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

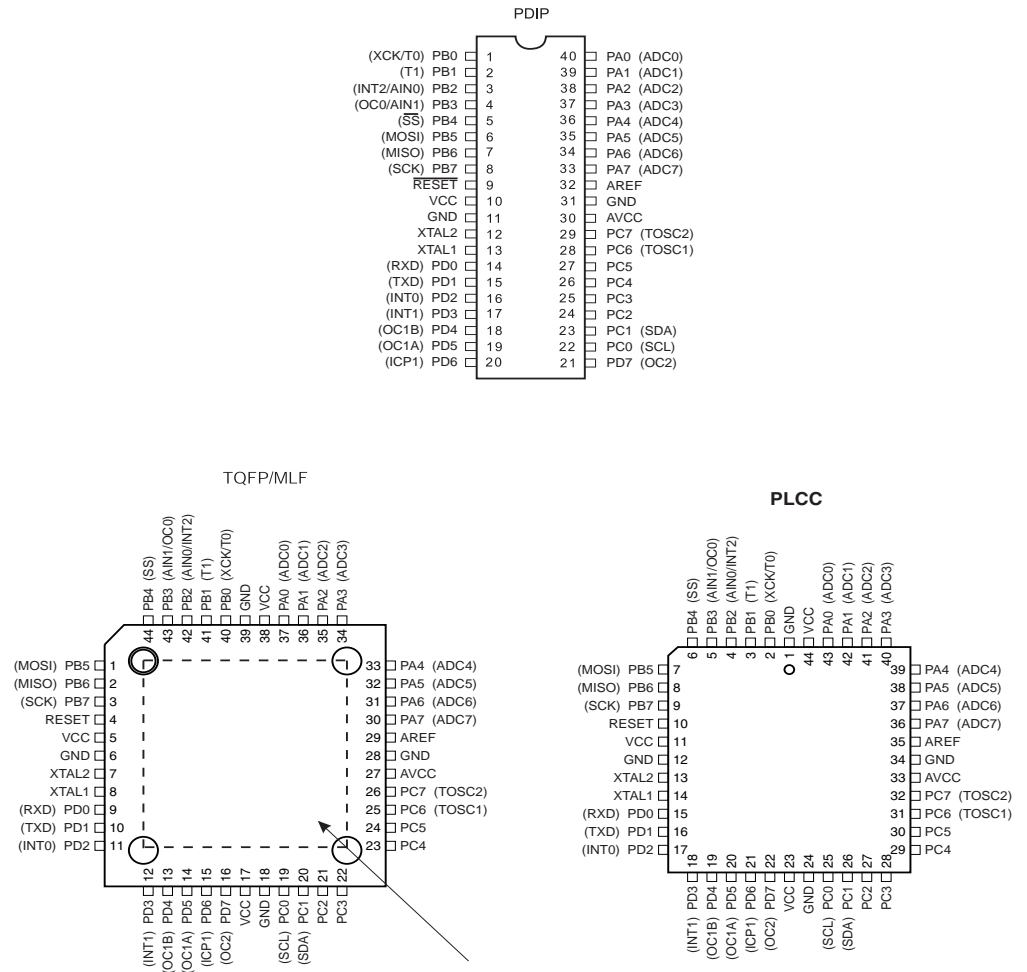
Applications of "[Embedded - Microcontrollers](#)"

Details

| | |
|----------------------------|---|
| Product Status | Active |
| Core Processor | AVR |
| Core Size | 8-Bit |
| Speed | 16MHz |
| Connectivity | I ² C, SPI, UART/USART |
| Peripherals | Brown-out Detect/Reset, POR, PWM, WDT |
| Number of I/O | 32 |
| Program Memory Size | 8KB (4K x 16) |
| Program Memory Type | FLASH |
| EEPROM Size | 512 x 8 |
| RAM Size | 512 x 8 |
| Voltage - Supply (Vcc/Vdd) | 4.5V ~ 5.5V |
| Data Converters | A/D 8x10b |
| Oscillator Type | Internal |
| Operating Temperature | -40°C ~ 85°C (TA) |
| Mounting Type | Through Hole |
| Package / Case | 40-DIP (0.600", 15.24mm) |
| Supplier Device Package | 40-PDIP |
| Purchase URL | https://www.e-xfl.com/product-detail/microchip-technology/atmega8535-16pu |

Pin Configurations

Figure 1. Pinout ATmega8535



NOTE: MLF Bottom pad should be soldered to ground.

Disclaimer

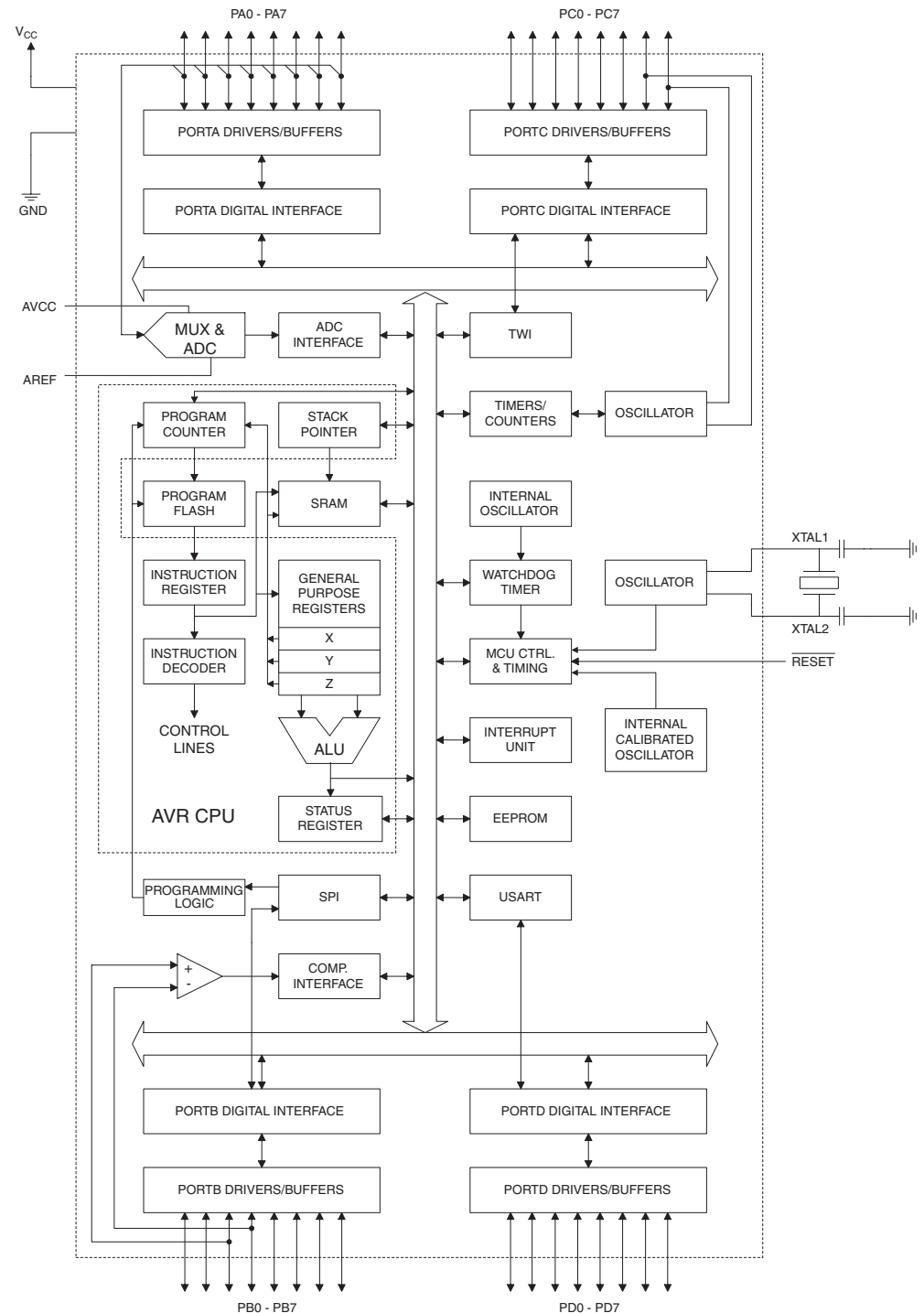
Typical values contained in this data sheet are based on simulations and characterization of other AVR microcontrollers manufactured on the same process technology. Min and Max values will be available after the device is characterized.

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.



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 ⁽¹⁾ (0x40) ⁽¹⁾ | 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 |
|--|----------|--|---|---------------|-----------|
| ARITHMETIC AND LOGIC INSTRUCTIONS | | | | | |
| 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 |
| BRANCH INSTRUCTIONS | | | | | |
| 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 |
| DATA TRANSFER INSTRUCTIONS | | | | | |

| 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 |
| BIT AND BIT-TEST INSTRUCTIONS | | | | | |
| 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 |
| MCU CONTROL INSTRUCTIONS | | | | | |
| 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

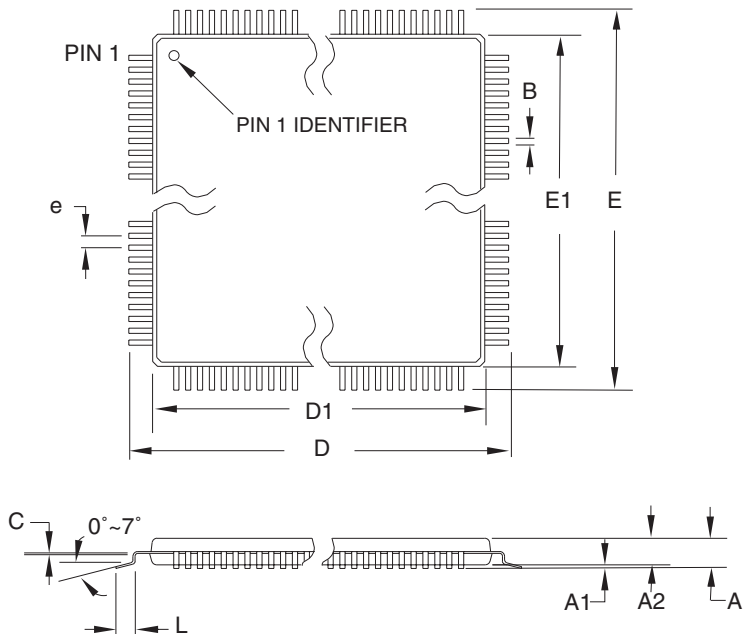
| Speed (MHz) | Power Supply | Ordering Code | Package ⁽¹⁾ | Operation Range |
|-------------|--------------|--------------------------------|------------------------|-------------------------------|
| 8 | 2.7 - 5.5V | ATmega8535L-8AC | 44A | Commercial (0°C to 70°C) |
| | | ATmega8535L-8PC | 40P6 |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

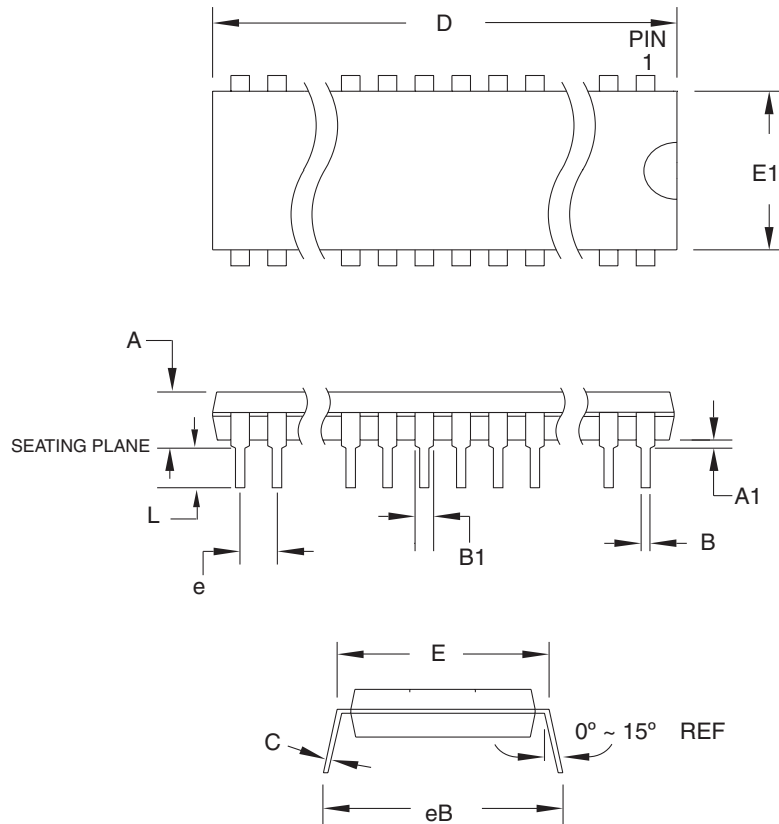
| SYMBOL | MIN | NOM | MAX | NOTE |
|--------|----------|-------|-------|--------|
| A | – | – | 1.20 | |
| A1 | 0.05 | – | 0.15 | |
| A2 | 0.95 | 1.00 | 1.05 | |
| D | 11.75 | 12.00 | 12.25 | |
| D1 | 9.90 | 10.00 | 10.10 | Note 2 |
| E | 11.75 | 12.00 | 12.25 | |
| E1 | 9.90 | 10.00 | 10.10 | Note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

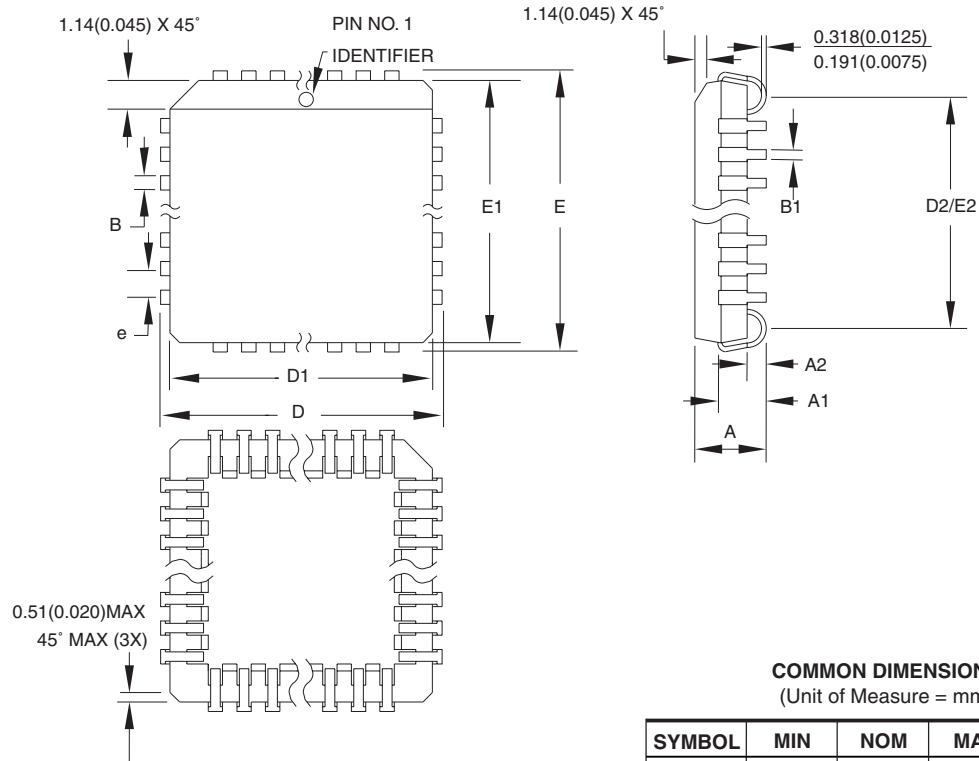
DRAWING NO.

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)

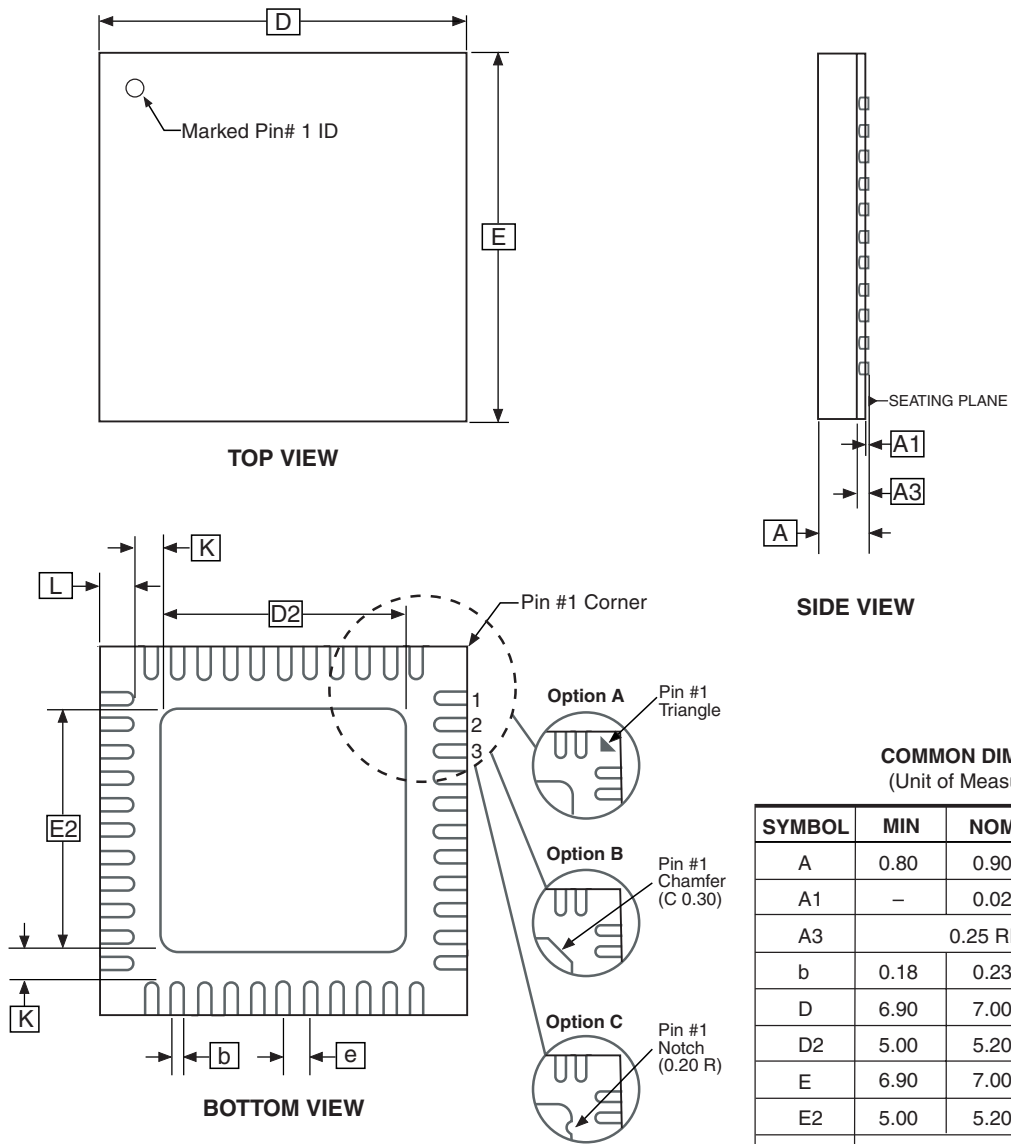
DRAWING NO.

44J

REV.

B

44M1-A



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

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**



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