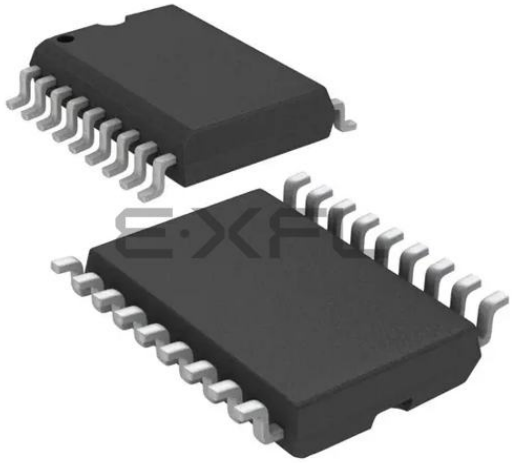

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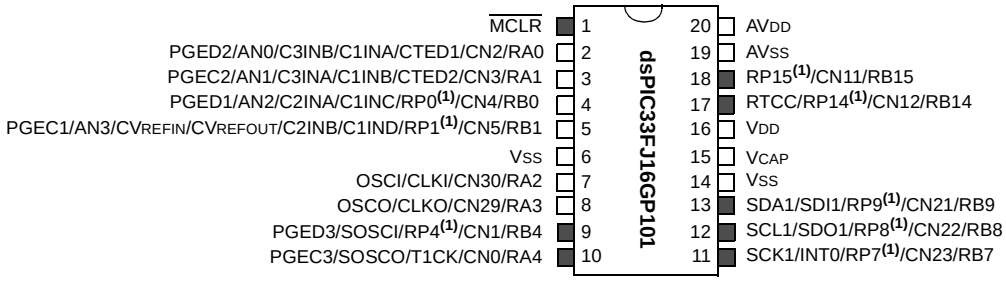
Applications of "Embedded - Microcontrollers"

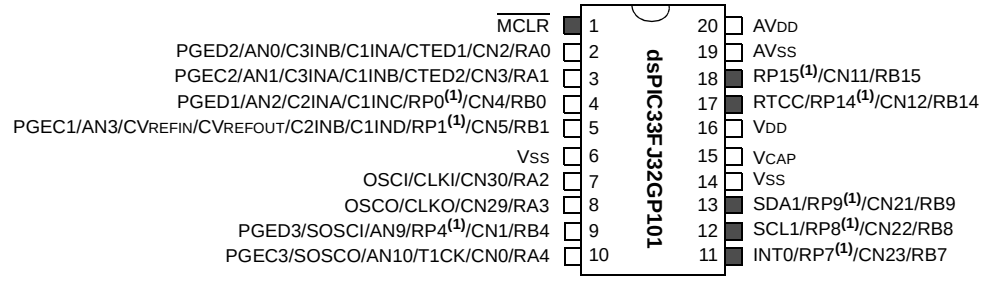
Details	
Product Status	Active
Core Processor	dsPIC
Core Size	16-Bit
Speed	16 MIPs
Connectivity	I²C, IrDA, LINbus, SPI, UART/USART
Peripherals	Brown-out Detect/Reset, POR, PWM, WDT
Number of I/O	13
Program Memory Size	32KB (11K x 24)
Program Memory Type	FLASH
EEPROM Size	-
RAM Size	1K x 16
Voltage - Supply (Vcc/Vdd)	3V ~ 3.6V
Data Converters	A/D 6x10b
Oscillator Type	Internal
Operating Temperature	-40°C ~ 85°C (TA)
Mounting Type	Surface Mount
Package / Case	18-SOIC (0.295", 7.50mm Width)
Supplier Device Package	18-SOIC
Purchase URL	https://www.e-xfl.com/product-detail/microchip-technology/dspic33fj32gp101-i-so

Pin Diagrams (Continued)

20-Pin SSOP

■ = Pins are up to 5V tolerant



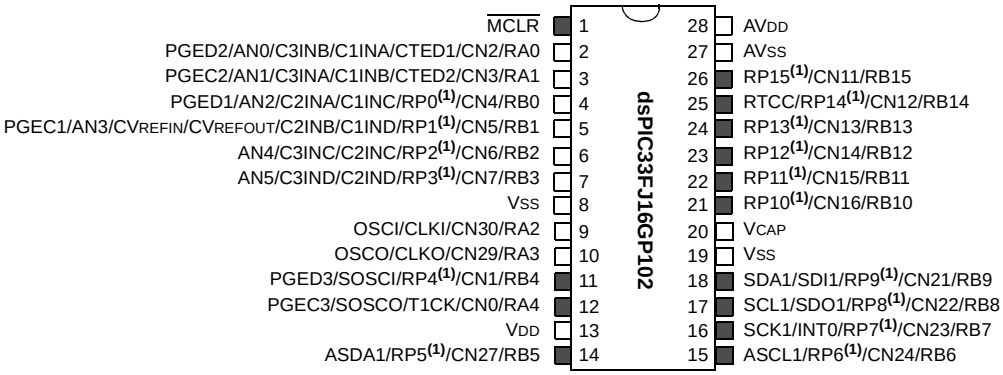


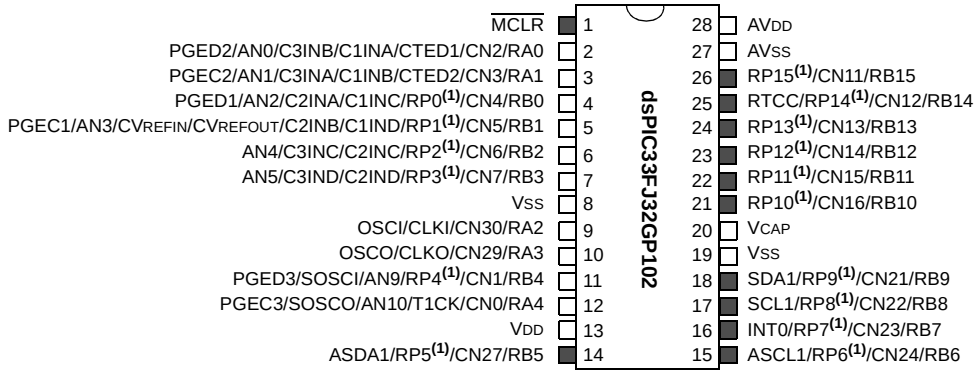
Note 1: The RPn pins can be used by any remappable peripheral. See Table 1 for the list of available peripherals.

Pin Diagrams (Continued)

28-Pin SPDIP/SOIC/SSOP

■ = Pins are up to 5V tolerant



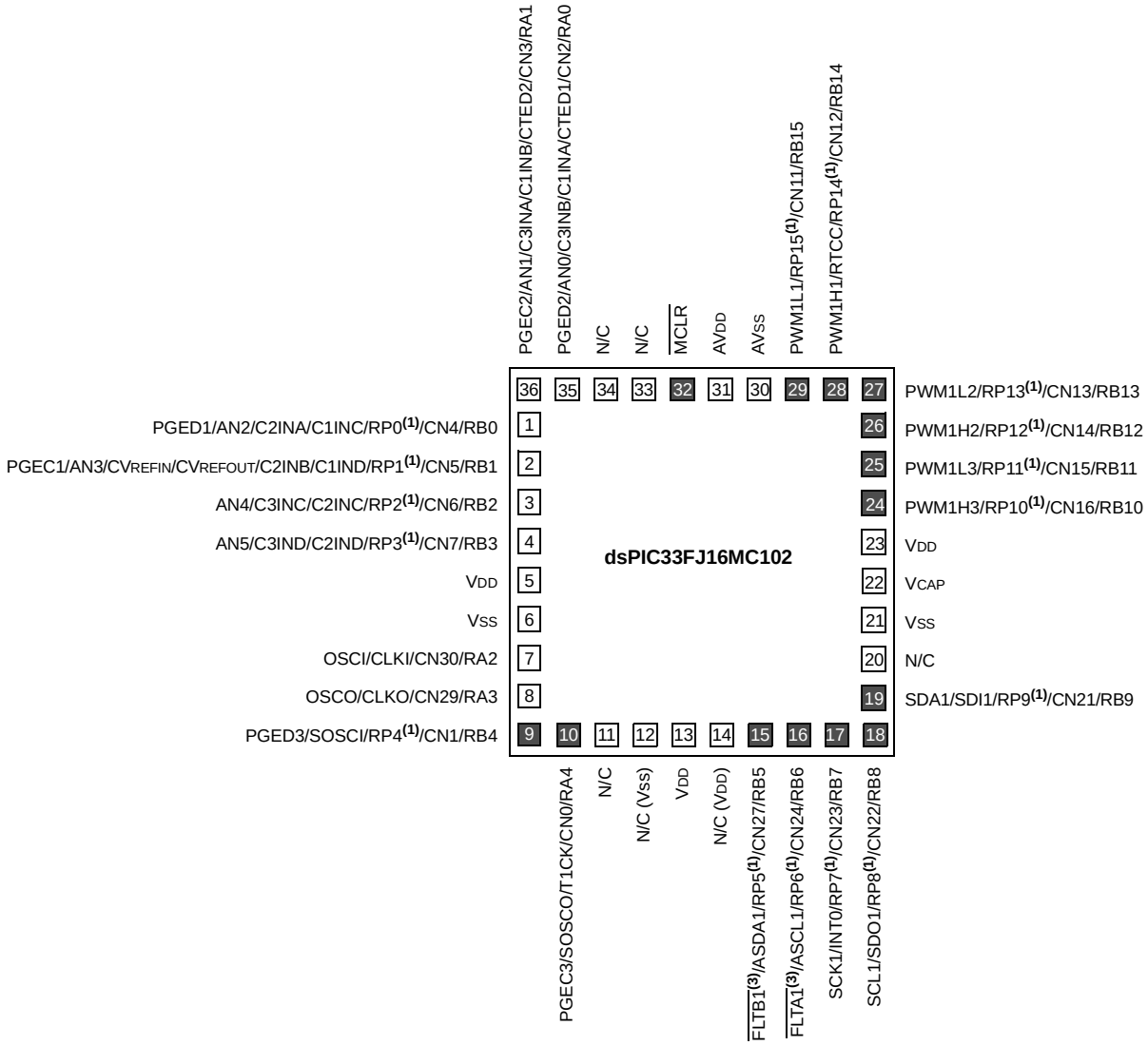


Note 1: The RPn pins can be used by any remappable peripheral. See Table 1 for the list of available peripherals.

Pin Diagrams (Continued)

36-Pin VTLA(2)

■ = Pins are up to 5V tolerant

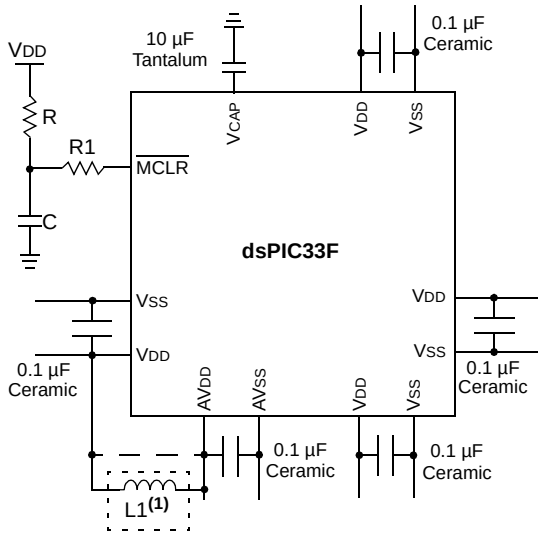


Note 1: The RPn pins can be used by any remappable peripheral. See Table 1 for the list of available peripherals.

2: The metal pad at the bottom of the device is not connected to any pins and is recommended to be connected to VSS externally.

3: The PWM Fault pins are enabled and asserted during any Reset event. Refer to **Section 15.2 "PWM Faults"** for more information on the PWM Faults.

FIGURE 2-1: RECOMMENDED MINIMUM CONNECTION



Note 1: As an option, instead of a hard-wired connection, an inductor (L1) can be substituted between VDD and AVDD to improve ADC noise rejection. The inductor impedance should be less than 1Ω and the inductor capacity greater than 10 mA.

Where:

$$f = \frac{F_{CNV}}{2}$$ (i.e., ADC conversion rate/2)

$$f = \frac{1}{(2\pi\sqrt{LC})}$$

$$L = \left(\frac{1}{(2\pi f\sqrt{C})}\right)^2$$

2.2.1 TANK CAPACITORS

On boards with power traces running longer than six inches in length, it is suggested to use a tank capacitor for integrated circuits including DSCs to supply a local power source. The value of the tank capacitor should be determined based on the trace resistance that connects the power supply source to the device and the maximum current drawn by the device in the application. In other words, select the tank capacitor so that it meets the acceptable voltage sag at the device. Typical values range from 4.7 µF to 47 µF.

2.3 CPU Logic Filter Capacitor Connection (VCAP)

A low-ESR (< 5 Ohms) capacitor is required on the VCAP pin, which is used to stabilize the voltage regulator output voltage. The VCAP pin must not be connected to VDD, and must have a capacitor between 4.7 µF and 10 µF, 16V connected to ground. The type can be ceramic or tantalum. Refer to **Section 26.0 "Electrical Characteristics"** for additional information.

The placement of this capacitor should be close to the VCAP. It is recommended that the trace length not exceed one-quarter inch (6 mm). Refer to **Section 23.2 "On-Chip Voltage Regulator"** for details.

2.4 Master Clear (MCLR) Pin

The MCLR pin provides two specific device functions:

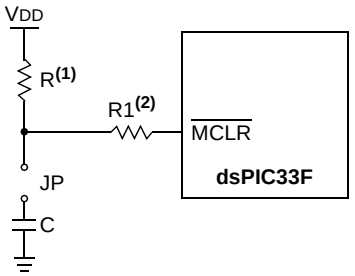
- Device Reset
- Device programming and debugging

During device programming and debugging, the resistance and capacitance that can be added to the pin must be considered. Device programmers and debuggers drive the MCLR pin. Consequently, specific voltage levels (VIH and VIL) and fast signal transitions must not be adversely affected. Therefore, specific values of R and C will need to be adjusted based on the application and PCB requirements.

For example, as shown in Figure 2-2, it is recommended that the capacitor C, be isolated from the MCLR pin during programming and debugging operations.

Place the components shown in Figure 2-2 within one-quarter inch (6 mm) from the MCLR pin.

FIGURE 2-2: EXAMPLE OF MCLR PIN CONNECTIONS



Note 1: R ≤ 10 kΩ is recommended. A suggested starting value is 10 kΩ. Ensure that the MCLR pin VIH and VIL specifications are met.

2: R1 ≤ 470Ω will limit any current flowing into MCLR from the external capacitor, C, in the event of MCLR pin breakdown, due to Electrostatic Discharge (ESD) or Electrical Overstress (EOS). Ensure that the MCLR pin VIH and VIL specifications are met.

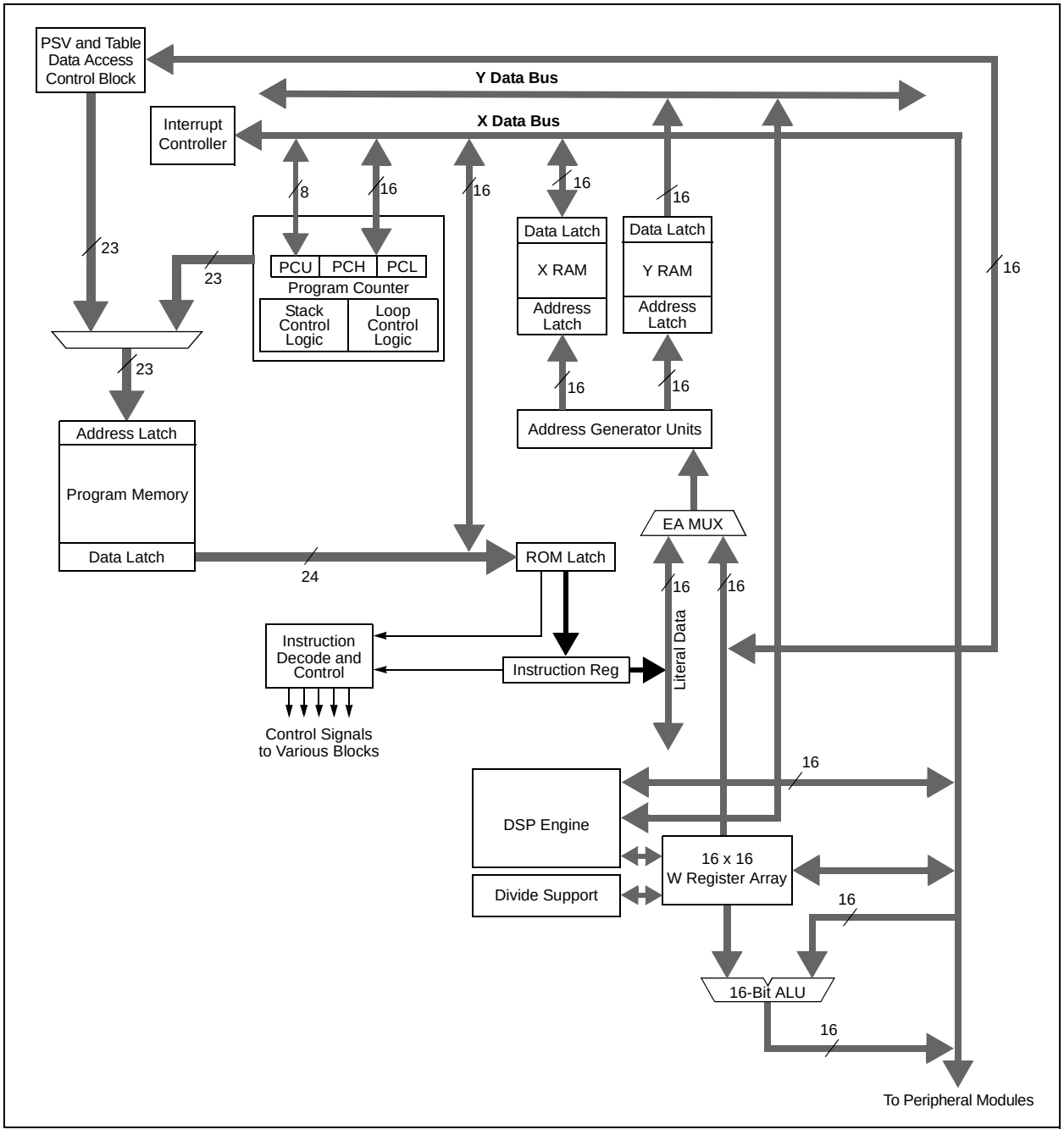
3.3 Special MCU Features

The dsPIC33FJ16(GP/MC)101/102 and dsPIC33FJ32(GP/MC)101/102/104 features a 17-bit by 17-bit, single-cycle multiplier that is shared by both the MCU ALU and DSP engine. The multiplier can perform signed, unsigned and mixed-sign multiplication. Using a 17-bit by 17-bit multiplier for 16-bit by 16-bit multiplication not only allows you to perform mixed-sign multiplication, it also achieves accurate results for special operations, such as (-1.0) x (-1.0).

The dsPIC33FJ16(GP/MC)101/102 and dsPIC33FJ32(GP/MC)101/102/104 supports 16/16 and 32/16 divide operations, both fractional and integer. All divide instructions are iterative operations. They must be executed within a REPEAT loop, resulting in a total execution time of 19 instruction cycles. The divide operation can be interrupted during any of those 19 cycles without loss of data.

A 40-bit barrel shifter is used to perform up to a 16-bit left or right shift in a single cycle. The barrel shifter can be used by both MCU and DSP instructions.

FIGURE 3-1: dsPIC33FJ16(GP/MC)101/102 AND dsPIC33FJ32(GP/MC)101/102/104 CPU CORE BLOCK DIAGRAM



3.6.1 MULTIPLIER

The 17-bit x 17-bit multiplier is capable of signed or unsigned operation and can multiplex its output using a scaler to support either 1.31 fractional (Q31) or 32-bit integer results. Unsigned operands are zero-extended into the 17th bit of the multiplier input value. Signed operands are sign-extended into the 17th bit of the multiplier input value. The output of the 17-bit x 17-bit multiplier/scaler is a 33-bit value that is sign-extended to 40 bits. Integer data is inherently represented as a signed 2's complement value, where the Most Significant bit (MSb) is defined as a sign bit. The range of an N-bit 2's complement integer is -2^{N-1} to $2^{N-1} – 1$.

- For a 16-bit integer, the data range is -32768 (0x8000) to 32767 (0x7FFF) including 0.
- For a 32-bit integer, the data range is -2,147,483,648 (0x8000 0000) to 2,147,483,647 (0x7FFF FFFF).

When the multiplier is configured for fractional multiplication, the data is represented as a 2's complement fraction, where the MSb is defined as a sign bit and the radix point is implied to lie just after the sign bit (QX format). The range of an N-bit 2's complement fraction with this implied radix point is -1.0 to $(1 – 2^{1-N})$. For a 16-bit fraction, the Q15 data range is -1.0 (0x8000) to 0.999969482 (0x7FFF) including 0 and has a precision of 3.01518×10^{-5}. In Fractional mode, the 16 x 16 multiply operation generates a 1.31 product that has a precision of 4.65661×10^{-10}.

The same multiplier is used to support the MCU multiply instructions, which include integer 16-bit signed, unsigned and mixed sign multiply operations.

The MUL instruction can be directed to use byte or word-sized operands. Byte operands will direct a 16-bit result and word operands will direct a 32-bit result to the specified register(s) in the W array.

3.6.2 DATA ACCUMULATORS AND ADDER/SUBTRACTER

The data accumulator consists of a 40-bit adder/subtracter with automatic sign extension logic. It can select one of two accumulators (A or B) as its pre-accumulation source and post-accumulation destination. For the ADD and LAC instructions, the data to be accumulated or loaded can be optionally scaled using the barrel shifter prior to accumulation.

3.6.2.1 Adder/Subtracter, Overflow and Saturation

The adder/subtracter is a 40-bit adder with an optional zero input into one side and either true or complement data into the other input.

- In the case of addition, the Carry/$\overline{\text{Borrow}}$ input is active-high and the other input is true data (not complemented).
- In the case of subtraction, the Carry/$\overline{\text{Borrow}}$ input is active-low and the other input is complemented.

The adder/subtracter generates Overflow Status bits, SA/SB and OA/OB, which are latched and reflected in the STATUS Register:

- Overflow from bit 39: this is a catastrophic overflow in which the sign of the accumulator is destroyed.
- Overflow into guard bits 32 through 39: this is a recoverable overflow. This bit is set whenever all the guard bits are not identical to each other.

The adder has an additional saturation block that controls accumulator data saturation, if selected. It uses the result of the adder, the Overflow Status bits described previously, and the SAT<A:B> (CORCON<7:6>) and ACCSAT (CORCON<4>) mode control bits to determine when and to what value, to saturate.

Six STATUS Register bits support saturation and overflow:

- OA: ACCA overflowed into guard bits
- OB: ACCB overflowed into guard bits
- SA: ACCA saturated (bit 31 overflow and saturation)

  or

  ACCA overflowed into guard bits and saturated (bit 39 overflow and saturation)
- SB: ACCB saturated (bit 31 overflow and saturation)

  or

  ACCB overflowed into guard bits and saturated (bit 39 overflow and saturation)
- OAB: Logical OR of OA and OB
- SAB: Logical OR of SA and SB

The OA and OB bits are modified each time data passes through the adder/subtracter. When set, they indicate that the most recent operation has overflowed into the accumulator guard bits (bits 32 through 39). The OA and OB bits can also optionally generate an arithmetic warning trap when OA and OB are set and the corresponding Overflow Trap Flag Enable bits (OVATE, OVBTE) in the INTCON1 register are set (refer to **Section 7.0 "Interrupt Controller"**). This allows the user application to take immediate action; for example, to correct system gain.

TABLE 4-2: CHANGE NOTIFICATION REGISTER MAP FOR dsPIC33FJXXGP101 DEVICES

SFR Name	SFR Addr	Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	All Resets
CNEN1	0060	—	—	—	CN12IE	CN11IE	—	—	—	—	—	CN5IE	CN4IE	CN3IE	CN2IE	CN1IE	CN0IE	0000
CNEN2	0062	—	CN30IE	CN29IE	—	—	—	—	—	CN23IE	CN22IE	CN21IE	—	—	—	—	—	0000
CNPU1	0068	—	—	—	CN12PUE	CN11PUE	—	—	—	—	—	CN5PUE	CN4PUE	CN3PUE	CN2PUE	CN1PUE	CN0PUE	0000
CNPU2	006A	—	CN30PUE	CN29PUE	—	—	—	—	—	CN23PUE	CN22PUE	CN21PUE	—	—	—	—	—	0000

Legend: — = unimplemented, read as '0'. Reset values are shown in hexadecimal.

TABLE 4-3: CHANGE NOTIFICATION REGISTER MAP FOR dsPIC33FJXXMC101 DEVICES

SFR Name	SFR Addr	Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	All Resets
CNEN1	0060	—	CN14IE	CN13IE	CN12IE	CN11IE	—	—	—	—	—	CN5IE	CN4IE	CN3IE	CN2IE	CN1IE	CN0IE	0000
CNEN2	0062	—	CN30IE	CN29IE	—	—	—	—	—	CN23IE	CN22IE	CN21IE	—	—	—	—	—	0000
CNPU1	0068	—	CN14PUE	CN13PUE	CN12PUE	CN11PUE	—	—	—	—	—	CN5PUE	CN4PUE	CN3PUE	CN2PUE	CN1PUE	CN0PUE	0000
CNPU2	006A	—	CN30PUE	CN29PUE	—	—	—	—	—	CN23PUE	CN22PUE	CN21PUE	—	—	—	—	—	0000

Legend: — = unimplemented, read as '0'. Reset values are shown in hexadecimal.

TABLE 4-4: CHANGE NOTIFICATION REGISTER MAP FOR dsPIC33FJXX(GP/MC)102 DEVICES

SFR Name	SFR Addr	Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	All Resets
CNEN1	0060	CN15IE	CN14IE	CN13IE	CN12IE	CN11IE	—	—	—	CN7IE	CN6IE	CN5IE	CN4IE	CN3IE	CN2IE	CN1IE	CN0IE	0000
CNEN2	0062	—	CN30IE	CN29IE	—	CN27IE	—	—	CN24IE	CN23IE	CN22IE	CN21IE	—	—	—	—	CN16IE	0000
CNPU1	0068	CN15PUE	CN14PUE	CN13PUE	CN12PUE	CN11PUE	—	—	—	CN7PUE	CN6PUE	CN5PUE	CN4PUE	CN3PUE	CN2PUE	CN1PUE	CN0PUE	0000
CNPU2	006A	—	CN30PUE	CN29PUE	—	CN27PUE	—	—	CN24PUE	CN23PUE	CN22PUE	CN21PUE	—	—	—	—	CN16PUE	0000

Legend: — = unimplemented, read as '0'. Reset values are shown in hexadecimal.

TABLE 4-5: CHANGE NOTIFICATION REGISTER MAP FOR dsPIC33FJ32(GP/MC)104 DEVICES

SFR Name	SFR Addr	Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	All Resets
CNEN1	0060	CN15IE	CN13IE	CN13IE	CN12IE	CN11IE	CN10IE	CN9IE	CN8IE	CN7IE	CN6IE	CN5IE	CN4IE	CN3IE	CN2IE	CN1IE	CN0IE	0000
CNEN2	0062	—	CN30IE	CN29IE	CN28IE	CN27IE	CN26IE	CN25IE	CN24IE	CN23IE	CN22IE	CN21IE	CN20IE	CN19IE	CN18IE	CN17IE	CN16IE	0000
CNPU1	0068	CN15PUE	CN13PUE	CN13PUE	CN12PUE	CN11PUE	CN10PUE	CN9PUE	CN8PUE	CN7PUE	CN6PUE	CN5PUE	CN4PUE	CN3PUE	CN2PUE	CN1PUE	CN0PUE	0000
CNPU2	006A	—	CN30PUE	CN29PUE	CN28PUE	CN27PUE	CN26PUE	CN25PUE	CN24PUE	CN23PUE	CN22PUE	CN21PUE	CN20PUE	CN19PUE	CN18PUE	CN17PUE	CN16PUE	0000

Legend: — = unimplemented, read as '0'. Reset values are shown in hexadecimal.

REGISTER 5-1: NVMCON: FLASH MEMORY CONTROL REGISTER

R/SO-0(1)	R/W-0(1)	R/W-0(1)	U-0	U-0	U-0	U-0	U-0
WR	WREN	WRERR	—	—	—	—	—
bit 15							bit 8

U-0	R/W-0(1)	U-0	U-0	R/W-0(1)	R/W-0(1)	R/W-0(1)	R/W-0(1)
—	ERASE	—	—	NVMOP3(2)	NVMOP2(2)	NVMOP1(2)	NVMOP0(2)
bit 7							bit 0

Legend:	SO = Settable Only bit		
R = Readable bit	W = Writable bit	U = Unimplemented bit, read as '0'	
-n = Value at POR	'1' = Bit is set	'0' = Bit is cleared	x = Bit is unknown

bit 15 **WR:** Write Control bit(1)
- 1 = Initiates a Flash memory program or erase operation; the operation is self-timed and the bit is cleared by hardware once operation is complete
- 0 = Program or erase operation is complete and inactive

bit 14 **WREN:** Write Enable bit(1)
- 1 = Enables Flash program/erase operations
- 0 = Inhibits Flash program/erase operations

bit 13 **WRERR:** Write Sequence Error Flag bit(1)
- 1 = An improper program or erase sequence attempt or termination has occurred (bit is set automatically on any set attempt of the WR bit)
- 0 = The program or erase operation completed normally

bit 12-7 **Unimplemented:** Read as '0'

bit 6 **ERASE:** Erase/Program Enable bit(1)
- 1 = Performs the erase operation specified by NVMOP<3:0> on the next WR command
- 0 = Performs the program operation specified by NVMOP<3:0> on the next WR command

bit 5-4 **Unimplemented:** Read as '0'

bit 3-0 **NVMOP<3:0>:** NVM Operation Selection bits(1,2)

If ERASE = 1:
- 1111 = No operation
- 1101 = Erase General Segment
- 1100 = No operation
- 0011 = No operation
- 0010 = Memory page erase operation
- 0001 = No operation
- 0000 = No operation

If ERASE = 0:
- 1111 = No operation
- 1101 = No operation
- 1100 = No operation
- 0011 = Memory word program operation
- 0010 = No operation
- 0001 = No operation
- 0000 = No operation

Note 1: These bits can only be reset on a POR.

2: All other combinations of NVMOP<3:0> are unimplemented.

REGISTER 5-2: NVMKEY: NONVOLATILE MEMORY KEY REGISTER

U-0	U-0	U-0	U-0	U-0	U-0	U-0	U-0
—	—	—	—	—	—	—	—

6.3 POR

A POR circuit ensures the device is reset from power-on. The POR circuit is active until VDD crosses the VPOR threshold and the delay, TPOR, has elapsed. The delay, TPOR, ensures that the internal device bias circuits become stable.

The device supply voltage characteristics must meet the specified starting voltage and rise rate requirements to generate the POR. Refer to **Section 26.0 "Electrical Characteristics"** for details.

The Power-on Reset (POR) status bit in the Reset Control (RCON<0>) register is set to indicate the Power-on Reset.

6.4 BOR and PWRT

The on-chip regulator has a BOR circuit that resets the device when the VDD is too low (VDD < VBOR) for proper device operation. The BOR circuit keeps the device in Reset until VDD crosses the VBOR threshold and the delay, TBOR, has elapsed. The delay, TBOR, ensures the voltage regulator output becomes stable.

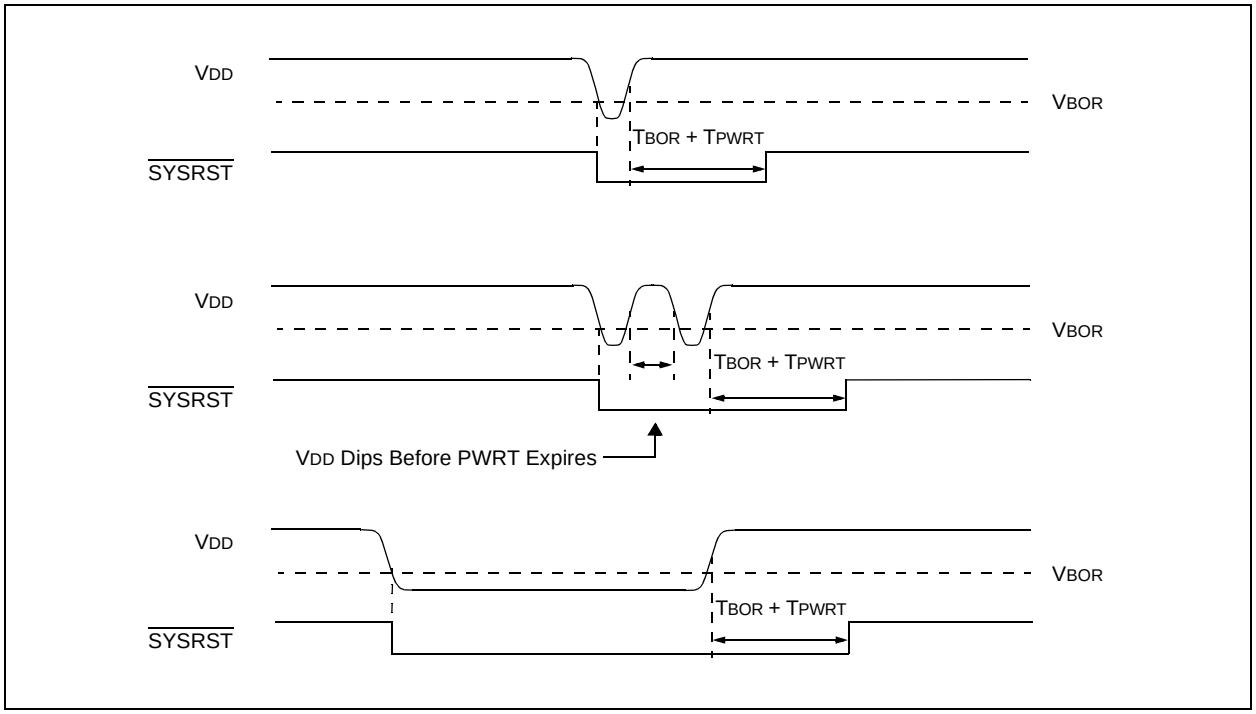
The Brown-out Reset (BOR) status bit in the Reset Control (RCON<1>) register is set to indicate the Brown-out Reset.

The device will not run at full speed after a BOR as the VDD should rise to acceptable levels for full-speed operation. The Power-up Timer (PWRT) provides power-up time delay (TPWRT) to ensure that the system power supplies have stabilized at the appropriate levels for full-speed operation before the $\overline{\text{SYSRST}}$ is released.

Refer to **Section 23.0 "Special Features"** for further details.

Figure 6-3 shows the typical brown-out scenarios. The Reset delay (TBOR + TPWRT) is initiated each time VDD rises above the VBOR trip point.

FIGURE 6-3: BROWN-OUT RESET SITUATIONS



REGISTER 10-3: RPINR3: PERIPHERAL PIN SELECT INPUT REGISTER 3

U-0	U-0	U-0	R/W-1	R/W-1	R/W-1	R/W-1	R/W-1
—	—	—	T3CKR4	T3CKR3	T3CKR2	T3CKR1	T3CKR0
bit 15							bit 8

U-0	U-0	U-0	R/W-1	R/W-1	R/W-1	R/W-1	R/W-1
—	—	—	T2CKR4	T2CKR3	T2CKR2	T2CKR1	T2CKR0
bit 7							bit 0

Legend:			
R = Readable bit	W = Writable bit	U = Unimplemented bit, read as ‘0’	
-n = Value at POR	‘1’ = Bit is set	‘0’ = Bit is cleared	x = Bit is unknown

bit 15-13 **Unimplemented:** Read as ‘0’

bit 12-8 **T3CKR<4:0>:** Assign Timer3 External Clock (T3CK) to the Corresponding RPn Pin bits

11111 = Input tied to Vss
11110 = Reserved
.
.
.
11010 = Reserved
11001 = Input tied to RP25
.
.
.
00001 = Input tied to RP1
00000 = Input tied to RP0

bit 7-5 **Unimplemented:** Read as ‘0’

bit 4-0 **T2CKR<4:0>:** Assign Timer2 External Clock (T2CK) to the Corresponding RPn Pin bits

11111 = Input tied to Vss
11110 = Reserved
.
.
.
11010 = Reserved
11001 = Input tied to RP25
.
.
.
00001 = Input tied to RP1
00000 = Input tied to RP0

REGISTER 12-3: T4CON: TIMER4 CONTROL REGISTER(1)

R/W-0	U-0	R/W-0	U-0	U-0	U-0	U-0	U-0
TON	—	TSIDL	—	—	—	—	—
bit 15							bit 8

U-0	R/W-0	R/W-0	R/W-0	R/W-0	U-0	R/W-0	U-0
—	TGATE	TCKPS1	TCKPS0	T32	—	TCS	—
bit 7							bit 0

Legend:			
R = Readable bit	W = Writable bit	U = Unimplemented bit, read as '0'	
-n = Value at POR	'1' = Bit is set	'0' = Bit is cleared	x = Bit is unknown

bit 15 **TON:** Timer4 On bit
When T32 = 1:
1 = Starts 32-bit Timer4/5
0 = Stops 32-bit Timer4/5
When T32 = 0:
1 = Starts 16-bit Timer4
0 = Stops 16-bit Timer4

bit 14 **Unimplemented:** Read as '0'

bit 13 **TSIDL:** Timer4 Stop in Idle Mode bit
1 = Discontinues module operation when device enters Idle mode
0 = Continues module operation in Idle mode

bit 12-7 **Unimplemented:** Read as '0'

bit 6 **TGATE:** Timer4 Gated Time Accumulation Enable bit
When TCS = 1:
This bit is ignored.
When TCS = 0:
1 = Gated time accumulation is enabled
0 = Gated time accumulation is disabled

bit 5-4 **TCKPS<1:0>:** Timer4 Input Clock Prescale Select bits
11 = 1:256
10 = 1:64
01 = 1:8
00 = 1:1

bit 3 **T32:** 32-Bit Timer Mode Select bit
1 = Timer4 and Timer5 form a single 32-bit timer
0 = Timer4 and Timer5 act as two 16-bit timers

bit 2 **Unimplemented:** Read as '0'

bit 1 **TCS:** Timer4 Clock Source Select bit
1 = External clock from pin, T4CK (on the rising edge)
0 = Internal clock (FCY)

bit 0 **Unimplemented:** Read as '0'

Note 1: This register is available in dsPIC33FJ32(GP/MC)10X devices only.

REGISTER 15-2: PxTMR: PWMx TIMER COUNT VALUE REGISTER

R-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
PTDIR	PTMR<14:8>						
bit 15							bit 8

R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
PTMR<7:0>							
bit 7							bit 0

Legend:			
R = Readable bit	W = Writable bit	U = Unimplemented bit, read as ‘0’	
-n = Value at POR	‘1’ = Bit is set	‘0’ = Bit is cleared	x = Bit is unknown

bit 15 **PTDIR:** PWMx Time Base Count Direction Status bit (read-only)
1 = PWMx time base is counting down
0 = PWMx time base is counting up

bit 14-0 **PTMR <14:0>:** PWMx Time Base Register Count Value bits

REGISTER 15-3: PxTPER: PWMx TIME BASE PERIOD REGISTER

U-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
—	PTPER<14:8>						
bit 15							bit 8

R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
PTPER<7:0>							
bit 7							bit 0

Legend:			
R = Readable bit	W = Writable bit	U = Unimplemented bit, read as ‘0’	
-n = Value at POR	‘1’ = Bit is set	‘0’ = Bit is cleared	x = Bit is unknown

bit 15 **Unimplemented:** Read as ‘0’

bit 14-0 **PTPER<14:0>:** PWMx Time Base Period Value bits

REGISTER 15-5: PWMxCON1: PWMx CONTROL REGISTER 1(1)

U-0	U-0	U-0	U-0	U-0	R/W-0	R/W-0	R/W-0
—	—	—	—	—	PMOD3	PMOD2	PMOD1
bit 15							bit 8

U-0	R/W-0	R/W-0	R/W-0	U-0	R/W-0	R/W-0	R/W-0
—	PEN3H(2)	PEN2H(2)	PEN1H(2)	—	PEN3L(2)	PEN2L(2)	PEN1L(2)
bit 7							bit 0

Legend:			
R = Readable bit	W = Writable bit	U = Unimplemented bit, read as '0'	
-n = Value at POR	'1' = Bit is set	'0' = Bit is cleared	x = Bit is unknown

bit 15-11 **Unimplemented:** Read as '0'

bit 10-8 **PMOD<3:1>:** PWMx I/O Pair Mode bits
1 = PWMx I/O pin pair is in the Independent PWM Output mode
0 = PWMx I/O pin pair is in the Complementary Output mode

bit 7 **Unimplemented:** Read as '0'

bit 6-4 **PEN3H:PEN1H:** PWMxH I/O Enable bits(2)
1 = PWMxH pin is enabled for PWMx output
0 = PWMxH pin is disabled, I/O pin becomes a general purpose I/O

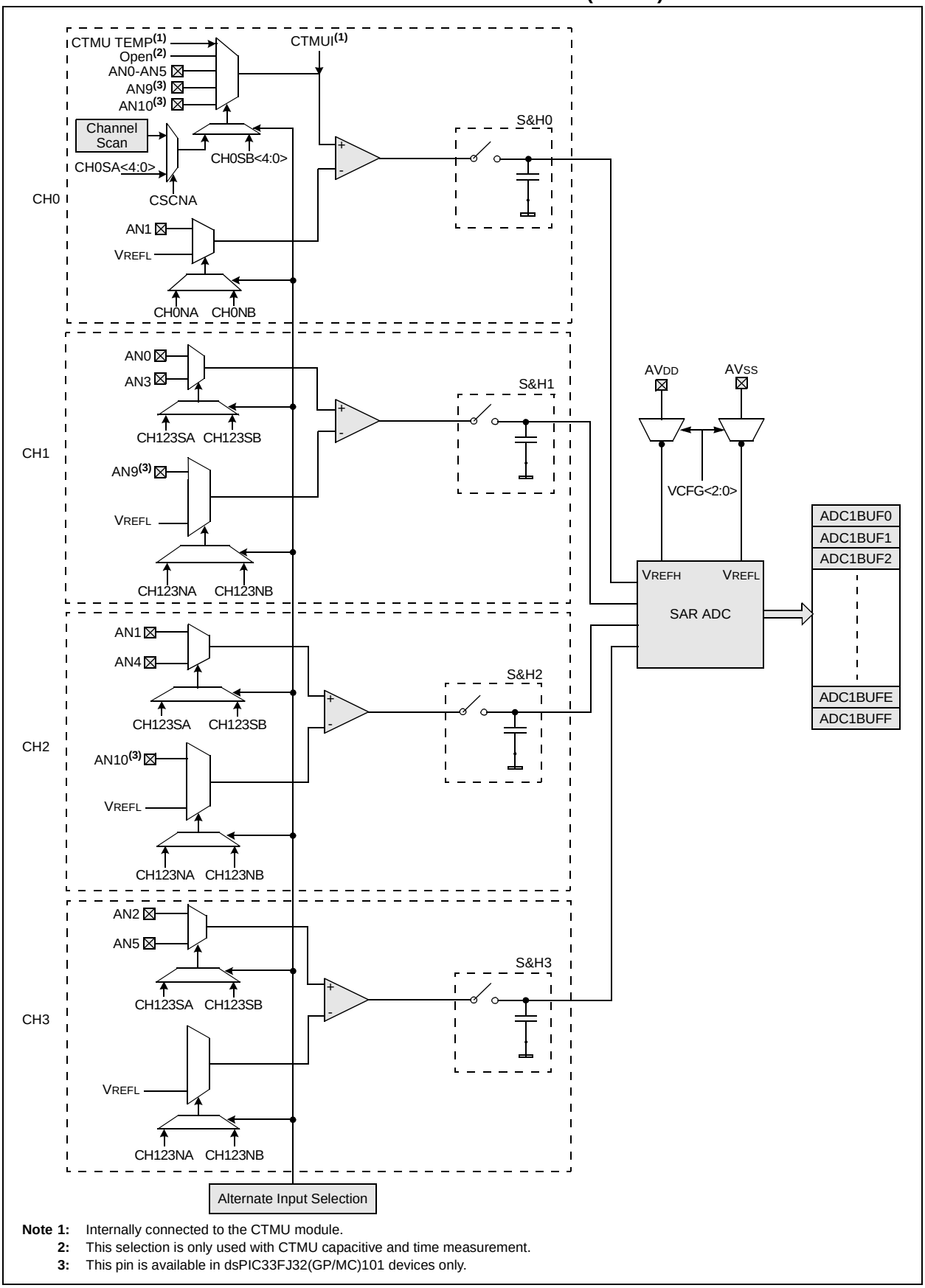
bit 3 **Unimplemented:** Read as '0'

bit 2-0 **PEN3L:PEN1L:** PWMxL I/O Enable bits(2)
1 = PWMxL pin is enabled for PWMx output
0 = PWMxL pin is disabled, I/O pin becomes a general purpose I/O

Note 1: The PWMxCON1 register is a write-protected register. Refer to **Section 15.3 "Write-Protected Registers"** for more information on the unlock sequence.

2: The Reset status for these bits depends on the setting of the PWMPIN Configuration bit (FPOR<7>):
- If PWMPIN = 1 (default), the PWM pins are controlled by the PORT register at Reset, meaning they are initially programmed as inputs (i.e., tri-stated).
- If PWMPIN = 0, the PWM pins are controlled by the PWM module at Reset and are therefore, initially programmed as output pins.

FIGURE 19-2: ADC1 BLOCK DIAGRAM FOR dsPIC33FJXX(GP/MC)102 DEVICES



Note 1: Internally connected to the CTMU module.
2: This selection is only used with CTMU capacitive and time measurement.
3: This pin is available in dsPIC33FJ32(GP/MC)101 devices only.

REGISTER 21-9: ALRMVAL (WHEN ALRMPTR<1:0> = 01): ALARM WEEKDAY AND HOURS VALUE REGISTER(1)

U-0	U-0	U-0	U-0	U-0	R/W-x	R/W-x	R/W-x
—	—	—	—	—	WDAY2	WDAY1	WDAY0
bit 15							bit 8

U-0	U-0	R/W-x	R/W-x	R/W-x	R/W-x	R/W-x	R/W-x
—	—	HRTEN1	HRTEN0	HRONE3	HRONE2	HRONE1	HRONE0
bit 7							bit 0

Legend:			
R = Readable bit	W = Writable bit	U = Unimplemented bit, read as ‘0’	
-n = Value at POR	‘1’ = Bit is set	‘0’ = Bit is cleared	x = Bit is unknown

bit 15-11 **Unimplemented:** Read as ‘0’

bit 10-8 **WDAY<2:0>:** Binary Coded Decimal Value of Weekday Digit bits
Contains a value from 0 to 6.

bit 7-6 **Unimplemented:** Read as ‘0’

bit 5-4 **HRTEN<1:0>:** Binary Coded Decimal Value of Hour’s Tens Digit bits
Contains a value from 0 to 2.

bit 3-0 **HRONE<3:0>:** Binary Coded Decimal Value of Hour’s Ones Digit bits
Contains a value from 0 to 9.

Note 1: A write to this register is only allowed when RTCWREN = 1.

TABLE 26-4: DC TEMPERATURE AND VOLTAGE SPECIFICATIONS

DC CHARACTERISTICS			Standard Operating Conditions: 3.0V to 3.6V (unless otherwise stated) Operating temperature -40°C ≤ TA ≤ +85°C for Industrial -40°C ≤ TA ≤ +125°C for Extended				
Param No.	**Symbol**	**Characteristic**	**Min**	**Typ(1)**	**Max**	**Units**	**Conditions**
Operating Voltage							
DC10	**Supply Voltage(3)**						
	VDD	—	VBOR	—	3.6	V	Industrial and Extended
DC12	VDR	**RAM Data Retention Voltage(2)**	1.8	—	—	V	
DC16	VPOR	**VDD Start Voltage** to Ensure Internal Power-on Reset Signal	—	1.75	VSS	V	
DC17	SVDD	**VDD Rise Rate** to Ensure Internal Power-on Reset Signal	0.024	—	—	V/ms	0-2.4V in 0.1s

Note 1: Data in "Typ" column is at 3.3V, +25°C unless otherwise stated.

2: This is the limit to which VDD may be lowered without losing RAM data.

3: Overall functional device operation at VBOR < VDD < VDDMIN is ensured but not characterized. All device analog modules, such as the ADC, etc., will function but with degraded performance below VDDMIN.

TABLE 26-5: ELECTRICAL CHARACTERISTICS: BROWN-OUT RESET (BOR)

DC CHARACTERISTICS			Standard Operating Conditions: 3.0V to 3.6V (unless otherwise stated) Operating temperature -40°C ≤ TA ≤ +85°C for Industrial -40°C ≤ TA ≤ +125°C for Extended				
Param No.	**Symbol**	**Characteristic**	**Min(1)**	**Typ**	**Max**	**Units**	**Conditions**
BO10	VBOR	BOR Event on VDD Transition High-to-Low	2.40	2.48	2.55	V	See **Note 2**

Note 1: Parameters are for design guidance only and are not tested in manufacturing.

2: Overall functional device operation at VBOR < VDD < VDDMIN is ensured but not characterized. All device analog modules, such as the ADC, etc., will function but with degraded performance below VDDMIN.

TABLE 26-10: DC CHARACTERISTICS: I/O PIN INPUT SPECIFICATIONS

DC CHARACTERISTICS			Standard Operating Conditions: 3.0V to 3.6V (unless otherwise stated) Operating temperature -40°C ≤ TA ≤ +85°C for Industrial -40°C ≤ TA ≤ +125°C for Extended				
Param No.	**Symbol**	**Characteristic**	**Min**	**Typ(1)**	**Max**	**Units**	**Conditions**
	VIL	**Input Low Voltage**					
DI10		I/O Pins	VSS	—	0.2 VDD	V	
DI15		$\overline{\text{MCLR}}$	VSS	—	0.2 VDD	V	
DI18		I/O Pins with SDAx, SCLx	VSS	—	0.3 VDD	V	SMBus disabled
DI19		I/O Pins with SDAx, SCLx	VSS	—	0.8	V	SMBus enabled
	VIH	**Input High Voltage**					
DI20		I/O Pins Not 5V Tolerant(4) I/O Pins 5V Tolerant(4)	0.7 VDD 0.7 VDD	— —	VDD 5.5	V V	
DI28		SDAx, SCLx	0.7 VDD	—	5.5	V	SMBus disabled
DI29		SDAx, SCLx	2.1	—	5.5	V	SMBus enabled
	ICNPU	**CNx Pull-up Current**					
DI30			50	250	450	µA	VDD = 3.3V, VPIN = VSS
	IIL	**Input Leakage Current(2,3)**					
DI50		I/O Pins 5V Tolerant(4)	—	—	±2	µA	VSS ≤ VPIN ≤ VDD, Pin at high-impedance
DI51		I/O Pins Not 5V Tolerant(4)	—	—	±1	µA	VSS ≤ VPIN ≤ VDD, Pin at high-impedance, -40°C ≤ TA ≤ +85°C
DI51a		I/O Pins Not 5V Tolerant(4)	—	—	±2	µA	Shared with external reference pins, -40°C ≤ TA ≤ +85°C
DI51b		I/O Pins Not 5V Tolerant(4)	—	—	±3.5	µA	VSS ≤ VPIN ≤ VDD, Pin at high-impedance, -40°C ≤ TA ≤ +125°C
DI51c		I/O Pins Not 5V Tolerant(4)	—	—	±8	µA	Analog pins shared with external reference pins, -40°C ≤ TA ≤ +125°C
DI55		$\overline{\text{MCLR}}$	—	—	±2	µA	VSS ≤ VPIN ≤ VDD
DI56		OSC1	—	—	±2	µA	VSS ≤ VPIN ≤ VDD, XT and HS modes

Note 1: Data in “Typ” column is at 3.3V, +25°C unless otherwise stated.

2: The leakage current on the $\overline{\text{MCLR}}$ pin is strongly dependent on the applied voltage level. The specified levels represent normal operating conditions. Higher leakage current can be measured at different input voltages.

3: Negative current is defined as current sourced by the pin.

4: See the **“Pin Diagrams”** section for the 5V tolerant I/O pins.

5: VIL source < (VSS – 0.3). Characterized but not tested.

6: Non-5V tolerant pins, VIH source > (VDD + 0.3), 5V tolerant pins, VIH source > 5.5V. Characterized but not tested.

7: Digital 5V tolerant pins cannot tolerate any “positive” input injection current from input sources > 5.5V.

8: Injection currents > | 0 | can affect the ADC results by approximately 4-6 counts.

9: Any number and/or combination of I/O pins, not excluded under IICL or IICH conditions, are permitted provided the mathematical “absolute instantaneous” sum of the input injection currents from all pins do not exceed the specified limit. Characterized but not tested.

TABLE 26-10: DC CHARACTERISTICS: I/O PIN INPUT SPECIFICATIONS (CONTINUED)

DC CHARACTERISTICS			Standard Operating Conditions: 3.0V to 3.6V (unless otherwise stated) Operating temperature -40°C ≤ TA ≤ +85°C for Industrial -40°C ≤ TA ≤ +125°C for Extended				
Param No.	**Symbol**	**Characteristic**	**Min**	**Typ(1)**	**Max**	**Units**	**Conditions**
DI60a	IICL	**Input Low Injection Current**	0	-5(5,8)	—	mA	All pins except VDD, VSS, AVDD, AVSS, MCLR, VCAP, SOSCI, SOSCO and RB14
DI60b	IICH	**Input High Injection Current**	0	—	+5(6,7,8)	mA	All pins except VDD, VSS, AVDD, AVSS, MCLR, VCAP, SOSCI, SOSCO, RB14 and digital 5V tolerant designated pins
DI60c	∑ IICT	**Total Input Injection Current** (sum of all I/O and control pins)	-20(9)	—	+20(9)	mA	Absolute instantaneous sum of all ± input injection currents from all I/O pins (| IICL + | IICH |) ≤ ∑ IICT

Note 1: Data in "Typ" column is at 3.3V, +25°C unless otherwise stated.

2: The leakage current on the MCLR pin is strongly dependent on the applied voltage level. The specified levels represent normal operating conditions. Higher leakage current can be measured at different input voltages.

3: Negative current is defined as current sourced by the pin.

4: See the **"Pin Diagrams"** section for the 5V tolerant I/O pins.

5: VIL source < (VSS – 0.3). Characterized but not tested.

6: Non-5V tolerant pins, VIH source > (VDD + 0.3), 5V tolerant pins, VIH source > 5.5V. Characterized but not tested.

7: Digital 5V tolerant pins cannot tolerate any "positive" input injection current from input sources > 5.5V.

8: Injection currents > | 0 | can affect the ADC results by approximately 4-6 counts.

9: Any number and/or combination of I/O pins, not excluded under IICL or IICH conditions, are permitted provided the mathematical "absolute instantaneous" sum of the input injection currents from all pins do not exceed the specified limit. Characterized but not tested.

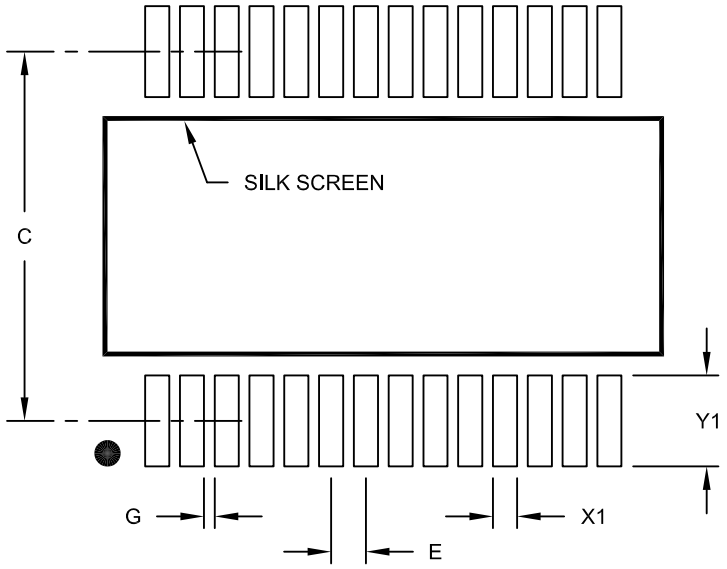
TABLE 26-11: DC CHARACTERISTICS: I/O PIN OUTPUT SPECIFICATIONS

DC CHARACTERISTICS			Standard Operating Conditions: 3.0V to 3.6V (unless otherwise stated) Operating temperature -40°C ≤ TA ≤ +85°C for Industrial -40°C ≤ TA ≤ +125°C for Extended				
Param No.	**Symbol**	**Characteristic**	**Min**	**Typ(1)**	**Max**	**Units**	**Conditions**
DO10	VOL	**Output Low Voltage** I/O Pins: 4x Sink Driver Pins – All Pins excluding OSCO	—	—	0.4	V	IOL ≤ 6 mA, VDD = 3.3V, See **Note 1**
		Output Low Voltage I/O Pins: 8x Sink Driver Pins – OSCO	—	—	0.4	V	IOL ≤ 10 mA, VDD = 3.3V, See **Note 1**
DO20	VOH	**Output High Voltage** I/O Pins: 4x Source Driver Pins – All Pins excluding OSCO	2.4	—	—	V	IOL ≥ -6 mA, VDD = 3.3V, See **Note 1**
		Output High Voltage I/O Pins: 8x Source Driver Pins – OSCO	2.4	—	—	V	IOL ≥ -10 mA, VDD = 3.3V, See **Note 1**
DO20A	VOH1	**Output High Voltage** I/O Pins: 4x Source Driver Pins – All Pins excluding OSCO	1.5	—	—	V	IOH ≥ -12 mA, VDD = 3.3V, See **Note 1**
			2.0	—	—		IOH ≥ -11 mA, VDD = 3.3V, See **Note 1**
			3.0	—	—		IOH ≥ -3 mA, VDD = 3.3V, See **Note 1**
		Output High Voltage I/O Pins: 8x Source Driver Pins – OSCO	1.5	—	—	V	IOH ≥ -16 mA, VDD = 3.3V, See **Note 1**
			2.0	—	—		IOH ≥ -12 mA, VDD = 3.3V, See **Note 1**
			3.0	—	—		IOH ≥ -4 mA, VDD = 3.3V, See **Note 1**

Note 1: Data in “Typ” column is at 3.3V, +25°C unless otherwise stated.

28-Lead Plastic Shrink Small Outline (SS) - 5.30 mm Body [SSOP]

Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



RECOMMENDED LAND PATTERN

Units		MILLIMETERS		
Dimension Limits		MIN	NOM	MAX
Contact Pitch	E	0.65 BSC		
Contact Pad Spacing	C		7.20	
Contact Pad Width (X28)	X1			0.45
Contact Pad Length (X28)	Y1			1.75
Distance Between Pads	G	0.20		

Notes:

1. Dimensioning and tolerancing per ASME Y14.5M

BSC: Basic Dimension. Theoretically exact value shown without tolerances.

Microchip Technology Drawing No. C04-2073A