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PIC18F2221/2321/4221/4321 Family Data Sheet

Enhanced Flash Microcontrollers with 10-Bit A/D and nanoWatt Technology

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28/40/44-Pin Enhanced Flash Microcontrollers with 10-Bit A/D and nanoWatt Technology

Power-Managed Modes:

- Run: CPU On, Peripherals On
- Idle: CPU Off, Peripherals On
- Sleep: CPU Off, Peripherals Off
- Idle mode Currents Down to 2.5 μA Typical
- Sleep mode Currents Down to 500 nA Typical
- Timer1 Oscillator: 1.8 μA, 32 kHz, 2V Typical
- Watchdog Timer: 1.6 μA, 2V Typical
- Two-Speed Oscillator Start-up

Flexible Oscillator Structure:

- Four Crystal modes, up to 40 MHz
- 4x Phase Lock Loop (PLL) – Available for Crystal and Internal Oscillators
- Two External RC modes, up to 4 MHz
- Two External Clock modes, up to 40 MHz
- Internal Oscillator Block:
  - 8 user-selectable frequencies, from 31 kHz to 8 MHz
  - Provides a complete range of clock speeds from 31 kHz to 32 MHz when used with PLL
  - User-tunable to compensate for frequency drift
- Secondary Oscillator using Timer1 @ 32 kHz
- Fail-Safe Clock Monitor
  - Allows for safe shutdown if peripheral clock stops

Peripheral Highlights:

- High-Current Sink/Source 25 mA/25 mA
- Three Programmable External Interrupts
- Four Input Change Interrupts
- Up to 2 Capture/Compare/PWM (CCP) modules, one with Auto-Shutdown (28-pin devices)
- Enhanced Capture/Compare/PWM (ECCP) module (40/44-pin devices only):
  - One, two or four PWM outputs
  - Selectable polarity
  - Programmable dead time
  - Auto-shutdown and auto-restart

Peripheral Highlights (Continued):

- Master Synchronous Serial Port (MSSP) module Supporting 3-Wire SPI (all 4 modes) and I^2C™ Master and Slave modes
- Enhanced Addressable USART module:
  - Supports RS-485, RS-232 and LIN/J2602
  - Auto-wake-up on Start bit
  - Auto-Baud Detect
- 10-Bit, up to 13-Channel Analog-to-Digital Converter module (A/D):
  - Auto-acquisition capability
  - Conversion available during Sleep
- Dual Analog Comparators with Input Multiplexing
- Programmable 16-Level High/Low-Voltage Detection (HLVD) module:
  - Supports interrupt on High/Low-Voltage Detection

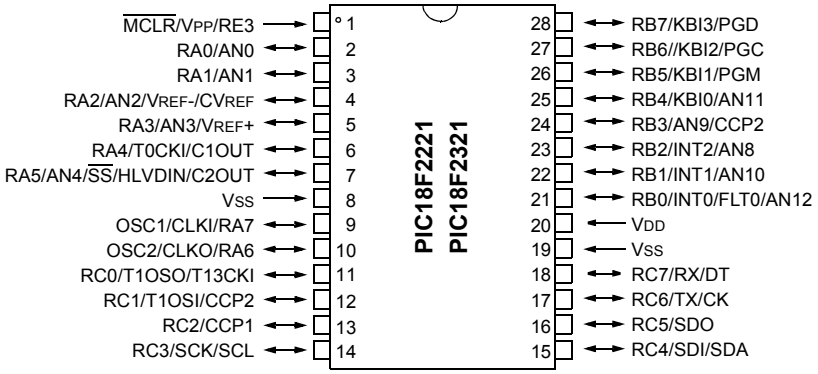
Special Microcontroller Features:

- C Compiler Optimized Architecture:
  - Optional extended instruction set designed to optimize re-entrant code
- 100,000 Erase/Write Cycle Enhanced Flash Program Memory Typical
- 1,000,000 Erase/Write Cycle Data EEPROM Memory Typical
- Flash/Data EEPROM Retention: 100 Years Typical
- Self-Programmable under Software Control
- Priority Levels for Interrupts
- 8 x 8 Single-Cycle Hardware Multiplier
- Extended Watchdog Timer (WDT):
  - Programmable period from 4 ms to 131s
- Single-Supply 5V In-Circuit Serial Programming™ (ICSP™) via Two Pins
- In-Circuit Debug (ICD) via Two Pins
- Wide Operating Voltage Range: 2.0V to 5.5V
- Programmable Brown-out Reset (BOR) with Software Enable Option)

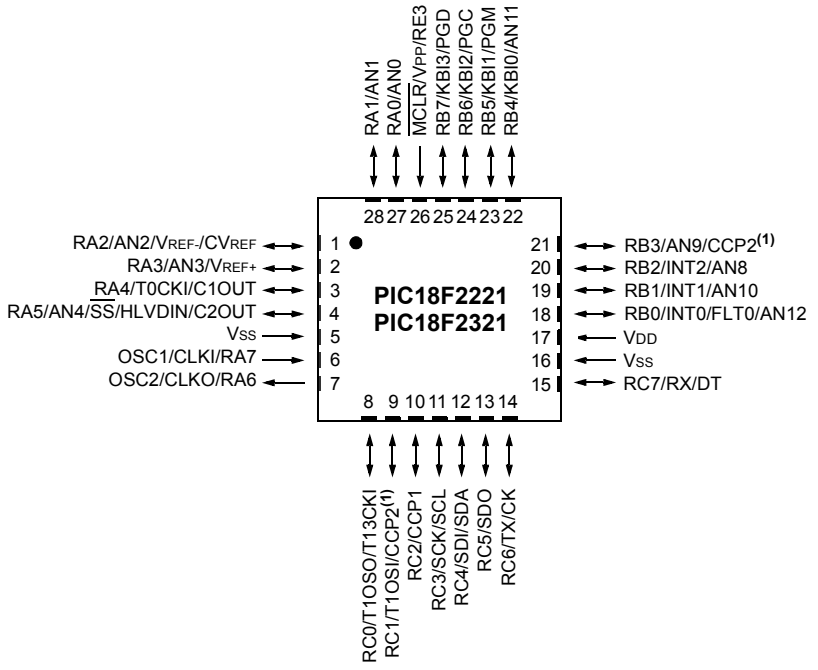
Device	Program Memory		Data Memory		I/O	10-Bit A/D (ch)	CCP/ ECCP (PWM)	MSSP		EUSART	Comp.	Timers 8/16-Bit
	Flash (bytes)	# Single-Word Instructions	SRAM (bytes)	EEPROM (bytes)				SPI	Master I^2C™			
PIC18F2221	4K	2048	512	256	25	10	2/0	Y	Y	1	2	1/3
PIC18F2321	8K	4096	512	256	25	10	2/0	Y	Y	1	2	1/3
PIC18F4221	4K	2048	512	256	36	13	1/1	Y	Y	1	2	1/3
PIC18F4321	8K	4096	512	256	36	13	1/1	Y	Y	1	2	1/3

Pin Diagrams

28-Pin SPDIP, SOIC, SSOP



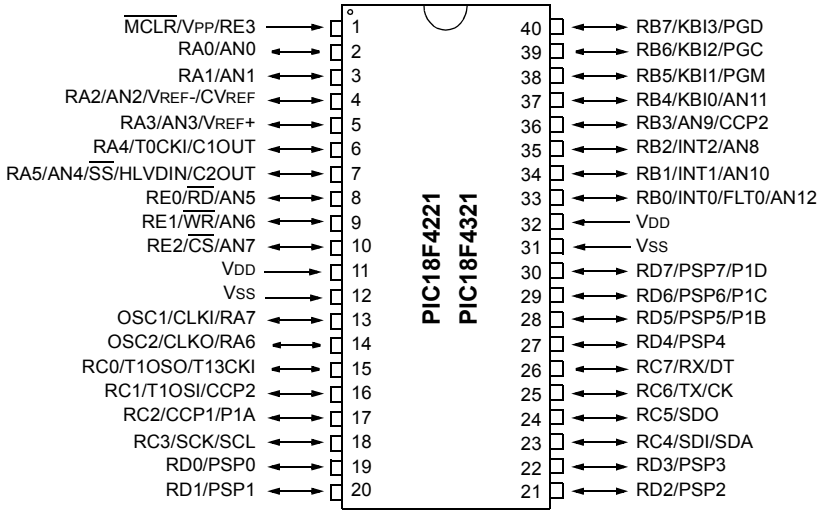
28-Pin QFN



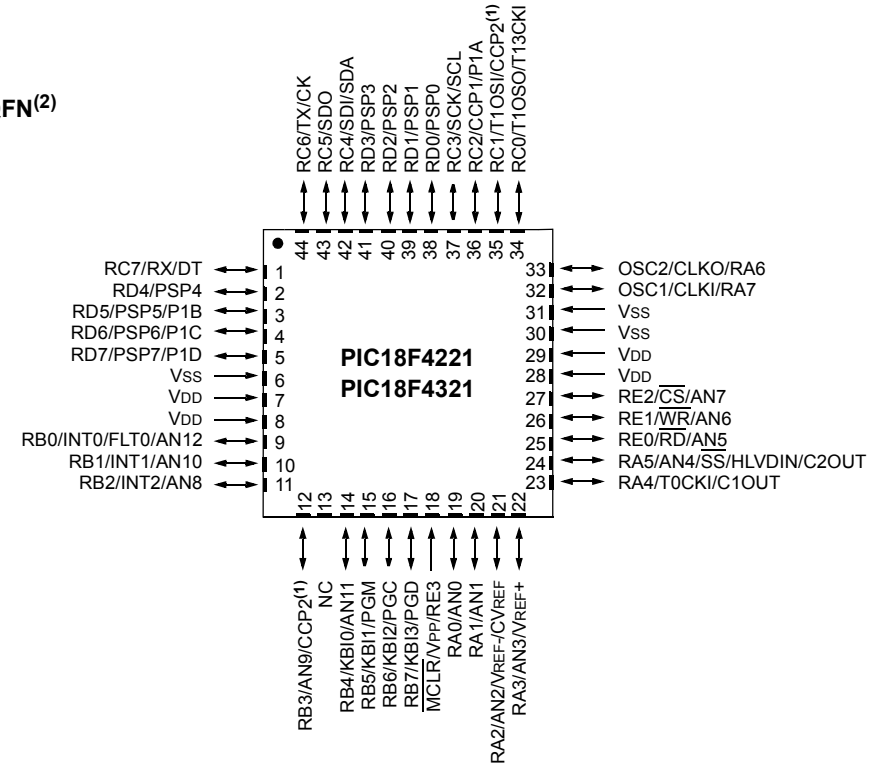
Note 1: RB3 is the alternate pin for CCP2 multiplexing.

Pin Diagrams (Continued)

40-Pin PDIP



44-Pin QFN(2)

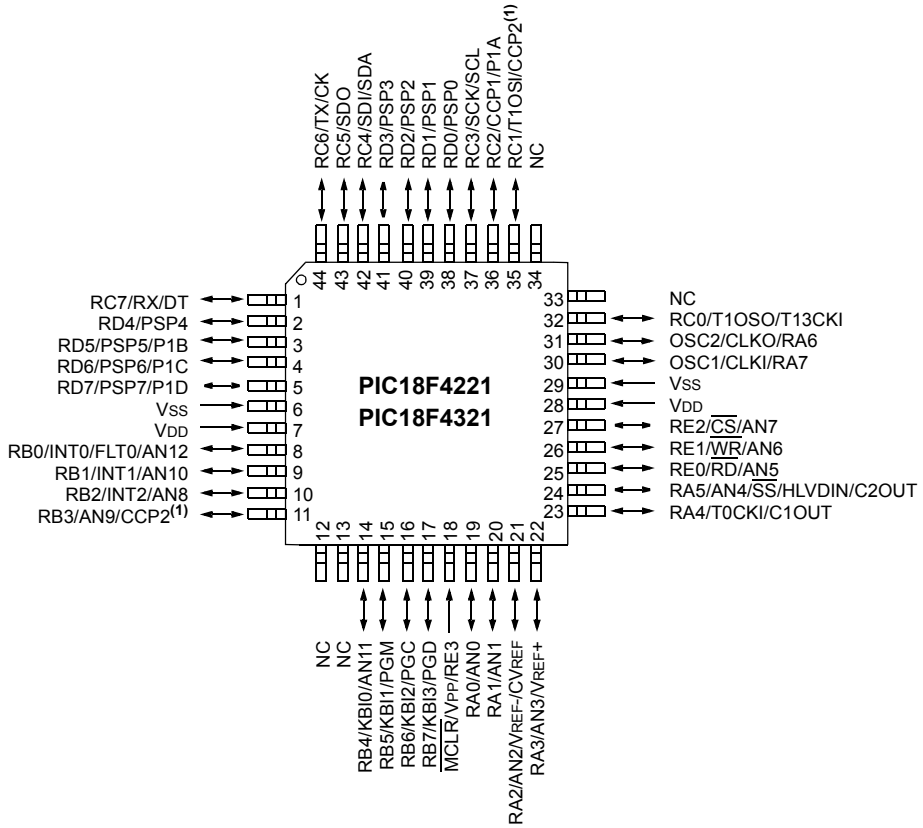


Note 1: RB3 is the alternate pin for CCP2 multiplexing.

2: For the QFN package, it is recommended that the bottom pad be connected to VSS.

Pin Diagrams (Continued)

44-Pin TQFP



Note 1: RB3 is the alternate pin for CCP2 multiplexing.

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1.0 DEVICE OVERVIEW

This document contains device specific information for the following devices:

- PIC18F2221
- PIC18LF2221
- PIC18F2321
- PIC18LF2321
- PIC18F4221
- PIC18LF4221
- PIC18F4321
- PIC18LF4321

This family offers the advantages of all PIC18 microcontrollers – namely, high computational performance at an economical price – with the addition of high-endurance, Enhanced Flash program memory. On top of these features, the PIC18F2221/2321/4221/4321 family introduces design enhancements that make these microcontrollers a logical choice for many high-performance, power sensitive applications.

1.1 New Core Features

1.1.1 nanoWatt TECHNOLOGY

All of the devices in the PIC18F2221/2321/4221/4321 family incorporate a range of features that can significantly reduce power consumption during operation. Key items include:

- **Alternate Run Modes:** By clocking the controller from the Timer1 source or the internal oscillator block, power consumption during code execution can be reduced by as much as 90%.
- **Multiple Idle Modes:** The controller can also run with its CPU core disabled but the peripherals still active. In these states, power consumption can be reduced even further, to as little as 4% of normal operation requirements.
- **On-the-Fly Mode Switching:** The power-managed modes are invoked by user code during operation, allowing the user to incorporate power-saving ideas into their application's software design.
- **Low Consumption in Key Modules:** The power requirements for both Timer1 and the Watchdog Timer are minimized. See **Section 27.0 "Electrical Characteristics"** for values.

1.1.2 MULTIPLE OSCILLATOR OPTIONS AND FEATURES

All of the devices in the PIC18F2221/2321/4221/4321 family offer ten different oscillator options, allowing users a wide range of choices in developing application hardware. These include:

- Four Crystal modes, using crystals or ceramic resonators.
- Two External Clock modes, offering the option of using two pins (oscillator input and a divide-by-4 clock output) or one pin (oscillator input, with the second pin reassigned as general I/O).
- Two External RC Oscillator modes with the same pin options as the External Clock modes.
- Two Internal Oscillator modes which provide an 8 MHz clock and an INTRC source (approximately 31 kHz), as well as a range of 6 user-selectable clock frequencies, between 125 kHz to 4 MHz, for a total of 8 clock frequencies. One or both of the oscillator pins can be used for general purpose I/O.
- A Phase Lock Loop (PLL) frequency multiplier, available to both the high-speed crystal and internal oscillator modes, which allows clock speeds of up to 40 MHz. Used with the internal oscillator, the PLL gives users a complete selection of clock speeds, from 31 kHz to 32 MHz – all without using an external crystal or clock circuit.

Besides its availability as a clock source, the internal oscillator block provides a stable reference source that gives the family additional features for robust operation:

- **Fail-Safe Clock Monitor:** This option constantly monitors the main clock source against a reference signal provided by the internal oscillator. If a clock failure occurs, the controller is switched to the internal oscillator block, allowing for continued low-speed operation or a safe application shutdown.
- **Two-Speed Start-up:** This option allows the internal oscillator to serve as the clock source from Power-on Reset, or wake-up from Sleep mode, until the primary clock source is available.

1.2 Other Special Features

- **Memory Endurance:** The Enhanced Flash cells for both program memory and data EEPROM are rated to last for many thousands of erase/write cycles – up to 100,000 for program memory and 1,000,000 for EEPROM. Data retention without refresh is conservatively estimated to be greater than 40 years.
- **Self-Programmability:** These devices can write to their own program memory spaces under internal software control. By using a bootloader routine, located in the protected Boot Block at the top of program memory, it becomes possible to create an application that can update itself in the field.
- **Extended Instruction Set:** The PIC18F2221/2321/4221/4321 family introduces an optional extension to the PIC18 instruction set, which adds 8 new instructions and an Indexed Addressing mode. This extension, enabled as a device configuration option, has been specifically designed to optimize re-entrant application code originally developed in high-level languages, such as C.
- **Enhanced CCP Module:** In PWM mode, this module provides 1, 2 or 4 modulated outputs for controlling half-bridge and full-bridge drivers. Other features include auto-shutdown, for disabling PWM outputs on interrupt or other select conditions and auto-restart, to reactivate outputs once the condition has cleared.
- **Enhanced Addressable USART:** This serial communication module is capable of standard RS-232 operation and provides support for the LIN/J2602 bus protocol. Other enhancements include automatic baud rate detection and a 16-bit Baud Rate Generator for improved resolution. When the microcontroller is using the internal oscillator block, the EUSART provides stable operation for applications that talk to the outside world without using an external crystal (or its accompanying power requirement).
- **10-Bit A/D Converter:** This module incorporates programmable acquisition time, allowing for a channel to be selected and a conversion to be initiated without waiting for a sampling period and thus, reducing code overhead.
- **Extended Watchdog Timer (WDT):** This Enhanced version incorporates a 16-bit prescaler, allowing an extended time-out range that is stable across operating voltage and temperature. See **Section 27.0 "Electrical Characteristics"** for time-out periods.

1.3 Details on Individual Family Members

Devices in the PIC18F2221/2321/4221/4321 family are available in 28-pin and 40/44-pin packages. Block diagrams for the two groups are shown in Figure 1-1 and Figure 1-2.

The devices are differentiated from each other in five ways:

1. Flash program memory (4 Kbytes for PIC18F2221/4221 devices, 8 Kbytes for PIC18F2321/4321).
2. A/D channels (10 for 28-pin devices, 13 for 40/44-pin devices).
3. I/O ports (3 bidirectional ports on 28-pin devices, 5 bidirectional ports on 40/44-pin devices).
4. CCP and Enhanced CCP implementation (28-pin devices have 2 standard CCP modules, 40/44-pin devices have one standard CCP module and one ECCP module).
5. Parallel Slave Port (present only on 40/44-pin devices).

All other features for devices in this family are identical. These are summarized in Table 1-1.

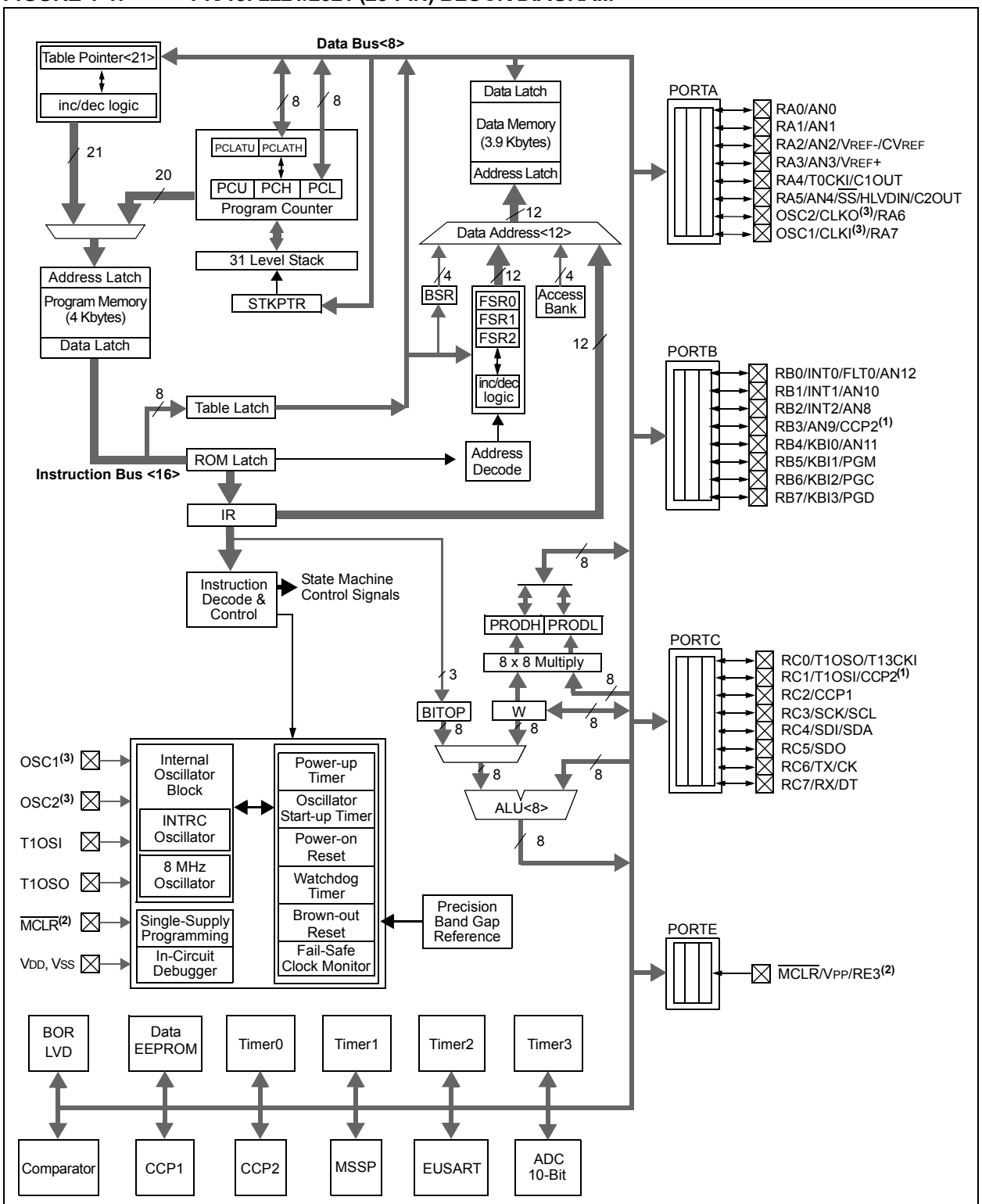
The pinouts for all devices are listed in Table 1-2 and Table 1-3.

Like all Microchip PIC18 devices, members of the PIC18F2221/2321/4221/4321 family are available as both standard and low-voltage devices. Standard devices with Enhanced Flash memory, designated with an "F" in the part number (such as PIC18**F**2321), accommodate an operating V_{DD} range of 4.2V to 5.5V. Low-voltage parts, designated by "LF" (such as PIC18**LF**2321), function over an extended V_{DD} range of 2.0V to 5.5V.

TABLE 1-1: DEVICE FEATURES

Features	PIC18F2221	PIC18F2321	PIC18F4221	PIC18F4321
Operating Frequency	DC – 40 MHz	DC – 40 MHz	DC – 40 MHz	DC – 40 MHz
Program Memory (Bytes)	4096	8192	4096	8192
Program Memory (Instructions)	2048	4096	2048	4096
Data Memory (Bytes)	512	512	512	512
Data EEPROM Memory (Bytes)	256	256	256	256
Interrupt Sources	19	19	20	20
I/O Ports	Ports A, B, C, (E)	Ports A, B, C, (E)	Ports A, B, C, D, E	Ports A, B, C, D, E
Timers	4	4	4	4
Capture/Compare/PWM Modules	2	2	1	1
Enhanced Capture/Compare/ PWM Modules	0	0	1	1
Serial Communications	MSSP, Enhanced USART	MSSP, Enhanced USART	MSSP, Enhanced USART	MSSP, Enhanced USART
Parallel Communications (PSP)	No	No	Yes	Yes
10-bit Analog-to-Digital Module	10 Input Channels	10 Input Channels	13 Input Channels	13 Input Channels
Resets (and Delays)	POR, BOR, RESET Instruction, Stack Full, Stack Underflow (PWRT, OST), $\overline{\text{MCLR}}$ (optional), WDT	POR, BOR, RESET Instruction, Stack Full, Stack Underflow (PWRT, OST), $\overline{\text{MCLR}}$ (optional), WDT	POR, BOR, RESET Instruction, Stack Full, Stack Underflow (PWRT, OST), $\overline{\text{MCLR}}$ (optional), WDT	POR, BOR, RESET Instruction, Stack Full, Stack Underflow (PWRT, OST), $\overline{\text{MCLR}}$ (optional), WDT
Programmable Low-Voltage Detect	Yes	Yes	Yes	Yes
Programmable Brown-out Reset	Yes	Yes	Yes	Yes
Instruction Set	75 Instructions; 83 with Extended Instruction Set enabled	75 Instructions; 83 with Extended Instruction Set enabled	75 Instructions; 83 with Extended Instruction Set enabled	75 Instructions; 83 with Extended Instruction Set enabled
Packages	28-pin SPDIP 28-pin SOIC 28-pin SSOP 28-pin QFN	28-pin SPDIP 28-pin SOIC 28-pin SSOP 28-pin QFN	40-pin PDIP 44-pin QFN 44-pin TQFP	40-pin PDIP 44-pin QFN 44-pin TQFP

FIGURE 1-1: PIC18F2221/2321 (28-PIN) BLOCK DIAGRAM

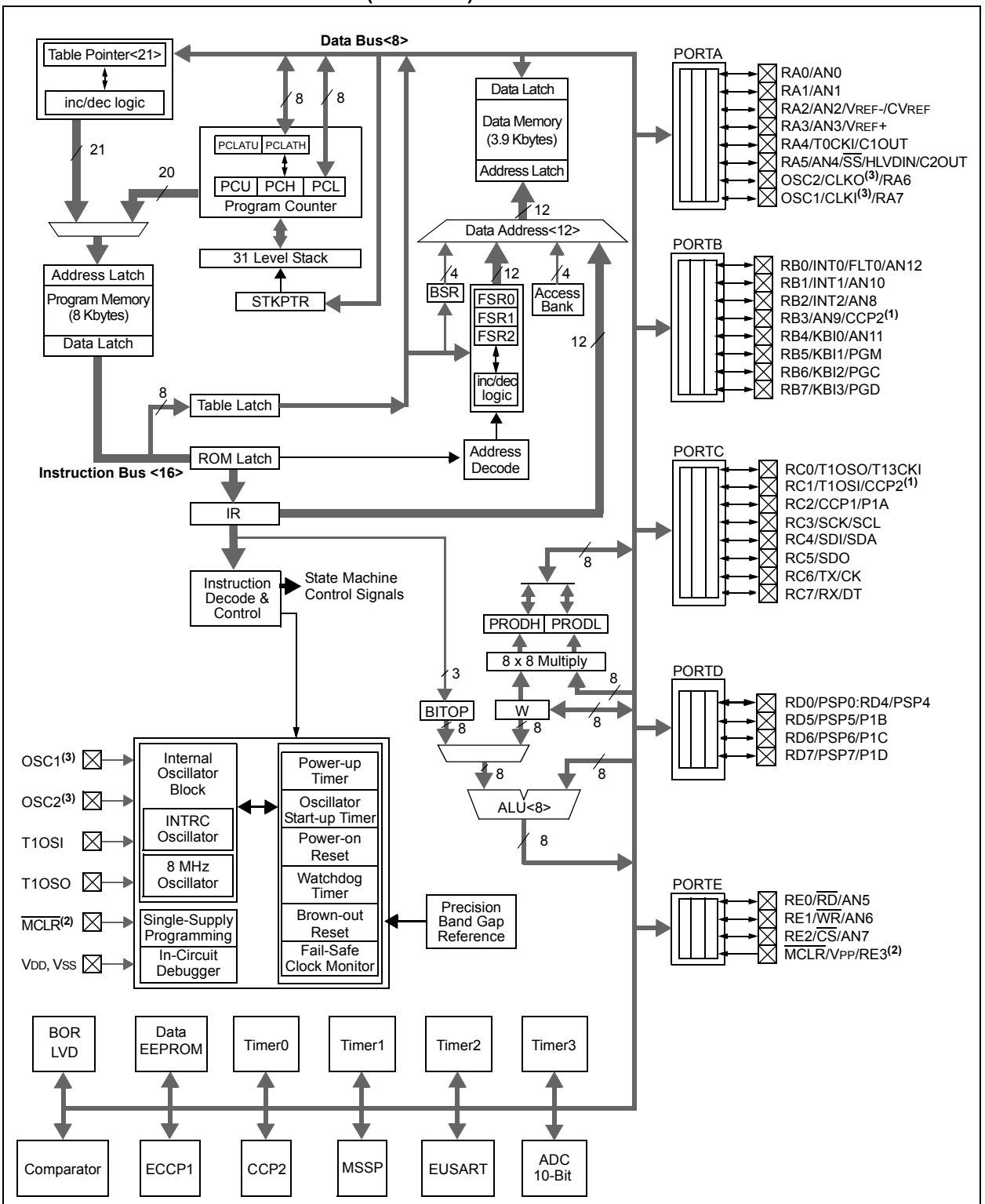


Note 1: CCP2 is multiplexed with RC1 when Configuration bit, CCP2MX, is set, or RB3 when CCP2MX is not set.

2: RE3 is only available when MCLR functionality is disabled.

3: OSC1/CLKI and OSC2/CLKO are only available in select oscillator modes and when these pins are not being used as digital I/O. Refer to **Section 3.0 "Oscillator Configurations"** for additional information.

FIGURE 1-2: PIC18F4221/4321 (40/44-PIN) BLOCK DIAGRAM



Note 1: CCP2 is multiplexed with RC1 when Configuration bit, CCP2MX, is set, or RB3 when CCP2MX is not set.

2: RE3 is only available when MCLR functionality is disabled.

3: OSC1/CLKI and OSC2/CLKO are only available in select oscillator modes and when these pins are not being used as digital I/O. Refer to **Section 3.0 "Oscillator Configurations"** for additional information.

TABLE 1-2: PIC18F2221/2321 PINOUT I/O DESCRIPTIONS

Pin Name	Pin Number		Pin Type	Buffer Type	Description
	SPDIP, SOIC, SSOP	QFN			
MCLR/VPP/RE3	1	26			Master Clear (input) or programming voltage (input).
MCLR			I	ST	Master Clear (Reset) input. This pin is an active-low Reset to the device.
VPP			P		Programming voltage input.
RE3			I	ST	Digital input.
OSC1/CLKI/RA7	9	6			Oscillator crystal or external clock input.
OSC1			I	Analog	Oscillator crystal input or external clock source input. ST buffer when configured in RC mode; CMOS otherwise.
CLKI			I	CMOS	External clock source input. Always associated with pin function OSC1. (See related OSC1/CLKI, OSC2/CLKO pins.)
RA7			I/O	TTL	General purpose I/O pin.
OSC2/CLKO/RA6	10	7			Oscillator crystal or clock output.
OSC2			O	—	Oscillator crystal output. Connects to crystal or resonator in Crystal Oscillator mode.
CLKO			O	—	In RC, EC and INTIO modes, OSC2 pin outputs CLKO which has one-fourth the frequency of OSC1 and denotes the instruction cycle rate.
RA6			I/O	TTL	General purpose I/O pin.

Legend: TTL = TTL compatible input; CMOS = CMOS compatible input or output; ST = Schmitt Trigger input with CMOS levels; I = Input; P = Power; I^2C = ST with I^2C™ or SMB levels; O = Output

Note 1: Default assignment for CCP2 when Configuration bit, CCP2MX, is set.

2: Alternate assignment for CCP2 when Configuration bit, CCP2MX, is cleared.

TABLE 1-2: PIC18F2221/2321 PINOUT I/O DESCRIPTIONS (CONTINUED)

Pin Name	Pin Number		Pin Type	Buffer Type	Description
	SPDIP, SOIC, SSOP	QFN			
					PORTA is a bidirectional I/O port.
RA0/AN0	2	27			
RA0			I/O	TTL	Digital I/O.
AN0			I	Analog	Analog Input 0.
RA1/AN1	3	28			
RA1			I/O	TTL	Digital I/O.
AN1			I	Analog	Analog Input 1.
RA2/AN2/VREF-/CVREF	4	1			
RA2			I/O	TTL	Digital I/O.
AN2			I	Analog	Analog Input 2.
VREF-			I	Analog	A/D reference voltage (low) input.
CVREF			O	Analog	Comparator reference voltage output.
RA3/AN3/VREF+	5	2			
RA3			I/O	TTL	Digital I/O.
AN3			I	Analog	Analog Input 3.
VREF+			I	Analog	A/D reference voltage (high) input.
RA4/T0CKI/C1OUT	6	3			
RA4			I/O	ST	Digital I/O. Open-collector output.
T0CKI			I	ST	Timer0 external clock input.
C1OUT			O	—	Comparator 1 output.
RA5/AN4/$\overline{SS}$/HLVDIN/C2OUT	7	4			
RA5			I/O	TTL	Digital I/O.
AN4			I	Analog	Analog Input 4.
$\overline{SS}$			I	TTL	SPI slave select input.
HLVDIN			I	Analog	High/Low-Voltage Detect input.
C2OUT			O	—	Comparator 2 output.
RA6					See the OSC2/CLKO/RA6 pin.
RA7					See the OSC1/CLKI/RA7 pin.

Legend: TTL = TTL compatible input; CMOS = CMOS compatible input or output; ST = Schmitt Trigger input with CMOS levels; I = Input; P = Power; I^2C = ST with I^2C™ or SMB levels; O = Output

Note 1: Default assignment for CCP2 when Configuration bit, CCP2MX, is set.

2: Alternate assignment for CCP2 when Configuration bit, CCP2MX, is cleared.

TABLE 1-2: PIC18F2221/2321 PINOUT I/O DESCRIPTIONS (CONTINUED)

Pin Name	Pin Number		Pin Type	Buffer Type	Description
	SPDIP, SOIC, SSOP	QFN			
					PORTB is a bidirectional I/O port. PORTB can be software programmed for internal weak pull-ups on all inputs.
RB0/INT0/FLT0/AN12	21	18			
RB0			I/O	TTL	Digital I/O.
INT0			I	ST	External Interrupt 0.
FLT0			I	ST	PWM Fault input for CCP1.
AN12			I	Analog	Analog Input 12.
RB1/INT1/AN10	22	19			
RB1			I/O	TTL	Digital I/O.
INT1			I	ST	External Interrupt 1.
AN10			I	Analog	Analog Input 10.
RB2/INT2/AN8	23	20			
RB2			I/O	TTL	Digital I/O.
INT2			I	ST	External Interrupt 2.
AN8			I	Analog	Analog Input 8.
RB3/AN9/CCP2	24	21			
RB3			I/O	TTL	Digital I/O.
AN9			I	Analog	Analog Input 9.
CCP2(2)			I/O	ST	Capture 2 input/Compare 2 output/PWM2 output.
RB4/KBI0/AN11	25	22			
RB4			I/O	TTL	Digital I/O.
KBI0			I	TTL	Interrupt-on-change pin.
AN11			I	Analog	Analog Input 11.
RB5/KBI1/PGM	26	23			
RB5			I/O	TTL	Digital I/O.
KBI1			I	TTL	Interrupt-on-change pin.
PGM			I/O	ST	Low-Voltage ICSP™ programming enable pin.
RB6/KBI2/PGC	27	24			
RB6			I/O	TTL	Digital I/O.
KBI2			I	TTL	Interrupt-on-change pin.
PGC			I/O	ST	In-circuit debugger and ICSP programming clock pin.
RB7/KBI3/PGD	28	25			
RB7			I/O	TTL	Digital I/O.
KBI3			I	TTL	Interrupt-on-change pin.
PGD			I/O	ST	In-circuit debugger and ICSP programming data pin.

Legend: TTL = TTL compatible input; CMOS = CMOS compatible input or output; ST = Schmitt Trigger input with CMOS levels; I = Input; P = Power; I^2C = ST with I^2C™ or SMB levels; O = Output

Note 1: Default assignment for CCP2 when Configuration bit, CCP2MX, is set.

2: Alternate assignment for CCP2 when Configuration bit, CCP2MX, is cleared.

TABLE 1-2: PIC18F2221/2321 PINOUT I/O DESCRIPTIONS (CONTINUED)

Pin Name	Pin Number		Pin Type	Buffer Type	Description
	SPDIP, SOIC, SSOP	QFN			
					PORTC is a bidirectional I/O port.
RC0/T1OSO/T13CKI	11	8			
RC0			I/O	ST	Digital I/O.
T1OSO			O	—	Timer1 oscillator analog output.
T13CKI			I	ST	Timer1/Timer3 external clock input.
RC1/T1OSI/CCP2	12	9			
RC1			I/O	ST	Digital I/O.
T1OSI			I	Analog	Timer1 oscillator analog input.
CCP2(1)			I/O	ST	Capture 2 input/Compare 2 output/PWM2 output.
RC2/CCP1	13	10			
RC2			I/O	ST	Digital I/O.
CCP1			I/O	ST	Capture 1 input/Compare 1 output/PWM1 output.
RC3/SCK/SCL	14	11			
RC3			I/O	ST	Digital I/O.
SCK			I/O	ST	Synchronous serial clock input/output for SPI mode.
SCL			I/O	I^2C	Synchronous serial clock input/output for I^2C™ mode.
RC4/SDI/SDA	15	12			
RC4			I/O	ST	Digital I/O.
SDI			I	ST	SPI data in.
SDA			I/O	I^2C	I^2C data I/O.
RC5/SDO	16	13			
RC5			I/O	ST	Digital I/O.
SDO			O	—	SPI data out.
RC6/TX/CK	17	14			
RC6			I/O	ST	Digital I/O.
TX			O	—	EUSART asynchronous transmit.
CK			I/O	ST	EUSART synchronous clock (see related RX/DT).
RC7/RX/DT	18	15			
RC7			I/O	ST	Digital I/O.
RX			I	ST	EUSART asynchronous receive.
DT			I/O	ST	EUSART synchronous data (see related TX/CK).
RE3	—	—	—	—	See $\overline{MCLR}$/VPP/RE3 pin.
VSS	8, 19	5, 16	P	—	Ground reference for logic and I/O pins.
VDD	20	17	P	—	Positive supply for logic and I/O pins.

Legend: TTL = TTL compatible input CMOS = CMOS compatible input or output
ST = Schmitt Trigger input with CMOS levels I = Input P = Power
I^2C = ST with I^2C™ or SMB levels O = Output

Note 1: Default assignment for CCP2 when Configuration bit, CCP2MX, is set.

2: Alternate assignment for CCP2 when Configuration bit, CCP2MX, is cleared.

TABLE 1-3: PIC18F4221/4321 PINOUT I/O DESCRIPTIONS

Pin Name	Pin Number			Pin Type	Buffer Type	Description
	PDIP	QFN	TQFP			
$\overline{MCLR}$/VPP/RE3	1	18	18			Master Clear (input) or programming voltage (input).
$\overline{MCLR}$				I	ST	Master Clear (Reset) input. This pin is an active-low Reset to the device.
VPP				P		Programming voltage input.
RE3				I	ST	Digital input.
OSC1/CLKI/RA7	13	32	30			Oscillator crystal or external clock input.
OSC1				I	Analog	Oscillator crystal input or external clock source input. ST buffer when configured in RC mode; analog otherwise.
CLKI				I	Analog	External clock source input. Always associated with pin function OSC1. (See related OSC1/CLKI, OSC2/CLKO pins.)
RA7				I/O	TTL	General purpose I/O pin.
OSC2/CLKO/RA6	14	33	31			Oscillator crystal or clock output.
OSC2				O	—	Oscillator crystal output. Connects to crystal or resonator in Crystal Oscillator mode.
CLKO				O	—	In RC, EC and INTIO modes, OSC2 pin outputs CLKO which has one-fourth the frequency of OSC1 and denotes the instruction cycle rate.
RA6				I/O	TTL	General purpose I/O pin.

Legend: TTL = TTL compatible input; CMOS = CMOS compatible input or output; ST = Schmitt Trigger input with CMOS levels; I = Input; P = Power; I^2C = ST with I^2C™ or SMB levels; O = Output

Note 1: Default assignment for CCP2 when Configuration bit, CCP2MX, is set.

2: Alternate assignment for CCP2 when Configuration bit, CCP2MX, is cleared.

TABLE 1-3: PIC18F4221/4321 PINOUT I/O DESCRIPTIONS (CONTINUED)

Pin Name	Pin Number			Pin Type	Buffer Type	Description
	PDIP	QFN	TQFP			
						PORTA is a bidirectional I/O port.
RA0/AN0	2	19	19			
RA0				I/O	TTL	Digital I/O.
AN0				I	Analog	Analog Input 0.
RA1/AN1	3	20	20			
RA1				I/O	TTL	Digital I/O.
AN1				I	Analog	Analog Input 1.
RA2/AN2/VREF-/CVREF	4	21	21			
RA2				I/O	TTL	Digital I/O.
AN2				I	Analog	Analog Input 2.
VREF-				I	Analog	A/D reference voltage (low) input.
CVREF				O	Analog	Comparator reference voltage output.
RA3/AN3/VREF+	5	22	22			
RA3				I/O	TTL	Digital I/O.
AN3				I	Analog	Analog Input 3.
VREF+				I	Analog	A/D reference voltage (high) input.
RA4/T0CKI/C1OUT	6	23	23			
RA4				I/O	ST	Digital I/O.
T0CKI				I	ST	Timer0 external clock input.
C1OUT				O	—	Comparator 1 output.
RA5/AN4/$\overline{SS}$/HLVDIN/C2OUT	7	24	24			
RA5				I/O	TTL	Digital I/O.
AN4				I	Analog	Analog Input 4.
$\overline{SS}$				I	TTL	SPI slave select input.
HLVDIN				I	Analog	High/Low-Voltage Detect input.
C2OUT				O	—	Comparator 2 output.
RA6						See the OSC2/CLKO/RA6 pin.
RA7						See the OSC1/CLKI/RA7 pin.

Legend: TTL = TTL compatible input; CMOS = CMOS compatible input or output; ST = Schmitt Trigger input with CMOS levels; I = Input; P = Power; I^2C = ST with I^2C™ or SMB levels; O = Output

Note 1: Default assignment for CCP2 when Configuration bit, CCP2MX, is set.

2: Alternate assignment for CCP2 when Configuration bit, CCP2MX, is cleared.

TABLE 1-3: PIC18F4221/4321 PINOUT I/O DESCRIPTIONS (CONTINUED)

Pin Name	Pin Number			Pin Type	Buffer Type	Description
	PDIP	QFN	TQFP			
						PORTB is a bidirectional I/O port. PORTB can be software programmed for internal weak pull-ups on all inputs.
RB0/INT0/FLT0/AN12	33	9	8			
RB0				I/O	TTL	Digital I/O.
INT0				I	ST	External Interrupt 0.
FLT0				I	ST	PWM Fault input for Enhanced CCP1.
AN12				I	Analog	Analog input 12.
RB1/INT1/AN10	34	10	9			
RB1				I/O	TTL	Digital I/O.
INT1				I	ST	External Interrupt 1.
AN10				I	Analog	Analog Input 10.
RB2/INT2/AN8	35	11	10			
RB2				I/O	TTL	Digital I/O.
INT2				I	ST	External Interrupt 2.
AN8				I	Analog	Analog Input 8.
RB3/AN9/CCP2	36	12	11			
RB3				I/O	TTL	Digital I/O.
AN9				I	Analog	Analog Input 9.
CCP2(2)				I/O	ST	Capture 2 input/Compare 2 output/PWM2 output.
RB4/KBI0/AN11	37	14	14			
RB4				I/O	TTL	Digital I/O.
KBI0				I	TTL	Interrupt-on-change pin.
AN11				I	Analog	Analog input 11.
RB5/KBI1/PGM	38	15	15			
RB5				I/O	TTL	Digital I/O.
KBI1				I	TTL	Interrupt-on-change pin.
PGM				I/O	ST	Low-Voltage ICSP™ Programming enable pin.
RB6/KBI2/PGC	39	16	16			
RB6				I/O	TTL	Digital I/O.
KBI2				I	TTL	Interrupt-on-change pin.
PGC				I/O	ST	In-circuit debugger and ICSP programming clock pin.
RB7/KBI3/PGD	40	17	17			
RB7				I/O	TTL	Digital I/O.
KBI3				I	TTL	Interrupt-on-change pin.
PGD				I/O	ST	In-circuit debugger and ICSP programming data pin.

Legend: TTL = TTL compatible input; CMOS = CMOS compatible input or output; ST = Schmitt Trigger input with CMOS levels; I = Input; P = Power; I^2C = ST with I^2C™ or SMB levels; O = Output

Note 1: Default assignment for CCP2 when Configuration bit, CCP2MX, is set.

2: Alternate assignment for CCP2 when Configuration bit, CCP2MX, is cleared.

TABLE 1-3: PIC18F4221/4321 PINOUT I/O DESCRIPTIONS (CONTINUED)

Pin Name	Pin Number			Pin Type	Buffer Type	Description
	PDIP	QFN	TQFP			
						PORTC is a bidirectional I/O port.
RC0/T1OSO/T13CKI	15	34	32			
RC0				I/O	ST	Digital I/O.
T1OSO				O	—	Timer1 oscillator analog output.
T13CKI				I	ST	Timer1/Timer3 external clock input.
RC1/T1OSI/CCP2	16	35	35			
RC1				I/O	ST	Digital I/O.
T1OSI				I	CMOS	Timer1 oscillator analog input.
CCP2(1)				I/O	ST	Capture 2 input/Compare 2 output/PWM2 output.
RC2/CCP1/P1A	17	36	36			
RC2				I/O	ST	Digital I/O.
CCP1				I/O	ST	Capture 1 input/Compare 1 output/PWM1 output.
P1A				O	—	Enhanced CCP1 output.
RC3/SCK/SCL	18	37	37			
RC3				I/O	ST	Digital I/O.
SCK				I/O	ST	Synchronous serial clock input/output for SPI mode.
SCL				I/O	I^2C	Synchronous serial clock input/output for I^2C™ mode.
RC4/SDI/SDA	23	42	42			
RC4				I/O	ST	Digital I/O.
SDI				I	ST	SPI data in.
SDA				I/O	I^2C	I^2C data I/O.
RC5/SDO	24	43	43			
RC5				I/O	ST	Digital I/O.
SDO				O	—	SPI data out.
RC6/TX/CK	25	44	44			
RC6				I/O	ST	Digital I/O.
TX				O	—	EUSART asynchronous transmit.
CK				I/O	ST	EUSART synchronous clock (see related RX/DT).
RC7/RX/DT	26	1	1			
RC7				I/O	ST	Digital I/O.
RX				I	ST	EUSART asynchronous receive.
DT				I/O	ST	EUSART synchronous data (see related TX/CK).

Legend: TTL = TTL compatible input CMOS = CMOS compatible input or output
ST = Schmitt Trigger input with CMOS levels I = Input P = Power
I^2C = ST with I^2C™ or SMB levels O = Output

Note 1: Default assignment for CCP2 when Configuration bit, CCP2MX, is set.
2: Alternate assignment for CCP2 when Configuration bit, CCP2MX, is cleared.

TABLE 1-3: PIC18F4221/4321 PINOUT I/O DESCRIPTIONS (CONTINUED)

Pin Name	Pin Number			Pin Type	Buffer Type	Description
	PDIP	QFN	TQFP			
						PORTD is a bidirectional I/O port or a Parallel Slave Port (PSP) for interfacing to a microprocessor port. These pins have TTL input buffers when the PSP module is enabled.
RD0/PSP0	19	38	38			
RD0				I/O	ST	Digital I/O.
PSP0				I/O	TTL	Parallel Slave Port data.
RD1/PSP1	20	39	39			
RD1				I/O	ST	Digital I/O.
PSP1				I/O	TTL	Parallel Slave Port data.
RD2/PSP2	21	40	40			
RD2				I/O	ST	Digital I/O.
PSP2				I/O	TTL	Parallel Slave Port data.
RD3/PSP3	22	41	41			
RD3				I/O	ST	Digital I/O.
PSP3				I/O	TTL	Parallel Slave Port data.
RD4/PSP4	27	2	2			
RD4				I/O	ST	Digital I/O.
PSP4				I/O	TTL	Parallel Slave Port data.
RD5/PSP5/P1B	28	3	3			
RD5				I/O	ST	Digital I/O.
PSP5				I/O	TTL	Parallel Slave Port data.
P1B				O	—	Enhanced CCP1 output.
RD6/PSP6/P1C	29	4	4			
RD6				I/O	ST	Digital I/O.
PSP6				I/O	TTL	Parallel Slave Port data.
P1C				O	—	Enhanced CCP1 output.
RD7/PSP7/P1D	30	5	5			
RD7				I/O	ST	Digital I/O.
PSP7				I/O	TTL	Parallel Slave Port data.
P1D				O	—	Enhanced CCP1 output.

Legend: TTL = TTL compatible input; CMOS = CMOS compatible input or output; ST = Schmitt Trigger input with CMOS levels; I = Input; P = Power; I^2C = ST with I^2C™ or SMB levels; O = Output

Note 1: Default assignment for CCP2 when Configuration bit, CCP2MX, is set.

2: Alternate assignment for CCP2 when Configuration bit, CCP2MX, is cleared.

TABLE 1-3: PIC18F4221/4321 PINOUT I/O DESCRIPTIONS (CONTINUED)

Pin Name	Pin Number			Pin Type	Buffer Type	Description
	PDIP	QFN	TQFP			
						PORTE is a bidirectional I/O port.
RE0/$\overline{RD}$/AN5	8	25	25			
RE0				I/O	ST	Digital I/O.
$\overline{RD}$				I	TTL	Read control for Parallel Slave Port (see also $\overline{WR}$ and $\overline{CS}$ pins).
AN5				I	Analog	Analog Input 5.
RE1/$\overline{WR}$/AN6	9	26	26			
RE1				I/O	ST	Digital I/O.
$\overline{WR}$				I	TTL	Write control for Parallel Slave Port (see $\overline{CS}$ and $\overline{RD}$ pins).
AN6				I	Analog	Analog Input 6.
RE2/$\overline{CS}$/AN7	10	27	27			
RE2				I/O	ST	Digital I/O.
$\overline{CS}$				I	TTL	Chip Select control for Parallel Slave Port (see related $\overline{RD}$ and $\overline{WR}$).
AN7				I	Analog	Analog Input 7.
RE3	—	—	—	—	—	See $\overline{MCLR}$/V_{PP}/RE3 pin.
V_{SS}	12, 31	6, 30, 31	6, 29	P	—	Ground reference for logic and I/O pins.
V_{DD}	11, 32	7, 8, 28, 29	7, 28	P	—	Positive supply for logic and I/O pins.
NC	—	13	12, 13, 33, 34	—	—	No Connect.

Legend: TTL = TTL compatible input; CMOS = CMOS compatible input or output; ST = Schmitt Trigger input with CMOS levels; I = Input; P = Power; I^2C = ST with I^2C™ or SMB levels; O = Output

Note 1: Default assignment for CCP2 when Configuration bit, CCP2MX, is set.

2: Alternate assignment for CCP2 when Configuration bit, CCP2MX, is cleared.

NOTES:

2.0 GUIDELINES FOR GETTING STARTED WITH PIC18F MICROCONTROLLERS

2.1 Basic Connection Requirements

Getting started with the PIC18F2221/2321/4221/4321 family family of 8-bit microcontrollers requires attention to a minimal set of device pin connections before proceeding with development.

The following pins must always be connected:

- All VDD and VSS pins
  (see **Section 2.2 "Power Supply Pins"**)
- All AVDD and AVSS pins, regardless of whether or not the analog device features are used
  (see **Section 2.2 "Power Supply Pins"**)
- $\overline{\text{MCLR}}$ pin
  (see **Section 2.3 "Master Clear (MCLR) Pin"**)

These pins must also be connected if they are being used in the end application:

- PGC/PGD pins used for In-Circuit Serial Programming™ (ICSP™) and debugging purposes
  (see **Section 2.4 "ICSP Pins"**)
- OSCI and OSCO pins when an external oscillator source is used
  (see **Section 2.5 "External Oscillator Pins"**)

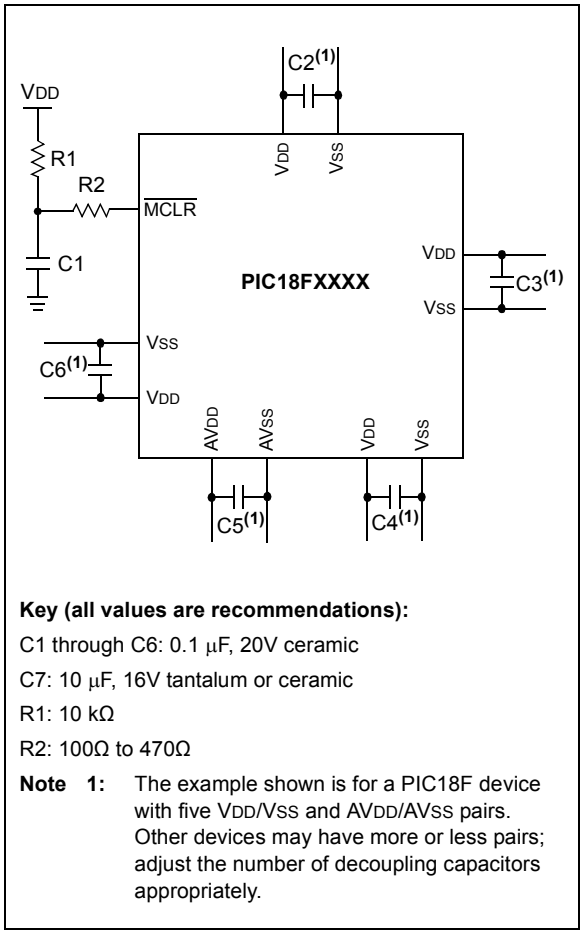
Additionally, the following pins may be required:

- VREF+/VREF- pins used when external voltage reference for analog modules is implemented

Note:	The AVDD and AVSS pins must always be connected, regardless of whether any of the analog modules are being used.

The minimum mandatory connections are shown in Figure 2-1.

FIGURE 2-1: RECOMMENDED MINIMUM CONNECTIONS



Key (all values are recommendations):

C1 through C6: 0.1 μF, 20V ceramic

C7: 10 μF, 16V tantalum or ceramic

R1: 10 kΩ

R2: 100Ω to 470Ω

Note 1: The example shown is for a PIC18F device with five VDD/VSS and AVDD/AVSS pairs. Other devices may have more or less pairs; adjust the number of decoupling capacitors appropriately.