

**Features**

- **Fast Read Access Time - 45ns**
- **Fast Byte Write - 1ms**
- **Self-Timed Byte Write Cycle**
  - Internal Address and Data Latches
  - Internal Control Timer
  - Automatic Clear Before Write
- **Direct Microprocessor Control**
  - DATA POLLING
- **Low Power**
  - 80mA Active Current
  - 500µA CMOS Standby Current (28HC16L)
- **High Reliability CMOS Technology**
  - Endurance: 10<sup>6</sup> cycles
  - Data Retention: 10 years
- **5 V ± 10% Supply**
- **CMOS & TTL Compatible Inputs and Outputs**
- **JEDEC Approved Byte-Wide Pinout**
- **Full Military, Commercial, and Industrial Temperature Ranges**

**16K (2K x 8)  
High Speed  
CMOS  
E<sup>2</sup>PROM**

**Description**

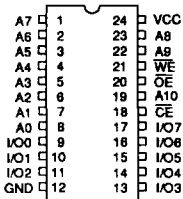
The AT28HC16/16L is a high-speed, low-power Electrically Erasable and Programmable Read Only Memory. The device is optimized for high speed applications, featuring access times to 45ns. Its 16k of memory is organized as 2,048 words by 8 bits. The AT28HC16/16L comes in a space saving 24 pin DIP.

The AT28HC16/16L 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 a write cycle, the device being written will go to a busy state and automatically clear and write the latched data using an internal control timer. Data polling of I/O7 may be used to detect the end of the write cycle. Once a write cycle has been completed, a new access for a read or a write may begin immediately.

Atmel's high-speed CMOS technology is used to achieve access times of 45ns for the AT28HC16 with under 440mW of power dissipation. The AT28HC16L offers ultra low standby power consumption of under 2.75mW at access time to 55ns.

The AT28HC16/16L has additional features to ensure high quality and manufacturability. The device utilizes internal error correction for extended endurance and for improved data retention characteristics. An extra 16 bytes of E<sup>2</sup>PROM are available for device identification or tracking.

**Pin Configurations**

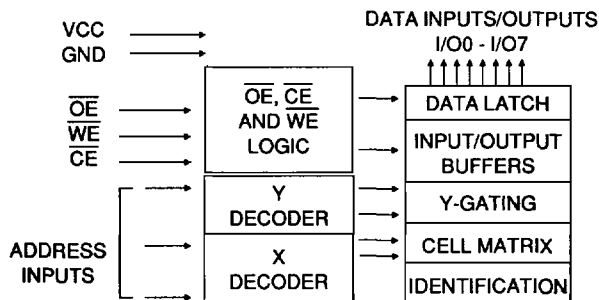


Pin Name	Function
A0 - A10	Addresses
CE	Chip Enable
OE	Output Enable
WE	Write Enable
I/O0 - I/O7	Data Inputs/Outputs
NC	No Connect





## Block Diagram



## Operating Modes

Mode	$\overline{CE}$	$\overline{OE}$	$\overline{WE}$	I/O
Read	V <sub>IL</sub>	V <sub>IL</sub>	V <sub>IH</sub>	DOUT
Write <sup>(2)</sup>	V <sub>IL</sub>	V <sub>IH</sub>	V <sub>IL</sub>	DIN
Standby/Write Inhibit	V <sub>IH</sub>	X <sup>(1)</sup>	X	High Z
Write Inhibit	X	X	V <sub>IH</sub>	
Write Inhibit	X	V <sub>IL</sub>	X	
Output Disable	X	V <sub>IH</sub>	X	High Z
Chip Erase	V <sub>IL</sub>	V <sub>IH</sub> <sup>(3)</sup>	V <sub>IL</sub>	High Z

Notes: 1. X can be V<sub>IL</sub> or V<sub>IH</sub>.

2. Refer to A.C. Programming Waveforms.

3. V<sub>IH</sub> = 12.0V ± 0.5V.

## Device Operation

**READ:** The AT28HC16/16L is accessed like a Static RAM. When CE and OE are low and WE is high, the data stored at the memory location determined by the address pins is asserted on the outputs. The outputs are put in a high impedance state whenever CE or OE is high. This dual line control gives designers increased flexibility in preventing bus contention.

**BYTE WRITE:** Writing data into the AT28HC16/16L is similar to writing into a Static RAM. A low pulse on the WE or CE input with OE high and CE or WE low (respectively) initiates a byte write. The address location is latched on the last falling edge of WE (or CE); the new data is latched on the first rising edge. Internally, the device performs a self-clear before write. Once a byte write has been started, it will automatically time itself to completion.

**DATA POLLING:** The AT28HC16/16L provides DATA POLLING to signal the completion of a write cycle. During a write cycle, an attempted read of the data being written results in the complement of that data for I/O7 (the other outputs are indeterminate). When the write cycle is finished, true data appears on all outputs.

**WRITE PROTECTION:** Inadvertent writes to the device are protected against in the following ways: (a) Vcc sense— if Vcc is below 3.8V (typical) the write function is inhibited. (b) Vcc power on delay— once Vcc has reached 3.8V the device will automatically time out 5ms (typical) before allowing a byte write. (c) Write Inhibit— holding any one of OE low, CE high or WE high inhibits byte write cycles. (d) Noise Protection— a WE or CE pulse of less than 10ns (typical) will not initiate a write cycle.

**CHIP CLEAR:** The contents of the entire memory of the AT28HC16/16L may be set to the high state by the CHIP CLEAR operation. By setting CE low and OE to 12 volts, the chip is cleared when a 10 msec low pulse is applied to WE.

**DEVICE IDENTIFICATION:** In the AT28HC16/16L there are an extra 16 bytes of E<sup>2</sup>PROM memory available to the user for device identification. By raising A9 to 12 ± 0.5V and using address locations 7F0H to 7FFH the additional bytes may be written to or read from in the same manner as the regular memory array.

## Absolute Maximum Ratings\*

Temperature Under Bias.....	-55°C to +125°C
Storage Temperature.....	-65°C to +150°C
All Input Voltages (including N.C. Pins) with Respect to Ground .....	-0.6V to +6.25V
All Output Voltages with Respect to Ground .....	-0.6V to V <sub>CC</sub> +0.6V
Voltage on $\overline{OE}$ and A9 with Respect to Ground .....	-0.6V to +13.5V

\*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 indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

## D.C. and A.C. Operating Range

		AT28HC16-45	AT28HC16L-55	AT28HC16-55	AT28HC16-70 AT28HC16L-70	AT28HC16-90 AT28HC16L-90
Operating Temperature (Case)	Com.	0°C - 70°C	0°C - 70°C	0°C - 70°C	0°C - 70°C	0°C - 70°C
	Ind.	-40°C - 85°C	-40°C - 85°C	-40°C - 85°C	-40°C - 85°C	-40°C - 85°C
	Mil.		-55°C - 125°C	-55°C - 125°C	-55°C - 125°C	-55°C - 125°C
V <sub>CC</sub> Power Supply		5V±10%	5V±10%	5V±10%	5V±10%	5V±10%

## D.C. Characteristics

Symbol	Parameter	Condition	Min	Max	Units
I <sub>LI</sub>	Input Load Current	V <sub>IN</sub> =0V to V <sub>CC</sub> + 1V		10	μA
I <sub>LO</sub>	Output Leakage Current	V <sub>IO</sub> =0V to V <sub>CC</sub>		10	μA
I <sub>SB1</sub>	V <sub>CC</sub> Standby Current CMOS	$\overline{CE}$ =V <sub>CC</sub> -0.3V to V <sub>CC</sub> + 1.0V	(AT28HC16L)	500	μA
I <sub>SB2</sub>	V <sub>CC</sub> Standby Current TTL	$\overline{CE}$ =2.0V to V <sub>CC</sub> + 1.0V	AT28HC16L	3	mA
			AT28HC16	60	mA
I <sub>CC</sub>	V <sub>CC</sub> Active Current A.C.	f=10MHz; I <sub>OUT</sub> =0mA		80	mA
V <sub>IL</sub>	Input Low Voltage			0.8	V
V <sub>IH</sub>	Input High Voltage		2.0		V
V <sub>OL</sub>	Output Low Voltage	I <sub>OL</sub> =12mA		.4	V
V <sub>OH</sub>	Output High Voltage	I <sub>OH</sub> =-4.0mA	2.4		V

## Pin Capacitance (f=1MHz T=25°C)<sup>(5)</sup>

	Typ	Max	Units	Conditions
C <sub>IN</sub>	4	6	pF	V <sub>IN</sub> = 0V
C <sub>OUT</sub>	8	12	pF	V <sub>OUT</sub> = 0V

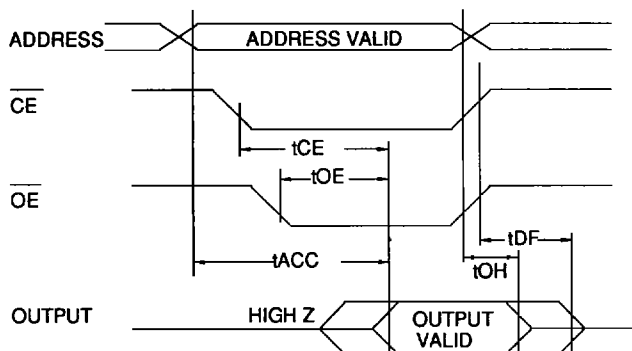




## A.C. Read Characteristics <sup>(1)</sup>

Symbol	Parameter	AT28HC16 -45		AT28HC16 -55		AT28HC16L -55		AT28HC16 -70		AT28HC16L -70		AT28HC16L -90		Units
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	
$t_{ACC}$	Address to Output Delay	45		55		55		70		70		90		ns
$t_{CE}^{(2)}$	$\overline{CE}$ to Output Delay	30		40		55		50		70		90		ns
$t_{OE}^{(3)}$	$\overline{OE}$ to Output Delay	0	30	0	40	0	40	0	50	0	50	0	50	ns
$t_{DF}^{(4,5)}$	$\overline{OE}$ to Output Float	0	30	0	40	0	40	0	50	0	50	0	50	ns
$t_{OH}$	Output Hold from $\overline{OE}$ or Address, whichever occurred first	0		0		0		0		0		0		ns

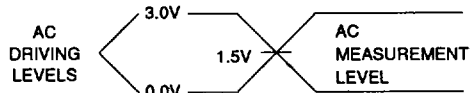
## A.C. Read Waveforms



### Notes:

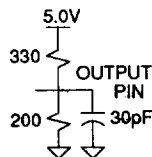
- $C_L = 30\text{pF}$ .
- $\overline{CE}$  may be delayed up to  $t_{ACC} - t_{CE}$  after the address transition without impact on  $t_{ACC}$ .
- $\overline{OE}$  may be delayed up to  $t_{CE} - t_{OE}$  after the falling edge of  $\overline{CE}$  without impact on  $t_{CE}$  or by  $t_{ACC} - t_{OE}$  after an address change without impact on  $t_{ACC}$ .
- $t_{DF}$  is specified from  $\overline{OE}$  or  $\overline{CE}$  whichever occurs first ( $C_L = 5\text{pF}$ ).
- This parameter is characterized and is not 100% tested.

## Input Test Waveforms and Measurement Level



$t_R, t_F < 5\text{ns}$

## Output Test Load

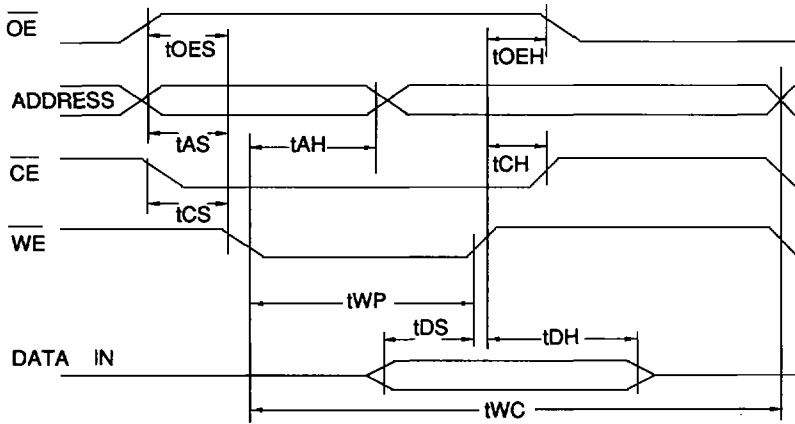


**A.C. Write Characteristics**

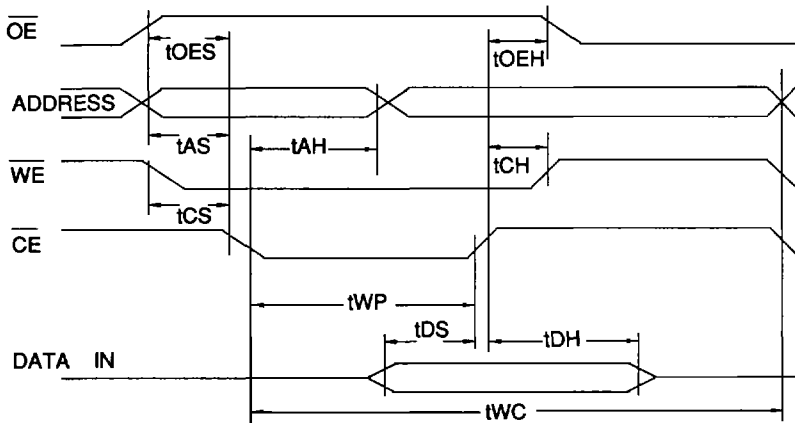
Symbol	Parameter	Min	Typ	Max	Units
t <sub>AS</sub> , t <sub>OES</sub>	Address, $\overline{OE}$ Set-up Time	0			ns
t <sub>AH</sub>	Address Hold Time	50			ns
t <sub>WP</sub>	Write Pulse Width	100		1000	ns
t <sub>DS</sub>	Data Set-up Time	50			ns
t <sub>DH</sub> , t <sub>OEH</sub>	Data, $\overline{OE}$ Hold Time	0			ns
t <sub>WC</sub>	Write Cycle Time		0.5	1.0	ms

2

**A.C. Write Waveforms-  $\overline{WE}$  Controlled**



**A.C. Write Waveforms-  $\overline{CE}$  Controlled**

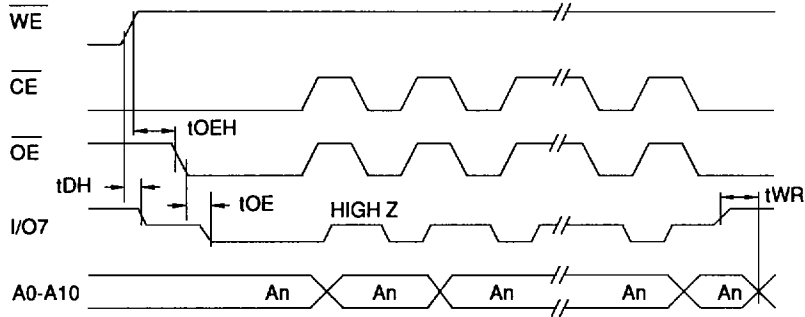


## Data Polling Characteristics<sup>(1)</sup>

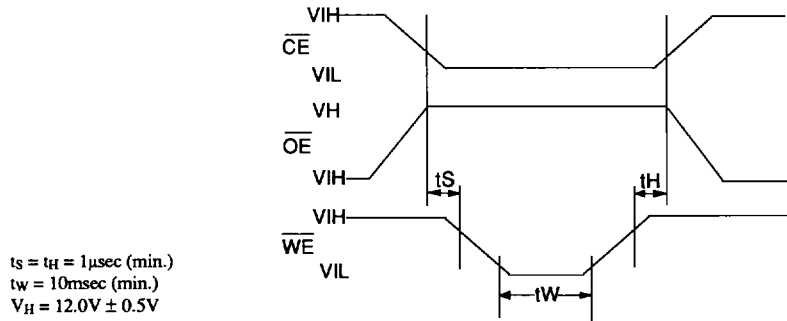
Symbol	Parameter	Min	Typ	Max	Units
t <sub>DH</sub>	Data Hold Time	0			ns
t <sub>OE<sub>H</sub></sub>	$\overline{\text{OE}}$ Hold Time	0			ns
t <sub>OE</sub>	$\overline{\text{OE}}$ to Output Delay			100	ns
t <sub>WR</sub>	Write Recovery Time	0			ns

Note: 1. These parameters are characterized and not 100% tested.

## Data Polling Waveforms

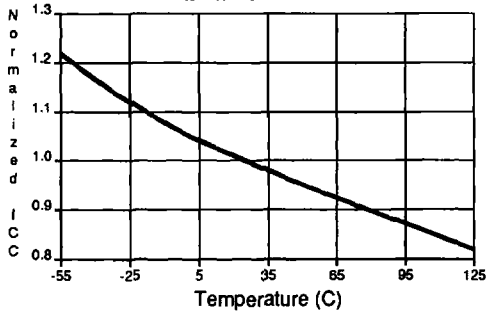


## Chip Erase Waveforms

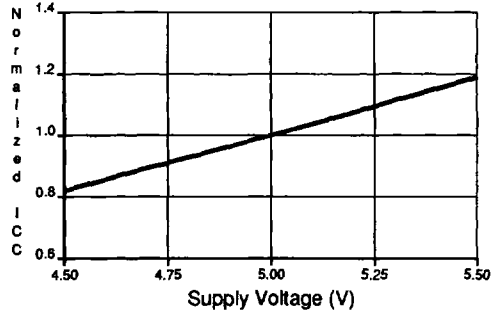


t<sub>S</sub> = t<sub>H</sub> = 1μsec (min.)  
t<sub>W</sub> = 10msec (min.)  
V<sub>H</sub> = 12.0V ± 0.5V

NORMALIZED SUPPLY CURRENT vs. TEMPERATURE

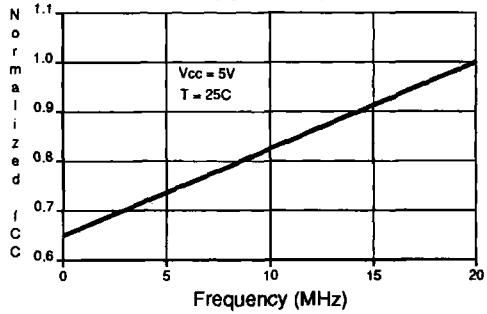


NORMALIZED SUPPLY CURRENT vs. SUPPLY VOLTAGE



2

NORMALIZED SUPPLY CURRENT vs. ADDRESS FREQUENCY





## Ordering Information

(Contact Factory: Not recommended for new designs.)

t <sub>acc</sub> (ns)	I <sub>cc</sub> (mA)		Ordering Code	Package	Operation Range
	Active	Standby			
45	80	60	AT28HC16N-45DC AT28HC16-45DC AT28HC16N-45PC AT28HC16-45PC	24D3 24D6 24P3 24P6	Commercial (0°C to 70°C)
			AT28HC16N-45DI AT28HC16-45DI AT28HC16N-45PI AT28HC16-45PI	24D3 24D6 24P3 24P6	Industrial (-40°C to 85°C)
55	80	60	AT28HC16N-55DC AT28HC16-55DC AT28HC16N-55PC AT28HC16-55PC	24D3 24D6 24P3 24P6	Commercial (0°C to 70°C)
			AT28HC16N-55DI AT28HC16-55DI AT28HC16N-55PI AT28HC16-55PI	24D3 24D6 24P3 24P6	Industrial (-40°C to 85°C)
			AT28HC16N-55DM AT28HC16-55DM	24D3 24D6	Military (-55°C to 125°C)
			AT28HC16N-55DM/883 AT28HC16-55DM/883	24D3 24D6	Military with Burn-In (-55°C to 125°C)
70	80	60	AT28HC16N-70DC AT28HC16-70DC AT28HC16N-70PC AT28HC16-70PC	24D3 24D6 24P3 24P6	Commercial (0°C to 70°C)
			AT28HC16N-70DI AT28HC16-70DI AT28HC16N-70PI AT28HC16-70PI	24D3 24D6 24P3 24P6	Industrial (-40°C to 85°C)
			AT28HC16N-70DM AT28HC16-70DM	24D3 24D6	Military (-55°C to 125°C)
			AT28HC16N-70DM/883 AT28HC16-70DM/883	24D3 24D6	Military with Burn-In (-55°C to 125°C)
90	80	60	AT28HC16N-90DC AT28HC16-90DC AT28HC16N-90PC AT28HC16-90PC	24D3 24D6 24P3 24P6	Commercial (0°C to 70°C)
			AT28HC16N-90DI AT28HC16-90DI AT28HC16N-90PI AT28HC16-90PI	24D3 24D6 24P3 24P6	Industrial (-40°C to 85°C)



## Ordering Information

(Contact Factory: Not recommended for new designs.)

t <sub>ACC</sub> (ns)	I <sub>CC</sub> (mA)		Ordering Code	Package	Operation Range
	Active	Standby			
90	80	60	AT28HC16N-90DM AT28HC16-90DM	24D3 24D6	Military (-55°C to 125°C)
			AT28HC16N-90DM/883 AT28HC16-90DM/883	24D3 24D6	Military with Burn-In (-55°C to 125°C)

2

Package Type	
<b>24D3</b>	24 Lead, 0.300" Wide, Non-Windowed, Ceramic Dual Inline Package (Cerdip)
<b>24D6</b>	24 Lead, 0.600" Wide, Non-Windowed, Ceramic Dual Inline Package (Cerdip)
<b>24P3</b>	24 Lead, 0.300" Wide, Plastic Dual Inline Package (PDIP)
<b>24P6</b>	24 Lead, 0.600" Wide, Plastic Dual Inline Package (PDIP)





## Ordering Information

(Contact Factory: Not recommended for new designs.)

t <sub>acc</sub> (ns)	I <sub>cc</sub> (mA)		Ordering Code	Package	Operation Range
	Active	Standby			
55	80	0.5	AT28HC16LN-55DC AT28HC16L-55DC AT28HC16LN-55PC AT28HC16L-55PC	24D3 24D6 24P3 24P6	Commercial (0°C to 70°C)
			AT28HC16LN-55DI AT28HC16L-55DI AT28HC16LN-55PI AT28HC16L-55PI	24D3 24D6 24P3 24P6	Industrial (-40°C to 85°C)
			AT28HC16LN-55DM AT28HC16L-55DM	24D3 24D6	Military (-55°C to 125°C)
			AT28HC16LN-55DM/883 AT28HC16L-55DM/883	24D3 24D6	Military with Burn-In (-55°C to 125°C)
70	80	0.5	AT28HC16LN-70DC AT28HC16L-70DC AT28HC16LN-70PC AT28HC16L-70PC	24D3 24D6 24P3 24P6	Commercial (0°C to 70°C)
			AT28HC16LN-70DI AT28HC16L-70DI AT28HC16LN-70PI AT28HC16L-70PI	24D3 24D6 24P3 24P6	Industrial (-40°C to 85°C)
			AT28HC16LN-70DM AT28HC16L-70DM	24D3 24D6	Military (-55°C to 125°C)
			AT28HC16LN-70DM/883 AT28HC16L-70DM/883	24D3 24D6	Military with Burn-In (-55°C to 125°C)
90	80	0.5	AT28HC16LN-90DC AT28HC16L-90DC AT28HC16LN-90PC AT28HC16L-90PC AT28HC16L-W	24D3 24D6 24P3 24P6 DIE	Commercial (0°C to 70°C)
			AT28HC16LN-90DI AT28HC16L-90DI AT28HC16LN-90PI AT28HC16L-90PI	24D3 24D6 24P3 24P6	Industrial (-40°C to 85°C)
			AT28HC16LN-90DM AT28HC16L-90DM	24D3 24D6	Military (-55°C to 125°C)
			AT28HC16LN-90DM/883 AT28HC16L-90DM/883	24D3 24D6	Military with Burn-In (-55°C to 125°C)

**Ordering Information**

(Contact Factory: Not recommended for new designs.)

<b>Package Type</b>	
<b>24D3</b>	24 Lead, 0.300" Wide, Non-Windowed, Ceramic Dual Inline Package (Cerdip)
<b>24D6</b>	24 Lead, 0.600" Wide, Non-Windowed, Ceramic Dual Inline Package (Cerdip)
<b>24P3</b>	24 Lead, 0.300" Wide, Plastic Dual Inline Package (PDIP)
<b>24P6</b>	24 Lead, 0.600" Wide, Plastic Dual Inline Package (PDIP)
<b>W</b>	Die

**2**