

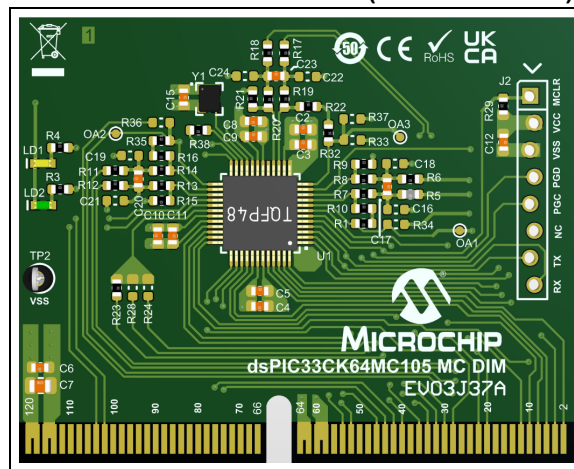
dsPIC33CK64MC105 Motor Control Dual In-Line Module (DIM) Information Sheet

The dsPIC33CK64MC105 Motor Control DIM (P/N: EV03J37A) is designed to demonstrate the motor control capabilities of the dsPIC33CK64MC105 device. This dsPIC[®] DSC features a 100 MIPS, single-core 16-bit Digital Signal Controller (DSC) with enhanced on-chip peripherals.

This motor control DIM is designed to take advantage of the high-speed PWM module, a shared ADC core, and operational amplifiers in the device to enable various motor control applications.

The DIM can be used to demonstrate and develop motor control applications by inserting it in the DIM interface header, provided on the compatible motor control development boards. [Table 1](#) provides information on the hardware versions of the motor control boards that are compatible with this DIM. The DIM is designed to run a single motor with all the compatible development boards. For additional information regarding development boards, refer to the respective user's guide available on the Microchip website (www.microchip.com).

FIGURE 1: dsPIC33CK64MC105 MOTOR CONTROL DIM (P/N: EV03J37A)



The 8-pin header J2 is provided for interfacing the programmer/debugger. An 8-pin connector is included with the DIM. This connector can be inserted when needed. Alternatively, any 8-pin, single row, 0.100" (2.54 mm) pitch, unshrouded male header can be used (example, P/N: 6130081121).

The LED LD2 indicates the power-on status of the DIM. A general purpose LED LD1 is provided on the board for debug purposes. The clock for the dsPIC DSC is generated by the MEMS Oscillator (Y1 – DSC6011-JI2B-008.0000) provided on the DIM.

TABLE 1: HARDWARE COMPATIBILITY⁽¹⁾

| Compatible Development Board | Part Number | Compatible Hardware Revision |
|------------------------------|-------------|------------------------------|
| MCLV-48V-300W | EV18H47A | All Revisions |

Note 1: The DIM is not compatible with earlier motor control development boards (e.g., dsPICDEM™ MCLV-2 Development Board, dsPICDEM MCHV-3 Development Board).

WARNING

Do not connect non-isolated oscilloscope probes to the test points on the DIM when inserted in a High-Voltage Development Board. Failure to heed this warning could result in hardware damage.

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Table 2 provides pin mapping from the 48-pin dsPIC33CK64MC105 device to the DIM interface connector.

TABLE 2: PIN MAPPING – dsPIC33CK64MC105 TO DIM INTERFACE CONNECTOR (SORTED BY DEVICE PIN NUMBER)

| Device Pin # | DIM Pin # | dsPIC33CK64MC105 Pin Function | Remarks |
|--------------|--|----------------------------------|--|
| 1 | DIM:001 | RP46/PWM1H/RB14 | Direct Connection |
| 2 | DIM:003 | RP47/PWM1L/RB15 | Direct Connection |
| 3 | DIM:052 | RP60/RC12 | Direct Connection; also directly connected to Pin 7 of Header J2 |
| 4 | DIM:054 | RP61/RC13 | Direct Connection; also directly connected to Pin 8 of Header J2 |
| 5 | DIM:047 (MCLR) | MCLR | Direct Connection; also directly connected to Pin 1 of Header J2 |
| 6 | DIM:036 | ANN0/RP77/RD13 | Direct Connection |
| 7 | DIM:010 | AN12/RP48/RC0 | Direct Connection |
| 8 | DIM:017 | OA1OUT/AN0/CMP1A/IBIAS0/RA0 | Output of Op Amp 1 (OA1) when configured and enabled; remove resistor R34 |
| | DIM:019 | | Can be connected via 0R (R34) resistor; when connecting the signal: <ul style="list-style-type: none"> • Disable the amplifier Op Amp 1 (OA1) and • Remove resistor R1 |
| 9 | DIM:015 | OA1IN-/RA1 | Op Amp 1 Negative Input – connected via amplifier input resistors |
| 10 | DIM:013 | OA1IN+/AN9/RA2 | Op Amp 1 Positive Input – connected via amplifier input resistors |
| 11 | DIM:011 | DACOUT/AN3/CMP1C/RA3 | Direct Connection |
| 12 | DIM:033 | OA3OUT/AN4/IBIAS3/RA4 | Output of Op Amp 3 (OA3) when configured and enabled; remove resistors R33 and R37 |
| | DIM:035 | | Can be connected via 0R (R33) resistor; when connecting the signal: <ul style="list-style-type: none"> • Disable the amplifier Op Amp 3 (OA3) and • Remove resistors R32 and R37 |
| | DIM:020 | | Can be connected via 0R (R37) resistor; when connecting the signal: <ul style="list-style-type: none"> • Disable the amplifier Op Amp 3 (OA3) and • Remove resistors R32 and R33 |
| 13 | DIM:057 to DIM:060, DIM:113 to DIM:116 | AVDD | Digital Power (Vcc) |
| 14 | DIM:061 to DIM:064, DIM:117 to DIM:120 | AVSS | Digital Ground (Vss) |
| 15 | DIM:031 | OA3IN-/AN13/CMP1B/ISRC0/RP49/RC1 | Op Amp 3 Negative Input – connected via amplifier input resistors |
| 16 | DIM:029 | OAIN+/AN14/ISRC1/RP50/RC2 | Op Amp 3 Positive Input – connected via amplifier input resistors |
| 17 | DIM:046 | IBIAS1/RP54/RC6 | Direct Connection |
| 18 | DIM:057 to DIM:060, DIM:113 to DIM:116 | VDD | Digital Power (Vcc) |
| 19 | DIM:061 to DIM:064, DIM:117 to DIM:120 | VSS | Digital Ground (Vss) |

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TABLE 2: PIN MAPPING – dsPIC33CK64MC105 TO DIM INTERFACE CONNECTOR (SORTED BY DEVICE PIN NUMBER) (CONTINUED)

| Device Pin # | DIM Pin # | dsPIC33CK64MC105 Pin Function | Remarks |
|--------------|---|------------------------------------|---|
| 20 | DIM:012 | AN15/IBIAS2/RP51/RC3 | Direct Connection |
| 21 | — | OSCI/CLKI/AN5/RP32/RB0 | CLKI – clock output of MEMS Oscillator (Y1) is connected as input clock of dsPIC® DSC (U1) |
| 22 | DIM:022 | OSCO/CLKO/AN6/RP33/RB1 | Connected via 0R (R38) resistor |
| 23 | DIM:030 | ISRC3/RP74/RD10 | Direct Connection |
| 24 | DIM:032 | ISRC2/RP55/RC7 | Direct Connection; this pin is connected to a general purpose LED (LD1) on the DIM |
| 25 | DIM:025 | OA2OUT/AN1/AN7/CMP1D/RP34/INT0/RB2 | Output of Op Amp 2 (OA2) when configured and enabled; remove resistor R36 |
| | DIM:027 | | Can be connected via 0R (R36) resistor; when connecting the signal: <ul style="list-style-type: none"> • Disable the amplifier Op Amp 2 (OA2) and • Remove resistor R35 |
| 26 | DIM:023 | PGD2/OA2IN-/AN8/RP35/RB3 | Op Amp 2 Negative Input – connected via amplifier input resistors |
| 27 | DIM:021 | PGC2/OA2IN+/RP36/RB4 | Op Amp 2 Positive Input – connected via amplifier input resistors |
| 28 | DIM:102 | RP56/ASDA1/SCK2/RC8 | Direct Connection |
| 29 | DIM:104 | RP57/ASCL1/SDI2/RC9 | Direct Connection |
| 30 | DIM:040 | RP72/SDO2/PCI19/RD8 | Connected via 0R (R23) resistor |
| | DIM:041 | | Can be connected via 0R (R24) resistor |
| | DIM:043 | | Can be connected via 0R (R28) resistor |
| 31 | DIM:061 to DIM:064, DIM:117 to DIM:120 | Vss | Digital Ground (Vss) |
| 32 | DIM:057 to DIM:060, DIM:113 to DIM:116 | VDD | Digital Power (Vcc) |
| 33 | DIM:049 (PGD) | PGD3/RP37/RB5 | Direct Connection; also directly connected to Pin 4 of Header J2 |
| 34 | DIM:051 (PGC) | PGC3/RP38/RB6 | Direct Connection; also directly connected to Pin 5 of Header J2 |
| 35 | DIM:009 | TDO/AN2/RP39/RB7 | Direct Connection |
| 36 | DIM:039 | PGD1/AN10/RP40/SCL1/RB8 | Direct Connection |
| 37 | DIM:028 | PGC1/AN11/RP41/SDA1/RB9 | Direct Connection |
| 38 | DIM:042 | RP52/RC4 | Direct Connection |
| 39 | DIM:044 | RP53/RC5 | Direct Connection |
| 40 | DIM:034 | RP58/RC10 | Direct Connection |
| 41 | DIM:008 | RP59/RC11 | Direct Connection |
| 42 | DIM:061 to DIM:064, DIM:117 to DIM:120 | Vss | Digital Ground (Vss) |
| 43 | DIM:057 to DIM:060, DIM:113 to DIM:116 | VDD | Digital Power (Vcc) |
| 44 | DIM:006 | RP65/PWM4H/RD1 | Direct Connection |
| 45 | DIM:002 | TMS/RP42/PWM3H/RB10 | Direct Connection |
| 46 | DIM:004 | TCK/RP43/PWM3L/RB11 | Direct Connection |
| 47 | DIM:005 | TDI/RP44/PWM2H/RB12 | Direct Connection |
| 48 | DIM:007 | RP45/PWM2L/RB13 | Direct Connection |

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Table 3 provides pin mapping from the DIM interface connector to the 48-pin dsPIC33CK64MC105 device.

TABLE 3: PIN MAPPING – DIM INTERFACE CONNECTOR TO dsPIC33CK64MC105 (SORTED BY DIM PIN NUMBER)

| DIM Pin # | Device Pin # | dsPIC33CK64MC105 Pin Function | Remarks |
|-----------|--------------|------------------------------------|--|
| DIM:001 | 1 | RP46/PWM1H/RB14 | Direct Connection |
| DIM:002 | 45 | TMS/RP42/PWM3H/RB10 | Direct Connection |
| DIM:003 | 2 | RP47/PWM1L/RB15 | Direct Connection |
| DIM:004 | 46 | TCK/RP43/PWM3L/RB11 | Direct Connection |
| DIM:005 | 47 | TDI/RP44/PWM2H/RB12 | Direct Connection |
| DIM:006 | 44 | RP65/PWM4H/RD1 | Direct Connection |
| DIM:007 | 48 | RP45/PWM2L/RB13 | Direct Connection |
| DIM:008 | 41 | RP59/RC11 | Direct Connection |
| DIM:009 | 35 | TDO/AN2/RP39/RB7 | Direct Connection |
| DIM:010 | 7 | AN12/RP48/RC0 | Direct Connection |
| DIM:011 | 11 | DACOUT/AN3/CMP1C/RA3 | Direct Connection |
| DIM:012 | 20 | AN15/IBIAS2/RP51/RC3 | Direct Connection |
| DIM:013 | 10 | OA1IN+/AN9/RA2 | Op Amp 1 Positive Input – connected via amplifier input resistors |
| DIM:014 | — | — | No Connection |
| DIM:015 | 9 | OA1IN-/RA1 | Op Amp 1 Negative Input – connected via amplifier input resistors |
| DIM:016 | — | — | No Connection |
| DIM:017 | 8 | OA1OUT/AN0/CMP1A/IBIAS0/RA0 | Output of Op Amp 1 (OA1) when configured and enabled; remove resistor R34 |
| DIM:018 | — | — | No Connection |
| DIM:019 | 8 | OA1OUT/AN0/CMP1A/IBIAS0/RA0 | Can be connected via 0R (R34) resistor; when connecting the signal: <ul style="list-style-type: none"> • Disable the amplifier Op Amp 1 (OA1) and • Remove resistor R1 |
| DIM:020 | 12 | OA3OUT/AN4/IBIAS3/RA4 | Can be connected via 0R (R37) resistor; when connecting the signal: <ul style="list-style-type: none"> • Disable the amplifier Op Amp 3 (OA3) and • Remove resistors R32 and R33 |
| DIM:021 | 27 | PGC2/OA2IN+/RP36/RB4 | Op Amp 2 Positive Input – connected via amplifier input resistors |
| DIM:022 | 22 | OSCO/CLKO/AN6/RP33/RB1 | Connected via 0R (R38) resistor |
| DIM:023 | 26 | PGD2/OA2IN-/AN8/RP35/RB3 | Op Amp 2 Negative Input – connected via amplifier input resistors |
| DIM:024 | — | — | No Connection |
| DIM:025 | 25 | OA2OUT/AN1/AN7/CMP1D/RP34/INT0/RB2 | Output of Op Amp 2 (OA2) when configured and enabled; remove resistor R36 |
| DIM:026 | — | — | No Connection |
| DIM:027 | 25 | OA2OUT/AN1/AN7/CMP1D/RP34/INT0/RB2 | Can be connected via 0R (R36) resistor; when connecting the signal: <ul style="list-style-type: none"> • Disable the amplifier Op Amp 2 (OA2) and • Remove resistor R35 |
| DIM:028 | 37 | PGC1/AN11/RP41/SDA1/RB9 | Direct Connection |
| DIM:029 | 16 | OA3IN+/AN14/SRC1/RP50/RC2 | Op Amp 3 Positive Input – connected via amplifier input resistors |

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TABLE 3: PIN MAPPING – DIM INTERFACE CONNECTOR TO dsPIC33CK64MC105 (SORTED BY DIM PIN NUMBER) (CONTINUED)

| DIM Pin # | Device Pin # | dsPIC33CK64MC105 Pin Function | Remarks |
|----------------------|----------------|--|--|
| DIM:030 | 23 | ISRC3/RP74/RD10 | Direct Connection |
| DIM:031 | 15 | OA3IN-/AN13/CMP1B/ISRC0/RP49/RC1 | Op Amp 3 Negative Input – connected via amplifier input resistors |
| DIM:032 | 24 | ISRC2/RP55/RC7 | Direct Connection; also, this pin is connected to a general purpose LED (LD1) on the DIM |
| DIM:033 | 12 | OA3OUT/AN4/IBIAS3/RA4 | Output of Op Amp 3 (OA3) when configured and enabled; remove resistors R33 and R37 |
| DIM:034 | 40 | RP58/RC10 | Direct Connection |
| DIM:035 | 12 | OA3OUT/AN4/IBIAS3/RA4 | Can be connected via 0R (R33) resistor; when connecting the signal: <ul style="list-style-type: none"> • Disable the amplifier Op Amp 3 (OA3) and • Remove resistors R32 and R37 |
| DIM:036 | 6 | ANN0/RP77/RD13 | Direct Connection |
| DIM:037 (VREF) | 10, 16, 27 | Connected to the positive input of amplifiers OA1, OA2 and OA3 through gain resistor | VREF (+1.65V) Input from Motor Control Board |
| DIM:038 | — | — | No Connection |
| DIM:039 | 36 | PGD1/AN10/RP40/SCL1/RB8 | Direct Connection |
| DIM:040 | 30 | RP72/SDO2/PCI19/RD8 | Connected via 0R (R23) resistor |
| DIM:041 | 30 | RP72/SDO2/PCI19/RD8 | Can be connected via 0R (R24) resistor |
| DIM:042 | 38 | RP52/RC4 | Direct Connection |
| DIM:043 | 30 | RP72/SDO2/PCI19/RD8 | Can be connected via 0R (R28) resistor |
| DIM:044 | 39 | RP53/RC5 | Direct Connection |
| DIM:045 | — | — | No Connection |
| DIM:046 | 17 | IBIAS1/RP54/RC6 | Direct Connection |
| DIM:047 (MCLR) | 5 | MCLR | Direct Connection; also directly connected to Pin 1 of Header J2 |
| DIM:048 | — | — | No Connection |
| DIM:049 (PGD) | 33 | PGD3/RP37/RB5 | Direct Connection; also directly connected to Pin 4 of Header J2 |
| DIM:050 | — | — | No Connection |
| DIM:051 (PGC) | 34 | PGC3/RP38/RB6 | Direct Connection; also directly connected to Pin 5 of Header J2 |
| DIM:052 | 3 | RP60/RC12 | Direct Connection; also directly connected to Pin 7 of Header J2 |
| DIM:053 | — | — | No Connection |
| DIM:054 | 4 | RP61/RC13 | Direct Connection; also directly connected to Pin 8 of Header J2 |
| DIM:055 (VCC_SELECT) | — | — | No Connection |
| DIM:056 | — | — | No Connection |
| DIM:057 to DIM:060 | 13, 18, 32, 43 | VDD | Digital Power (Vcc) |
| DIM:061 to DIM:064 | 14, 19, 31, 42 | Vss | Digital Ground (Vss) |
| DIM:065 to DIM:101 | — | — | No Connection |
| DIM:102 | 28 | RP56/ASDA1/SCK2/RC8 | Direct Connection |
| DIM:103 | — | — | No Connection |
| DIM:104 | 29 | RP57/ASCL1/SDI2/RC9 | Direct Connection |
| DIM:105 to DIM:112 | — | — | No Connection |

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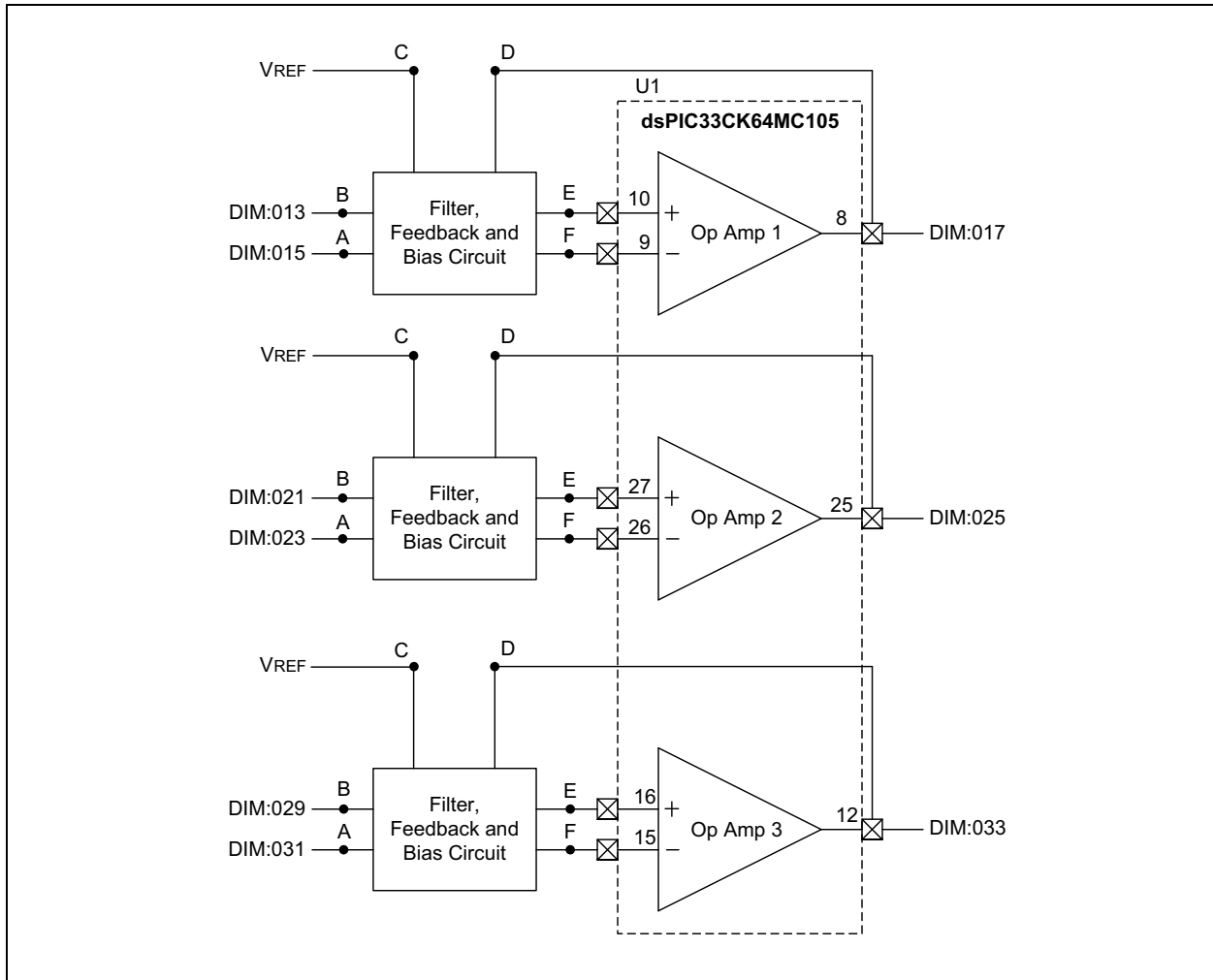
TABLE 3: PIN MAPPING – DIM INTERFACE CONNECTOR TO dsPIC33CK64MC105 (SORTED BY DIM PIN NUMBER) (CONTINUED)

| DIM Pin # | Device Pin # | dsPIC33CK64MC105 Pin Function | Remarks |
|--------------------|---------------------|--------------------------------------|----------------------|
| DIM:113 to DIM:116 | 13, 18, 32, 43 | VDD | Digital Power (Vcc) |
| DIM:117 to DIM:120 | 14, 19, 31, 42 | Vss | Digital Ground (Vss) |

INTERNAL AMPLIFIER

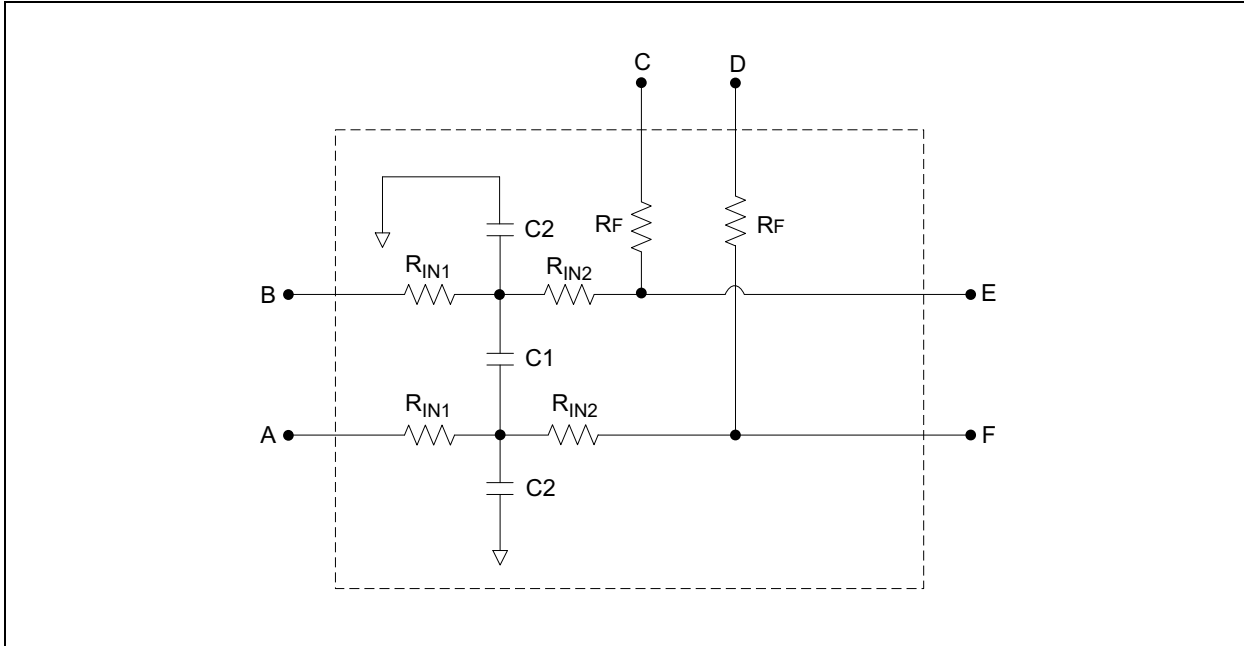
Operational amplifiers internal to the dsPIC33CK64MC105 can be configured and enabled for amplifying motor currents. The amplifier circuits are shown in Figure 2. The detailed schematics of the block, “Filter, Feedback and Bias Circuit” used in Figure 2, are shown in Figure 3.

FIGURE 2: dsPIC® DSC INTERNAL AMPLIFIERS



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FIGURE 3: FILTER, FEEDBACK AND BIAS CIRCUIT



Equation 1 provides the amplifier gain calculations. Equation 2 and Equation 3 provide 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

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

EQUATION 3: CUTOFF FREQUENCY COMMON-MODE FILTER

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

Table 4 summarizes the amplifier gain and filter cutoff frequencies for the amplifier circuit used in the DIM. The customer can select different values based on the application requirements, ensuring peak current is within the operating range of the Motor Control Board in which the DIM is inserted.

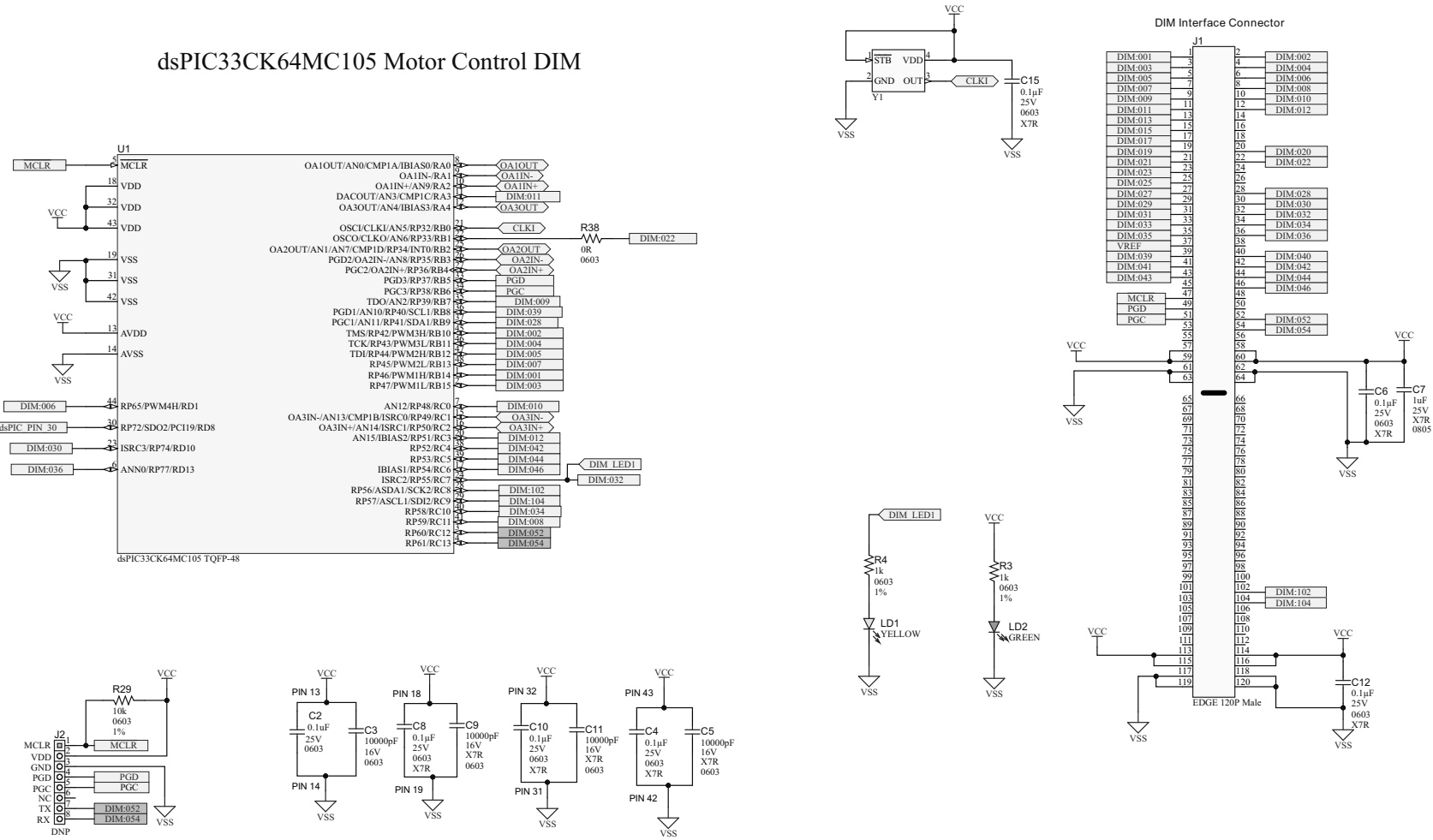
TABLE 4: AMPLIFIER GAIN AND CUTOFF FREQUENCIES

| Component Values | | | | | Amplifier Gain | Differential-Mode Filter Cutoff Frequency | Common-Mode Filter Cutoff Frequency |
|------------------|------------------|----------------|---------|---------------|----------------|---|-------------------------------------|
| R _{IN1} | R _{IN2} | R _F | C1 | C2 | | | |
| 100Ω | 100Ω | 4.99 kΩ | 1000 pF | Not Populated | 24.95 | 796 kHz | — |

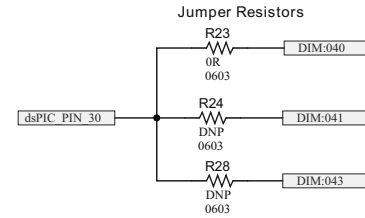
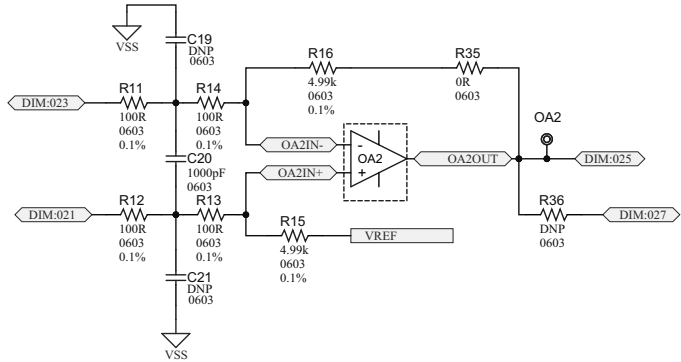
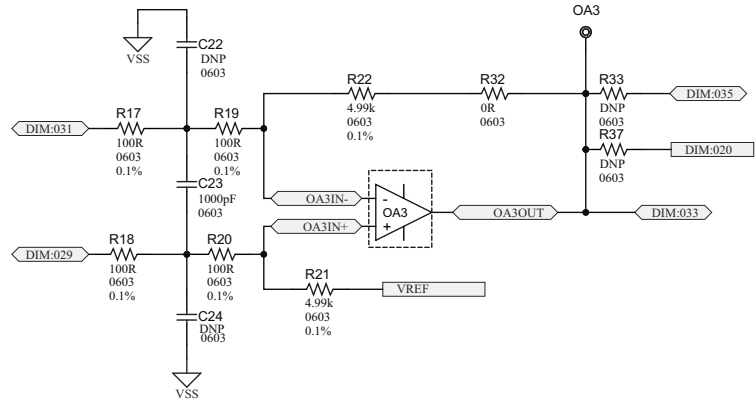
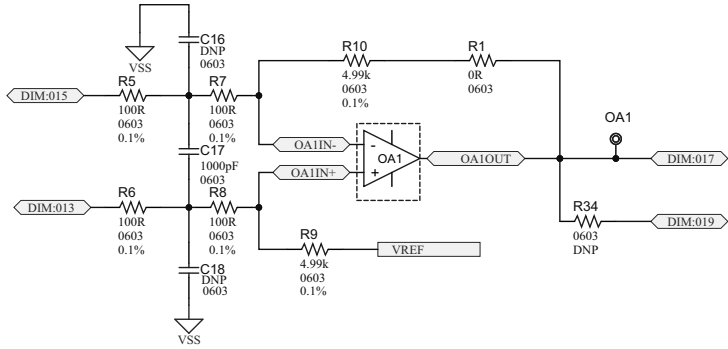
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Schematic Revision 2.0, Page 1 of 2

dsPIC33CK64MC105 Motor Control DIM



dsPIC33CK64MC105 Motor Control DIM



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NOTES:

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India - Pune
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Japan - Osaka
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Japan - Tokyo
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Korea - Daegu
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Malaysia - Penang
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Philippines - Manila
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Taiwan - Hsin Chu
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Vietnam - Ho Chi Minh
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