Pin #             | Device Pin #   | dsPIC33CK256MP508 Device Functional Description    | Remarks                             |
|-----------------------|----------------|--|-------------------------------------|
| PIM:36 <sup>(4)</sup> | 11, 32, 50, 70 | Vss  | Digital Ground (DGND)               |
| PIM:37 <sup>(3)</sup> | 12, 31, 51, 71 | VDD  | Digital Power (DVDD)                |
| PIM:38                | —              | —  | Not Connected                       |
| PIM:39                | —              | —  | Not Connected                       |
| PIM:40                | 57             | RE10   | Direct Connection                   |
| PIM:41                | 59             | RE11   | Direct Connection                   |
| PIM:42                | —              | —  | Not Connected                       |
| PIM:43                | 30             | AN17/ANN1/IBIAS1/RP54/PMD12/PMA12/RC6              | Direct Connection                   |
| PIM:44                | —              | —  | Not Connected                       |
| PIM:45                | —              | —  | Not Connected                       |
| PIM:46                | —              | —  | Not Connected                       |
| PIM:47                | 72             | RP66/RD2   | Direct Connection                   |
| PIM:48                | 69             | RP67/ASCL3/RD3                                     | Direct Connection                   |
| PIM:49                | 52             | RP71/PMD15/RD7                                     | Direct Connection                   |
| PIM:50                | 53             | RP70/PMD14/RD6                                     | Direct Connection                   |
| PIM:51                | —              | —  | Not Connected                       |
| PIM:52                | —              | —  | Not Connected                       |
| PIM:53                | —              | —  | Not Connected                       |
| PIM:54                | 65             | RP53/PWM5L/ASCL2/PMWR/PMENB/PSWR/RC5               | Direct Connection                   |
| PIM:55                | 15             | AN12/ANN0/RP48/RC0                                 | Direct Connection                   |
| PIM:56 <sup>(2)</sup> | 18             | OA1IN-/ANA1/RA1                                    | Can be Connected via 0 Ohm Resistor |
| PIM:57 <sup>(2)</sup> | 16             | OA1OUT/AN0/CMP1A/IBIAS0/RA0                        | Can be Connected via 0 Ohm Resistor |
| PIM:58                | —              | —  | Not Connected                       |
| PIM:59                | 62             | RE12   | Direct Connection                   |
| PIM:60                | 42             | RE8  | Direct Connection                   |
| PIM:61                | 68             | RP68/ASDA3/RD4                                     | Direct Connection                   |
| PIM:62 <sup>(3)</sup> | 12, 31, 51, 71 | VDD  | Digital Power (DVDD)                |
| PIM:63                | 34             | OSCI/CLKI/AN5/RP32/PMD10/PMA10/RB0                 | Direct Connection                   |
| PIM:64                | 35             | OSCO/CLKO/AN6/RP33/PMA1/PMALH/PSA1/RB1             | Direct Connection                   |
| PIM:65 <sup>(4)</sup> | 11, 32, 50, 70 | Vss  | Digital Ground (DGND)               |
| PIM:66                | 20, 28, 43     | Op Amp Inputs (refer to <a href="#">Figure 2</a> ) | Internal Op Amp Connection          |
| PIM:67                | 18             | Op Amp Input (refer to <a href="#">Figure 2</a> )  | Internal Op Amp Connection          |
| PIM:68                | 24             | RE5  | Direct Connection                   |
| PIM:69                | 22             | RE4  | Direct Connection                   |
| PIM:70                | —              | —  | Not Connected                       |
| PIM:71                | —              | —  | Not Connected                       |
| PIM:72                | —              | —  | Not Connected                       |
| PIM:73                | 29             | Op Amp Input (refer to <a href="#">Figure 2</a> )  | Internal Op Amp Connection          |
| PIM:74                | 45             | Op Amp Input (refer to <a href="#">Figure 2</a> )  | Internal Op Amp Connection          |
| PIM:75 <sup>(4)</sup> | 11, 32, 50, 70 | Vss  | Digital Ground (DGND)               |
| PIM:76                | 63             | RP52/PWM5H/ASDA2/RC4                               | Direct Connection                   |
| PIM:77                | —              | —  | Not Connected                       |

- 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 0 Ohm resistor, R27, on the PIM.



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

| PIM Pin #             | Device Pin #   | dsPIC33CK256MP508 Device Functional Description | Remarks              |
|-----------------------|----------------|---|----------------------|
| PIM:78                | 74             | RP64/PWM4L/PMD0/RD0                             | Direct Connection    |
| PIM:79                | 40             | AN16/ISRC2/RP55/PMD8/PMA8/RC7                   | Direct Connection    |
| PIM:80                | 73             | RP65/PWM4H/RD1                                  | Direct Connection    |
| PIM:81                | —              | —   | Not Connected        |
| PIM:82                | 77             | RE14  | Direct Connection    |
| PIM:83                | 54             | RP69/PMA15/PMCS2/RD5                            | Direct Connection    |
| PIM:84                | 39             | RE7   | Direct Connection    |
| PIM:85                | 27             | RP76/RD12                                       | Direct Connection    |
| PIM:86 <sup>(3)</sup> | 12, 31, 51, 71 | VDD   | Digital Power (DVDD) |
| PIM:87                | —              | —   | Not Connected        |
| PIM:88                | —              | —   | Not Connected        |
| PIM:89                | 14             | ANN2/RP77/RD13                                  | Direct Connection    |
| PIM:90                | 79             | RE15  | Direct Connection    |
| PIM:91                | —              | —   | Not Connected        |
| PIM:92                | 13             | RP78/PCI21/RD14                                 | Direct Connection    |
| PIM:93                | 3              | RP47/PWM1L/PMD6/RB15                            | Direct Connection    |
| PIM:94                | 1              | RP46/PWM1H/PMD5/RB14                            | Direct Connection    |
| PIM:95                | 46             | RP56/ASDA1/SCK2/RC8                             | Direct Connection    |
| PIM:96                | 47             | RP57/ASCL1/SDI2/RC9                             | Direct Connection    |
| PIM:97                | —              | —   | Not Connected        |
| PIM:98                | 80             | RP45/PWM2L/PMD4/RB13                            | Direct Connection    |
| PIM:99                | 78             | TDI/RP44/PWM2H/PMD3/RB12                        | Direct Connection    |
| PIM:100               | 76             | TCK/RP43/PWM3L/PMD2/RB11                        | 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.
- 5:** Analog Ground (AGND) connection via PIM:31 is shorted with Digital Ground (DGND) through 0 Ohm resistor, R27, on the PIM.

# dsPIC33CK256MP508

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

Op Amp 1, as seen in Figure 3, is not used by default. If the filter, bias and feedback circuit section are populated, and configured by software, it can be used to amplify the I<sub>bus</sub> current. Prior to using Op Amp 1, the

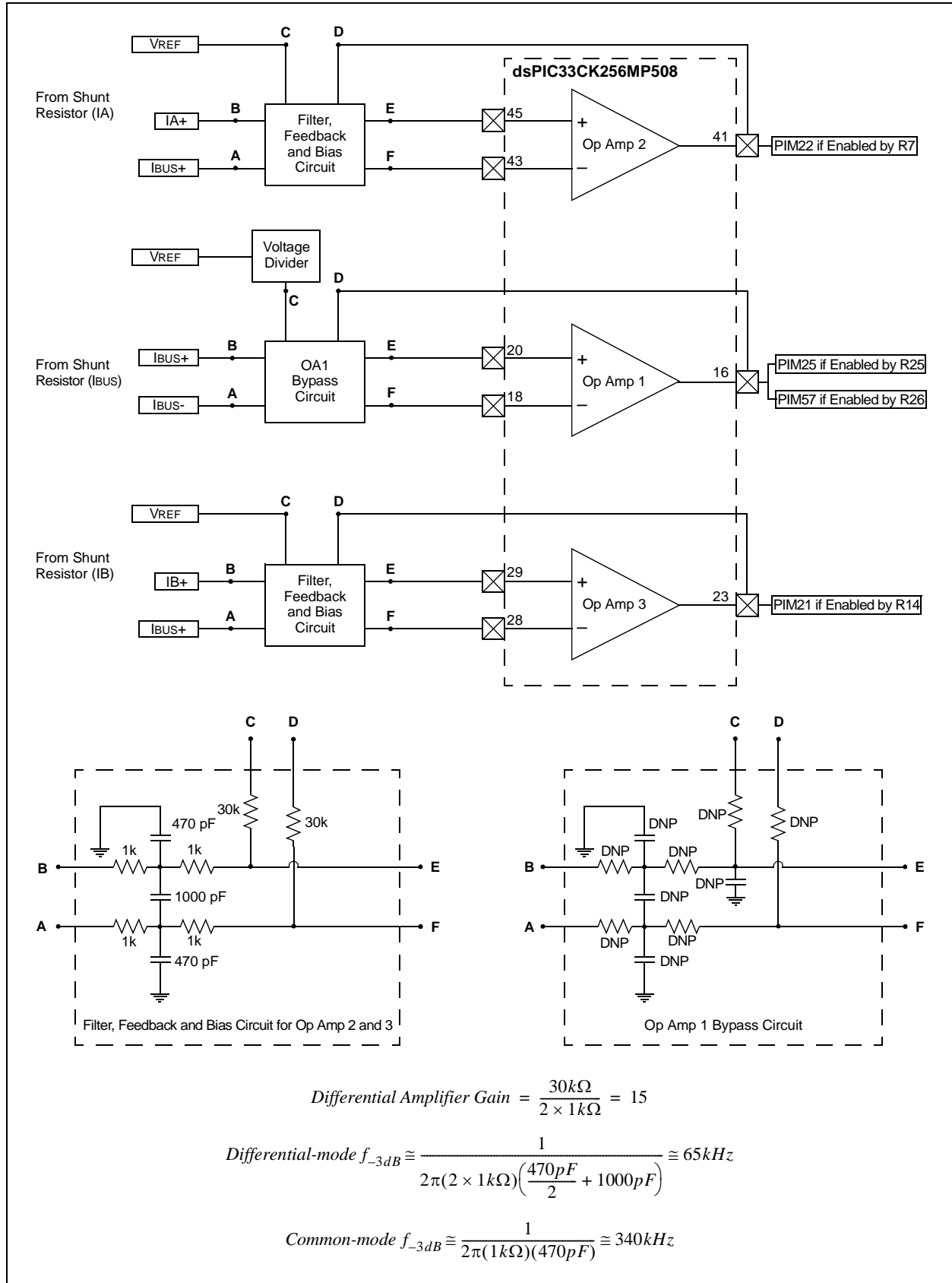
resistor jumpers, R23, R24, R25, R26, should be removed to enable I<sub>bus</sub> current to use the Op Amp 1 inputs. As a result, this limits the Power Factor Correction (PFC) functionality in the case of MCHV-2 or Field Oriented Control (FOC) on Inverter B of the Low-Voltage Motor Control Development Bundle.

**TABLE 4: ANALOG FUNCTIONALITY LISTING**

| Op Amp # | Analog Function                 | Passive Components                | Design Equations  |
|----------|---------------------------------|-----------------------------------|---|
| 1        | Low-Pass Filter                 | R15, R16, R17, R18, C14, C15, C16 | $R15 = R16 = R17 = R18 = R$<br>$C14 = C16 = C$<br>$R10 = R11$<br>$Common-mode f_{-3dB} \cong \frac{1}{2\pi RC}$<br>$Differential-mode f_{-3dB} \cong \frac{1}{2\pi(2R) \left(\frac{C}{2} + C15\right)}$<br>$Differential Amplifier Gain = \frac{R22}{2R}$ |
|          | Reference Voltage Bias          | R19, R20, R21, R22                |   |
|          | Voltage Divider                 | R20, R21                          |   |
|          | Differential Amplifier Input    | R15, R16, R17, R18                |   |
|          | Differential Amplifier Feedback | R22                               |   |
| 2        | Low-Pass Filter                 | R1, R2, R3, R4, C8, C9, C10       | $R1 = R2 = R3 = R4 = R$<br>$C8 = C110 = C$<br>$R5 = R6$<br>$Common-mode f_{-3dB} \cong \frac{1}{2\pi RC}$<br>$Differential-mode f_{-3dB} \cong \frac{1}{2\pi(2R) \left(\frac{C}{2} + C9\right)}$<br>$Differential Amplifier Gain = \frac{R6}{2R}$         |
|          | Reference Voltage Bias          | R5, R6                            |   |
|          | Differential Amplifier Input    | R1, R2, R3, R4                    |   |
|          | Differential Amplifier Feedback | R6                                |   |
| 3        | Low-Pass Filter                 | R8, R9, R10, R11, C11, C12, C13   | $R8 = R9 = R10 = R11 = R$<br>$C11 = C13 = C$<br>$R12 = R13$<br>$Common-mode f_{-3dB} \cong \frac{1}{2\pi RC}$<br>$Differential-mode f_{-3dB} \cong \frac{1}{2\pi(2R) \left(\frac{C}{2} + C12\right)}$<br>$Differential Amplifier Gain = \frac{R13}{2R}$   |
|          | Reference Voltage Bias          | R12, R13                          |   |
|          | Differential Amplifier Input    | R8, R9, R10, R11                  |   |
|          | Differential Amplifier Feedback | R13                               |   |



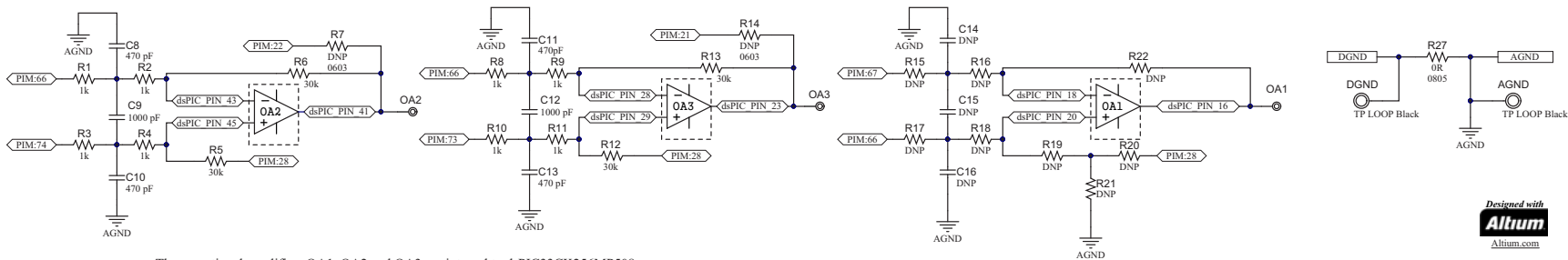
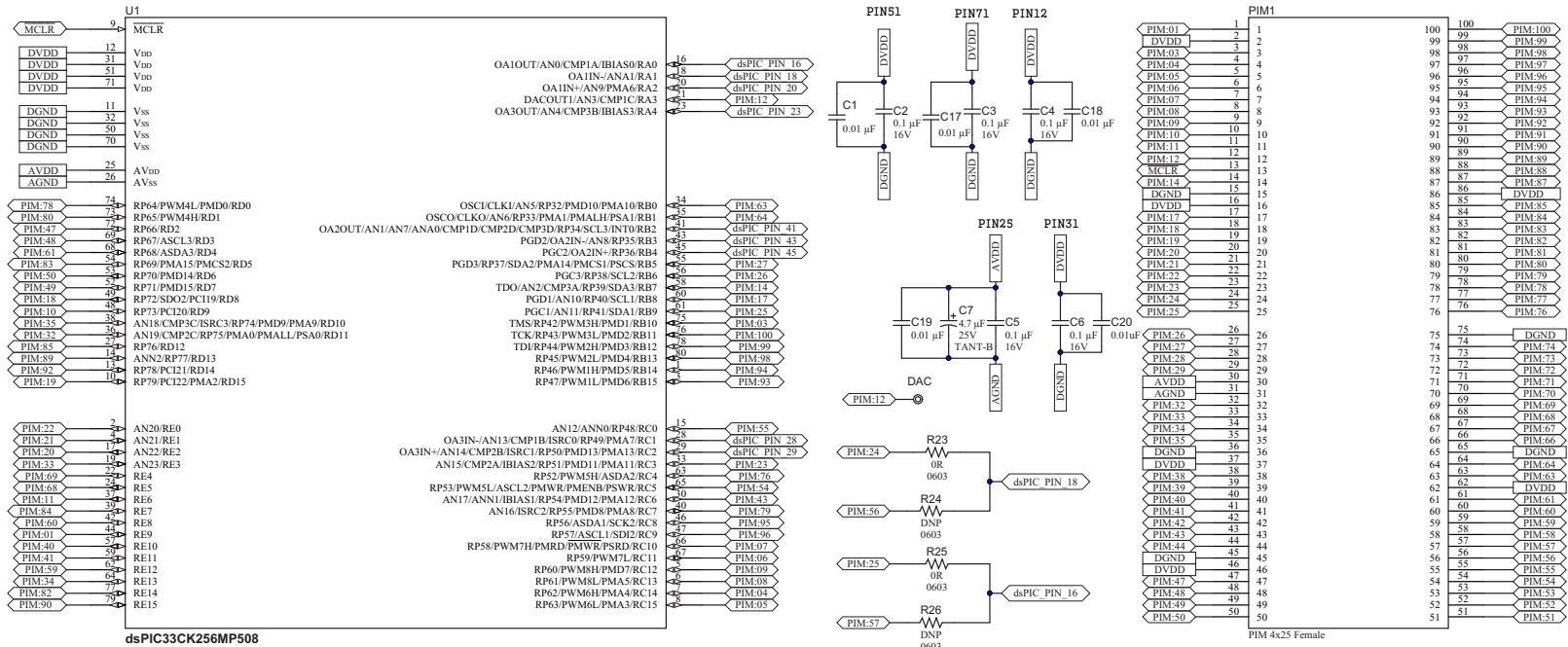
**FIGURE 3: INTERNAL OP AMP CONFIGURATION**



# dsPIC33CK256MP508 Motor Control Plug-In Module (PIM) Information Sheet for Internal Op Amp Configuration

## Schematic Revision 1.0

### dsPIC33CK256MP508 Internal Op Amp Motor Control PIM



The operational amplifiers OA1, OA2 and OA3 are internal to dsPIC33CK256MP508



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