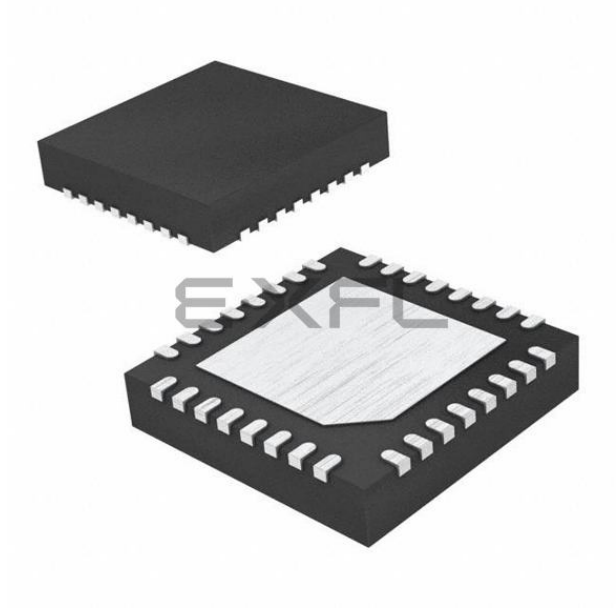
Microchip Technology - DSPIC33FJ06GS202A-E/MM Datasheet



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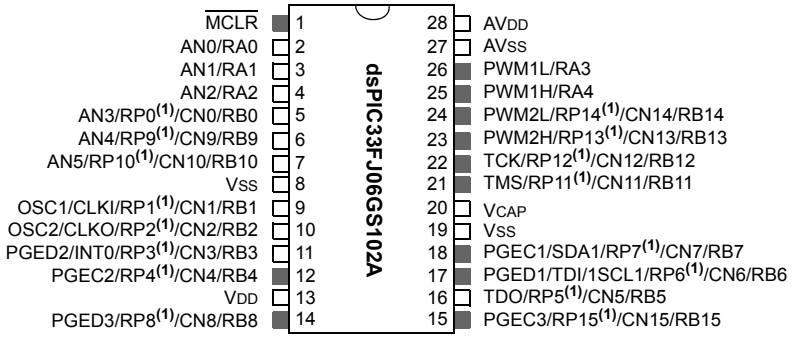
Applications of "Embedded - Microcontrollers"

Details	
Product Status	Active
Core Processor	dsPIC
Core Size	16-Bit
Speed	40 MIPs
Connectivity	I²C, IrDA, LINbus, SPI, UART/USART
Peripherals	Brown-out Detect/Reset, POR, PWM, WDT
Number of I/O	21
Program Memory Size	6KB (2K x 24)
Program Memory Type	FLASH
EEPROM Size	-
RAM Size	1K x 8
Voltage - Supply (Vcc/Vdd)	3V ~ 3.6V
Data Converters	A/D 6x10b; D/A 2x10b
Oscillator Type	Internal
Operating Temperature	-40°C ~ 125°C (TA)
Mounting Type	Surface Mount
Package / Case	28-VQFN Exposed Pad
Supplier Device Package	28-QFN-S (6x6)
Purchase URL	https://www.e-xfl.com/product-detail/microchip-technology/dspic33fj06gs202a-e-mm

Pin Diagrams (Continued)

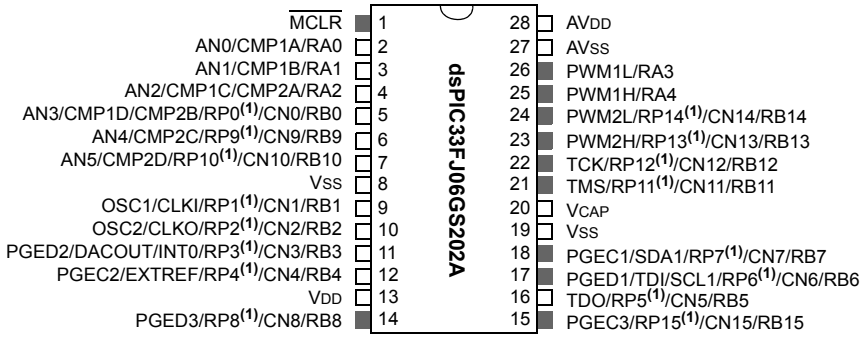
28-Pin SOIC, SPDIP, SSOP

■ = Pins are up to 5V tolerant



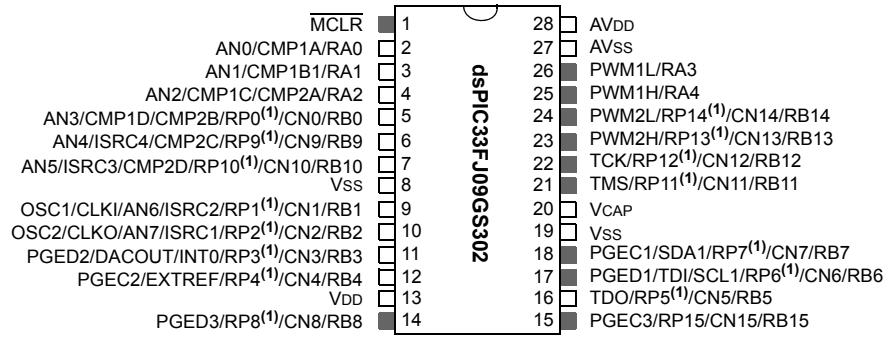
28-Pin SPDIP, SOIC, SSOP

■ = Pins are up to 5V tolerant



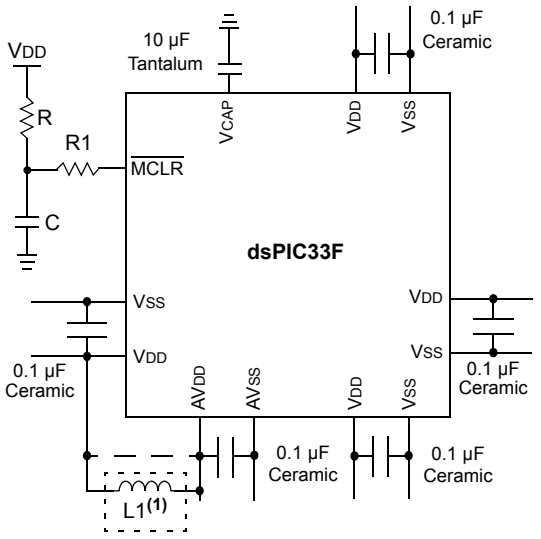
28-Pin SPDIP, SOIC, SSOP

■ = 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.

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:

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

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

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

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 Capacitor on Internal Voltage Regulator (VCAP)

A low-ESR (<0.5 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 25.0 "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 22.2 "On-Chip Voltage Regulator"** for details.

2.4 Master Clear ($\overline{\text{MCLR}}$) Pin

The $\overline{\text{MCLR}}$ pin provides for two specific device functions:

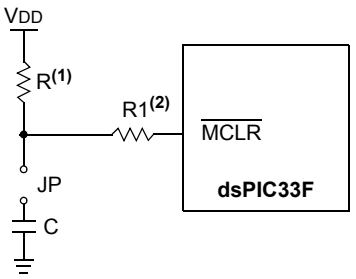
- Device Reset
- Device Programming and Debugging

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 $\overline{\text{MCLR}}$ 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 $\overline{\text{MCLR}}$ pin during programming and debugging operations.

Place the components shown in Figure 2-2 within one-quarter inch (6 mm) from the $\overline{\text{MCLR}}$ pin.

FIGURE 2-2: EXAMPLE OF $\overline{\text{MCLR}}$ PIN CONNECTIONS



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

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

FIGURE 4-3: DATA MEMORY MAP FOR dsPIC33FJ06GS001/101A/102A DEVICES WITH 256 BYTES OF RAM

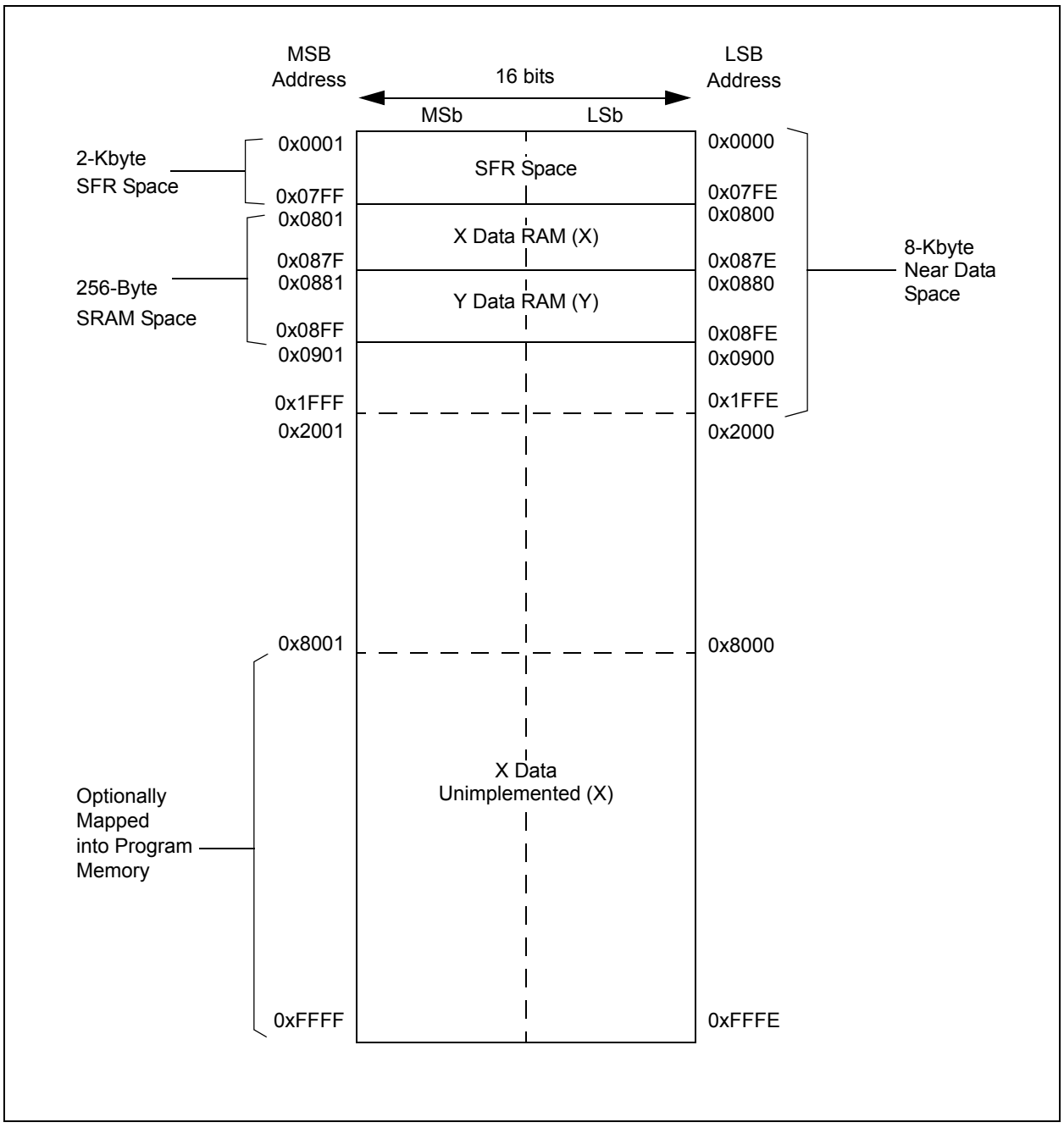


TABLE 4-21: HIGH-SPEED 10-BIT ADC REGISTER MAP FOR dsPIC33FJ06GS102A AND dsPIC33FJ06GS202A

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
ADCON	0300	ADON	—	ADSIDL	SLOWCLK	—	GSWTRG	—	FORM	EIE	ORDER	SEQSAMP	ASYNCSAMP	—	ADCS<2:0>			0003
ADPCFG	0302	—	—	—	—	—	—	—	—	—	—	PCFG5	PCFG4	PCFG3	PCFG2	PCFG1	PCFG0	0000
ADSTAT	0306	—	—	—	—	—	—	—	—	—	P6RDY	—	—	—	P2RDY	P1RDY	P0RDY	0000
ADBASE	0308	ADBASE<15:1>															—	0000
ADCPC0	030A	IRQEN1	PEND1	SWTRG1	TRGSRC1<4:0>					IRQEN0	PEND0	SWTRG0	TRGSRC0<4:0>					0000
ADCPC1	030C	—	—	—	—	—	—	—	—	IRQEN2	PEND2	SWTRG2	TRGSRC2<4:0>					0000
ADCPC3	0310	—	—	—	—	—	—	—	—	IRQEN6	PEND6	SWTRG6	TRGSRC6<4:0>					0000
ADCBUF0	0320	ADC Data Buffer 0																xxxx
ADCBUF1	0322	ADC Data Buffer 1																xxxx
ADCBUF2	0324	ADC Data Buffer 2																xxxx
ADCBUF3	0326	ADC Data Buffer 3																xxxx
ADCBUF4	0328	ADC Data Buffer 4																xxxx
ADCBUF5	032A	ADC Data Buffer 5																xxxx
ADCBUF12	0338	ADC Data Buffer 12																xxxx
ADCBUF13	033A	ADC Data Buffer 13																xxxx

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

4.7.3 READING DATA FROM PROGRAM MEMORY USING PROGRAM SPACE VISIBILITY

The upper 32 Kbytes of data space may optionally be mapped into any 16K word page of the program space. This option provides transparent access to stored constant data from the data space without the need to use special instructions (such as TBLRDL or TBLRDH).

Program space access through the data space occurs if the Most Significant bit of the data space EA is '1' and program space visibility is enabled by setting the PSV bit in the Core Control register (CORCON<2>). The location of the program memory space to be mapped into the data space is determined by the Program Space Visibility Page register (PSVPAG). This 8-bit register defines any one of 256 possible pages of 16K words in program space. In effect, PSVPAG functions as the upper 8 bits of the program memory address, with the 15 bits of the EA functioning as the lower bits. By incrementing the PC by 2 for each program memory word, the lower 15 bits of data space addresses directly map to the lower 15 bits in the corresponding program space addresses.

Data reads to this area add a cycle to the instruction being executed, since two program memory fetches are required.

Although each data space address 0x8000 and higher maps directly into a corresponding program memory address (see Figure 4-10), only the lower 16 bits of the 24-bit program word are used to contain the data. The upper 8 bits of any program space location used as data should be programmed with '1111 1111' or '0000 0000' to force a NOP. This prevents possible issues should the area of code ever be accidentally executed.

Note:	PSV access is temporarily disabled during table reads/writes.

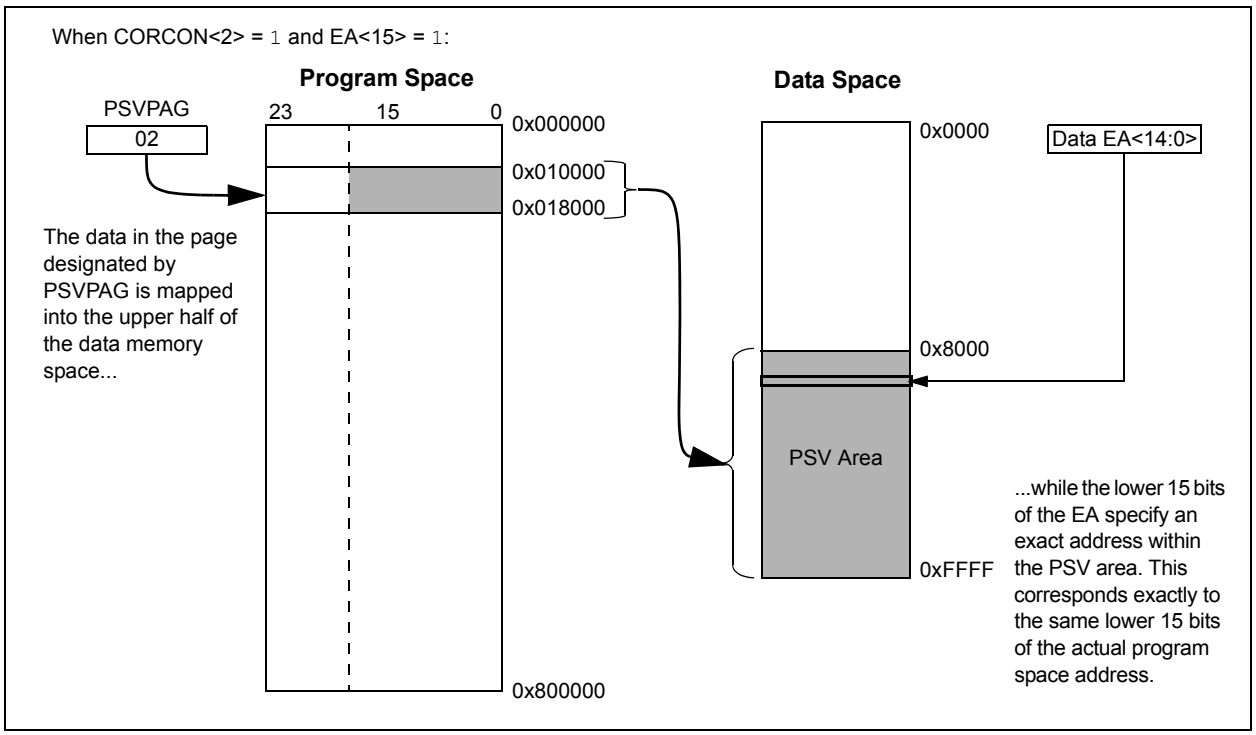
For operations that use PSV and are executed outside a REPEAT loop, the MOV and MOV.D instructions require one instruction cycle in addition to the specified execution time. All other instructions require two instruction cycles in addition to the specified execution time.

For operations that use PSV, and are executed inside a REPEAT loop, these instances require two instruction cycles in addition to the specified execution time of the instruction:

- Execution in the first iteration
- Execution in the last iteration
- Execution prior to exiting the loop due to an interrupt
- Execution upon re-entering the loop after an interrupt is serviced

Any other iteration of the REPEAT loop will allow the instruction using PSV to access data, to execute in a single cycle.

FIGURE 4-10: PROGRAM SPACE VISIBILITY OPERATION



REGISTER 7-20: IPC1: INTERRUPT PRIORITY CONTROL REGISTER 1

U-0	R/W-1	R/W-0	R/W-0	U-0	U-0	U-0	U-0
—	T2IP<2:0>			—	—	—	—
bit 15							bit 8

U-0	U-0	U-0	U-0	U-0	U-0	U-0	U-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 14-12 **T2IP<2:0>:** Timer2 Interrupt Priority bits
111 = Interrupt is Priority 7 (highest priority interrupt)
•
•
•
001 = Interrupt is Priority 1
000 = Interrupt source is disabled

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

REGISTER 8-1: OSCCON: OSCILLATOR CONTROL REGISTER(1,3) (CONTINUED)

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

bit 3 **CF:** Clock Fail Detect bit (read/clear by application)
1 = FSCM has detected clock failure
0 = FSCM has not detected clock failure

bit 2-1 **Unimplemented:** Read as '0'

bit 0 **OSWEN:** Oscillator Switch Enable bit
1 = Request oscillator switch to selection specified by NOSC<2:0> bits
0 = Oscillator switch is complete

Note 1: Writes to this register require an unlock sequence. Refer to **Section 42. "Oscillator (Part IV)"** (DS70307) in the *"dsPIC33F/PIC24H Family Reference Manual"* for details.

2: Direct clock switches between any Primary Oscillator mode with PLL and FRCPLL mode are not permitted. This applies to clock switches in either direction. In these instances, the application must switch to FRC mode as a transition clock source between the two PLL modes.

3: This register is reset only on a Power-on Reset (POR).

NOTES:

REGISTER 10-20: RPOR4: PERIPHERAL PIN SELECT OUTPUT REGISTER 4

U-0	U-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
—	—	RP9R<5:0>(1)					
bit 15							bit 8

U-0	U-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
—	—	RP8R<5:0>(1)					
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 15-14 **Unimplemented:** Read as '0'

bit 13-8 **RP9R<5:0>:** Peripheral Output Function is Assigned to RP9 Output Pin bits(1)
(see Table 10-2 for peripheral function numbers)

bit 7-6 **Unimplemented:** Read as '0'

bit 5-0 **RP8R<5:0>:** Peripheral Output Function is Assigned to RP8 Output Pin bits(1)
(see Table 10-2 for peripheral function numbers)

Note 1: These bits are not implemented in dsPIC33FJ06GS001/101A devices.

REGISTER 10-21: RPOR5: PERIPHERAL PIN SELECT OUTPUT REGISTER 5

U-0	U-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
—	—	RP11R<5:0>(1)					
bit 15							bit 8

U-0	U-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
—	—	RP10R<5:0>(1)					
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 15-14 **Unimplemented:** Read as '0'

bit 13-8 **RP11R<5:0>:** Peripheral Output Function is Assigned to RP11 Output Pin bits(1)
(see Table 10-2 for peripheral function numbers)

bit 7-6 **Unimplemented:** Read as '0'

bit 5-0 **RP10R<5:0>:** Peripheral Output Function is Assigned to RP10 Output Pin bits(1)
(see Table 10-2 for peripheral function numbers)

Note 1: These bits are not implemented in dsPIC33FJ06GS001/101A devices.

REGISTER 10-22: RPOR6: PERIPHERAL PIN SELECT OUTPUT REGISTER 6

U-0	U-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
—	—	RP13R<5:0>(1)					
bit 15							bit 8

U-0	U-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
—	—	RP12R<5:0>(1)					
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 15-14 **Unimplemented:** Read as '0'

bit 13-8 **RP13R<5:0>:** Peripheral Output Function is Assigned to RP13 Output Pin bits(1)
(see Table 10-2 for peripheral function numbers)

bit 7-6 **Unimplemented:** Read as '0'

bit 5-0 **RP12R<5:0>:** Peripheral Output Function is Assigned to RP12 Output Pin bits(1)
(see Table 10-2 for peripheral function numbers)

Note 1: These bits are not implemented in dsPIC33FJ06GS001/101A devices.

REGISTER 10-23: RPOR7: PERIPHERAL PIN SELECT OUTPUT REGISTER 7

U-0	U-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
—	—	RP15R<5:0>(1)					
bit 15							bit 8

U-0	U-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
—	—	RP14R<5:0>(1)					
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 15-14 **Unimplemented:** Read as '0'

bit 13-8 **RP15R<5:0>:** Peripheral Output Function is Assigned to RP15 Output Pin bits(1)
(see Table 10-2 for peripheral function numbers)

bit 7-6 **Unimplemented:** Read as '0'

bit 5-0 **RP14R<5:0>:** Peripheral Output Function is Assigned to RP14 Output Pin bits(1)
(see Table 10-2 for peripheral function numbers)

Note 1: These bits are not implemented in dsPIC33FJ06GS001/101A devices.

14.0 OUTPUT COMPARE

Note 1: This data sheet summarizes the features of the dsPIC33FJ06GS001/101A/102A/202A and dsPIC33FJ09GS302 families of devices. It is not intended to be a comprehensive reference source. To complement the information in this data sheet, refer to **Section 13. "Output Compare"** (DS70209) in the *"dsPIC33F/PIC24H Family Reference Manual"*, which is available on the Microchip web site (www.microchip.com).

2: Some registers and associated bits described in this section may not be available on all devices. Refer to **Section 4.0 "Memory Organization"** in this data sheet for device-specific register and bit information.

The output compare module can select either Timer1 or Timer2 for its time base. The module compares the value of the timer with the value of one or two Compare registers, depending on the operating mode selected. The state of the output pin changes when the timer value matches the Output Compare register value. The output compare module generates either a single output pulse, or a sequence of output pulses, by changing the state of the output pin on the compare match events. The output compare module can also generate interrupts on compare match events.

The output compare module has multiple operating modes:

- Active-Low One-Shot mode
- Active-High One-Shot mode
- Toggle mode
- Delayed One-Shot mode
- Continuous Pulse mode
- PWM mode without Fault Protection
- PWM mode with Fault Protection

Note: The output compare module is not implemented in the dsPIC33FJ06GS001 device.

If a Fault condition is detected on the OCFA pin, the output pin(s) of the output compare module are placed in tri-state. The user may elect to use a pull-down or pull-up resistor on the PWM pin to provide for a desired state if a Fault condition occurs.

FIGURE 14-1: OUTPUT COMPARE MODULE BLOCK DIAGRAM

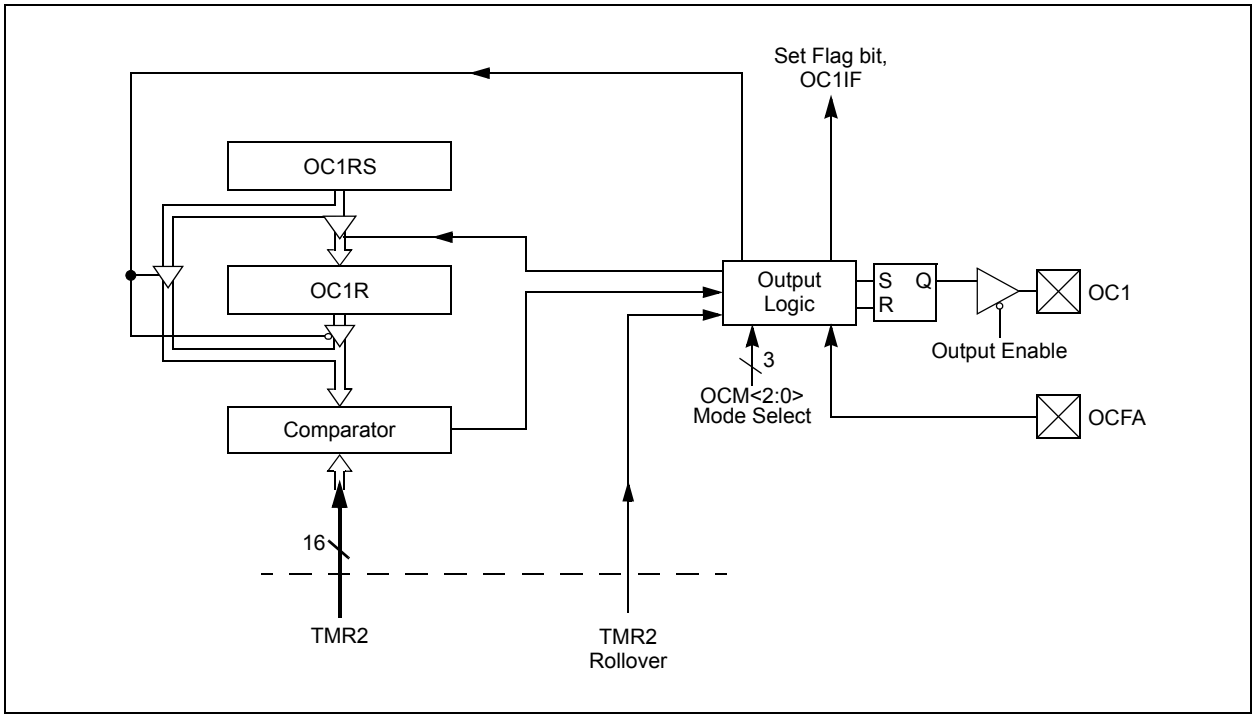
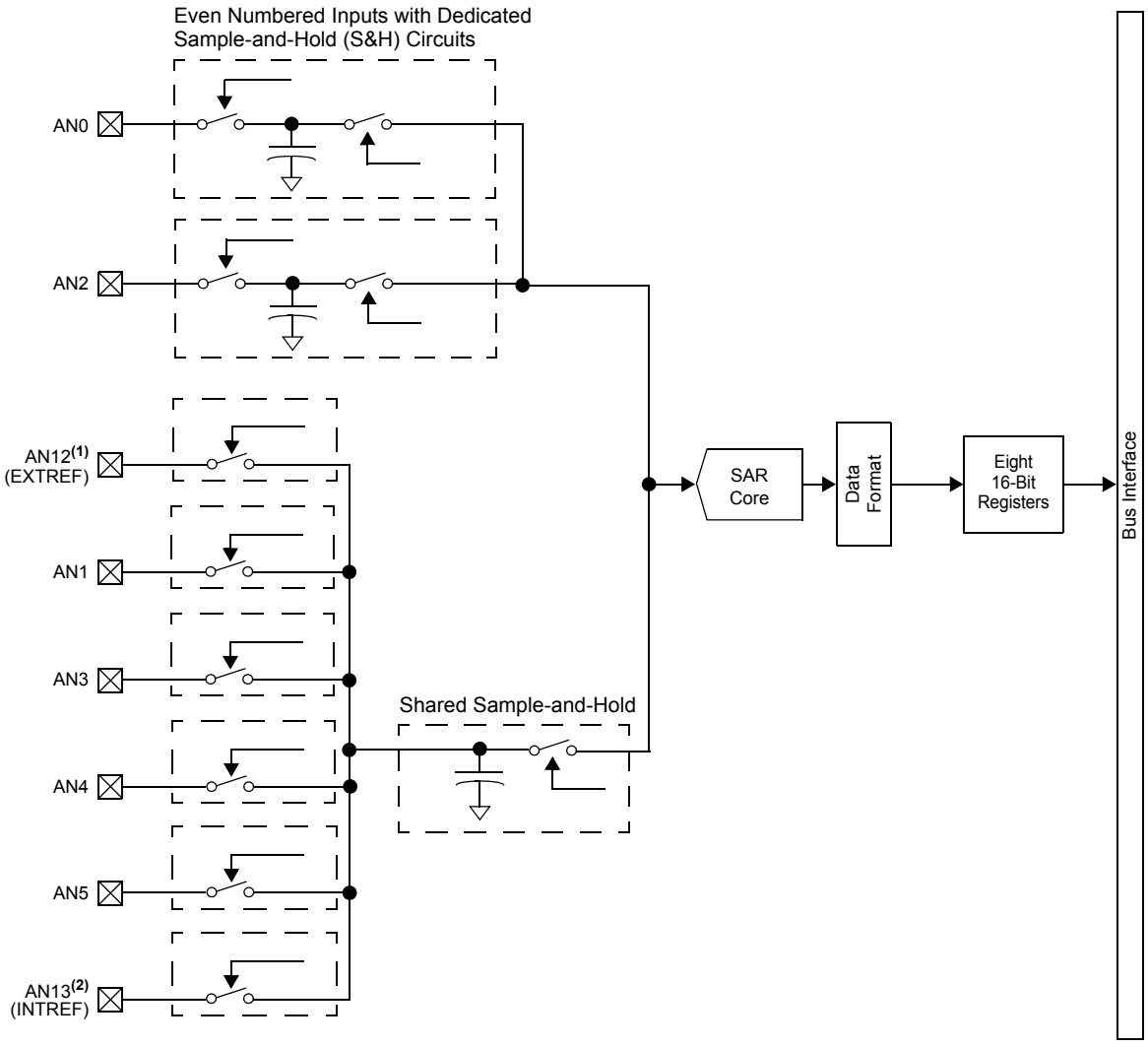


FIGURE 19-4: ADC BLOCK DIAGRAM FOR dsPIC33FJ06GS202A DEVICE



Note 1: To measure the voltage at AN12 (EXTREF), an analog comparator must be enabled and EXTREF must be selected as the comparator reference.

2: AN13 (INTREF) is an internal analog input and is not available on a pin.

REGISTER 19-4: ADPCFG: ADC PORT CONFIGURATION REGISTER

U-0	U-0	U-0	U-0	U-0	U-0	U-0	U-0
—	—	—	—	—	—	—	—
bit 15							bit 8

R/W-0	R/W-0	U-0	U-0	R/W-0	R/W-0	R/W-0	R/W-0
PCFG7(1)	PCFG6(1)	—	—	PCFG3	PCFG2	PCFG1	PCFG0
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 15-8 **Unimplemented:** Read as '0'

bit 7-6 **PCFG<7:6>:** Analog-to-Digital Port Configuration Control bits(1)

1 = Port pin is in Digital mode; port read input is enabled; Analog-to-Digital input multiplexer is connected to AVSS

0 = Port pin is in Analog mode; port read input is disabled; Analog-to-Digital samples pin voltage

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

bit 3-0 **PCFG<3:0>:** Analog-to-Digital Port Configuration Control bits

1 = Port pin is in Digital mode; port read input is enabled; Analog-to-Digital input multiplexer is connected to AVSS

0 = Port pin is in Analog mode; port read input is disabled; Analog-to-Digital samples pin voltage

Note 1: This bit is not implemented in dsPIC33FJ06GS102A/202A devices.

2: This bit is not implemented in dsPIC33FJ06GS001/101A devices.

REGISTER 19-6: ADCPC1: ADC CONVERT PAIR CONTROL REGISTER 1

R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
IRQEN3(1)	PEND3(1)	SWTRG3(1)	TRGSRC3<4:0>(1)				
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
IRQEN2(2)	PEND2(2)	SWTRG2(2)	TRGSRC2<4:0>(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 **IRQEN3:** Interrupt Request Enable 3 bit(1)
1 = Enables IRQ generation when requested conversion of channels AN7 and AN6 is completed
0 = IRQ is not generated

bit 14 **PEND3:** Pending Conversion Status 3 bit(1)
1 = Conversion of channels AN7 and AN6 is pending; set when selected trigger is asserted
0 = Conversion is complete

bit 13 **SWTRG3:** Software Trigger 3 bit(1)
1 = Starts conversion of AN7 and AN6 (if selected by the TRGSRCx bits)(3)
This bit is automatically cleared by hardware when the PEND3 bit is set.
0 = Conversion has not started

bit 12-8 **TRGSRC3<4:0>:** Trigger 3 Source Selection bits(1)
Selects trigger source for conversion of analog channels AN7 and AN6.
11111 = Timer2 period match
•
•
•
11011 = Reserved
11010 = PWM Generator 4 current-limit ADC trigger
11001 = Reserved
11000 = PWM Generator 2 current-limit ADC trigger
10111 = PWM Generator 1 current-limit ADC trigger
10110 = Reserved
•
•
•
10010 = Reserved
10001 = PWM Generator 4 secondary trigger is selected
10000 = Reserved
01111 = PWM Generator 2 secondary trigger is selected
01110 = PWM Generator 1 secondary trigger is selected
01101 = Reserved
01100 = Timer1 period match
•
•
•
01000 = Reserved
00111 = PWM Generator 4 primary trigger is selected
00110 = Reserved
00101 = PWM Generator 2 primary trigger is selected
00100 = PWM Generator 1 primary trigger is selected
00011 = PWM Special Event Trigger is selected
00010 = Global software trigger is selected
00001 = Individual software trigger is selected
00000 = No conversion is enabled

Note 1: This bit is available in dsPIC33FJ06GS001/101A and dsPIC33FJ09GS302 devices only.
2: This bit is available in dsPIC33FJ06GS102A/201A and dsPIC33FJ09GS302 devices only.
3: The trigger source must be set as a global software trigger prior to setting this bit to '1'. If other conversions are in progress, conversion will be performed when the conversion resources are available.

22.2 On-Chip Voltage Regulator

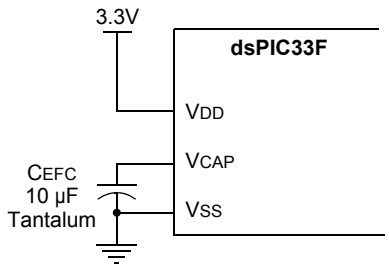
The devices power their core digital logic at a nominal 2.5V. This can create a conflict for designs that are required to operate at a higher typical voltage, such as 3.3V. To simplify system design, all devices incorporate an on-chip regulator that allows the device to run its core logic from VDD.

The regulator provides power to the core from the other VDD pins. When the regulator is enabled, a low-ESR (less than 5 ohms) capacitor (such as tantalum or ceramic) must be connected to the VCAP pin (Figure 22-1). This helps to maintain the stability of the regulator. The recommended value for the filter capacitor is provided in Table 25-13, located in **Section 25.1 "DC Characteristics"**.

Note:	It is important for the low-ESR capacitor to be placed as close as possible to the VCAP pin.

On a POR, it takes approximately 20 μs for the on-chip voltage regulator to generate an output voltage. During this time, designated as TSTARTUP, code execution is disabled. TSTARTUP is applied every time the device resumes operation after any power-down.

FIGURE 22-1: CONNECTIONS FOR THE ON-CHIP VOLTAGE REGULATOR(1,2,3)



Note 1: These are typical operating voltages. Refer to Table 25-13 located in **Section 25.1 "DC Characteristics"** for the full operating ranges of VDD.

2: It is important for the low-ESR capacitor to be placed as close as possible to the VCAP pin.

3: Typical VCAP pin voltage = 2.5V when VDD ≥ VDDMIN.

22.3 Brown-out Reset (BOR)

The Brown-out Reset (BOR) module is based on an internal voltage reference circuit. The main purpose of the BOR module is to generate a device Reset when a brown-out condition occurs. Brown-out conditions are generally caused by glitches on the AC mains (for example, missing portions of the AC cycle waveform due to bad power transmission lines or voltage sags due to excessive current draw when a large inductive load is turned on).

A BOR generates a Reset pulse which resets the device. The BOR selects the clock source, based on the device Configuration bit values (FNOSC<2:0> and POSCMD<1:0>).

If an oscillator mode is selected, the BOR activates the Oscillator Start-up Timer (OST). The system clock is held until the OST expires. If the PLL is used, the clock is held until the LOCK bit (OSCCON<5>) is '1'.

Concurrently, the PWRT time-out (TPWRT) is applied before the internal Reset is released. If TPWRT = 0 and a crystal oscillator is being used, then a nominal delay of, TFSCM = 100, is applied. The total delay in this case is TFSCM.

The BOR status bit (RCON<1>) is set to indicate that a BOR has occurred. The BOR circuit continues to operate while in Sleep or Idle modes and resets the device should VDD fall below the BOR threshold voltage.

24.0 DEVELOPMENT SUPPORT

The PIC® microcontrollers and dsPIC® digital signal controllers are supported with a full range of software and hardware development tools:

- Integrated Development Environment
  - MPLAB® IDE Software
- Compilers/Assemblers/Linkers
  - MPLAB C Compiler for Various Device Families
  - HI-TECH C® for Various Device Families
  - MPASM™ Assembler
  - MPLINK™ Object Linker/ MPLIB™ Object Librarian
  - MPLAB Assembler/Linker/Librarian for Various Device Families
- Simulators
  - MPLAB SIM Software Simulator
- Emulators
  - MPLAB REAL ICE™ In-Circuit Emulator
- In-Circuit Debuggers
  - MPLAB ICD 3
  - PICkit™ 3 Debug Express
- Device Programmers
  - PICkit™ 2 Programmer
  - MPLAB PM3 Device Programmer
- Low-Cost Demonstration/Development Boards, Evaluation Kits, and Starter Kits

24.1 MPLAB Integrated Development Environment Software

The MPLAB IDE software brings an ease of software development previously unseen in the 8/16/32-bit microcontroller market. The MPLAB IDE is a Windows® operating system-based application that contains:

- A single graphical interface to all debugging tools
  - Simulator
  - Programmer (sold separately)
  - In-Circuit Emulator (sold separately)
  - In-Circuit Debugger (sold separately)
- A full-featured editor with color-coded context
- A multiple project manager
- Customizable data windows with direct edit of contents
- High-level source code debugging
- Mouse over variable inspection
- Drag and drop variables from source to watch windows
- Extensive on-line help
- Integration of select third party tools, such as IAR C Compilers

The MPLAB IDE allows you to:

- Edit your source files (either C or assembly)
- One-touch compile or assemble, and download to emulator and simulator tools (automatically updates all project information)
- Debug using:
  - Source files (C or assembly)
  - Mixed C and assembly
  - Machine code

MPLAB IDE supports multiple debugging tools in a single development paradigm, from the cost-effective simulators, through low-cost in-circuit debuggers, to full-featured emulators. This eliminates the learning curve when upgrading to tools with increased flexibility and power.

24.11 PICkit 2 Development Programmer/Debugger and PICkit 2 Debug Express

The PICkit™ 2 Development Programmer/Debugger is a low-cost development tool with an easy to use interface for programming and debugging Microchip's Flash families of microcontrollers. The full featured Windows® programming interface supports baseline (PIC10F, PIC12F5xx, PIC16F5xx), midrange (PIC12F6xx, PIC16F), PIC18F, PIC24, dsPIC30, dsPIC33, and PIC32 families of 8-bit, 16-bit, and 32-bit microcontrollers, and many Microchip Serial EEPROM products. With Microchip's powerful MPLAB Integrated Development Environment (IDE) the PICkit™ 2 enables in-circuit debugging on most PIC® microcontrollers. In-Circuit-Debugging runs, halts and single steps the program while the PIC microcontroller is embedded in the application. When halted at a breakpoint, the file registers can be examined and modified.

The PICkit 2 Debug Express include the PICkit 2, demo board and microcontroller, hookup cables and CDROM with user's guide, lessons, tutorial, compiler and MPLAB IDE software.

24.12 MPLAB PM3 Device Programmer

The MPLAB PM3 Device Programmer is a universal, CE compliant device programmer with programmable voltage verification at VDDMIN and VDDMAX for maximum reliability. It features a large LCD display (128 x 64) for menus and error messages and a modular, detachable socket assembly to support various package types. The ICSP™ cable assembly is included as a standard item. In Stand-Alone mode, the MPLAB PM3 Device Programmer can read, verify and program PIC devices without a PC connection. It can also set code protection in this mode. The MPLAB PM3 connects to the host PC via an RS-232 or USB cable. The MPLAB PM3 has high-speed communications and optimized algorithms for quick programming of large memory devices and incorporates an MMC card for file storage and data applications.

24.13 Demonstration/Development Boards, Evaluation Kits, and Starter Kits

A wide variety of demonstration, development and evaluation boards for various PIC MCUs and dsPIC DSCs allows quick application development on fully functional systems. Most boards include prototyping areas for adding custom circuitry and provide application firmware and source code for examination and modification.

The boards support a variety of features, including LEDs, temperature sensors, switches, speakers, RS-232 interfaces, LCD displays, potentiometers and additional EEPROM memory.

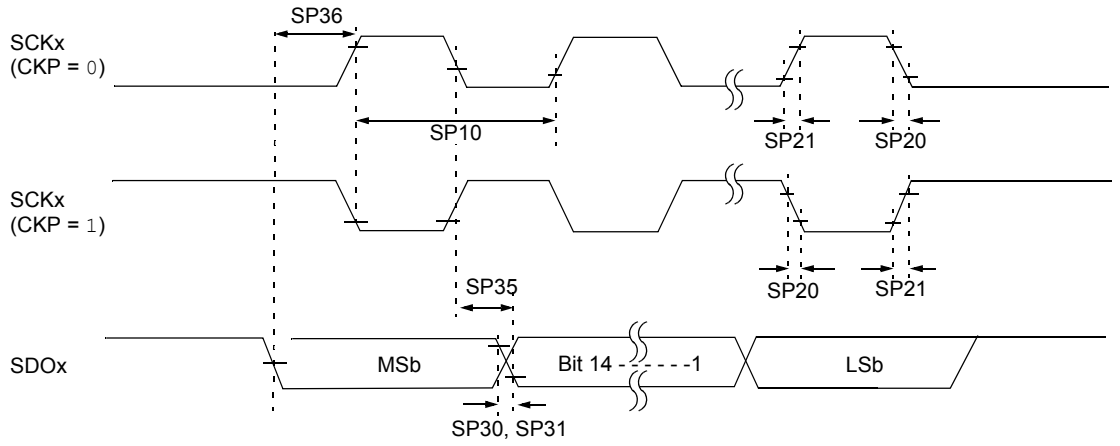
The demonstration and development boards can be used in teaching environments, for prototyping custom circuits and for learning about various microcontroller applications.

In addition to the PICDEM™ and dsPICDEM™ demonstration/development board series of circuits, Microchip has a line of evaluation kits and demonstration software for analog filter design, KEELOQ® security ICs, CAN, IrDA®, PowerSmart battery management, SEEVAL® evaluation system, Sigma-Delta ADC, flow rate sensing, plus many more.

Also available are starter kits that contain everything needed to experience the specified device. This usually includes a single application and debug capability, all on one board.

Check the Microchip web page (www.microchip.com) for the complete list of demonstration, development and evaluation kits.

FIGURE 25-12: SPIx MASTER MODE (HALF-DUPLEX, TRANSMIT ONLY, CKE = 1) TIMING CHARACTERISTICS



Note: Refer to Figure 25-1 for load conditions.

TABLE 25-30: SPIx MASTER MODE (HALF-DUPLEX, TRANSMIT ONLY) TIMING REQUIREMENTS

AC 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(1)**	**Min**	**Typ(2)**	**Max**	**Units**	**Conditions**
SP10	TscP	Maximum SCKx Frequency	—	—	15	MHz	See **Note 3**
SP20	TscF	SCKx Output Fall Time	—	—	—	ns	See Parameter DO32 and **Note 4**
SP21	TscR	SCKx Output Rise Time	—	—	—	ns	See Parameter DO31 and **Note 4**
SP30	TdoF	SDOx Data Output Fall Time	—	—	—	ns	See Parameter DO32 and **Note 4**
SP31	TdoR	SDOx Data Output Rise Time	—	—	—	ns	See Parameter DO31 and **Note 4**
SP35	TscH2doV, TscL2doV	SDOx Data Output Valid after SCKx Edge	—	6	20	ns	
SP36	TdiV2scH, TdiV2scL	SDOx Data Output Setup to First SCKx Edge	30	—	—	ns	

Note 1: These parameters are characterized, but are not tested in manufacturing.

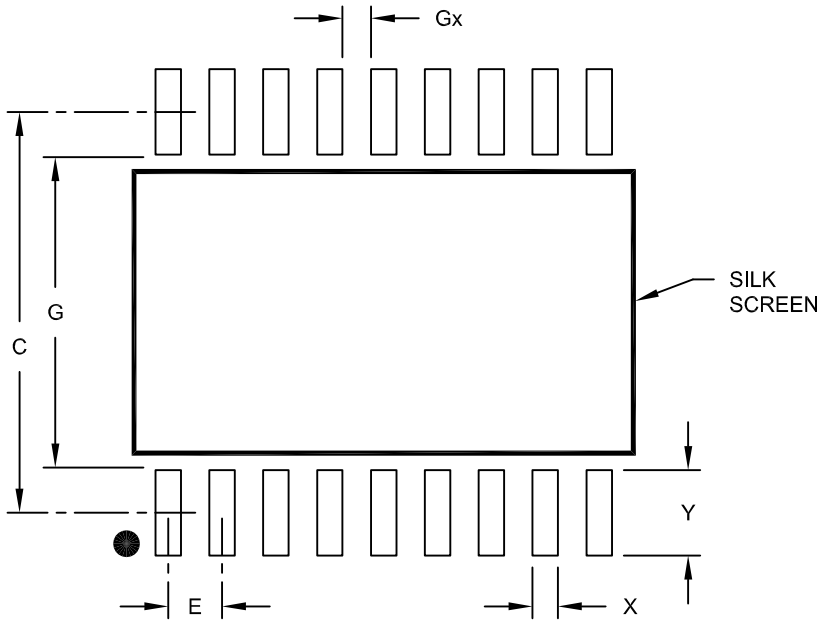
2: Data in "Typ" column is at 3.3V, 25°C unless otherwise stated.

3: The minimum clock period for SCKx is 66.7 ns. Therefore, the clock generated in master mode must not violate this specification.

4: Assumes 50 pF load on all SPIx pins.

18-Lead Plastic Small Outline (SO) - Wide, 7.50 mm Body [SOIC]

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		1.27 BSC	
Contact Pad Spacing	C		9.40	
Contact Pad Width	X			0.60
Contact Pad Length	Y			2.00
Distance Between Pads	Gx	0.67		
Distance Between Pads	G	7.40		

Notes:

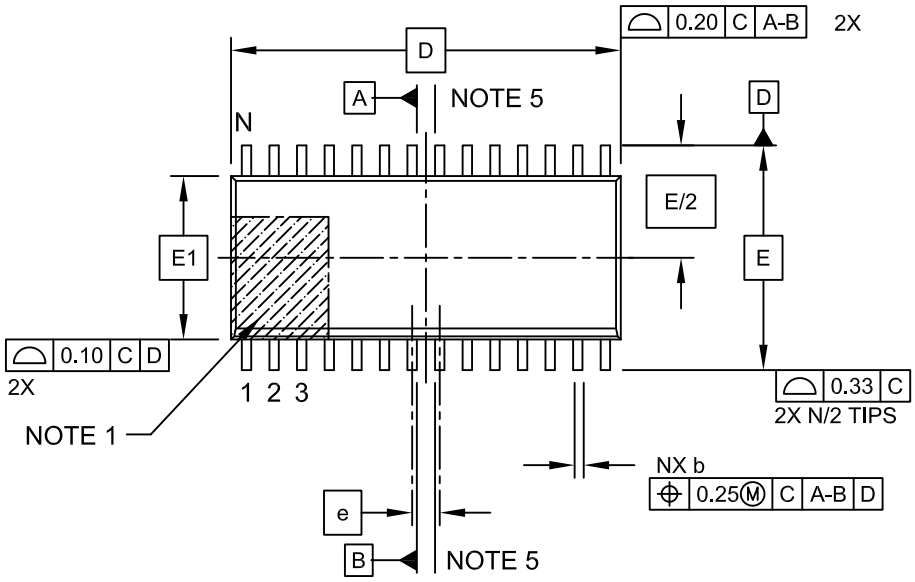
1. Dimensioning and tolerancing per ASME Y14.5M

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

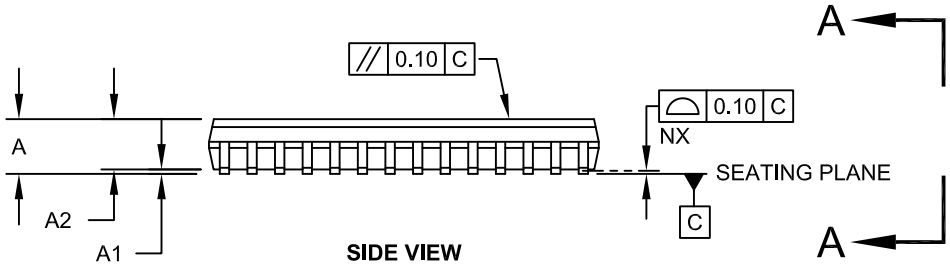
Microchip Technology Drawing No. C04-2051A

28-Lead Plastic Small Outline (SO) - Wide, 7.50 mm Body [SOIC]

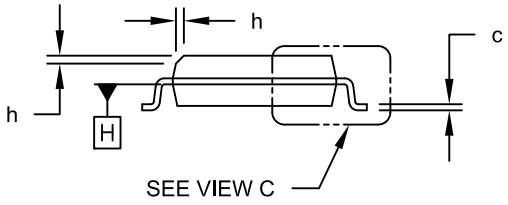
Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



TOP VIEW



SIDE VIEW



VIEW A-A

Microchip Technology Drawing C04-052C Sheet 1 of 2