## Features

- **Programmable 33,554,432 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, Stratix™, Lattice (ORCA®) FPGAs, Spartan®, Virtex® FPGAs**
- **Cascadable Read-back to Support Additional Configurations or Higher-density Arrays**
- **Low-power CMOS FLASH Process**
- **Available in 44-lead PLCC Package**
- **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**
- **LHF Package Available (Lead and Halide Free)**

## 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 44-lead PLCC, see Table 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.** AT17F Series Packages

| Package | AT17F32 |
|---|---|
| 44-lead PLCC | Yes |

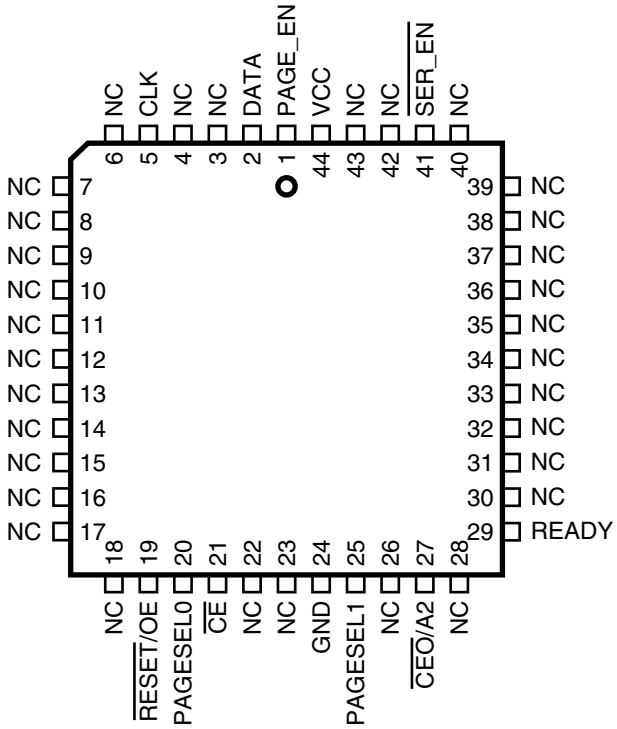
# FPGA Configuration Flash Memory

# AT17F32

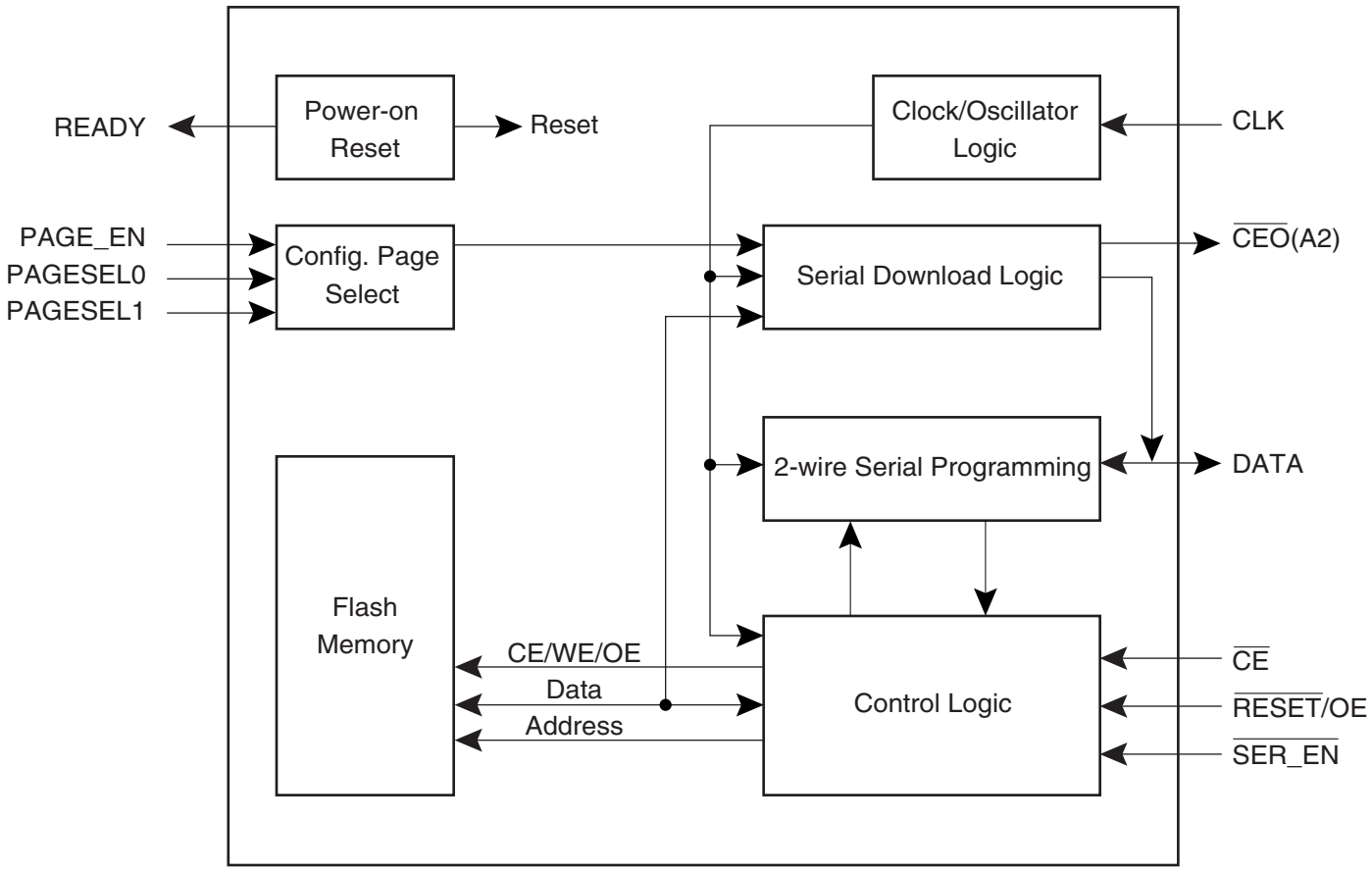
Rev. 3393A–CNFG–5/11/04

## Pin Configuration

**44-lead PLCC**



## Block Diagram




## 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.

## Pin Description

| Name | I/O | AT17F32 |
|---|---|---|
| | | 44 PLCC |
| DATA | I/O | 2 |
| CLK | I | 5 |
| PAGE_EN | I | 1 |
| PAGESEL0 | I | 20 |
| PAGESEL1 | I | 25 |
| $\overline{\text{RESET}}$/OE | I | 19 |
| $\overline{\text{CE}}$ | I | 21 |
| GND | – | 24 |
| $\overline{\text{CEO}}$ | O | 27 |
| A2 | I | |
| READY | O | 29 |
| $\overline{\text{SER\_EN}}$ | I | 41 |
| $V_{CC}$ | – | 44 |

**DATA**(1)

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

**CLK**(1)

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

**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 $\overline{\text{SER\_EN}}$ 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.

**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 2. When $\overline{\text{SER\_EN}}$ is Low (ISP mode) these pins have no effect.

**Table 2.** Address Space

| Paging Decodes | AT17F32 (32 Mbits) |
|---|---|
| PAGESEL = 00, PAGE_EN = 1 | 0000000 – 07FFFFFh |
| PAGESEL = 01, PAGE_EN = 1 | 0800000 – 0FFFFFFh |
| PAGESEL = 10, PAGE_EN = 1 | 1000000 – 17FFFFFh |
| PAGESEL = 11, PAGE_EN = 1 | 1800000 – 1FFFFFFh |
| PAGESEL = XX, PAGE_EN = 0 | 0000000 – 1FFFFFFh |

**$\overline{\text{RESET}}$/OE**(1)

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

**$\overline{\text{CE}}$**(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 $\overline{\text{CE}}$ 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 ($\overline{\text{SER\_EN}}$ Low).

**GND**

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

**$\overline{\text{CEO}}$**

Chip Enable Output (when $\overline{\text{SER\_EN}}$ 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 2 on page 5. In a daisy chain of AT17F Series devices, the $\overline{\text{CEO}}$ pin of one device must be connected to the $\overline{\text{CE}}$ input of the next device in the chain. It will stay Low as long as $\overline{\text{CE}}$ is Low and OE is High. It will then follow $\overline{\text{CE}}$ until OE goes Low; thereafter, $\overline{\text{CEO}}$ will stay High until the entire EEPROM is read again.

**A2**(1)

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

**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).

**$\overline{\text{SER\_EN}}$**(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 $V_{CC}$.

**$V_{CC}$**

+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.

## 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.

## 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 at logic high level (internal pull-up provided) 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 2 on page 5.

## 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.

## Programming Mode

The programming mode is entered by bringing $\overline{SER\_EN}$ 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 ATDH2200 programming system along with many third party programmers.

## Standby Mode

The AT17F Series Configurators enter a low-power standby mode whenever $\overline{SER\_EN}$ is High and $\overline{CE}$ is asserted High. In this mode, the AT17F Configurator typically consumes less than 1 mA of current at 3.3V. The output remains in a high-impedance state regardless of the state of the OE input.

## 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.

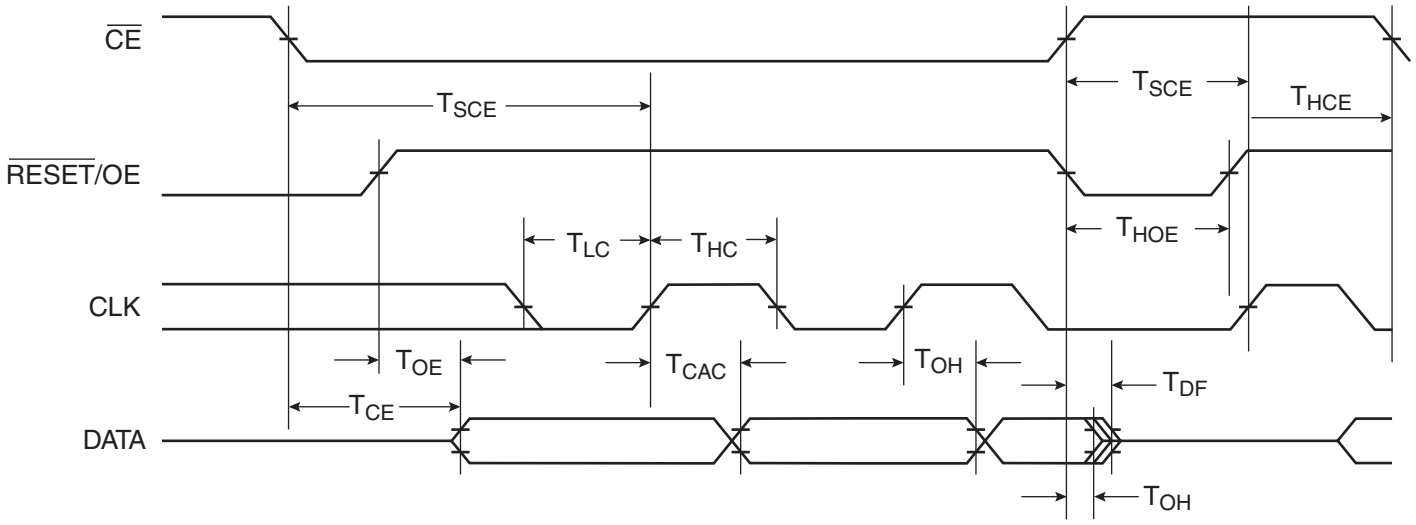
## Operating Conditions

| 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 |

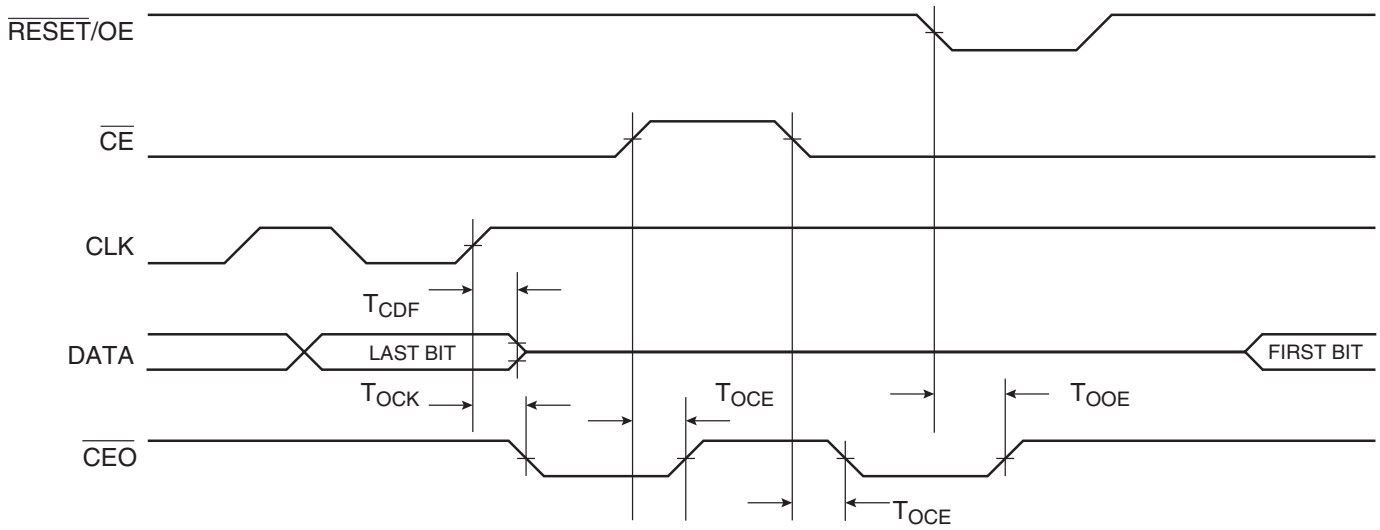
## DC Characteristics

| Symbol | Description | | AT17F32 Min | AT17F32 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 | | | 50 | mA |
| $I_L$ | Input or Output Leakage Current ($V_{IN}$ = $V_{CC}$ or GND) | | -10 | 10 | µA |
| $I_{CCS}$ | Supply Current, Standby Mode | Commercial | | 3 | mA |
| | | Industrial | | 3 | mA |
| $I_{CCE}$ | Supply Current, Erase Mode | Commercial | | 50 | mA |
| | | Industrial | | 50 | mA |

## AC Characteristics




## AC Characteristics when Cascading



## AC Characteristics

| Symbol | Description | | AT17F32 Min | AT17F32 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 | | 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 |
| $T_{HOE}$ | Reset/OE Low Time (guarantees counter is reset) | Commercial | 20 | | ns |
| | | Industrial[1] | 20 | | ns |
| $F_{MAX}$ | Maximum Input Clock Frequency SEREN = 0 | Commercial | | 10 | MHz |
| | | Industrial[1] | | 10 | MHz |
| $F_{MAX}$ | Maximum Input Clock Frequency SEREN = 1 | Commercial | | 33 | MHz |
| | | Industrial[1] | | 33 | MHz |
| $T_{WR}$ | Write Cycle Time[4] | Commercial | | 30 | µs |
| | | Industrial[1] | | 30 | µs |
| $T_{EC}$ | Erase Cycle Time[4] | Commercial | | 10 | µs |
| | | Industrial[1] | | 10 | µs |

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.
5. Times given are per byte typical.

## AC Characteristics When Cascading

| Symbol | Description | | AT17F32 Min | AT17F32 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 |

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.

## Thermal Resistance Coefficients

| Package Type | | | AT17F32 |
|---|---|---|---|
| 44J | Plastic Leaded Chip Carrier (PLCC) | $\theta_{JC}$ [°C/W] | 15 |
| | | $\theta_{JA}$ [°C/W](1) | 50 |

Note: 1. Airflow = 0 ft/min.

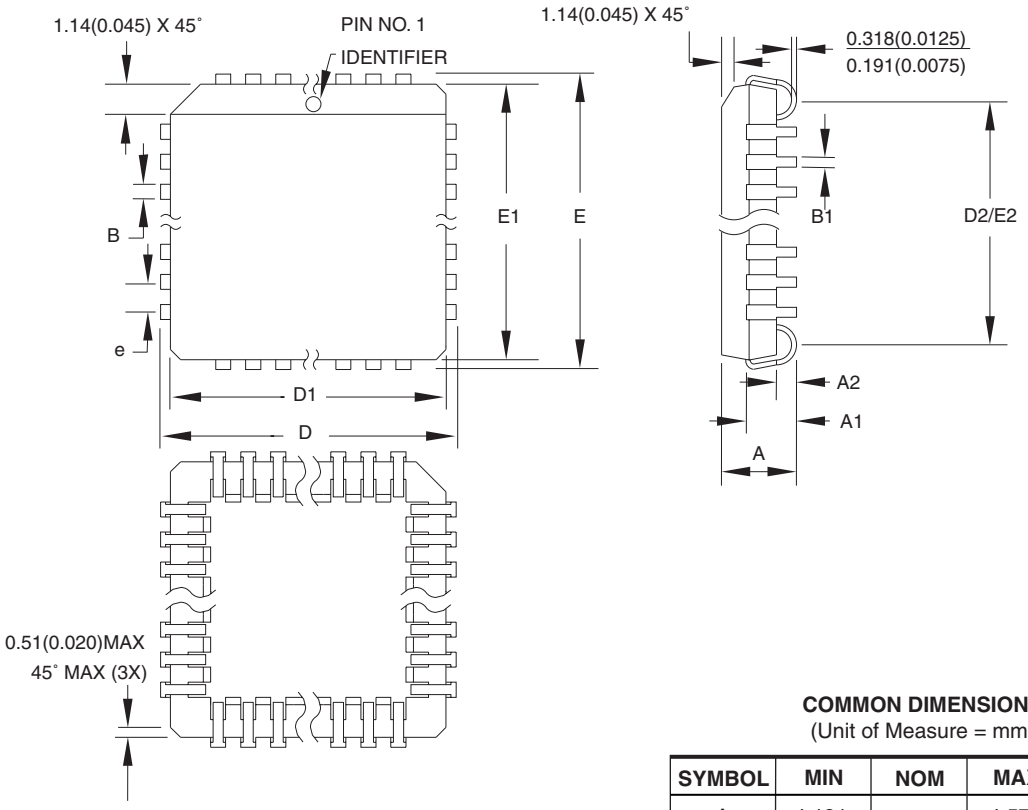
## Ordering Information

| Memory Size | Ordering Code | Package | Operation Range |
|---|---|---|---|
| 32-Mbit | AT17F32-30BJC | 44J - 44 PLCC | Commercial |
| | AT17F32-30BJI | 44J - 44 PLCC | Industrial |
| | AT17F32-30BJU | 44J - 44 PLCC | LHF Industrial |

| Package Type | |
|---|---|
| **44J** | 44-lead, Plastic J-leaded Chip Carrier (PLCC) |

# Packaging Information

## 44J – 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 | 17.399 | – | 17.653 | |
| D1 | 16.510 | – | 16.662 | Note 2 |
| E | 17.399 | – | 17.653 | |
| E1 | 16.510 | – | 16.662 | Note 2 |
| D2/E2 | 14.986 | – | 16.002 | |
| 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 AC.
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<br>San Jose, CA 95131 | **44J**, 44-lead, Plastic J-leaded Chip Carrier (PLCC) | 44J | B |

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