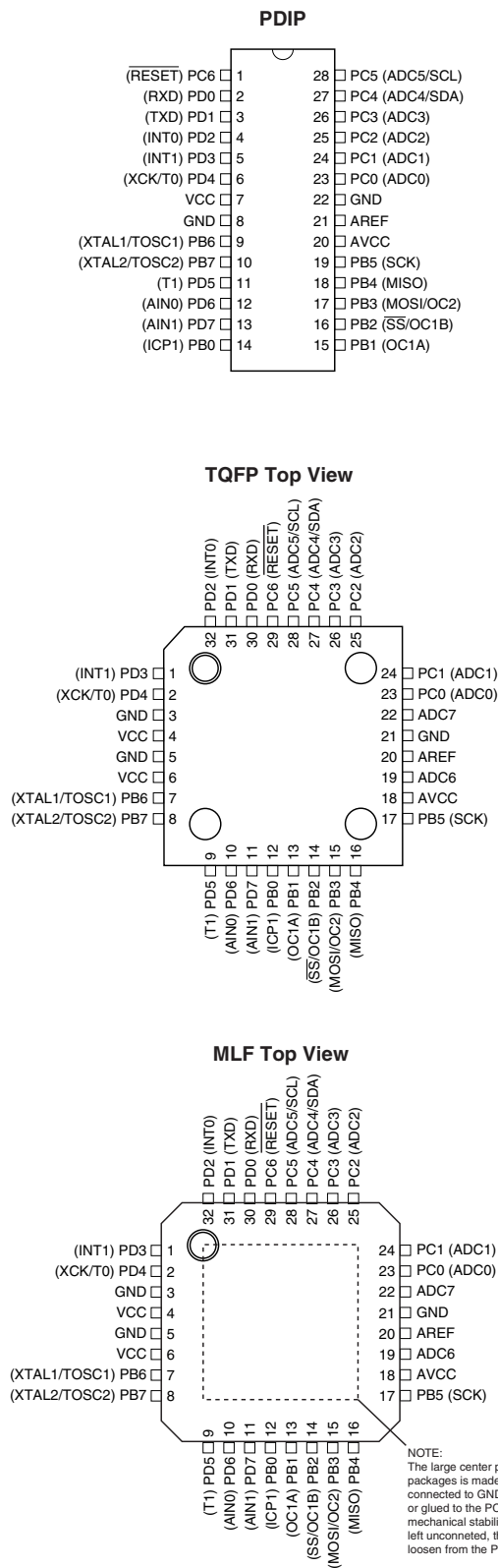


### Features

- High-performance, Low-power Atmel® AVR® 8-bit Microcontroller
- Advanced RISC Architecture
  - 130 Powerful Instructions – Most Single-clock Cycle Execution
  - 32 x 8 General Purpose Working Registers
  - Fully Static Operation
  - Up to 16MIPS Throughput at 16MHz
  - On-chip 2-cycle Multiplier
- High Endurance Non-volatile Memory segments
  - 8KBytes of In-System Self-programmable Flash program memory
  - 512Bytes EEPROM
  - 1KByte Internal SRAM
  - Write/Erase Cycles: 10,000 Flash/100,000 EEPROM
  - Data retention: 20 years at 85°C/100 years at 25°C<sup>(1)</sup>
  - Optional Boot Code Section with Independent Lock Bits
    - In-System Programming by On-chip Boot Program
    - True Read-While-Write Operation
  - Programming Lock for Software Security
- Atmel QTouch® library support
  - Capacitive touch buttons, sliders and wheels
  - Atmel QTouch and QMatrix acquisition
  - Up to 64 sense channels
- Peripheral Features
  - Two 8-bit Timer/Counters with Separate Prescaler, one Compare Mode
  - One 16-bit Timer/Counter with Separate Prescaler, Compare Mode, and Capture Mode
  - Real Time Counter with Separate Oscillator
  - Three PWM Channels
  - 8-channel ADC in TQFP and QFN/MLF package
    - Eight Channels 10-bit Accuracy
  - 6-channel ADC in PDIP package
    - Six Channels 10-bit Accuracy
  - Byte-oriented Two-wire Serial Interface
  - Programmable Serial USART
  - Master/Slave SPI Serial Interface
  - Programmable Watchdog Timer with Separate On-chip Oscillator
  - On-chip Analog Comparator
- Special Microcontroller Features
  - Power-on Reset and Programmable Brown-out Detection
  - Internal Calibrated RC Oscillator
  - External and Internal Interrupt Sources
  - Five Sleep Modes: Idle, ADC Noise Reduction, Power-save, Power-down, and Standby
- I/O and Packages
  - 23 Programmable I/O Lines
  - 28-lead PDIP, 32-lead TQFP, and 32-pad QFN/MLF
- Operating Voltages
  - 2.7 - 5.5V
  - 0 - 16MHz
- Power Consumption at 4MHz, 3V, 25°C
  - Active: 3.6mA
  - Idle Mode: 1.0mA
  - Power-down Mode: 0.5µA

# 1. Pin Configurations

Figure 1-1. Pinout ATmega8A

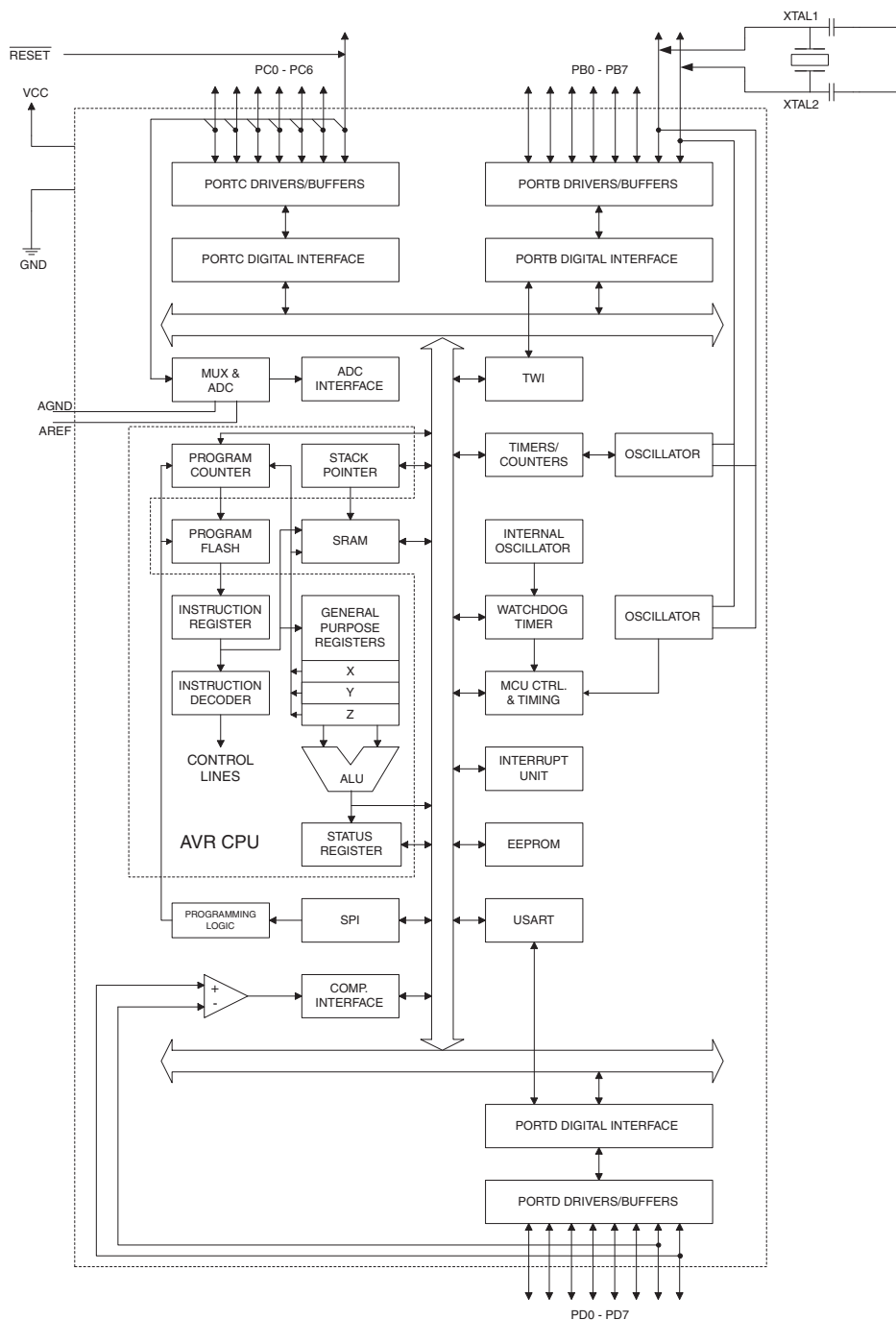


## 2. Overview

The Atmel®AVR® ATmega8A is a low-power CMOS 8-bit microcontroller based on the AVR RISC architecture. By executing powerful instructions in a single clock cycle, the ATmega8A achieves throughputs approaching 1 MIPS per MHz, allowing the system designer to optimize power consumption versus processing speed.

### 2.1 Block Diagram

Figure 2-1. Block Diagram



The Atmel® AVR® 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 ATmega8A provides the following features: 8K bytes of In-System Programmable Flash with Read-While-Write capabilities, 512 bytes of EEPROM, 1K byte of SRAM, 23 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, a 6-channel ADC (eight channels in TQFP and QFN/MLF packages) with 10-bit accuracy, 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. 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.

The device is manufactured using Atmel's high density non-volatile memory technology. The Flash Program memory can 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 ATmega8A is a powerful microcontroller that provides a highly-flexible and cost-effective solution to many embedded control applications.

The Atmel AVR ATmega8A is supported with a full suite of program and system development tools, including C compilers, macro assemblers, program simulators and evaluation kits.

## 2.2 Pin Descriptions

### 2.2.1 VCC

Digital supply voltage.

### 2.2.2 GND

Ground.

### 2.2.3 Port B (PB7:PB0) – XTAL1/XTAL2/TOSC1/TOSC2

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.

Depending on the clock selection fuse settings, PB6 can be used as input to the inverting Oscillator amplifier and input to the internal clock operating circuit.

Depending on the clock selection fuse settings, PB7 can be used as output from the inverting Oscillator amplifier.

If the Internal Calibrated RC Oscillator is used as chip clock source, PB7:6 is used as TOSC2:1 input for the Asynchronous Timer/Counter2 if the AS2 bit in ASSR is set.

The various special features of Port B are elaborated in [“Alternate Functions of Port B” on page 56](#) and [“System Clock and Clock Options” on page 24](#).

#### 2.2.4 Port C (PC5:PC0)

Port C is an 7-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.

#### 2.2.5 PC6/ $\overline{\text{RESET}}$

If the RSTDISBL Fuse is programmed, PC6 is used as an I/O pin. Note that the electrical characteristics of PC6 differ from those of the other pins of Port C.

If the RSTDISBL Fuse is unprogrammed, PC6 is used as a 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 26-3 on page 228](#). Shorter pulses are not guaranteed to generate a Reset.

The various special features of Port C are elaborated on [page 59](#).

#### 2.2.6 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 ATmega8A as listed on [page 61](#).

#### 2.2.7 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 26-3 on page 228](#). Shorter pulses are not guaranteed to generate a reset.

#### 2.2.8 $\text{AV}_{\text{CC}}$

$\text{AV}_{\text{CC}}$  is the supply voltage pin for the A/D Converter, Port C (3:0), and ADC (7:6). It should be externally connected to  $\text{V}_{\text{CC}}$ , even if the ADC is not used. If the ADC is used, it should be connected to  $\text{V}_{\text{CC}}$  through a low-pass filter. Note that Port C (5:4) use digital supply voltage,  $\text{V}_{\text{CC}}$ .

#### 2.2.9 AREF

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

#### 2.2.10 ADC7:6 (TQFP and QFN/MLF Package Only)

In the TQFP and QFN/MLF package, ADC7:6 serve as analog inputs to the A/D converter. These pins are powered from the analog supply and serve as 10-bit ADC channels.

### 3. Resources

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

### 4. Data Retention

Reliability Qualification results show that the projected data retention failure rate is much less than 1 PPM over 20 years at 85°C or 100 years at 25°C.

### 5. About Code Examples

This datasheet 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.

### 6. Capacitive touch sensing

The Atmel® QTouch® Library provides a simple to use solution to realize touch sensitive interfaces on most Atmel AVR® microcontrollers. The QTouch Library includes support for the QTouch and QMatrix® acquisition methods.

Touch sensing can be added to any application by linking the appropriate Atmel QTouch Library for the AVR Microcontroller. This is done by using a simple set of APIs to define the touch channels and sensors, and then calling the touch sensing API's to retrieve the channel information and determine the touch sensor states.

The QTouch Library is FREE and downloadable from the Atmel website at the following location: [www.atmel.com/qtouchlibrary](http://www.atmel.com/qtouchlibrary). For implementation details and other information, refer to the [Atmel QTouch Library User Guide](#) - also available for download from the Atmel website.

## 7. Ordering Information

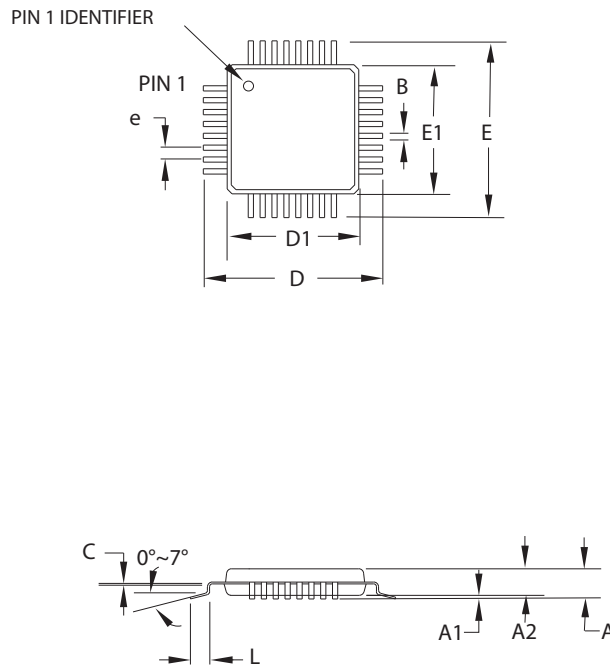
Speed (MHz)	Power Supply (V)	Ordering Code <sup>(2)</sup>	Package <sup>(1)</sup>	Operation Range
16	2.7 - 5.5	ATmega8A-AU ATmega8A-AUR <sup>(3)</sup> ATmega8A-PU ATmega8A-MU ATmega8A-MUR <sup>(3)</sup>	32A 32A 28P3 32M1-A 32M1-A	Industrial (-40°C to 85°C)
		ATmega8A-AN ATmega8A-ANR <sup>(3)</sup> ATmega8A-PN ATmega8A-MN ATmega8A-MNR <sup>(3)</sup>	32A 32A 28P3 32M1-A 32M1-A	Extended (-40°C to 105°C) <sup>(4)</sup>

- 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. Pb-free packaging alternative, complies to the European Directive for Restriction of Hazardous Substances (RoHS directive). Also Halide free and fully Green.
  3. Tape & Reel
  4. See characterization specifications at 105°C

Package Type	
<b>32A</b>	32-lead, Thin (1.0mm) Plastic Quad Flat Package (TQFP)
<b>28P3</b>	28-lead, 0.300" Wide, Plastic Dual Inline Package (PDIP)
<b>32M1-A</b>	32-pad, 5 x 5 x 1.0 body, Lead Pitch 0.50 mm Quad Flat No-Lead/Micro Lead Frame Package (QFN/MLF)

## 8. Packaging Information

### 8.1 32A



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	8.75	9.00	9.25	
D1	6.90	7.00	7.10	Note 2
E	8.75	9.00	9.25	
E1	6.90	7.00	7.10	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 ABA.
2. Dimensions D1 and E1 do not include mold protrusion. Allowable protrusion is 0.25mm per side. Dimensions D1 and E1 are maximum plastic body size dimensions including mold mismatch.
3. Lead coplanarity is 0.10mm maximum.

2010-10-20

**Atmel**

TITLE

32A, 32-lead, 7 x 7mm body size, 1.0mm body thickness,  
0.8mm lead pitch, thin profile plastic quad flat package (TQFP)

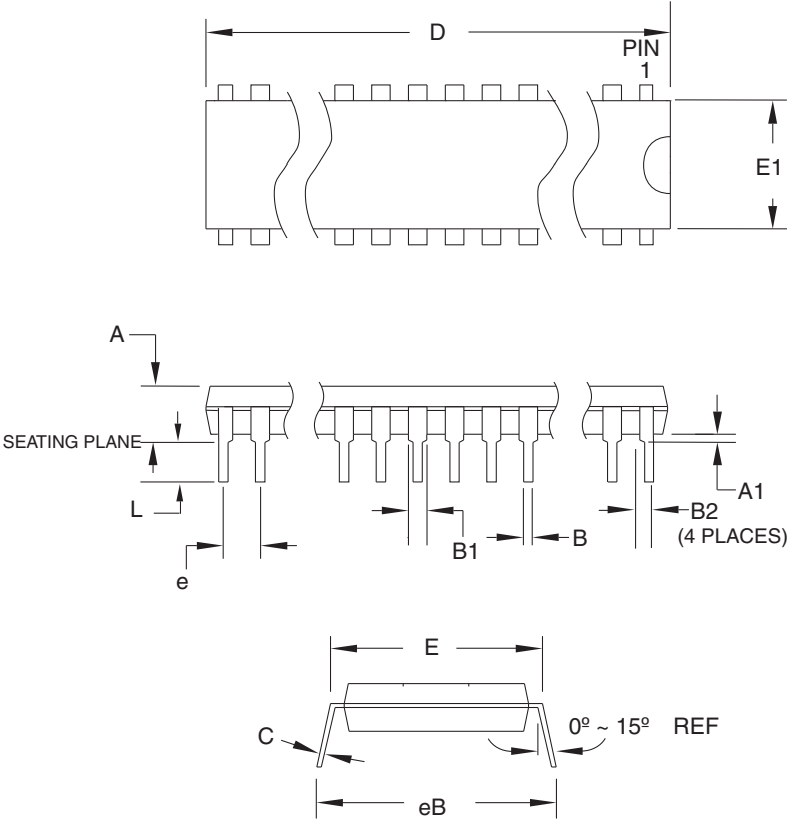
DRAWING NO.

32A

REV.

C

8.2 28P3



COMMON DIMENSIONS  
(Unit of Measure = mm)

SYMBOL	MIN	NOM	MAX	NOTE
A	–	–	4.5724	
A1	0.508	–	–	
D	34.544	–	34.798	Note 1
E	7.620	–	8.255	
E1	7.112	–	7.493	Note 1
B	0.381	–	0.533	
B1	1.143	–	1.397	
B2	0.762	–	1.143	
L	3.175	–	3.429	
C	0.203	–	0.356	
eB	–	–	10.160	
e	2.540 TYP			

Note: 1. Dimensions D and E1 do not include mold Flash or Protrusion.  
Mold Flash or Protrusion shall not exceed 0.25mm (0.010").

09/28/01



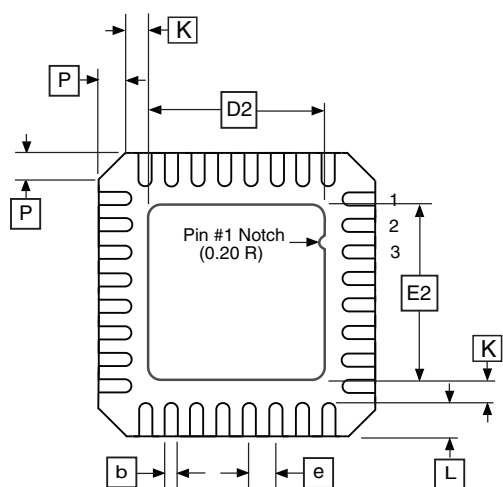
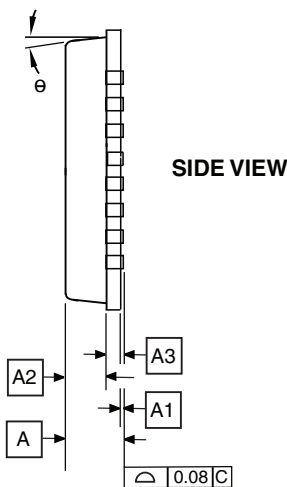
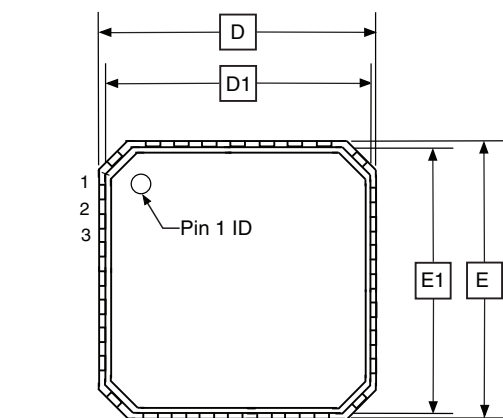
2325 Orchard Parkway  
San Jose, CA 95131

**TITLE**  
**28P3**, 28-lead (0.300"/7.62mm Wide) Plastic Dual  
Inline Package (PDIP)

**DRAWING NO.**  
28P3

**REV.**  
B

32M1-A



COMMON DIMENSIONS  
(Unit of Measure = mm)

SYMBOL	MIN	NOM	MAX	NOTE
A	0.80	0.90	1.00	
A1	—	0.02	0.05	
A2	—	0.65	1.00	
A3	0.20 REF			
b	0.18	0.23	0.30	
D	4.90	5.00	5.10	
D1	4.70	4.75	4.80	
D2	2.95	3.10	3.25	
E	4.90	5.00	5.10	
E1	4.70	4.75	4.80	
E2	2.95	3.10	3.25	
e	0.50 BSC			
L	0.30	0.40	0.50	
P	—	—	0.60	
$\theta$	—	—	12 <sup>0</sup>	
K	0.20	—	—	

Note: JEDEC Standard MO-220, Fig. 2 (Anvil Singulation), VHHD-2.

5/25/06

 2325 Orchard Parkway San Jose, CA 95131	<b>TITLE</b> <b>32M1-A</b> , 32-pad, 5 x 5 x 1.0mm Body, Lead Pitch 0.50mm, 3.10mm Exposed Pad, Micro Lead Frame Package (MLF)	<b>DRAWING NO.</b> 32M1-A	<b>REV.</b> E

## 9. Errata

The revision letter in this section refers to the revision of the ATmega8A device.

### 9.1 ATmega8A, rev. L

- **First Analog Comparator conversion may be delayed**
- **Interrupts may be lost when writing the timer registers in the asynchronous timer**
- **Signature may be Erased in Serial Programming Mode**
- **CKOPT Does not Enable Internal Capacitors on XTALn/TOSCn Pins when 32kHz Oscillator is Used to Clock the Asynchronous Timer/Counter2**
- **Reading EEPROM by using ST or STS to set EERE bit triggers unexpected interrupt request**

#### 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. Interrupts may be lost when writing the timer registers in the asynchronous timer

The interrupt will be lost if a timer register that is synchronous timer clock is written when the asynchronous Timer/Counter register (TCNTx) is 0x00.

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

Always check that the asynchronous Timer/Counter register neither have the value 0xFF nor 0x00 before writing to the asynchronous Timer Control Register (TCCR<sub>x</sub>), asynchronous Timer Counter Register (TCNT<sub>x</sub>), or asynchronous Output Compare Register (OCR<sub>x</sub>).

#### 3. Signature may be Erased in Serial Programming Mode

If the signature bytes are read before a chip erase command is completed, the signature may be erased causing the device ID and calibration bytes to disappear. This is critical, especially, if the part is running on internal RC oscillator.

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

Ensure that the chip erase command has succeeded before applying the next command.

#### 4. CKOPT Does not Enable Internal Capacitors on XTALn/TOSCn Pins when 32kHz Oscillator is Used to Clock the Asynchronous Timer/Counter2

When the internal RC Oscillator is used as the main clock source, it is possible to run the Timer/Counter2 asynchronously by connecting a 32kHz Oscillator between XTAL1/TOSC1 and XTAL2/TOSC2. But when the internal RC Oscillator is selected as the main clock source, the CKOPT Fuse does not control the internal capacitors on XTAL1/TOSC1 and XTAL2/TOSC2. As long as there are no capacitors connected to XTAL1/TOSC1 and XTAL2/TOSC2, safe operation of the Oscillator is not guaranteed.

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

Use external capacitors in the range of 20 - 36 pF on XTAL1/TOSC1 and XTAL2/TOSC2. This will be fixed in ATmega8A Rev. G where the CKOPT Fuse will control internal capacitors also when internal RC Oscillator is selected as main clock source. For ATmega8A Rev. G, CKOPT = 0 (programmed) will enable the internal capacitors on XTAL1 and XTAL2. Customers who want compatibility between Rev. G and older revisions, must ensure that CKOPT is unprogrammed (CKOPT = 1).

**5. Reading EEPROM by using ST or STS to set EERE bit triggers unexpected interrupt request.**

Reading EEPROM by using the ST or STS command to set the EERE bit in the EECR register triggers an unexpected EEPROM interrupt request.

**Problem Fix / Workaround**

Always use OUT or SBI to set EERE in EECR.



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