Preliminary

T-46-13-29

Am27C512L

65,536 x 8-Bit Ultra-Low CMOS EPROM

Advanced Micro Devices

DISTINCTIVE CHARACTERISTICS

- **Fast access time—70ns**
- **Ultra-low power consumption:**
  - **5 mA maximum active current at 5 MHz**
  - **20 µA maximum standby current**
- **Programming voltage: 12.75 V**
- **Single +5 -V power supply**
- **JEDEC–approved pinout**
  - **Plug in replacement for Am27C512**
- **±10% power supply tolerance**
- **Fast Flashrite™ programming**
  - **Typical programming time of 15 seconds**
- **Latch-up protected to 100 mA from –1 V to Vcc +1 V**

GENERAL DESCRIPTION

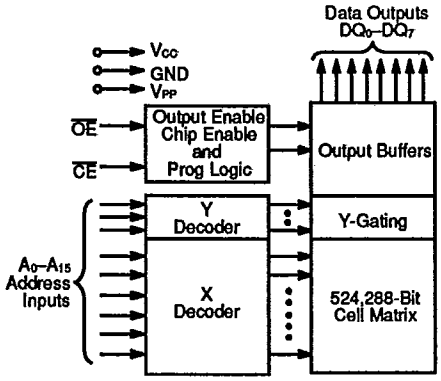
The Am27C512L is a 512K-bit, ultraviolet erasable programmable read-only memory. It is organized as 65,536 words by 8 bits per word, operates from a single +5-V supply, has a static standby mode, and features fast single address location programming. Products are available in windowed ceramic DIP and LCC packages, as well as plastic one-time programmable (OTP) packages.

Typically, any byte can be accessed in less than 70 ns, allowing operation with high-performance microprocessors without any WAIT states. The Am27C512L offers separate Output Enable ($\overline{OE}$) and Chip Enable ($\overline{CE}$) controls, thus eliminating bus contention in a multiple bus microprocessor system.

AMD's CMOS process technology provides high speed, low power, and high noise immunity. Typical power consumption is only 25 mW in active mode and 5 MHz operation, and 100 µW in standby mode and CMOS levels.

All signals are TTL levels, including programming signals. Bit locations may be programmed singly, in blocks, or at random.

BLOCK DIAGRAM



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PRODUCT SELECTOR GUIDE

Family Part No.	Am27C512L					
Ordering Part Number ±5% Vcc Tolerance	-75	-95	-125			-255
±10% Vcc Tolerance	–	-90	-120	-150	-200	-250
Max. Access Time (ns)	70	90	120	150	200	250
$\overline{CE}$ ($\overline{E}$) Access (ns)	70	90	120	150	200	250
$\overline{OE}$ ($\overline{G}$) Access (ns)	40	40	50	50	75	100

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CONNECTION DIAGRAMS
Top View

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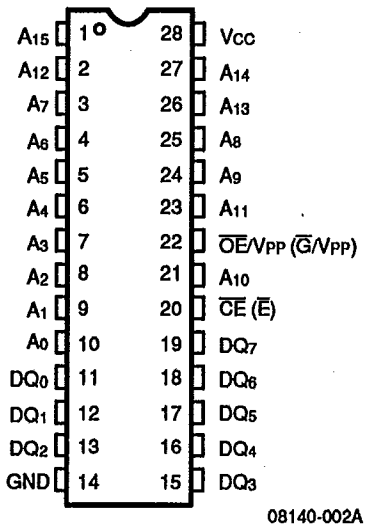
DIP



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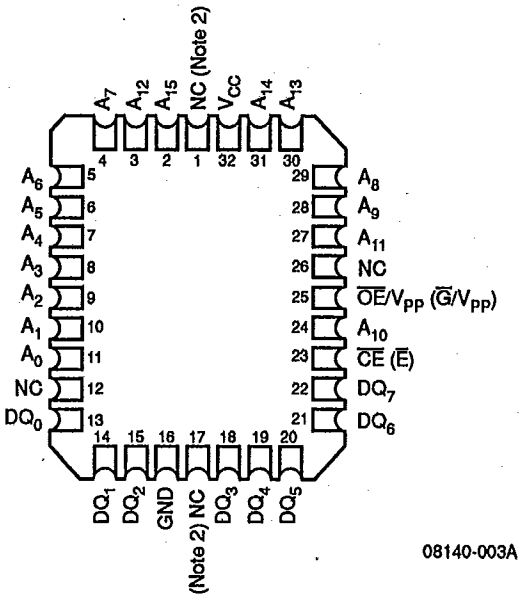
LCC*



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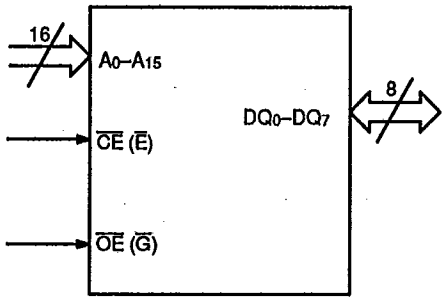
* Also Available in a 32-pin rectangular plastic leaded chip carrier

Notes:
1. JEDEC nomenclature is in parantheses.
2. Don't use (DU) for PLCC.

LOGIC SYMBOL



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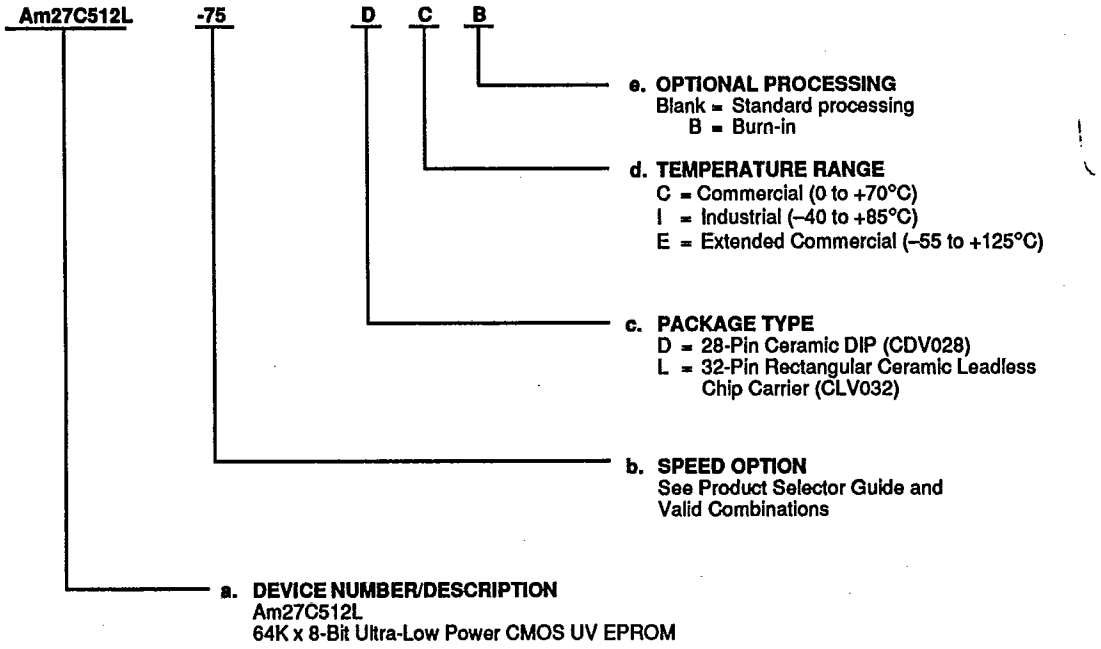
PIN DESCRIPTION

$A_0 - A_{15}$	=	Address Inputs
$\overline{CE}$ ($\overline{E}$)	=	Chip Enable Input
$DQ_0 - DQ_7$	=	Data Inputs/Outputs
$\overline{OE}$ ($\overline{G}$)	=	Output Enable Input
V_{CC}	=	V_{CC} Supply Voltage
V_{PP}	=	Program Supply Voltage
GND	=	Ground
NC	=	No Internal Connection
DU	=	No External Connection

ORDERING INFORMATION
Standard Products

AMD standard products are available in several packages and operating ranges. The order number (Valid Combination) is formed by a combination of:

a. Device Number
b. Speed Option
c. Package Type
d. Temperature Range
e. Optional Processing



Valid Combinations	
Am27C512L-75	DC, DCB, LC, LCB
Am27C512L-95	DC, DCB, DI, DIB, LC, LCB, LI, LIB
Am27C512L-125	
Am27C512L-90	
Am27C512L-120	DC, DCB, DI, DIB, DE, DEB, LC, LCB, LI, LIB, LE, LEB
Am27C512L-150	
Am27C512L-200	
Am27C512L-255	

Valid Combinations

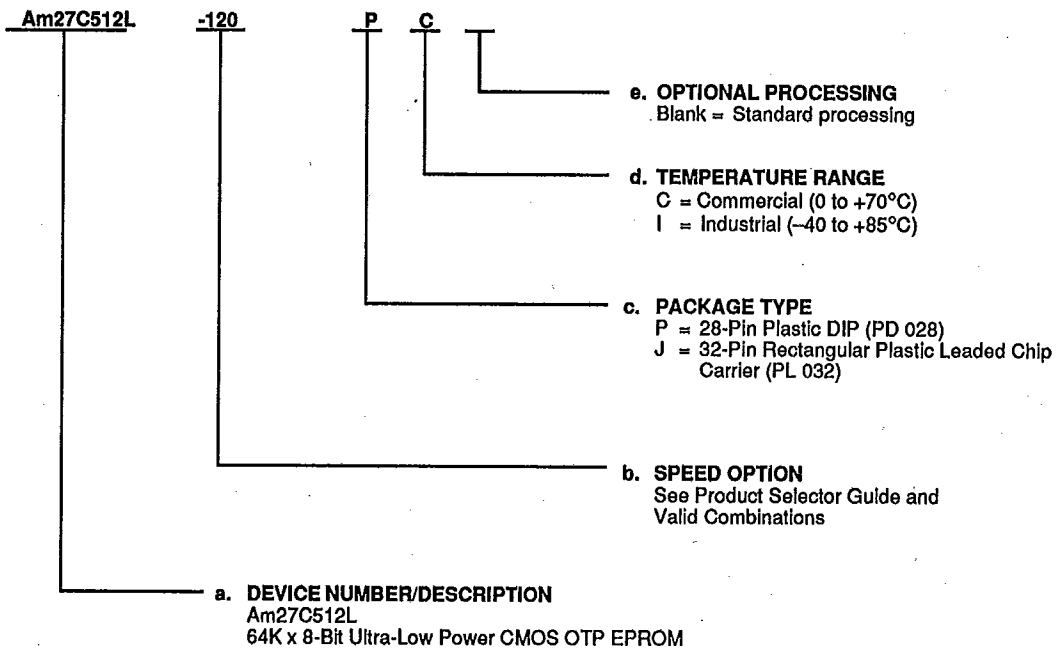
Valid Combinations list configurations planned to be supported in volume for this device. Consult the local AMD sales office to confirm availability of specific valid combinations or to check on newly released combinations.

ORDERING INFORMATION

OTP Products

AMD standard products are available in several packages and operating ranges. The order number (Valid Combination) is formed by a combination of:

a. Device Number
b. Speed Option
c. Package Type
d. Temperature Range
e. Optional Processing



Valid Combinations	
Am27C512L-120	JC, PC, JI, PI
Am27C512L-150	
Am27C512L-200	
Am27C512L-255	

Valid Combinations

Valid Combinations list configurations planned to be supported in volume for this device. Consult the local AMD sales office to confirm availability of specific valid combinations or to check on newly released combinations.

MILITARY ORDERING INFORMATION
APL Products

AMD products for Aerospace and Defense applications are available in several packages and operating ranges. APL (Approved Products List) products are fully compliant with MIL-STD-883C requirements. The order number (Valid Combination) is formed by a combination of:

a. Device Number
b. Speed Option
c. Package Type
d. Temperature Range
e. Lead Finish

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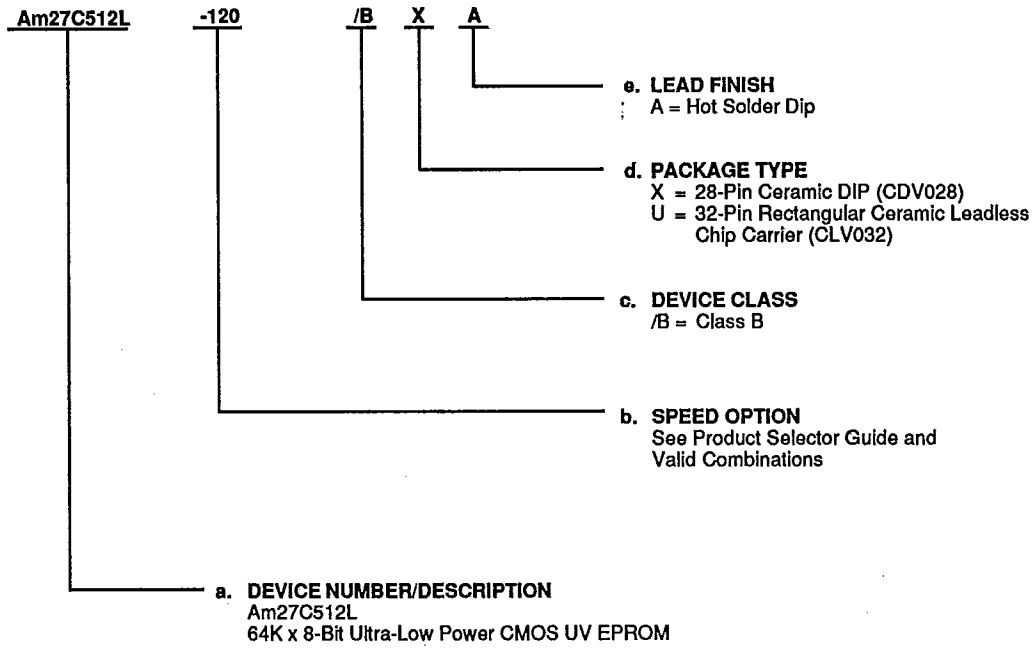

Valid Combinations	
Am27C512L-120	/BXA, /BUA
Am27C512L-150	
Am27C512L-200	
Am27C512L-250	

Valid Combinations

Valid Combinations list configurations planned to be supported in volume for this device. Consult the local AMD sales office to confirm availability of specific valid combinations, or to check on newly released combinations.

Group A Tests

Group A tests consist of Subgroups 1, 2, 3, 7, 8, 9, 10, 11.

FUNCTIONAL DESCRIPTION

Erasing the Am27C512L

In order to clear all locations of their programmed contents, it is necessary to expose the Am27C512L to an ultraviolet light source. A dosage of 15 W seconds/cm^2 is required to completely erase an Am27C512L. This dosage can be obtained by exposure to an ultraviolet lamp—wavelength of 2537 Angstroms (Å)—with intensity of 12,000 µW/cm^2 for 15 to 20 minutes. The Am27C512L should be directly under and about one inch from the source and all filters should be removed from the UV light source prior to erasure.

It is important to note that the Am27C512L, and similar devices, will erase with light sources having wavelengths shorter than 4000 Å. Although erasure times will be much longer than with UV sources at 2537 Å, nevertheless the exposure to fluorescent light and sunlight will eventually erase the Am27C512L and exposure to them should be prevented to realize maximum system reliability. If used in such an environment, the package window should be covered by an opaque label or substance.

Programming the Am27C512L

Upon delivery, or after each erasure, the Am27C512L has all 524,288 bits in the "ONE", or HIGH state. "ZEROs" are loaded into the Am27C512L through the procedure of programming.

The programming mode is entered when 12.75 ± 0.25 V is applied to the $\overline{OE}/V_{PP}$ pin, and $\overline{CE}$ is at V_{IL}.

For programming, the data to be programmed is applied 8 bits in parallel to the data output pins.

The Flashrite programming algorithm (shown in Figure 1) reduces programming time by using initial 100 µs pulses followed by a byte verification to determine whether the byte has been successfully programmed. If the data does not verify, an additional pulse is applied for a maximum of 25 pulses. This process is repeated while sequencing through each address of the EPROM.

The Flashrite programming algorithm programs and verifies at V_{CC} = 6.25 V and V_{PP} = 12.75 V. After the final address is completed, all bytes are compared to the original data with $V_{CC} = V_{PP}$ = 5.25 V.

Program Inhibit

Programming of multiple Am27C512Ls in parallel with different data is also easily accomplished. Except for $\overline{CE}$, all like inputs of the parallel Am27C512L including $\overline{OE}/V_{PP}$ may be common. A TTL low-level program pulse applied to an Am27C512L $\overline{CE}$ input with $\overline{OE}/V_{PP}$ = 12.75 ± 0.25 V will program that Am27C512L. A high-level $\overline{CE}$ input inhibits the other Am27C512Ls from being programmed.

Program Verify

A verify should be performed on the programmed bits to determine that they were correctly programmed. The verify should be performed with $\overline{OE}/V_{PP}$ and $\overline{CE}$ at V_{IL}. Data should be verified t_{DV} after the falling edge of $\overline{CE}$.

Auto Select Mode

The auto select mode allows the reading out of a binary code from an EPROM that will identify its manufacturer and type. This mode is intended for use by programming equipment for the purpose of automatically matching the device to be programmeed with its corresponding programming algorithm. This mode is functional in the 25°C ± 5°C ambient temperature range that is required when programming the Am27C512L.

To activate this mode, the programming equipment must force 12.0 ± 0.5 V on address line A_9 of the Am27C512L. Two identifier bytes may then be sequenced from the device outputs by toggling address line A_0 from V_{IL} to V_{IH}. All other address lines must be held at V_{IL} during auto select mode.

Byte 0 ($A_0 = V_{IL}$) represents the manufacturer code, and byte 1 ($A_0 = V_{IH}$), the device identifier code. For the Am27C512L, these two identifier bytes are given in the Mode Select table. All identifiers for manufacturer and device codes will possess odd parity, with the MSB (DQ_7) defined as the parity bit.

Read Mode

The Am27C512L 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 should be 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 outputs 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}.

Standby Mode

The Am27C512L has a CMOS standby mode which reduces the maximum V_{CC} current to 20 µA. It is placed in CMOS-standby when $\overline{CE}$ is at V_{CC} ± 0.3 V. The Am27C512L also has a TTL-standby mode which reduces the maximum V_{CC} current to 1.0 mA. It is placed in TTL–standby when $\overline{CE}$ is at V_{IH}. When in standby mode, the outputs are in a high–impedance state, independent of the $\overline{OE}$ input.

Output OR–Tieing

To accomodate multiple memory connections, a two–line control function is provided to allow for:

1. Low memory power dissipation, and
2. Assurance that output bus contention will not occur.

It is recommended that $\overline{CE}$ be decoded and used as the primary device-selecting function, while $\overline{OE}$ be made a common connection to all devices in the array and connected to the READ line from the system control bus. This assures that all deselected memory devices are in their low-power standby mode and that the output pins are only active when data is desired from a particular memory device.

System Applications

During the switch between active and standby conditions, transient current peaks are produced on the rising and falling edges of Chip Enable. The magnitude of these transient current peaks is dependent on the output capacitance loading of the device. At a minimum, a 0.1 µF ceramic capacitor (high frequency, low inherent inductance) should be used on each device between V_{CC} and GND to minimize transient effects. In addition, to overcome the voltage drop caused by the inductive effects of the printed circuit board traces on EPROM arrays, a 4.7 µF bulk electrolytic capacitor should be used between V_{CC} and GND for each eight devices. The location of the capacitor should be close to where the power supply is connected to the array.

Mode Select Table

Mode \ Pins		$\overline{CE}$	$\overline{OE}/V_{PP}$	A_0	A_9	Outputs
Read		V_{IL}	V_{IL}	X	X	D_{OUT}
Output Disable		V_{IL}	V_{IH}	X	X	High Z
Standby (TTL)		V_{IH}	X	X	X	High Z
Standby (CMOS)		$V_{CC} \pm 0.3$ V	X	X	X	High Z
Program		V_{IL}	V_{PP}	X	X	D_{IN}
Program Verify		V_{IL}	V_{IL}	X	X	D_{OUT}
Program Inhibit		V_{IH}	V_{PP}	X	X	High Z
Auto Select (Note 3)	Manufacturer Code	V_{IL}	V_{IL}	V_{IL}	V_H	01H
	Device Code	V_{IL}	V_{IL}	V_{IH}	V_H	91H

Notes:

1. X can be either V_{IL} or V_{IH}
2. $V_H = 12.0 \text{ V} \pm 0.5 \text{ V}$
3. A_1–$A_8 = A_{10}$–$A_{15} = V_{IL}$
4. See DC Programming Characteristics for V_{PP} voltage during programming.

ABSOLUTE MAXIMUM RATINGS

Storage Temperature:	
OTP Products	−65 to + 125°C
All Other Products	−65 to + 150°C
Ambient Temperature with Power Applied	−55 to +125°C
Voltage with Respect to Ground:	
All pins except A_9, V_{PP}, and V_{CC} (Note 1)	−0.6 to V_{CC} + 0.6 V
A_9 and V_{PP} (Note 2)	−0.6 to 13.5 V
V_{CC}	−0.6 to 7.0 V

Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only; functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. Exposure of the device to absolute maximum rating conditions for extended periods may affect device reliability.

Notes:

1. During transitions the inputs may undershoot GND to −2.0 V for periods of up to 20 ns. Maximum DC voltage on input and I/O may overshoot to V_{CC} + 2.0 V for periods up to 20 ns.
2. During transitions, A_9 and V_{PP} may undershoot GND to −2.0 V for periods of up to 20 ns. A_9 and V_{PP} must not exceed 13.5 V for any period of time.

OPERATING RANGES T-46-13-29

Commercial (C) Devices	
Case Temperature (T_C)	0 to +70°C
Industrial (I) Devices	
Case Temperature (T_C)	−40 to +85°C
Extended Commercial (E) Devices	
Case Temperature (T_C)	−55 to +125°C
Military (M) Devices	
Case Temperature (T_C)	−55 to +125°C
Supply Read Voltages:	
V_{CC}/V_{PP} for Am27C512L–XX5	+4.75 to +5.25 V
V_{CC}/V_{PP} for Am27C512L–XX0	+4.50 to +5.50 V

Operating ranges define those limits between which the functionality of the device is guaranteed.

DC CHARACTERISTICS over operating range unless otherwise specified (Notes 1, 4, 5 & 7)

TTL and NMOS

Parameter Symbol	Parameter Description	Test Conditions		Min.	Max.	Unit
V_{OH}	Output HIGH Voltage	I_{OH} = −400 µA		2.4		V
V_{OL}	Output LOW Voltage	I_{OL} = 2.1 mA			0.45	V
V_{IH}	Input HIGH Voltage			2.0	V_{CC} + 0.5	V
V_{IL}	Input LOW Voltage			−0.3	+0.8	V
I_{LI}	Input Load Current	V_{IN} = 0 V to V_{CC}	C/I Devices		1.0	µA
			E/M Devices		5.0	
I_{LO}	Output Leakage Current	V_{OUT} = 0 V to V_{CC}	C/I Devices		2.0	µA
			E/M Devices		5.0	
I_{CC1}	V_{CC} Active Current (Note 5)	$\overline{CE}$ = VIL, f = 10 MHz, I_{OUT} = 0 mA (Open Outputs)	C/I Devices		15	mA
			E/M Devices		25	
I_{CC2}	V_{CC} Standby Current	$\overline{CE}$ = V_{IH}, $\overline{OE}$ = V_{IL}	C/I Devices		1.0	mA
			E/M Devices		1.0	

DC CHARACTERISTICS over operating range unless otherwise specified (Continued)

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CMOS

Parameter Symbol	Parameter Description	Test Conditions		Min.	Max.	Unit
V_{OH}	Output HIGH Voltage	I_{OH} = –400 µA		V_{CC} – 0.8		V
V_{OL}	Output LOW Voltage	I_{OL} = 2.1 mA			0.45	V
V_{IH}	Input HIGH Voltage			0.7 V_{CC}	V_{CC} + 0.5	V
V_{IL}	Input LOW Voltage			–0.5	+0.8	V
I_{LI}	Input Load Current	V_{IN} = 0 V to V_{CC}	C/I Devices		1.0	µA
			E/M Devices		1.0	
I_{LO}	Output Leakage Current	V_{OUT} = 0 V to V_{CC}	C/I Devices		2.0	µA
			E/M Devices		5.0	
I_{CC1}	V_{CC} Active Current (Note 5 & 8)	$\overline{CE}$ = VIL, f = 5 MHz, I_{OUT} = 0 mA (Open Outputs)	C/I Devices		5.0	mA
			E/M Devices		10	
I_{CC2}	V_{CC} Standby Current	$\overline{CE}$ = V_{CC} ± 0.3 V	C/I Devices		20	µA
			E/M Devices		40	

CAPACITANCE (Notes 2, 3, & 6)

Parameter Symbol	Parameter Description	Test Conditions	CDV028 Max.	CLV032 Max.	Unit
C_{IN1}	Address Input Capacitance	V_{IN} = 0 V	12	9	pF
C_{IN2}	$\overline{OE}/V_{PP}$ Input Capacitance	V_{IN} = 0 V	20	20	pF
C_{IN3}	$\overline{CE}$ Input Capacitance	V_{IN} = 0 V	12	9	pF
C_{OUT}	Output Capacitance	V_{OUT} = 0 V	15	12	pF

Notes:

1. V_{CC} must be applied simultaneously or before V_{PP}, and removed simultaneously or after V_{PP}.
2. Typical values are for nominal supply voltages.
3. This parameter is only sampled and not 100% tested.
4. **Caution:** The Am27C512L must not be removed from, or inserted into, a socket or board when V_{PP} or V_{CC} is applied.
5. I_{CC1} is tested with $\overline{OE}$ = V_{IH} to simulate open outputs.
6. TA = 25°C, f = 1 MHz.
7. During transitions, the inputs may overshoot to –2.0 V for periods less than 20 ns. Maximum DC voltage on input pins may overshoot to V_{CC} + 2.0 V for periods less than 20 ns.
8. I_{CC1} varies 1 mA per MHz for C/I devices. I_{CC1} varies 2 mA per MHz for E/M devices.

SWITCHING CHARACTERISTICS over operating ranges unless otherwise specified (Notes 1, 3, & 4)

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Parameter Symbols		Parameter Description	Test Conditions		Am27C512L						Unit
JEDEC	Standard				-75	-90, -95	-120, -125	-150	-200	-255, -250	
t_{AVQV}	t_{ACC}	Address to Output Delay	$\overline{CE} = \overline{OE}/V_{PP} = V_{IL}$	Min.							ns
				Max.	70	90	120	150	200	250	
t_{ELQV}	t_{CE}	Chip Enable to Output Delay	$\overline{OE}/V_{PP} = V_{IL}$	Min.							ns
				Max.	70	90	120	150	200	250	
t_{GLQV}	t_{OE}	Output Enable to Output Delay	$\overline{CE} = V_{IL}$	Min.							ns
				Max.	40	40	50	50	75	100	
t_{EHQZ}, t_{GHQZ}	t_{DF}	Output Enable HIGH to Output Float (Note 2)		Min.							ns
				Max.	25	30	30	30	30	30	
t_{AXQX}	t_{OH}	Output Hold from Addresses, $\overline{CE}$, or $\overline{OE}$, whichever occurred first		Min.	0	0	0	0	0	0	ns
				Max.							

Notes:

1. V_{CC} must be applied simultaneously or before V_{PP}, and removed simultaneously or after V_{PP}.
2. This parameter is only sampled and not 100% tested.
3. **Caution:** The Am27C512L must not be removed from, or inserted into, a socket or board when V_{PP} or V_{CC} is applied.
4. For the Am27C512L-75:
   Output Load: 1 TTL gate and C_L = 30 pF,
   Input Rise and Fall Times: 20 ns,
   Input Pulse Levels: 0 to 3 V,
   Timing Measurement Reference Level: 1.5 V for inputs and outputs.

For all other versions:
   Output Load: 1 TTL gate and CL = 100 pF,
   Input Rise and Fall Times: 20 ns,
   Input Pulse Levels: 0.45 to 2.4 V,
   Timing Measurement Reference Level: 0.8 V and 2 V for inputs and outputs.

SWITCHING TEST CIRCUIT

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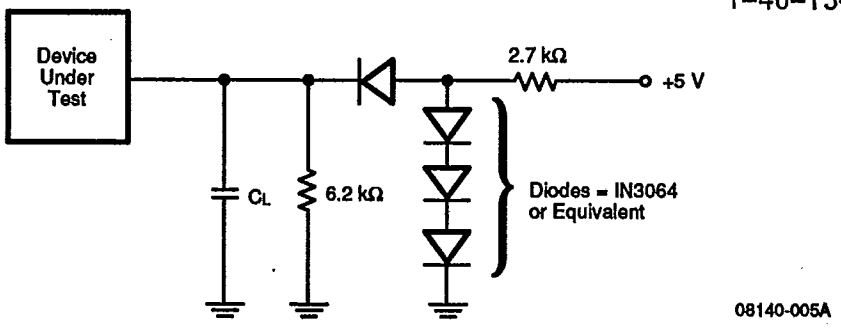
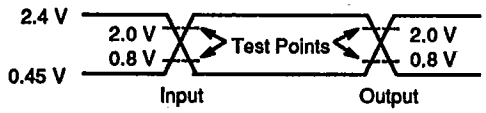
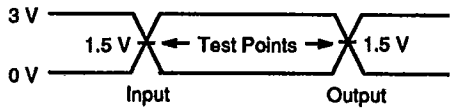


C_L = 100 pF including jig capacitance (30 pF for -75)

SWITCHING TEST WAVEFORMS



AC Testing: Inputs are driven at 2.4 V for a logic "1" and 0.45 V for a logic "0". Input pulse rise and fall times are ≤ 20 ns.



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AC Testing: Inputs are driven at 3.0 V for a logic "1" and 0 V for a logic "0". Input pulse rise and fall times are ≤ 20 ns for -75 devices.

SWITCHING WAVEFORMS

Key to Switching Waveforms

WAVEFORM	INPUTS	OUTPUTS
	Must be Steady	Will be Steady
	May Change from H to L	Will be Changing from H to L
	May Change from L to H	Will be Changing from L to H
	Don't Care, Any Change Permitted	Changing, State Unknown
	Does Not Apply	Center Line is High-Impedance "Off" State

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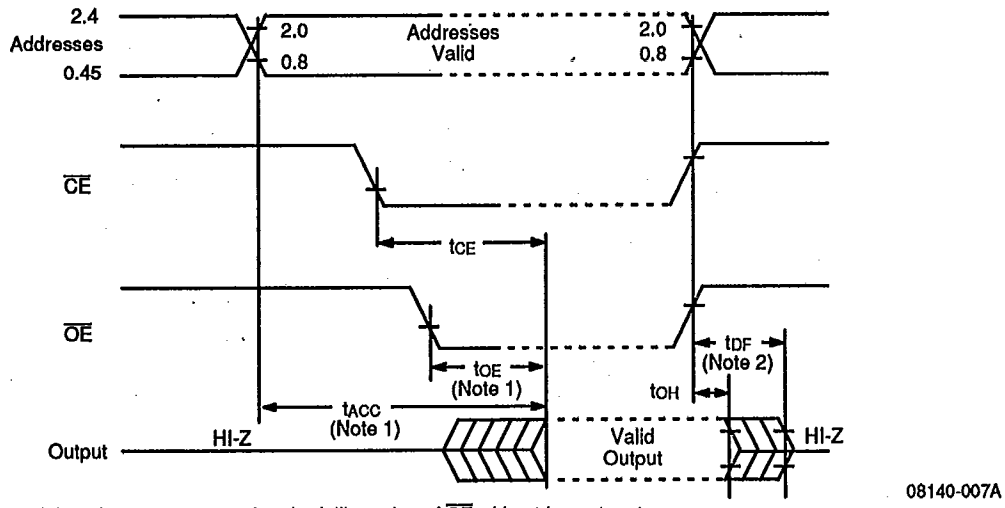

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Notes:
1. $\overline{OE}$ may be delayed up to $t_{ACC}-t_{OE}$ after the falling edge of $\overline{CE}$ without impact on t_{ACC}.
2. t_{DF} is specified from $\overline{OE}$ or $\overline{CE}$, whichever occurs first.

PROGRAMMING FLOW CHART

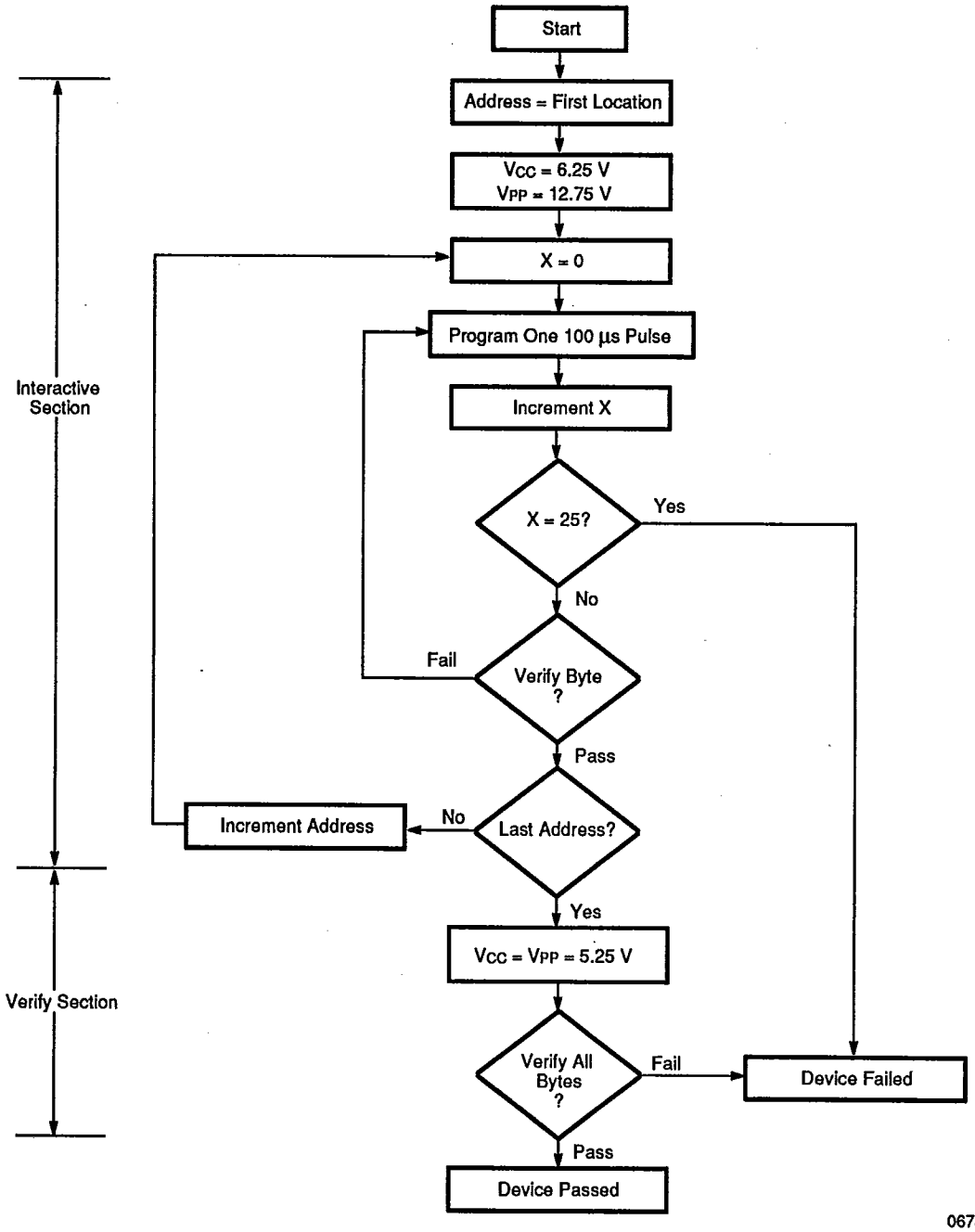

Figure 1. Flashrite Programming Flow Chart

DC PROGRAMMING CHARACTERISTICS (T_A = +25°C ± 5°C) (Notes 1, 2, & 3)

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Parameter Symbol	Parameter Description	Test Conditions	Min.	Max.	Unit
I_{LI}	Input Current (All Inputs)	$V_{IN} = V_{IL}$ or V_{IH}		10.0	µA
V_{IL}	Input LOW Level (All Inputs)		–0.3	0.8	V
V_{IH}	Input HIGH Level		2.0	V_{CC} + 0.5	V
V_{OL}	Output LOW Voltage During Verify	I_{OL} = 2.1 mA		0.45	V
V_{OH}	Output HIGH Voltage During Verify	I_{OH} = –400 µA	2.4		V
V_H	A_9 Auto Select Voltage		11.5	12.5	V
I_{CC}	V_{CC} Supply Current (Program & Verify)			50	mA
I_{PP}	V_{PP} Supply Current (Program)	$\overline{CE} = V_{IL}$		30	mA
V_{CC}	Flashrite Supply Voltage		6.00	6.50	V
V_{PP}	Flashrite Programming Voltage		12.5	13.0	V

SWITCHING PROGRAMMING CHARACTERISTICS (T_A = +25°C ± 5°C) (Notes 1, 2, & 3)

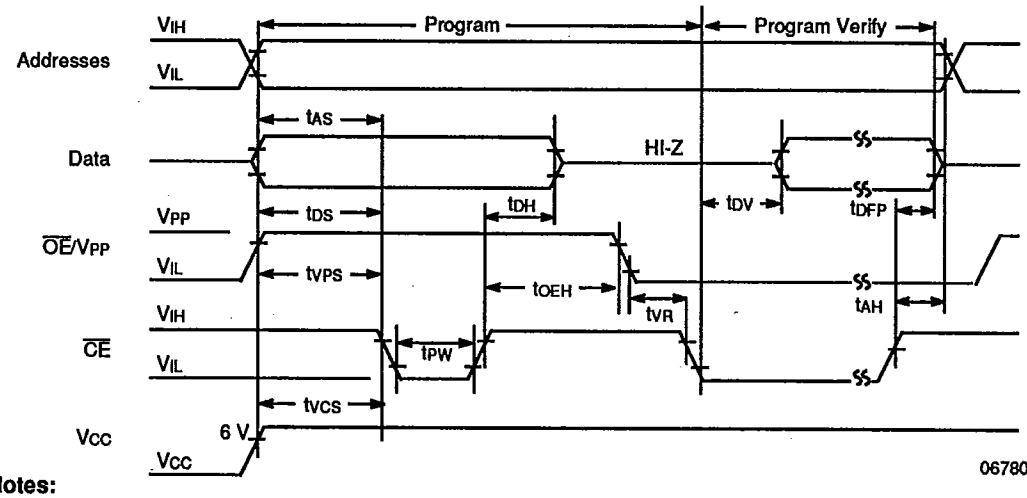
Parameter Symbols		Parameter Description	Min.	Max.	Unit
JEDEC	Standard				
t_{AVEL}	t_{AS}	Address Setup Time	2		µs
t_{DVEL}	t_{DS}	Data Setup Time	2		µs
t_{GHAX}	t_{AH}	Address Hold Time	0		µs
t_{EHDX}	t_{DH}	Data Hold Time	2		µs
t_{EHQZ}	t_{DFP}	Chip Enable to Output Float Delay	0	60	ns
t_{VPS}	t_{VPS}	V_{PP} Setup Time	2		µs
t_{ELEH}	t_{PW}	$\overline{CE}$ Program Pulse Width	95	105	µs
t_{VCS}	t_{VCS}	V_{CC} Setup Time	2		µs
t_{ELQV}	t_{DV}	Data Valid from $\overline{CE}$		250	ns
t_{EHGL}	t_{OEH}	$\overline{OE}$/V_{PP} Hold Time	2		µs
t_{GLEL}	t_{VR}	$\overline{OE}$/V_{PP} Recovery Time	2		µs

Notes:

1. V_{CC} must be applied simultaneously or before V_{PP}, and removed simultaneously or after V_{PP}.
2. When programming the Am27C512L, a 0.1 µF capacitor is required across V_{PP} and ground to suppress spurious voltage transients which may damage the device.
3. Programming characteristics are sampled but not 100% tested at worst-case conditions.

PROGRAMMING ALGORITHM WAVEFORMS (Notes 1 & 2)

T-46-13-29



Notes:

1. The input timing reference level is 0.8 V for V_{IL} and 2.0 V for V_{IH}.
2. t_{OE} and t_{DFP} are characteristics of the device, but must be accommodated by the programmer.