

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 20 MIPS Throughput at 20 MHz
 - On-chip 2-cycle Multiplier
- High Endurance Non-volatile Memory segments
 - 4/8/16K Bytes of In-System Self-programmable Flash program memory
 - 256/512/512 Bytes EEPROM
 - 512/1K/1K Bytes Internal SRAM
 - Write/Erase cycles: 10,000 Flash/100,000 EEPROM ⁽¹⁾⁽³⁾
 - Data retention: 20 years at 85°C/100 years at 25°C ⁽²⁾⁽³⁾
 - 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
- Peripheral Features
 - Two 8-bit Timer/Counters with Separate Prescaler and Compare Mode
 - One 16-bit Timer/Counter with Separate Prescaler, Compare Mode, and Capture Mode
 - Real Time Counter with Separate Oscillator
 - Six PWM Channels
 - 8-channel 10-bit ADC in TQFP and QFN/MLF package
 - 6-channel 10-bit ADC in PDIP Package
 - Programmable Serial USART
 - Master/Slave SPI Serial Interface
 - Byte-oriented 2-wire Serial Interface (Philips I²C compatible)
 - Programmable Watchdog Timer with Separate On-chip Oscillator
 - On-chip Analog Comparator
 - Interrupt and Wake-up on Pin Change
- Special Microcontroller Features
 - Power-on Reset and Programmable Brown-out Detection
 - Internal Calibrated 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-pin PDIP, 32-lead TQFP, 28-pad QFN/MLF and 32-pad QFN/MLF
- Operating Voltage:
 - 1.8 - 5.5V for ATmega48V/88V/168V
 - 2.7 - 5.5V for ATmega48/88/168
- Temperature Range:
 - -40°C to 85°C
- Speed Grade:
 - ATmega48V/88V/168V: 0 - 4 MHz @ 1.8 - 5.5V, 0 - 10 MHz @ 2.7 - 5.5V
 - ATmega48/88/168: 0 - 10 MHz @ 2.7 - 5.5V, 0 - 20 MHz @ 4.5 - 5.5V
- Low Power Consumption
 - Active Mode:
 - 250 µA at 1 MHz, 1.8V
 - 15 µA at 32 kHz, 1.8V (including Oscillator)
 - Power-down Mode:
 - 0.1µA at 1.8V

- Notes:
1. Worst case temperature. Guaranteed after last write cycle.
 2. Failure rate less than 1 ppm.
 3. Characterized through accelerated tests.



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

**ATmega48/V
ATmega88/V
ATmega168/V**

Summary



6. Ordering Information

6.1 ATmega48

Speed (MHz)	Power Supply	Ordering Code	Package ⁽¹⁾	Operational Range
10	1.8 - 5.5	ATmega48V-10AI	32A	Industrial (-40°C to 85°C)
		ATmega48V-10MI	32M1-A	
		ATmega48V-10PI	28P3	
		ATmega48V-10AU ⁽²⁾	32A	
		ATmega48V-10MMU ⁽²⁾	28M1	
		ATmega48V-10MU ⁽²⁾	32M1-A	
		ATmega48V-10PU ⁽²⁾	28P3	
20	2.7 - 5.5	ATmega48-20AI	32A	Industrial (-40°C to 85°C)
		ATmega48-20MI	32M1-A	
		ATmega48-20PI	28P3	
		ATmega48-20AU ⁽²⁾	32A	
		ATmega48-20MMU ⁽²⁾	28M1	
		ATmega48-20MU ⁽²⁾	32M1-A	
		ATmega48-20PU ⁽²⁾	28P3	

- Note:
1. This device can also be supplied in wafer form. Please contact your local Atmel sales office for detailed ordering information and minimum quantities.
 2. Pb-free packaging alternative, complies to the European Directive for Restriction of Hazardous Substances (RoHS directive). Also Halide free and fully Green.

Package Type	
32A	32-lead, Thin (1.0 mm) Plastic Quad Flat Package (TQFP)
28M1	28-pad, 4 x 4 x 1.0 body, Lead Pitch 0.45 mm Quad Flat No-Lead/Micro Lead Frame Package (QFN/MLF)
32M1-A	32-pad, 5 x 5 x 1.0 body, Lead Pitch 0.50 mm Quad Flat No-Lead/Micro Lead Frame Package (QFN/MLF)
28P3	28-lead, 0.300" Wide, Plastic Dual Inline Package (PDIP)



6.2 ATmega88

Speed (MHz)	Power Supply	Ordering Code	Package ⁽¹⁾	Operational Range
10	1.8 - 5.5	ATmega88V-10AI ATmega88V-10MI ATmega88V-10PI ATmega88V-10AU ⁽²⁾ ATmega88V-10MU ⁽²⁾ ATmega88V-10PU ⁽²⁾	32A 32M1-A 28P3 32A 32M1-A 28P3	Industrial (-40°C to 85°C)
20	2.7 - 5.5	ATmega88-20AI ATmega88-20MI ATmega88-20PI ATmega88-20AU ⁽²⁾ ATmega88-20MU ⁽²⁾ ATmega88-20PU ⁽²⁾	32A 32M1-A 28P3 32A 32M1-A 28P3	Industrial (-40°C to 85°C)

- Note:
1. This device can also be supplied in wafer form. Please contact your local Atmel sales office for detailed ordering information and minimum quantities.
 2. Pb-free packaging alternative, complies to the European Directive for Restriction of Hazardous Substances (RoHS directive). Also Halide free and fully Green.

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

ATmega48/88/168

6.3 ATmega168

Speed (MHz)	Power Supply	Ordering Code	Package ⁽¹⁾	Operational Range
10	1.8 - 5.5	ATmega168V-10AI ATmega168V-10MI ATmega168V-10PI ATmega168V-10AU ⁽²⁾ ATmega168V-10MU ⁽²⁾ ATmega168V-10PU ⁽²⁾	32A 32M1-A 28P3 32A 32M1-A 28P3	Industrial (-40°C to 85°C)
20	2.7 - 5.5	ATmega168-20AI ATmega168-20MI ATmega168-20PI ATmega168-20AU ⁽²⁾ ATmega168-20MU ⁽²⁾ ATmega168-20PU ⁽²⁾	32A 32M1-A 28P3 32A 32M1-A 28P3	Industrial (-40°C to 85°C)

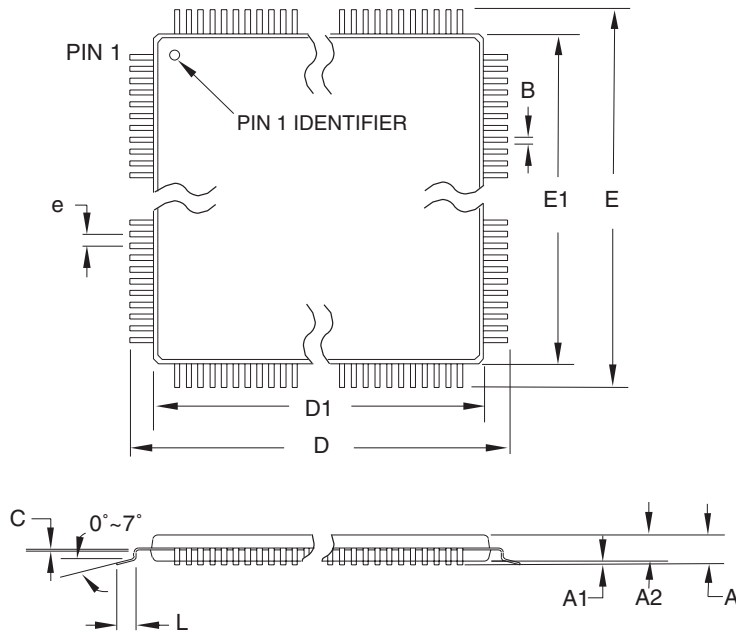
- Note:
1. This device can also be supplied in wafer form. Please contact your local Atmel sales office for detailed ordering information and minimum quantities.
 2. Pb-free packaging alternative, complies to the European Directive for Restriction of Hazardous Substances (RoHS directive). Also Halide free and fully Green.

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



7. Packaging Information

7.1 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 0.25 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

**32A, 32-lead, 7 x 7 mm Body Size, 1.0 mm Body Thickness,
0.8 mm Lead Pitch, Thin Profile Plastic Quad Flat Package (TQFP)**

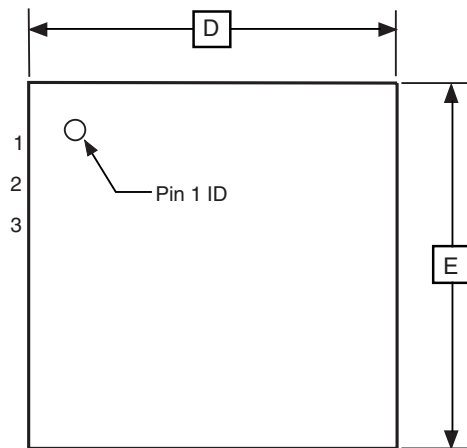
DRAWING NO.

32A

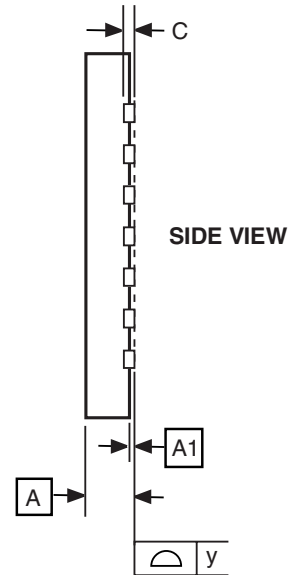
REV.

B

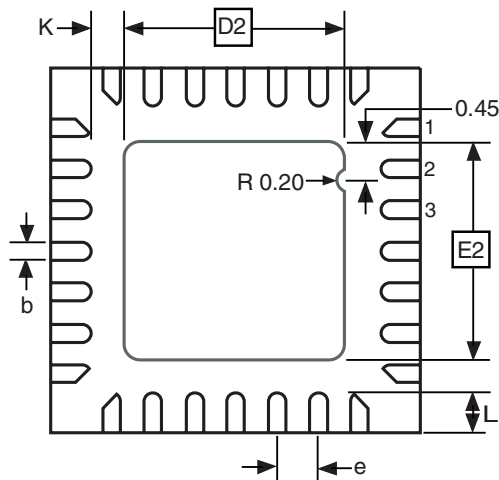
7.2 28M1



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	0.00	0.02	0.05	
b	0.17	0.22	0.27	
C	0.20 REF			
D	3.95	4.00	4.05	
D2	2.35	2.40	2.45	
E	3.95	4.00	4.05	
E2	2.35	2.40	2.45	
e	0.45			
L	0.35	0.40	0.45	
y	0.00	-	0.08	
K	0.20	-	-	

Note: The terminal #1 ID is a Laser-marked Feature.

9/7/06



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TITLE

**28M1, 28-pad, 4 x 4 x 1.0 mm Body, Lead Pitch 0.45 mm,
2.4 mm Exposed Pad, Micro Lead Frame Package (MLF)**

DRAWING NO.

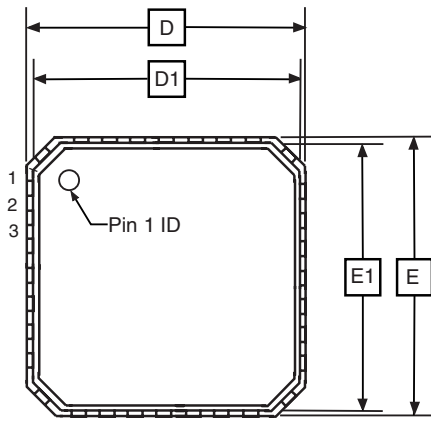
28M1

REV.

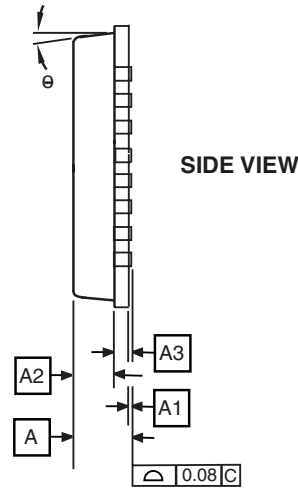
A



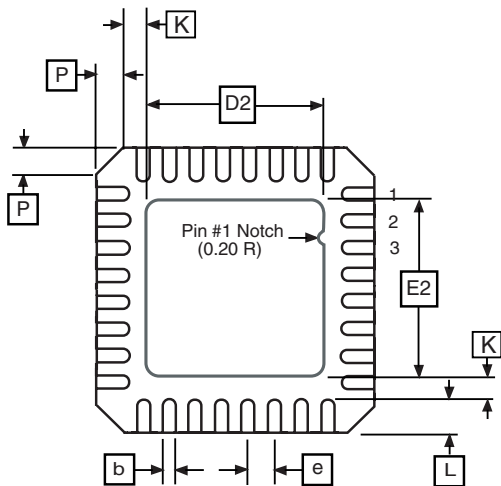
7.3 32M1-A



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	
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	
θ	-	-	12 ⁰	
K	0.20	-	-	

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

5/25/06



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TITLE

32M1-A, 32-pad, 5 x 5 x 1.0 mm Body, Lead Pitch 0.50 mm,
3.10 mm Exposed Pad, Micro Lead Frame Package (MLF)

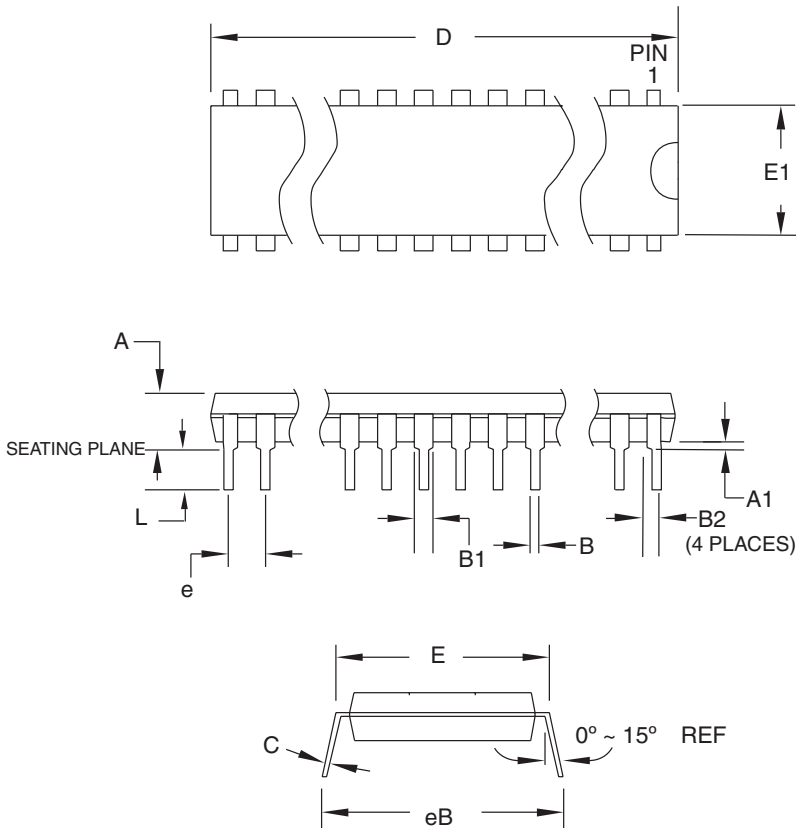
DRAWING NO.

32M1-A

REV.

E

7.4 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 0.25 mm (0.010").

09/28/01



2325 Orchard Parkway
San Jose, CA 95131

TITLE

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

DRAWING NO.

28P3

REV.

B

