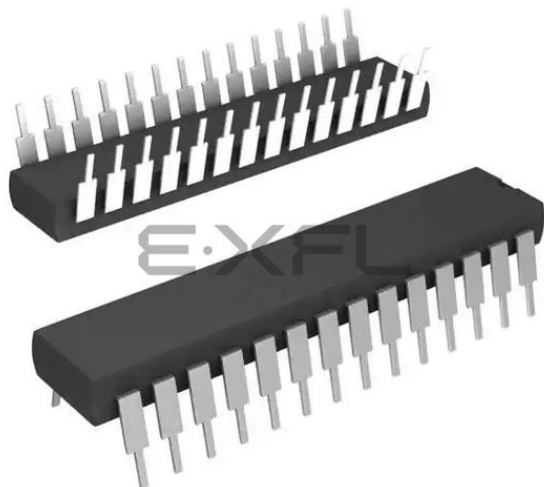




Welcome to [E-XFL.COM](https://www.e-xfl.com)

### What is "[Embedded - Microcontrollers](#)"?

"[Embedded - Microcontrollers](#)" refer to small, integrated circuits designed to perform specific tasks within larger systems. These microcontrollers are essentially compact computers on a single chip, containing a processor core, memory, and programmable input/output peripherals. They are called "embedded" because they are embedded within electronic devices to control various functions, rather than serving as standalone computers. Microcontrollers are crucial in modern electronics, providing the intelligence and control needed for a wide range of applications.

### Applications of "[Embedded - Microcontrollers](#)"

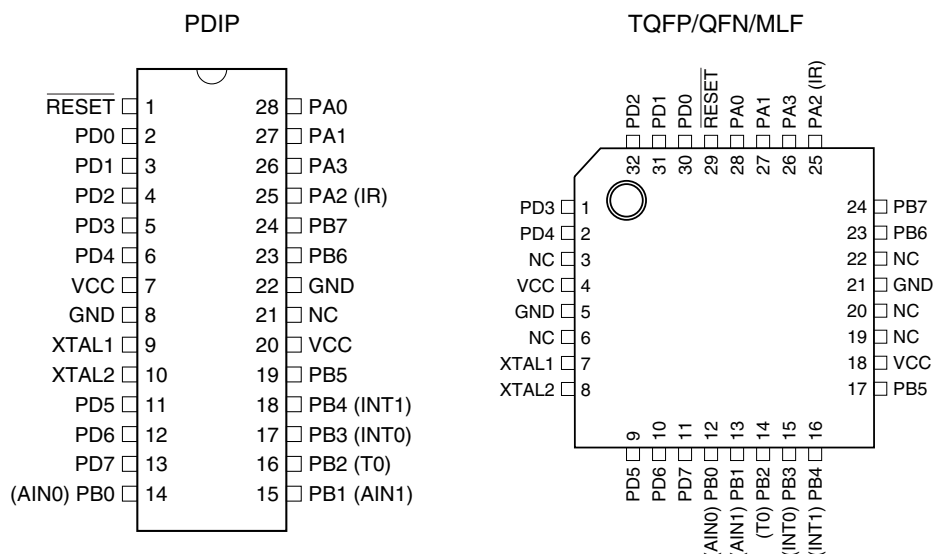
#### Details

|                            |                                                                                                                                                               |
|----------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Product Status             | Obsolete                                                                                                                                                      |
| Core Processor             | AVR                                                                                                                                                           |
| Core Size                  | 8-Bit                                                                                                                                                         |
| Speed                      | 1.2MHz                                                                                                                                                        |
| Connectivity               | -                                                                                                                                                             |
| Peripherals                | POR, WDT                                                                                                                                                      |
| Number of I/O              | 11                                                                                                                                                            |
| Program Memory Size        | 2KB (1K x 16)                                                                                                                                                 |
| Program Memory Type        | FLASH                                                                                                                                                         |
| EEPROM Size                | -                                                                                                                                                             |
| RAM Size                   | -                                                                                                                                                             |
| Voltage - Supply (Vcc/Vdd) | 1.8V ~ 5.5V                                                                                                                                                   |
| Data Converters            | -                                                                                                                                                             |
| Oscillator Type            | Internal                                                                                                                                                      |
| Operating Temperature      | 0°C ~ 70°C (TA)                                                                                                                                               |
| Mounting Type              | Through Hole                                                                                                                                                  |
| Package / Case             | 28-DIP (0.300", 7.62mm)                                                                                                                                       |
| Supplier Device Package    | 28-PDIP                                                                                                                                                       |
| Purchase URL               | <a href="https://www.e-xfl.com/product-detail/microchip-technology/attiny28v-1pc">https://www.e-xfl.com/product-detail/microchip-technology/attiny28v-1pc</a> |

## Features

- Utilizes the AVR<sup>®</sup> RISC Architecture
- AVR – High-performance and Low-power RISC Architecture
  - 90 Powerful Instructions – Most Single Clock Cycle Execution
  - 32 x 8 General-purpose Working Registers
  - Up to 4 MIPS Throughput at 4 MHz
- Nonvolatile Program Memory
  - 2K Bytes of Flash Program Memory
  - Endurance: 1,000 Write/Erase Cycles
  - Programming Lock for Flash Program Data Security
- Peripheral Features
  - Interrupt and Wake-up on Low-level Input
  - One 8-bit Timer/Counter with Separate Prescaler
  - On-chip Analog Comparator
  - Programmable Watchdog Timer with On-chip Oscillator
  - Built-in High-current LED Driver with Programmable Modulation
- Special Microcontroller Features
  - Low-power Idle and Power-down Modes
  - External and Internal Interrupt Sources
  - Power-on Reset Circuit with Programmable Start-up Time
  - Internal Calibrated RC Oscillator
- Power Consumption at 1 MHz, 2V, 25°C
  - Active: 3.0 mA
  - Idle Mode: 1.2 mA
  - Power-down Mode: <1 µA
- I/O and Packages
  - 11 Programmable I/O Lines, 8 Input Lines and a High-current LED Driver
  - 28-lead PDIP, 32-lead TQFP, and 32-pad MLF
- Operating Voltages
  - V<sub>CC</sub>: 1.8V - 5.5V for the ATtiny28V
  - V<sub>CC</sub>: 2.7V - 5.5V for the ATtiny28L
- Speed Grades
  - 0 - 1.2 MHz for the ATtiny28V
  - 0 - 4 MHz For the ATtiny28L

## Pin Configurations



## 8-bit AVR<sup>®</sup> Microcontroller with 2K Bytes of Flash

ATtiny28L  
ATtiny28V

## Summary

Rev. 1062FS-AVR-07/06



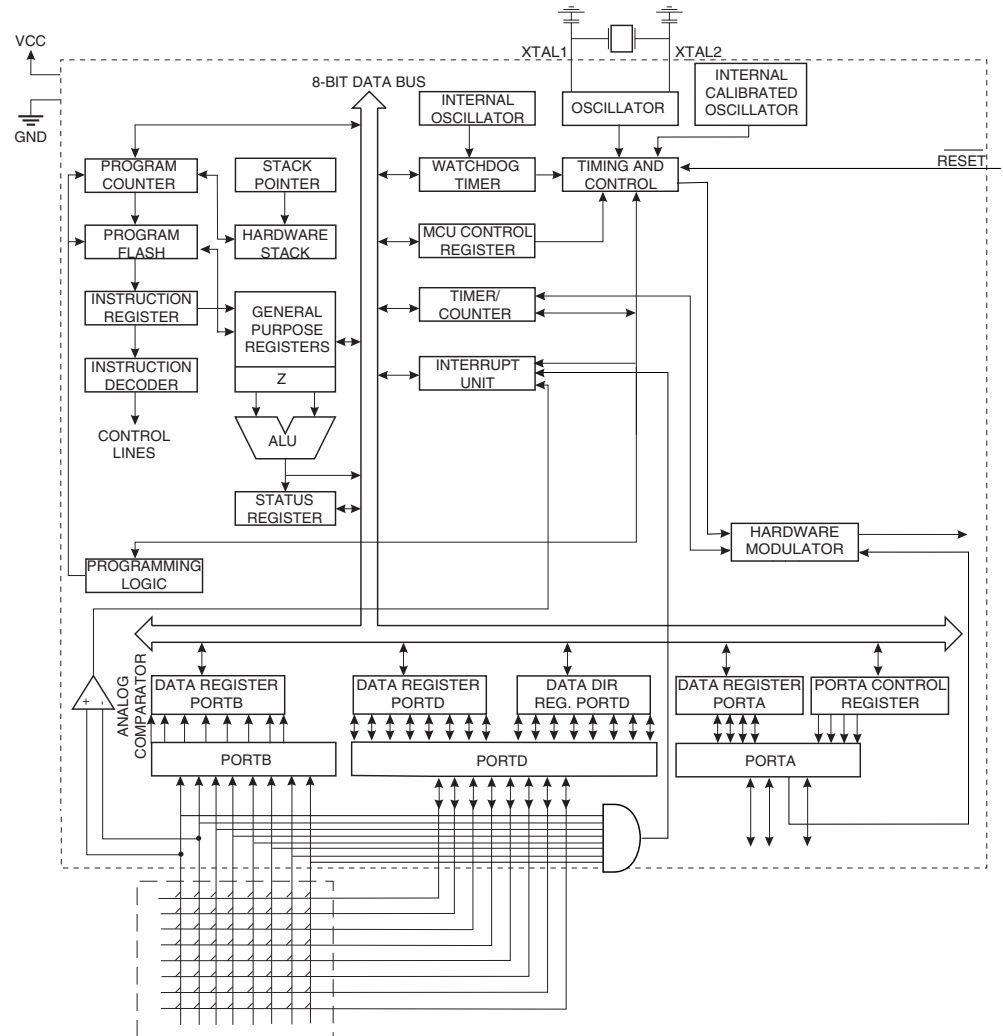
Note: This is a summary document. A complete document is available on our Web site at [www.atmel.com](http://www.atmel.com).

## Description

The ATtiny28 is a low-power CMOS 8-bit microcontroller based on the AVR RISC architecture. By executing powerful instructions in a single clock cycle, the ATtiny28 achieves throughputs approaching 1 MIPS per MHz, allowing the system designer to optimize power consumption versus processing speed. 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 architecture is more code efficient while achieving throughputs up to ten times faster than conventional CISC microcontrollers.

## Block Diagram

**Figure 1.** The ATtiny28 Block Diagram



The ATtiny28 provides the following features: 2K bytes of Flash, 11 general-purpose I/O lines, 8 input lines, a high-current LED driver, 32 general-purpose working registers, an 8-bit timer/counter, internal and external interrupts, programmable Watchdog Timer with internal oscillator and 2 software-selectable power-saving modes. The Idle Mode stops the CPU while allowing the timer/counter and interrupt system to continue functioning. The Power-down mode saves the register contents but freezes the oscillator, disabling all other chip functions until the next interrupt or hardware reset. The wake-up or inter-

rupt on low-level input feature enables the ATtiny28 to be highly responsive to external events, still featuring the lowest power consumption while in the power-down modes.

The device is manufactured using Atmel's high-density, nonvolatile memory technology. By combining an enhanced RISC 8-bit CPU with Flash on a monolithic chip, the Atmel ATtiny28 is a powerful microcontroller that provides a highly flexible and cost-effective solution to many embedded control applications. The ATtiny28 AVR is supported with a full suite of program and system development tools including: macro assemblers, program debugger/simulators, in-circuit emulators and evaluation kits.

## Pin Descriptions

|                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|---------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>VCC</b>                                  | Supply voltage pin.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>GND</b>                                  | Ground pin.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>Port A (PA3..PA0)</b>                    | Port A is a 4-bit I/O port. PA2 is output-only and can be used as a high-current LED driver. At $V_{CC} = 2.0V$ , the PA2 output buffer can sink 25 mA. PA3, PA1 and PA0 are bi-directional I/O pins with internal pull-ups (selected for each bit). The port pins are tri-stated when a reset condition becomes active, even if the clock is not running.                                                                                                                                                                  |
| <b>Port B (PB7..PB0)</b>                    | <p>Port B is an 8-bit input port with internal pull-ups (selected for all Port B pins). Port B pins that are externally pulled low will source current if the pull-ups are activated.</p> <p>Port B also serves the functions of various special features of the ATtiny28 as listed on page 27. If any of the special features are enabled, the pull-up(s) on the corresponding pin(s) is automatically disabled. The port pins are tri-stated when a reset condition becomes active, even if the clock is not running.</p> |
| <b>Port D (PD7..PD0)</b>                    | Port D is an 8-bit I/O port. Port pins can provide internal pull-up resistors (selected for each bit). The port pins are tri-stated when a reset condition becomes active, even if the clock is not running.                                                                                                                                                                                                                                                                                                                |
| <b>XTAL1</b>                                | Input to the inverting oscillator amplifier and input to the internal clock operating circuit.                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <b>XTAL2</b>                                | Output from the inverting oscillator amplifier.                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <b><math>\overline{\text{RESET}}</math></b> | Reset input. An external reset is generated by a low level on the $\overline{\text{RESET}}$ pin. Reset pulses longer than 50 ns will generate a reset, even if the clock is not running. Shorter pulses are not guaranteed to generate a reset.                                                                                                                                                                                                                                                                             |

## Register Summary

| Address | Name     | Bit 7                           | Bit 6  | Bit 5  | Bit 4  | Bit 3  | Bit 2  | Bit 1  | Bit 0  | Page    |
|---------|----------|---------------------------------|--------|--------|--------|--------|--------|--------|--------|---------|
| \$3F    | SREG     | I                               | T      | H      | S      | V      | N      | Z      | C      | page 6  |
| \$3E    | Reserved |                                 |        |        |        |        |        |        |        |         |
| ...     | Reserved |                                 |        |        |        |        |        |        |        |         |
| \$20    | Reserved |                                 |        |        |        |        |        |        |        |         |
| \$1F    | Reserved |                                 |        |        |        |        |        |        |        |         |
| \$1E    | Reserved |                                 |        |        |        |        |        |        |        |         |
| \$1D    | Reserved |                                 |        |        |        |        |        |        |        |         |
| \$1C    | Reserved |                                 |        |        |        |        |        |        |        |         |
| \$1B    | PORTA    | -                               | -      | -      | -      | PORTA3 | PORTA2 | PORTA1 | PORTA0 | page 32 |
| \$1A    | PACR     | -                               | -      | -      | -      | DDA3   | PA2HC  | DDA1   | DDA0   | page 32 |
| \$19    | PINA     | -                               | -      | -      | -      | PINA3  | -      | PINA1  | PINA0  | page 32 |
| \$18    | Reserved |                                 |        |        |        |        |        |        |        |         |
| \$17    | Reserved |                                 |        |        |        |        |        |        |        |         |
| \$16    | PINB     | PINB7                           | PINB6  | PINB5  | PINB4  | PINB3  | PINB2  | PINB1  | PINB0  | page 32 |
| \$15    | Reserved |                                 |        |        |        |        |        |        |        |         |
| \$14    | Reserved |                                 |        |        |        |        |        |        |        |         |
| \$13    | Reserved |                                 |        |        |        |        |        |        |        |         |
| \$12    | PORTD    | PORTD7                          | PORTD6 | PORTD5 | PORTD4 | PORTD3 | PORTD2 | PORTD1 | PORTD0 | page 33 |
| \$11    | DDRD     | DDD7                            | DDD6   | DDD5   | DDD4   | DDD3   | DDD2   | DDD1   | DDD0   | page 33 |
| \$10    | PIND     | PIND7                           | PIND6  | PIND5  | PIND4  | PIND3  | PIND2  | PIND1  | PIND0  | page 33 |
| \$0F    | Reserved |                                 |        |        |        |        |        |        |        |         |
| \$0E    | Reserved |                                 |        |        |        |        |        |        |        |         |
| \$0D    | Reserved |                                 |        |        |        |        |        |        |        |         |
| \$0C    | Reserved |                                 |        |        |        |        |        |        |        |         |
| \$0B    | Reserved |                                 |        |        |        |        |        |        |        |         |
| \$0A    | Reserved |                                 |        |        |        |        |        |        |        |         |
| \$09    | Reserved |                                 |        |        |        |        |        |        |        |         |
| \$08    | ACSR     | ACD                             | -      | ACO    | ACI    | ACIE   | -      | ACIS1  | ACIS0  | page 44 |
| \$07    | MCUCS    | PLUPB                           | -      | SE     | SM     | WDRF   | -      | EXTRF  | PORF   | page 19 |
| \$06    | ICR      | INT1                            | INT0   | LLIE   | TOIE0  | ISC11  | ISC10  | ISC01  | ISC00  | page 22 |
| \$05    | IFR      | INTF1                           | INTF0  | -      | TOV0   | -      | -      | -      | -      | page 23 |
| \$04    | TCCR0    | FOV0                            | -      | -      | OOM01  | OOM00  | CS02   | CS01   | CS00   | page 35 |
| \$03    | TCNT0    | Timer/Counter0 (8-bit)          |        |        |        |        |        |        |        | page 36 |
| \$02    | MODCR    | ONTIM4                          | ONTIM3 | ONTIM2 | ONTIM1 | ONTIM0 | MCONF2 | MCONF1 | MCONF0 | page 43 |
| \$01    | WDTCSR   | -                               | -      | -      | WDTOE  | WDE    | WDP2   | WDP1   | WDP0   | page 37 |
| \$00    | OSCCAL   | Oscillator Calibration Register |        |        |        |        |        |        |        | page 9  |

- Notes:
- For compatibility with future devices, reserved bits should be written to zero if accessed. Reserved I/O memory addresses should never be written.
  - Some of the status flags are cleared by writing a logical “1” to them. Note that the CBI and SBI instructions will operate on all bits in the I/O register, writing a one back into any flag read as set, thus clearing the flag. The CBI and SBI instructions work with registers \$00 to \$1F only.

## Instruction Set Summary

| Mnemonic                                 | Operands | Description                            | Operation                                             | Flags     | # Clocks |
|------------------------------------------|----------|----------------------------------------|-------------------------------------------------------|-----------|----------|
| <b>ARITHMETIC AND LOGIC INSTRUCTIONS</b> |          |                                        |                                                       |           |          |
| ADD                                      | Rd, Rr   | Add Two Registers                      | $Rd \leftarrow Rd + Rr$                               | Z,C,N,V,H | 1        |
| ADC                                      | Rd, Rr   | Add with Carry Two Registers           | $Rd \leftarrow Rd + Rr + C$                           | Z,C,N,V,H | 1        |
| SUB                                      | Rd, Rr   | Subtract Two Registers                 | $Rd \leftarrow Rd - Rr$                               | Z,C,N,V,H | 1        |
| SUBI                                     | Rd, K    | Subtract Constant from Register        | $Rd \leftarrow Rd - K$                                | Z,C,N,V,H | 1        |
| SBC                                      | Rd, Rr   | Subtract with Carry Two Registers      | $Rd \leftarrow Rd - Rr - C$                           | Z,C,N,V,H | 1        |
| SBCI                                     | Rd, K    | Subtract with Carry Constant from Reg. | $Rd \leftarrow Rd - K - C$                            | Z,C,N,V,H | 1        |
| AND                                      | Rd, Rr   | Logical AND Registers                  | $Rd \leftarrow Rd \cdot Rr$                           | Z,N,V     | 1        |
| ANDI                                     | Rd, K    | Logical AND Register and Constant      | $Rd \leftarrow Rd \cdot K$                            | Z,N,V     | 1        |
| OR                                       | Rd, Rr   | Logical OR Registers                   | $Rd \leftarrow Rd \vee Rr$                            | Z,N,V     | 1        |
| ORI                                      | Rd, K    | Logical OR Register and Constant       | $Rd \leftarrow Rd \vee K$                             | Z,N,V     | 1        |
| EOR                                      | Rd, Rr   | Exclusive OR Registers                 | $Rd \leftarrow Rd \oplus Rr$                          | Z,N,V     | 1        |
| COM                                      | Rd       | One's Complement                       | $Rd \leftarrow \$FF - Rd$                             | Z,C,N,V   | 1        |
| NEG                                      | Rd       | Two's Complement                       | $Rd \leftarrow \$00 - Rd$                             | Z,C,N,V,H | 1        |
| SBR                                      | Rd, K    | Set Bit(s) in Register                 | $Rd \leftarrow Rd \vee K$                             | Z,N,V     | 1        |
| CBR                                      | Rd, K    | Clear Bit(s) in Register               | $Rd \leftarrow Rd \cdot (FFh - K)$                    | Z,N,V     | 1        |
| INC                                      | Rd       | Increment                              | $Rd \leftarrow Rd + 1$                                | Z,N,V     | 1        |
| DEC                                      | Rd       | Decrement                              | $Rd \leftarrow Rd - 1$                                | Z,N,V     | 1        |
| TST                                      | Rd       | Test for Zero or Minus                 | $Rd \leftarrow Rd \cdot Rd$                           | Z,N,V     | 1        |
| CLR                                      | Rd       | Clear Register                         | $Rd \leftarrow Rd \oplus Rd$                          | Z,N,V     | 1        |
| SER                                      | Rd       | Set Register                           | $Rd \leftarrow \$FF$                                  | None      | 1        |
| <b>BRANCH INSTRUCTIONS</b>               |          |                                        |                                                       |           |          |
| RJMP                                     | k        | Relative Jump                          | $PC \leftarrow PC + k + 1$                            | None      | 2        |
| RCALL                                    | k        | Relative Subroutine Call               | $PC \leftarrow PC + k + 1$                            | None      | 3        |
| RET                                      |          | Subroutine Return                      | $PC \leftarrow STACK$                                 | None      | 4        |
| RETI                                     |          | Interrupt Return                       | $PC \leftarrow STACK$                                 | I         | 4        |
| CPSE                                     | Rd, Rr   | Compare, Skip if Equal                 | if $(Rd = Rr)$ $PC \leftarrow PC + 2$ or 3            | None      | 1/2      |
| CP                                       | Rd, Rr   | Compare                                | $Rd - Rr$                                             | Z,N,V,C,H | 1        |
| CPC                                      | Rd, Rr   | Compare with Carry                     | $Rd - Rr - C$                                         | Z,N,V,C,H | 1        |
| CPI                                      | Rd, K    | Compare Register with Immediate        | $Rd - K$                                              | Z,N,V,C,H | 1        |
| SBRC                                     | Rr, b    | Skip if Bit in Register Cleared        | if $(Rr(b) = 0)$ $PC \leftarrow PC + 2$ or 3          | None      | 1/2      |
| SBRS                                     | Rr, b    | Skip if Bit in Register is Set         | if $(Rr(b) = 1)$ $PC \leftarrow PC + 2$ or 3          | None      | 1/2      |
| SBIC                                     | P, b     | Skip if Bit in I/O Register Cleared    | if $(P(b) = 0)$ $PC \leftarrow PC + 2$ or 3           | None      | 1/2      |
| SBIS                                     | P, b     | Skip if Bit in I/O Register is Set     | if $(P(b) = 1)$ $PC \leftarrow PC + 2$ or 3           | None      | 1/2      |
| BRBS                                     | s, k     | Branch if Status Flag Set              | if $(SREG(s) = 1)$ then $PC \leftarrow PC + k + 1$    | None      | 1/2      |
| BRBC                                     | s, k     | Branch if Status Flag Cleared          | if $(SREG(s) = 0)$ then $PC \leftarrow PC + k + 1$    | None      | 1/2      |
| BREQ                                     | k        | Branch if Equal                        | if $(Z = 1)$ then $PC \leftarrow PC + k + 1$          | None      | 1/2      |
| BRNE                                     | k        | Branch if Not Equal                    | if $(Z = 0)$ then $PC \leftarrow PC + k + 1$          | None      | 1/2      |
| BRCS                                     | k        | Branch if Carry Set                    | if $(C = 1)$ then $PC \leftarrow PC + k + 1$          | None      | 1/2      |
| BRCC                                     | k        | Branch if Carry Cleared                | if $(C = 0)$ then $PC \leftarrow PC + k + 1$          | None      | 1/2      |
| BRSH                                     | k        | Branch if Same or Higher               | if $(C = 0)$ then $PC \leftarrow PC + k + 1$          | None      | 1/2      |
| BRLO                                     | k        | Branch if Lower                        | if $(C = 1)$ then $PC \leftarrow PC + k + 1$          | None      | 1/2      |
| BRMI                                     | k        | Branch if Minus                        | if $(N = 1)$ then $PC \leftarrow PC + k + 1$          | None      | 1/2      |
| BRPL                                     | k        | Branch if Plus                         | if $(N = 0)$ then $PC \leftarrow PC + k + 1$          | None      | 1/2      |
| BRGE                                     | k        | Branch if Greater or Equal, Signed     | if $(N \oplus V = 0)$ then $PC \leftarrow PC + k + 1$ | None      | 1/2      |
| BRLT                                     | k        | Branch if Less than Zero, Signed       | if $(N \oplus V = 1)$ then $PC \leftarrow PC + k + 1$ | None      | 1/2      |
| BRHS                                     | k        | Branch if Half-carry Flag Set          | if $(H = 1)$ then $PC \leftarrow PC + k + 1$          | None      | 1/2      |
| BRHC                                     | k        | Branch if Half-carry Flag Cleared      | if $(H = 0)$ then $PC \leftarrow PC + k + 1$          | None      | 1/2      |
| BRTS                                     | k        | Branch if T-flag Set                   | if $(T = 1)$ then $PC \leftarrow PC + k + 1$          | None      | 1/2      |
| BRTC                                     | k        | Branch if T-flag Cleared               | if $(T = 0)$ then $PC \leftarrow PC + k + 1$          | None      | 1/2      |
| BRVS                                     | k        | Branch if Overflow Flag is Set         | if $(V = 1)$ then $PC \leftarrow PC + k + 1$          | None      | 1/2      |
| BRVC                                     | k        | Branch if Overflow Flag is Cleared     | if $(V = 0)$ then $PC \leftarrow PC + k + 1$          | None      | 1/2      |
| BRIE                                     | k        | Branch if Interrupt Enabled            | if $(I = 1)$ then $PC \leftarrow PC + k + 1$          | None      | 1/2      |
| BRID                                     | k        | Branch if Interrupt Disabled           | if $(I = 0)$ then $PC \leftarrow PC + k + 1$          | None      | 1/2      |

## Instruction Set Summary (Continued)

| Mnemonic                             | Operands | Description                     | Operation                                                          | Flags   | # Clocks |
|--------------------------------------|----------|---------------------------------|--------------------------------------------------------------------|---------|----------|
| <b>DATA TRANSFER INSTRUCTIONS</b>    |          |                                 |                                                                    |         |          |
| LD                                   | Rd, Z    | Load Register Indirect          | $Rd \leftarrow (Z)$                                                | None    | 2        |
| ST                                   | Z, Rr    | Store Register Indirect         | $(Z) \leftarrow Rr$                                                | None    | 2        |
| MOV                                  | Rd, Rr   | Move between Registers          | $Rd \leftarrow Rr$                                                 | None    | 1        |
| LDI                                  | Rd, K    | Load Immediate                  | $Rd \leftarrow K$                                                  | None    | 1        |
| IN                                   | Rd, P    | In Port                         | $Rd \leftarrow P$                                                  | None    | 1        |
| OUT                                  | P, Rr    | Out Port                        | $P \leftarrow Rr$                                                  | None    | 1        |
| LPM                                  |          | Load Program Memory             | $R0 \leftarrow (Z)$                                                | None    | 3        |
| <b>BIT AND BIT-TEST INSTRUCTIONS</b> |          |                                 |                                                                    |         |          |
| SBI                                  | P, b     | Set Bit in I/O Register         | $I/O(P,b) \leftarrow 1$                                            | None    | 2        |
| CBI                                  | P, b     | Clear Bit in I/O Register       | $I/O(P,b) \leftarrow 0$                                            | None    | 2        |
| LSL                                  | Rd       | Logical Shift Left              | $Rd(n+1) \leftarrow Rd(n), Rd(0) \leftarrow 0$                     | Z,C,N,V | 1        |
| LSR                                  | Rd       | Logical Shift Right             | $Rd(n) \leftarrow Rd(n+1), Rd(7) \leftarrow 0$                     | Z,C,N,V | 1        |
| ROL                                  | Rd       | Rotate Left through Carry       | $Rd(0) \leftarrow C, Rd(n+1) \leftarrow Rd(n), C \leftarrow Rd(7)$ | Z,C,N,V | 1        |
| ROR                                  | Rd       | Rotate Right through Carry      | $Rd(7) \leftarrow C, Rd(n) \leftarrow Rd(n+1), C \leftarrow Rd(0)$ | Z,C,N,V | 1        |
| ASR                                  | Rd       | Arithmetic Shift Right          | $Rd(n) \leftarrow Rd(n+1), n = 0..6$                               | Z,C,N,V | 1        |
| SWAP                                 | Rd       | Swap Nibbles                    | $Rd(3..0) \leftarrow Rd(7..4), Rd(7..4) \leftarrow Rd(3..0)$       | None    | 1        |
| BSET                                 | s        | Flag Set                        | $SREG(s) \leftarrow 1$                                             | SREG(s) | 1        |
| BCLR                                 | s        | Flag Clear                      | $SREG(s) \leftarrow 0$                                             | SREG(s) | 1        |
| BST                                  | Rr, b    | Bit Store from Register to T    | $T \leftarrow Rr(b)$                                               | T       | 1        |
| BLD                                  | Rd, b    | Bit Load from T to Register     | $Rd(b) \leftarrow T$                                               | None    | 1        |
| SEC                                  |          | Set Carry                       | $C \leftarrow 1$                                                   | C       | 1        |
| CLC                                  |          | Clear Carry                     | $C \leftarrow 0$                                                   | C       | 1        |
| SEN                                  |          | Set Negative Flag               | $N \leftarrow 1$                                                   | N       | 1        |
| CLN                                  |          | Clear Negative Flag             | $N \leftarrow 0$                                                   | N       | 1        |
| SEZ                                  |          | Set Zero Flag                   | $Z \leftarrow 1$                                                   | Z       | 1        |
| CLZ                                  |          | Clear Zero Flag                 | $Z \leftarrow 0$                                                   | Z       | 1        |
| SEI                                  |          | Global Interrupt Enable         | $I \leftarrow 1$                                                   | I       | 1        |
| CLI                                  |          | Global Interrupt Disable        | $I \leftarrow 0$                                                   | I       | 1        |
| SES                                  |          | Set Signed Test Flag            | $S \leftarrow 1$                                                   | S       | 1        |
| CLS                                  |          | Clear Signed Test Flag          | $S \leftarrow 0$                                                   | S       | 1        |
| SEV                                  |          | Set Two's Complement Overflow   | $V \leftarrow 1$                                                   | V       | 1        |
| CLV                                  |          | Clear Two's Complement Overflow | $V \leftarrow 0$                                                   | V       | 1        |
| SET                                  |          | Set T in SREG                   | $T \leftarrow 1$                                                   | T       | 1        |
| CLT                                  |          | Clear T in SREG                 | $T \leftarrow 0$                                                   | T       | 1        |
| SEH                                  |          | Set Half-carry Flag in SREG     | $H \leftarrow 1$                                                   | H       | 1        |
| CLH                                  |          | Clear Half-carry Flag in SREG   | $H \leftarrow 0$                                                   | H       | 1        |
| NOP                                  |          | No Operation                    |                                                                    | None    | 1        |
| SLEEP                                |          | Sleep                           | (see specific descr. for Sleep function)                           | None    | 1        |
| WDR                                  |          | Watchdog Reset                  | (see specific descr. for WDR/timer)                                | None    | 1        |

## Ordering Information

| Speed (MHz) | Power Supply (Volts) | Ordering Code                | Package <sup>(1)</sup> | Operation Range               |
|-------------|----------------------|------------------------------|------------------------|-------------------------------|
| 4           | 2.7 - 5.5            | ATtiny28L-4AC                | 32A                    | Commercial<br>(0°C to 70°C)   |
|             |                      | ATtiny28L-4PC                | 28P3                   |                               |
|             |                      | ATtiny28L-4MC                | 32M1-A                 |                               |
|             |                      | ATtiny28L-4AI                | 32A                    | Industrial<br>(-40°C to 85°C) |
|             |                      | ATtiny28L-4AU <sup>(2)</sup> | 32A                    |                               |
|             |                      | ATtiny28L-4PI                | 28P3                   |                               |
| 1.2         | 1.8 - 5.5            | ATtiny28L-4PU <sup>(2)</sup> | 28P3                   |                               |
|             |                      | ATtiny28L-4MI                | 32M1-A                 |                               |
|             |                      | ATtiny28L-4MU <sup>(2)</sup> | 32M1-A                 |                               |
|             |                      | ATtiny28V-1AC                | 32A                    | Commercial<br>(0°C to 70°C)   |
|             |                      | ATtiny28V-1PC                | 28P3                   |                               |
|             |                      | ATtiny28V-1MC                | 32M1-A                 |                               |
|             |                      | ATtiny28V-1AI                | 32A                    | Industrial<br>(-40°C to 85°C) |
|             |                      | ATtiny28V-1AU <sup>(2)</sup> | 32A                    |                               |
|             |                      | ATtiny28V-1PI                | 28P3                   |                               |
|             |                      | ATtiny28V-1PU <sup>(2)</sup> | 28P3                   |                               |
|             |                      | ATtiny28V-1MI                | 32M1-A                 |                               |
|             |                      | ATtiny28V-1MU <sup>(2)</sup> | 32M1-A                 |                               |

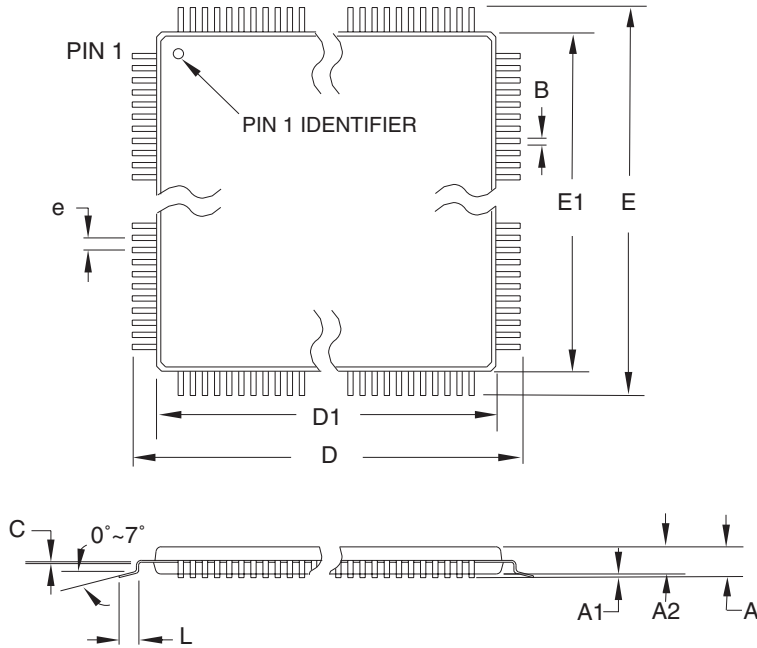
- Notes:
1. This device can also be supplied in wafer form. Please contact your local Atmel sales office for detailed ordering information and minimum quantities.
  2. Pb-free packaging alternative, complies to the European Directive for Restriction of Hazardous Substances (RoHS directive). Also Halide free and fully Green.

| Package Type  |                                                                                               |
|---------------|-----------------------------------------------------------------------------------------------|
| <b>32A</b>    | 32-lead, Thin (1.0 mm) Plastic Quad Flat Package (TQFP)                                       |
| <b>28P3</b>   | 28-lead, 0.300" Wide, Plastic Dual Inline Package (PDIP)                                      |
| <b>32M1-A</b> | 32-pad, 5x5x1.0 body, Lead Pitch 0.50mm, Quad Flat No-lead/Micro Lead Frame Package (QFN/MLF) |



## Packaging Information

32A



**COMMON DIMENSIONS**  
(Unit of Measure = mm)

| SYMBOL | MIN      | NOM  | MAX  | NOTE   |
|--------|----------|------|------|--------|
| A      | —        | —    | 1.20 |        |
| A1     | 0.05     | —    | 0.15 |        |
| A2     | 0.95     | 1.00 | 1.05 |        |
| D      | 8.75     | 9.00 | 9.25 |        |
| D1     | 6.90     | 7.00 | 7.10 | Note 2 |
| E      | 8.75     | 9.00 | 9.25 |        |
| E1     | 6.90     | 7.00 | 7.10 | Note 2 |
| B      | 0.30     | —    | 0.45 |        |
| C      | 0.09     | —    | 0.20 |        |
| L      | 0.45     | —    | 0.75 |        |
| e      | 0.80 TYP |      |      |        |

- Notes:
1. This package conforms to JEDEC reference MS-026, Variation ABA.
  2. Dimensions D1 and E1 do not include mold protrusion. Allowable protrusion is 0.25 mm per side. Dimensions D1 and E1 are maximum plastic body size dimensions including mold mismatch.
  3. Lead coplanarity is 0.10 mm maximum.

10/5/2001



2325 Orchard Parkway  
San Jose, CA 95131

### TITLE

**32A**, 32-lead, 7 x 7 mm Body Size, 1.0 mm Body Thickness,  
0.8 mm Lead Pitch, Thin Profile Plastic Quad Flat Package (TQFP)

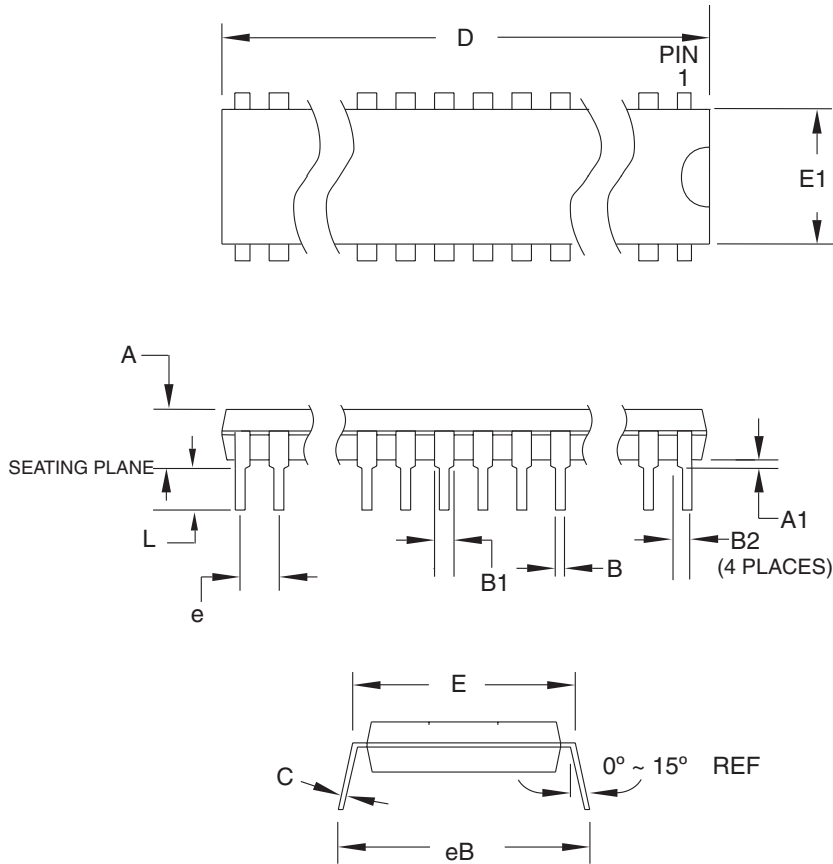
### DRAWING NO.

32A

### REV.

B

## 28P3



**COMMON DIMENSIONS**  
(Unit of Measure = mm)

| SYMBOL | MIN       | NOM | MAX    | NOTE   |
|--------|-----------|-----|--------|--------|
| A      | —         | —   | 4.5724 |        |
| A1     | 0.508     | —   | —      |        |
| D      | 34.544    | —   | 34.798 | Note 1 |
| E      | 7.620     | —   | 8.255  |        |
| E1     | 7.112     | —   | 7.493  | Note 1 |
| B      | 0.381     | —   | 0.533  |        |
| B1     | 1.143     | —   | 1.397  |        |
| B2     | 0.762     | —   | 1.143  |        |
| L      | 3.175     | —   | 3.429  |        |
| C      | 0.203     | —   | 0.356  |        |
| eB     | —         | —   | 10.160 |        |
| e      | 2.540 TYP |     |        |        |

Note: 1. Dimensions D and E1 do not include mold Flash or Protrusion.  
Mold Flash or Protrusion shall not exceed 0.25 mm (0.010").

09/28/01



2325 Orchard Parkway  
San Jose, CA 95131

### TITLE

**28P3**, 28-lead (0.300"/7.62 mm Wide) Plastic Dual  
Inline Package (PDIP)

### DRAWING NO.

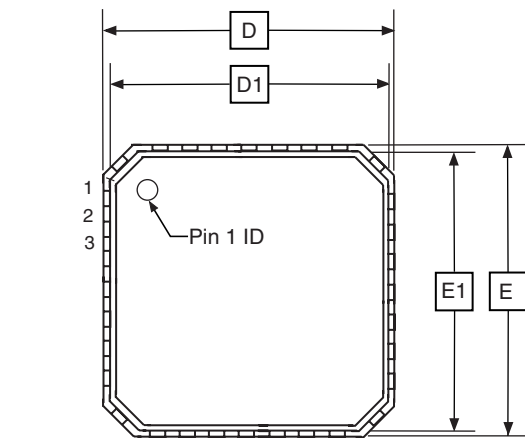
28P3

### REV.

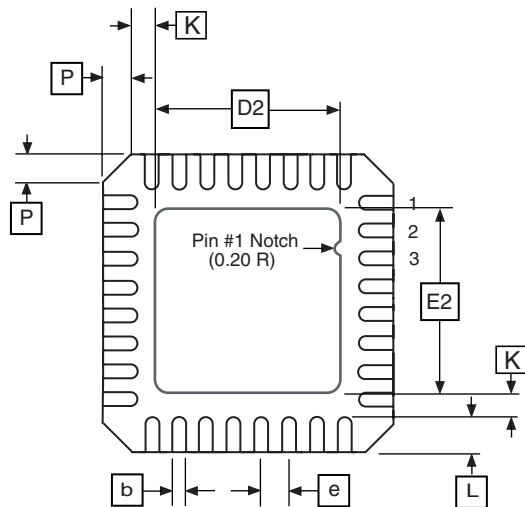
B



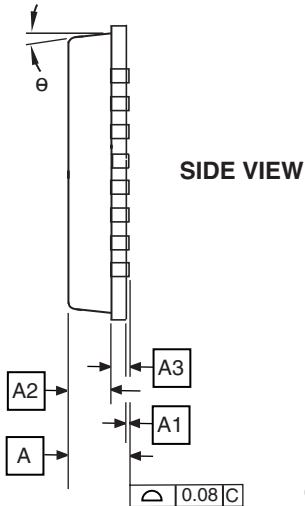
# 32M1-A



TOP VIEW



BOTTOM VIEW



SIDE VIEW

COMMON DIMENSIONS  
(Unit of Measure = mm)

| SYMBOL | MIN      | NOM  | MAX  | NOTE |
|--------|----------|------|------|------|
| A      | 0.80     | 0.90 | 1.00 |      |
| A1     | —        | 0.02 | 0.05 |      |
| A2     | —        | 0.65 | 1.00 |      |
| A3     | 0.20 REF |      |      |      |
| b      | 0.18     | 0.23 | 0.30 |      |
| D      | 4.90     | 5.00 | 5.10 |      |
| D1     | 4.70     | 4.75 | 4.80 |      |
| D2     | 2.95     | 3.10 | 3.25 |      |
| E      | 4.90     | 5.00 | 5.10 |      |
| E1     | 4.70     | 4.75 | 4.80 |      |
| E2     | 2.95     | 3.10 | 3.25 |      |
| e      | 0.50 BSC |      |      |      |
| L      | 0.30     | 0.40 | 0.50 |      |
| P      | —        | —    | 0.60 |      |
| Θ      | —        | —    | 12°  |      |
| K      | 0.20     | —    | —    |      |

Note: JEDEC Standard MO-220, Fig. 2 (Anvil Singulation), VHHD-2.

5/25/06



2325 Orchard Parkway  
San Jose, CA 95131

## TITLE

**32M1-A**, 32-pad, 5 x 5 x 1.0 mm Body, Lead Pitch 0.50 mm,  
3.10 mm Exposed Pad, Micro Lead Frame Package (MLF)

## DRAWING NO.

32M1-A

## REV.

E

## **Errata**

### **All revisions**

No known errata.

## Datasheet Revision History

Please note that the referring page numbers in this section are referred to this document. The referring revision in this section are referring to the document revision.

### Rev – 01/06G

1. Updated chapter layout.
2. Updated “Ordering Information” on page 7.

### Rev – 01/06G

1. Updated description for “Port A” on page 25.
2. Added note 6 in “DC Characteristics” on page 54.
3. Updated “Ordering Information” on page 7.
4. Added “Errata” on page 11.

### Rev – 03/05F

1. Updated “Electrical Characteristics” on page 54.
2. MLF-package alternative changed to “Quad Flat No-Lead/Micro Lead Frame Package QFN/MLF”.
3. Updated “Ordering Information” on page 7.



## Atmel Corporation

2325 Orchard Parkway  
San Jose, CA 95131, USA  
Tel: 1(408) 441-0311  
Fax: 1(408) 487-2600

## Regional Headquarters

### Europe

Atmel Sarl  
Route des Arsenalux 41  
Case Postale 80  
CH-1705 Fribourg  
Switzerland  
Tel: (41) 26-426-5555  
Fax: (41) 26-426-5500

### Asia

Room 1219  
Chinachem Golden Plaza  
77 Mody Road Tsimshatsui  
East Kowloon  
Hong Kong  
Tel: (852) 2721-9778  
Fax: (852) 2722-1369

### Japan

9F, Tonetsu Shinkawa Bldg.  
1-24-8 Shinkawa  
Chuo-ku, Tokyo 104-0033  
Japan  
Tel: (81) 3-3523-3551  
Fax: (81) 3-3523-7581

## Atmel Operations

### Memory

2325 Orchard Parkway  
San Jose, CA 95131, USA  
Tel: 1(408) 441-0311  
Fax: 1(408) 436-4314

### Microcontrollers

2325 Orchard Parkway  
San Jose, CA 95131, USA  
Tel: 1(408) 441-0311  
Fax: 1(408) 436-4314

La Chantrerie  
BP 70602  
44306 Nantes Cedex 3, France  
Tel: (33) 2-40-18-18-18  
Fax: (33) 2-40-18-19-60

### ASIC/ASSP/Smart Cards

Zone Industrielle  
13106 Rousset Cedex, France  
Tel: (33) 4-42-53-60-00  
Fax: (33) 4-42-53-60-01

1150 East Cheyenne Mtn. Blvd.  
Colorado Springs, CO 80906, USA  
Tel: 1(719) 576-3300  
Fax: 1(719) 540-1759

Scottish Enterprise Technology Park  
Maxwell Building  
East Kilbride G75 0QR, Scotland  
Tel: (44) 1355-803-000  
Fax: (44) 1355-242-743

### RF/Automotive

Theresienstrasse 2  
Postfach 3535  
74025 Heilbronn, Germany  
Tel: (49) 71-31-67-0  
Fax: (49) 71-31-67-2340

1150 East Cheyenne Mtn. Blvd.  
Colorado Springs, CO 80906, USA  
Tel: 1(719) 576-3300  
Fax: 1(719) 540-1759

### Biometrics/Imaging/Hi-Rel MPU/ High Speed Converters/RF Datacom

Avenue de Rochepleine  
BP 123  
38521 Saint-Egreve Cedex, France  
Tel: (33) 4-76-58-30-00  
Fax: (33) 4-76-58-34-80

---

### Literature Requests

[www.atmel.com/literature](http://www.atmel.com/literature)

**Disclaimer:** The information in this document is provided in connection with Atmel products. No license, express or implied, by estoppel or otherwise, to any intellectual property right is granted by this document or in connection with the sale of Atmel products. **EXCEPT AS SET FORTH IN ATMEL'S TERMS AND CONDITIONS OF SALE LOCATED ON ATMEL'S WEB SITE, ATMEL ASSUMES NO LIABILITY WHATSOEVER AND DISCLAIMS ANY EXPRESS, IMPLIED OR STATUTORY WARRANTY RELATING TO ITS PRODUCTS INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTY OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, OR NON-INFRINGEMENT. IN NO EVENT SHALL ATMEL BE LIABLE FOR ANY DIRECT, INDIRECT, CONSEQUENTIAL, PUNITIVE, SPECIAL OR INCIDENTAL DAMAGES (INCLUDING, WITHOUT LIMITATION, DAMAGES FOR LOSS OF PROFITS, BUSINESS INTERRUPTION, OR LOSS OF INFORMATION) ARISING OUT OF THE USE OR INABILITY TO USE THIS DOCUMENT, EVEN IF ATMEL HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES.** Atmel makes no representations or warranties with respect to the accuracy or completeness of the contents of this document and reserves the right to make changes to specifications and product descriptions at any time without notice. Atmel does not make any commitment to update the information contained herein. Unless specifically provided otherwise, Atmel products are not suitable for, and shall not be used in, automotive applications. Atmel's products are not intended, authorized, or warranted for use as components in applications intended to support or sustain life.

© 2006 Atmel Corporation. All rights reserved. ATMEL®, logo and combinations thereof, Everywhere You Are®, AVR®, AVR Studio®, and others, are registered trademarks or trademarks of Atmel Corporation or its subsidiaries. Other terms and product names may be trademarks of others.