

## Features

- High-performance, Low-power AVR<sup>®</sup> 8-bit Microcontroller
- Advanced RISC Architecture
  - 130 Powerful Instructions – Most Single Clock Cycle Execution
  - 32 x 8 General Purpose Working Registers
  - Fully Static Operation
  - Up to 16 MIPS Throughput at 16 MHz
  - On-chip 2-cycle Multiplier
- Nonvolatile Program and Data Memories
  - 8K Bytes of In-System Self-Programmable Flash
    - Endurance: 10,000 Write/Erase Cycles
  - Optional Boot Code Section with Independent Lock Bits
    - In-System Programming by On-chip Boot Program
    - True Read-While-Write Operation
  - 512 Bytes EEPROM
    - Endurance: 100,000 Write/Erase Cycles
  - 512 Bytes Internal SRAM
  - Programming Lock for Software Security
- Peripheral Features
  - Two 8-bit Timer/Counters with Separate Prescalers and Compare Modes
  - One 16-bit Timer/Counter with Separate Prescaler, Compare Mode, and Capture Mode
  - Real Time Counter with Separate Oscillator
  - Four PWM Channels
  - 8-channel, 10-bit ADC
    - 8 Single-ended Channels
    - 7 Differential Channels for TQFP Package Only
    - 2 Differential Channels with Programmable Gain at 1x, 10x, or 200x for TQFP Package Only
  - Byte-oriented Two-wire Serial Interface
  - Programmable Serial USART
  - Master/Slave SPI Serial Interface
  - Programmable Watchdog Timer with Separate On-chip Oscillator
  - On-chip Analog Comparator
- Special Microcontroller Features
  - Power-on Reset and Programmable Brown-out Detection
  - Internal Calibrated RC 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
  - 32 Programmable I/O Lines
  - 40-pin PDIP, 44-lead TQFP, 44-lead PLCC, and 44-pad QFN/MLF
- Operating Voltages
  - 2.7 - 5.5V for ATmega8535L
  - 4.5 - 5.5V for ATmega8535
- Speed Grades
  - 0 - 8 MHz for ATmega8535L
  - 0 - 16 MHz for ATmega8535



## 8-bit AVR<sup>®</sup> Microcontroller with 8K Bytes In-System Programmable Flash

**ATmega8535**  
**ATmega8535L**

## Summary

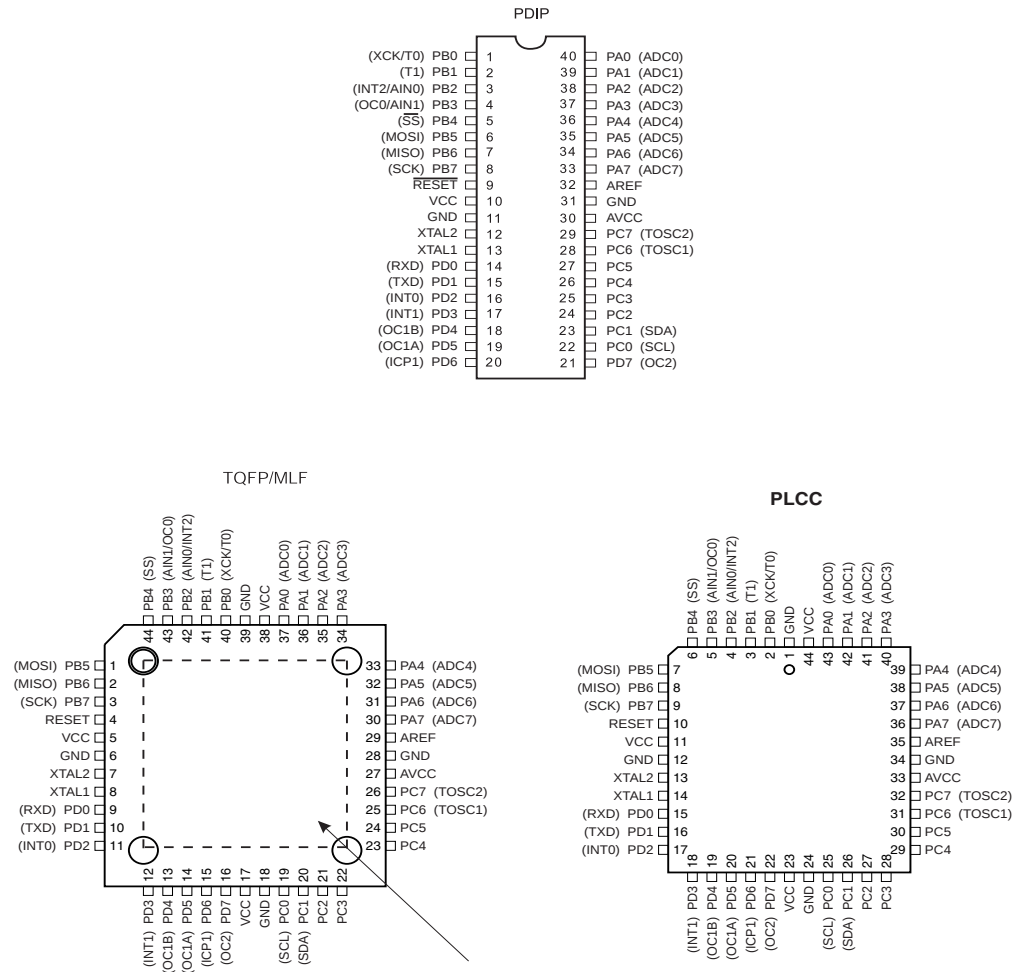
2502KS-AVR-10/06



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

## Pin Configurations

Figure 1. Pinout ATmega8535



NOTE: MLF Bottom pad should be soldered to ground.

## Disclaimer

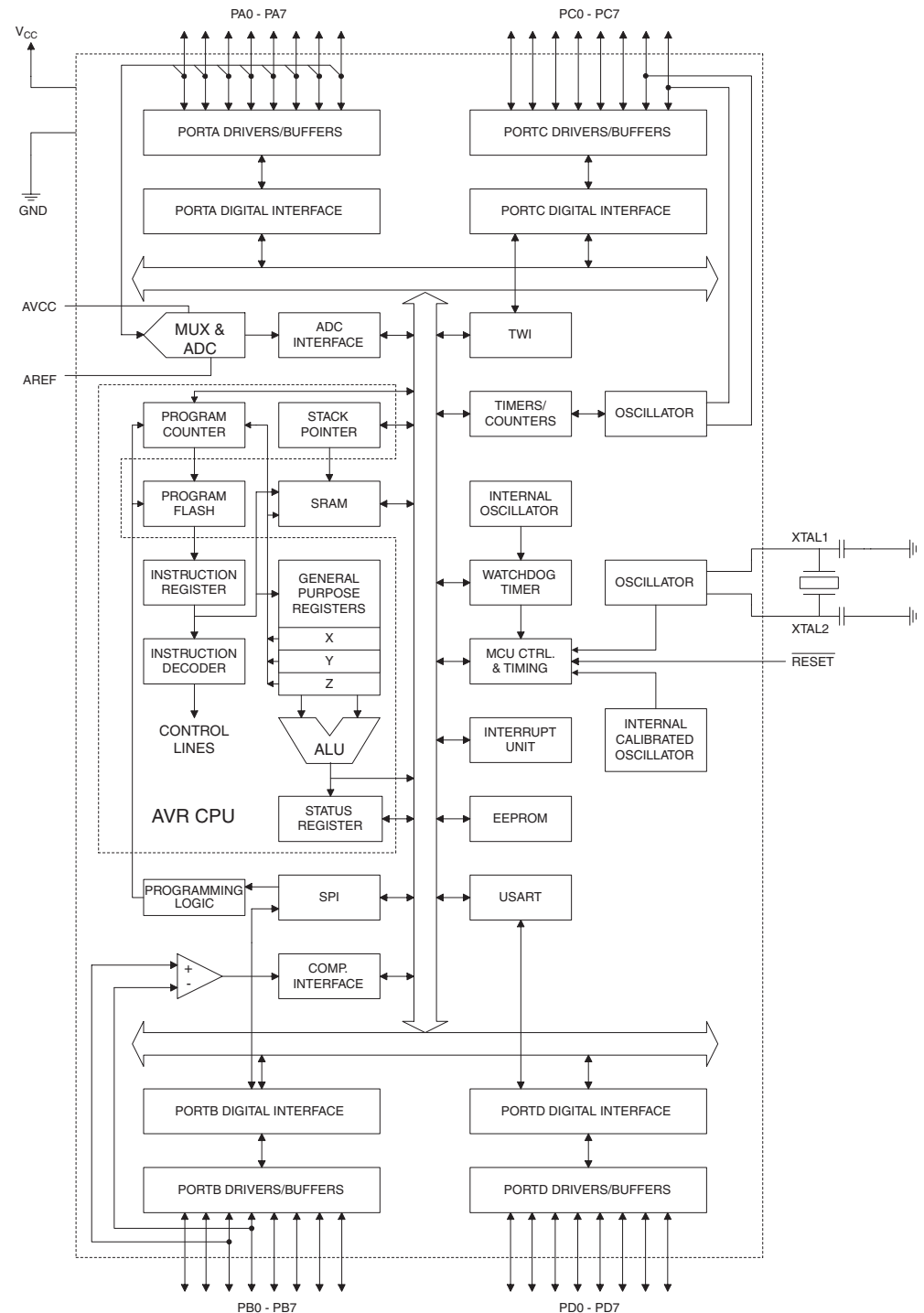
Typical values contained in this data sheet are based on simulations and characterization of other AVR microcontrollers manufactured on the same process technology. Min and Max values will be available after the device is characterized.

## Overview

The ATmega8535 is a low-power CMOS 8-bit microcontroller based on the AVR enhanced RISC architecture. By executing instructions in a single clock cycle, the ATmega8535 achieves throughputs approaching 1 MIPS per MHz allowing the system designer to optimize power consumption versus processing speed.

## Block Diagram

**Figure 2. Block Diagram**





The AVR core combines a rich instruction set with 32 general purpose working registers. All 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.

The ATmega8535 provides the following features: 8K bytes of In-System Programmable Flash with Read-While-Write capabilities, 512 bytes EEPROM, 512 bytes SRAM, 32 general purpose I/O lines, 32 general purpose working registers, three flexible Timer/Counters with compare modes, internal and external interrupts, a serial programmable USART, a byte oriented Two-wire Serial Interface, an 8-channel, 10-bit ADC with optional differential input stage with programmable gain in TQFP package, a programmable Watchdog Timer with Internal Oscillator, an SPI serial port, and six software selectable power saving modes. The Idle mode stops the CPU while allowing the SRAM, Timer/Counters, SPI port, 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. In Power-save mode, the asynchronous timer continues to run, allowing the user to maintain a timer base while the rest of the device is sleeping. The ADC Noise Reduction mode stops the CPU and all I/O modules except asynchronous timer and ADC, to minimize switching noise during ADC conversions. In Standby mode, the crystal/resonator Oscillator is running while the rest of the device is sleeping. This allows very fast start-up combined with low-power consumption. In Extended Standby mode, both the main Oscillator and the asynchronous timer continue to run.

The device is manufactured using Atmel's high density nonvolatile memory technology. The On-chip ISP Flash allows the program memory to be reprogrammed In-System through an SPI serial interface, by a conventional nonvolatile memory programmer, or by an On-chip Boot program running on the AVR core. The boot program can use any interface to download the application program in the Application Flash memory. Software in the Boot Flash section will continue to run while the Application Flash section is updated, providing true Read-While-Write operation. By combining an 8-bit RISC CPU with In-System Self-Programmable Flash on a monolithic chip, the Atmel ATmega8535 is a powerful microcontroller that provides a highly flexible and cost effective solution to many embedded control applications.

The ATmega8535 AVR is supported with a full suite of program and system development tools including: C compilers, macro assemblers, program debugger/simulators, In-Circuit Emulators, and evaluation kits.

## **AT90S8535 Compatibility**

The ATmega8535 provides all the features of the AT90S8535. In addition, several new features are added. The ATmega8535 is backward compatible with AT90S8535 in most cases. However, some incompatibilities between the two microcontrollers exist. To solve this problem, an AT90S8535 compatibility mode can be selected by programming the S8535C fuse. ATmega8535 is pin compatible with AT90S8535, and can replace the AT90S8535 on current Printed Circuit Boards. However, the location of fuse bits and the electrical characteristics differs between the two devices.

### **AT90S8535 Compatibility Mode**

Programming the S8535C fuse will change the following functionality:

- The timed sequence for changing the Watchdog Time-out period is disabled. See "Timed Sequences for Changing the Configuration of the Watchdog Timer" on page 45 for details.
- The double buffering of the USART Receive Register is disabled. See "AVR USART vs. AVR UART – Compatibility" on page 146 for details.

## Pin Descriptions

|                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|--------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>V<sub>CC</sub></b>    | Digital supply voltage.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>GND</b>               | Ground.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>Port A (PA7..PA0)</b> | <p>Port A serves as the analog inputs to the A/D Converter.</p> <p>Port A also serves as an 8-bit bi-directional I/O port, if the A/D Converter is not used. Port pins can provide internal pull-up resistors (selected for each bit). The Port A output buffers have symmetrical drive characteristics with both high sink and source capability. When pins PA0 to PA7 are used as inputs and are externally pulled low, they will source current if the internal pull-up resistors are activated. The Port A pins are tri-stated when a reset condition becomes active, even if the clock is not running.</p> |
| <b>Port B (PB7..PB0)</b> | <p>Port B is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port B output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port B pins that are externally pulled low will source current if the pull-up resistors are activated. The Port B pins are tri-stated when a reset condition becomes active, even if the clock is not running.</p> <p>Port B also serves the functions of various special features of the ATmega8535 as listed on page 60.</p>                                                    |
| <b>Port C (PC7..PC0)</b> | <p>Port C is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port C output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port C pins that are externally pulled low will source current if the pull-up resistors are activated. The Port C pins are tri-stated when a reset condition becomes active, even if the clock is not running.</p>                                                                                                                                                                |
| <b>Port D (PD7..PD0)</b> | <p>Port D is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port D output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port D pins that are externally pulled low will source current if the pull-up resistors are activated. The Port D pins are tri-stated when a reset condition becomes active, even if the clock is not running.</p> <p>Port D also serves the functions of various special features of the ATmega8535 as listed on page 64.</p>                                                    |
| <b>RESET</b>             | <p>Reset input. A low level on this pin for longer than the minimum pulse length will generate a reset, even if the clock is not running. The minimum pulse length is given in Table 15 on page 37. Shorter pulses are not guaranteed to generate a reset.</p>                                                                                                                                                                                                                                                                                                                                                  |
| <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>AVCC</b>              | <p>AVCC is the supply voltage pin for Port A and the A/D Converter. It should be externally connected to V<sub>CC</sub>, even if the ADC is not used. If the ADC is used, it should be connected to V<sub>CC</sub> through a low-pass filter.</p>                                                                                                                                                                                                                                                                                                                                                               |
| <b>AREF</b>              | AREF is the analog reference pin for the A/D Converter.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |



## Resources

A comprehensive set of development tools, application notes and datasheets are available for download on <http://www.atmel.com/avr>.

## **About Code Examples**

This documentation contains simple code examples that briefly show how to use various parts of the device. These code examples assume that the part specific header file is included before compilation. Be aware that not all C compiler vendors include bit definitions in the header files and interrupt handling in C is compiler dependent. Please confirm with the C Compiler documentation for more details.

## Register Summary

| Address                                   | Name   | Bit 7                                                | Bit 6  | Bit 5  | Bit 4  | Bit 3      | Bit 2  | Bit 1  | Bit 0  | Page                  |
|-------------------------------------------|--------|------------------------------------------------------|--------|--------|--------|------------|--------|--------|--------|-----------------------|
| 0x3F (0x5F)                               | SREG   | I                                                    | T      | H      | S      | V          | N      | Z      | C      | 10                    |
| 0x3E (0x5E)                               | SPH    | –                                                    | –      | –      | –      | –          | –      | SP9    | SP8    | 12                    |
| 0x3D (0x5D)                               | SPL    | SP7                                                  | SP6    | SP5    | SP4    | SP3        | SP2    | SP1    | SP0    | 12                    |
| 0x3C (0x5C)                               | OCR0   | Timer/Counter0 Output Compare Register               |        |        |        |            |        |        |        | 85                    |
| 0x3B (0x5B)                               | GICR   | INT1                                                 | INT0   | INT2   | –      | –          | –      | IVSEL  | IVCE   | 49, 69                |
| 0x3A (0x5A)                               | GIFR   | INTF1                                                | INTF0  | INTF2  | –      | –          | –      | –      | –      | 70                    |
| 0x39 (0x59)                               | TIMSK  | OCIE2                                                | TOIE2  | TICIE1 | OCIE1A | OCIE1B     | TOIE1  | OCIE0  | TOIE0  | 85, 115, 133          |
| 0x38 (0x58)                               | TIFR   | OCF2                                                 | TOV2   | ICF1   | OCF1A  | OCF1B      | TOV1   | OCF0   | TOV0   | 86, 116, 134          |
| 0x37 (0x57)                               | SPMCR  | SPMIE                                                | RWWSB  | –      | RWWSRE | BLBSET     | PGWRT  | PGERS  | SPMEN  | 228                   |
| 0x36 (0x56)                               | TWCR   | TWINT                                                | TWEA   | TWSTA  | TWSTO  | TWWC       | TWEN   | –      | TWIE   | 181                   |
| 0x35 (0x55)                               | MCUCR  | SM2                                                  | SE     | SM1    | SM0    | ISC11      | ISC10  | ISC01  | ISC00  | 32, 68                |
| 0x34 (0x54)                               | MCUCSR | –                                                    | ISC2   | –      | –      | WDRF       | BORF   | EXTRF  | PORF   | 40, 69                |
| 0x33 (0x53)                               | TCCR0  | FOC0                                                 | WGM00  | COM01  | COM00  | WGM01      | CS02   | CS01   | CS00   | 83                    |
| 0x32 (0x52)                               | TCNT0  | Timer/Counter0 (8 Bits)                              |        |        |        |            |        |        |        | 85                    |
| 0x31 (0x51)                               | OSCCAL | Oscillator Calibration Register                      |        |        |        |            |        |        |        | 30                    |
| 0x30 (0x50)                               | SFIOR  | ADTS2                                                | ADTS1  | ADTS0  | –      | ACME       | PUD    | PSR2   | PSR10  | 59, 88, 135, 203, 223 |
| 0x2F (0x4F)                               | TCCR1A | COM1A1                                               | COM1A0 | COM1B1 | COM1B0 | FOC1A      | FOC1B  | WGM11  | WGM10  | 110                   |
| 0x2E (0x4E)                               | TCCR1B | ICNC1                                                | ICES1  | –      | WGM13  | WGM12      | CS12   | CS11   | CS10   | 113                   |
| 0x2D (0x4D)                               | TCNT1H | Timer/Counter1 – Counter Register High Byte          |        |        |        |            |        |        |        | 114                   |
| 0x2C (0x4C)                               | TCNT1L | Timer/Counter1 – Counter Register Low Byte           |        |        |        |            |        |        |        | 114                   |
| 0x2B (0x4B)                               | OCR1AH | Timer/Counter1 – Output Compare Register A High Byte |        |        |        |            |        |        |        | 114                   |
| 0x2A (0x4A)                               | OCR1AL | Timer/Counter1 – Output Compare Register A Low Byte  |        |        |        |            |        |        |        | 114                   |
| 0x29 (0x49)                               | OCR1BH | Timer/Counter1 – Output Compare Register B High Byte |        |        |        |            |        |        |        | 114                   |
| 0x28 (0x48)                               | OCR1BL | Timer/Counter1 – Output Compare Register B Low Byte  |        |        |        |            |        |        |        | 114                   |
| 0x27 (0x47)                               | ICR1H  | Timer/Counter1 – Input Capture Register High Byte    |        |        |        |            |        |        |        | 114                   |
| 0x26 (0x46)                               | ICR1L  | Timer/Counter1 – Input Capture Register Low Byte     |        |        |        |            |        |        |        | 114                   |
| 0x25 (0x45)                               | TCCR2  | FOC2                                                 | WGM20  | COM21  | COM20  | WGM21      | CS22   | CS21   | CS20   | 128                   |
| 0x24 (0x44)                               | TCNT2  | Timer/Counter2 (8 Bits)                              |        |        |        |            |        |        |        | 130                   |
| 0x23 (0x43)                               | OCR2   | Timer/Counter2 Output Compare Register               |        |        |        |            |        |        |        | 131                   |
| 0x22 (0x42)                               | ASSR   | –                                                    | –      | –      | –      | AS2        | TCN2UB | OCR2UB | TCR2UB | 131                   |
| 0x21 (0x41)                               | WDTCSR | –                                                    | –      | –      | WDCE   | WDE        | WDP2   | WDP1   | WDP0   | 42                    |
| 0x20 <sup>(1)</sup> (0x40) <sup>(1)</sup> | UBRRH  | URSEL                                                | –      | –      | –      | UBRR[11:8] |        |        |        | 169                   |
|                                           | UCSRC  | URSEL                                                | UMSEL  | UPM1   | UPM0   | USBS       | UCSZ1  | UCSZ0  | UCPOL  | 167                   |
| 0x1F (0x3F)                               | EEARH  | –                                                    | –      | –      | –      | –          | –      | –      | EEAR8  | 19                    |
| 0x1E (0x3E)                               | EEARL  | EEPROM Address Register Low Byte                     |        |        |        |            |        |        |        | 19                    |
| 0x1D (0x3D)                               | EEDR   | EEPROM Data Register                                 |        |        |        |            |        |        |        | 19                    |
| 0x1C (0x3C)                               | EEDR   | –                                                    | –      | –      | –      | EERIE      | EEMWE  | EWE    | EERE   | 19                    |
| 0x1B (0x3B)                               | PORTA  | PORTA7                                               | PORTA6 | PORTA5 | PORTA4 | PORTA3     | PORTA2 | PORTA1 | PORTA0 | 66                    |
| 0x1A (0x3A)                               | DDRA   | DDA7                                                 | DDA6   | DDA5   | DDA4   | DDA3       | DDA2   | DDA1   | DDA0   | 66                    |
| 0x19 (0x39)                               | PINA   | PINA7                                                | PINA6  | PINA5  | PINA4  | PINA3      | PINA2  | PINA1  | PINA0  | 66                    |
| 0x18 (0x38)                               | PORTB  | PORTB7                                               | PORTB6 | PORTB5 | PORTB4 | PORTB3     | PORTB2 | PORTB1 | PORTB0 | 66                    |
| 0x17 (0x37)                               | DDRB   | ddb7                                                 | ddb6   | ddb5   | ddb4   | ddb3       | ddb2   | ddb1   | ddb0   | 66                    |
| 0x16 (0x36)                               | PINB   | PINB7                                                | PINB6  | PINB5  | PINB4  | PINB3      | PINB2  | PINB1  | PINB0  | 67                    |
| 0x15 (0x35)                               | PORTC  | PORTC7                                               | PORTC6 | PORTC5 | PORTC4 | PORTC3     | PORTC2 | PORTC1 | PORTC0 | 67                    |
| 0x14 (0x34)                               | DDRC   | DDC7                                                 | DDC6   | DDC5   | DDC4   | DDC3       | DDC2   | DDC1   | DDC0   | 67                    |
| 0x13 (0x33)                               | PINC   | PINC7                                                | PINC6  | PINC5  | PINC4  | PINC3      | PINC2  | PINC1  | PINC0  | 67                    |
| 0x12 (0x32)                               | PORTD  | PORTD7                                               | PORTD6 | PORTD5 | PORTD4 | PORTD3     | PORTD2 | PORTD1 | PORTD0 | 67                    |
| 0x11 (0x31)                               | DDRD   | DDD7                                                 | DDD6   | DDD5   | DDD4   | DDD3       | DDD2   | DDD1   | DDD0   | 67                    |
| 0x10 (0x30)                               | PIND   | PIND7                                                | PIND6  | PIND5  | PIND4  | PIND3      | PIND2  | PIND1  | PIND0  | 67                    |
| 0x0F (0x2F)                               | SPDR   | SPI Data Register                                    |        |        |        |            |        |        |        | 143                   |
| 0x0E (0x2E)                               | SPSR   | SPIF                                                 | WCOL   | –      | –      | –          | –      | –      | SPI2X  | 143                   |
| 0x0D (0x2D)                               | SPCR   | SPIE                                                 | SPE    | DORD   | MSTR   | CPOL       | CPHA   | SPR1   | SPR0   | 141                   |
| 0x0C (0x2C)                               | UDR    | USART I/O Data Register                              |        |        |        |            |        |        |        | 164                   |
| 0x0B (0x2B)                               | UCSRA  | RXC                                                  | TXC    | UDRE   | FE     | DOR        | PE     | U2X    | MPCM   | 165                   |
| 0x0A (0x2A)                               | UCSRB  | RXCIE                                                | TXCIE  | UDRIE  | RXEN   | TXEN       | UCSZ2  | RXB8   | TXB8   | 166                   |
| 0x09 (0x29)                               | UBRRL  | USART Baud Rate Register Low Byte                    |        |        |        |            |        |        |        | 169                   |
| 0x08 (0x28)                               | ACSR   | ACD                                                  | ACBG   | ACO    | ACI    | ACIE       | ACIC   | ACIS1  | ACIS0  | 203                   |
| 0x07 (0x27)                               | ADMUX  | REFS1                                                | REFS0  | ADLAR  | MUX4   | MUX3       | MUX2   | MUX1   | MUX0   | 219                   |
| 0x06 (0x26)                               | ADCSRA | ADEN                                                 | ADSC   | ADATE  | ADIF   | ADIE       | ADPS2  | ADPS1  | ADPS0  | 221                   |
| 0x05 (0x25)                               | ADCH   | ADC Data Register High Byte                          |        |        |        |            |        |        |        | 222                   |
| 0x04 (0x24)                               | ADCL   | ADC Data Register Low Byte                           |        |        |        |            |        |        |        | 222                   |
| 0x03 (0x23)                               | TWDR   | Two-wire Serial Interface Data Register              |        |        |        |            |        |        |        | 183                   |
| 0x02 (0x22)                               | TWAR   | TWA6                                                 | TWA5   | TWA4   | TWA3   | TWA2       | TWA1   | TWA0   | TWGCE  | 183                   |
| 0x01 (0x21)                               | TWSR   | TWS7                                                 | TWS6   | TWS5   | TWS4   | TWS3       | –      | TWPS1  | TWPS0  | 183                   |

## Register Summary (Continued)

| Address     | Name | Bit 7                                       | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 | Page |
|-------------|------|---------------------------------------------|-------|-------|-------|-------|-------|-------|-------|------|
| 0x00 (0x20) | TWBR | Two-wire Serial Interface Bit Rate Register |       |       |       |       |       |       |       | 181  |

- Notes:
1. Refer to the USART description for details on how to access UBRRH and UCSRC.
  2. For compatibility with future devices, reserved bits should be written to zero if accessed. Reserved I/O memory addresses should never be written.
  3. Some of the status flags are cleared by writing a logical one 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 0x00 to 0x1F only.

## Instruction Set Summary

| Mnemonics                                | 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         |
| ADIW                                     | Rdl, K   | Add Immediate to Word                    | $Rdh:Rdl \leftarrow Rdh:Rdl + K$                      | Z,C,N,V,S     | 2         |
| 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         |
| SBIW                                     | Rdl, K   | Subtract Immediate from Word             | $Rdh:Rdl \leftarrow Rdh:Rdl - K$                      | Z,C,N,V,S     | 2         |
| AND                                      | Rd, Rr   | Logical AND Registers                    | $Rd \leftarrow Rd \bullet Rr$                         | Z,N,V         | 1         |
| ANDI                                     | Rd, K    | Logical AND Register and Constant        | $Rd \leftarrow Rd \bullet K$                          | 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                         | $Rd \leftarrow 0xFF - Rd$                             | Z,C,N,V       | 1         |
| NEG                                      | Rd       | Two's Complement                         | $Rd \leftarrow 0x00 - Rd$                             | 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                 | $Rd \leftarrow Rd \bullet (0xFF - K)$                 | 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                   | $Rd \leftarrow Rd \bullet Rd$                         | Z,N,V         | 1         |
| CLR                                      | Rd       | Clear Register                           | $Rd \leftarrow Rd \oplus Rd$                          | Z,N,V         | 1         |
| SER                                      | Rd       | Set Register                             | $Rd \leftarrow 0xFF$                                  | None          | 1         |
| MUL                                      | Rd, Rr   | Multiply Unsigned                        | $R1:R0 \leftarrow Rd \times Rr$                       | Z,C           | 2         |
| MULS                                     | Rd, Rr   | Multiply Signed                          | $R1:R0 \leftarrow Rd \times Rr$                       | Z,C           | 2         |
| MULSU                                    | Rd, Rr   | Multiply Signed with Unsigned            | $R1:R0 \leftarrow Rd \times Rr$                       | Z,C           | 2         |
| FMUL                                     | Rd, Rr   | Fractional Multiply Unsigned             | $R1:R0 \leftarrow (Rd \times Rr) \ll 1$               | Z,C           | 2         |
| FMULS                                    | Rd, Rr   | Fractional Multiply Signed               | $R1:R0 \leftarrow (Rd \times Rr) \ll 1$               | Z,C           | 2         |
| FMULSU                                   | Rd, Rr   | Fractional Multiply Signed with Unsigned | $R1:R0 \leftarrow (Rd \times Rr) \ll 1$               | Z,C           | 2         |
| <b>BRANCH INSTRUCTIONS</b>               |          |                                          |                                                       |               |           |
| RJMP                                     | k        | Relative Jump                            | $PC \leftarrow PC + k + 1$                            | None          | 2         |
| IJMP                                     |          | Indirect Jump to (Z)                     | $PC \leftarrow Z$                                     | None          | 2         |
| RCALL                                    | k        | Relative Subroutine Call                 | $PC \leftarrow PC + k + 1$                            | None          | 3         |
| ICALL                                    |          | Indirect Call to (Z)                     | $PC \leftarrow Z$                                     | 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 / 3 |
| 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 / 3 |
| SBRS                                     | Rr, b    | Skip if Bit in Register is Set           | if $(Rr(b)=1)$ $PC \leftarrow PC + 2$ or 3            | None          | 1 / 2 / 3 |
| SBIC                                     | P, b     | Skip if Bit in I/O Register Cleared      | if $(P(b)=0)$ $PC \leftarrow PC + 2$ or 3             | None          | 1 / 2 / 3 |
| 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 / 3 |
| 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     |
| <b>DATA TRANSFER INSTRUCTIONS</b>        |          |                                          |                                                       |               |           |

| Mnemonics                            | Operands | Description                      | Operation                                                          | Flags      | #Clocks |
|--------------------------------------|----------|----------------------------------|--------------------------------------------------------------------|------------|---------|
| MOV                                  | Rd, Rr   | Move Between Registers           | $Rd \leftarrow Rr$                                                 | None       | 1       |
| MOVW                                 | Rd, Rr   | Copy Register Word               | $Rd+1:Rd \leftarrow Rr+1:Rr$                                       | None       | 1       |
| LDI                                  | Rd, K    | Load Immediate                   | $Rd \leftarrow K$                                                  | None       | 1       |
| LD                                   | Rd, X    | Load Indirect                    | $Rd \leftarrow (X)$                                                | None       | 2       |
| LD                                   | Rd, X+   | Load Indirect and Post-Inc.      | $Rd \leftarrow (X), X \leftarrow X + 1$                            | None       | 2       |
| LD                                   | Rd, -X   | Load Indirect and Pre-Dec.       | $X \leftarrow X - 1, Rd \leftarrow (X)$                            | None       | 2       |
| LD                                   | Rd, Y    | Load Indirect                    | $Rd \leftarrow (Y)$                                                | None       | 2       |
| LD                                   | Rd, Y+   | Load Indirect and Post-Inc.      | $Rd \leftarrow (Y), Y \leftarrow Y + 1$                            | None       | 2       |
| LD                                   | Rd, -Y   | Load Indirect and Pre-Dec.       | $Y \leftarrow Y - 1, Rd \leftarrow (Y)$                            | None       | 2       |
| LDD                                  | Rd, Y+q  | Load Indirect with Displacement  | $Rd \leftarrow (Y + q)$                                            | None       | 2       |
| LD                                   | Rd, Z    | Load Indirect                    | $Rd \leftarrow (Z)$                                                | None       | 2       |
| LD                                   | Rd, Z+   | Load Indirect and Post-Inc.      | $Rd \leftarrow (Z), Z \leftarrow Z + 1$                            | None       | 2       |
| LD                                   | Rd, -Z   | Load Indirect and Pre-Dec.       | $Z \leftarrow Z - 1, Rd \leftarrow (Z)$                            | None       | 2       |
| LDD                                  | Rd, Z+q  | Load Indirect with Displacement  | $Rd \leftarrow (Z + q)$                                            | None       | 2       |
| LDS                                  | Rd, k    | Load Direct from SRAM            | $Rd \leftarrow (k)$                                                | None       | 2       |
| ST                                   | X, Rr    | Store Indirect                   | $(X) \leftarrow Rr$                                                | None       | 2       |
| ST                                   | X+, Rr   | Store Indirect and Post-Inc.     | $(X) \leftarrow Rr, X \leftarrow X + 1$                            | None       | 2       |
| ST                                   | -X, Rr   | Store Indirect and Pre-Dec.      | $X \leftarrow X - 1, (X) \leftarrow Rr$                            | None       | 2       |
| ST                                   | Y, Rr    | Store Indirect                   | $(Y) \leftarrow Rr$                                                | None       | 2       |
| ST                                   | Y+, Rr   | Store Indirect and Post-Inc.     | $(Y) \leftarrow Rr, Y \leftarrow Y + 1$                            | None       | 2       |
| ST                                   | -Y, Rr   | Store Indirect and Pre-Dec.      | $Y \leftarrow Y - 1, (Y) \leftarrow Rr$                            | None       | 2       |
| STD                                  | Y+q, Rr  | Store Indirect with Displacement | $(Y + q) \leftarrow Rr$                                            | None       | 2       |
| ST                                   | Z, Rr    | Store Indirect                   | $(Z) \leftarrow Rr$                                                | None       | 2       |
| ST                                   | Z+, Rr   | Store Indirect and Post-Inc.     | $(Z) \leftarrow Rr, Z \leftarrow Z + 1$                            | None       | 2       |
| ST                                   | -Z, Rr   | Store Indirect and Pre-Dec.      | $Z \leftarrow Z - 1, (Z) \leftarrow Rr$                            | None       | 2       |
| STD                                  | Z+q, Rr  | Store Indirect with Displacement | $(Z + q) \leftarrow Rr$                                            | None       | 2       |
| STS                                  | k, Rr    | Store Direct to SRAM             | $(k) \leftarrow Rr$                                                | None       | 2       |
| LPM                                  |          | Load Program Memory              | $R0 \leftarrow (Z)$                                                | None       | 3       |
| LPM                                  | Rd, Z    | Load Program Memory              | $Rd \leftarrow (Z)$                                                | None       | 3       |
| LPM                                  | Rd, Z+   | Load Program Memory and Post-Inc | $Rd \leftarrow (Z), Z \leftarrow Z + 1$                            | None       | 3       |
| SPM                                  |          | Store Program Memory             | $(Z) \leftarrow R1:R0$                                             | None       | -       |
| IN                                   | Rd, P    | In Port                          | $Rd \leftarrow P$                                                  | None       | 1       |
| OUT                                  | P, Rr    | Out Port                         | $P \leftarrow Rr$                                                  | None       | 1       |
| PUSH                                 | Rr       | Push Register on Stack           | $STACK \leftarrow Rr$                                              | None       | 2       |
| POP                                  | Rd       | Pop Register from Stack          | $Rd \leftarrow STACK$                                              | None       | 2       |
| <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 Twos Complement Overflow     | $V \leftarrow 1$                                                   | V          | 1       |
| CLV                                  |          | Clear Twos 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       |
| <b>MCU CONTROL INSTRUCTIONS</b>      |          |                                  |                                                                    |            |         |
| NOP                                  |          | No Operation                     |                                                                    | None       | 1       |



| Mnemonics | Operands | Description    | Operation                                | Flags | #Clocks |
|-----------|----------|----------------|------------------------------------------|-------|---------|
| SLEEP     |          | Sleep          | (see specific descr. for Sleep function) | None  | 1       |
| WDR       |          | Watchdog Reset | (see specific descr. for WDR/Timer)      | None  | 1       |
| BREAK     |          | Break          | For On-chip Debug Only                   | None  | N/A     |

## Ordering Information

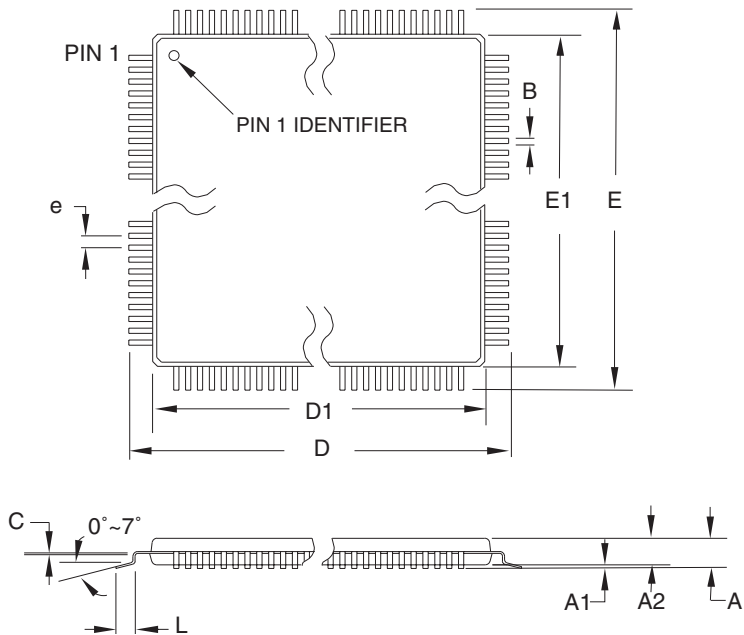
| Speed (MHz) | Power Supply | Ordering Code                  | Package <sup>(1)</sup> | Operation Range               |
|-------------|--------------|--------------------------------|------------------------|-------------------------------|
| 8           | 2.7 - 5.5V   | ATmega8535L-8AC                | 44A                    | Commercial<br>(0°C to 70°C)   |
|             |              | ATmega8535L-8PC                | 40P6                   |                               |
|             |              | ATmega8535L-8JC                | 44J                    |                               |
|             |              | ATmega8535L-8MC                | 44M1                   |                               |
|             |              | ATmega8535L-8AI                | 44A                    | Industrial<br>(-40°C to 85°C) |
|             |              | ATmega8535L-8PI                | 40P6                   |                               |
|             |              | ATmega8535L-8JI                | 44J                    |                               |
|             |              | ATmega8535L-8MI                | 44M1                   |                               |
|             | 4.5 - 5.5V   | ATmega8535L-8AU <sup>(2)</sup> | 44A                    |                               |
|             |              | ATmega8535L-8PU <sup>(2)</sup> | 40P6                   |                               |
|             |              | ATmega8535L-8JU <sup>(2)</sup> | 44J                    |                               |
|             |              | ATmega8535L-8MU <sup>(2)</sup> | 44M1                   |                               |
| 16          | 2.7 - 5.5V   | ATmega8535-16AC                | 44A                    | Commercial<br>(0°C to 70°C)   |
|             |              | ATmega8535-16PC                | 40P6                   |                               |
|             |              | ATmega8535-16JC                | 44J                    |                               |
|             |              | ATmega8535-16MC                | 44M1                   |                               |
|             | 4.5 - 5.5V   | ATmega8535-16AI                | 44A                    | Industrial<br>(-40°C to 85°C) |
|             |              | ATmega8535-16PI                | 40P6                   |                               |
|             |              | ATmega8535-16JI                | 44J                    |                               |
|             |              | ATmega8535-16MI                | 44M1                   |                               |
|             |              | ATmega8535-16AU <sup>(2)</sup> | 44A                    |                               |
|             |              | ATmega8535-16PU <sup>(2)</sup> | 40P6                   |                               |
|             |              | ATmega8535-16JU <sup>(2)</sup> | 44J                    |                               |
|             |              | ATmega8535-16MU <sup>(2)</sup> | 44M1                   |                               |

- Note:
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>44A</b>    | 44-lead, Thin (1.0 mm) Plastic Gull Wing Quad Flat Package (TQFP)                                     |
| <b>40P6</b>   | 40-pin, 0.600" Wide, Plastic Dual Inline Package (PDIP)                                               |
| <b>44J</b>    | 44-lead, Plastic J-leaded Chip Carrier (PLCC)                                                         |
| <b>44M1-A</b> | 44-pad, 7 x 7 x 1.0 mm body, lead pitch 0.50 mm, Quad Flat No-Lead/Micro Lead Frame Package (QFN/MLF) |

# Packaging Information

44A



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

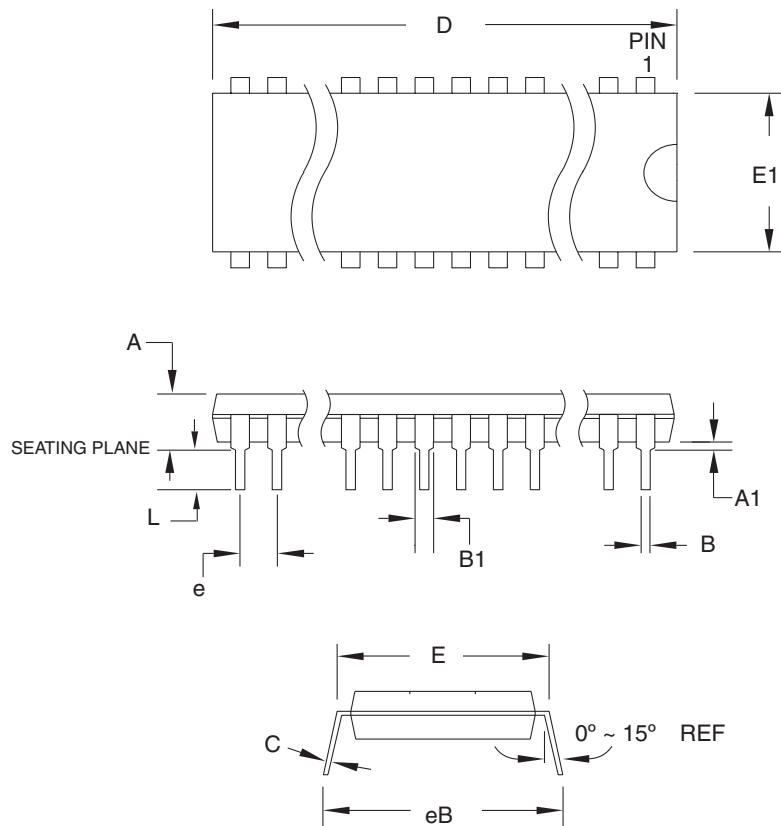
| SYMBOL | MIN      | NOM   | MAX   | NOTE   |
|--------|----------|-------|-------|--------|
| A      | –        | –     | 1.20  |        |
| A1     | 0.05     | –     | 0.15  |        |
| A2     | 0.95     | 1.00  | 1.05  |        |
| D      | 11.75    | 12.00 | 12.25 |        |
| D1     | 9.90     | 10.00 | 10.10 | Note 2 |
| E      | 11.75    | 12.00 | 12.25 |        |
| E1     | 9.90     | 10.00 | 10.10 | 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 ACB.
  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<br>San Jose, CA 95131 | <b>TITLE</b><br><b>44A</b> , 44-lead, 10 x 10 mm Body Size, 1.0 mm Body Thickness,<br>0.8 mm Lead Pitch, Thin Profile Plastic Quad Flat Package (TQFP) | <b>DRAWING NO.</b> | <b>REV.</b> |
|                                            |                                                                                                                                                        | 44A                | B           |

## 40P6



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

| SYMBOL | MIN       | NOM | MAX    | NOTE   |
|--------|-----------|-----|--------|--------|
| A      | —         | —   | 4.826  |        |
| A1     | 0.381     | —   | —      |        |
| D      | 52.070    | —   | 52.578 | Note 2 |
| E      | 15.240    | —   | 15.875 |        |
| E1     | 13.462    | —   | 13.970 | Note 2 |
| B      | 0.356     | —   | 0.559  |        |
| B1     | 1.041     | —   | 1.651  |        |
| L      | 3.048     | —   | 3.556  |        |
| C      | 0.203     | —   | 0.381  |        |
| eB     | 15.494    | —   | 17.526 |        |
| e      | 2.540 TYP |     |        |        |

- Notes:
1. This package conforms to JEDEC reference MS-011, Variation AC.
  2. 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

**40P6**, 40-lead (0.600"/15.24 mm Wide) Plastic Dual  
Inline Package (PDIP)

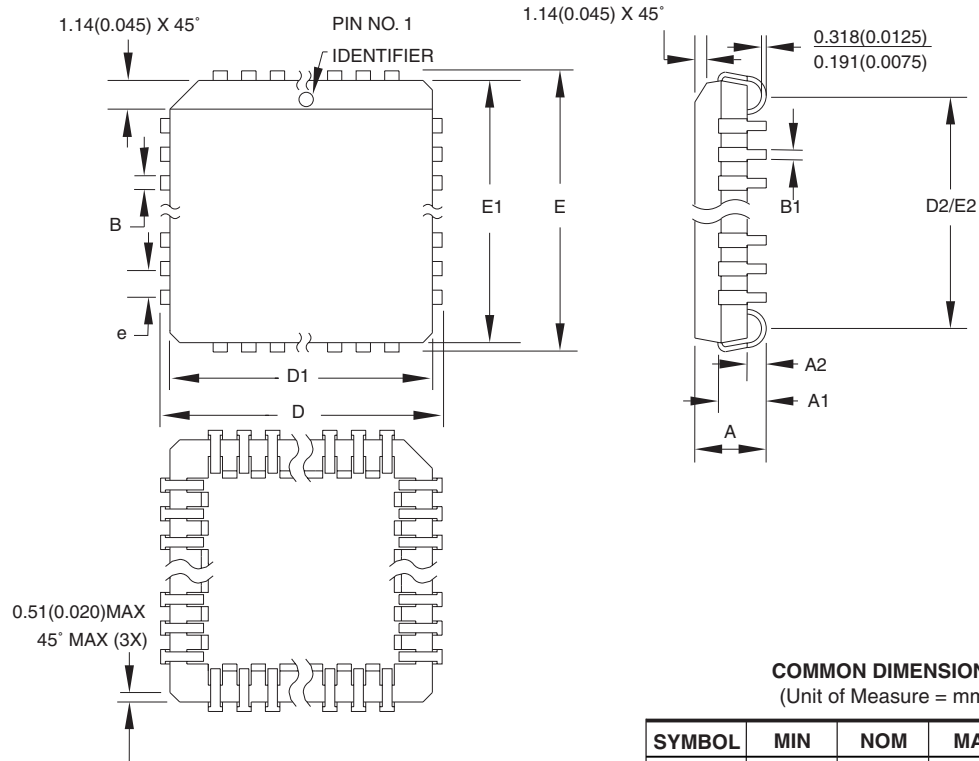
### DRAWING NO.

40P6

### REV.

B





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

| SYMBOL | MIN       | NOM | MAX    | NOTE   |
|--------|-----------|-----|--------|--------|
| A      | 4.191     | —   | 4.572  |        |
| A1     | 2.286     | —   | 3.048  |        |
| A2     | 0.508     | —   | —      |        |
| D      | 17.399    | —   | 17.653 |        |
| D1     | 16.510    | —   | 16.662 | Note 2 |
| E      | 17.399    | —   | 17.653 |        |
| E1     | 16.510    | —   | 16.662 | Note 2 |
| D2/E2  | 14.986    | —   | 16.002 |        |
| B      | 0.660     | —   | 0.813  |        |
| B1     | 0.330     | —   | 0.533  |        |
| e      | 1.270 TYP |     |        |        |

- Notes:
1. This package conforms to JEDEC reference MS-018, Variation AC.
  2. Dimensions D1 and E1 do not include mold protrusion. Allowable protrusion is .010"(0.254 mm) per side. Dimension D1 and E1 include mold mismatch and are measured at the extreme material condition at the upper or lower parting line.
  3. Lead coplanarity is 0.004" (0.102 mm) maximum.

10/04/01



2325 Orchard Parkway  
San Jose, CA 95131

**TITLE**

**44J**, 44-lead, Plastic J-leaded Chip Carrier (PLCC)

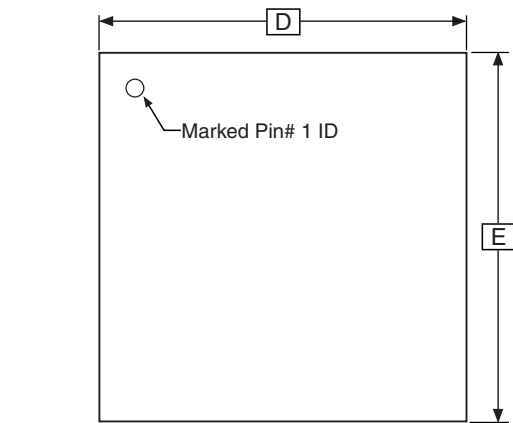
**DRAWING NO.**

44J

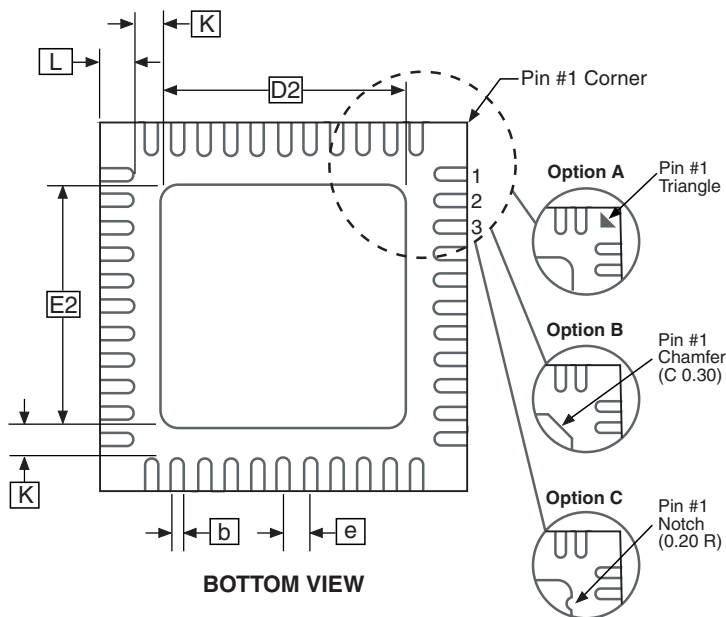
**REV.**

B

## 44M1-A

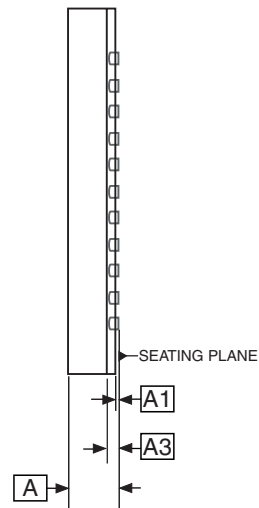


TOP VIEW



BOTTOM VIEW

Note: JEDEC Standard MO-220, Fig. 1 (SAW Singulation) VKKD-3.



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 |      |
| A3     | 0.25 REF |      |      |      |
| b      | 0.18     | 0.23 | 0.30 |      |
| D      | 6.90     | 7.00 | 7.10 |      |
| D2     | 5.00     | 5.20 | 5.40 |      |
| E      | 6.90     | 7.00 | 7.10 |      |
| E2     | 5.00     | 5.20 | 5.40 |      |
| e      | 0.50 BSC |      |      |      |
| L      | 0.59     | 0.64 | 0.69 |      |
| K      | 0.20     | 0.26 | 0.41 |      |

5/27/06



2325 Orchard Parkway  
San Jose, CA 95131

### TITLE

**44M1**, 44-pad, 7 x 7 x 1.0 mm Body, Lead Pitch 0.50 mm,  
5.20 mm Exposed Pad, Micro Lead Frame Package (MLF)

### DRAWING NO.

44M1

### REV.

G



## Errata

### ATmega8535 Rev. A and B

The revision letter refer to the device revision.

- **First Analog Comparator conversion may be delayed**
- **Asynchronous Oscillator does not stop in Power-down**

#### 1. **First Analog Comparator conversion may be delayed**

If the device is powered by a slow rising  $V_{CC}$ , the first Analog Comparator conversion will take longer than expected on some devices.

##### **Problem Fix/Workaround**

When the device has been powered or reset, disable then enable the Analog Comparator before the first conversion.

#### 2. **Asynchronous Oscillator does not stop in Power-down**

The asynchronous oscillator does not stop when entering Power-down mode. This leads to higher power consumption than expected.

##### **Problem Fix/Workaround**

Manually disable the asynchronous timer before entering Power-down.

## Datasheet Revision History

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

**Changes from Rev.  
2502J- 08/06 to Rev.  
2502K- 10/06**

1. Updated TOP/BOTTOM description for all Timer/Counters Fast PWM mode.
2. Updated “Errata” on page 18.

**Changes from Rev.  
2502I- 06/06 to Rev.  
2502J- 08/06**

1. Updated “Ordering Information” on page 13.

**Changes from Rev.  
2502H- 04/06 to Rev.  
2502I- 06/06**

1. Updated code example “USART Initialization” on page 150.

**Changes from Rev.  
2502G- 04/05 to Rev.  
2502H- 04/06**

1. Added “Resources” on page 6.
2. Updated Table 7 on page 29, Table 17 on page 42 and Table 111 on page 258.
3. Updated “Serial Peripheral Interface – SPI” on page 136.
4. Updated note in “Bit Rate Generator Unit” on page 180.

**Changes from Rev.  
2502F- 06/04 to Rev.  
2502G- 04/05**

1. Removed “Preliminary” and TBD’s.
2. Updated Table 37 on page 69 and Table 113 on page 261.
3. Updated “Electrical Characteristics” on page 255.
4. Updated “Ordering Information” on page 13.

**Changes from Rev.  
2502E-12/03 to Rev.  
2502G-06/04**

1. MLF-package alternative changed to “Quad Flat No-Lead/Micro Lead Frame Package QFN/MLF”.

**Changes from Rev.  
2502E-12/03 to Rev.  
2502F-06/04**

1. Updated “Reset Characteristics” on page 37.
2. Updated SPH in “Stack Pointer” on page 12.
3. Updated C code in “USART Initialization” on page 150.
4. Updated “Errata” on page 18.

**Changes from Rev.  
2502D-09/03 to Rev.  
2502E-12/03**

1. Updated “Calibrated Internal RC Oscillator” on page 29.
2. Added section “Errata” on page 18.

**Changes from Rev.  
2502C-04/03 to Rev.  
2502D-09/03**

1. Removed “Advance Information” and some TBD’s from the datasheet.
2. Added note to “Pinout ATmega8535” on page 2.
3. Updated “Reset Characteristics” on page 37.
4. Updated “Absolute Maximum Ratings” and “DC Characteristics” in “Electrical Characteristics” on page 255.
5. Updated Table 111 on page 258.
6. Updated “ADC Characteristics” on page 263.
7. Updated “ATmega8535 Typical Characteristics” on page 266.
8. Removed CALL and JMP instructions from code examples and “Instruction Set Summary” on page 10.

**Changes from Rev.  
2502B-09/02 to Rev.  
2502C-04/03**

1. Updated “Packaging Information” on page 14.
2. Updated Figure 1 on page 2, Figure 84 on page 179, Figure 85 on page 185, Figure 87 on page 191, Figure 98 on page 207.
3. Added the section “EEPROM Write During Power-down Sleep Mode” on page 22.
4. Removed the references to the application notes “Multi-purpose Oscillator” and “32 kHz Crystal Oscillator”, which do not exist.
5. Updated code examples on page 44.
6. Removed ADHSM bit.
7. Renamed Port D pin ICP to ICP1. See “Alternate Functions of Port D” on page 64.
8. Added information about PWM symmetry for Timer 0 on page 79 and Timer 2 on page 126.
9. Updated Table 68 on page 169, Table 75 on page 190, Table 76 on page 193, Table 77 on page 196, Table 108 on page 253, Table 113 on page 261.
10. Updated description on “Bit 5 – TWSTA: TWI START Condition Bit” on page 182.
11. Updated the description in “Filling the Temporary Buffer (Page Loading)” and “Performing a Page Write” on page 231.
12. Removed the section description in “SPI Serial Programming Characteristics” on page 254.
13. Updated “Electrical Characteristics” on page 255.

- 14. Updated “ADC Characteristics” on page 263.
- 14. Updated “Register Summary” on page 8.
- 15. Various Timer 1 corrections.
- 16. Added WD\_FUSE period in Table 108 on page 253.
- 1. Canged the Endurance on the Flash to 10,000 Write/Erase Cycles.

**Changes from Rev.  
2502A-06/02 to Rev.  
2502B-09/02**



## 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. 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®, and others are the trademarks or registered trademarks of Atmel Corporation or its subsidiaries. Other terms and product names may be trademarks of others.