

dsPIC33EP256MC506 Plug-In Module (PIM) Information Sheet for Internal Op amp Configuration

The dsPIC33EP256MC506 Internal Op amp Motor Control PIM is designed to demonstrate the capabilities of the dsPIC33EP256MC506 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 dsPIC33EP256MC506 is a high-performance, 16-bit Digital Signal Controller (DSC) in a 64-pin TQFP package. This device is equipped with three internal Op amp/Comparators and one dedicated Analog Comparator. The dsPIC33EP256MC506 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).

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 dsPIC33EP256MC506 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.

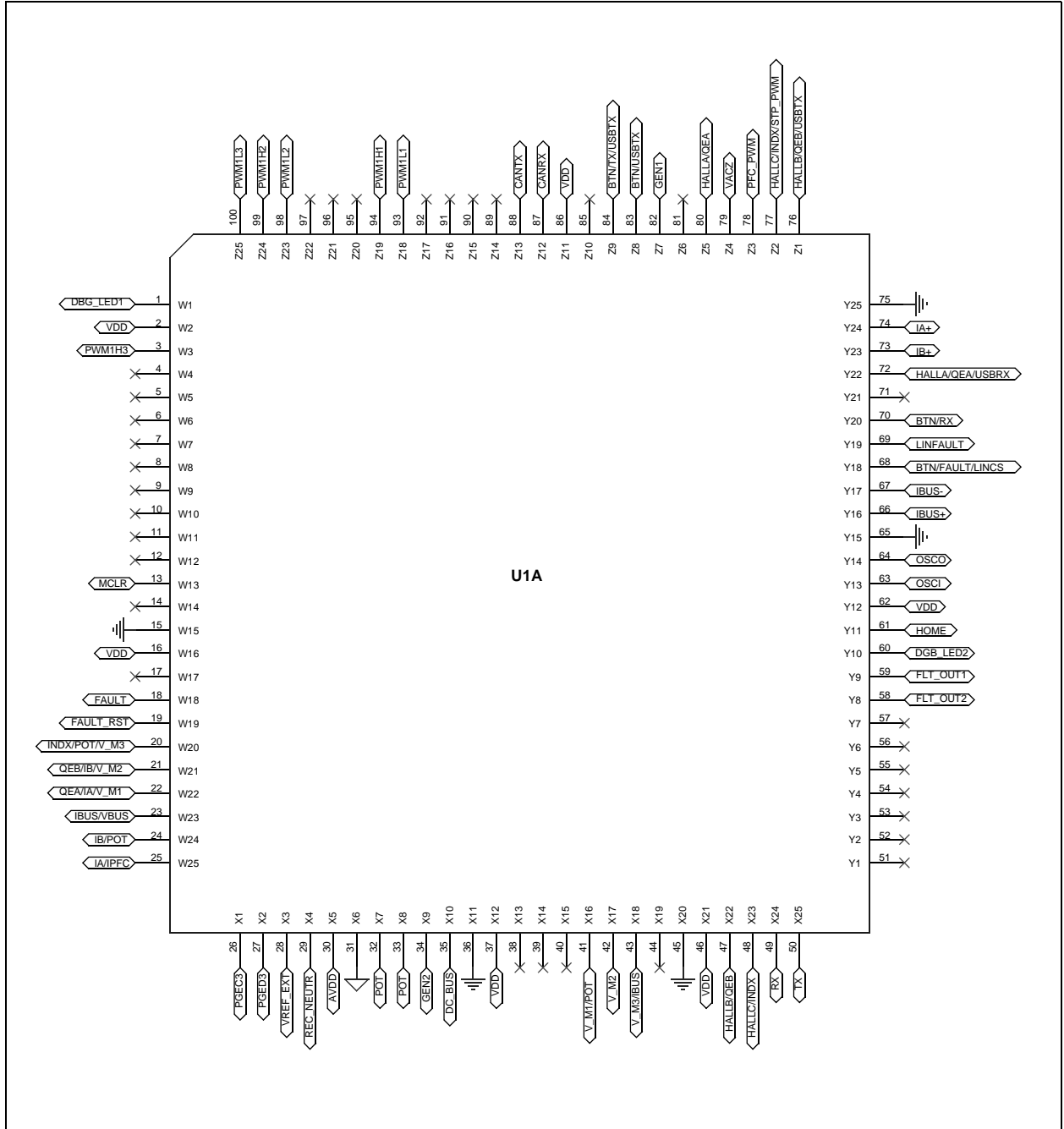
Table 2 provides the static mapping between the 100-pin PIM pins and the device pins.

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

| Device Pin # | dsPIC33EP256MC506 Device Functional Description | PIM Pin # | PIM Functional Description |
|--------------|---|--------------------------|-----------------------------------|
| 1 | TDI/RA7 | — | Not connected |
| 2 | RPI46/PWM1H/T3CK/RB14 | 94 | PWM Out – H1 |
| 3 | RPI47/PWM1L/T5CK/RB15 | 93 | PWM Out – L1 |
| 4 | RP118/RG6 | 84 | Switch/UART TX |
| 5 | RPI119/RG7 | 83 | Switch |
| 6 | RP120/RG8 | 76 | HALLB/QEB/USB TX |
| 7 | MCLR | 13 | Device Master Clear |
| 8 | RPI121/RG9 | 72 | HALLA/QEA/USB RX |
| 9 | Vss | 15, 36, 45, 65, 75 | N/A |
| 10 | VDD | 2, 16, 37, 46, 62, 86 | N/A |
| 11 | AN10/RPI28/RA12 | 35 | DC_BUS voltage (scaled) |
| 12 | AN9/RPI27/RA11 | 25 | IA/IPFC current |
| 13 | AN0/OA2OUT/RA0 | 42 | V_M2 motor phase voltage |
| 14 | AN1/C2IN1+/RA1 | 22, 41 | QEA/IA/V_M1/POT |
| 15 | PGED3/VREF-/AN2/C2IN1-/SS1/RPI32/CTED2/RB0 | 43 | V_M3/IBUS/HALLC |
| 16 | PGEC3/VREF+/AN3/OA1OUT/RPI33/CTED1/RB1 | 59 | Op amp 1 output |
| 17 | PGEC1/AN4/C1IN1+/RPI34/RB2 | 21 | QEB/IB/V_M2 |
| 18 | PGED1/AN5/C1IN1-/RP35/RB3 | — | Used by Op amp circuit |
| 19 | AVDD | 30 | N/A |
| 20 | AVSS | 31 | N/A |
| 21 | AN6/OA3OUT/C4IN1+/OCFB/RC0 | 58 | Op amp 3 output |
| 22 | AN7/C3IN1-/C4IN1-/RC1 | — | Used by Op amp circuit |
| 23 | AN8/C3IN1+/U1RTS/BCLK1/FLT3/RC2 | 20 | INDX/POT/V_M3 |
| 24 | AN11/C1IN2-/U1CTS/FLT4/RC11 | 24 | IB/POT |
| 25 | Vss | 15, 36, 45, 65, 75 | N/A |
| 26 | VDD | 2, 16, 37, 46, 62, 86 | N/A |
| 27 | AN12/C2IN2-/U2RTS/BCLK2/RE12 | — | Reconstructed motor neutral input |
| 28 | AN13/C3IN2-/U2CTS/RE13 | 32, 33 | Potentiometer |
| 29 | AN14/RPI94/RE14 | 23 | IBUS / VBUS |
| 30 | AN15/RPI95/RE15 | 34 | General purpose I/O |
| 31 | SDA2/RPI24/RA8 | 80 | HALLA/QEA |
| 32 | FLT32/SCL2/RP36/RB4 | 18 | Overcurrent Fault input |

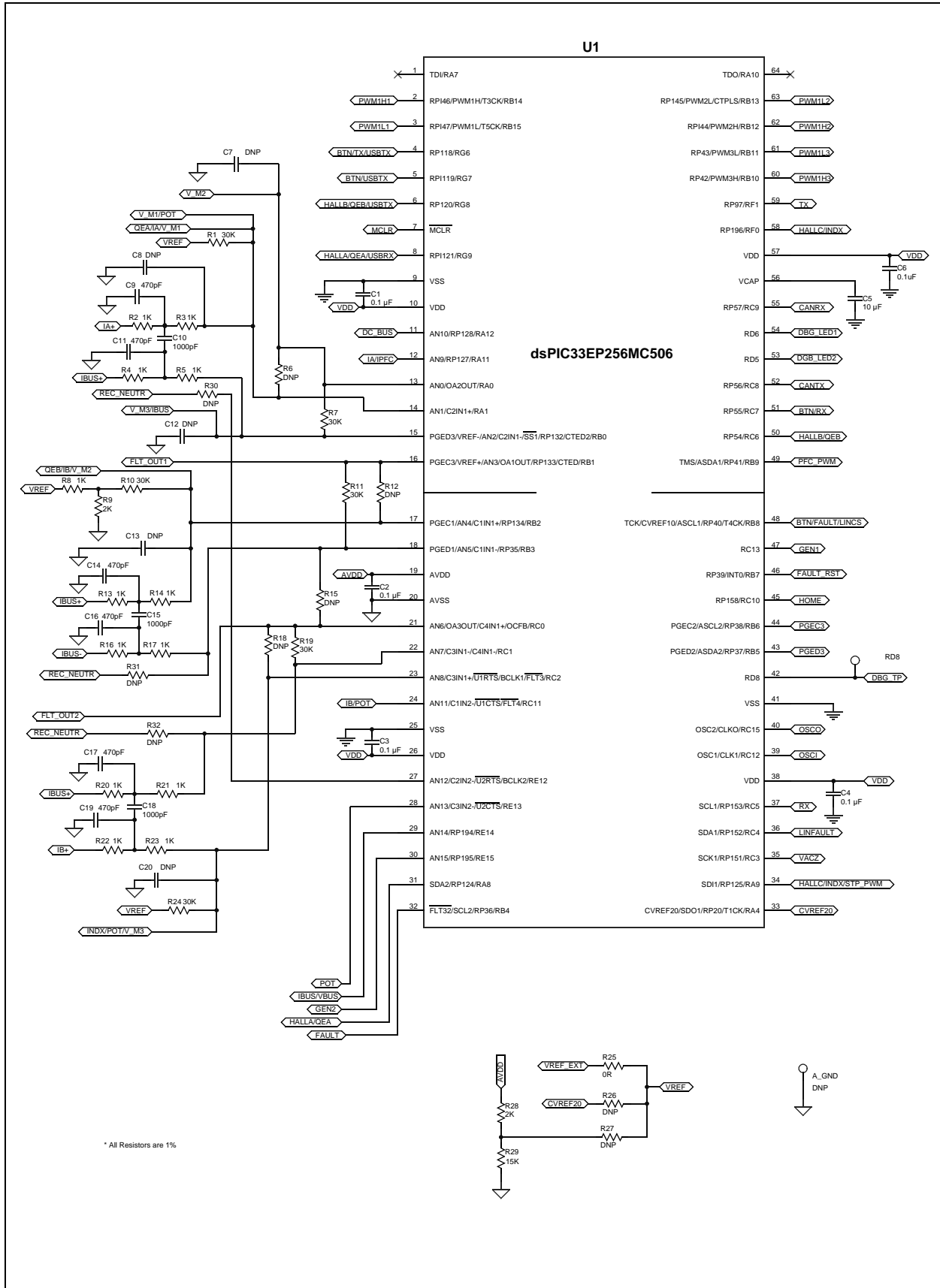
| Device Pin # | dsPIC33EP256MC506 Device Functional Description | PIM Pin # | PIM Functional Description |
|--------------|---|--------------------------|----------------------------|
| 33 | CVREF20/SDO1/RP20/T1CK/RA4 | — | Used by Op amp circuit |
| 34 | SDI1/RPI25/RA9 | 77 | HALLC/INDX/STP_PWM |
| 35 | SCK1/RPI51/RC3 | 79 | AC input zero cross |
| 36 | SDA1/RPI52/RC4 | 69 | LIN Fault |
| 37 | SCL1/RPI53/RC5 | 49 | UART RX |
| 38 | VDD | 2, 16, 37, 46, 62, 86 | N/A |
| 39 | OSC1/CLKI/RC12 | 63 | OSCI |
| 40 | OSC2/CLKO/RC15 | 64 | OSCO |
| 41 | Vss | 15, 36, 45, 65, 75 | N/A |
| 42 | RD8 | — | Debug test point |
| 43 | PGED2/ASDA2/RP37/RB5 | 27 | PGED2 |
| 44 | PGEC2/ASCL2/RP38/RB6 | 26 | PGEC2 |
| 45 | RPI58/RC10 | 61 | HOME signal (QE1) |
| 46 | RP39/INT0/RB7 | 19 | PFC Fault/UART TX |
| 47 | RC13 | 82 | General purpose I/O |
| 48 | TCK/CVREF10/ASCL1/RP40/T4CK/RB8 | 68 | BTN/LINCS |
| 49 | TMS/ASDA1/RP41/RB9 | 78 | PFC PWM/CAN RX |
| 50 | RP54/RC6 | 47 | HALLB/QEB |
| 51 | RP55/RC7 | 70 | BTN/RX |
| 52 | RP56/RC8 | 88 | CAN TX |
| 53 | RD5 | 60 | Debug LED2 |
| 54 | RD6 | 1 | Debug LED1 |
| 55 | RP57/RC9 | 87 | CAN RX |
| 56 | VCAP | — | Not connected |
| 57 | VDD | 2, 16, 37, 46, 62, 86 | N/A |
| 58 | RPI96/RF0 | 48 | HALLC/INDX |
| 59 | RP97/RF1 | 50 | UART TX |
| 60 | RP42/PWM3H/RB10 | 3 | PWM Out – H3 |
| 61 | RP43/PWM3L/RB11 | 100 | PWM Out – L3 |
| 62 | RPI44/PWM2H/RB12 | 99 | PWM Out – H2 |
| 63 | RPI45/PWM2L/CTPLS/RB13 | 98 | PWM Out – L2 |
| 64 | TDO/RA10 | — | Not connected |

FIGURE 2: 100-PIN HEADER SCHEMATIC



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FIGURE 3: 64-PIN DEVICE SCHEMATIC



In the schematic shown in [Figure 3](#), resistors R25, R26 and R27 are used to choose the reference voltage (VREF) from motor control board (VREF_EXT) or device internal reference (CVREF20) or a simple voltage divider (R28-R29), respectively. By default, the PIM is configured to source the reference voltage from the motor control board.

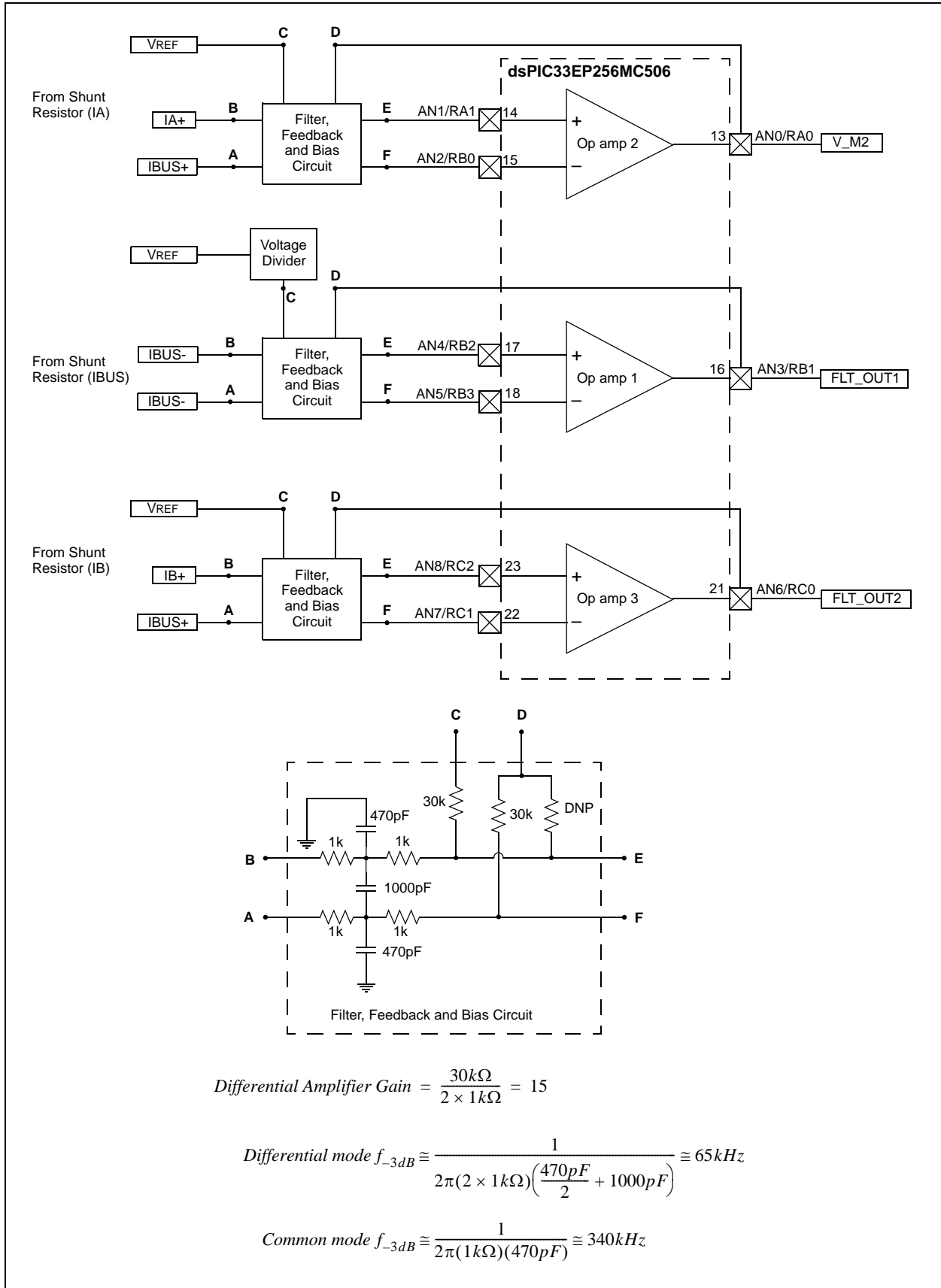
[Table 3](#) classifies the passive components according to their functionality and also quotes the design equations applicable in each case.

TABLE 3: ANALOG FUNCTIONALITY LISTING

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

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FIGURE 4: OP AMP CIRCUIT BLOCK DIAGRAM



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