

16K (2K x 8) CMOS EEPROM

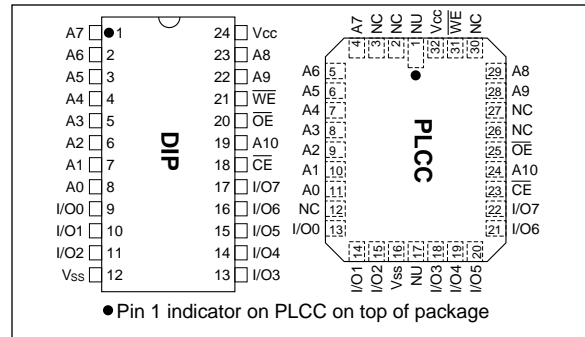
FEATURES

- Fast Read Access Time—150 ns
- CMOS Technology for Low Power Dissipation
 - 30 mA Active
 - 100 μ A Standby
- Fast Byte Write Time—200 μ s or 1 ms
- Data Retention >200 years
- High Endurance - Minimum 10^4 Erase/Write Cycles
- Automatic Write Operation
 - Internal Control Timer
 - Auto-Clear Before Write Operation
 - On-Chip Address and Data Latches
- Data polling
- Chip Clear Operation
- Enhanced Data Protection
 - VCC Detector
 - Pulse Filter
 - Write Inhibit
- Electronic Signature for Device Identification
- 5-Volt-Only Operation
- Organized 2Kx8 JEDEC Standard Pinout
- 24-pin Dual-In-Line Package
- 32-pin PLCC Package
- Available for Extended Temperature Ranges:
 - Commercial: 0°C to +70°C
 - Industrial: -40°C to +85°C

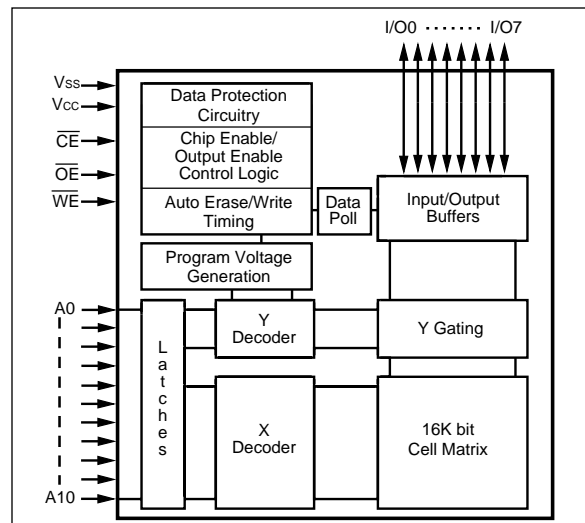
DESCRIPTION

The Microchip Technology Inc. 28C16A is a CMOS 16K non-volatile electrically Erasable PROM. The 28C16A 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 a write cycle is complete, the 28C16A uses $\overline{\text{Data}}$ polling. $\overline{\text{Data}}$ 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



BLOCK DIAGRAM



28C16A

1.0 ELECTRICAL CHARACTERISTICS

1.1 MAXIMUM RATINGS*

VCC and input voltages w.r.t. VSS -0.6V to + 6.25V
 Voltage on \overline{OE} w.r.t. VSS -0.6V to +13.5V
 Voltage on A9 w.r.t. VSS -0.6V to +13.5V
 Output Voltage w.r.t. VSS -0.6V to VCC+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 - A10 | Address Inputs |
| \overline{CE} | Chip Enable |
| \overline{OE} | Output Enable |
| \overline{WE} | Write Enable |
| I/O0 - I/O7 | Data Inputs/Outputs |
| 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 CHARACTERISTICS

| VCC = +5V ±10% | | | | | | |
|---------------------------------------|--------------------------------------|--|-------------|---------------------------|----------------|--|
| Commercial (C): Tamb = 0°C to +70°C | | | | | | |
| Industrial (I): Tamb = -40°C to +85°C | | | | | | |
| Parameter | Status | Symbol | Min | Max | Units | Conditions |
| Input Voltages | Logic '1' Logic '0'; | V _{IH} V _{IL} | 2.0 -0.1 | V _{CC} +1 0.8 | V V | |
| Input Leakage | — | I _{LI} | -10 | 10 | μA | V _{IN} = -0.1V to V _{CC} +1 |
| Input Capacitance | — | C _{IN} | — | 10 | pF | V _{IN} = 0V; Tamb = 25°C; f = 1 MHz |
| Output Voltages | Logic '1' Logic '0' | V _{OH} V _{OL} | 2.4 | 0.45 | V V | I _{OH} = -400μA I _{OL} = 2.1 mA |
| Output Leakage | — | I _{LO} | -10 | 10 | μA | V _{OUT} = -0.1V to V _{CC} +0.1V |
| Output Capacitance | — | C _{OUT} | — | 12 | pF | V _{IN} = 0V; Tamb = 25°C; f = 1 MHz |
| Power Supply Current, Active | TTL input | I _{CC} | — | 30 | mA | f = 5 MHz (Note 1) V _{CC} = 5.5V; |
| Power Supply Current, Standby | TTL input TTL input CMOS input | I _{CC(S)TTL} I _{CC(S)TTL} I _{CC(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} = V _{CC} -0.3 to V _{CC} +1 \overline{OE} = V _{CC} Other inputs equal V _{CC} or V _{SS} |

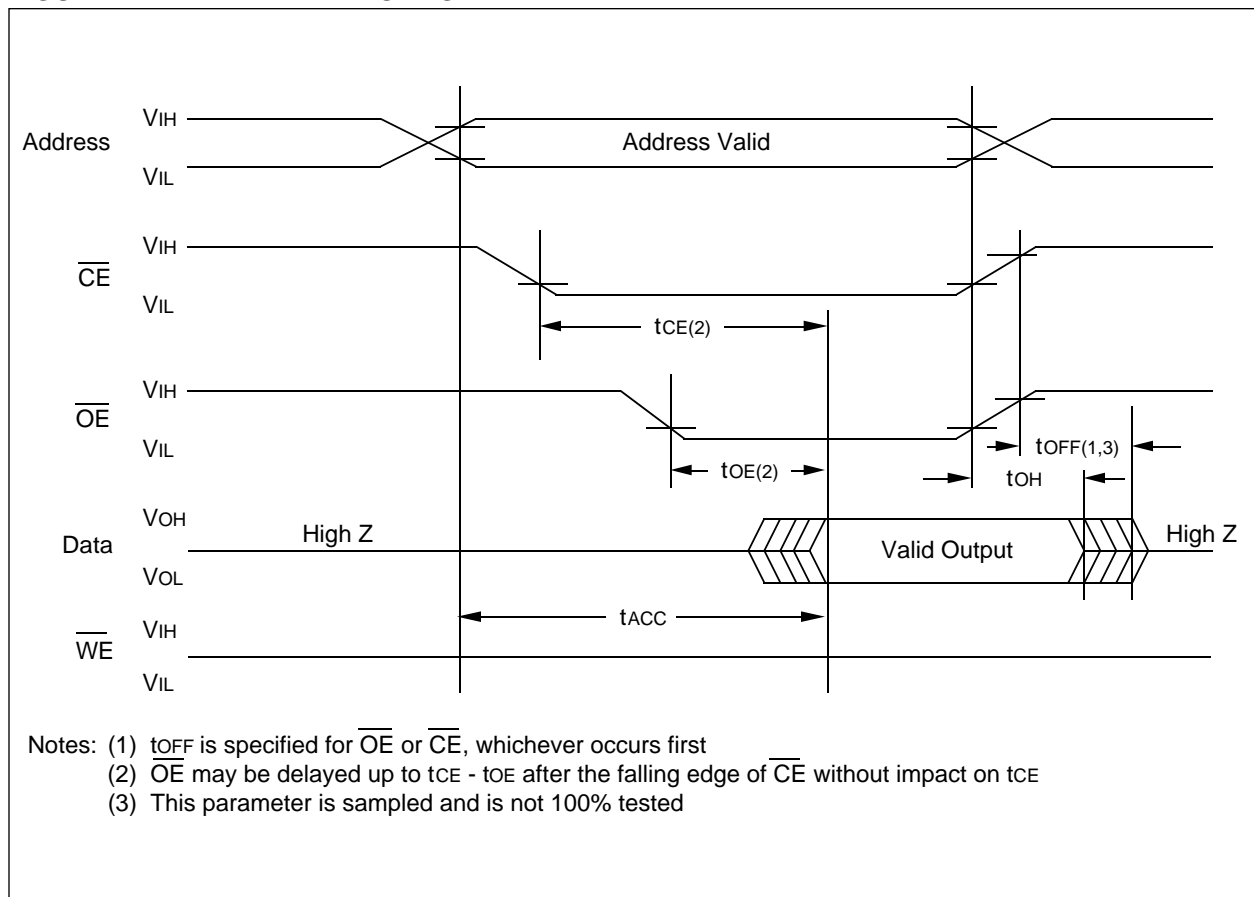
Note 1: AC power supply current above 5 MHz; 1 mA/MHz.

TABLE 1-3: READ OPERATION AC CHARACTERISTICS

| Parameter | Sym | 28C16A-15 | | 28C16A-20 | | 28C16A-25 | | Units | Conditions |
|--|------------------|-----------|-----|-----------|-----|-----------|-----|--------|---|
| | | Min | Max | Min | Max | Min | Max | | |
| Address to Output Delay | t _{ACC} | — | 150 | — | 200 | — | 250 | ns | $\overline{OE} = \overline{CE} = V_{IL}$ |
| \overline{CE} to Output Delay | t _{CE} | — | 150 | — | 200 | — | 250 | ns | $\overline{OE} = V_{IL}$ |
| \overline{OE} to Output Delay | t _{OE} | — | 70 | — | 80 | — | 100 | ns | $\overline{CE} = V_{IL}$ |
| \overline{CE} or \overline{OE} High to Output Float | t _{OFF} | 0 | 50 | 0 | 55 | 0 | 70 | ns | |
| Output Hold from \overline{CE} or \overline{OE} , whichever occurs first | t _{OH} | 0 | — | 0 | — | 0 | — | ns | |
| Endurance | — | 1M | — | 1M | — | 1M | — | cycles | 25°C, V _{CC} = 5.0V, Block Mode (Note) |

Note: 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



28C16A

TABLE 1-4: BYTE WRITE AC CHARACTERISTICS

| Parameter | Symbol | Min | Max | Units | Remarks |
|--|------------|-----|------|---------|---------------------|
| AC Testing Waveform: $V_{IH} = 2.4V$ and $V_{IL} = 0.45V$; $V_{OH} = 2.0V$; $V_{OL} = 0.8V$ Output Load: 1 TTL Load + 100 pF Input Rise/Fall Times: 20 ns Ambient Temperature: Commercial (C): $T_{amb} = 0^{\circ}C$ to $+70^{\circ}C$ Industrial (I): $T_{amb} = -40^{\circ}C$ to $+85^{\circ}C$ | | | | | |
| 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 | $t_{OE H}$ | 10 | — | ns | |
| \overline{OE} Set-Up Time | $t_{OE S}$ | 10 | — | ns | |
| Data Valid Time | t_{DV} | — | 1000 | ns | Note 2 |
| Write Cycle Time (28C16A) | t_{WC} | — | 1 | ms | 0.5 ms typical |
| Write Cycle Time (28C16AF) | t_{WC} | — | 200 | μs | 100 μs typical |

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

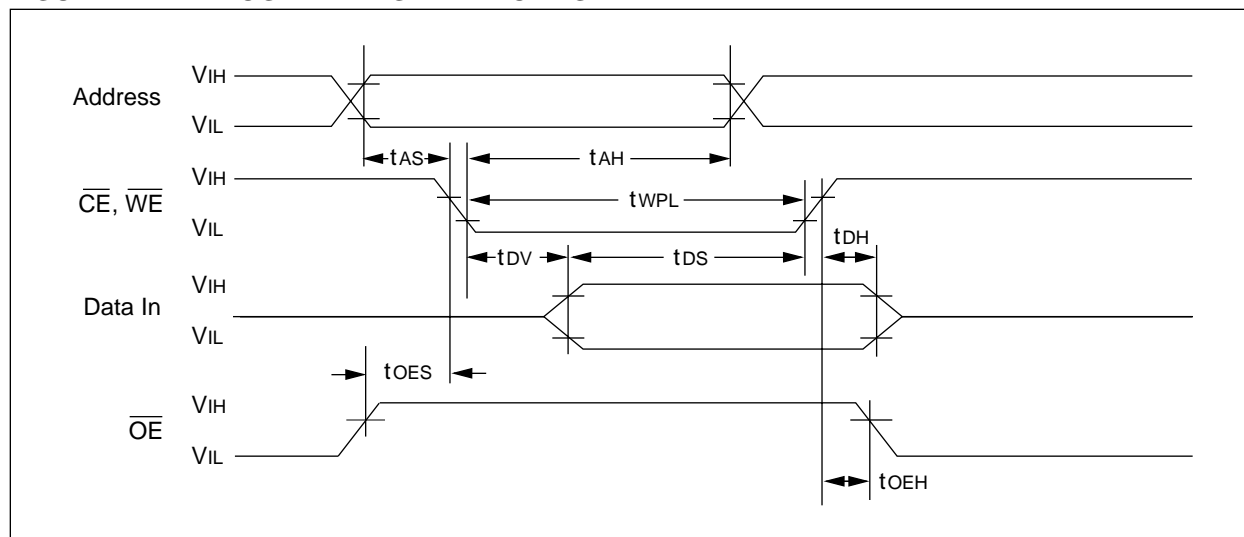


FIGURE 1-3: DATA POLLING WAVEFORMS

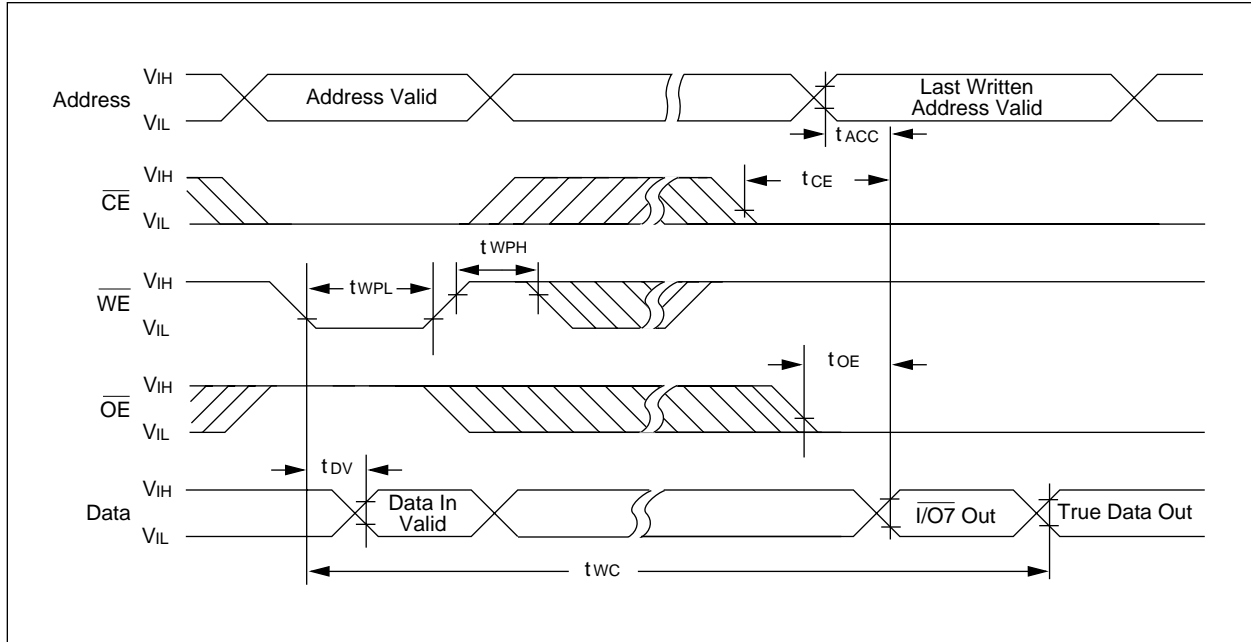


FIGURE 1-4: CHIP CLEAR WAVEFORMS

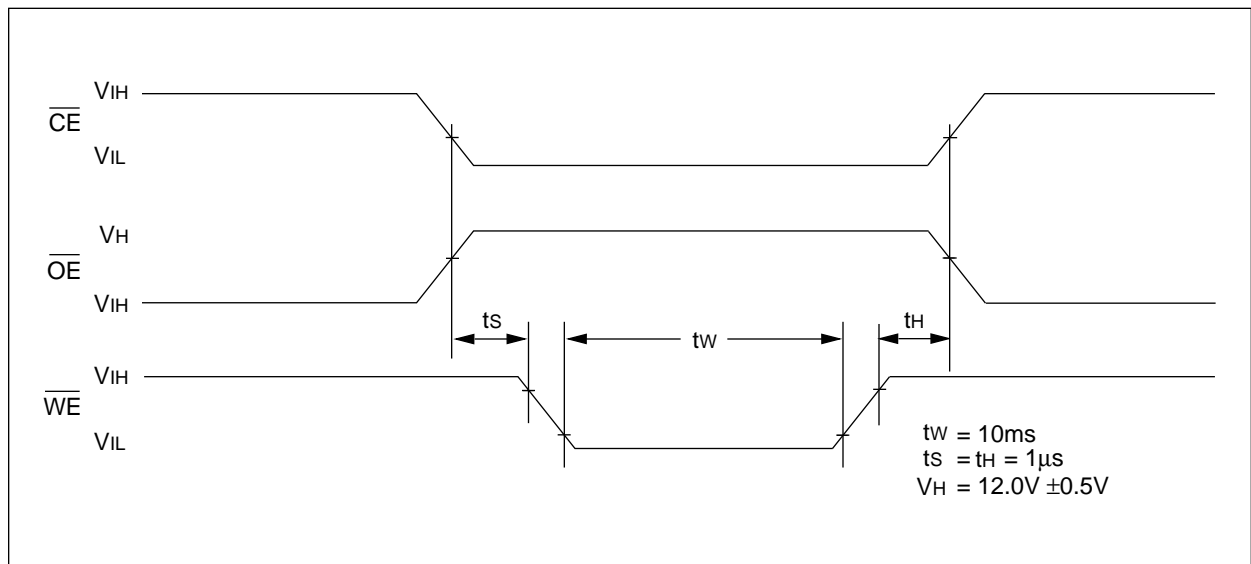


TABLE 1-5: SUPPLEMENTARY CONTROL

| Mode | CE | OE | WE | A9 | Vcc | I/Oi |
|-----------------|-----|-----|-----|---------|-----|----------|
| Chip Clear | VIL | VH | VIL | X | Vcc | |
| Extra Row Read | VIL | VIL | VIH | A9 = VH | Vcc | Data Out |
| Extra Row Write | * | VIH | * | A9 = VH | Vcc | Data In |

Note 1: V_H = 12.0V ± 0.5V * Pulsed per programming waveforms.

28C16A

2.0 DEVICE OPERATION

The Microchip Technology Inc. 28C16A 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 |
|----------------|-------------------------------|-----------------|-----------------|--------|
| Read | L | L | H | DOUT |
| Standby | H | X | X | High Z |
| Write Inhibit | H | X | X | High Z |
| Write Inhibit | X | L | X | High Z |
| Write Inhibit | X | X | H | High Z |
| Byte Write | L | H | L | DIN |
| Byte Clear | Automatic Before Each "Write" | | | |

X = Any TTL level.

2.1 Read Mode

The 28C16A 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 (t_{ACC}) is equal to the delay from \overline{CE} to output (t_{CE}). Data is available at the output t_{OE} after the falling edge of \overline{OE} , assuming that \overline{CE} has been low and addresses have been stable for at least $t_{ACC}-t_{OE}$.

2.2 Standby Mode

The 28C16A 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 28C16A 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.

2.5 Data Polling

The 28C16A features 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 indeterminate). After completion of the write cycle, true data is available. 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

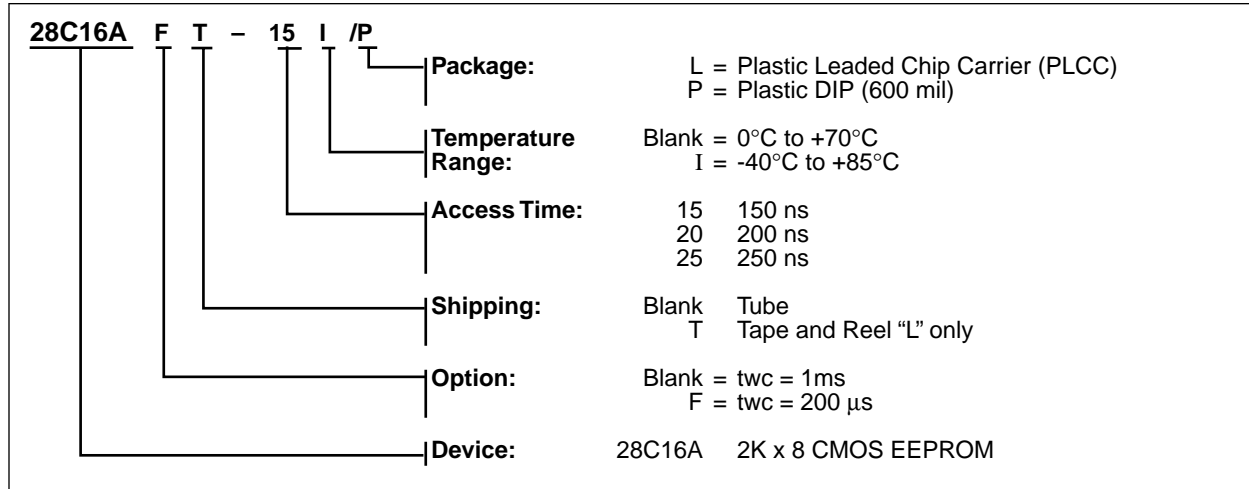
An extra row of 32 bytes of EEPROM memory is available to the user for device identification. By raising A9 to 12V \pm 0.5V and using address locations 7E0 to 7FF, the additional bytes can be written to or read from in the same manner as the regular memory array.

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.

28C16A 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.





MICROCHIP

WORLDWIDE SALES AND SERVICE

AMERICAS

Corporate Office

Microchip Technology Inc.
2355 West Chandler Blvd.
Chandler, AZ 85224-6199
Tel: 602-786-7200 Fax: 602-786-7277
Technical Support: 602 786-7627
Web: <http://www.microchip.com>

Atlanta

Microchip Technology Inc.
500 Sugar Mill Road, Suite 200B
Atlanta, GA 30350
Tel: 770-640-0034 Fax: 770-640-0307

Boston

Microchip Technology Inc.
5 Mount Royal Avenue
Marlborough, MA 01752
Tel: 508-480-9990 Fax: 508-480-8575

Chicago

Microchip Technology Inc.
333 Pierce Road, Suite 180
Itasca, IL 60143
Tel: 630-285-0071 Fax: 630-285-0075

Dallas

Microchip Technology Inc.
14651 Dallas Parkway, Suite 816
Dallas, TX 75240-8809
Tel: 972-991-7177 Fax: 972-991-8588

Dayton

Microchip Technology Inc.
Two Prestige Place, Suite 150
Miamisburg, OH 45342
Tel: 937-291-1654 Fax: 937-291-9175

Detroit

Microchip Technology Inc.
42705 Grand River, Suite 201
Novi, MI 48375-1727
Tel: 248-374-1888 Fax: 248-374-2874

Los Angeles

Microchip Technology Inc.
18201 Von Karman, Suite 1090
Irvine, CA 92612
Tel: 714-263-1888 Fax: 714-263-1338

New York

Microchip Technology Inc.
150 Motor Parkway, Suite 202
Hauppauge, NY 11788
Tel: 516-273-5305 Fax: 516-273-5335

San Jose

Microchip Technology Inc.
2107 North First Street, Suite 590
San Jose, CA 95131
Tel: 408-436-7950 Fax: 408-436-7955

AMERICAS (continued)

Toronto

Microchip Technology Inc.
5925 Airport Road, Suite 200
Mississauga, Ontario L4V 1W1, Canada
Tel: 905-405-6279 Fax: 905-405-6253

ASIA/PACIFIC

Hong Kong

Microchip Asia Pacific
RM 3801B, Tower Two
Metroplaza
223 Hing Fong Road
Kwai Fong, N.T., Hong Kong
Tel: 852-2-401-1200 Fax: 852-2-401-3431

India

Microchip Technology Inc.
India Liaison Office
No. 6, Legacy, Convent Road
Bangalore 560 025, India
Tel: 91-80-229-0061 Fax: 91-80-229-0062

Japan

Microchip Technology Intl. Inc.
Benex S-1 6F
3-18-20, Shinyokohama
Kohoku-Ku, Yokohama-shi
Kanagawa 222-0033 Japan
Tel: 81-45-471-6166 Fax: 81-45-471-6122

Korea

Microchip Technology Korea
168-1, Youngbo Bldg. 3 Floor
Samsung-Dong, Kangnam-Ku
Seoul, Korea
Tel: 82-2-554-7200 Fax: 82-2-558-5934

Shanghai

Microchip Technology
RM 406 Shanghai Golden Bridge Bldg.
2077 Yan'an Road West, Hong Qiao District
Shanghai, PRC 200335
Tel: 86-21-6275-5700 Fax: 86 21-6275-5060

ASIA/PACIFIC (continued)

Singapore

Microchip Technology Singapore Pte Ltd.
200 Middle Road
#07-02 Prime Centre
Singapore 188980
Tel: 65-334-8870 Fax: 65-334-8850

Taiwan, R.O.C

Microchip Technology Taiwan
10F-1C 207
Tung Hua North Road
Taipei, Taiwan, ROC
Tel: 886-2-2717-7175 Fax: 886-2-2545-0139

EUROPE

United Kingdom

Arizona Microchip Technology Ltd.
505 Eskdale Road
Winnersh Triangle
Wokingham
Berkshire, England RG41 5TU
Tel: 44-1189-21-5858 Fax: 44-1189-21-5835

France

Arizona Microchip Technology SARL
Zone Industrielle de la Bonde
2 Rue du Buisson aux Fraises
91300 Massy, France
Tel: 33-1-69-53-63-20 Fax: 33-1-69-30-90-79

Germany

Arizona Microchip Technology GmbH
Gustav-Heinemann-Ring 125
D-81739 München, Germany
Tel: 49-89-627-144 0 Fax: 49-89-627-144-44

Italy

Arizona Microchip Technology SRL
Centro Direzionale Colleoni
Palazzo Taurus 1 V. Le Colleoni 1
20041 Agrate Brianza
Milan, Italy
Tel: 39-39-6899939 Fax: 39-39-6899883

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Microchip received ISO 9001 Quality System certification for its worldwide headquarters, design, and wafer fabrication facilities in January, 1997. Our field-programmable PICmicro™ 8-bit MCUs, Serial EEPROMs, related specialty memory products and development systems conform to the stringent quality standards of the International Standard Organization (ISO).

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