27C400
4M (256K x 16 or 512K x 8) CHMOS EPROM

- **Word-Wide or Byte-Wide Configurable**
- **4M 40-Pin Mask ROM Compatible**
  - **40-Lead CERDIP Package**
- **Low Power Dissipation**
  - **50 mA Max Active @ 5 MHz**
  - **100 μA Max Standby**
- **High Performance**
  - **150 ns Maximum Access Time**
  - **V_{CC} = 5V ±10%**
- **FAST Programming**
  - **Quick-Pulse Programming™ Algorithm**
  - **Programming as Fast as 28 Seconds**

The Intel 27C400 is a 5V only 4,194,304 bit Erasable Programmable Read Only Memory, organized as 262,144 words of 16 bits each. A byte enable switch on pin 31 allows the device to be addressed as a 8 by 524,288 bit device. The 27C400 in pin-out and functionally compatible with 40-pin 4M Mask ROMs.

The 27C400 employs advanced CHMOS* III-E circuitry for systems requiring low power, high speed performance and noise immunity.

The 27C400 is equally at home in both TTL or CMOS environments. Programming time is as fast as 28 seconds using Intel's Quick Pulse Programming Algorithm.

*CHMOS is a patented process of Intel Corporation.

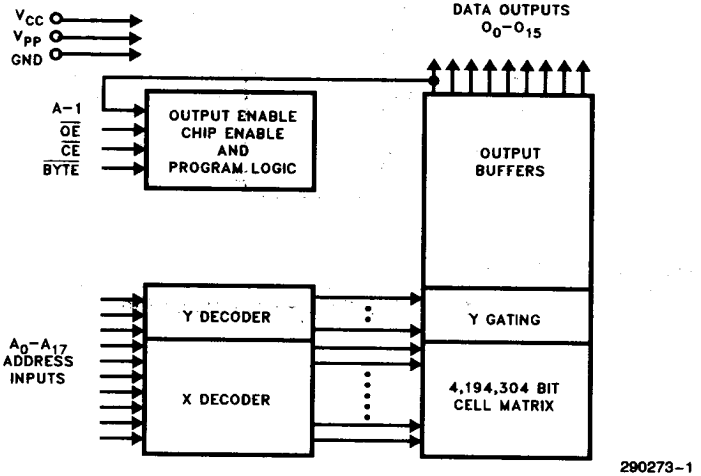

Figure 1. 27C400 Block Diagram

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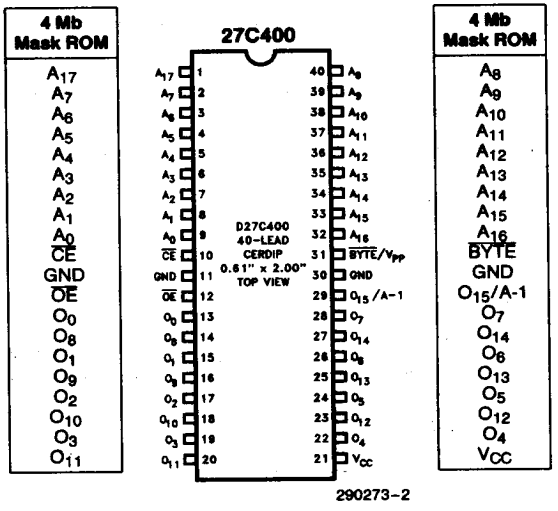
October 1991
Order Number: 290273-002

Pin Names

A_0–A_{17}	ADDRESSES
O_0–O_{15}	OUTPUTS
$\overline{OE}$	OUTPUT ENABLE
$\overline{CE}$	CHIP ENABLE
$\overline{BYTE}$	WORD/BYTE ENABLE
A-1	BYTE SELECT
NC	NO INTERNAL CONNECT



NOTE:
Model Number Prefixes: D = CERDIP.

Figure 2. 27C400 Pin Configuration

ABSOLUTE MAXIMUM RATINGS*

Operating Temperature ..... 0°C to 70°C(1)
Temperature under Bias ..... −10°C to 80°C
Storage Temperature ..... −65°C to 125°C
Voltage on Any Pin (Except A_9, V_{CC} and $\overline{BYTE}/V_{PP}$) with Respect to GND ..... −0.6V to 6.5V(2)
Voltage on A_9, with Respect to GND ..... −0.6V to 13V(2)
$\overline{BYTE}/V_{PP}$ Supply Voltage with Respect to GND ..... −0.6V to 14V(2)
V_{CC} Supply Voltage with Respect to GND ..... −0.6V to 7V(2)

NOTICE: This data sheet contains preliminary information on new products in production. The specifications are subject to change without notice. Verify with your local Intel Sales office that you have the latest data sheet before finalizing a design.

**WARNING: Stressing the device beyond the "Absolute Maximum Ratings" may cause permanent damage. These are stress ratings only. Operation beyond the "Operating Conditions" is not recommended and extended exposure beyond the "Operating Conditions" may affect device reliability.*

READ OPERATION DC CHARACTERISTICS(1) V_{CC} = 5.0V ±10%

Symbol	Parameter	Notes	Min	Typ	Max	Unit	Test Condition
I_{LI}	Input Load Current	7		0.01	1.0	µA	V_{IN} = 0V to V_{CC}
I_{LO}	Output Leakage Current				±10	µA	V_{OUT} = 0V to V_{CC}
I_{SB}	V_{CC} Standby Current	5			1.0	mA	$\overline{CE}$ = V_{IH}
					100	µA	$\overline{CE}$ = V_{CC} ± 0.2V
I_{CC}	V_{CC} Operating Current	3			50	mA	f = 5 MHz, $\overline{CE}$ = V_{IL}, I_{OUT} = 0 mA
I_{PP}	V_{PP} Operating Current	3			10	µA	V_{PP} = V_{CC}
I_{OS}	Output Short Circuit Current	4, 6			100	mA	
V_{IL}	Input Low Voltage		−0.5		0.8	V	
V_{IH}	Input High Voltage		2.0		V_{CC} + 0.5	V	
V_{OL}	Output Low Voltage				0.45	V	I_{OL} = 2.1 mA
V_{OH}	Output High Voltage		2.4			V	I_{OH} = −400 µA

NOTES:
1. Operating temperature is for commercial product defined by this specification.
2. Minimum DC voltage is −0.5V on input/output pins. During transitions, this level may undershoot to −2.0V for periods <20 ns. Maximum DC voltage on input/output pins is V_{CC} + 0.5V which, during transitions, may overshoot to V_{CC} + 2.0V for periods <20 ns.
3. Maximum active power usage is the sum I_{PP} + I_{CC}. Maximum current value is with outputs O_0–O_{15} unloaded.
4. Output shorted for no more than one second. No more than one output shorted at a time.
5. $\overline{BYTE}/V_{PP}$ = V_{CC} ± 0.2V or GND ± 0.2V.
6. Sampled, not 100% tested.
7. Typical limits are at V_{CC} = 5V, T_A = 25°C.

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READ OPERATION AC CHARACTERISTICS(1) V_{CC} = 5.0V ±10%

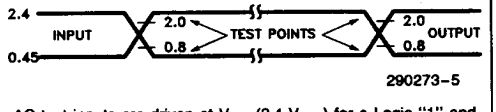
Version	V_{CC} ± 10%		27C400-150V10(5)		27C400-200V10		Unit
Symbol	Parameter	Notes	Min	Max	Min	Max	
t_{ACC}	Address to Output Delay			150		200	ns
t_{CE}	$\overline{CE}$ to Output Delay	2		150		200	ns
t_{OE}	$\overline{OE}$ to Output Delay	2		60		70	ns
t_{DF}	$\overline{OE}$ High to Output High Z	3		50		60	ns
t_{OH}	Output Hold from Addresses, $\overline{CE}$ or $\overline{OE}$ Change— Whichever Occurs First	3	0		0		ns

NOTES:
1. See AC Input/Output Reference Waveform for timing measurements.
2. $\overline{OE}$ may be delayed up to $t_{CE}-t_{OE}$ after the falling edge of $\overline{CE}$ without impact on t_{CE}.
3. Sampled, not 100% tested.
voltages.
4. Includes O_{15}/A-1.
5. Both byte- and word-wide-read mode are available with the 27C400-200V10. 27C400-150V10 specs are valid only in word-wide-read mode operation.

CAPACITANCE(3) T_A = 25°C, f = 1 MHz

Symbol	Parameter	Typical	Max	Unit	Condition
C_{IN}	Input Capacitance	4	8	pF	V_{IN} = 0V
C_{OUT}	Output Capacitance(4)	8	12	pF	V_{OUT} = 0V
C_{VPP}	V_{PP} Capacitance	18	25	pF	V_{PP} = 0V

AC INPUT/OUTPUT REFERENCE WAVEFORM



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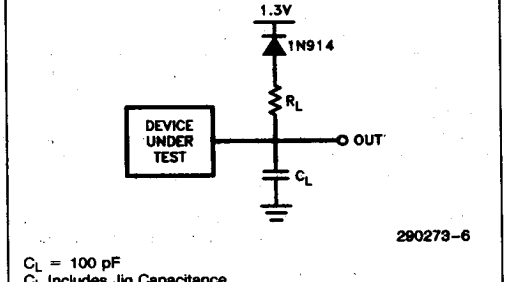
AC test inputs are driven at V_{OH} (2.4 V_{TTL}) for a Logic "1" and V_{OL} (0.45 V_{TTL}) for a Logic "0". Input timing begins at V_{IH} (2.0 V_{TTL}) and V_{IL} (0.8 V_{TTL}). Output timing ends at V_{IH} and V_{IL}. Input rise and fall times (10% to 90%) ≤ 10 ns.

AC TESTING LOAD CIRCUIT



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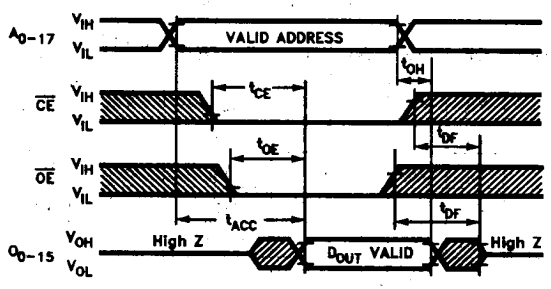
C_L = 100 pF
C_L includes Jig Capacitance
R_L = 3.3 kΩ

AC WAVEFORMS

Word-Wide Read Mode



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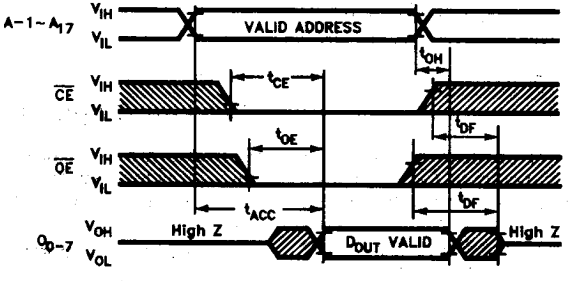
NOTE:
$\overline{BYTE}/V_{PP} = V_{CC} \pm 0.2V$

Byte-Wide Read Mode



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NOTE:
$\overline{BYTE}/V_{PP} = GND \pm 0.2V$

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DEVICE OPERATION

The Mode Selection table lists 27C400 operating modes. Read Mode requires a single 5V power supply. All inputs, except V_{CC} and $\overline{BYTE}/V_{PP}$, and A_9 during int$_e$ligent Identifier™ Mode, are TTL or CMOS.

Table 1. Mode Selection

Mode	Notes	$\overline{CE}$	$\overline{OE}$	A_9	A_0	O_{15}/A-1	$\overline{BYTE}/V_{PP}$(4)	V_{CC}	O_{8-14}	O_{0-7}
Read (Word)	1	V_{IL}	V_{IL}	X	X	D_{15} Out	V_{CC}	V_{CC}	D_{8-14} Out	D_{0-7} Out
Read (Upper Byte)		V_{IL}	V_{IL}	X	X	V_{IH}	GND	V_{CC}	High Z	D_{8-15} Out
Read (Lower Byte)		V_{IL}	V_{IL}	X	X	V_{IL}	GND	V_{CC}	High Z	D_{0-7} Out
Output Disable		V_{IL}	V_{IH}	X	X	High Z	X	V_{CC}	High Z	High Z
Standby		V_{IH}	X	X	X	High Z	X	V_{CC}	High Z	High Z
Program	2	V_{IL}	V_{IH}	X	X	D_{15} In	V_{PP}	V_{CP}	D_{8-14} In	D_{0-7} In
Program Verify		V_{IH}	V_{IL}	X	X	D_{15} Out	V_{PP}	V_{CP}	D_{8-14} Out	D_{0-7} Out
Program Inhibit		V_{IH}	V_{IH}	X	X	High Z	V_{PP}	V_{CP}	High Z	High Z
int$_e$ligent Identifier	2, 3	V_{IL}	V_{IL}	V_{ID}	V_{IL}	0B	V_{CC}	V_{CC}	OOH	89H
—Manufacturer		V_{IL}	V_{IL}	V_{ID}	V_{IH}	0B	V_{CC}	V_{CC}	44H	EFH
—Device										

NOTES:
1. X can be V_{IL} or V_{IH}. For $\overline{BYTE}/V_{PP}$, X = GND or V_{CC}.
2. See DC Programming Characteristics for V_{CP}, V_{PP} and V_{ID} voltages.
3. A_1–A_8, A_{10}–A_{17} = V_{IL}.
4. $\overline{BYTE}/V_{PP}$ is intended for operation under DC Voltage conditions only.

Read Mode

The 27C400 has two control functions; both must be enabled to obtain data at the outputs. $\overline{CE}$ is the power control and device select. $\overline{OE}$ controls the output buffers to gate data to the outputs. With addresses stable, the address access time (t_{ACC}) equals the delay from $\overline{CE}$ to output (t_{CE}). Outputs display valid data t_{OE} after $\overline{OE}$'s falling edge, assuming t_{ACC} and t_{CE} times are met.

Word-Wide Mode

With $\overline{BYTE}/V_{PP}$ at V_{CC} ± 0.2V outputs O_{0-7} present data D_{0-7} and outputs O_{8-15} present data D_{8-15}, after $\overline{CE}$ and $\overline{OE}$ are appropriately enabled.

Byte-Wide Mode

With $\overline{BYTE}/V_{PP}$ at GND ± 0.2V, outputs O_{8-14} are tri-stated. If O_{15}/A-1 = V_{IH}, outputs O_{0-7} present data bits D_{8-15}. If O_{15}/A-1 = V_{IL}, outputs O_{0-7} present data bits D_{0-7}.

Read Operation AC Characteristic specifications are currently valid in byte-wide mode only when using the 27C400–200V10. Please contact your local Intel sales office for additional information.

Two Line Output Control

EPROMs are often used in larger memory arrays. Intel provides two control inputs to accommodate multiple memory connections. Two-line control provides for:

a. lowest possible memory power dissipation

b. complete assurance that data bus contention will not occur

To efficiently use these two control inputs, an address decoder should enable $\overline{CE}$ while $\overline{OE}$ should be connected to all memory devices and the system's $\overline{READ}$ control line. This assures that only selected memory devices have active outputs while deselected memory devices are in Standby Mode.

Standby Mode

Standby Mode substantially reduces V_{CC} current. When $\overline{CE}$ = V_{IH}, outputs are in a high impedance state, independent of $\overline{OE}$.

Program Mode

Caution: Exceeding 14V on $\overline{BYTE}/V_{PP}$ will permanently damage the device.

Initially, and after each erasure, all EPROM bits are in the "1" state. Data is introduced by selectively programming "0s" into the desired bit locations. Although only "0s" are programmed the data word can contain both "1s" and "0s". Ultraviolet light erasure is the only way to change "0s" to "1s".

Program Mode is entered when $\overline{BYTE}/V_{PP}$ is raised to 12.75V. Data is introduced by applying a 16-bit word to the output pins. Pulsing $\overline{CE}$ low while $\overline{OE}$ = V_{IH} programs that data into the device.

Program Verify

A verify should be performed following a program operation to determine that bits have been correctly programmed. With V_{CC} at 6.25V, a substantial program margin is ensured. The verify is performed with $\overline{CE}$ at V_{IH}. Valid data is available on O_{0-15} t_{OE} after $\overline{OE}$ falls low.

Program Inhibit

Program Inhibit mode allows parallel programming of multiple EPROMs with different data. $\overline{CE}$-high inhibits programming of non-targeted devices. Except for $\overline{CE}$ and $\overline{OE}$, parallel EPROMs may have common inputs.

inteligent Identifier™ Mode

The inteligent Identifier Mode will determine an EPROM's manufacturer and device type, allowing programming equipment to automatically match a device with its proper programming algorithm.

This mode is activated when a programmer forces 12V ±0.5V on A_9. With $\overline{CE}$, $\overline{OE}$, A_1–A_8, and A_{10}–A_{17} = V_{IL}, A_0 = V_{IL} will present the manufacturer's code and A_0 = V_{IH} the device code. This mode functions in the 25°C ±5°C ambient temperature range required during programming.

SYSTEM CONSIDERATIONS

EPROM power switching characteristics require careful device decoupling. System designers are interested in three supply current issues—standby currents levels (I_{SB}), active current levels (I_{CC}), and transient current peaks produced by falling and rising edges of $\overline{CE}$. Transient current magnitudes depend on the device outputs' capacitive and inductive loading. Two-Line Control and proper decoupling capacitor selection will suppress transient voltage peaks. Each device should have a 0.1 µF ceramic capacitor connected between its V_{CC} and GND. This high frequency, low inherent-inductance capacitor should be placed as close as possible to the device. Additionally, for every eight devices, a 4.7 µF electrolytic capacitor should be placed at the array's power supply connection between V_{CC} and GND. The bulk capacitor will overcome voltage slumps caused by PC board trace inductances.

ERASURE CHARACTERISTICS

Erasure begins when EPROMs are exposed to light with wavelengths shorter than approximately 4000 Angstroms (Å). It should be noted that sunlight and certain fluorescent lamps have wavelengths in the 3000–4000Å range. Data shows that constant exposure to room level fluorescent lighting can erase an EPROM in approximately 3 years, while it takes approximately 1 week when exposed to direct sunlight. If the device is exposed to these lighting conditions for extended periods, opaque labels should be placed over the window to prevent unintentional erasure.

The recommended erasure procedure is exposure to ultraviolet light of wavelengths 2537Å. The intergrated dose (UV intensity × exposure time) for erasure should be a minimum of 15 Wsec/cm^2. Erasure time is approximately 15 to 20 minutes using an ultraviolet lamp with a 12000 µW/cm^2 power rating. The EPROM should be placed within 1 inch of the lamp tubes. An EPROM can be permanently damaged if the integrated dose exceeds 7258 Wsec/cm^2 (1 week @ 12000 µW/cm^2).

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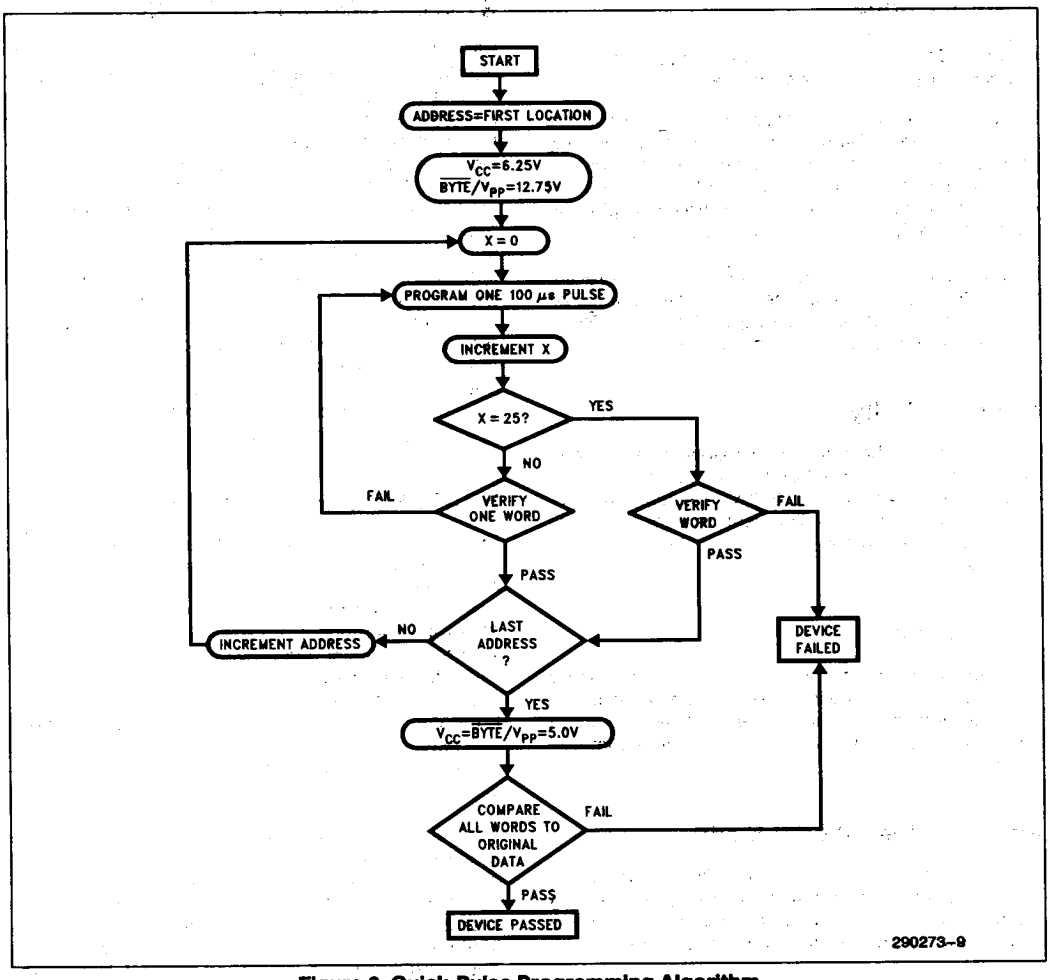

Figure 3. Quick-Pulse Programming Algorithm

Quick-Pulse Programming™ Algorithm

The Quick-Pulse Programming™ algorithm programs Intel's 27C400. Developed to substantially reduce programming throughput, this algorithm can program the 27C400 as fast as 28 seconds. Actual programming time depends on programmer overhead.

The Quick-Pulse Programming algorithm employs a 100 μs pulse followed by a word verification to determine when the addressed word has been successfully programmed. The algorithm terminates if 25 attempts fail to program a word.

The entire program-pulse/word-verify sequence is performed with $\overline{BYTE}/V_{PP}$ = 12.75V and V_{CC} = 6.25V. When programming is complete, all words are compared to the original data with V_{CC} = $\overline{BYTE}/V_{PP}$ = 5.0V.

DC PROGRAMMING CHARACTERISTICS $T_A = 25°C \pm 5°C$

Symbol	Parameter	Notes	Min	Typ	Max	Unit	Test Conditions
I_{LI}	Input Load Current				1	μA	$V_{IN} = V_{IL}$ or V_{IH}
I_{CP}	V_{CP} Program Current	1			50	mA	$\overline{CE} = V_{IL}$
I_{PP}	V_{PP} Program Current	1			50	mA	$\overline{CE} = V_{IL}$
V_{IL}	Input Low Voltage		−0.1		0.8	V	
V_{IH}	Input High Voltage		2.4		6.5	V	
V_{OL}	Output Low Voltage (Verify)				0.45	V	$I_{OL} = 2.1$ mA
V_{OH}	Output High Voltage (Verify)		3.5			V	$I_{OH} = -2.5$ mA
V_{ID}	A9 intelligent Identifer Voltage		11.5	12.0	12.5	V	
V_{PP}	V_{PP} Program Voltage	2, 3	12.5	12.75	13.0	V	
V_{CP}	V_{CC} Supply Voltage (Program)	2	6.0	6.25	6.5	V	

AC PROGRAMMING CHARACTERISTICS(4) $T_A = 25°C \pm 5°C$

Symbol	Parameter	Notes	Min	Typ	Max	Unit
t_{VCS}	V_{CP} Setup Time	2	2			μs
t_{VPS}	V_{PP} Setup Time	2	2			μs
t_{AS}	Address Setup Time		2			μs
t_{DS}	Data Setup Time		2			μs
t_{PW}	$\overline{CE}$ Program Pulse Width		95	100	105	μs
t_{DH}	Data Hold Time		2			μs
t_{OES}	$\overline{OE}$ Setup Time		2			μs
t_{OE}	Data Valid from $\overline{OE}$	5			150	ns
t_{DFP}	$\overline{OE}$ High to Output High Z	5, 6	0		130	ns
t_{AH}	Address Hold Time		0			μs

NOTES:
1. Maximum current is with outputs O_0–O_{15} unloaded.
2. V_{CP} must be applied simultaneously or before V_{PP} and removed simultaneously or after V_{PP}.
3. When programming, a 0.1 μF capacitor is required between V_{PP} and GND to suppress spurious voltage transients, which can damage the device.
4. See AC Input/Output Reference Waveform for timing measurements.
5. t_{OE} and t_{DFP} are device characteristics but must be accommodated by the programmer.
6. Sampled, not 100% tested.

PROGRAMMING WAVEFORMS