28C64A

64K (8K x 8) CMOS EEPROM

FEATURES

- Fast Read Access Time—150 ns
- CMOS Technology for Low Power Dissipation
  - 30 mA Active
  - 100 µA Standby
- Fast Byte Write Time—200 µs or 1 ms
- Data Retention >200 years
- High Endurance - Minimum 100,000 Erase/Write Cycles
- Automatic Write Operation
  - Internal Control Timer
  - Auto-Clear Before Write Operation
  - On-Chip Address and Data Latches
- $\overline{\text{Data}}$ Polling
- Ready/$\overline{\text{Busy}}$
- Chip Clear Operation
- Enhanced Data Protection
  - V_{CC} Detector
  - Pulse Filter
  - Write Inhibit
- Electronic Signature for Device Identification
- 5-Volt-Only Operation
- Organized 8Kx8 JEDEC Standard Pinout
  - 28-pin Dual-In-Line Package
  - 32-pin PLCC Package
  - 28-pin SOIC Package
- Available for Extended Temperature Ranges:
  - Commercial: 0°C to +70°C
 - Industrial: -40°C to +85°C

DESCRIPTION

The Microchip Technology Inc. 28C64A is a CMOS 64K non-volatile electrically Erasable PROM. The 28C64A is accessed like a static RAM for the read or write cycles without the need of external components. During a "byte write", the address and data are latched internally, freeing the microprocessor address and data bus for other operations. Following the initiation of write cycle, the device will go to a busy state and automatically clear and write the latched data using an internal control timer. To determine when the write cycle is complete, the user has a choice of monitoring the Ready/$\overline{\text{Busy}}$ output or using $\overline{\text{Data}}$ polling. The Ready/$\overline{\text{Busy}}$ pin is an open drain output, which allows easy configuration in wired-or systems. Alternatively, $\overline{\text{Data}}$ polling allows the user to read the location last written to when the write operation is complete. CMOS design and processing enables this part to be used in systems where reduced power consumption and reliability are required. A complete family of packages is offered to provide the utmost flexibility in applications.

PACKAGE TYPES

● Pin 1 indicator on PLCC on top of package
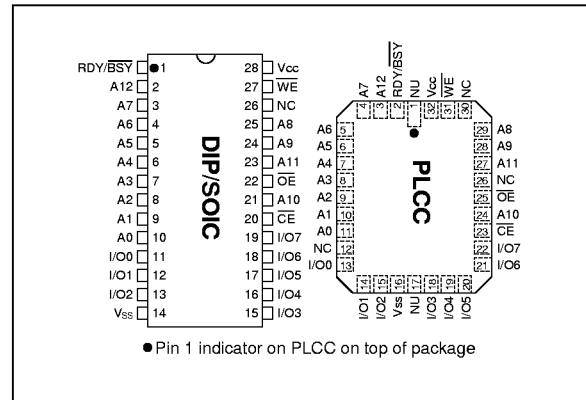
BLOCK DIAGRAM
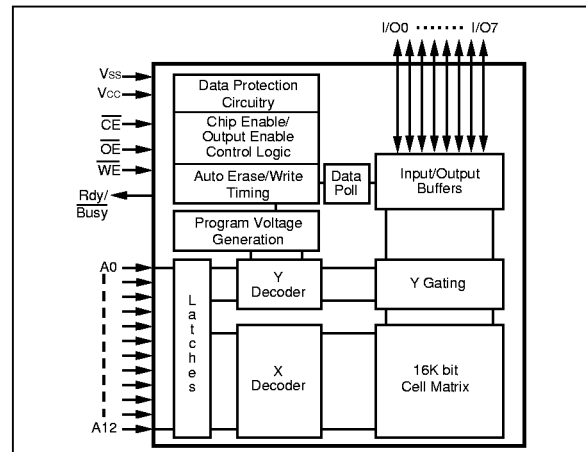
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1.0   ELECTRICAL CHARACTERISTICS

1.1   MAXIMUM RATINGS*

Vcc and input voltages w.r.t. V ss .... -0.6V to + 6.25V

Voltage on $\overline{OE}$ w.r.t. Vss .... -0.6V to +13.5V

Voltage on A9 w.r.t. V ss .... -0.6V to +13.5V

Output Voltage w.r.t. Vss .... -0.6V to V cc+0.6V

Storage temperature .... -65°C to +125°C

Ambient temp. with power applied .... -50°C to +95°C

*Notice: Stresses above those listed under "Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at those or any other conditions above those indicated in the operation listings of this specification is not implied Exposure to maximum rating conditions for extended periods may affect device reliability.

TABLE 1-1:   PIN FUNCTION TABLE

Name	Function
A0 - A12	Address Inputs
$\overline{CE}$	Chip Enable
$\overline{OE}$	Output Enable
$\overline{WE}$	Write Enable
I/O0 - I/O7	Data Inputs/Outputs
RDY/$\overline{Busy}$	Ready/$\overline{Busy}$
Vcc	+5V Power Supply
Vss	Ground
NC	No Connect, No Internal Connection
NU	Not Used, No External Connection is Allowed

TABLE 1-2:   READ/WRITE OPERATION DC CHARACTERISTIC

Parameter	Status	Symbol	Min	Max	Units	Conditions
				Vcc = +5V ±10% Commercial (C): Tamb = 0°C to +70°C Industrial (I): Tamb = -40°C to +85°C		
Input Voltages	Logic '1' Logic '0'	VIH VIL	2.0 -0.1	Vcc+1 0.8	V V	
Input Leakage	—	ILI	-10	10	µA	VIN = -0.1V to Vcc +1
Input Capacitance	—	C IN	—	10	pF	V IN = 0V; Tamb = 25°C; f = 1 MHz (Note 2)
Output Voltages	Logic '1' Logic '0'	VOH VOL	2.4	0.45	V V	IOH = -400 µA IOL = 2.1 mA
Output Leakage	—	ILO	-10	10	µA	VOUT = -0.1V to Vcc +0.1V
Output Capacitance	—	C OUT	—	12	pF	V IN = 0V; Tamb = 25°C; f = 1 MHz (Note 2)
Power Supply Current, Active	TTL input	ICC	—	30	mA	f = 5 MHz (Note 1) VCC = 5.5V
Power Supply Current, Standby	TTL input TTL input CMOS input	ICC(S)TTL ICC(S)TTL ICC(S)CMOS	—	2 3 100	mA mA µA	$\overline{CE}$ = V IH (0°C to +70°C) $\overline{CE}$ = V IH (-40°C to +85°C) $\overline{CE}$ = VCC-0.3 to Vcc +1 $\overline{OE}$ = $\overline{WE}$ = Vcc All other inputs equal V CC or Vss

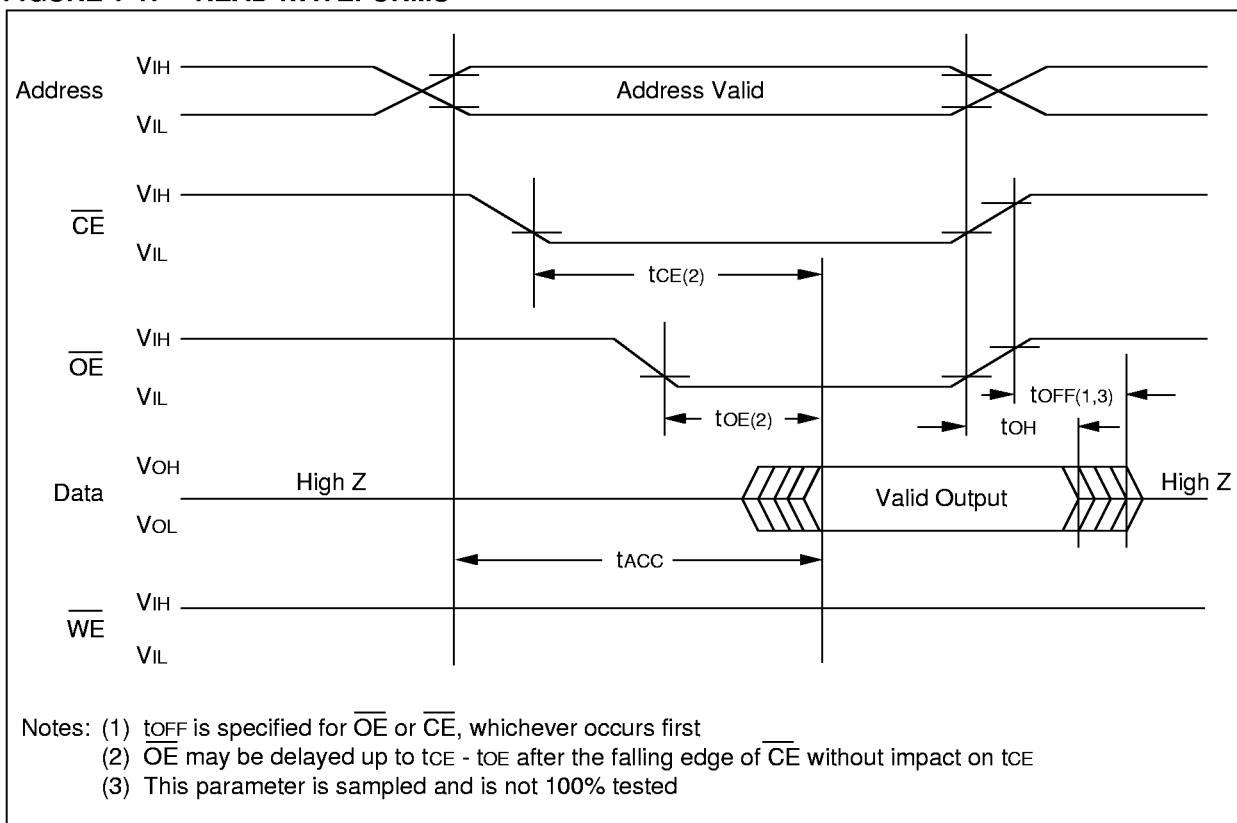Note 1:   AC power supply current above 5MHz: 2mA/MHz.
     2:   Not 100% tested.

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TABLE 1-3: READ OPERATION AC CHARACTERISTICS

		AC Testing Waveform:		V_{IH} = 2.4V; V_{IL} = 0.45V; V_{OH} = 2.0V; V_{OL} = 0.8V				
		Output Load:		1 TTL Load + 100 pF				
		Input Rise and Fall Times:		20 ns				
		Ambient Temperature:		Commercial (C): Tamb = 0°C to +70°C				
				Industrial (I): Tamb = -40°C to +85°C				

Parameter	Symbol	28C64A-15		28C64A-20		28C64A-25		Units	Conditions
		Min	Max	Min	Max	Min	Max		
Address to Output Delay	tACC	—	150	—	200	—	250	ns	$\overline{OE} = \overline{CE} = V_{IL}$
$\overline{CE}$ to Output Delay	tCE	—	150	—	200	—	250	ns	$\overline{OE} = V_{IL}$
$\overline{OE}$ to Output Delay	tOE	—	70	—	80	—	100	ns	$\overline{CE} = V_{IL}$
$\overline{CE}$ or $\overline{OE}$ High to Output Float	tOFF	0	50	0	55	0	70	ns	(Note 1)
Output Hold from Address, $\overline{CE}$ or $\overline{OE}$, whichever occurs first.	tOH	0	—	0	—	0	—	ns	(Note 1)
Endurance	—	1M	—	1M	—	1M	—	cycles	25°C, Vcc = 5.0V, Block Mode (Note 2)

Note 1: Not 100% tested.
2: This parameter is not tested but guaranteed by characterization. For endurance estimates in a specific application, please consult the Total Endurance Model which can be obtained on our BBS or website.

FIGURE 1-1: READ WAVEFORMS

Notes: (1) tOFF is specified for $\overline{OE}$ or $\overline{CE}$, whichever occurs first
(2) $\overline{OE}$ may be delayed up to tCE - tOE after the falling edge of $\overline{CE}$ without impact on tCE
(3) This parameter is sampled and is not 100% tested

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TABLE 1-4: BYTE WRITE AC CHARACTERISTICS

|	AC Testing Waveform: Output Load: Input Rise/Fall Times: Ambient Temperature:		V_{IH} = 2.4V; V_{IL} = 0.45V; V_{OH} = 2.0V; V_{OL} = 0.8V 1 TTL Load + 100 pF 20 ns Commercial (C): Tamb = 0˚C to +70˚C Industrial (I): Tamb = -40˚C to +85˚C		
Parameter	**Symbol**	**Min**	**Max**	**Units**	**Remarks**
Address Set-Up Time	t_{AS}	10	—	ns	
Address Hold Time	t_{AH}	50	—	ns	
Data Set-Up Time	t_{DS}	50	—	ns	
Data Hold Time	t_{DH}	10	—	ns	
Write Pulse Width	t_{WPL}	100	—	ns	Note 1
Write Pulse High Time	t_{WPH}	50	—	ns	
$\overline{OE}$ Hold Time	t_{OEH}	10	—	ns	
$\overline{OE}$ Set-Up Time	t_{OES}	10	—	ns	
Data Valid Time	t_{DV}	—	1000	ns	Note 2
Time to Device Busy	t_{DB}	2	50	ns	
Write Cycle Time (28C64A)	t_{WC}	—	1	ms	0.5 ms typical
Write Cycle Time (28C64AF)	t_{WC}	—	200	µs	100 µs typical

Note 1: A write cycle can be initiated be $\overline{CE}$ or $\overline{WE}$ going low, whichever occurs last. The data is latched on the positive edge $\overline{WE}$, whichever occurs first.

2: Data must be valid within 1000ns max. after a write cycle is initiated and must be stable at least until t_{DH} after the positive edge of $\overline{WE}$ or $\overline{CE}$, whichever occurs first.
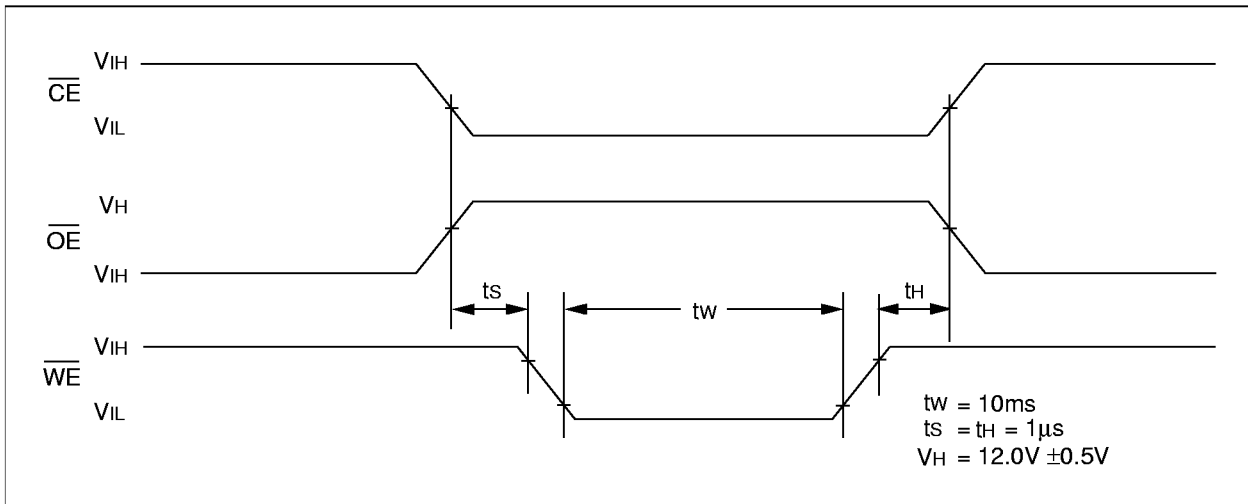
FIGURE 1-2: PROGRAMMING WAVEFORMS

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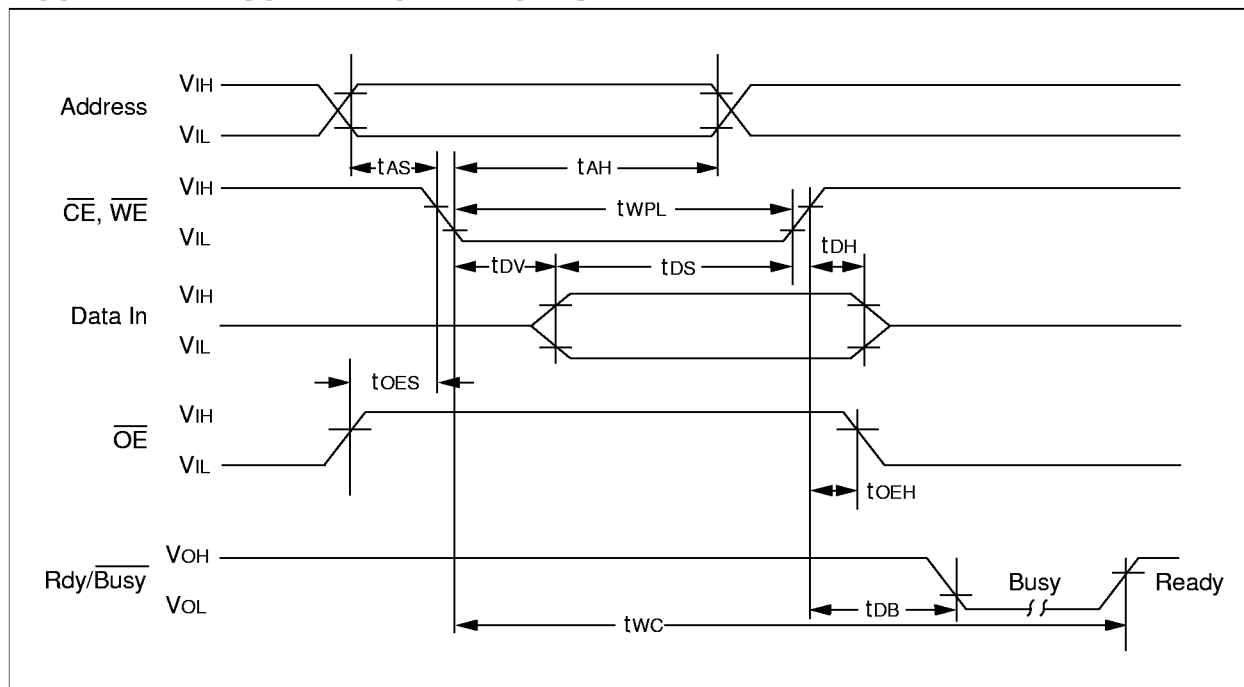
FIGURE 1-3:   DATA POLLING WAVEFORMS
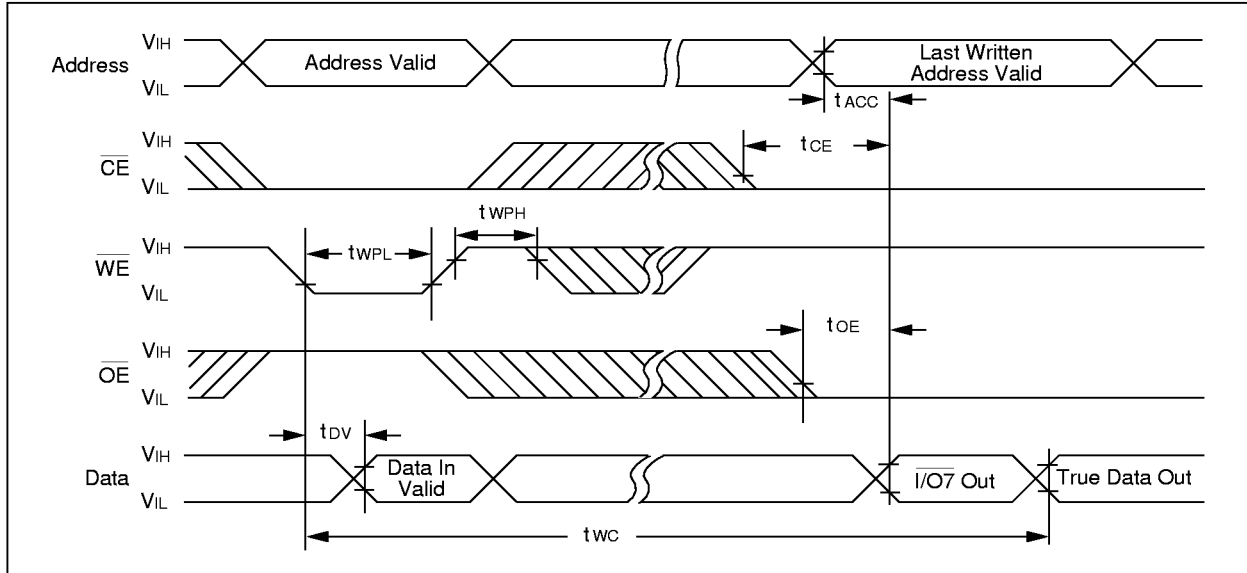
FIGURE 1-4:   CHIP CLEAR WAVEFORMS

tw = 10ms
tS = tH = 1μs
VH = 12.0V ±0.5V

TABLE 1-5:   SUPPLEMENTARY CONTROL

Mode	$\overline{CE}$	$\overline{OE}$	$\overline{WE}$	A9	Vcc	I/Ol
Chip Clear	VIL	VIH	VIL	X	Vcc	
Extra Row Read	VIL	VIL	VIH	A9 = VH	Vcc	Data Out
Extra Row Write	*	VIH	*	A9 = VH	Vcc	Data In
Note: VH = 12.0V±0.5V. *Pulsed per programming waveforms.						

2.0 DEVICE OPERATION

The Microchip Technology Inc. 28C64A has four basic modes of operation—read, standby, write inhibit, and byte write—as outlined in the following table.

Operation Mode	$\overline{CE}$	$\overline{OE}$	$\overline{WE}$	I/O	Rdy/$\overline{Busy}$ (1)
Read	L	L	H	D$_{OUT}$	H
Standby	H	X	X	High Z	H
Write Inhibit	H	X	X	High Z	H
Write Inhibit	X	L	X	High Z	H
Write Inhibit	X	X	H	High Z	H
Byte Write	L	H	L	D$_{IN}$	L
Byte Clear	Automatic Before Each "Write"				

Note 1: Open drain output.
    2: X = Any TTL level.

2.1 Read Mode

The 28C64A has two control functions, both of which must be logically satisfied in order to obtain data at the outputs. Chip enable ($\overline{CE}$) is the power control and should be used for device selection. Output Enable ($\overline{OE}$) is the output control and is used to gate data to the output pins independent of device selection. Assuming that addresses are stable, address access time (tACC) is equal to the delay from $\overline{CE}$ to output (tCE). Data is available at the output tOE after the falling edge of $\overline{OE}$, assuming that $\overline{CE}$ has been low and addresses have been stable for at least tACC-tOE.

2.2 Standby Mode

The 28C64A is placed in the standby mode by applying a high signal to the $\overline{CE}$ input. When in the standby mode, the outputs are in a high impedance state, independent of the $\overline{OE}$ input.

2.3 Data Protection

In order to ensure data integrity, especially during critical power-up and power-down transitions, the following enhanced data protection circuits are incorporated:

First, an internal Vcc detect (3.3 volts typical) will inhibit the initiation of non-volatile programming operation when Vcc is less than the Vcc detect circuit trip.

Second, there is a $\overline{WE}$ filtering circuit that prevents $\overline{WE}$ pulses of less than 10 ns duration from initiating a write cycle.

Third, holding $\overline{WE}$ or $\overline{CE}$ high or $\overline{OE}$ low, inhibits a write cycle during power-on and power-off (Vcc).

2.4 Write Mode

The 28C64A has a write cycle similar to that of a Static RAM. The write cycle is completely self-timed and initiated by a low going pulse on the $\overline{WE}$ pin. On the falling edge of $\overline{WE}$, the address information is latched. On rising edge, the data and the control pins ($\overline{CE}$ and $\overline{OE}$) are latched. The Ready/$\overline{Busy}$ pin goes to a logic low level indicating that the 28C64A is in a write cycle which signals the microprocessor host that the system bus is free for other activity. When Ready/$\overline{Busy}$ goes back to a high, the 28C64A has completed writing and is ready to accept another cycle.

2.5 $\overline{Data}$ Polling

The 28C64A features $\overline{Data}$ polling to signal the completion of a byte write cycle. During a write cycle, an attempted read of the last byte written results in the data complement of I/O7 (I/O0 to I/O6 are indeterminable). After completion of the write cycle, true data is available. $\overline{Data}$ polling allows a simple read/compare operation to determine the status of the chip eliminating the need for external hardware.
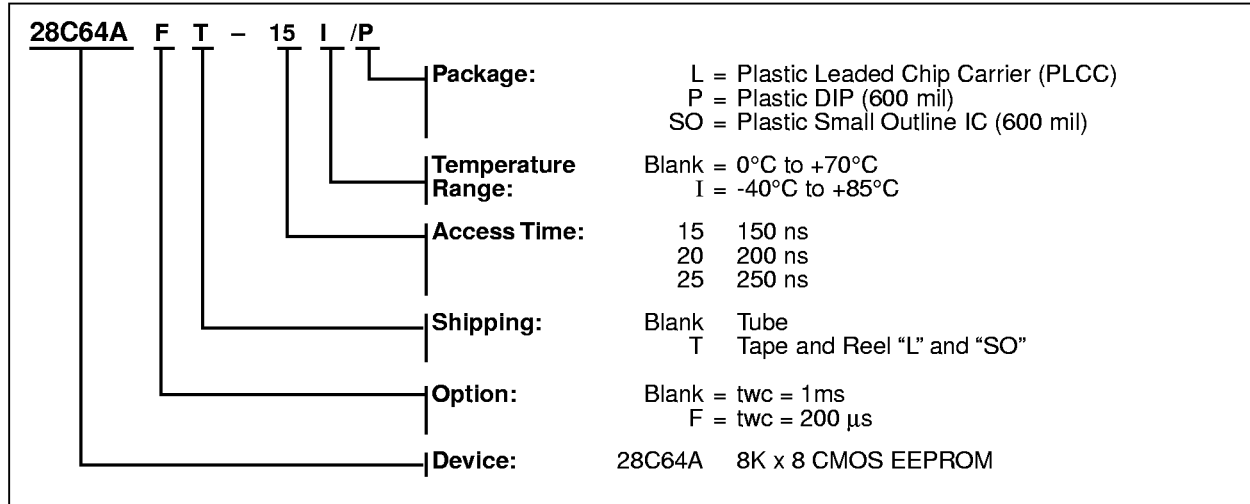
2.6 Electronic Signature for Device Identification

An extra row of 32 bytes of EEPROM memory is available to the user for device identification. By raising A9 to 12V $\pm$0.5V and using address locations 1FE0 to 1FFF, the additional bytes can be written to or read from in the same manner as the regular memory array.

2.7 Chip Clear

All data may be cleared to 1's in a chip clear cycle by raising $\overline{OE}$ to 12 volts and bringing the $\overline{WE}$ and $\overline{CE}$ low. This procedure clears all data, except for the extra row.

28C64A Product Identification System

To order or to obtain information, e.g., on pricing or delivery, please use the listed part numbers, and refer to the factory or the listed sales offices.

28C64A F T – 15 I /P

Package:	L = Plastic Leaded Chip Carrier (PLCC)	
	P = Plastic DIP (600 mil)	
	SO = Plastic Small Outline IC (600 mil)	
Temperature Range:	Blank = 0°C to +70°C	
	I = -40°C to +85°C	
Access Time:	15	150 ns
	20	200 ns
	25	250 ns
Shipping:	Blank	Tube
	T	Tape and Reel "L" and "SO"
Option:	Blank = twc = 1ms	
	F = twc = 200 µs	
Device:	28C64A	8K x 8 CMOS EEPROM

Packaging Diagrams and Parameters

Package Type: K04-079 28-Lead Plastic Dual In-line (P) – 600 mil
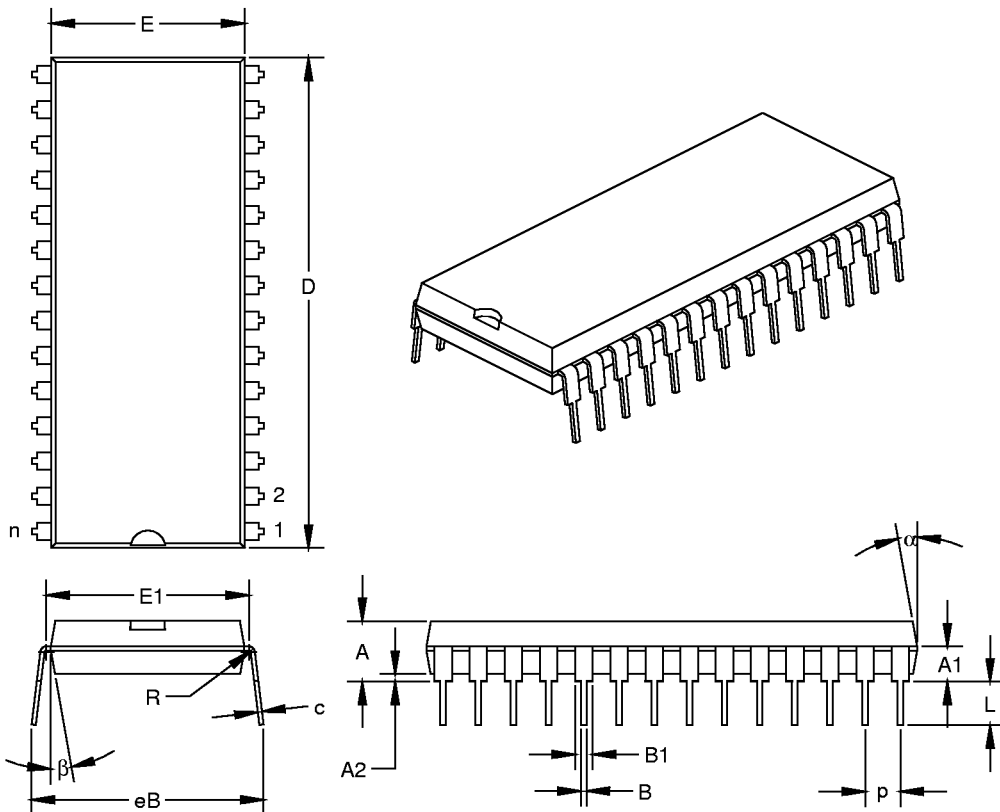
Units		INCHES*			MILLIMETERS		
Dimension Limits		MIN	NOM	MAX	MIN	NOM	MAX
PCB Row Spacing			0.600			15.24	
Number of Pins	n		28			28	
Pitch	p		0.100			2.54	
Lower Lead Width	B	0.014	0.016	0.018	0.36	0.41	0.46
Upper Lead Width	B1†	0.040	0.050	0.060	1.02	1.27	1.52
Shoulder Radius	R	0.000	0.005	0.010	0.00	0.13	0.25
Lead Thickness	c	0.008	0.012	0.015	0.20	0.29	0.38
Top to Seating Plane	A	0.160	0.173	0.185	4.06	4.38	4.70
Top of Lead to Seating Plane	A1	0.081	0.101	0.121	2.04	2.55	3.06
Base to Seating Plane	A2	0.015	0.023	0.030	0.38	0.57	0.76
Tip to Seating Plane	L	0.115	0.125	0.135	2.92	3.18	3.43
Package Length	D‡	1.380	1.395	1.465	35.05	35.43	37.20
Molded Package Width	E‡	0.505	0.550	0.555	12.80	13.97	14.10
Radius to Radius Width	E1	0.567	0.577	0.587	14.40	14.66	14.91
Overall Row Spacing	eB	0.640	0.660	0.680	16.26	16.76	17.27
Mold Draft Angle Top	α	5	10	15	5	10	15
Mold Draft Angle Bottom	β	5	10	15	5	10	15

* Controlling Parameter.

† Dimension "B1" does not include dam-bar protrusions. Dam-bar protrusions shall not exceed 0.003" (0.076 mm) per side or 0.006" (0.152 mm) more than dimension "B1."
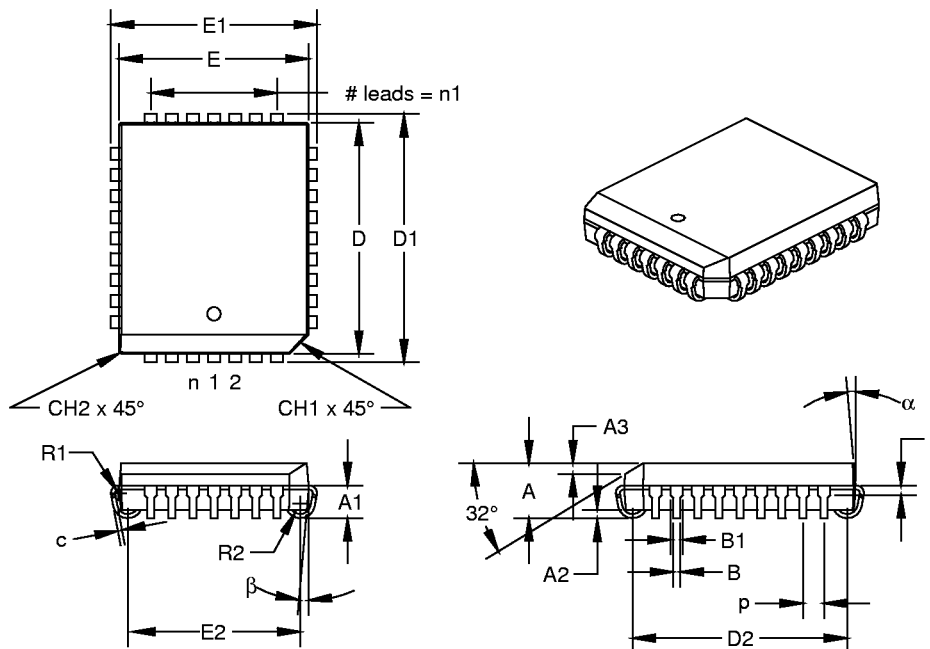
‡ Dimensions "D" and "E" do not include mold flash or protrusions. Mold flash or protrusions shall not exceed 0.010" (0.254 mm) per side or 0.020" (0.508 mm) more than dimensions "D" or "E."

JEDEC equivalent: MS-011 AB

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Packaging Diagrams and Parameters

Package Type: K04-023 32-Lead Plastic Leaded Chip Carrier (L) – Rectangle

Units		INCHES*			MILLIMETERS		
Dimension Limits		MIN	NOM	MAX	MIN	NOM	MAX
Number of Pins	n		32			32	
Pitch	p		0.050			1.27	
Overall Pack. Height	A	0.127	0.131	0.135	3.23	3.33	3.43
Shoulder Height	A1	0.060	0.078	0.095	1.52	1.97	2.41
Standoff	A2	0.015	0.020	0.025	0.38	0.51	0.64
Side 1 Chamfer Dim.	A3	0.021	0.026	0.031	0.53	0.66	0.79
Corner Chamfer (1)	CH1	0.035	0.045	0.055	0.89	1.14	1.40
Corner Chamfer (other)	CH2	0.000	0.005	0.010	0.00	0.13	0.25
Overall Pack. Width	E1	0.485	0.490	0.495	12.32	12.45	12.57
Overall Pack. Length	D1	0.585	0.590	0.595	14.86	14.99	15.11
Molded Pack. Width	E‡	0.447	0.450	0.453	11.35	11.43	11.51
Molded Pack. Length	D‡	0.547	0.550	0.553	13.89	13.97	14.05
Footprint Width	E2	0.380	0.410	0.440	9.65	10.41	11.18
Footprint Length	D2	0.480	0.510	0.540	12.19	12.95	13.72
Pins along Width	n1		7			7	
Lead Thickness	c	0.008	0.010	0.012	0.20	0.25	0.30
Upper Lead Width	B1†	0.026	0.029	0.032	0.66	0.74	0.81
Lower Lead Width	B	0.013	0.017	0.021	0.33	0.43	0.53
Upper Lead Length	L	0.010	0.020	0.030	0.25	0.51	0.76
Shoulder Inside Radius	R1	0.003	0.008	0.013	0.08	0.20	0.33
J-Bend Inside Radius	R2	0.020	0.025	0.030	0.51	0.64	0.76
Mold Draft Angle Top	α	0	5	10	0	5	10
Mold Draft Angle Bottom	β	0	5	10	0	5	10

* Controlling Parameter.

† Dimension "B1" does not include dam-bar protrusions. Dam-bar protrusions shall not exceed 0.003" (0.076 mm) per side or 0.006" (0.152 mm) more than dimension "B1."

‡ Dimensions "D" and "E" do not include mold flash or protrusions. Mold flash or protrusions shall not exceed 0.010" (0.254 mm) per side or 0.020" (0.508 mm) more than dimensions "D" or "E."

JEDEC equivalent: MS-016 AE

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