## Features

- High-performance, Low-power AVR ${ }^{\circledR}$ 8-bit Microcontroller
- Advanced RISC Architecture
- 130 Powerful Instructions - Most Single Clock Cycle Execution
- $32 \times 8$ 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


## ATmega8535 ATmega8535L

Summary

Note: This is a summary document. A complete document is available on our Web site at www.atmel.com.

## Pin Configurations



## 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

Block Diagram
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.

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: 8 K 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, InCircuit 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

## $\mathrm{V}_{\mathrm{cc}}$

## GND

Port A (PA7..PAO)

Port B (PB7..PB0)

Port C (PC7..PC0)

Port D (PD7..PDO)

RESET

XTAL1
XTAL2
AVCC

## AREF

Digital supply voltage.

## Ground.

Port A serves as the analog inputs to the A/D Converter.
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.

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.

Port B also serves the functions of various special features of the ATmega8535 as listed on page 60.

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.

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.

Port D also serves the functions of various special features of the ATmega8535 as listed on page 64.

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.

Input to the inverting Oscillator amplifier and input to the internal clock operating circuit.
Output from the inverting Oscillator amplifier.
AVCC is the supply voltage pin for Port A and the A/D Converter. It should be externally connected to $V_{C C}$, even if the ADC is not used. If the ADC is used, it should be connected to $\mathrm{V}_{\mathrm{CC}}$ through a low-pass filter.

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 <br> 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 | 1 | 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 |
| $0 \times 3 \mathrm{C}$ (0x5C) | OCRO | Timer/Counter0 Output Compare Register |  |  |  |  |  |  |  | 85 |
| 0x3B (0x5B) | GICR | INT1 | INTO | INT2 | - | - | - | IVSEL | IVCE | 49, 69 |
| 0x3A (0x5A) | GIFR | INTF1 | INTF0 | INTF2 | - | - | - | - | - | 70 |
| 0x39 (0x59) | TIMSK | OCIE2 | TOIE2 | TICIE1 | OCIE1A | OCIE1B | TOIE1 | OCIEO | TOIE0 | 85, 115, 133 |
| 0x38 (0x58) | TIFR | OCF2 | TOV2 | ICF1 | OCF1A | OCF1B | TOV1 | OCFO | 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 |
| $0 \times 35$ (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 | FOCO | WGM00 | COM01 | COM00 | WGM01 | CS02 | CS01 | CSOO | 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) | WDTCR | - | - | - | WDCE | WDE | WDP2 | WDP1 | WDP0 | 42 |
|  | UBRRH | URSEL | - | - | - | UBRR[11:8] |  |  |  | 169 |
| 0x20) (0x40) | UCSRC | URSEL | UMSEL | UPM1 | UPM0 | USBS | UCSZ1 | UCSZO | 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) | EECR | - | - | - | - | EERIE | EEMWE | EEWE | EERE | 19 |
| 0x1B (0x3B) | PORTA | PORTA7 | PORTA6 | PORTA5 | PORTA4 | PORTA3 | PORTA2 | PORTA1 | PORTAO | 66 |
| $0 \times 1 \mathrm{~A}(0 \times 3 \mathrm{~A})$ | DDRA | DDA7 | DDA6 | DDA5 | DDA4 | DDA3 | DDA2 | DDA1 | DDAO | 66 |
| 0x19 (0x39) | PINA | PINA7 | PINA6 | PINA5 | PINA4 | PINA3 | PINA2 | PINA1 | PINAO | 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 | PINCO | 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 |
| $0 \times 0 \mathrm{C}$ (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 |
| $0 \times 08$ (0x28) | ACSR | ACD | ACBG | ACO | ACl | ACIE | ACIC | ACIS1 | ACISO | 203 |
| 0x07 (0x27) | ADMUX | REFS1 | REFSO | ADLAR | MUX4 | MUX3 | MUX2 | MUX1 | MUX0 | 219 |
| 0x06 (0x26) | ADCSRA | ADEN | ADSC | ADATE | ADIF | ADIE | ADPS2 | ADPS1 | ADPSO | 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 | TWAO | TWGCE | 183 |
| 0x01 (0x21) | TWSR | TWS7 | TWS6 | TWS5 | TWS4 | TWS3 | - | TWPS1 | TWPSO | 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 $0 \times 00$ to $0 x 1 F$ only.

Instruction Set Summary

| Mnemonics | Operands | Description | Operation | Flags | \#Clocks |
| :---: | :---: | :---: | :---: | :---: | :---: |
| ARITHMETIC AND LOGIC INSTRUCTIONS |  |  |  |  |  |
| ADD | Rd, Rr | Add two Registers | $\mathrm{Rd} \leftarrow \mathrm{Rd}+\mathrm{Rr}$ | Z,C,N,V,H | 1 |
| ADC | Rd, Rr | Add with Carry two Registers | $\mathrm{Rd} \leftarrow \mathrm{Rd}+\mathrm{Rr}+\mathrm{C}$ | 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 | $\mathrm{Rd} \leftarrow \mathrm{Rd}-\mathrm{Rr}$ | Z,C,N,V,H | 1 |
| SUBI | Rd, K | Subtract Constant from Register | $\mathrm{Rd} \leftarrow \mathrm{Rd}-\mathrm{K}$ | Z,C,N,V,H | 1 |
| SBC | Rd, Rr | Subtract with Carry two Registers | $\mathrm{Rd} \leftarrow \mathrm{Rd}-\mathrm{Rr}-\mathrm{C}$ | Z,C,N,V,H | 1 |
| SBCI | Rd, K | Subtract with Carry Constant from Reg. | $\mathrm{Rd} \leftarrow \mathrm{Rd}-\mathrm{K}-\mathrm{C}$ | Z,C,N,V,H | 1 |
| SBIW | Rdi, K | Subtract Immediate from Word | Rdh:RdI $\leftarrow$ Rdh:Rdl - K | Z,C,N,V,S | 2 |
| AND | Rd, Rr | Logical AND Registers | $\mathrm{Rd} \leftarrow \mathrm{Rd} \bullet \mathrm{Rr}$ | Z,N,V | 1 |
| ANDI | Rd, K | Logical AND Register and Constant | $\mathrm{Rd} \leftarrow \mathrm{Rd} \bullet \mathrm{K}$ | Z,N,V | 1 |
| OR | Rd, Rr | Logical OR Registers | $\mathrm{Rd} \leftarrow \mathrm{Rdv} \mathrm{Rr}$ | Z,N,V | 1 |
| ORI | Rd, K | Logical OR Register and Constant | $\mathrm{Rd} \leftarrow \mathrm{Rd}$ v K | Z,N,V | 1 |
| EOR | Rd, Rr | Exclusive OR Registers | $\mathrm{Rd} \leftarrow \mathrm{Rd} \oplus \mathrm{Rr}$ | Z,N,V | 1 |
| COM | Rd | One's Complement | $\mathrm{Rd} \leftarrow 0 \mathrm{xFF}-\mathrm{Rd}$ | Z,C,N,V | 1 |
| NEG | Rd | Two's Complement | $\mathrm{Rd} \leftarrow 0 \times 00-\mathrm{Rd}$ | Z,C,N,V,H | 1 |
| SBR | Rd, K | Set Bit(s) in Register | $\mathrm{Rd} \leftarrow \mathrm{Rd} \mathrm{v}$ K | Z,N,V | 1 |
| CBR | Rd, K | Clear Bit(s) in Register | $\mathrm{Rd} \leftarrow \mathrm{Rd} \bullet(0 x \mathrm{FF}-\mathrm{K})$ | Z,N,V | 1 |
| INC | Rd | Increment | $\mathrm{Rd} \leftarrow \mathrm{Rd}+1$ | Z,N,V | 1 |
| DEC | Rd | Decrement | $\mathrm{Rd} \leftarrow \mathrm{Rd}-1$ | Z,N,V | 1 |
| TST | Rd | Test for Zero or Minus | $\mathrm{Rd} \leftarrow \mathrm{Rd} \bullet \mathrm{Rd}$ | Z,N,V | 1 |
| CLR | Rd | Clear Register | $\mathrm{Rd} \leftarrow \mathrm{Rd} \oplus \mathrm{Rd}$ | Z,N,V | 1 |
| SER | Rd | Set Register | $\mathrm{Rd} \leftarrow 0 \mathrm{xFF}$ | None | 1 |
| MUL | Rd, Rr | Multiply Unsigned | $\mathrm{R} 1: \mathrm{R0} \leftarrow \mathrm{Rd} \times \mathrm{Rr}$ | Z,C | 2 |
| MULS | Rd, Rr | Multiply Signed | $\mathrm{R} 1: \mathrm{R0} 5 \mathrm{Rdx} \times \mathrm{Rr}$ | Z,C | 2 |
| MULSU | Rd, Rr | Multiply Signed with Unsigned | $\mathrm{R} 1: \mathrm{R0} \leftarrow \mathrm{Rd} \times \mathrm{Rr}$ | Z,C | 2 |
| FMUL | Rd, Rr | Fractional Multiply Unsigned | $\mathrm{R} 1: \mathrm{RO} \leftarrow(\mathrm{Rd} \times \mathrm{Rr}) \ll 1$ | Z,C | 2 |
| FMULS | Rd, Rr | Fractional Multiply Signed | $\mathrm{R} 1: \mathrm{R} 0 \leftarrow(\mathrm{Rd} \times \mathrm{Rr}) \ll 1$ | Z,C | 2 |
| FMULSU | Rd, Rr | Fractional Multiply Signed with Unsigned | $\mathrm{R} 1: \mathrm{R0} \leftarrow(\mathrm{Rd} \times \mathrm{Rr}) \ll 1$ | Z,C | 2 |
| BRANCH INSTRUCTIONS |  |  |  |  |  |
| RJMP | k | Relative Jump | $\mathrm{PC} \leftarrow \mathrm{PC}+\mathrm{k}+1$ | None | 2 |
| IJMP |  | Indirect Jump to (Z) | $\mathrm{PC} \leftarrow \mathrm{Z}$ | None | 2 |
| RCALL | k | Relative Subroutine Call | $\mathrm{PC} \leftarrow \mathrm{PC}+\mathrm{k}+1$ | None | 3 |
| ICALL |  | Indirect Call to (Z) | $\mathrm{PC} \leftarrow \mathrm{Z}$ | None | 3 |
| RET |  | Subroutine Return | $\mathrm{PC} \leftarrow$ STACK | None | 4 |
| RETI |  | Interrupt Return | $\mathrm{PC} \leftarrow$ STACK | 1 | 4 |
| CPSE | Rd, Rr | Compare, Skip if Equal | if ( $\mathrm{Rd}=\mathrm{Rr}$ ) $\mathrm{PC} \leftarrow \mathrm{PC}+2$ or 3 | None | 1/2/3 |
| CP | Rd, Rr | Compare | $\mathrm{Rd}-\mathrm{Rr}$ | Z, N, V, C, H | 1 |
| CPC | Rd, Rr | Compare with Carry | $\mathrm{Rd}-\mathrm{Rr}-\mathrm{C}$ | 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 $(\operatorname{Rr}(\mathrm{b})=0) \mathrm{PC} \leftarrow \mathrm{PC}+2$ or 3 | None | 1/2/3 |
| SBRS | Rr, b | Skip if Bit in Register is Set | if $(\operatorname{Rr}(\mathrm{b})=1) \mathrm{PC} \leftarrow \mathrm{PC}+2$ or 3 | None | 1/2/3 |
| SBIC | P, b | Skip if Bit in I/O Register Cleared | if $(P(b)=0) P C \leftarrow P C+2$ or 3 | None | 1/2/3 |
| SBIS | P, b | Skip if Bit in I/O Register is Set | if $(P(b)=1) P C \leftarrow P C+2$ or 3 | None | 1/2/3 |
| BRBS | s, k | Branch if Status Flag Set | if (SREG(s) $=1$ ) then $\mathrm{PC} \leftarrow \mathrm{PC}+\mathrm{k}+1$ | None | 1/2 |
| BRBC | s, k | Branch if Status Flag Cleared | if (SREG(s) $=0$ ) then $\mathrm{PC} \leftarrow \mathrm{PC}+\mathrm{k}+1$ | None | 1/2 |
| BREQ | k | Branch if Equal | if $(Z=1)$ then $\mathrm{PC} \leftarrow \mathrm{PC}+\mathrm{k}+1$ | None | 1/2 |
| BRNE | k | Branch if Not Equal | if $(Z=0)$ then $P C \leftarrow P C+k+1$ | None | 1/2 |
| BRCS | k | Branch if Carry Set | if ( $\mathrm{C}=1)$ then $\mathrm{PC} \leftarrow \mathrm{PC}+\mathrm{k}+1$ | None | 1/2 |
| BRCC | k | Branch if Carry Cleared | if ( $\mathrm{C}=0)$ then $\mathrm{PC} \leftarrow \mathrm{PC}+\mathrm{k}+1$ | None | 1/2 |
| BRSH | k | Branch if Same or Higher | if ( $\mathrm{C}=0)$ then $\mathrm{PC} \leftarrow \mathrm{PC}+\mathrm{k}+1$ | None | 1/2 |
| BRLO | k | Branch if Lower | if ( $\mathrm{C}=1$ ) then $\mathrm{PC} \leftarrow \mathrm{PC}+\mathrm{k}+1$ | None | 1/2 |
| BRMI | k | Branch if Minus | if ( $\mathrm{N}=1$ ) then $\mathrm{PC} \leftarrow \mathrm{PC}+\mathrm{k}+1$ | None | 1/2 |
| BRPL | k | Branch if Plus | if ( $\mathrm{N}=0)$ then $\mathrm{PC} \leftarrow \mathrm{PC}+\mathrm{k}+1$ | None | 1/2 |
| BRGE | k | Branch if Greater or Equal, Signed | if ( $\mathrm{N} \oplus \mathrm{V}=0$ ) then $\mathrm{PC} \leftarrow \mathrm{PC}+\mathrm{k}+1$ | None | 1/2 |
| BRLT | k | Branch if Less Than Zero, Signed | if ( $\mathrm{N} \oplus \mathrm{V}=1$ ) then $\mathrm{PC} \leftarrow \mathrm{PC}+\mathrm{k}+1$ | None | 1/2 |
| BRHS | k | Branch if Half Carry Flag Set | if ( $\mathrm{H}=1$ ) then $\mathrm{PC} \leftarrow \mathrm{PC}+\mathrm{k}+1$ | None | 1/2 |
| BRHC | k | Branch if Half Carry Flag Cleared | if ( $\mathrm{H}=0)$ then $\mathrm{PC} \leftarrow \mathrm{PC}+\mathrm{k}+1$ | None | 1/2 |
| BRTS | k | Branch if T Flag Set | if ( $\mathrm{T}=1)$ then $\mathrm{PC} \leftarrow \mathrm{PC}+\mathrm{k}+1$ | None | 1/2 |
| BRTC | k | Branch if T Flag Cleared | if ( $\mathrm{T}=0)$ then $\mathrm{PC} \leftarrow \mathrm{PC}+\mathrm{k}+1$ | None | 1/2 |
| BRVS | k | Branch if Overflow Flag is Set | if ( $\mathrm{V}=1)$ then $\mathrm{PC} \leftarrow \mathrm{PC}+\mathrm{k}+1$ | None | 1/2 |
| BRVC | k | Branch if Overflow Flag is Cleared | if ( $\mathrm{V}=0)$ then $\mathrm{PC} \leftarrow \mathrm{PC}+\mathrm{k}+1$ | None | 1/2 |
| BRIE | k | Branch if Interrupt Enabled | if $(\mathrm{I}=1)$ then $\mathrm{PC} \leftarrow \mathrm{PC}+\mathrm{k}+1$ | None | 1/2 |
| BRID | k | Branch if Interrupt Disabled | if $(\mathrm{I}=0)$ then $\mathrm{PC} \leftarrow \mathrm{PC}+\mathrm{k}+1$ | None | 1/2 |
| DATA TRANSFER INSTRUCTIONS |  |  |  |  |  |


| Mnemonics | Operands | Description | Operation | Flags | \#Clocks |
| :---: | :---: | :---: | :---: | :---: | :---: |
| MOV | Rd, Rr | Move Between Registers | $\mathrm{Rd} \leftarrow \mathrm{Rr}$ | None | 1 |
| MOVW | Rd, Rr | Copy Register Word | $\mathrm{Rd}+1: \mathrm{Rd} \leftarrow \mathrm{Rr}+1: \mathrm{Rr}$ | None | 1 |
| LDI | Rd, K | Load Immediate | $\mathrm{Rd} \leftarrow \mathrm{K}$ | None | 1 |
| LD | Rd, X | Load Indirect | $\mathrm{Rd} \leftarrow(\mathrm{X})$ | None | 2 |
| LD | Rd, $\mathrm{X}^{+}$ | Load Indirect and Post-Inc. | $\mathrm{Rd} \leftarrow(\mathrm{X}), \mathrm{X} \leftarrow \mathrm{X}+1$ | None | 2 |
| LD | Rd, - X | Load Indirect and Pre-Dec. | $\mathrm{X} \leftarrow \mathrm{X}-1, \mathrm{Rd} \leftarrow(\mathrm{X})$ | None | 2 |
| LD | Rd, Y | Load Indirect | $\mathrm{Rd} \leftarrow(\mathrm{Y})$ | None | 2 |
| LD | Rd, $\mathrm{Y}+$ | Load Indirect and Post-Inc. | $\mathrm{Rd} \leftarrow(\mathrm{Y}), \mathrm{Y} \leftarrow \mathrm{Y}+1$ | None | 2 |
| LD | Rd, - Y | Load Indirect and Pre-Dec. | $\mathrm{Y} \leftarrow \mathrm{Y}-1, \mathrm{Rd} \leftarrow(\mathrm{Y})$ | None | 2 |
| LDD | Rd, $\mathrm{Y}+\mathrm{q}$ | Load Indirect with Displacement | $\mathrm{Rd} \leftarrow(\mathrm{Y}+\mathrm{q})$ | None | 2 |
| LD | Rd, Z | Load Indirect | $\mathrm{Rd} \leftarrow(\mathrm{Z})$ | None | 2 |
| LD | Rd, $\mathrm{Z}_{+}$ | Load Indirect and Post-Inc. | $\mathrm{Rd} \leftarrow(\mathrm{Z}), \mathrm{Z} \leftarrow \mathrm{Z}+1$ | None | 2 |
| LD | Rd, -Z | Load Indirect and Pre-Dec. | $\mathrm{Z} \leftarrow \mathrm{Z}-1, \mathrm{Rd} \leftarrow(\mathrm{Z})$ | None | 2 |
| LDD | Rd, $\mathrm{Z}+\mathrm{q}$ | Load Indirect with Displacement | $\mathrm{Rd} \leftarrow(\mathrm{Z}+\mathrm{q})$ | None | 2 |
| LDS | Rd, k | Load Direct from SRAM | $\mathrm{Rd} \leftarrow(\mathrm{k})$ | None | 2 |
| ST | X, Rr | Store Indirect | $(\mathrm{X}) \leftarrow \mathrm{Rr}$ | None | 2 |
| ST | $\mathrm{X}+$, Rr | Store Indirect and Post-Inc. | $(\mathrm{X}) \leftarrow \mathrm{Rr}, \mathrm{X} \leftarrow \mathrm{X}+1$ | None | 2 |
| ST | - X, Rr | Store Indirect and Pre-Dec. | $\mathrm{X} \leftarrow \mathrm{X}-1,(\mathrm{X}) \leftarrow \mathrm{Rr}$ | None | 2 |
| ST | $\mathrm{Y}, \mathrm{Rr}$ | Store Indirect | $(\mathrm{Y}) \leftarrow \mathrm{Rr}$ | None | 2 |
| ST | Y + , Rr | Store Indirect and Post-Inc. | $(\mathrm{Y}) \leftarrow \mathrm{Rr}, \mathrm{Y} \leftarrow \mathrm{Y}+1$ | None | 2 |
| ST | - $\mathrm{Y}, \mathrm{Rr}$ | Store Indirect and Pre-Dec. | $\mathrm{Y} \leftarrow \mathrm{Y}-1,(\mathrm{Y}) \leftarrow \mathrm{Rr}$ | None | 2 |
| STD | $\mathrm{Y}+\mathrm{q}, \mathrm{Rr}$ | Store Indirect with Displacement | $(\mathrm{Y}+\mathrm{q}) \leftarrow \mathrm{Rr}$ | None | 2 |
| ST | Z, Rr | Store Indirect | $(\mathrm{Z}) \leftarrow \mathrm{Rr}$ | None | 2 |
| ST | Z + , Rr | Store Indirect and Post-Inc. | $(\mathrm{Z}) \leftarrow \mathrm{Rr}, \mathrm{Z} \leftarrow \mathrm{Z}+1$ | None | 2 |
| ST | -Z, Rr | Store Indirect and Pre-Dec. | $\mathrm{Z} \leftarrow \mathrm{Z}-1,(\mathrm{Z}) \leftarrow \mathrm{Rr}$ | None | 2 |
| STD | $\mathrm{Z}+\mathrm{q}, \mathrm{Rr}$ | Store Indirect with Displacement | $(Z+q) \leftarrow \operatorname{Rr}$ | None | 2 |
| STS | k, Rr | Store Direct to SRAM | $(\mathrm{k}) \leftarrow \mathrm{Rr}$ | None | 2 |
| LPM |  | Load Program Memory | $\mathrm{R} 0 \leftarrow(\mathrm{Z})$ | None | 3 |
| LPM | Rd, Z | Load Program Memory | $\mathrm{Rd} \leftarrow(\mathrm{Z})$ | None | 3 |
| LPM | Rd, $\mathrm{Z}^{+}$ | Load Program Memory and Post-Inc | $\mathrm{Rd} \leftarrow(\mathrm{Z}), \mathrm{Z} \leftarrow \mathrm{Z}+1$ | None | 3 |
| SPM |  | Store Program Memory | $(\mathrm{Z}) \leftarrow \mathrm{R} 1: \mathrm{R0}$ | None | - |
| IN | Rd, P | In Port | $\mathrm{Rd} \leftarrow \mathrm{P}$ | None | 1 |
| OUT | $\mathrm{P}, \mathrm{Rr}$ | Out Port | $\mathrm{P} \leftarrow \mathrm{Rr}$ | None | 1 |
| PUSH | Rr | Push Register on Stack | STACK $\leftarrow \mathrm{Rr}$ | None | 2 |
| POP | Rd | Pop Register from Stack | $\mathrm{Rd} \leftarrow$ STACK | None | 2 |
| BIT AND BIT-TEST INSTRUCTIONS |  |  |  |  |  |
| SBI | P, b | Set Bit in I/O Register | $\mathrm{l} / \mathrm{O}(\mathrm{P}, \mathrm{b}) \leftarrow 1$ | None | 2 |
| CBI | P, b | Clear Bit in I/O Register | $\mathrm{l} / \mathrm{O}(\mathrm{P}, \mathrm{b}) \leftarrow 0$ | None | 2 |
| LSL | Rd | Logical Shift Left | $\operatorname{Rd}(\mathrm{n}+1) \leftarrow \operatorname{Rd}(\mathrm{n}), \mathrm{Rd}(0) \leftarrow 0$ | Z,C,N, V | 1 |
| LSR | Rd | Logical Shift Right | $\operatorname{Rd}(\mathrm{n}) \leftarrow \operatorname{Rd}(\mathrm{n}+1), \operatorname{Rd}(7) \leftarrow 0$ | Z,C,N, V | 1 |
| ROL | Rd | Rotate Left Through Carry | $\operatorname{Rd}(0) \leftarrow \mathrm{C}, \operatorname{Rd}(\mathrm{n}+1) \leftarrow \operatorname{Rd}(\mathrm{n}), \mathrm{C} \leftarrow \operatorname{Rd}(7)$ | Z,C,N, V | 1 |
| ROR | Rd | Rotate Right Through Carry | $\operatorname{Rd}(7) \leftarrow C, \operatorname{Rd}(\mathrm{n}) \leftarrow \operatorname{Rd}(\mathrm{n}+1), \mathrm{C} \leftarrow \operatorname{Rd}(0)$ | Z,C,N,V | 1 |
| ASR | Rd | Arithmetic Shift Right | $\operatorname{Rd}(\mathrm{n}) \leftarrow \operatorname{Rd}(\mathrm{n}+1), \mathrm{n}=0 . .6$ | Z,C,N, V | 1 |
| SWAP | Rd | Swap Nibbles | $\operatorname{Rd}(3 . .0) \leftarrow \operatorname{Rd}(7 . .4), \operatorname{Rd}(7 . .4) \leftarrow \operatorname{Rd}(3 . .0)$ | 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 | $\mathrm{Rr}, \mathrm{b}$ | Bit Store from Register to T | $\mathrm{T} \leftarrow \operatorname{Rr}(\mathrm{b})$ | T | 1 |
| BLD | Rd, b | Bit load from T to Register | $\operatorname{Rd}(\mathrm{b}) \leftarrow \mathrm{T}$ | None | 1 |
| SEC |  | Set Carry | $\mathrm{C} \leftarrow 1$ | C | 1 |
| CLC |  | Clear Carry | $\mathrm{C} \leftarrow 0$ | C | 1 |
| SEN |  | Set Negative Flag | $N \leftarrow 1$ | N | 1 |
| CLN |  | Clear Negative Flag | $\mathrm{N} \leftarrow 0$ | N | 1 |
| SEZ |  | Set Zero Flag | $\mathrm{Z} \leftarrow 1$ | Z | 1 |
| CLZ |  | Clear Zero Flag | $\mathrm{Z} \leftarrow 0$ | z | 1 |
| SEI |  | Global Interrupt Enable | $1 \leftarrow 1$ | 1 | 1 |
| CLI |  | Global Interrupt Disable | $1 \leftarrow 0$ | 1 | 1 |
| SES |  | Set Signed Test Flag | $\mathrm{S} \leftarrow 1$ | S | 1 |
| CLS |  | Clear Signed Test Flag | $\mathrm{S} \leftarrow 0$ | S | 1 |
| SEV |  | Set Twos Complement Overflow. | $\mathrm{V} \leftarrow 1$ | V | 1 |
| CLV |  | Clear Twos Complement Overflow | $\mathrm{V} \leftarrow 0$ | V | 1 |
| SET |  | Set T in SREG | $\mathrm{T} \leftarrow 1$ | T | 1 |
| CLT |  | Clear T in SREG | $\mathrm{T} \leftarrow 0$ | T | 1 |
| SEH |  | Set Half Carry Flag in SREG | $\mathrm{H} \leftarrow 1$ | H | 1 |
| CLH |  | Clear Half Carry Flag in SREG | $\mathrm{H} \leftarrow 0$ | H | 1 |
| MCU CONTROL INSTRUCTIONS |  |  |  |  |  |
| NOP |  | No Operation |  | None | 1 |


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

## Ordering Information

| Speed (MHz) | Power Supply | Ordering Code | Package ${ }^{(1)}$ | Operation Range |
| :---: | :---: | :---: | :---: | :---: |
| 8 | 2.7-5.5V | ATmega8535L-8AC <br> ATmega8535L-8PC <br> ATmega8535L-8JC <br> ATmega8535L-8MC | $\begin{aligned} & \hline 44 \mathrm{~A} \\ & 40 \mathrm{P} 6 \\ & 44 \mathrm{~J} \\ & 44 \mathrm{M} 1 \end{aligned}$ | $\begin{aligned} & \text { Commercial } \\ & \left(0^{\circ} \mathrm{C} \text { to } 70^{\circ} \mathrm{C}\right) \end{aligned}$ |
|  |  | ATmega8535L-8AI <br> ATmega8535L-8PI <br> ATmega8535L-8JI <br> ATmega8535L-8MI <br> ATmega8535L-8AU ${ }^{(2)}$ <br> ATmega8535L-8PU(2) <br> ATmega8535L-8JU ${ }^{(2)}$ <br> ATmega8535L-8MU ${ }^{(2)}$ | 44A <br> 40P6 <br> 44J <br> 44M1 <br> 44A <br> 40P6 <br> 44J <br> 44M1 | Industrial <br> $\left(-40^{\circ} \mathrm{C}\right.$ to $\left.85^{\circ} \mathrm{C}\right)$ |
| 16 | 4.5-5.5V | ATmega8535-16AC <br> ATmega8535-16PC <br> ATmega8535-16JC <br> ATmega8535-16MC | 44A <br> 40P6 <br> 44 J <br> 44M1 | $\begin{aligned} & \text { Commercial } \\ & \left(0^{\circ} \mathrm{C} \text { to } 70^{\circ} \mathrm{C}\right) \end{aligned}$ |
|  |  | ATmega8535-16AI <br> ATmega8535-16PI <br> ATmega8535-16JI <br> ATmega8535-16MI <br> ATmega8535-16AU ${ }^{(2)}$ <br> ATmega8535-16PU(2) <br> ATmega8535-16JU ${ }^{(2)}$ <br> ATmega8535-16MU ${ }^{(2)}$ | 44A <br> 40P6 <br> 44J <br> 44M1 <br> 44A <br> 40P6 <br> 44J <br> 44M1 | Industrial <br> $\left(-40^{\circ} \mathrm{C}\right.$ to $\left.85^{\circ} \mathrm{C}\right)$ |

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 |  |
| :--- | :--- |
| 44A | 44-lead, Thin (1.0 mm) Plastic Gull Wing Quad Flat Package (TQFP) |
| 40P6 | 40-pin, 0.600" Wide, Plastic Dual Inline Package (PDIP) |
| 44J | 44-lead, Plastic J-leaded Chip Carrier (PLCC) |
| 44M1-A | 44-pad, $7 \times 7 \times 1.0 \mathrm{~mm}$ body, lead pitch 0.50 mm, Quad Flat No-Lead/Micro Lead Frame Package (QFN/MLF) |

## Packaging Information

## 44A



## 40P6



44J


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 $.010^{\prime \prime}(0.254 \mathrm{~mm})$ 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 $0.004^{\prime \prime}(0.102 \mathrm{~mm})$ maximum.

COMMON DIMENSIONS
(Unit of Measure $=\mathrm{mm}$ )

| 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 |  |  |  |

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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 $\mathrm{V}_{\mathrm{CC}}$, 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.

1. Updated TOP/BOTTOM description for all Timer/Counters Fast PWM mode.
2. Updated "Errata" on page 18.
3. Updated "Ordering Information" on page 13.
4. Updated code example "USART Initialization" on page 150.
5. Added "Resources" on page 6.
6. Updated Table 7 on page 29, Table 17 on page 42 and Table 111 on page 258.
7. Updated "Serial Peripheral Interface - SPI" on page 136.
8. Updated note in "Bit Rate Generator Unit" on page 180.
9. Removed "Preliminary" and TBD's.
10. Updated Table 37 on page 69 and Table 113 on page 261.
11. Updated "Electrical Characteristics" on page 255.
12. Updated "Ordering Information" on page 13.
13. MLF-package alternative changed to "Quad Flat No-Lead/Micro Lead Frame Package QFN/MLF".
14. Updated "Reset Characteristics" on page 37.
15. Updated SPH in "Stack Pointer" on page 12.
16. Updated C code in "USART Initialization" on page 150.
17. Updated "Errata" on page 18.
18. Updated "Calibrated Internal RC Oscillator" on page 29.
19. Added section "Errata" on page 18.

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

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

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

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.
9. Updated "Packaging Information" on page 14.
10. 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.
11. Added the section "EEPROM Write During Power-down Sleep Mode" on page 22.
12. Removed the references to the application notes "Multi-purpose Oscillator" and " 32 kHz Crystal Oscillator", which do not exist.
13. Updated code examples on page 44.
14. Removed ADHSM bit.
15. Renamed Port D pin ICP to ICP1. See "Alternate Functions of Port D" on page 64.
16. Added information about PWM symmetry for Timer 0 on page 79 and Timer 2 on page 126.
17. 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.
18. Updated description on "Bit 5 - TWSTA: TWI START Condition Bit" on page 182.
19. Updated the description in "Filling the Temporary Buffer (Page Loading)" and "Performing a Page Write" on page 231.
20. Removed the section description in "SPI Serial Programming Characteristics" on page 254.
21. Updated "Electrical Characteristics" on page 255.
22. Updated "ADC Characteristics" on page 263.
23. Updated "Register Summary" on page 8.
24. Various Timer 1 corrections.
25. Added WD_FUSE period in Table 108 on page 253.

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

1. Canged the Endurance on the Flash to $\mathbf{1 0 , 0 0 0}$ Write/Erase Cycles.

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