1. Pin Configurations

Figure 1-1. Pinout ATmega48A/PA/88A/PA/168A/PA/328/P
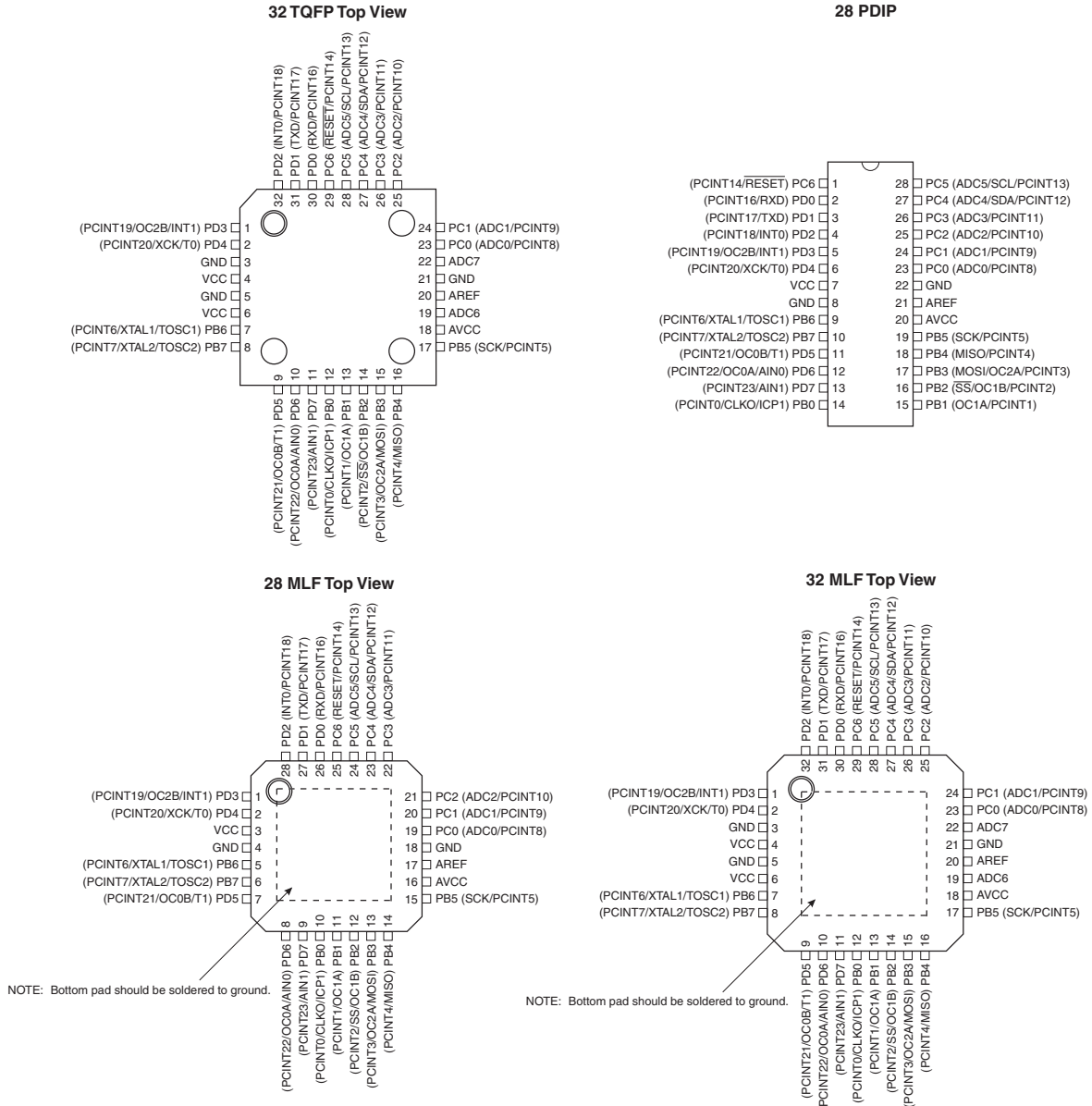

32 TQFP Top View

28 PDIP

28 MLF Top View

NOTE: Bottom pad should be soldered to ground.

32 MLF Top View

NOTE: Bottom pad should be soldered to ground.

Table 1-1. 32UFBGA - Pinout ATmega48A/48PA/88A/88PA/168A/168PA

	1	2	3	4	5	6
A	PD2	PD1	PC6	PC4	PC2	PC1
B	PD3	PD4	PD0	PC5	PC3	PC0
C	GND	GND			ADC7	GND
D	VDD	VDD			AREF	ADC6
E	PB6	PD6	PB0	PB2	AVDD	PB5
F	PB7	PD5	PD7	PB1	PB3	PB4

Features

- **High Performance, Low Power Atmel®AVR® 8-Bit Microcontroller**
- **Advanced RISC Architecture**
  - **131 Powerful Instructions – Most Single Clock Cycle Execution**
  - **32 x 8 General Purpose Working Registers**
  - **Fully Static Operation**
  - **Up to 20 MIPS Throughput at 20MHz**
  - **On-chip 2-cycle Multiplier**
- **High Endurance Non-volatile Memory Segments**
  - **4/8/16/32KBytes of In-System Self-Programmable Flash program memory**
  - **256/512/512/1KBytes EEPROM**
  - **512/1K/1K/2KBytes Internal SRAM**
  - **Write/Erase Cycles: 10,000 Flash/100,000 EEPROM**
  - **Data retention: 20 years at 85°C/100 years at 25°C[1]**
  - **Optional Boot Code Section with Independent Lock Bits**
    In-System Programming by On-chip Boot Program
    True Read-While-Write Operation
  - **Programming Lock for Software Security**
- **Atmel® QTouch® library support**
  - **Capacitive touch buttons, sliders and wheels**
  - **QTouch and QMatrix® acquisition**
  - **Up to 64 sense channels**
- **Peripheral Features**
  - **Two 8-bit Timer/Counters with Separate Prescaler and Compare Mode**
  - **One 16-bit Timer/Counter with Separate Prescaler, Compare Mode, and Capture Mode**
  - **Real Time Counter with Separate Oscillator**
  - **Six PWM Channels**
  - **8-channel 10-bit ADC in TQFP and QFN/MLF package**
    Temperature Measurement
  - **6-channel 10-bit ADC in PDIP Package**
    Temperature Measurement
  - **Programmable Serial USART**
  - **Master/Slave SPI Serial Interface**
  - **Byte-oriented 2-wire Serial Interface (Philips I²C compatible)**
  - **Programmable Watchdog Timer with Separate On-chip Oscillator**
  - **On-chip Analog Comparator**
  - **Interrupt and Wake-up on Pin Change**
- **Special Microcontroller Features**
  - **Power-on Reset and Programmable Brown-out Detection**
  - **Internal Calibrated Oscillator**
  - **External and Internal Interrupt Sources**
  - **Six Sleep Modes: Idle, ADC Noise Reduction, Power-save, Power-down, Standby, and Extended Standby**
- **I/O and Packages**
  - **23 Programmable I/O Lines**
  - **28-pin PDIP, 32-lead TQFP, 28-pad QFN/MLF and 32-pad QFN/MLF**
- **Operating Voltage:**
  - **1.8 - 5.5V**
- **Temperature Range:**
  - **-40°C to 85°C**
- **Speed Grade:**
  - **0 - 4MHz@1.8 - 5.5V, 0 - 10MHz@2.7 - 5.5.V, 0 - 20MHz @ 4.5 - 5.5V**
- **Power Consumption at 1MHz, 1.8V, 25°C**
  - **Active Mode: 0.2mA**
  - **Power-down Mode: 0.1µA**
  - **Power-save Mode: 0.75µA (Including 32kHz RTC)**

8-bit Atmel Microcontroller with 4/8/16/32K Bytes In-System Programmable Flash

**ATmega48A
ATmega48PA
ATmega88A
ATmega88PA
ATmega168A
ATmega168PA
ATmega328
ATmega328P**

2. Overview

The ATmega48A/PA/88A/PA/168A/PA/328/P is a low-power CMOS 8-bit microcontroller based on the AVR enhanced RISC architecture. By executing powerful instructions in a single clock cycle, the ATmega48A/PA/88A/PA/168A/PA/328/P achieves throughputs approaching 1 MIPS per MHz allowing the system designer to optimize power consumption versus processing speed.

2.1 Block Diagram

Figure 2-1. Block Diagram
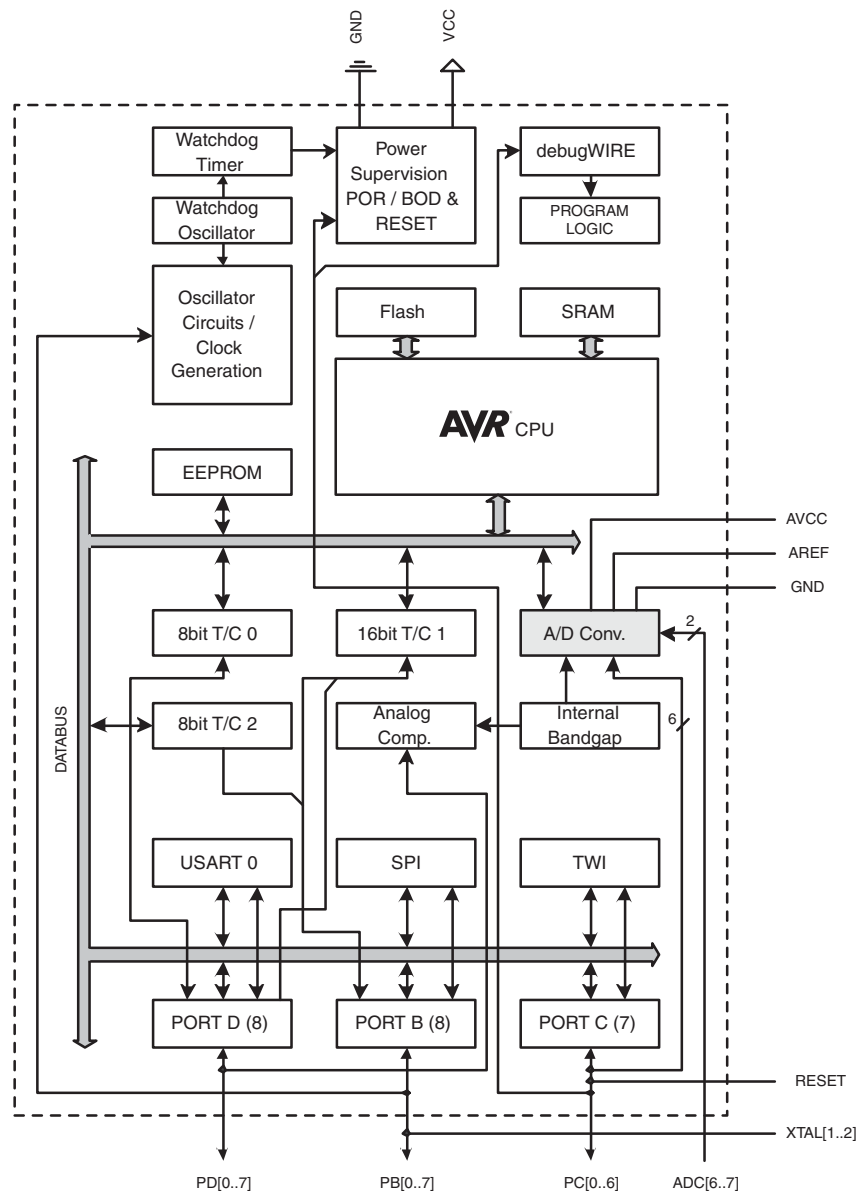
The AVR core combines a rich instruction set with 32 general purpose working registers. All the 32 registers are directly connected to the Arithmetic Logic Unit (ALU), allowing two independent registers to be accessed in one single instruction executed in one clock cycle. The resulting