
Features

- High-performance, Low-power AVR[®] 8-bit Microcontroller
- Advanced RISC Architecture
 - 131 Powerful Instructions – Most Single-clock Cycle Execution
 - 32 x 8 General Purpose Working Registers
 - Fully Static Operation
 - Up to 16 MIPS Throughput at 16 MHz
 - On-chip 2-cycle Multiplier
- Non-volatile Program and Data Memories
 - 16K 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
 - 1K Bytes Internal SRAM
 - Up to 64K Bytes Optional External Memory Space
 - Programming Lock for Software Security
- JTAG (IEEE std. 1149.1 Compliant) Interface
 - Boundary-scan Capabilities According to the JTAG Standard
 - Extensive On-chip Debug Support
 - Programming of Flash, EEPROM, Fuses, and Lock Bits through the JTAG Interface
- Peripheral Features
 - Two 8-bit Timer/Counters with Separate Prescalers and Compare Modes
 - Two 16-bit Timer/Counters with Separate Prescalers, Compare Modes, and Capture Modes
 - Real Time Counter with Separate Oscillator
 - Six PWM Channels
 - Dual Programmable Serial USARTs
 - 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
 - Five Sleep Modes: Idle, Power-save, Power-down, Standby, and Extended Standby
- I/O and Packages
 - 35 Programmable I/O Lines
 - 40-pin PDIP, 44-lead TQFP, and 44-pad MLF
- Operating Voltages
 - 1.8 - 5.5V for ATmega162V
 - 2.7 - 5.5V for ATmega162
- Speed Grades
 - 0 - 8 MHz for ATmega162V (see Figure 113)
 - 0 - 16 MHz for ATmega162 (see Figure 114)



**8-bit AVR[®]
Microcontroller
with 16K Bytes
In-System
Programmable
Flash**

**ATmega162
ATmega162V**

**Advance
Information**

Summary

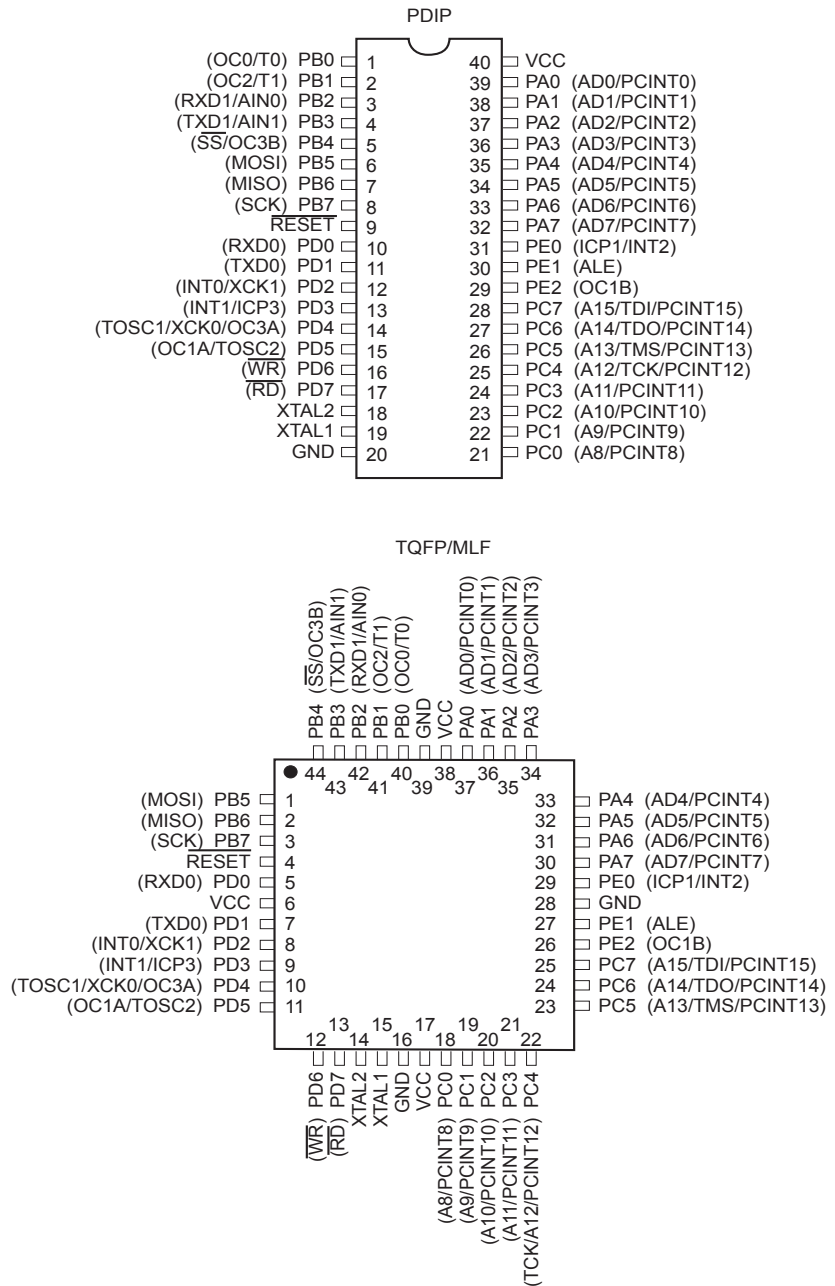
Rev. 2513DS-AVR-04/03



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

Pin Configurations

Figure 1. Pinout ATmega162



Disclaimer

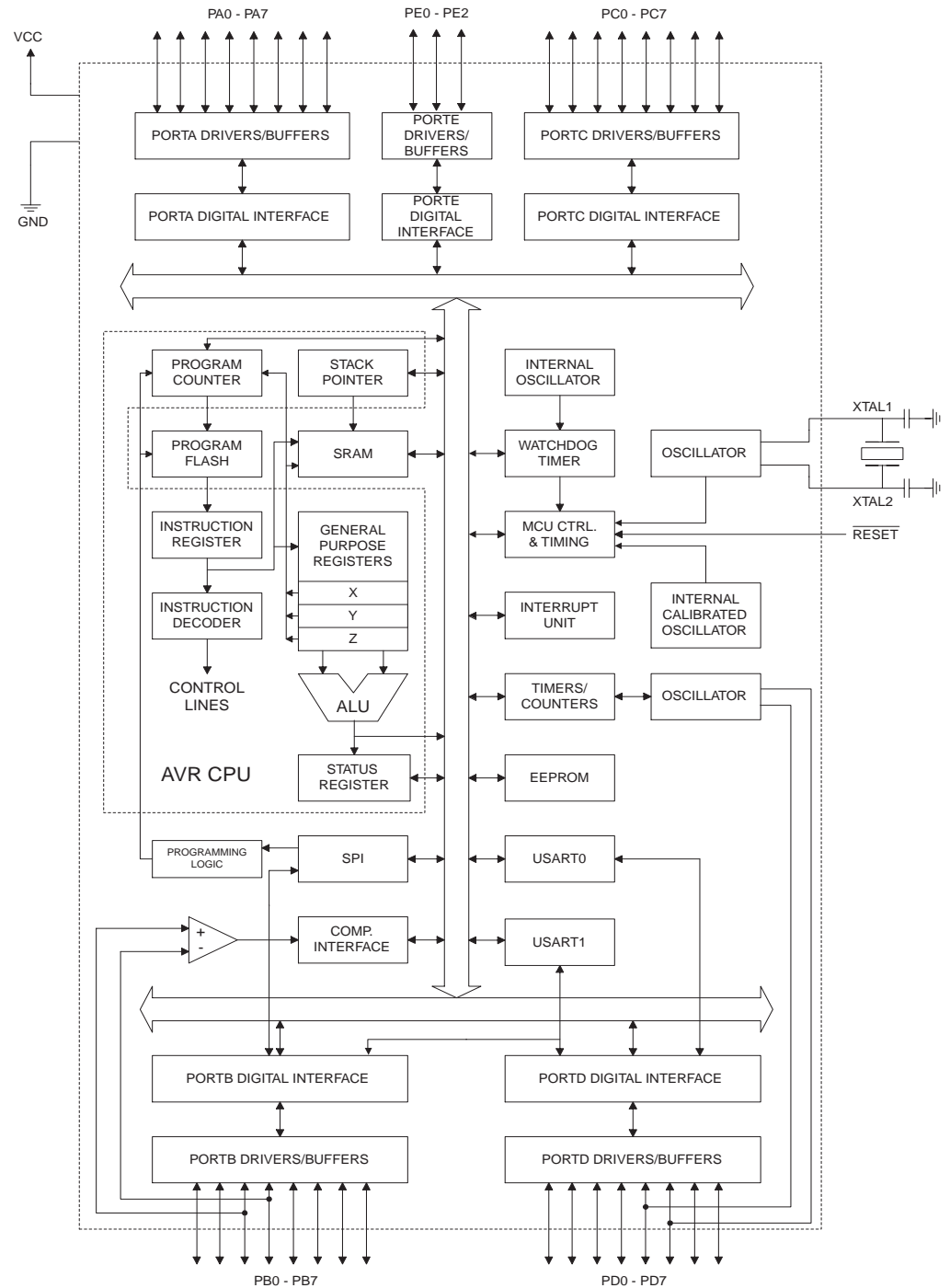
Typical values contained in this data sheet are based on simulations and characterization of other AVR microcontrollers manufactured on the same process technology. Min and Max values will be available after the device is characterized.

Overview

The ATmega162 is a low-power CMOS 8-bit microcontroller based on the AVR enhanced RISC architecture. By executing powerful instructions in a single clock cycle, the ATmega162 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 the 32 registers are directly connected to the Arithmetic Logic Unit (ALU), allowing two independent registers to be accessed in one single instruction executed in one clock cycle. The resulting architecture is more code efficient while achieving throughputs up to ten times faster than conventional CISC microcontrollers.

The ATmega162 provides the following features: 16K bytes of In-System Programmable Flash with Read-While-Write capabilities, 512 bytes EEPROM, 1K bytes SRAM, an external memory interface, 35 general purpose I/O lines, 32 general purpose working registers, a JTAG interface for Boundary-scan, On-chip Debugging support and programming, four flexible Timer/Counters with compare modes, internal and external interrupts, two serial programmable USARTs, a programmable Watchdog Timer with Internal Oscillator, an SPI serial port, and five 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. 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 non-volatile memory technology. The On-chip ISP Flash allows the program memory to be reprogrammed In-System through an SPI serial interface, by a conventional non-volatile 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 ATmega162 is a powerful microcontroller that provides a highly flexible and cost effective solution to many embedded control applications.

The ATmega162 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.

ATmega161 and ATmega162 Compatibility

The ATmega162 is a highly complex microcontroller where the number of I/O locations supersedes the 64 I/O locations reserved in the AVR instruction set. To ensure backward compatibility with the ATmega161, all I/O locations present in ATmega161 have the same locations in ATmega162. Some additional I/O locations are added in an Extended I/O space starting from 0x60 to 0xFF, (i.e., in the ATmega162 internal RAM space). These locations can be reached by using LD/LDS/LDD and ST/STS/STD instructions only, not by using IN and OUT instructions. The relocation of the internal RAM space may still be a problem for ATmega161 users. Also, the increased number of Interrupt Vectors might be a problem if the code uses absolute addresses. To solve these problems, an ATmega161 compatibility mode can be selected by programming the fuse M161C. In this mode, none of the functions in the Extended I/O space are in use, so the internal RAM is located as in ATmega161. Also, the Extended Interrupt Vectors are removed. The ATmega162 is 100% pin compatible with ATmega161, and can replace the ATmega161 on current Printed Circuit Boards. However, the location of Fuse bits and the electrical characteristics differs between the two devices.

ATmega161 Compatibility Mode

Programming the M161C will change the following functionality:

- The extended I/O map will be configured as internal RAM once the M161C Fuse is programmed.
- 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 54 for details.
- The double buffering of the USART Receive Registers is disabled. See “AVR USART vs. AVR UART – Compatibility” on page 166 for details.
- Pin change interrupts are not supported (Control Registers are located in Extended I/O).
- One 16 bits Timer/Counter (Timer/Counter1) only. Timer/Counter3 is not accessible.

Note that the shared UBRRHI Register in ATmega161 is split into two separate registers in ATmega162, UBRR0H and UBRR1H. The location of these registers will not be affected by the ATmega161 compatibility fuse.

Pin Descriptions

VCC	Digital supply voltage
GND	Ground
Port A (PA7..PA0)	<p>Port A is an 8-bit bi-directional I/O port with 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> <p>Port A also serves the functions of various special features of the ATmega162 as listed on page 70.</p>
Port B (PB7..PB0)	<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 ATmega162 as listed on page 70.</p>
Port C (PC7..PC0)	<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. If the JTAG interface is enabled, the pull-up resistors on pins PC7(TDI), PC5(TMS) and PC4(TCK) will be activated even if a Reset occurs.</p> <p>Port C also serves the functions of the JTAG interface and other special features of the ATmega162 as listed on page 73.</p>

Port D (PD7..PD0)

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 ATmega162 as listed on page 76.

Port E (PE2..PE0)

Port E is an 3-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port E output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port E pins that are externally pulled low will source current if the pull-up resistors are activated. The Port E pins are tri-stated when a reset condition becomes active, even if the clock is not running.

Port E also serves the functions of various special features of the ATmega162 as listed on page 79.

RESET

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 18 on page 46. Shorter pulses are not guaranteed to generate a reset.

XTAL1

Input to the Inverting Oscillator amplifier and input to the internal clock operating circuit.

XTAL2

Output from the Inverting Oscillator amplifier.

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
(0xFF)	Reserved	–	–	–	–	–	–	–	–	
..	Reserved	–	–	–	–	–	–	–	–	
(0x9E)	Reserved	–	–	–	–	–	–	–	–	
(0x9D)	Reserved	–	–	–	–	–	–	–	–	
(0x9C)	Reserved	–	–	–	–	–	–	–	–	
(0x9B)	Reserved	–	–	–	–	–	–	–	–	
(0x9A)	Reserved	–	–	–	–	–	–	–	–	
(0x99)	Reserved	–	–	–	–	–	–	–	–	
(0x98)	Reserved	–	–	–	–	–	–	–	–	
(0x97)	Reserved	–	–	–	–	–	–	–	–	
(0x96)	Reserved	–	–	–	–	–	–	–	–	
(0x95)	Reserved	–	–	–	–	–	–	–	–	
(0x94)	Reserved	–	–	–	–	–	–	–	–	
(0x93)	Reserved	–	–	–	–	–	–	–	–	
(0x92)	Reserved	–	–	–	–	–	–	–	–	
(0x91)	Reserved	–	–	–	–	–	–	–	–	
(0x90)	Reserved	–	–	–	–	–	–	–	–	
(0x8F)	Reserved	–	–	–	–	–	–	–	–	
(0x8E)	Reserved	–	–	–	–	–	–	–	–	
(0x8D)	Reserved	–	–	–	–	–	–	–	–	
(0x8C)	Reserved	–	–	–	–	–	–	–	–	
(0x8B)	TCCR3A	COM3A1	COM3A0	COM3B1	COM3B0	FOC3A	FOC3B	WGM31	WGM30	129
(0x8A)	TCCR3B	ICNC3	ICES3	–	WGM33	WGM32	CS32	CS31	CS30	126
(0x89)	TCNT3H	Timer/Counter3 – Counter Register High Byte								131
(0x88)	TCNT3L	Timer/Counter3 – Counter Register Low Byte								131
(0x87)	OCR3AH	Timer/Counter3 – Output Compare Register A High Byte								131
(0x86)	OCR3AL	Timer/Counter3 – Output Compare Register A Low Byte								131
(0x85)	OCR3BH	Timer/Counter3 – Output Compare Register B High Byte								131
(0x84)	OCR3BL	Timer/Counter3 – Output Compare Register B Low Byte								131
(0x83)	Reserved	–	–	–	–	–	–	–	–	
(0x82)	Reserved	–	–	–	–	–	–	–	–	
(0x81)	ICR3H	Timer/Counter3 – Input Capture Register High Byte								132
(0x80)	ICR3L	Timer/Counter3 – Input Capture Register Low Byte								132
(0x7F)	Reserved	–	–	–	–	–	–	–	–	
(0x7E)	Reserved	–	–	–	–	–	–	–	–	
(0x7D)	ETIMSK	–	–	TICIE3	OCIE3A	OCIE3B	TOIE3	–	–	133
(0x7C)	ETIFR	–	–	ICF3	OCF3A	OCF3B	TOV3	–	–	134
(0x7B)	Reserved	–	–	–	–	–	–	–	–	
(0x7A)	Reserved	–	–	–	–	–	–	–	–	
(0x79)	Reserved	–	–	–	–	–	–	–	–	
(0x78)	Reserved	–	–	–	–	–	–	–	–	
(0x77)	Reserved	–	–	–	–	–	–	–	–	
(0x76)	Reserved	–	–	–	–	–	–	–	–	
(0x75)	Reserved	–	–	–	–	–	–	–	–	
(0x74)	Reserved	–	–	–	–	–	–	–	–	
(0x73)	Reserved	–	–	–	–	–	–	–	–	
(0x72)	Reserved	–	–	–	–	–	–	–	–	
(0x71)	Reserved	–	–	–	–	–	–	–	–	
(0x70)	Reserved	–	–	–	–	–	–	–	–	
(0x6F)	Reserved	–	–	–	–	–	–	–	–	
(0x6E)	Reserved	–	–	–	–	–	–	–	–	
(0x6D)	Reserved	–	–	–	–	–	–	–	–	
(0x6C)	PCMSK1	PCINT15	PCINT14	PCINT13	PCINT12	PCINT11	PCINT10	PCINT9	PCINT8	86
(0x6B)	PCMSK0	PCINT7	PCINT6	PCINT5	PCINT4	PCINT3	PCINT2	PCINT1	PCINT0	86
(0x6A)	Reserved	–	–	–	–	–	–	–	–	
(0x69)	Reserved	–	–	–	–	–	–	–	–	
(0x68)	Reserved	–	–	–	–	–	–	–	–	
(0x67)	Reserved	–	–	–	–	–	–	–	–	
(0x66)	Reserved	–	–	–	–	–	–	–	–	
(0x65)	Reserved	–	–	–	–	–	–	–	–	
(0x64)	Reserved	–	–	–	–	–	–	–	–	
(0x63)	Reserved	–	–	–	–	–	–	–	–	
(0x62)	Reserved	–	–	–	–	–	–	–	–	
(0x61)	CLKPR	CLKPCE	–	–	–	CLKPS3	CLKPS2	CLKPS1	CLKPS0	39

Address	Name	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Page
(0x60)	Reserved	–	–	–	–	–	–	–	–	
0x3F (0x5F)	SREG	I	T	H	S	V	N	Z	C	8
0x3E (0x5E)	SPH	SP15	SP14	SP13	SP12	SP11	SP10	SP9	SP8	11
0x3D (0x5D)	SPL	SP7	SP6	SP5	SP4	SP3	SP2	SP1	SP0	11
0x3C ⁽²⁾ (0x5C) ⁽²⁾	UBRR1H	URSEL1					UBRR1[11:8]			188
	UCSR1C	URSEL1	UMSEL1	UPM11	UPM10	USBS1	UCSZ11	UCSZ10	UCPOL1	187
0x3B (0x5B)	GICR	INT1	INT0	INT2	PCIE1	PCIE0	–	IVSEL	IVCE	59, 84
0x3A (0x5A)	GIFR	INTF1	INTF0	INTF2	PCIF1	PCIF0	–	–	–	85
0x39 (0x59)	TIMSK	TOIE1	OCIE1A	OCIE1B	OCIE2	TICIE1	TOIE2	TOIE0	OCIE0	100, 132, 153
0x38 (0x58)	TIFR	TOV1	OCF1A	OCF1B	OCF2	ICF1	TOV2	TOV0	OCF0	101, 134, 154
0x37 (0x57)	SPMCR	SPMIE	RWWWSB	–	RWWWSRE	BLBSET	PGWRT	PGERS	SPMEN	219
0x36 (0x56)	EMCUCR	SM0	SRL2	SRL1	SRL0	SRW01	SRW00	SRW11	ISC2	28,42,83
0x35 (0x55)	MCUCR	SRE	SRW10	SE	SM1	ISC11	ISC10	ISC01	ISC00	28,41,82
0x34 (0x54)	MCUCSR	JTD	–	SM2	JTRF	WDRF	BORF	EXTRF	PORF	41,49,205
0x33 (0x53)	TCCR0	FOC0	WGM00	COM01	COM00	WGM01	CS02	CS01	CS00	98
0x32 (0x52)	TCNT0	Timer/Counter0 (8 Bits)								100
0x31 (0x51)	OCR0	Timer/Counter0 Output Compare Register								100
0x30 (0x50)	SFIOR	TSM	XMBK	XMM2	XMM1	XMM0	PUD	PSR2	PSR310	30,68,103,155
0x2F (0x4F)	TCCR1A	COM1A1	COM1A0	COM1B1	COM1B0	FOC1A	FOC1B	WGM11	WGM10	126
0x2E (0x4E)	TCCR1B	ICNC1	ICES1	–	WGM13	WGM12	CS12	CS11	CS10	129
0x2D (0x4D)	TCNT1H	Timer/Counter1 – Counter Register High Byte								131
0x2C (0x4C)	TCNT1L	Timer/Counter1 – Counter Register Low Byte								131
0x2B (0x4B)	OCR1AH	Timer/Counter1 – Output Compare Register A High Byte								131
0x2A (0x4A)	OCR1AL	Timer/Counter1 – Output Compare Register A Low Byte								131
0x29 (0x49)	OCR1BH	Timer/Counter1 – Output Compare Register B High Byte								131
0x28 (0x48)	OCR1BL	Timer/Counter1 – Output Compare Register B Low Byte								131
0x27 (0x47)	TCCR2	FOC2	WGM20	COM21	COM20	WGM21	CS22	CS21	CS20	147
0x26 (0x46)	ASSR	–	–	–	–	AS2	TCON2UB	OCR2UB	TCR2UB	151
0x25 (0x45)	ICR1H	Timer/Counter1 – Input Capture Register High Byte								132
0x24 (0x44)	ICR1L	Timer/Counter1 – Input Capture Register Low Byte								132
0x23 (0x43)	TCNT2	Timer/Counter2 (8 Bits)								150
0x22 (0x42)	OCR2	Timer/Counter2 Output Compare Register								150
0x21 (0x41)	WDTCR	–	–	–	WDCE	WDE	WDP2	WDP1	WDP0	51
0x20 ⁽²⁾ (0x40) ⁽²⁾	UBRR0H	URSEL0	–	–	–	–	UBRR0[11:8]			188
	UCSR0C	URSEL0	UMSEL0	UPM01	UPM00	USBS0	UCSZ01	UCSZ00	UCPOL0	187
0x1F (0x3F)	EEARH	–	–	–	–	–	–	–	EEAR8	18
0x1E (0x3E)	EEARL	EEPROM Address Register Low Byte								18
0x1D (0x3D)	EEDR	EEPROM Data Register								19
0x1C (0x3C)	EECR	–	–	–	–	EERIE	EEMWE	EWE	EERE	19
0x1B (0x3B)	PORTA	PORTA7	PORTA6	PORTA5	PORTA4	PORTA3	PORTA2	PORTA1	PORTA0	80
0x1A (0x3A)	DDRA	DDA7	DDA6	DDA5	DDA4	DDA3	DDA2	DDA1	DDA0	80
0x19 (0x39)	PINA	PINA7	PINA6	PINA5	PINA4	PINA3	PINA2	PINA1	PINA0	80
0x18 (0x38)	PORTB	PORTB7	PORTB6	PORTB5	PORTB4	PORTB3	PORTB2	PORTB1	PORTB0	80
0x17 (0x37)	DDRB	DDB7	DDB6	DDB5	DDB4	DDB3	DDB2	DDB1	DDB0	80
0x16 (0x36)	PINB	PINB7	PINB6	PINB5	PINB4	PINB3	PINB2	PINB1	PINB0	80
0x15 (0x35)	PORTC	PORTC7	PORTC6	PORTC5	PORTC4	PORTC3	PORTC2	PORTC1	PORTC0	80
0x14 (0x34)	DDRC	DDC7	DDC6	DDC5	DDC4	DDC3	DDC2	DDC1	DDC0	80
0x13 (0x33)	PINC	PINC7	PINC6	PINC5	PINC4	PINC3	PINC2	PINC1	PINC0	81
0x12 (0x32)	PORTD	PORTD7	PORTD6	PORTD5	PORTD4	PORTD3	PORTD2	PORTD1	PORTD0	81
0x11 (0x31)	DDRD	DDD7	DDD6	DDD5	DDD4	DDD3	DDD2	DDD1	DDD0	81
0x10 (0x30)	PIND	PIND7	PIND6	PIND5	PIND4	PIND3	PIND2	PIND1	PIND0	81
0x0F (0x2F)	SPDR	SPI Data Register								162
0x0E (0x2E)	SPSR	SPIF	WCOL	–	–	–	–	–	SPI2X	162
0x0D (0x2D)	SPCR	SPIE	SPE	DORD	MSTR	CPOL	CPHA	SPR1	SPR0	160
0x0C (0x2C)	UDR0	USART0 I/O Data Register								184
0x0B (0x2B)	UCSROA	RXC0	TXC0	UDRE0	FE0	DOR0	UPE0	U2X0	MPCM0	184
0x0A (0x2A)	UCSR0B	RXCIE0	TXCIE0	UDRIE0	RXEN0	TXEN0	UCSZ02	RXB80	TXB80	185
0x09 (0x29)	UBRR0L	USART0 Baud Rate Register Low Byte								188
0x08 (0x28)	ACSR	ACD	ACBG	ACO	ACI	ACIE	ACIC	ACIS1	ACIS0	193
0x07 (0x27)	PORTE	–	–	–	–	–	PORTE2	PORTE1	PORTE0	81
0x06 (0x26)	DDRE	–	–	–	–	–	DDE2	DDE1	DDE0	81
0x05 (0x25)	PINE	–	–	–	–	–	PINE2	PINE1	PINE0	81
0x04 ⁽¹⁾ (0x24) ⁽¹⁾	OSCCAL	–	CAL6	CAL5	CAL4	CAL3	CAL2	CAL1	CAL0	37
	OCDR	On-chip Debug Register								200
0x03 (0x23)	UDR1	USART1 I/O Data Register								184
0x02 (0x22)	UCSR1A	RXC1	TXC1	UDRE1	FE1	DOR1	UPE1	U2X1	MPCM1	184

Address	Name	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Page
0x01 (0x21)	UCSR1B	RXCIE1	TXCIE1	UDRIE1	RXEN1	TXEN1	UCSZ12	RXB81	TXB81	185
0x00 (0x20)	UBRR1L	USART1 Baud Rate Register Low Byte								188

- Notes:
1. When the OCDEN Fuse is unprogrammed, the OSCCAL Register is always accessed on this address. Refer to the debugger specific documentation for details on how to use the OCDR Register.
 2. Refer to the USART description for details on how to access UBRRH and UCSRC.
 3. For compatibility with future devices, reserved bits should be written to zero if accessed. Reserved I/O memory addresses should never be written.
 4. 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	Rd,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	Rd,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	$R1:R0 \leftarrow (Rd \times Rr) \lll 1$	Z,C	2
FMULS	Rd, Rr	Fractional Multiply Signed	$R1:R0 \leftarrow (Rd \times Rr) \lll 1$	Z,C	2
FMULSU	Rd, Rr	Fractional Multiply Signed with Unsigned	$R1:R0 \leftarrow (Rd \times Rr) \lll 1$	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
JMP	k	Direct Jump	$PC \leftarrow k$	None	3
RCALL	k	Relative Subroutine Call	$PC \leftarrow PC + k + 1$	None	3
ICALL		Indirect Call to (Z)	$PC \leftarrow Z$	None	3
CALL	k	Direct Subroutine Call	$PC \leftarrow k$	None	4
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 $(SREG(s) = 1) PC \leftarrow PC + k + 1$	None	1/2
BRBC	s, k	Branch if Status Flag Cleared	if $(SREG(s) = 0) PC \leftarrow PC + k + 1$	None	1/2
BREQ	k	Branch if Equal	if $(Z = 1) PC \leftarrow PC + k + 1$	None	1/2
BRNE	k	Branch if Not Equal	if $(Z = 0) PC \leftarrow PC + k + 1$	None	1/2
BRCS	k	Branch if Carry Set	if $(C = 1) PC \leftarrow PC + k + 1$	None	1/2
BRCC	k	Branch if Carry Cleared	if $(C = 0) PC \leftarrow PC + k + 1$	None	1/2
BRSH	k	Branch if Same or Higher	if $(C = 0) PC \leftarrow PC + k + 1$	None	1/2
BRLO	k	Branch if Lower	if $(C = 1) PC \leftarrow PC + k + 1$	None	1/2
BRMI	k	Branch if Minus	if $(N = 1) PC \leftarrow PC + k + 1$	None	1/2
BRPL	k	Branch if Plus	if $(N = 0) PC \leftarrow PC + k + 1$	None	1/2
BRGE	k	Branch if Greater or Equal, Signed	if $(N \oplus V = 0) PC \leftarrow PC + k + 1$	None	1/2
BRLT	k	Branch if Less Than Zero, Signed	if $(N \oplus V = 1) PC \leftarrow PC + k + 1$	None	1/2
BRHS	k	Branch if Half Carry Flag Set	if $(H = 1) PC \leftarrow PC + k + 1$	None	1/2
BRHC	k	Branch if Half Carry Flag Cleared	if $(H = 0) PC \leftarrow PC + k + 1$	None	1/2
BRTS	k	Branch if T Flag Set	if $(T = 1) PC \leftarrow PC + k + 1$	None	1/2
BRTC	k	Branch if T Flag Cleared	if $(T = 0) PC \leftarrow PC + k + 1$	None	1/2
BRVS	k	Branch if Overflow Flag is Set	if $(V = 1) PC \leftarrow PC + k + 1$	None	1/2
BRVC	k	Branch if Overflow Flag is Cleared	if $(V = 0) PC \leftarrow PC + k + 1$	None	1/2

Mnemonics	Operands	Description	Operation	Flags	#Clocks
BRIE	k	Branch if Interrupt Enabled	if (I = 1) then PC ← PC + k + 1	None	1/2
BRID	k	Branch if Interrupt Disabled	if (I = 0) then PC ← PC + k + 1	None	1/2
DATA TRANSFER INSTRUCTIONS					
MOV	Rd, Rr	Move Between Registers	Rd ← Rr	None	1
MOVW	Rd, Rr	Copy Register Word	Rd+1:Rd ← Rr+1:Rr	None	1
LDI	Rd, K	Load Immediate	Rd ← K	None	1
LD	Rd, X	Load Indirect	Rd ← (X)	None	2
LD	Rd, X+	Load Indirect and Post-Inc.	Rd ← (X), X ← X + 1	None	2
LD	Rd, -X	Load Indirect and Pre-Dec.	X ← X - 1, Rd ← (X)	None	2
LD	Rd, Y	Load Indirect	Rd ← (Y)	None	2
LD	Rd, Y+	Load Indirect and Post-Inc.	Rd ← (Y), Y ← Y + 1	None	2
LD	Rd, -Y	Load Indirect and Pre-Dec.	Y ← Y - 1, Rd ← (Y)	None	2
LDD	Rd, Y+q	Load Indirect with Displacement	Rd ← (Y + q)	None	2
LD	Rd, Z	Load Indirect	Rd ← (Z)	None	2
LD	Rd, Z+	Load Indirect and Post-Inc.	Rd ← (Z), Z ← Z+1	None	2
LD	Rd, -Z	Load Indirect and Pre-Dec.	Z ← Z - 1, Rd ← (Z)	None	2
LDD	Rd, Z+q	Load Indirect with Displacement	Rd ← (Z + q)	None	2
LDS	Rd, k	Load Direct from SRAM	Rd ← (k)	None	2
ST	X, Rr	Store Indirect	(X) ← Rr	None	2
ST	X+, Rr	Store Indirect and Post-Inc.	(X) ← Rr, X ← X + 1	None	2
ST	-X, Rr	Store Indirect and Pre-Dec.	X ← X - 1, (X) ← Rr	None	2
ST	Y, Rr	Store Indirect	(Y) ← Rr	None	2
ST	Y+, Rr	Store Indirect and Post-Inc.	(Y) ← Rr, Y ← Y + 1	None	2
ST	-Y, Rr	Store Indirect and Pre-Dec.	Y ← Y - 1, (Y) ← Rr	None	2
STD	Y+q, Rr	Store Indirect with Displacement	(Y + q) ← Rr	None	2
ST	Z, Rr	Store Indirect	(Z) ← Rr	None	2
ST	Z+, Rr	Store Indirect and Post-Inc.	(Z) ← Rr, Z ← Z + 1	None	2
ST	-Z, Rr	Store Indirect and Pre-Dec.	Z ← Z - 1, (Z) ← Rr	None	2
STD	Z+q, Rr	Store Indirect with Displacement	(Z + q) ← Rr	None	2
STS	k, Rr	Store Direct to SRAM	(k) ← Rr	None	2
LPM		Load Program Memory	R0 ← (Z)	None	3
LPM	Rd, Z	Load Program Memory	Rd ← (Z)	None	3
LPM	Rd, Z+	Load Program Memory and Post-Inc	Rd ← (Z), Z ← Z+1	None	3
SPM		Store Program Memory	(Z) ← R1:R0	None	-
IN	Rd, P	In Port	Rd ← P	None	1
OUT	P, Rr	Out Port	P ← Rr	None	1
PUSH	Rr	Push Register on Stack	STACK ← Rr	None	2
POP	Rd	Pop Register from Stack	Rd ← STACK	None	2
BIT AND BIT-TEST INSTRUCTIONS					
SBI	P, b	Set Bit in I/O Register	I/O(P, b) ← 1	None	2
CBI	P, b	Clear Bit in I/O Register	I/O(P, b) ← 0	None	2
LSL	Rd	Logical Shift Left	Rd(n+1) ← Rd(n), Rd(0) ← 0	Z, C, N, V	1
LSR	Rd	Logical Shift Right	Rd(n) ← Rd(n+1), Rd(7) ← 0	Z, C, N, V	1
ROL	Rd	Rotate Left Through Carry	Rd(0) ← C, Rd(n+1) ← Rd(n), C ← Rd(7)	Z, C, N, V	1
ROR	Rd	Rotate Right Through Carry	Rd(7) ← C, Rd(n) ← Rd(n+1), C ← Rd(0)	Z, C, N, V	1
ASR	Rd	Arithmetic Shift Right	Rd(n) ← Rd(n+1), n=0..6	Z, C, N, V	1
SWAP	Rd	Swap Nibbles	Rd(3..0) ← Rd(7..4), Rd(7..4) ← Rd(3..0)	None	1
BSET	s	Flag Set	SREG(s) ← 1	SREG(s)	1
BCLR	s	Flag Clear	SREG(s) ← 0	SREG(s)	1
BST	Rr, b	Bit Store from Register to T	T ← Rr(b)	T	1
BLD	Rd, b	Bit load from T to Register	Rd(b) ← T	None	1
SEC		Set Carry	C ← 1	C	1
CLC		Clear Carry	C ← 0	C	1
SEN		Set Negative Flag	N ← 1	N	1
CLN		Clear Negative Flag	N ← 0	N	1
SEZ		Set Zero Flag	Z ← 1	Z	1
CLZ		Clear Zero Flag	Z ← 0	Z	1
SEI		Global Interrupt Enable	I ← 1	I	1
CLI		Global Interrupt Disable	I ← 0	I	1
SES		Set Signed Test Flag	S ← 1	S	1
CLS		Clear Signed Test Flag	S ← 0	S	1
SEV		Set Twos Complement Overflow	V ← 1	V	1
CLV		Clear Twos Complement Overflow	V ← 0	V	1
SET		Set T in SREG	T ← 1	T	1
CLT		Clear T in SREG	T ← 0	T	1
SEH		Set Half Carry Flag in SREG	H ← 1	H	1



Mnemonics	Operands	Description	Operation	Flags	#Clocks
CLH		Clear Half Carry Flag in SREG	$H \leftarrow 0$	H	1
MCU CONTROL INSTRUCTIONS					
NOP		No Operation		None	1
SLEEP		Sleep	(see specific descr. for Sleep function)	None	1
WDR		Watchdog Reset	(see specific descr. for WDR/Timer)	None	1
BREAK		Break	For On-chip Debug Only	None	N/A

Ordering Information

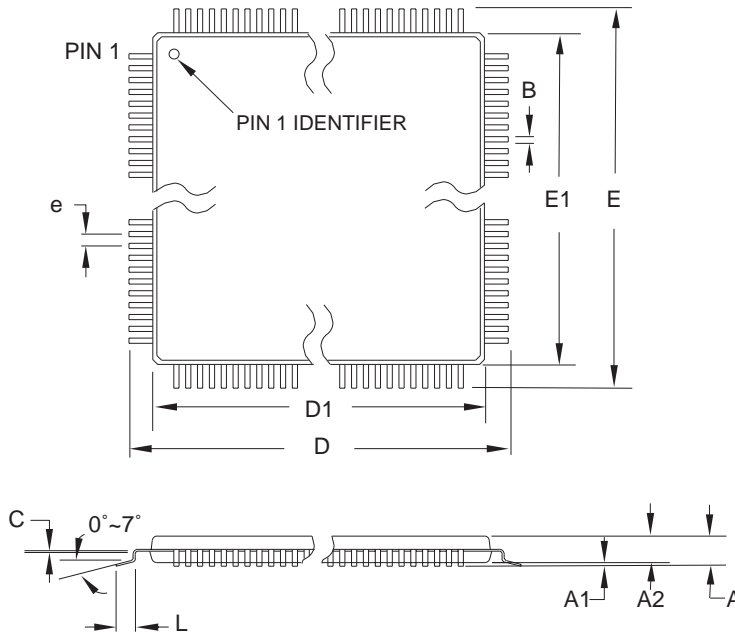
Speed (MHz)	Power Supply	Ordering Code	Package	Operation Range
8 ⁽²⁾	1.8 - 5.5V	ATmega162V-8AI ATmega162V-8PI ATmega162V-8MI	44A 40P6 44M1	Industrial (-40°C to 85°C)
16 ⁽³⁾	2.7 - 5.5V	ATmega162-16AI ATmega162-16PI ATmega162-16MI	44A 40P6 44M1	Industrial (-40°C to 85°C)

- Notes:
1. This device can also be supplied in wafer form. Please contact your local Atmel sales office for detailed ordering information and minimum quantities.
 2. See Figure 113 on page 264.
 3. See Figure 114 on page 264.

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)
44M1	44-pad, 7 x 7 x 1.0 mm body, lead pitch 0.50 mm, Micro Lead Frame Package (MLF)

Packaging Information

44A



COMMON DIMENSIONS
(Unit of Measure = mm)

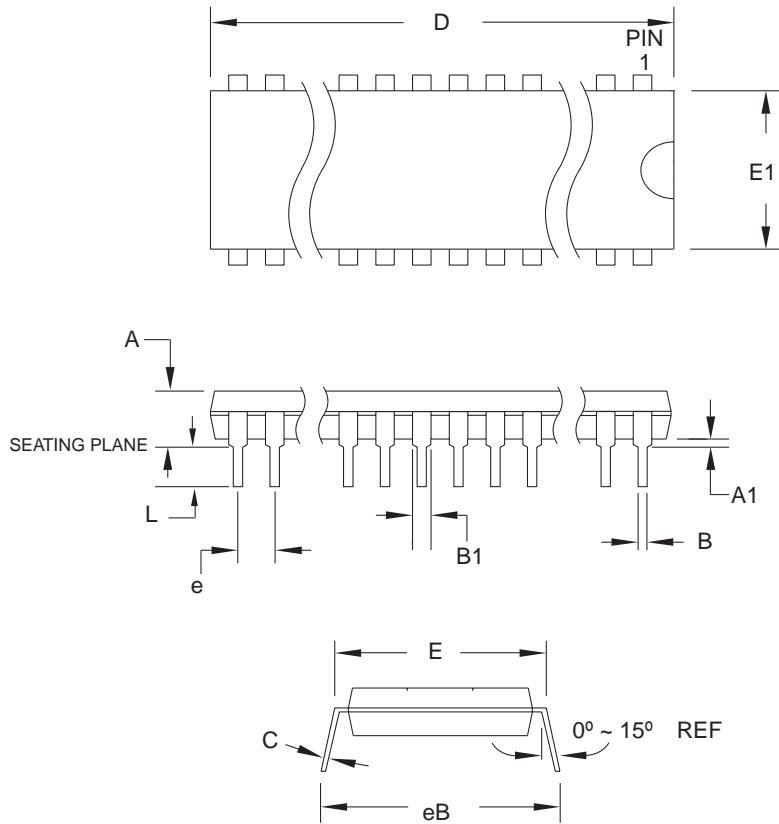
SYMBOL	MIN	NOM	MAX	NOTE
A	-	-	1.20	
A1	0.05	-	0.15	
A2	0.95	1.00	1.05	
D	11.75	12.00	12.25	
D1	9.90	10.00	10.10	Note 2
E	11.75	12.00	12.25	
E1	9.90	10.00	10.10	Note 2
B	0.30	-	0.45	
C	0.09	-	0.20	
L	0.45	-	0.75	
e	0.80 TYP			

- 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	DRAWING NO.	REV.
	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)	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").

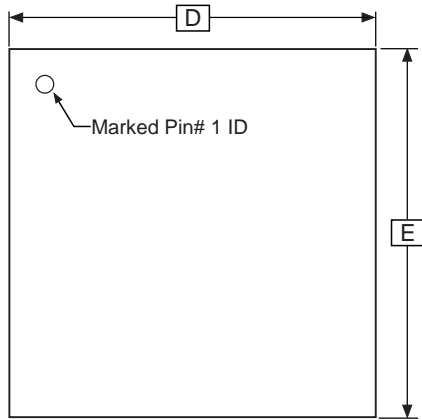
09/28/01

ATMEL 2325 Orchard Parkway
San Jose, CA 95131

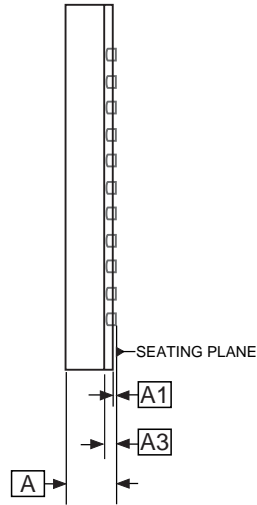
TITLE
40P6, 40-lead (0.600"/15.24 mm Wide) Plastic Dual
Inline Package (PDIP)

DRAWING NO. 40P6	REV. B
----------------------------	------------------

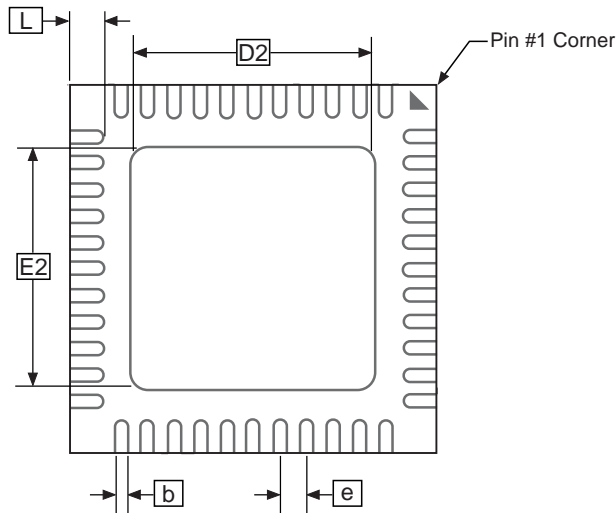
44M1



TOP VIEW



SIDE VIEW



BOTTOM 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	7.00 BSC			
D2	5.00	5.20	5.40	
E	7.00 BSC			
E2	5.00	5.20	5.40	
e	0.50 BSC			
L	0.35	0.55	0.75	

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

01/15/03

2325 Orchard Parkway
San Jose, CA 95131

TITLE
44M1, 44-pad, 7 x 7 x 1.0 mm Body, Lead Pitch 0.50 mm
Micro Lead Frame Package (MLF)

DRAWING NO.	REV.
44M1	C

Data Sheet Change Log for ATmega162

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

Changes from Rev. 2513A-05/02 to Rev. 2513B-09/02

1. **Added information for ATmega162U.**
Information about ATmega162U included in “Features” on page 1, Table 19, “BODLEVEL Fuse Coding,” on page 48, and “Ordering Information” on page 13.

Changes from Rev. 2513B-09/02 to Rev. 2513C-09/02

1. **Changed the Endurance on the Flash to 10,000 Write/Erase Cycles.**

Changes from Rev. 2513C-09/02 to Rev. 2513D-04/03

1. Updated the “Ordering Information” on page 13 and “Packaging Information” on page 14.
2. Updated “Features” on page 1.
3. Added characterization plots under “ATmega162 Typical Characteristics – Preliminary Data” on page 273.
4. Added Chip Erase as a first step under “Programming the Flash” on page 258 and “Programming the EEPROM” on page 260.
5. Changed CAL7, the highest bit in the OSCCAL Register, to a reserved bit on page 37 and in “Register Summary” on page 7.
6. Changed CPCE to CLKPCE on page 39.
7. Corrected code examples on page 53.
8. Corrected OCn waveforms in Figure 52 on page 118.
9. Various minor Timer1 corrections.
10. Added note under “Filling the Temporary Buffer (Page Loading)” on page 222 about writing to the EEPROM during an SPM Page Load.
11. Added section “EEPROM Write During Power-down Sleep Mode” on page 22.
12. Added information about PWM symmetry for Timer0 on page 96 and Timer2 on page 145.
13. Updated Table 18 on page 46, Table 20 on page 48, Table 36 on page 75, Table 83 on page 203, Table 110 on page 245, Table 113 on page 265, and Table 114 on page 266.
14. Added Figures for “Absolute Maximum Frequency as a function of VCC, ATmega162” on page 264.
15. Updated Figure 29 on page 62, Figure 32 on page 66, and Figure 88 on page 208.

16. Removed Table 114, “External RC Oscillator, Typical Frequencies⁽¹⁾,” on page 265.
17. Updated “Electrical Characteristics” on page 262.



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