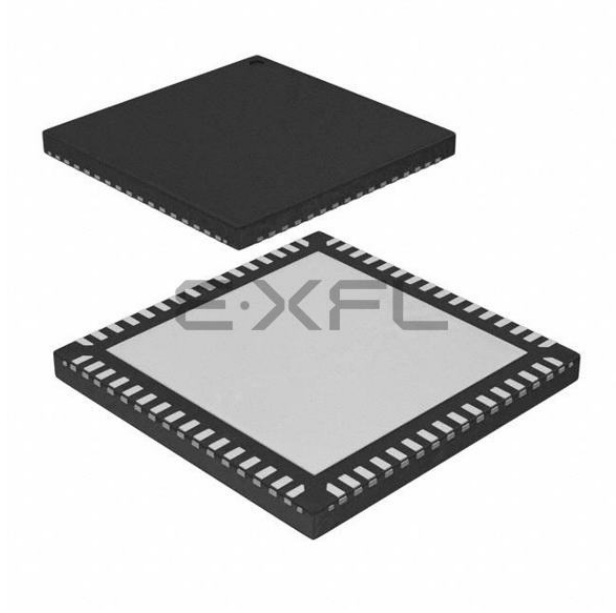

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"Embedded - Microcontrollers" refer to small, integrated circuits designed to perform specific tasks within larger systems. These microcontrollers are essentially compact computers on a single chip, containing a processor core, memory, and programmable 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"

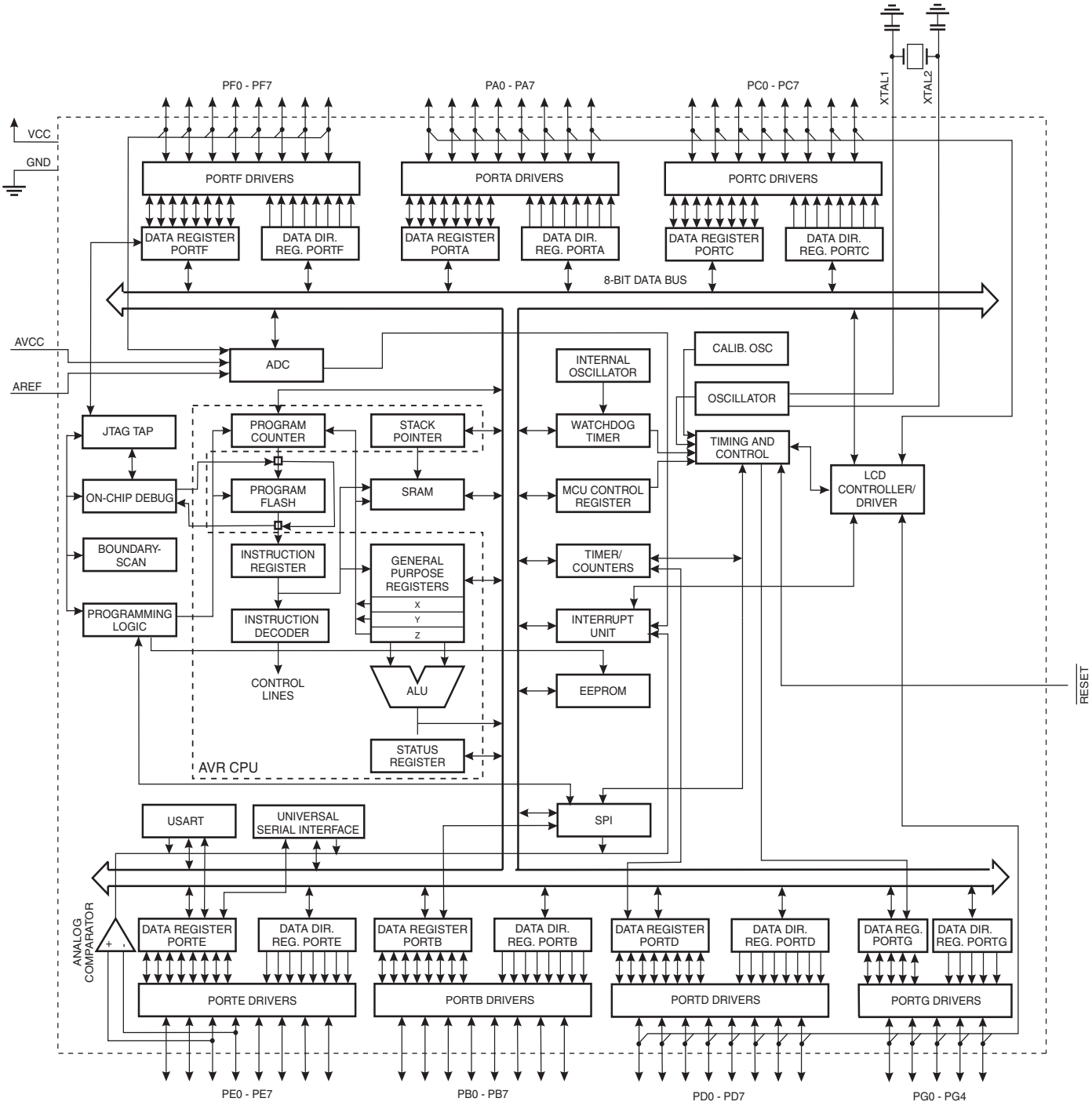
Details	
Product Status	Obsolete
Core Processor	AVR
Core Size	8-Bit
Speed	8MHz
Connectivity	SPI, UART/USART, USI
Peripherals	Brown-out Detect/Reset, LCD, POR, PWM, WDT
Number of I/O	54
Program Memory Size	16KB (8K x 16)
Program Memory Type	FLASH
EEPROM Size	512 x 8
RAM Size	1K x 8
Voltage - Supply (Vcc/Vdd)	1.8V ~ 5.5V
Data Converters	A/D 8x10b
Oscillator Type	Internal
Operating Temperature	-40°C ~ 85°C (TA)
Mounting Type	Surface Mount
Package / Case	64-VFQFN Exposed Pad
Supplier Device Package	64-QFN (9x9)
Purchase URL	https://www.e-xfl.com/product-detail/microchip-technology/atmega169v-8mi

Overview

The ATmega169 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 ATmega169 achieves throughputs approaching 1 MIPS per MHz allowing the system designer to optimize power consumption versus processing speed.

Block Diagram

Figure 2. Block Diagram



Pin Descriptions

VCC Digital supply voltage.

GND Ground.

Port A (PA7..PA0) 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. As inputs, Port A pins that are externally pulled low will source current if the 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 A also serves the functions of various special features of the ATmega169 as listed on page 60.

Port B (PB7..PB0) 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 has better driving capabilities than the other ports.

Port B also serves the functions of various special features of the ATmega169 as listed on page 61.

Port C (PC7..PC0) 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 C also serves the functions of special features of the ATmega169 as listed on page 64.

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 ATmega169 as listed on page 66.

Port E (PE7..PE0) Port E is an 8-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 ATmega169 as listed on page 68.

Port F (PF7..PF0) Port F serves as the analog inputs to the A/D Converter.

Port F 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 F output

buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port F pins that are externally pulled low will source current if the pull-up resistors are activated. The Port F 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 PF7(TDI), PF5(TMS), and PF4(TCK) will be activated even if a reset occurs.

Port F also serves the functions of the JTAG interface.

Port G (PG4..PG0) Port G is a 5-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port G output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port G pins that are externally pulled low will source current if the pull-up resistors are activated. The Port G pins are tri-stated when a reset condition becomes active, even if the clock is not running.

Port G also serves the functions of various special features of the ATmega169 as listed on page 68.

$\overline{\text{RESET}}$ 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 16 on page 38. 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.

AVCC AVCC is the supply voltage pin for Port F and the A/D Converter. It should be externally connected to V_{CC}, even if the ADC is not used. If the ADC is used, it should be connected to V_{CC} through a low-pass filter.

AREF This is the analog reference pin for the A/D Converter.

LCDCAP An external capacitor (typical > 470 nF) must be connected to the LCDCAP pin as shown in Figure 97. This capacitor acts as a reservoir for LCD power (V_{LCD}). A large capacitance reduces ripple on V_{LCD} but increases the time until VLCD reaches its target value.

Register Summary

Address	Name	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Page
(0xFF)	Reserved	–	–	–	–	–	–	–	–	
(0xFE)	LCDDR18	–	–	–	–	–	–	–	SEG324	227
(0xFD)	LCDDR17	SEG323	SEG322	SEG321	SEG320	SEG319	SEG318	SEG317	SEG316	227
(0xFC)	LCDDR16	SEG315	SEG314	SEG313	SEG312	SEG311	SEG310	SEG309	SEG308	227
(0xFB)	LCDDR15	SEG307	SEG306	SEG305	SEG304	SEG303	SEG302	SEG301	SEG300	227
(0xFA)	Reserved	–	–	–	–	–	–	–	–	
(0xF9)	LCDDR13	–	–	–	–	–	–	–	SEG224	227
(0xF8)	LCDDR12	SEG223	SEG222	SEG221	SEG220	SEG219	SEG218	SEG217	SEG216	227
(0xF7)	LCDDR11	SEG215	SEG214	SEG213	SEG212	SEG211	SEG210	SEG209	SEG208	227
(0xF6)	LCDDR10	SEG207	SEG206	SEG205	SEG204	SEG203	SEG202	SEG201	SEG200	227
(0xF5)	Reserved	–	–	–	–	–	–	–	–	
(0xF4)	LCDDR8	–	–	–	–	–	–	–	SEG124	227
(0xF3)	LCDDR7	SEG123	SEG122	SEG121	SEG120	SEG119	SEG118	SEG117	SEG116	227
(0xF2)	LCDDR6	SEG115	SEG114	SEG113	SEG112	SEG111	SEG110	SEG109	SEG108	227
(0xF1)	LCDDR5	SEG107	SEG106	SEG105	SEG104	SEG103	SEG102	SEG101	SEG100	227
(0xF0)	Reserved	–	–	–	–	–	–	–	–	
(0xEF)	LCDDR3	–	–	–	–	–	–	–	SEG024	227
(0xEE)	LCDDR2	SEG023	SEG022	SEG021	SEG020	SEG019	SEG018	SEG017	SEG016	227
(0xED)	LCDDR1	SEG015	SEG014	SEG013	SEG012	SEG011	SEG010	SEG09	SEG008	227
(0xEC)	LCDDR0	SEG007	SEG006	SEG005	SEG004	SEG003	SEG002	SEG001	SEG000	227
(0xEB)	Reserved	–	–	–	–	–	–	–	–	
(0xEA)	Reserved	–	–	–	–	–	–	–	–	
(0xE9)	Reserved	–	–	–	–	–	–	–	–	
(0xE8)	Reserved	–	–	–	–	–	–	–	–	
(0xE7)	LCDCCR	LCDCD2	LCDCD1	LCDCC0	–	LCDCC3	LCDCC2	LCDCC1	LCDCC0	225
(0xE6)	LCDFRR	–	LCDPS2	LCDPS1	LCDPS0	–	LCDCD2	LCDCD1	LCDCD0	223
(0xE5)	LCDCRB	LCDCS	LCD2B	LCDMUX1	LCDMUX0	–	LCDPM2	LCDPM1	LCDPM0	222
(0xE4)	LCDCRA	LCDEN	LCDAB	–	LCDIF	LCDIE	–	–	LCDBL	221
(0xE3)	Reserved	–	–	–	–	–	–	–	–	
(0xE2)	Reserved	–	–	–	–	–	–	–	–	
(0xE1)	Reserved	–	–	–	–	–	–	–	–	
(0xE0)	Reserved	–	–	–	–	–	–	–	–	
(0xDF)	Reserved	–	–	–	–	–	–	–	–	
(0xDE)	Reserved	–	–	–	–	–	–	–	–	
(0xDD)	Reserved	–	–	–	–	–	–	–	–	
(0xDC)	Reserved	–	–	–	–	–	–	–	–	
(0xDB)	Reserved	–	–	–	–	–	–	–	–	
(0xDA)	Reserved	–	–	–	–	–	–	–	–	
(0xD9)	Reserved	–	–	–	–	–	–	–	–	
(0xD8)	Reserved	–	–	–	–	–	–	–	–	
(0xD7)	Reserved	–	–	–	–	–	–	–	–	
(0xD6)	Reserved	–	–	–	–	–	–	–	–	
(0xD5)	Reserved	–	–	–	–	–	–	–	–	
(0xD4)	Reserved	–	–	–	–	–	–	–	–	
(0xD3)	Reserved	–	–	–	–	–	–	–	–	
(0xD2)	Reserved	–	–	–	–	–	–	–	–	
(0xD1)	Reserved	–	–	–	–	–	–	–	–	
(0xD0)	Reserved	–	–	–	–	–	–	–	–	
(0xCF)	Reserved	–	–	–	–	–	–	–	–	
(0xCE)	Reserved	–	–	–	–	–	–	–	–	
(0xCD)	Reserved	–	–	–	–	–	–	–	–	
(0xCC)	Reserved	–	–	–	–	–	–	–	–	
(0xCB)	Reserved	–	–	–	–	–	–	–	–	
(0xCA)	Reserved	–	–	–	–	–	–	–	–	
(0xC9)	Reserved	–	–	–	–	–	–	–	–	
(0xC8)	Reserved	–	–	–	–	–	–	–	–	
(0xC7)	Reserved	–	–	–	–	–	–	–	–	
(0xC6)	UDR	USART I/O Data Register								171
(0xC5)	UBRRH					USART Baud Rate Register High				175
(0xC4)	UBRRL	USART Baud Rate Register Low								175
(0xC3)	Reserved	–	–	–	–	–	–	–	–	
(0xC2)	UCSRC	–	UMSEL	UPM1	UPM0	USBS	UCSZ1	UCSZ0	UCPOL	171
(0xC1)	UCSRB	RXCIE	TXCIE	UDRIE	RXEN	TXEN	UCSZ2	RXB8	TXB8	171
(0xC0)	UCSRA	RXC	TXC	UDRE	FE	DOR	UPE	U2X	MPCM	171

Address	Name	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Page
(0xBF)	Reserved	–	–	–	–	–	–	–	–	
(0xBE)	Reserved	–	–	–	–	–	–	–	–	
(0xBD)	Reserved	–	–	–	–	–	–	–	–	
(0xBC)	Reserved	–	–	–	–	–	–	–	–	
(0xBB)	Reserved	–	–	–	–	–	–	–	–	
(0xBA)	USIDR	USI Data Register								186
(0xB9)	USISR	USISIF	USIOIF	USIPF	USIDC	USICNT3	USICNT2	USICNT1	USICNT0	187
(0xB8)	USICR	USISIE	USIOIE	USIWM1	USIWM0	USICS1	USICS0	USICLK	USITC	188
(0xB7)	Reserved	–		–	–	–	–	–	–	
(0xB6)	ASSR	–	–	–	EXCLK	AS2	TCN2UB	OCR2UB	TCR2UB	139
(0xB5)	Reserved	–	–	–	–	–	–	–	–	
(0xB4)	Reserved	–	–	–	–	–	–	–	–	
(0xB3)	OCR2A	Timer/Counter2 Output Compare Register A								138
(0xB2)	TCNT2	Timer/Counter2 (8-bit)								138
(0xB1)	Reserved	–	–	–	–	–	–	–	–	
(0xB0)	TCCR2A	FOC2A	WGM20	COM2A1	COM2A0	WGM21	CS22	CS21	CS20	136
(0xAF)	Reserved	–	–	–	–	–	–	–	–	
(0xAE)	Reserved	–	–	–	–	–	–	–	–	
(0xAD)	Reserved	–	–	–	–	–	–	–	–	
(0xAC)	Reserved	–	–	–	–	–	–	–	–	
(0xAB)	Reserved	–	–	–	–	–	–	–	–	
(0xAA)	Reserved	–	–	–	–	–	–	–	–	
(0xA9)	Reserved	–	–	–	–	–	–	–	–	
(0xA8)	Reserved	–	–	–	–	–	–	–	–	
(0xA7)	Reserved	–	–	–	–	–	–	–	–	
(0xA6)	Reserved	–	–	–	–	–	–	–	–	
(0xA5)	Reserved	–	–	–	–	–	–	–	–	
(0xA4)	Reserved	–	–	–	–	–	–	–	–	
(0xA3)	Reserved	–	–	–	–	–	–	–	–	
(0xA2)	Reserved	–	–	–	–	–	–	–	–	
(0xA1)	Reserved	–	–	–	–	–	–	–	–	
(0xA0)	Reserved	–	–	–	–	–	–	–	–	
(0x9F)	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)	OCR1BH	Timer/Counter1 - Output Compare Register B High Byte								122
(0x8A)	OCR1BL	Timer/Counter1 - Output Compare Register B Low Byte								122
(0x89)	OCR1AH	Timer/Counter1 - Output Compare Register A High Byte								122
(0x88)	OCR1AL	Timer/Counter1 - Output Compare Register A Low Byte								122
(0x87)	ICR1H	Timer/Counter1 - Input Capture Register High Byte								123
(0x86)	ICR1L	Timer/Counter1 - Input Capture Register Low Byte								123
(0x85)	TCNT1H	Timer/Counter1 - Counter Register High Byte								122
(0x84)	TCNT1L	Timer/Counter1 - Counter Register Low Byte								122
(0x83)	Reserved	–	–	–	–	–	–	–	–	
(0x82)	TCCR1C	FOC1A	FOC1B	–	–	–	–	–	–	121
(0x81)	TCCR1B	ICNC1	ICES1	–	WGM13	WGM12	CS12	CS11	CS10	120
(0x80)	TCCR1A	COM1A1	COM1A0	COM1B1	COM1B0	–	–	WGM11	WGM10	118
(0x7F)	DIDR1	–	–	–	–	–	–	AIN1D	AIN0D	193
(0x7E)	DIDR0	ADC7D	ADC6D	ADC5D	ADC4D	ADC3D	ADC2D	ADC1D	ADC0D	211

Address	Name	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Page
(0x7D)	Reserved	–	–	–	–	–	–	–	–	
(0x7C)	ADMUX	REFS1	REFS0	ADLAR	MUX4	MUX3	MUX2	MUX1	MUX0	207
(0x7B)	ADCSRB	–	ACME	–	–	–	ADTS2	ADTS1	ADTS0	191, 211
(0x7A)	ADCSRA	ADEN	ADSC	ADATE	ADIF	ADIE	ADPS2	ADPS1	ADPS0	209
(0x79)	ADCH	ADC Data Register High byte								210
(0x78)	ADCL	ADC Data Register Low byte								210
(0x77)	Reserved	–	–	–	–	–	–	–	–	
(0x76)	Reserved	–	–	–	–	–	–	–	–	
(0x75)	Reserved	–	–	–	–	–	–	–	–	
(0x74)	Reserved	–	–	–	–	–	–	–	–	
(0x73)	Reserved	–	–	–	–	–	–	–	–	
(0x72)	Reserved	–	–	–	–	–	–	–	–	
(0x71)	Reserved	–	–	–	–	–	–	–	–	
(0x70)	TIMSK2	–	–	–	–	–	–	OCIE2A	TOIE2	141
(0x6F)	TIMSK1	–	–	ICIE1	–	–	OCIE1B	OCIE1A	TOIE1	123
(0x6E)	TIMSK0	–	–	–	–	–	–	OCIE0A	TOIE0	93
(0x6D)	Reserved	–	–	–	–	–	–	–	–	
(0x6C)	PCMSK1	PCINT15	PCINT14	PCINT13	PCINT12	PCINT11	PCINT10	PCINT9	PCINT8	79
(0x6B)	PCMSK0	PCINT7	PCINT6	PCINT5	PCINT4	PCINT3	PCINT2	PCINT1	PCINT0	79
(0x6A)	Reserved	–	–	–	–	–	–	–	–	
(0x69)	EICRA	–	–	–	–	–	–	ISC01	ISC00	77
(0x68)	Reserved	–	–	–	–	–	–	–	–	
(0x67)	Reserved	–	–	–	–	–	–	–	–	
(0x66)	OSCCAL	Oscillator Calibration Register								28
(0x65)	Reserved	–	–	–	–	–	–	–	–	
(0x64)	PRR	–	–	–	PRLCD	PRTIM1	PRSPI	PRUSART0	PRADC	34
(0x63)	Reserved	–	–	–	–	–	–	–	–	
(0x62)	Reserved	–	–	–	–	–	–	–	–	
(0x61)	CLKPR	CLKPCE	–	–	–	CLKPS3	CLKPS2	CLKPS1	CLKPS0	29
(0x60)	WDTCR	–	–	–	WDCE	WDE	WDP2	WDP1	WDP0	43
0x3F (0x5F)	SREG	I	T	H	S	V	N	Z	C	9
0x3E (0x5E)	SPH	–	–	–	–	–	SP10	SP9	SP8	11
0x3D (0x5D)	SPL	SP7	SP6	SP5	SP4	SP3	SP2	SP1	SP0	11
0x3C (0x5C)	Reserved									
0x3B (0x5B)	Reserved									
0x3A (0x5A)	Reserved									
0x39 (0x59)	Reserved									
0x38 (0x58)	Reserved									
0x37 (0x57)	SPMCSR	SPMIE	RWWSB	–	RWWSRE	BLBSET	PGWRT	PGERS	SPMEN	259
0x36 (0x56)	Reserved	–	–	–	–	–	–	–	–	
0x35 (0x55)	MCUCR	JTD	–	–	PUD	–	–	IVSEL	IVCE	237
0x34 (0x54)	MCUSR	–	–	–	JTRF	WDRF	BORF	EXTRF	PORF	238
0x33 (0x53)	SMCR	–	–	–	–	SM2	SM1	SM0	SE	32
0x32 (0x52)	Reserved	–	–	–	–	–	–	–	–	
0x31 (0x51)	OCDR	IDRD/OCD	OCDR6	OCDR5	OCDR4	OCDR3	OCDR2	OCDR1	OCDR0	233
0x30 (0x50)	ACSR	ACD	ACBG	ACO	ACI	ACIE	ACIC	ACIS1	ACIS0	191
0x2F (0x4F)	Reserved	–	–	–	–	–	–	–	–	
0x2E (0x4E)	SPDR	SPI Data Register								151
0x2D (0x4D)	SPSR	SPIF	WCOL	–	–	–	–	–	SPI2X	151
0x2C (0x4C)	SPCR	SPIE	SPE	DORD	MSTR	CPOL	CPHA	SPR1	SPR0	149
0x2B (0x4B)	GPIOR2	General Purpose I/O Register 2								22
0x2A (0x4A)	GPIOR1	General Purpose I/O Register 1								22
0x29 (0x49)	Reserved	–	–	–	–	–	–	–	–	
0x28 (0x48)	Reserved	–	–	–	–	–	–	–	–	
0x27 (0x47)	OCR0A	Timer/Counter0 Output Compare Register A								93
0x26 (0x46)	TCNT0	Timer/Counter0 (8 Bit)								92
0x25 (0x45)	Reserved	–	–	–	–	–	–	–	–	
0x24 (0x44)	TCCR0A	FOC0A	WGM00	COM0A1	COM0A0	WGM01	CS02	CS01	CS00	90
0x23 (0x43)	GTCCR	TSM	–	–	–	–	–	PSR2	PSR10	95
0x22 (0x42)	EEARH	–	–	–	–	–	–	–	EEAR8	18
0x21 (0x41)	EEARL	EEPROM Address Register Low Byte								18
0x20 (0x40)	EEDR	EEPROM Data Register								18
0x1F (0x3F)	EECR	–	–	–	–	EERIE	EEMWE	EEWE	EERE	18
0x1E (0x3E)	GPIOR0	General Purpose I/O Register 0								22
0x1D (0x3D)	EIMSK	PCIE1	PCIE0	–	–	–	–	–	INT0	78
0x1C (0x3C)	EIFR	PCIF1	PCIF0	–	–	–	–	–	INTF0	78

Instruction Set Summary

Mnemonics	Operands	Description	Operation	Flags	#Clocks
ARITHMETIC AND LOGIC INSTRUCTIONS					
ADD	Rd, Rr	Add two Registers	Rd ← Rd + Rr	Z,C,N,V,H	1
ADC	Rd, Rr	Add with Carry two Registers	Rd ← Rd + Rr + C	Z,C,N,V,H	1
ADIW	Rdl,K	Add Immediate to Word	Rdh:Rdl ← Rdh:Rdl + K	Z,C,N,V,S	2
SUB	Rd, Rr	Subtract two Registers	Rd ← Rd - Rr	Z,C,N,V,H	1
SUBI	Rd, K	Subtract Constant from Register	Rd ← Rd - K	Z,C,N,V,H	1
SBC	Rd, Rr	Subtract with Carry two Registers	Rd ← Rd - Rr - C	Z,C,N,V,H	1
SBCI	Rd, K	Subtract with Carry Constant from Reg.	Rd ← Rd - K - C	Z,C,N,V,H	1
SBIW	Rdl,K	Subtract Immediate from Word	Rdh:Rdl ← Rdh:Rdl - K	Z,C,N,V,S	2
AND	Rd, Rr	Logical AND Registers	Rd ← Rd • Rr	Z,N,V	1
ANDI	Rd, K	Logical AND Register and Constant	Rd ← Rd • K	Z,N,V	1
OR	Rd, Rr	Logical OR Registers	Rd ← Rd v Rr	Z,N,V	1
ORI	Rd, K	Logical OR Register and Constant	Rd ← Rd v K	Z,N,V	1
EOR	Rd, Rr	Exclusive OR Registers	Rd ← Rd ⊕ Rr	Z,N,V	1
COM	Rd	One's Complement	Rd ← 0xFF − Rd	Z,C,N,V	1
NEG	Rd	Two's Complement	Rd ← 0x00 − Rd	Z,C,N,V,H	1
SBR	Rd,K	Set Bit(s) in Register	Rd ← Rd v K	Z,N,V	1
CBR	Rd,K	Clear Bit(s) in Register	Rd ← Rd • (0xFF - K)	Z,N,V	1
INC	Rd	Increment	Rd ← Rd + 1	Z,N,V	1
DEC	Rd	Decrement	Rd ← Rd − 1	Z,N,V	1
TST	Rd	Test for Zero or Minus	Rd ← Rd • Rd	Z,N,V	1
CLR	Rd	Clear Register	Rd ← Rd ⊕ Rd	Z,N,V	1
SER	Rd	Set Register	Rd ← 0xFF	None	1
MUL	Rd, Rr	Multiply Unsigned	R1:R0 ← Rd x Rr	Z,C	2
MULS	Rd, Rr	Multiply Signed	R1:R0 ← Rd x Rr	Z,C	2
MULSU	Rd, Rr	Multiply Signed with Unsigned	R1:R0 ← Rd x Rr	Z,C	2
FMUL	Rd, Rr	Fractional Multiply Unsigned	R1:R0 ← (Rd x Rr) << 1	Z,C	2
FMULS	Rd, Rr	Fractional Multiply Signed	R1:R0 ← (Rd x Rr) << 1	Z,C	2
FMULSU	Rd, Rr	Fractional Multiply Signed with Unsigned	R1:R0 ← (Rd x Rr) << 1	Z,C	2
BRANCH INSTRUCTIONS					
RJMP	k	Relative Jump	PC ← PC + k + 1	None	2
IJMP		Indirect Jump to (Z)	PC ← Z	None	2
JMP	k	Direct Jump	PC ← k	None	3
RCALL	k	Relative Subroutine Call	PC ← PC + k + 1	None	3
ICALL		Indirect Call to (Z)	PC ← Z	None	3
CALL	k	Direct Subroutine Call	PC ← k	None	4
RET		Subroutine Return	PC ← STACK	None	4
RETI		Interrupt Return	PC ← STACK	I	4
CPSE	Rd,Rr	Compare, Skip if Equal	if (Rd = Rr) PC ← 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 ← PC + 2 or 3	None	1/2/3
SBRS	Rr, b	Skip if Bit in Register is Set	if (Rr(b)=1) PC ← PC + 2 or 3	None	1/2/3
SBIC	P, b	Skip if Bit in I/O Register Cleared	if (P(b)=0) PC ← 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 ← PC + 2 or 3	None	1/2/3
BRBS	s, k	Branch if Status Flag Set	if (SREG(s) = 1) then PC←PC+k + 1	None	1/2
BRBC	s, k	Branch if Status Flag Cleared	if (SREG(s) = 0) then PC←PC+k + 1	None	1/2
BREQ	k	Branch if Equal	if (Z = 1) then PC ← PC + k + 1	None	1/2
BRNE	k	Branch if Not Equal	if (Z = 0) then PC ← PC + k + 1	None	1/2
BRCS	k	Branch if Carry Set	if (C = 1) then PC ← PC + k + 1	None	1/2
BRCC	k	Branch if Carry Cleared	if (C = 0) then PC ← PC + k + 1	None	1/2
BRSH	k	Branch if Same or Higher	if (C = 0) then PC ← PC + k + 1	None	1/2
BRLO	k	Branch if Lower	if (C = 1) then PC ← PC + k + 1	None	1/2
BRMI	k	Branch if Minus	if (N = 1) then PC ← PC + k + 1	None	1/2
BRPL	k	Branch if Plus	if (N = 0) then PC ← PC + k + 1	None	1/2
BRGE	k	Branch if Greater or Equal, Signed	if (N ⊕ V= 0) then PC ← PC + k + 1	None	1/2
BRLT	k	Branch if Less Than Zero, Signed	if (N ⊕ V= 1) then PC ← PC + k + 1	None	1/2
BRHS	k	Branch if Half Carry Flag Set	if (H = 1) then PC ← PC + k + 1	None	1/2
BRHC	k	Branch if Half Carry Flag Cleared	if (H = 0) then PC ← PC + k + 1	None	1/2
BRTS	k	Branch if T Flag Set	if (T = 1) then PC ← PC + k + 1	None	1/2
BRTC	k	Branch if T Flag Cleared	if (T = 0) then PC ← PC + k + 1	None	1/2
BRVS	k	Branch if Overflow Flag is Set	if (V = 1) then PC ← PC + k + 1	None	1/2
BRVC	k	Branch if Overflow Flag is Cleared	if (V = 0) then PC ← 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
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
CLH		Clear Half Carry Flag in SREG	H ← 0	H	1
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

Mnemonics	Operands	Description	Operation	Flags	#Clocks
POP	Rd	Pop Register from Stack	Rd ← STACK	None	2
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

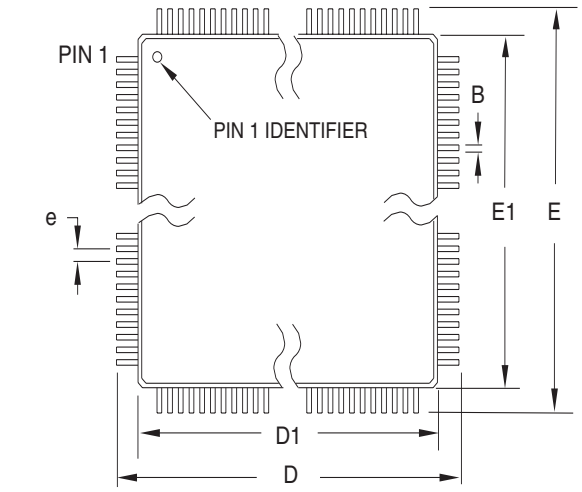
Speed (MHz)	Power Supply	Ordering Code	Package[1]	Operation Range
8[2]	1.8 - 5.5V	ATmega169V-8AI ATmega169V-8AJ[3] ATmega169V-8MI ATmega169V-8MJ[3]	64A 64A 64M1 64M1	Industrial (-40°C to 85°C)
16[2]	4.5 - 5.5V	ATmega169-16AI ATmega169-16AJ[3] ATmega169-16MI ATmega169-16MJ[3]	64A 64A 64M1 64M1	Industrial (-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 135 and Figure 136.
3. Pb-free alternative.

Package Type	
64A	64-Lead, Thin (1.0 mm) Plastic Gull Wing Quad Flat Package (TQFP)
64M1	64-pad, 9 x 9 x 1.0 mm body, lead pitch 0.50 mm, Micro Lead Frame Package (MLF)

Packaging Information

64A



COMMON DIMENSIONS
(Unit of Measure = mm)

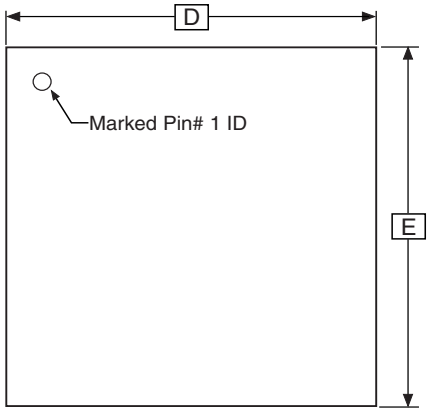
SYMBOL	MIN	NOM	MAX	NOTE
A	–	–	1.20	
A1	0.05	–	0.15	
A2	0.95	1.00	1.05	
D	15.75	16.00	16.25	
D1	13.90	14.00	14.10	Note 2
E	15.75	16.00	16.25	
E1	13.90	14.00	14.10	Note 2
B	0.30	–	0.45	
C	0.09	–	0.20	
L	0.45	–	0.75	
e	0.80 TYP			

Notes:
1. This package conforms to JEDEC reference MS-026, Variation AEB.
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.

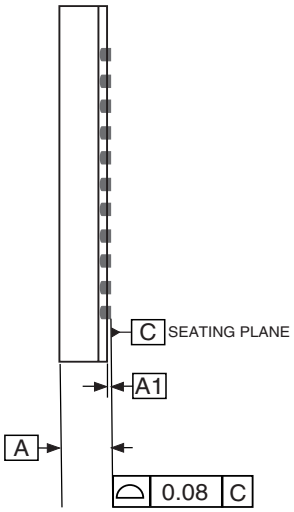
10/5/2001

	TITLE	DRAWING NO.	REV.
2325 Orchard Parkway San Jose, CA 95131	**64A,** 64-lead, 14 x 14 mm Body Size, 1.0 mm Body Thickness, 0.8 mm Lead Pitch, Thin Profile Plastic Quad Flat Package (TQFP)	64A	B

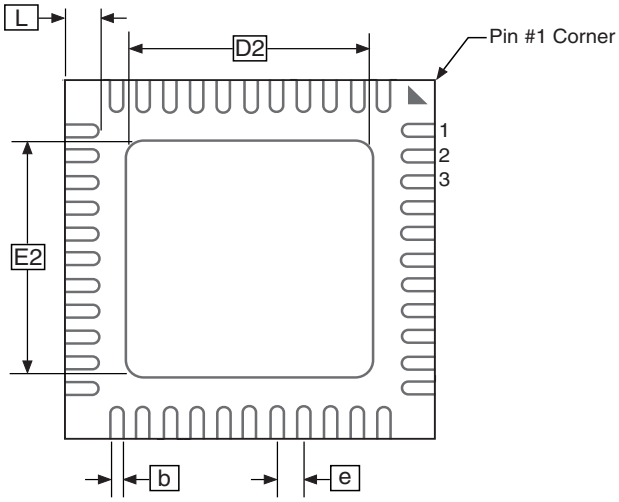
64M1



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	
b	0.23	0.25	0.28	
D		9.00 BSC		
D2	5.20	5.40	5.60	
E		9.00 BSC		
E2	5.20	5.40	5.60	
e		0.50 BSC		
L	0.35	0.40	0.45	

Notes: 1. JEDEC Standard MO-220, Fig. 1, VMMD.

01/15/03

2325 Orchard Parkway San Jose, CA 95131	**TITLE** **64M1**, 64-pad, 9 x 9 x 1.0 mm Body, Lead Pitch 0.50 mm Micro Lead Frame Package (MLF)	**DRAWING NO.** 64M1	**REV.** C

Errata

ATmega169 Rev E

No known errata.

ATmega169 Rev D

- **High serial resistance in the glass can result in dim segments on the LCD**
- **IDCODE masks data from TDI input**

2. High serial resistance in the glass can result in dim segments on the LCD

Some display types with high serial resistance (>20 kΩ) inside the glass can result in dim segments on the LCD

Problem Fix/Workaround

Add a 1 nF (0.47 - 1.5 nF) capacitor between each common pin and ground.

1. IDCODE masks data from TDI input

The JTAG instruction IDCODE is not working correctly. Data to succeeding devices are replaced by all-ones during Update-DR.

Problem Fix / Workaround

– If ATmega169 is the only device in the scan chain, the problem is not visible.

– Select the Device ID Register of the ATmega169 by issuing the IDCODE instruction or by entering the Test-Logic-Reset state of the TAP controller to read out the contents of its Device ID Register and possibly data from succeeding devices of the scan chain. Issue the BYPASS instruction to the ATmega169 while reading the Device ID Registers of preceding devices of the boundary scan chain.

– If the Device IDs of all devices in the boundary scan chain must be captured simultaneously, the ATmega169 must be the fist device in the chain.

ATmega169 Rev C

- **High Current Consumption In Power Down when JTAGEN is Programmed**
- **LCD Contrast Control**
- **Some Data Combinations Can Result in Dim Segments on the LCD**
- **LCD Current Consumption**
- **IDCODE masks data from TDI input**

5. High Current Consumption In Power Down when JTAGEN is Programmed

The input buffer on TDO (PF6) is always enabled and the pull-up is always disabled when JTAG is programmed. This can leave the output floating.

Problem Fix/Workaround

Add external pull-up to PF6.

Unprogram the JTAGEN Fuse before shipping out the end product.

4. LCD Contrast Control

The contrast control is not working properly when using synchronous clock (chip clock) to obtain an LCD clock, and the chip clock is 125 kHz or faster.

Problem Fix/Workaround

Use a low chip clock frequency (32 kHz) or apply an external voltage to the LCD-CAP pin.

3. Some Data Combinations Can Result in Dim Segments on the LCD

All segments connected to a common plane might be dimmed (lower contrast) when a certain combination of data is displayed.

Problem Fix/Workaround

Default waveform: If there are any unused segment pins, loading one of these with a 1 nF capacitor and always write '0' to this segment eliminates the problem.

Low power waveform: Add a 1 nF capacitor to each common pin.

2. LCD Current Consumption

In an interval where V_{CC} is within the range VLCD -0.2V to VLCD + 0.4V, the LCD current consumption is up to three times higher than expected. This will only be an issue in Power-save mode with the LCD running as the LCD current is negligible compared to the overall power consumption in all other modes of operation.

Problem Fix/Workaround

No known workaround.

1. IDCODE masks data from TDI input

The JTAG instruction IDCODE is not working correctly. Data to succeeding devices are replaced by all-ones during Update-DR.

Problem Fix / Workaround

– If ATmega169 is the only device in the scan chain, the problem is not visible.

– Select the Device ID Register of the ATmega169 by issuing the IDCODE instruction or by entering the Test-Logic-Reset state of the TAP controller to read out the contents of its Device ID Register and possibly data from succeeding devices of the scan chain. Issue the BYPASS instruction to the ATmega169 while reading the Device ID Registers of preceding devices of the boundary scan chain.

– If the Device IDs of all devices in the boundary scan chain must be captured simultaneously, the ATmega169 must be the fist device in the chain.

ATmega169 Rev B

- **Internal Oscillator Runs at 4 MHz**
- **LCD Contrast Voltage is not Correct**
- **External Oscillator is Non-functional**
- **USART**
- **ADC Measures with Lower Accuracy than Specified**
- **Serial Downloading**
- **IDCODE masks data from TDI input**

7. Internal Oscillator Runs at 4 MHz

The Internal Oscillator runs at 4 MHz instead of the specified 8 MHz. Therefore, all Flash/EEPROM programming times are twice as long as specified. This includes Chip Erase, Byte programming, Page programming, Fuse programming, Lock bit programming, EEPROM write from the CPU, and Flash Self-Programming.

For this reason, rev-B samples are shipped with the CKDIV8 Fuse unprogrammed.

Problem Fix/Workaround

If 8 MHz operation is required, apply an external clock (this will be fixed in rev. C).

6. LCD Contrast Voltage is not Correct

The LCD contrast voltage between 1.8V and 3.1V is incorrect. When the V_{CC} is between 1.8V and 3.1V, the LCD contrast voltage drops approx. 0.5V. The current consumption in this interval is higher than expected.

Problem Fix/Workaround

Contrast will be wrong, but display will still be readable, can be partly compensated for using the contrast control register (this will be fixed in rev. C).

5. External Oscillator is Non-functional

The external oscillator does not run with the setup described in the datasheet.

Problem Fix/Workaround

Use other clock source (this will be fixed in rev. C).

Alternative Problem Fix/Workaround

Adding a pull-down on XTAL1 will start the Oscillator.

4. USART

Writing TXEN to zero during transmission causes the transmission to suddenly stop. The datasheet description tells that the transmission should complete before stopping the USART when TXEN is written to zero.

Problem Fix/Workaround

Ensure that the transmission is complete before writing TXEN to zero (this will be fixed in rev. C).

3. ADC Measures with Lower Accuracy than Specified

The ADC does not work as intended. There is a positive offset in the result.

Problem Fix/Workaround

This will be fixed in rev. C.

2. Serial downloading

When entering Serial Programming mode the second byte will not echo back as described in the Serial Programming algorithm.

Problem Fix/Workaround

Check if the third byte echoes back to ensure that the device is in Programming mode (this will be fixed in rev. C).

1. IDCODE masks data from TDI input

The JTAG instruction IDCODE is not working correctly. Data to succeeding devices are replaced by all-ones during Update-DR.

Problem Fix / Workaround

- If ATmega169 is the only device in the scan chain, the problem is not visible.
- Select the Device ID Register of the ATmega169 by issuing the IDCODE instruction or by entering the Test-Logic-Reset state of the TAP controller to read out the contents of its Device ID Register and possibly data from succeeding devices of the scan chain. Issue the BYPASS instruction to the ATmega169 while reading the Device ID Registers of preceding devices of the boundary scan chain.
- If the Device IDs of all devices in the boundary scan chain must be captured simultaneously, the ATmega169 must be the fist device in the chain.

Datasheet Change Log for ATmega169

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. 2514J-12/03 to Rev. 2514K-04/04

1. **Changed size from 0x60 to 0xFF in "Stack Pointer" on page 11.**
2. **Updated Table 17 on page 40, Table 21 on page 44 and Table 115 on page 267.**
3. **Updated "Calibrated Internal RC Oscillator" on page 27.**
4. **Added new "Power Reduction Register" on page 34.**
   Examples found in "Using the Power Reduction Register" on page 312.
5. **Fixed typo in port description for the "Analog to Digital Converter" on page 194.**
6. **Removed old and added new "LCD Controller" on page 212.**
7. **Updated "Electrical Characteristics" on page 300.**
8. **Updated "ATmega169 Typical Characteristics" on page 307.**
9. **Updated "Ordering Information" on page 14.**
   ATmega169L replaced by ATmega169V and ATmega169.

Changes from Rev. 2514I-09/03 to Rev. 2514J-12/03

1. **Updated "Calibrated Internal RC Oscillator" on page 27**

Changes from Rev. 2514H-05/03 to Rev. 2514I-09/03

1. **Removed "Advance Information" from the datasheet.**
2. **Removed AGND from Figure 2 on page 3 and added "System Clock Prescaler" to Figure 11 on page 23.**
3. **Updated Table 16 on page 38, Table 17 on page 40, Table 19 on page 42 and Table 40 on page 70.**
4. **Renamed and updated "On-chip Debug System" to "JTAG Interface and On-chip Debug System" on page 36.**
5. **Updated COM01:0 to COM0A1:0 in "Timer/Counter Control Register A – TCCR0A" on page 90 and COM21:0 to COM2A1:0 in "Timer/Counter Control Register A– TCCR2A" on page 136.**
6. **Updated "Test Access Port – TAP" on page 228 regarding JTAGEN.**
7. **Updated description for the JTD bit on page 237.**
8. **Added a note regarding JTAGEN fuse to Table 119 on page 270.**
9. **Updated Absolute Maximum Ratings* and DC Characteristics in "Electrical Characteristics" on page 300.**
10. **Updated "Errata" on page 17 and added a proposal for solving problems regarding the JTAG instruction IDCODE.**

Changes from Rev. 2514G-04/03 to Rev. 2514H-05/03

1. Updated typo in Figure 147, Figure 167, and Figure 194.

Changes from Rev. 2514F-04/03 to Rev. 2514G-04/03

1. Updated “ATmega169 Typical Characteristics” on page 307.
2. Updated typo in “Ordering Information” on page 14.
3. Updated Figure 45 on page 110, Table 18 on page 40, and “Version” on page 235.

Changes from Rev. 2514E-02/03 to Rev. 2514F-04/03

1. Renamed ICP to ICP1 in whole document.
2. Removed note on “Crystal Oscillator Operating Modes” on page 25.
3. XTAL1/XTAL2 can be used as timer oscillator pins, described in chapter “Calibrated Internal RC Oscillator” on page 27.
4. Switching between prescaler settings in “Switching Time” on page 31.
5. Updated DC and ACD Characteristics in chapter “Electrical Characteristics” on page 300 are updated. Removed TBD’s from Table 16 on page 38, Table 19 on page 42, Table 134 on page 303.
6. Updated Figure 22 on page 53, Figure 25 on page 58 and Figure 109 on page 240 regarding WRITE PINx REGISTER.
7. Updated “Alternate Functions of Port F” on page 70 regarding JTAG.
8. Replaced Timer0 Overflow with Timer/Counter0 Compare Match in “Universal Serial Interface – USI” on page 180. Also updated “Start Condition Detector” on page 186 and “USI Control Register – USICR” on page 188.
9. Updated Features for “Analog to Digital Converter” on page 194 and Table 88 on page 207.
10. Added notes on Figure 117 on page 261 and Table 118 on page 269.

Changes from Rev. 2514D-01/03 to Rev. 2514E-02/03

1. Updated the section “Features” on page 1 with information regarding ATmega169 and ATmega169L.
2. Removed all references to the PG5 pin in Figure 1 on page 2, Figure 2 on page 3, “Port G (PG4..PG0)” on page 6, “Alternate Functions of Port G” on page 72, and “Register Description for I/O-Ports” on page 74.
3. Updated Table 118, “Extended Fuse Byte,” on page 269.
4. Added Errata for “Datasheet Change Log for ATmega169” on page 20, including “Significant Data Sheet Changes”.
5. Updated the “Ordering Information” on page 14 to include the new speed grade for ATmega169L and the new 16 MHz ATmega169.

Changes from Rev. 2514C-11/02 to Rev. 2514D-01/03

1. Added TCK frequency limit in “Programming via the JTAG Interface” on page 287.
2. Added Chip Erase as a first step in “Programming the Flash” on page 297 and “Programming the EEPROM” on page 298.
3. Added the section “Unconnected Pins” on page 57.
4. Added tips on how to disable the OCD system in “On-chip Debug System” on page 35.
5. Corrected interrupt addresses. ADC and ANA_COMP had swapped places.
6. Improved the table in “SPI Timing Characteristics” on page 303 and removed the table in “SPI Serial Programming Characteristics” on page 287.
7. Changed “will be ignored” to “must be written to zero” for unused Z-pointer bits in “Performing a Page Write” on page 262.
8. Corrected “LCD Frame Complete” to “LCD Start of Frame” in the LCDCRA Register description.
9. Changed OUT to STS and IN to LDS in USI code examples, and corrected f_{SCKmax}. The USI I/O Registers are in the extended I/O space, so IN and OUT cannot be used. LDS and STS take one more cycle when executed, so f_{SCKmax} had to be changed accordingly.
10. Removed TOSKON and TOSCK from Table 103 on page 241, and g10 and g20 from Figure 114 on page 243 and Table 105 on page 244, because these signals do not exist in boundary scan.
11. Changed from 4 to 16 MIPS and MHz in the device Features list.
12. Corrected Port A to Port F in “AVCC” on page 6 under “Pin Descriptions” on page 5.
13. Corrected 230.4 Mbps to 230.4 kbps in “Examples of Baud Rate Setting” on page 176.
14. Corrected placing of falling and rising XCK edges in Table 78, “UCPOL Bit Settings,” on page 175.
15. Removed reference to Multipurpose Oscillator Application Note, which does not exist.
16. Corrected Number of Calibrated RC Oscillator Cycles in Table 1 on page 19 from 8,448 to 67,584.
17. Various minor Timer1 corrections.
18. Added information about PWM symmetry for Timer0 and Timer2.
19. Corrected the contents of DIDR0 and DIDR1.

20. Made all bit names in the LCDDR Registers unique by adding the COM number digit in front of the two digits already there, e.g. SEG304.

21. Changed Extended Standby to ADC Noise Reduction mode under “Asynchronous Operation of Timer/Counter2” on page 140.

22. Added note about Port B having better driving capabilities than the other ports. As a consequence the table, “DC Characteristics” on page 300 was corrected as well.

23. Added note under “Filling the Temporary Buffer (Page Loading)” on page 262 about writing to the EEPROM during an SPM page load.

24. Removed ADHSM completely.

25. Updated “Packaging Information” on page 15.

Changes from Rev. 2514B-09/02 to Rev. 2514C-11/02

1. Added “Errata” on page 17.

2. Added Information for the 64-pad MLF Package in “Ordering Information” on page 14 and “Packaging Information” on page 15.

3. Changed Temperature Range and Removed Industrial Ordering Codes in “Packaging Information” on page 15.

Changes from Rev. 2514A-08/02 to Rev. 2514B-09/02

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

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