Features

- **Programmable 16,777,216 x 1-bit Serial Memories Designed to Store Configuration Programs for Field Programmable Gate Arrays (FPGAs)**
- **3.3V Output Capability**
- **5V Tolerant I/O Pins**
- **Program Support using the Atmel ATDH2200E System or Industry Third-party Programmers**
- **In-System Programmable (ISP) via 2-wire Bus**
- **Simple Interface to SRAM FPGAs**
- **Compatible with Atmel AT40K and AT94K Devices, Altera® FLEX®, APEX™ Devices, Lucent® ORCA® FPGAs, Xilinx® XC3000, XC4000, XC5200, Spartan®, Virtex® FPGAs, Motorola® MPA1000 FPGAs**
- **Cascadable Read-back to Support Additional Configurations or Higher-density Arrays**
- **Low-power CMOS FLASH Process**
- **Available in 6 mm x 6 mm x 1 mm 8-lead LAP (Pin-compatible with 8-lead SOIC/VOIC Footprint Packages), 20-lead PLCC and 44-lead TQFP Packages**
- **Emulation of Atmel's AT24CXXX Serial EEPROMs**
- **Low-power Standby Mode**
- **Single Device Capable of Holding 4-bit Stream Files Allowing Simple System Reconfiguration**
- **Fast Serial Download Speeds up to 33 MHz**
- **Endurance: 10,000 Write Cycles Typical**
- **Green (Pb/Halide-free/RoHS Compliant) Package Options Available**

FPGA Configuration Flash Memory

AT17F16

1. Description

The AT17F Series of In-System Programmable Configuration PROMs (Configurators) provide an easy-to-use, cost-effective configuration memory for Field Programmable Gate Arrays. The AT17F Series device is packaged in the 8-lead LAP, 20-lead PLCC and 44-lead TQFP, see Table 1-1. The AT17F Series Configurator uses a simple serial-access procedure to configure one or more FPGA devices.

The AT17F Series Configurators can be programmed with industry-standard programmers, Atmel's ATDH2200E Programming Kit or Atmel's ATDH2225 ISP Cable.

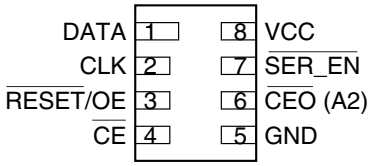
Table 1-1. AT17F Series Packages

Package	AT17F16
8-lead LAP	Yes
20-lead PLCC	Yes
44-lead TQFP	Yes

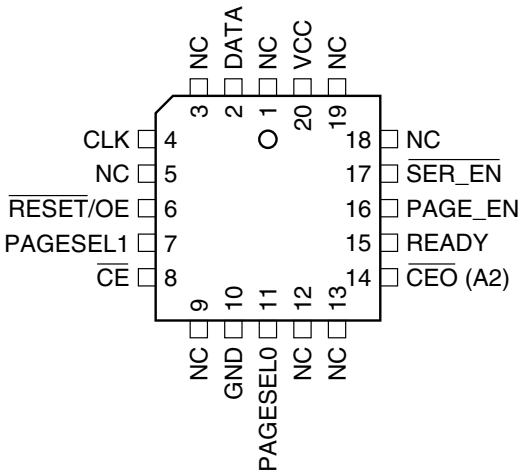
3392F–CNFG–2/08

2. Pin Configuration

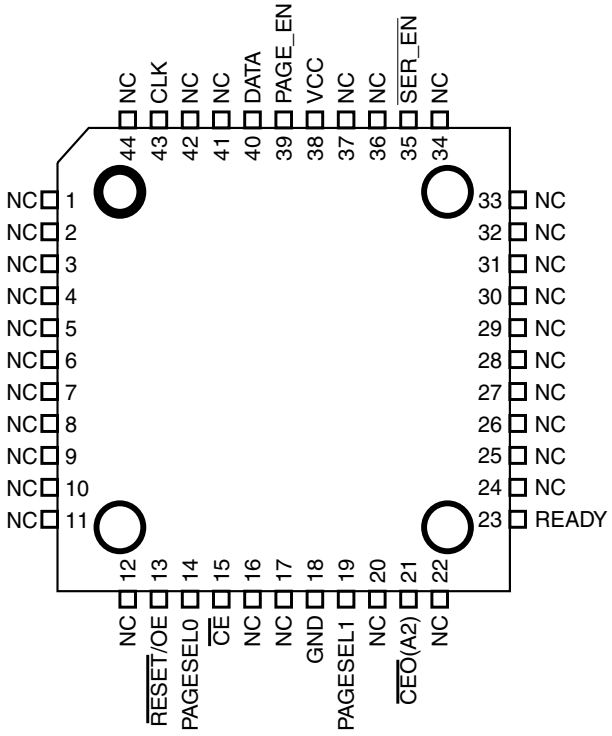
8-lead LAP



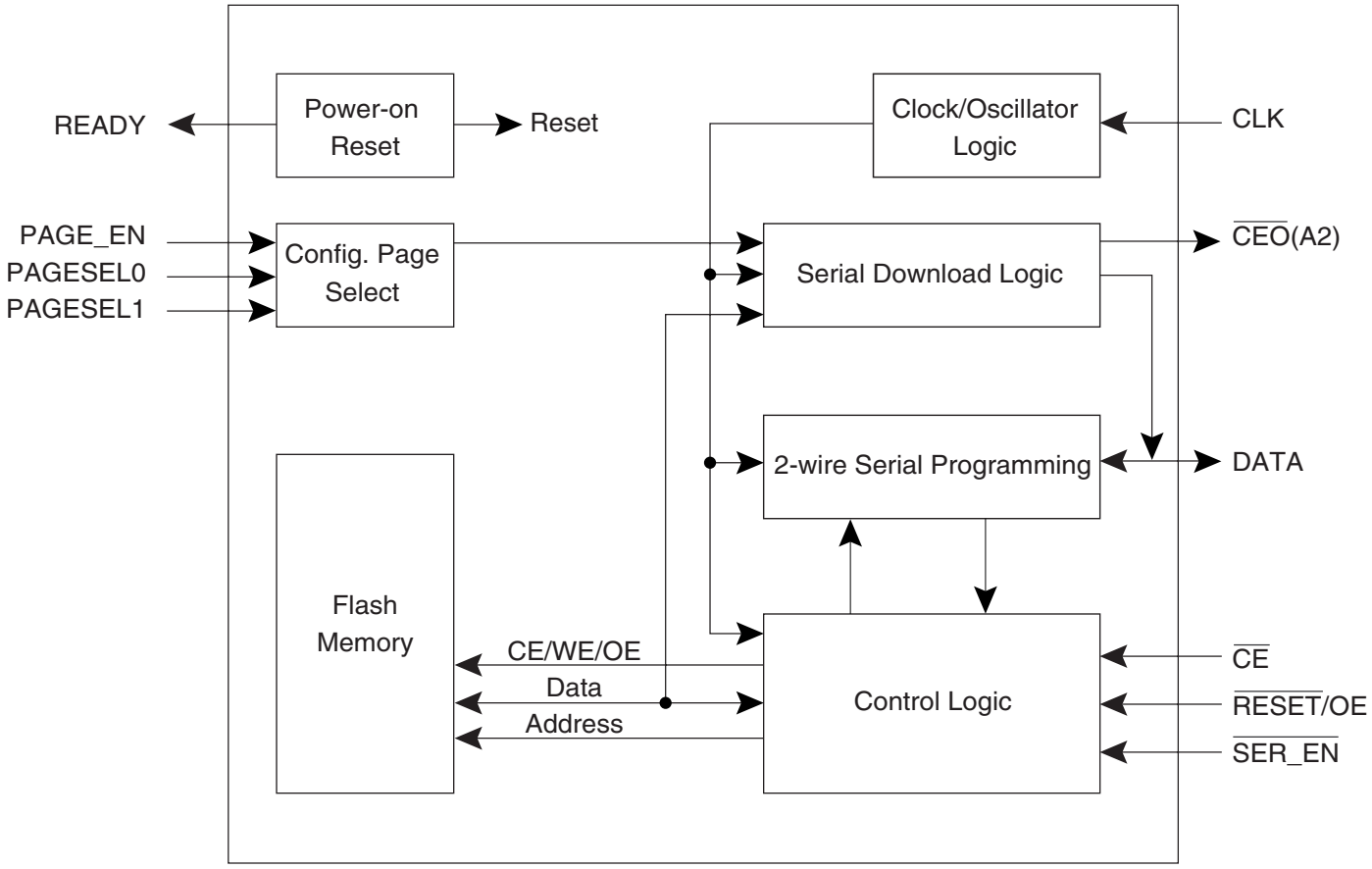
20-lead PLCC



44 TQFP



3. Block Diagram



4. Device Description

The control signals for the configuration memory device ($\overline{CE}$, $\overline{RESET}$/OE and CLK) interface directly with the FPGA device control signals. All FPGA devices can control the entire configuration process and retrieve data from the configuration device without requiring an external intelligent controller.

The $\overline{RESET}$/OE and $\overline{CE}$ pins control the tri-state buffer on the DATA output pin and enable the address counter. When $\overline{RESET}$/OE is driven Low, the configuration device resets its address counter and tri-states its DATA pin. The $\overline{CE}$ pin also controls the output of the AT17F Series Configurator. If $\overline{CE}$ is held High after the $\overline{RESET}$/OE reset pulse, the counter is disabled and the DATA output pin is tri-stated. When OE is subsequently driven High, the counter and the DATA output pin are enabled. When $\overline{RESET}$/OE is driven Low again, the address counter is reset and the DATA output pin is tri-stated, regardless of the state of $\overline{CE}$.

When the configurator has driven out all of its data and $\overline{CEO}$ is driven Low, the device tri-states the DATA pin to avoid contention with other configurators. Upon power-up, the address counter is automatically reset.

5. Pin Description

Table 5-1. Pin Description

Name	I/O	AT17F16		
		8 LAP	20 PLCC	44 TQFP
DATA	I/O	1	2	40
CLK	I	2	4	43
PAGE_EN	I	–	16	39
PAGESEL0	I	–	11	14
PAGESEL1	I	–	7	19
$\overline{\text{RESET}}$/OE	I	3	6	13
$\overline{\text{CE}}$	I	4	8	15
GND	–	5	10	18
$\overline{\text{CEO}}$	O	6	14	21
A2	I			
READY	O	–	15	23
$\overline{\text{SER_EN}}$	I	7	17	35
V_{CC}	–	8	20	38

5.1 DATA[1]

Three-state DATA output for configuration. Open-collector bi-directional pin for programming.

5.2 CLK[1]

Clock input. Used to increment the internal address and bit counter for reading and programming.

5.3 PAGE_EN[2]

Input used to enable page download mode. When PAGE_EN is high the configuration download address space is partitioned into 4 equal pages. This gives users the ability to easily store and retrieve multiple configuration bitstreams from a single configuration device. This input works in conjunction with the PAGESEL inputs. PAGE_EN must be remain low if paging is not desired. When SER_EN is Low (ISP mode) this pin has no effect.

Notes: 1. This pin has an internal 20 kΩ pull-up resistor.
2. This pin has an internal 30 kΩ pull-down resistor.

5.4 PAGESEL[1:0](2)

Page select inputs. Used to determine which of the 4 memory pages are targeted during a serial configuration download. The address space for each of the pages is shown in Table 5-2. When $\overline{SER_EN}$ is Low (ISP mode) these pins have no effect.

Table 5-2. Address Space

Paging Decodes	AT17F16 (16 Mbits)
PAGESEL = 00, PAGE_EN = 1	00000 – 3FFFFh
PAGESEL = 01, PAGE_EN = 1	40000 – 7FFFFh
PAGESEL = 10, PAGE_EN = 1	80000 – BFFFFh
PAGESEL = 11, PAGE_EN = 1	C0000 – FFFFFh
PAGESEL = XX, PAGE_EN = 0	00000 – FFFFFh

5.5 $\overline{RESET}$/$\overline{OE}$(1)

Output Enable (active High) and RESET (active Low) when $\overline{SER_EN}$ is High. A Low level on $\overline{RESET}$/$\overline{OE}$ resets both the address and bit counters. A High level (with $\overline{CE}$ Low) enables the data output driver.

5.6 $\overline{CE}$(1)

Chip Enable input (active Low). A Low level (with OE High) allows CLK to increment the address counter and enables the data output driver. A High level on $\overline{CE}$ disables both the address and bit counters and forces the device into a low-power standby mode. Note that this pin will *not* enable/disable the device in the 2-wire Serial Programming mode ($\overline{SER_EN}$ Low).

5.7 GND

Ground pin. A 0.2 µF decoupling capacitor between V_{CC} and GND is recommended.

5.8 $\overline{CEO}$

Chip Enable Output (when $\overline{SER_EN}$ is High). This output goes Low when the internal address counter has reached its maximum value. If the PAGE_EN input is set High, the maximum value is the highest address in the selected partition. The PAGESEL[1:0] inputs are used to make the 4 partition selections. If the PAGE_EN input is set Low, the device is not partitioned and the address maximum value is the highest address in the device, see Table 5-2 on page 5. In a daisy chain of AT17F Series devices, the $\overline{CEO}$ pin of one device must be connected to the $\overline{CE}$ input of the next device in the chain. It will stay Low as long as $\overline{CE}$ is Low and OE is High. It will then follow $\overline{CE}$ until OE goes Low; thereafter, $\overline{CEO}$ will stay High until the entire EEPROM is read again.

5.9 A2(1)

Device selection input, (when $\overline{SER_EN}$ Low). The input is used to enable (or chip select) the device during programming (i.e., when $\overline{SER_EN}$ is Low). Refer to the AT17F Programming Specification available on the Atmel web site for additional details.

Notes: 1. This pin has an internal 20 kΩ pull-up resistor.
2. This pin has an internal 30 kΩ pull-down resistor.

5.10 READY

Open collector reset state indicator. Driven Low during power-up reset, released when power-up is complete. (recommended 4.7 kΩ pull-up on this pin if used).

5.11 $\overline{\text{SER_EN}}$[1]

The serial enable input must remain High during FPGA configuration operations. Bringing $\overline{\text{SER_EN}}$ Low enables the 2-Wire Serial Programming Mode. For non-ISP applications, $\overline{\text{SER_EN}}$ should be tied to V_{CC}.

5.12 V_{CC}

+3.3V (±10%).

Notes: 1. This pin has an internal 20 kΩ pull-up resistor.
2. This pin has an internal 30 kΩ pull-down resistor.

6. FPGA Master Serial Mode Summary

The I/O and logic functions of any SRAM-based FPGA are established by a configuration program. The program is loaded either automatically upon power-up, or on command, depending on the state of the FPGA mode pins. In Master mode, the FPGA automatically loads the configuration program from an external memory. The AT17F Serial Configuration PROM has been designed for compatibility with the Master Serial mode.

This document discusses the Atmel AT40K, AT40KAL and AT94KAL applications as well as Xilinx applications.

7. Control of Configuration

Most connections between the FPGA device and the AT17F Serial Configurator PROM are simple and self-explanatory.

- The DATA output of the AT17F Series Configurator drives DIN of the FPGA devices.
- The master FPGA CCLK output drives the CLK input of the AT17F Series Configurator.
- The $\overline{CEO}$ output of any AT17F Series Configurator drives the $\overline{CE}$ input of the next Configurator in a cascade chain of configurator devices.
- $\overline{SER_EN}$ must be connected to V_{CC} or allowed to float to logic High via the internal pull-up resistor (except during ISP).
- The READY pin is available as an open-collector indicator of the device's reset status; it is driven Low while the device is in its power-on reset cycle and released (tri-stated) when the cycle is complete.
- PAGE_EN must be held Low if download paging is not desired. The PAGESEL[1:0] inputs must be tied off High or Low. If paging is desired, PAGE_EN must be High and the PAGESEL pins must be set to High or Low such that the desired page is selected, see Table 5-2 on page 5.

8. Cascading Serial Configuration Devices

For multiple FPGAs configured as a daisy-chain, or for FPGAs requiring larger configuration memories, cascaded configurators provide additional memory.

After the last bit from the first configurator is read, the clock signal to the configurator asserts its $\overline{CEO}$ output Low and disables its DATA line driver. The second configurator recognizes the Low level on its $\overline{CE}$ input and enables its DATA output.

After configuration is complete, the address counters of all cascaded configurators are reset if the $\overline{RESET}$/OE on each configurator is driven to its active (Low) level.

If the address counters are not to be reset upon completion, then the $\overline{RESET}$/OE input can be tied to its inactive (High) level.

9. Programming Mode

The programming mode is entered by bringing $\overline{\text{SER_EN}}$ Low. In this mode the chip can be programmed by the 2-wire serial bus. The programming is done at V_{CC} supply only. Programming super voltages are generated inside the chip. The AT17F parts are read/write at 3.3V nominal. Refer to the AT17F Programming Specification available on the Atmel web site (www.atmel.com) for more programming details. AT17F devices are supported by the Atmel ATDH2200E programming system along with many third party programmers.

10. Standby Mode

The AT17F Series Configurators enter a low-power standby mode whenever $\overline{\text{SER_EN}}$ is High and $\overline{\text{CE}}$ is asserted High. In this mode, the AT17F Configurator consumes less than 5 mA of current at 3.6V. The output remains in a high-impedance state regardless of the state of the OE input.

11. Absolute Maximum Ratings*

Operating Temperature	-40° C to +85° C
Storage Temperature	-65° C to +150° C
Voltage on Any Pin with Respect to Ground	-0.1V to V_{CC} +0.5V
Supply Voltage (V_{CC})	-0.5V to +4.0V
Maximum Soldering Temp. (10 sec. @ 1/16 in.)	260° C
ESD (R_{ZAP} = 1.5K, C_{ZAP} = 100 pF)	2000V

*NOTICE: Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions beyond those listed under operating conditions is not implied. Exposure to Absolute Maximum Rating conditions for extended periods of time may affect device reliability.

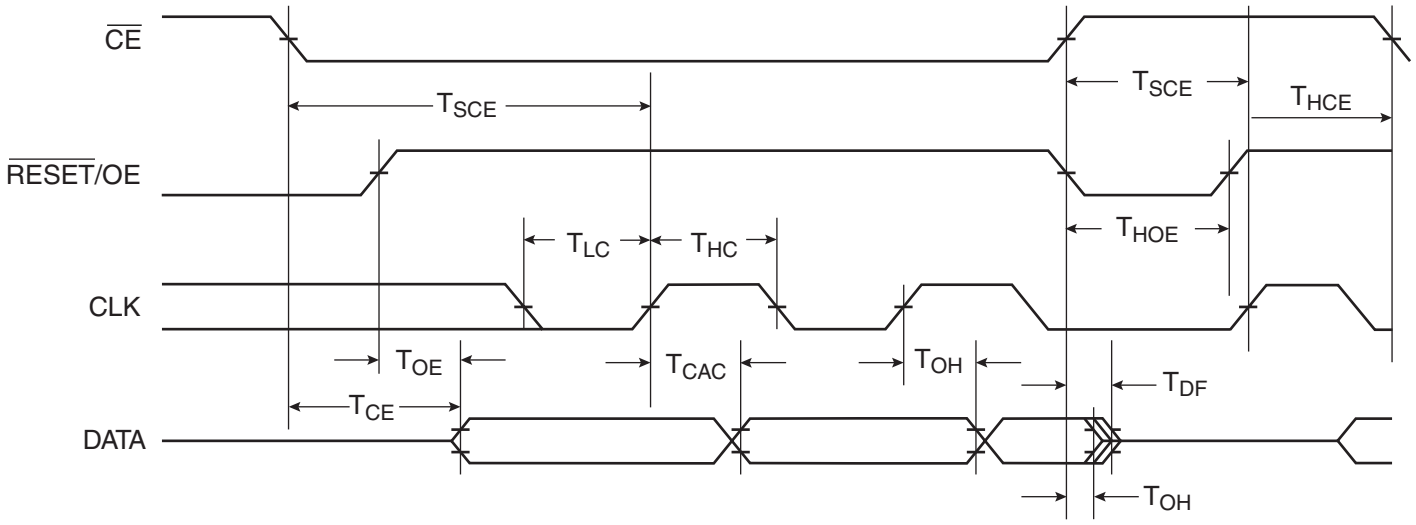
12. Operating Conditions

Symbol	Description		AT17F Series Configurator Min	AT17F Series Configurator Max	Units
V_{CC}	Commercial	Supply voltage relative to GND -0° C to +70° C	2.97	3.63	V
	Industrial	Supply voltage relative to GND -40° C to +85° C	2.97	3.63	V

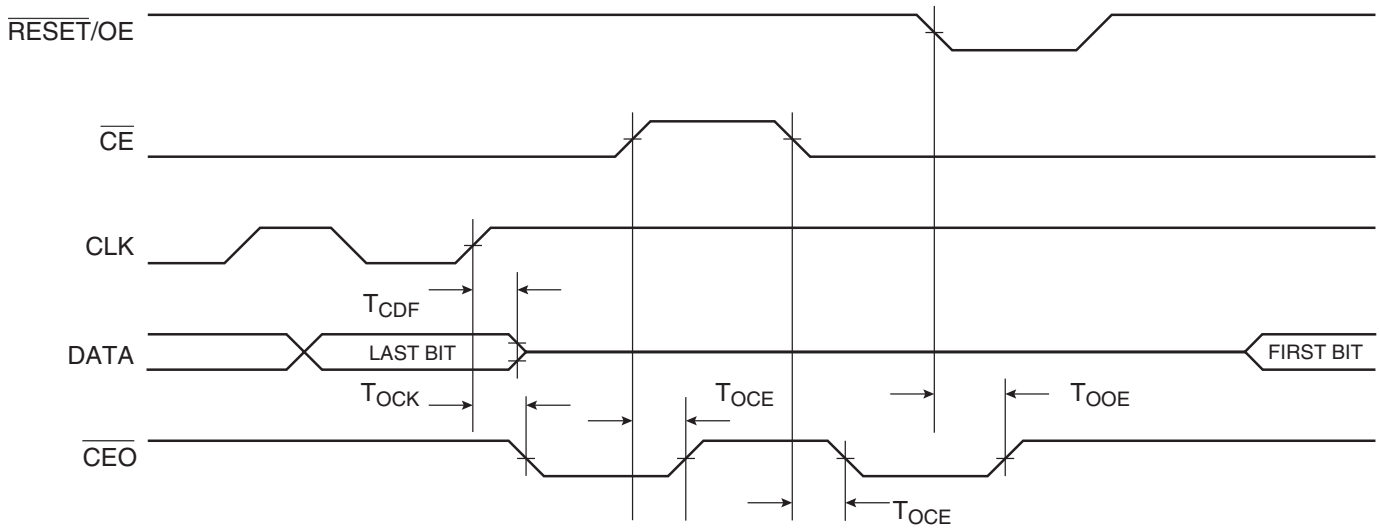
13. DC Characteristics

Symbol	Description		AT17F16 Min	AT17F16 Max	Units
V_{IH}	High-level Input Voltage		2.0	V_{CC}	V
V_{IL}	Low-level Input Voltage		0	0.8	V
V_{OH}	High-level Output Voltage (I_{OH} = -2.5 mA)	Commercial	2.4		V
V_{OL}	Low-level Output Voltage (I_{OL} = +3 mA)	Commercial		0.4	V
V_{OH}	High-level Output Voltage (I_{OH} = -2 mA)	Industrial	2.4		V
V_{OL}	Low-level Output Voltage (I_{OL} = +3 mA)	Industrial		0.4	V
I_{CCA}	Supply Current, Active Mode (3.6V 33 MHz)			40	mA
I_L	Input or Output Leakage Current (V_{IN} = V_{CC} or GND)		-10	10	µA
I_{CCS}	Supply Current, Standby Mode	Commercial		2	mA
		Industrial		2	mA

14. AC Characteristics



15. AC Characteristics when Cascading



16. AC Characteristics

Symbol	Description		AT17F16 Min	AT17F16 Typ	AT17F16 Max	Units
T_{OE}[2]	OE to Data Delay	Commercial			50	ns
		Industrial[1]			55	ns
T_{CE}[2]	$\overline{CE}$ to Data Delay	Commercial			55	ns
		Industrial[1]			60	ns
T_{CAC}[2]	CLK to Data Delay	Commercial	3		30	ns
		Industrial[1]			30	ns
T_{OH}	Data Hold from $\overline{CE}$, OE, or CLK	Commercial	0			ns
		Industrial[1]	0			ns
T_{DF}[3]	$\overline{CE}$ or OE to Data Float Delay	Commercial			15	ns
		Industrial[1]			15	ns
T_{LC}	CLK Low Time	Commercial	15			ns
		Industrial[1]	15			ns
T_{HC}	CLK High Time	Commercial	15			ns
		Industrial[1]	15			ns
T_{SCE}	$\overline{CE}$ Setup Time to CLK (to guarantee proper counting)	Commercial	20			ns
		Industrial[1]	25			ns
T_{HCE}	$\overline{CE}$ Hold Time from CLK (to guarantee proper counting)	Commercial	0			ns
		Industrial[1]	0			ns
T_{HOE}	$\overline{RESET}$/OE Low Time (guarantees counter is reset)	Commercial	20			ns
		Industrial[1]	20			ns
F_{MAX}	Maximum Input Clock Frequency $\overline{SEREN}$ = 0	Commercial			10	MHz
		Industrial[1]			10	MHz
F_{MAX}	Maximum Input Clock Frequency $\overline{SEREN}$ = 1	Commercial			33	MHz
		Industrial[1]			33	MHz
T_{WR}	Write Cycle Time[4]	Commercial		12		µs
		Industrial[1]		12		µs
T_{EC}	Erase Cycle Time[4]	Commercial		25		s
		Industrial[1]		25		s

Notes:
1. Preliminary specifications for military operating range only.
2. AC test lead = 50 pF.
3. Float delays are measured with 5 pF AC loads. Transition is measured ±200 mV from steady-state active levels.
4. See the AT17F Programming Specification for procedural information.

16.1 AC Characteristics When Cascading

Symbol	Description		AT17F16 Min	AT17F16 Max	Units
T_{CDF}[3]	CLK to Data Float Delay	Commercial		50	ns
		Industrial		50	ns
T_{OCK}[2]	CLK to $\overline{CEO}$ Delay	Commercial		50	ns
		Industrial		55	ns
T_{OCE}[2]	$\overline{CE}$ to $\overline{CEO}$ Delay	Commercial		35	ns
		Industrial		40	ns
T_{OOE}[2]	$\overline{RESET}$/OE to $\overline{CEO}$ Delay	Commercial		35	ns
		Industrial		35	ns
F_{MAX}	Maximum Input Clock Frequency	Commercial		33	MHz
		Industrial		33	MHz

Notes: 1. AC test lead = 50 pF.

2. Float delays are measured with 5 pF AC loads. Transition is measured ± 200 mV from steady-state active levels.

17. Thermal Resistance Coefficients

Package Type			AT17F16
8CN4	Leadless Array Package (LAP)	θ_{JC} [° C/W]	–
		θ_{JA} [° C/W][1]	–
20J	Plastic Leaded Chip Carrier (PLCC)	θ_{JC} [° C/W]	–
		θ_{JA} [° C/W][1]	–
44A	Thin Plastic Quad Flat Package (TQFP)	θ_{JC} [° C/W]	17
		θ_{JA} [° C/W][1]	62

Note: 1. Airflow = 0 ft/min.

18. Ordering Information

Memory Size	Ordering Code	Package[1][2]	Operation Range
16-Mbit	AT17F16-30TQC	44A - 44 TQFP	Commercial (0° C to 70° C)
	AT17F16-30TQI	44A - 44 TQFP	Industrial (-40° C to 85° C)

Notes: 1. For the -30BJC and -30BJI packages, customers may migrate to the AT17F32-BJU.
2. For the -30JC and -30JI packages, customers may migrate to the AT17F16-30JU.

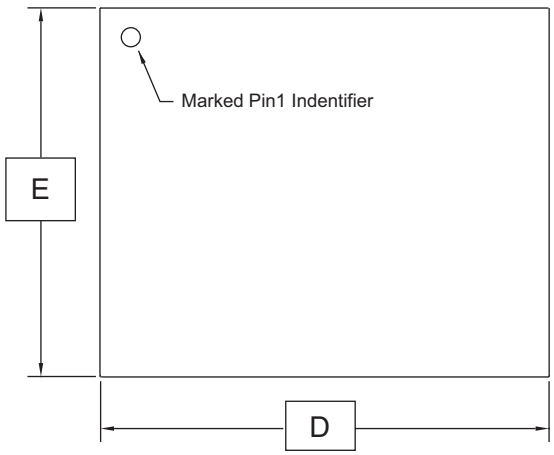
19. Green Package Options (Pb/Halide-free/RoHS Compliant)

Memory Size	Ordering Code	Package	Operation Range
16-Mbit	AT17F16-30CU AT17F16-30JU	8CN4 - 8 LAP 20J - 20 PLCC	Industrial (-40° C to 85° C)

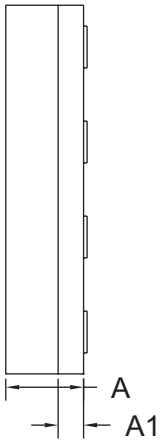
Package Type	
8CN4	8-lead, 6 mm x 6 mm x 1.04 mm, Leadless Array Package (LAP) – Pin-compatible with 8-lead SOIC/VOIC Packages
20J	20-lead, Plastic J-leaded Chip Carrier (PLCC)
44A	44-lead, Thin (1.0 mm) Plastic Quad Flat Package Carrier (TQFP)

20. Packaging Information

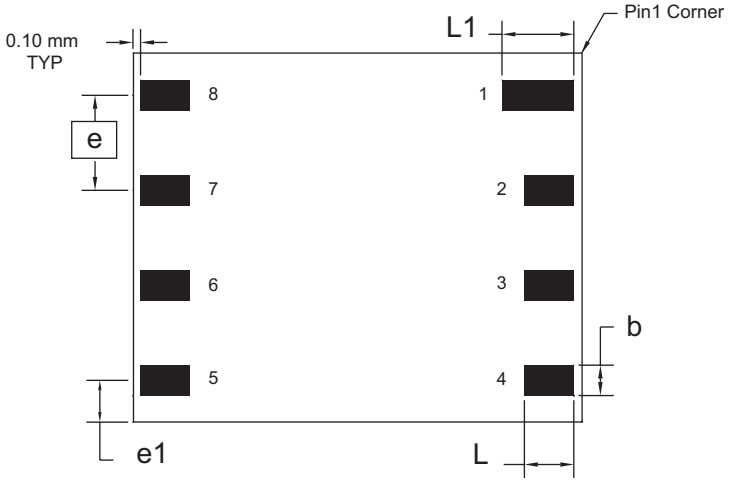
20.1 8CN4 – LAP



Top View



Side View



Bottom View

COMMON DIMENSIONS
(Unit of Measure = mm)

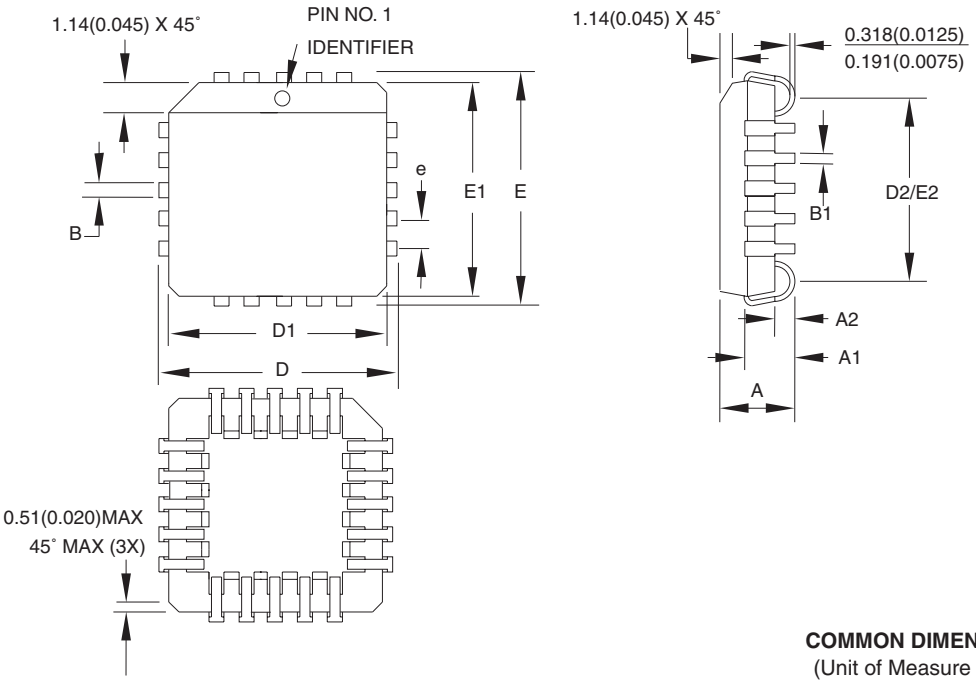
SYMBOL	MIN	NOM	MAX	NOTE
A	0.94	1.04	1.14	
A1	0.30	0.34	0.38	
b	0.45	0.50	0.55	1
D	5.89	5.99	6.09	
E	5.89	5.99	6.09	
e		1.27 BSC		
e1		1.10 REF		
L	0.95	1.00	1.05	1
L1	1.25	1.30	1.35	1

Note: 1. Metal Pad Dimensions.
2. All exposed metal area shall have the following finished platings.
Ni: 0.0005 to 0.015 mm
Au: 0.0005 to 0.001 mm

2/15/08

	TITLE	GPC	DRAWING NO.	REV.
Package Drawing Contact: packagedrawings@atmel.com	**8CN4**, 8-lead (6 x 6 x 1.04 mm Body), Lead Pitch 1.27mm, Leadless Array Package (LAP)	DMH	8CN4	D

20.2 20J – PLCC



COMMON DIMENSIONS
(Unit of Measure = mm)

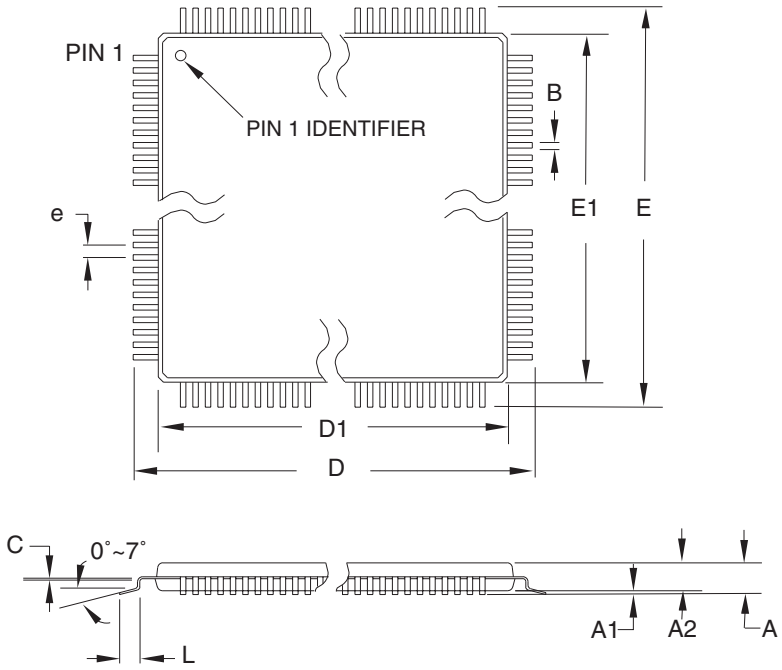
SYMBOL	MIN	NOM	MAX	NOTE
A	4.191	–	4.572	
A1	2.286	–	3.048	
A2	0.508	–	–	
D	9.779	–	10.033	
D1	8.890	–	9.042	Note 2
E	9.779	–	10.033	
E1	8.890	–	9.042	Note 2
D2/E2	7.366	–	8.382	
B	0.660	–	0.813	
B1	0.330	–	0.533	
e	1.270 TYP			

Notes:
1. This package conforms to JEDEC reference MS-018, Variation AA.
2. Dimensions D1 and E1 do not include mold protrusion. Allowable protrusion is .010"(0.254 mm) per side. Dimension D1 and E1 include mold mismatch and are measured at the extreme material condition at the upper or lower parting line.
3. Lead coplanarity is 0.004" (0.102 mm) maximum.

10/04/01

	TITLE	DRAWING NO.	REV.
2325 Orchard Parkway San Jose, CA 95131	**20J**, 20-lead, Plastic J-leaded Chip Carrier (PLCC)	20J	B

20.3 44A – TQFP



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

	TITLE	DRAWING NO.	REV.
2325 Orchard Parkway San Jose, CA 95131	**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

21. Revision History

Revision Level – Release Date	History
D – March 2006	Added last-time buy for AT17F16-30CC and AT17F16-30CI.
E – August 2007	Removed -30CC and -30CI devices from ordering information. Announced last-time buy for -30JC, -30BJC, -30JI, and -30BJI devices.
F – February 2008	Removed -30JC, -30JI, -30BJC and -30BJI devices from ordering information.

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