



PIC12F508/509/16F505

Data Sheet

8/14-Pin, 8-Bit Flash Microcontrollers

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PIC12F508/509/16F505

8/14-Pin, 8-Bit Flash Microcontrollers

Devices Included in This Data Sheet:

- PIC12F508 • PIC12F509 • PIC16F505

High-Performance RISC CPU:

- Only 33 Single-Word Instructions to Learn
- All Single-Cycle Instructions Except for Program Branches, which are Two-Cycle
- 12-Bit Wide Instructions
- 2-Level Deep Hardware Stack
- Direct, Indirect and Relative Addressing modes for Data and Instructions
- 8-Bit Wide Data Path
- 8 Special Function Hardware Registers
- Operating Speed:
 - DC – 20 MHz clock input (PIC16F505 only)
 - DC – 200 ns instruction cycle (PIC16F505 only)
 - DC – 4 MHz clock input
 - DC – 1000 ns instruction cycle

Special Microcontroller Features:

- 4 MHz Precision Internal Oscillator:
 - Factory calibrated to $\pm 1\%$
- In-Circuit Serial Programming™ (ICSP™)
- In-Circuit Debugging (ICD) Support
- Power-On Reset (POR)
- Device Reset Timer (DRT)
- Watchdog Timer (WDT) with Dedicated On-Chip RC Oscillator for Reliable Operation
- Programmable Code Protection
- Multiplexed MCLR Input Pin
- Internal Weak Pull-Ups on I/O Pins
- Power-Saving Sleep mode
- Wake-Up from Sleep on Pin Change
- Selectable Oscillator Options:
 - INTRC: 4 MHz precision internal oscillator
 - EXTRC: External low-cost RC oscillator
 - XT: Standard crystal/resonator
 - HS: High-speed crystal/resonator (PIC16F505 only)
 - LP: Power-saving, low-frequency crystal
 - EC: High-speed external clock input (PIC16F505 only)

Low-Power Features/CMOS Technology:

- Operating Current
 - $< 175 \mu\text{A}$ @ 2V, 4 MHz, typical
- Standby Current
 - 100 nA @ 2V, typical
- Low-Power, High-Speed Flash Technology
 - 100,000 Flash endurance
 - > 40 year retention
- Fully Static Design
- Wide Operating Voltage Range: 2.0V to 5.5V
- Wide Temperature Range:
 - Industrial: -40°C to $+85^{\circ}\text{C}$
 - Extended: -40°C to $+125^{\circ}\text{C}$

Peripheral Features (PIC12F508/509):

- 6 I/O Pins:
 - 5 I/O pins with individual direction control
 - 1 input only pin
 - High current sink/source for direct LED drive
 - Wake-on-change
 - Weak pull-ups
- 8-Bit Real-Time Clock/Counter (TMR0) with 8-Bit Programmable Prescaler

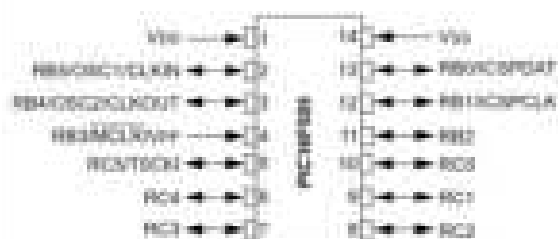
Peripheral Features (PIC16F505):

- 12 I/O Pins:
 - 11 I/O pins with individual direction control
 - 1 input only pin
 - High current sink/source for direct LED drive
 - Wake-on-change
 - Weak pull-ups
- 8-Bit Real-Time Clock/Counter (TMR0) with 8-Bit Programmable Prescaler

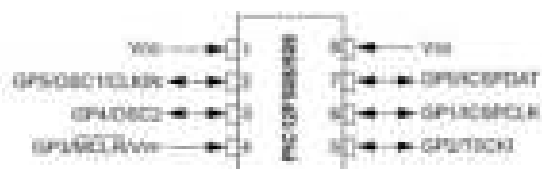
PIC12F508/509/16F505

Pin Diagrams

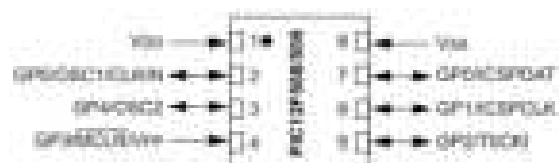
PDIP, SOIC, TSSOP



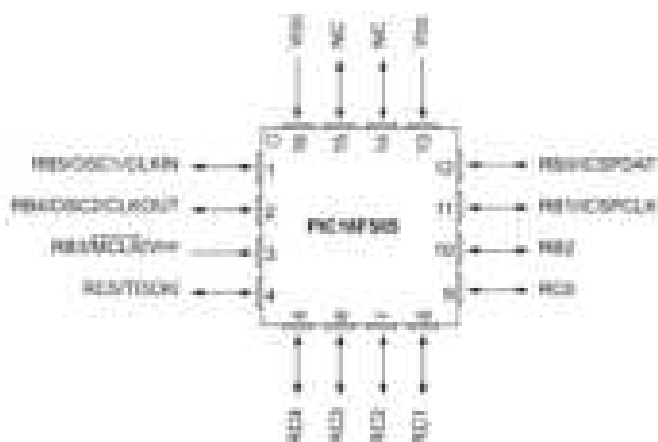
PDIP, SOIC, MSOP



QFN



PIC16F505 16-Pin Diagram (QFN)



PIC12F508/509/16F505

Device	Program Memory	Data Memory	I/O	Timers 8-bit
	Flash (words)	SRAM (bytes)		
PIC12F508	512	25	6	1
PIC12F509	1024	41	6	1
PIC16F505	1024	72	12	1

PIC12F508/509/16F505

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1.0 GENERAL DESCRIPTION

The PIC12F508/509/16F505 devices from Microchip Technology are low-cost, high-performance, 8-bit, fully-static, Flash-based CMOS microcontrollers. They employ a RISC architecture with only 33 single-word single-cycle instructions. All instructions are single cycle (200 ns) except for program branches, which take two cycles. The PIC12F508/509/16F505 devices deliver performance an order of magnitude higher than their competitors in the same price category. The 12-bit wide instructions are highly symmetrical, resulting in a typical 2:1 code compression over other 8-bit microcontrollers in its class. The easy-to-use and easy-to-remember instruction set reduces development time significantly.

The PIC12F508/509/16F505 products are equipped with special features that reduce system cost and power requirements. The Power-on Reset (POR) and Device Reset Timer (DRT) eliminate the need for external Reset circuitry. There are four oscillator configurations to choose from (six on the PIC16F505), including INTOSC Internal Oscillator mode and the power-saving LP (Low-Power) Oscillator mode. Power-Saving Sleep mode, Watchdog Timer and code protection features improve system cost, power and reliability.

The PIC12F508/509/16F505 devices are available in the cost-effective Flash programmable version, which is suitable for production in any volume. The customer can take full advantage of Microchip's price leadership in Flash programmable microcontrollers, while benefiting from the Flash programmable flexibility.

The PIC12F508/509/16F505 products are supported by a full-featured macro assembler, a software simulator, an in-circuit emulator, a 'C' compiler, a low-cost development programmer and a full featured programmer. All the tools are supported on IBM® PC and compatible machines.

1.1 Applications

The PIC12F508/509/16F505 devices fit in applications ranging from personal care appliances and security systems to low-power remote transmitters/receivers. The Flash technology makes customizing application programs (transmitter codes, appliance settings, receiver frequencies, etc.) extremely fast and convenient. The small footprint packages, for through hole or surface mounting, make these microcontrollers perfect for applications with space limitations. Low cost, low power, high performance, ease-of-use and I/O flexibility make the PIC12F508/509/16F505 devices very versatile even in areas where no microcontroller use has been considered before (e.g., timer functions, logic and PLDs in larger systems and coprocessor applications).

TABLE 1-1: PIC12F508/509/16F505 DEVICES

		PIC12F508	PIC12F509	PIC16F505
Clock	Maximum Frequency of Operation (MHz)	4	4	20
Memory	Flash Program Memory (words)	512	1024	1024
	Data Memory (bytes)	25	41	72
Peripherals	Timer Module(s)	TMR0	TMR0	TMR0
	Wake-up from Sleep on Pin Change	Yes	Yes	Yes
Features	I/O Pins	8	8	11
	Input Pins	1	1	1
	Internal Pull-ups	Yes	Yes	Yes
	In-Circuit Serial Programming	Yes	Yes	Yes
	Number of Instructions	33	33	33
	Packages	8-pin PDIP, SOIC, MSOP, DFN	8-pin PDIP, SOIC, MSOP, DFN	14-pin PDIP, SOIC, TSSOP

The PIC12F508/509/16F505 devices have Power-on Reset, selectable Watchdog Timer, selectable code-protect, high I/O current capability and precision internal oscillator.

The PIC12F508/509/16F505 devices use serial programming with data pin RB0/RGP0 and clock pin RB1/GP1.

PIC12F508/509/16F505

NOTES:

2.0 PIC12F508/509/16F505 DEVICE VARIETIES

A variety of packaging options are available. Depending on application and production requirements, the proper device option can be selected using the information in this section. When placing orders, please use the PIC12F508/509/16F505 Product Identification System at the back of this data sheet to specify the correct part number.

2.1 Quick Turn Programming (QTP) Devices

Microchip offers a QTP programming service for factory production orders. This service is made available for users who choose not to program medium-to-high quantity units and whose code patterns have stabilized. The devices are identical to the Flash devices but with all Flash locations and fuse options already programmed by the factory. Certain code and prototype verification procedures do apply before production shipments are available. Please contact your local Microchip Technology sales office for more details.

2.2 Serialized Quick Turn ProgrammingSM (SQTPSM) Devices

Microchip offers a unique programming service, where a few user-defined locations in each device are programmed with different serial numbers. The serial numbers may be random, pseudo-random or sequential.

Serial programming allows each device to have a unique number, which can serve as an entry code, password or ID number.

PIC12F508/509/16F505

NOTES:

3.0 ARCHITECTURAL OVERVIEW

The high performance of the PIC12F508/509/16F505 devices can be attributed to a number of architectural features commonly found in RISC microprocessors. To begin with, the PIC12F508/509/16F505 devices use a Harvard architecture in which program and data are accessed on separate buses. This improves bandwidth over traditional von Neumann architectures, where program and data are fetched on the same bus. Separating program and data memory further allows instructions to be sized differently than the 8-bit wide data word. Instruction opcodes are 12 bits wide, making it possible to have all single-word instructions. A 12-bit wide program memory access bus fetches a 12-bit instruction in a single cycle. A two-stage pipeline overlaps fetch and execution of instructions. Consequently, all instructions (33) execute in a single cycle (200 ns @ 20 MHz, 1 μ s @ 4 MHz) except for program branches.

Table 3-1 below lists program memory (Flash) and data memory (RAM) for the PIC12F508/509/16F505 devices.

TABLE 3-1: PIC12F508/509/16F505 MEMORY

Device	Memory	
	Program	Data
PIC12F508	512 $\times$ 12	25 $\times$ 8
PIC12F509	1024 $\times$ 12	41 $\times$ 8
PIC16F505	1024 $\times$ 12	72 $\times$ 8

The PIC12F508/509/16F505 devices can directly or indirectly address its register files and data memory. All Special Function Registers (SFR), including the PC, are mapped in the data memory. The PIC12F508/509/16F505 devices have a highly orthogonal (symmetrical) instruction set that makes it possible to carry out any operation, on any register, using any addressing mode. This symmetrical nature and lack of "special optimal situations" make programming with the PIC12F508/509/16F505 devices simple, yet efficient. In addition, the learning curve is reduced significantly.

The PIC12F508/509/16F505 devices contain an 8-bit ALU and working register. The ALU is a general purpose arithmetic unit. It performs arithmetic and Boolean functions between data in the working register and any register file.

The ALU is 8 bits wide and capable of addition, subtraction, shift and logical operations. Unless otherwise mentioned, arithmetic operations are two's complement in nature. In two-operand instructions, one operand is typically the W (working) register. The other operand is either a file register or an immediate constant. In single operand instructions, the operand is either the W register or a file register.

The W register is an 8-bit working register used for ALU operations. It is not an addressable register.

Depending on the instruction executed, the ALU may affect the values of the Carry (C), Digit Carry (DC) and Zero (Z) bits in the STATUS register. The C and DC bits operate as a borrow and digit borrow out bit, respectively, in subtraction. See the `STATUS` and `ADDWF` instructions for examples.

Simplified block diagrams are shown in Figure 3-1 and Figure 3-2, with the corresponding pin described in Table 3-2 and Table 3-3.

PIC12F508/509/16F505

FIGURE 3-1: PIC12F508/509 BLOCK DIAGRAM

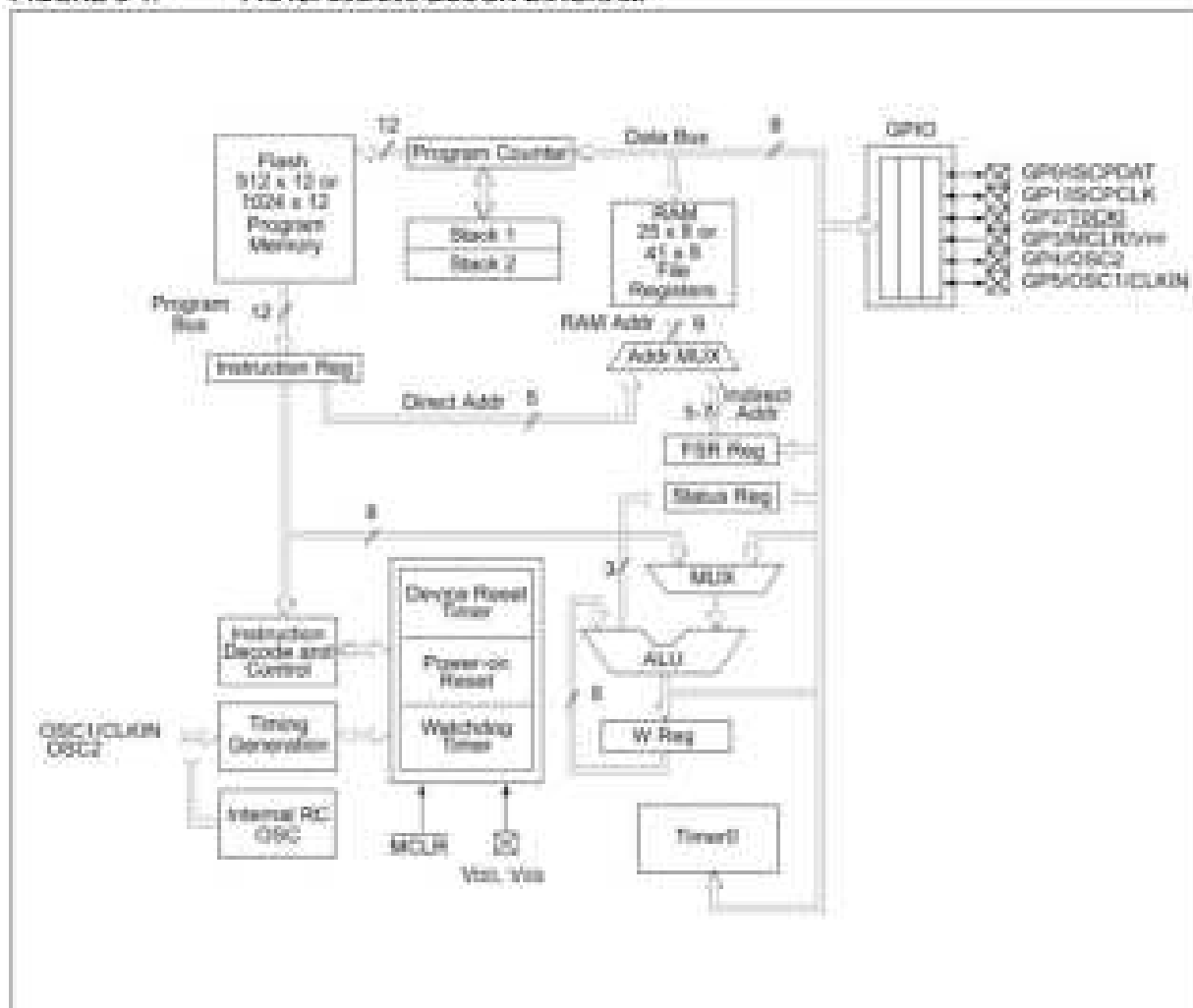


TABLE 3-2: PIC12F508/509 PINOUT DESCRIPTION

Name	Function	Input Type	Output Type	Description
GP0/ICSPDAT	GP0	TTL	CMOS	Bidirectional I/O pin. Can be software programmed for internal weak pull-up and wake-up from Sleep on pin change.
	ICSPDAT	ST	CMOS	In-Circuit Serial Programming™ data pin.
GP1/ICSPCLK	GP1	TTL	CMOS	Bidirectional I/O pin. Can be software programmed for internal weak pull-up and wake-up from Sleep on pin change.
	ICSPCLK	ST	CMOS	In-Circuit Serial Programming clock pin.
GP2/T0CKI	GP2	TTL	CMOS	Bidirectional I/O pin.
	T0CKI	ST	—	Clock input to TMR0.
GP3/MCLR/VPP	GP3	TTL	—	Input pin. Can be software programmed for internal weak pull-up and wake-up from Sleep on pin change.
	MCLR	ST	—	Master Clear (Reset). When configured as MCLR, this pin is an active-low Reset to the device. Voltage on MCLR/VPP must not exceed VDD during normal device operation or the device will enter Programming mode. Weak pull-up always on if configured as MCLR.
	VPP	HV	—	Programming voltage input.
GP4/OSC2	GP4	TTL	CMOS	Bidirectional I/O pin.
	OSC2	—	XTAL	Oscillator crystal output. Connections to crystal or resonator in Crystal Oscillator mode (XT and LP modes only, GPIO in other modes).
GP5/OSC1/CLKIN	GP5	TTL	CMOS	Bidirectional I/O pin.
	OSC1	XTAL	—	Oscillator crystal input.
	CLKIN	ST	—	External clock source input.
VDD	VDD	—	P	Positive supply for logic and I/O pins.
VSS	VSS	—	P	Ground reference for logic and I/O pins.

Legend: I = Input, O = Output, IO = Input/Output, P = Power, — = Not used, TTL = TTL input, ST = Schmitt Trigger input, HV = High Voltage

PIC12F508/509/16F505

FIGURE 3-2: PIC16F505 BLOCK DIAGRAM

