

# Am27C020

## 2 Megabit (262,144 x 8-Bit) CMOS EPROM

### DISTINCTIVE CHARACTERISTICS

- **Fast access time**
  - 55 ns maximum access time
- **Low power consumption**
  - 100  $\mu$ A typical CMOS standby current
- **JEDEC-approved pinout**
  - Plug in upgrade of 1 Mbit EPROM
  - Easy upgrade from 28-pin JEDEC EPROMs
- **Single +5 V power supply**
- **$\pm 10\%$  power supply tolerance available**
- **100% Flashrite programming**
  - Typical programming time of 32 seconds
- **Latch-up protected to 100 mA from  $-1\text{ V}$  to  $V_{CC} + 1\text{ V}$**
- **High noise immunity**
- **Versatile features for simple interfacing**
  - Both CMOS and TTL input/output compatibility
  - Two line control functions
- **Compact 32-pin DIP, PDIP, TSOP, and PLCC packages**

### GENERAL DESCRIPTION

The Am27C020 is a 2 Mbit, ultraviolet erasable programmable read-only memory. It is organized as 256K 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 packages, as well as plastic one-time programmable (OTP) including TSOP, PLCC, and PDIP.

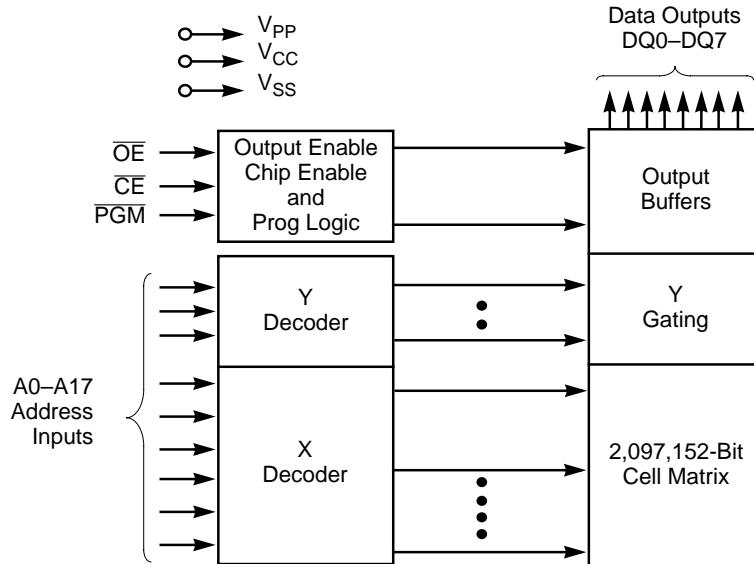
Typically, any byte can be accessed in less than 70 ns, allowing operation with high-performance microprocessors without any WAIT states. The Am27C020 offers separate Output Enable (OE) and Chip Enable ( $\overline{CE}$ )

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 100 mW in active mode, and 100  $\mu$ W in standby mode.

All signals are TTL levels, including programming signals. Bit locations may be programmed singly, in blocks, or at random. The Am27C020 supports AMD's Flashrite programming algorithm (100  $\mu$ s pulses) resulting in typical programming times of 32 seconds.

### BLOCK DIAGRAM



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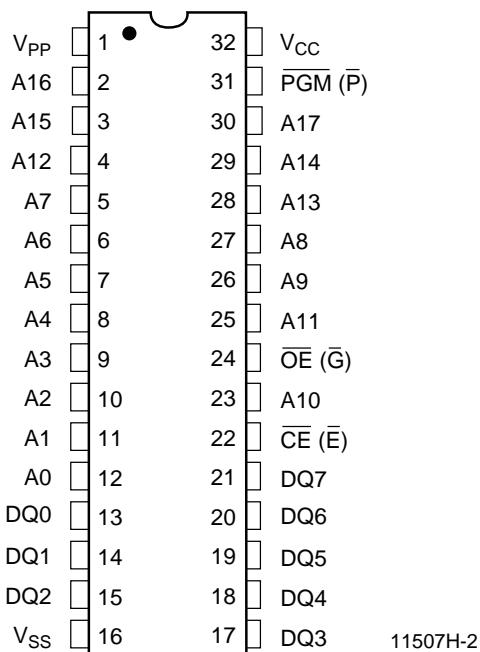
## PRODUCT SELECTOR GUIDE

Family Part No.	Am27C020						
Ordering Part No: $V_{CC} = 5.0\text{ V} \pm 5\%$ $V_{CC} = 5.0\text{ V} \pm 10\%$	-55	-75					-255
	-55	-70	-90	-120	-150	-200	
Max Access Time (ns)	55	70	90	120	150	200	250
$\overline{CE}(\bar{E})$ Access (ns)	55	70	90	120	150	200	250
$\overline{OE}(\bar{G})$ Access (ns)	35	40	40	50	65	75	75

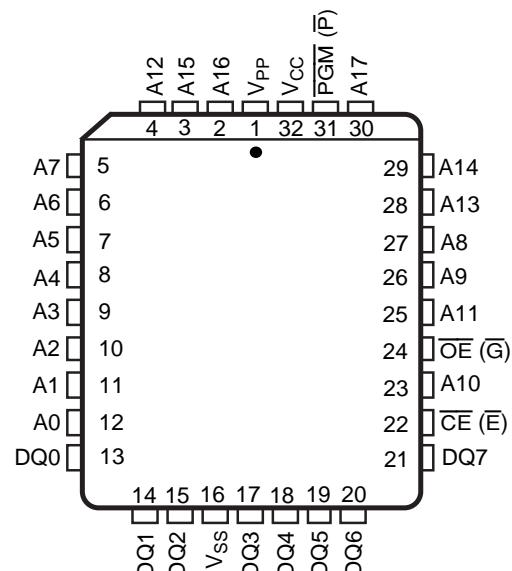
## CONNECTION DIAGRAMS

## Top View

DIP



PLCC



## Notes:

1. JEDEC nomenclature is in parenthesis.
2. The 32-pin DIP to 32-pin PLCC configuration varies from the JEDEC 28-pin DIP to 32-pin PLCC configuration.

## TSOP

A11	1	○	32	OE
A9	2		31	A10
A8	3		30	CE
A13	4		29	DQ7
A14	5		28	DQ6
A17	6		27	DQ5
PGM	7		26	DQ4
V <sub>CC</sub>	8		25	DQ3
V <sub>PP</sub>	9		24	V <sub>SS</sub>
A16	10		23	DQ2
A15	11		22	DQ1
A12	12		21	DQ0
A7	13		20	A0
A6	14		19	A1
A5	15		18	A2
A4	16		17	A3

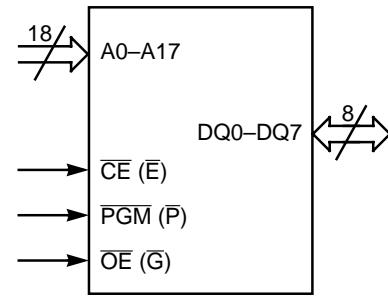
Standard Pinout

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## PIN DESIGNATIONS

A0–A17	= Address Inputs
CE (E)	= Chip Enable Input
DQ0–DQ7	= Data Input/Outputs
OE (G)	= Output Enable Input
PGM (P)	= Program Enable Input
V <sub>CC</sub>	= V <sub>CC</sub> Supply Voltage
V <sub>PP</sub>	= Program Voltage Input
V <sub>SS</sub>	= Ground

## LOGIC SYMBOL

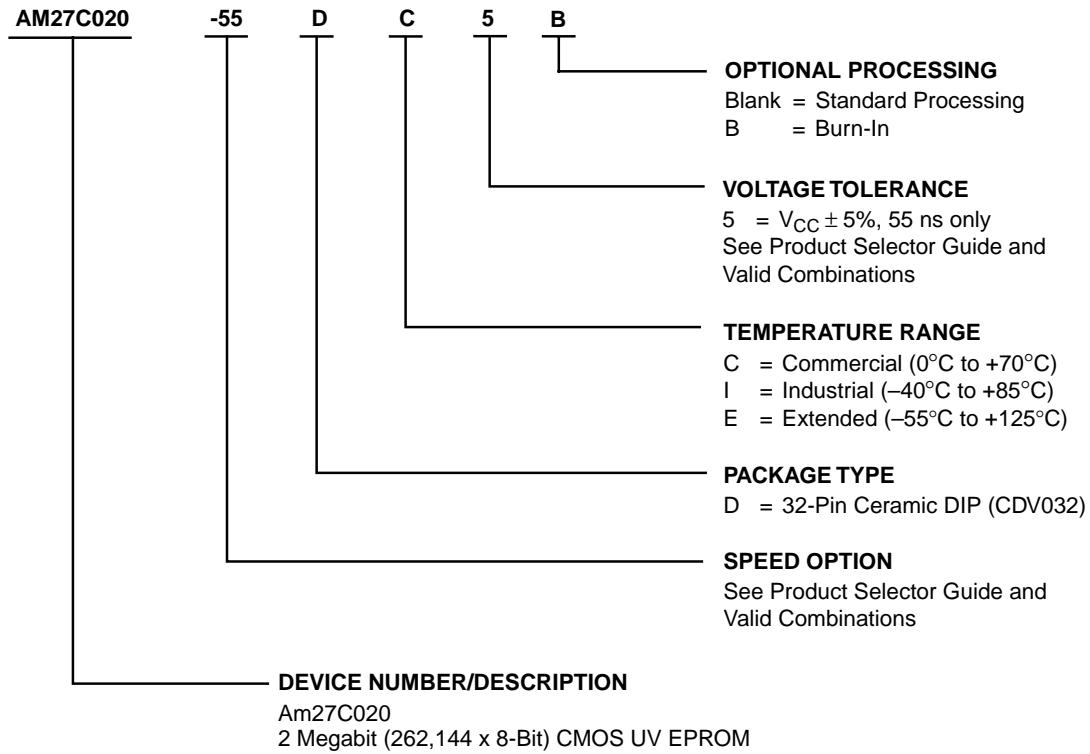


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## ORDERING INFORMATION

## UV EPROM Products

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



Valid Combinations	
AM27C020-55 $V_{CC} = 5.0 \text{ V} \pm 5\%$	DC5, DC5B, DI5, DI5B
AM27C020-55 $V_{CC} = 5.0 \text{ V} \pm 10\%$	
AM27C020-70	DC, DCB, DI, DIB
AM27C020-90	
AM27C020-120	
AM27C020-150	DC, DCB, DE, DEB, DI, DIB
AM27C020-200	
AM27C020-255 $V_{CC} = 5.0 \text{ V} \pm 5\%$	DC, DCB, DI, DIB

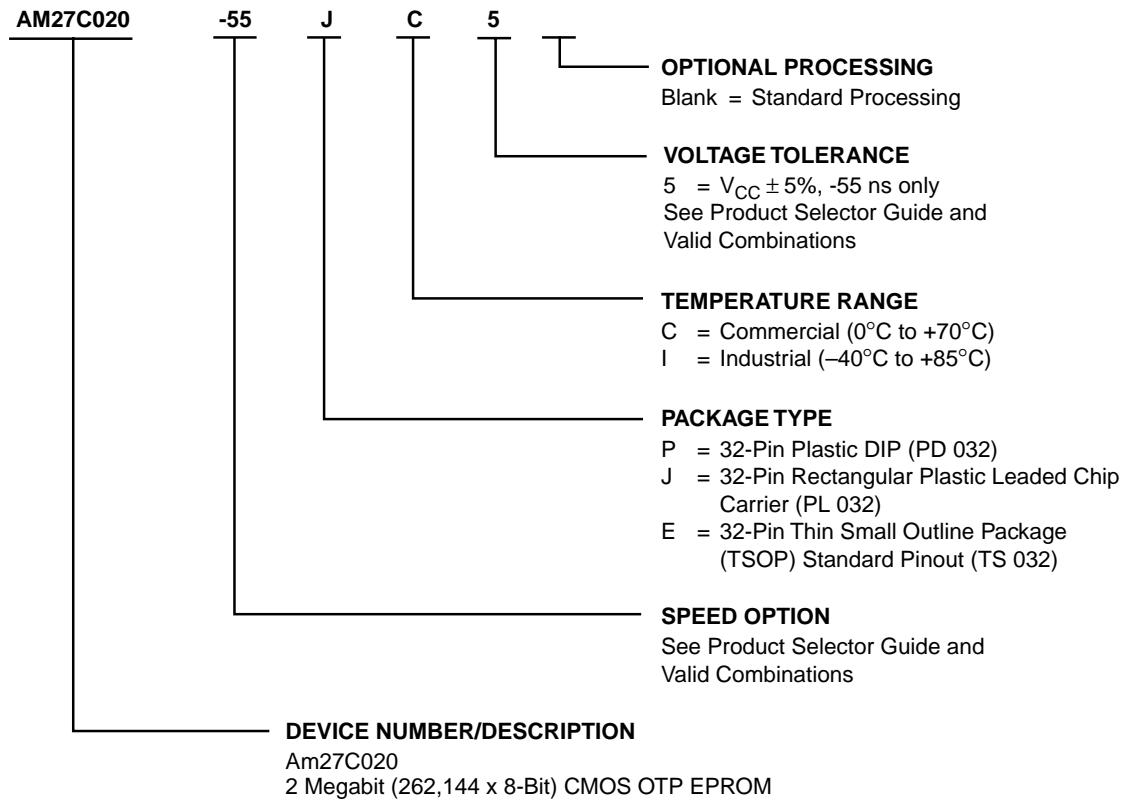
## Valid Combinations

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 and to check on newly released combinations.

## ORDERING INFORMATION

### OTP EPROM Products

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



Valid Combinations	
AM27C020-55 $V_{CC} = 5.0 \text{ V} \pm 5\%$	PC5, PI5, JC5, JI5, EC5, EI5
AM27C020-55 $V_{CC} = 5.0 \text{ V} \pm 10\%$	
AM27C020-75	
AM27C020-70	
AM27C020-90	
AM27C020-120	PC, PI, JC, JI, EC, EI
AM27C020-150	
AM27C020-200	
AM27C020-255 $V_{CC} = 5.0 \text{ V} \pm 5\%$	

### 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 and to check on newly released combinations.

## FUNCTIONAL DESCRIPTION

### Erasing the Am27C020

In order to clear all locations of their programmed contents, it is necessary to expose the Am27C020 to an ultraviolet light source. A dosage of 15 W seconds/cm<sup>2</sup> is required to completely erase an Am27C020. This dosage can be obtained by exposure to an ultraviolet lamp — wavelength of 2537 Å — with intensity of 12,000  $\mu$ W/cm<sup>2</sup> for 15 to 20 minutes. The Am27C020 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 Am27C020, 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 Am27C020 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 Am27C020

Upon delivery, or after each erasure, the Am27C020 has all 2,097,152 bits in the “ONE”, or HIGH state. “ZEROs” are loaded into the Am27C020 through the procedure of programming.

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

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

The Flashrite algorithm reduces programming time by using 100  $\mu$ s programming pulse and by giving each address only as many pulses as are necessary in order to reliably program the data. After each pulse is applied to a given address, the data in that address is verified. If the data does not verify, additional pulses are given until it verifies or the maximum is reached. This process is repeated while sequencing through each address of the Am27C020. This part of the algorithm is done at V<sub>CC</sub> = 6.25 V to assure that each EPROM bit is programmed to a sufficiently high threshold voltage. After the final address is completed, the entire EPROM memory is verified at V<sub>CC</sub> = V<sub>PP</sub> = 5.25 V.

### Program Inhibit

Programming of multiple Am27C020s in parallel with different data is also easily accomplished. Except for  $\overline{CE}$ , all like inputs of the parallel Am27C020 may be common. A TTL low-level program pulse applied to an

Am27C020  $\overline{CE}$  input with V<sub>PP</sub> = 12.75 V ± 0.25 V,  $\overline{PGM}$  LOW, and  $\overline{OE}$  HIGH will program that Am27C020.

A high-level  $\overline{CE}$  input inhibits the other Am27C020s 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  $\overline{OE}$  and  $\overline{CE}$  at V<sub>IL</sub>,  $\overline{PGM}$  at V<sub>IH</sub>, and V<sub>PP</sub> between 12.5 V and 13.0 V.

### 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 programmed with its corresponding programming algorithm. This mode is functional in the 25°C ± 5°C ambient temperature range that is required when programming the Am27C020.

To activate this mode, the programming equipment must force 12.0 V ± 0.5 V on address line A9 of the Am27C020. Two identifier bytes may then be sequenced from the device outputs by toggling address line A0 from V<sub>IL</sub> to V<sub>IH</sub>. All other address lines must be held at V<sub>IL</sub> during auto select mode.

Byte 0 (A0 = V<sub>IL</sub>) represents the manufacturer code, and Byte 1 (A0 = V<sub>IH</sub>), the device identifier code. For the Am27C020, 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 (DQ7) defined as the parity bit.

### Read Mode

The Am27C020 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<sub>ACC</sub>) is equal to the delay from  $\overline{CE}$  to output (t<sub>CE</sub>). Data is available at the outputs t<sub>OE</sub> after the falling edge of  $\overline{OE}$ , assuming that  $\overline{CE}$  has been LOW and addresses have been stable for at least t<sub>ACC</sub> - t<sub>OE</sub>.

### Standby Mode

The Am27C020 has a CMOS standby mode which reduces the maximum V<sub>CC</sub> current to 100 mA. It is placed in CMOS-standby when  $\overline{CE}$  is at V<sub>CC</sub> ± 0.3 V. The Am27C020 also has a TTL-standby mode which reduces the maximum V<sub>CC</sub> current to 1.0 mA. It is placed in TTL-standby when  $\overline{CE}$  is at V<sub>IH</sub>. When in standby mode, the outputs are in a high-impedance state, independent of the  $\overline{OE}$  input.

## Output OR-Tieing

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

- Low memory power dissipation, and
- 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  $0.1 \mu F$  ceramic capacitor (high frequency, low inherent inductance) should be used on each device between  $V_{CC}$  and  $V_{SS}$  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  $4.7 \mu F$  bulk electrolytic capacitor should be used between  $V_{CC}$  and  $V_{SS}$  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	$\overline{CE}$	$\overline{OE}$	$\overline{PGM}$	$A0$	$A9$	$V_{PP}$	Outputs
Read		$V_{IL}$	$V_{IL}$	X	X	X	X	$D_{OUT}$
Output Disable		X	$V_{IH}$	X	X	X	X	High Z
Standby (TTL)		$V_{IH}$	X	X	X	X	X	High Z
Standby (CMOS)		$V_{CC} \pm 0.3 V$	X	X	X	X	X	High Z
Program		$V_{IL}$	$V_{IH}$	$V_{IL}$	X	X	$V_{PP}$	$D_{IN}$
Program Verify		$V_{IL}$	$V_{IL}$	$V_{IH}$	X	X	$V_{PP}$	$D_{OUT}$
Program Inhibit		$V_{IH}$	X	X	X	X	$V_{PP}$	High Z
Auto Select (Note 3)	Manufacturer Code	$V_{IL}$	$V_{IL}$	X	$V_{IL}$	$V_H$	X	01H
	Device Code	$V_{IL}$	$V_{IL}$	X	$V_{IH}$	$V_H$	X	97H

### Notes:

1.  $V_H = 12.0 V \pm 0.5 V$ .
2. X = Either  $V_{IH}$  or  $V_{IL}$ .
3.  $A1-A8 = A10-A17 = V_{IL}$ .
4. See DC Programming Characteristics for  $V_{PP}$  voltage during programming.

## ABSOLUTE MAXIMUM RATINGS

### Storage Temperature:

OTP Products . . . . .  $-65^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$   
All Other Products . . . . .  $-65^{\circ}\text{C}$  to  $+150^{\circ}\text{C}$

Ambient Temperature  
with Power Applied. . . . .  $-55^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$

### Voltage with Respect to $V_{SS}$ :

All pins except A9,  $V_{PP}$ ,  $V_{CC}$  . . . . .  $-0.6\text{ V}$  to  $V_{CC} + 0.6\text{ V}$   
A9 and  $V_{PP}$  (Note 2) . . . . .  $-0.6\text{ V}$  to  $13.5\text{ V}$   
 $V_{CC}$  (Note 1) . . . . .  $-0.6\text{ V}$  to  $7.0\text{ V}$

### Notes:

1. Minimum DC voltage on input or I/O pins is  $-0.5\text{ V}$ . During voltage transitions, the input may overshoot  $V_{SS}$  to  $-2.0\text{ V}$  for periods of up to 20 ns. Maximum DC voltage on input and I/O pins is  $V_{CC} + 0.5\text{ V}$ . During voltage transitions, input and I/O pins may overshoot to  $V_{CC} + 2.0\text{ V}$  for periods of up to 20 ns.
2. Minimum DC input voltage on A9 pin is  $-0.5\text{ V}$ . During voltage transitions, A9 and  $V_{PP}$  may overshoot  $V_{SS}$  to  $-2.0\text{ V}$  for periods of up to 20 ns. A9 and  $V_{CC}$  must not exceed  $+13.5\text{ V}$  for any period of time.

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 to absolute maximum ratings for extended periods may affect device reliability.

## OPERATING RANGES

### Commercial (C) Devices

Ambient Temperature (TA) . . . . .  $0^{\circ}\text{C}$  to  $+70^{\circ}\text{C}$

### Industrial (I) Devices

Ambient Temperature (TA) . . . . .  $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$

### Extended (E) Devices

Ambient Temperature (TA) . . . . .  $-55^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$

### Supply Read Voltages:

$V_{CC}$  for Am27C020-55, 75, 255 . . . . .  $+4.75\text{ V}$  to  $+5.25\text{ V}$

$V_{CC}$  for Am27C020-55, 70,  
90, 120, 150, 200 . . . . .  $+4.50\text{ V}$  to  $+5.50\text{ V}$

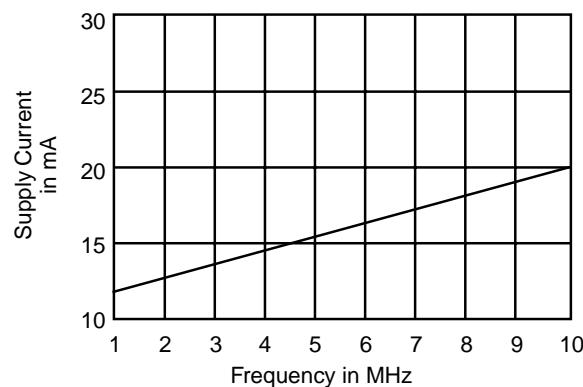
*Operating ranges define those limits between which the functionality of the device is guaranteed.*

**DC CHARACTERISTICS** over operating ranges unless otherwise specified  
(Notes 1, 2, and 4)

PRELIMINARY						
Parameter Symbol	Parameter Description	Test Conditions		Min	Max	Unit
$V_{OH}$	Output HIGH Voltage	$I_{OH} = -400 \mu A$		2.4		V
$V_{OL}$	Output LOW Voltage	$I_{OL} = 2.1 \text{ mA}$			0.45	V
$V_{IH}$	Input HIGH Voltage			2.0	$V_{CC} + 0.5$	V
$V_{IL}$	Input LOW Voltage			-0.5	+0.8	V
$I_{LI}$	Input Load Current	$V_{IN} = 0 \text{ V to } V_{CC}$			1.0	$\mu A$
$I_{LO}$	Output Leakage Current	$V_{OUT} = 0 \text{ V to } V_{CC}$			5.0	$\mu A$
$I_{CC1}$	$V_{CC}$ Active Current (Note 3)	$\overline{CE} = V_{IL}$ , $f = 10 \text{ MHz}$ , $I_{OUT} = 0 \text{ mA}$	<b>C/I Devices</b>	30	mA	
			<b>E Devices</b>	60		
$I_{CC2}$	$V_{CC}$ TTL Standby Current	$\overline{CE} = V_{IH}$			1.0	mA
$I_{CC3}$	$V_{CC}$ CMOS Standby Current	$\overline{CE} = V_{CC} + 0.3 \text{ V}$			100	$\mu A$
$I_{PP1}$	$V_{PP}$ Supply Current (Read)	$CE = OE = V_{IL}$ , $V_{PP} = V_{CC}$			100	$\mu A$

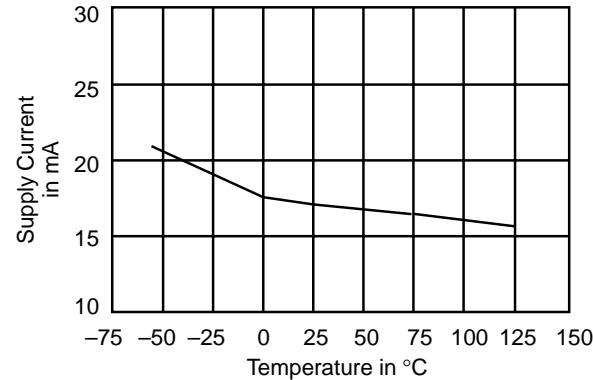
**Notes:**

1.  $V_{CC}$  must be applied simultaneously or before  $V_{PP}$  and removed simultaneously or after  $V_{PP}$
2. **Caution:** The Am27C020 must not be removed from (or inserted into) a socket when  $V_{CC}$  or  $V_{PP}$  is applied.
3.  $I_{CC1}$  is tested with  $\overline{OE} = V_{IH}$  to simulate open outputs.
4. Minimum DC Input Voltage is -0.5 V. During transitions, the inputs may overshoot to -2.0 V for periods less than 20 ns. Maximum DC Voltage on output pins is  $V_{CC} + 0.5$  V, which may overshoot to  $V_{CC} + 2.0$  V for periods less than 20 ns.



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**Figure 1. Typical Supply Current vs. Frequency**  
 $V_{CC} = 5.5 \text{ V}$ ,  $T = 25^\circ\text{C}$



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**Figure 2. Typical Supply Current vs. Temperature**  
 $V_{CC} = 5.5 \text{ V}$ ,  $f = 10 \text{ MHz}$

## CAPACITANCE

Parameter Symbol	Parameter Description	Test Conditions	CDV032		PD 032		PL 032		TS 032		Unit
			Typ	Max	Typ	Max	Typ	Max	Typ	Max	
$C_{IN}$	Input Capacitance	$V_{IN} = 0$	10	12	10	12	8	10	10	12	pF
$C_{OUT}$	Output Capacitance	$V_{OUT} = 0$	12	15	12	15	9	12	12	14	pF

**Notes:**

1. This parameter is only sampled and not 100% tested.
2.  $T_A = +25^\circ C$ ,  $f = 1$  MHz.

## AC CHARACTERISTICS

Parameter Symbols		Description	Test Setup		Am27C020							Unit
JEDEC	Standard				-55	-75	-70	-90	-120	-150	-200	
$t_{AVQV}$	$t_{ACC}$	Address to Output Delay	$\overline{CE}$ , $\overline{OE} = V_{IL}$	Max	55	70	90	120	150	200	250	ns
$t_{ELQV}$	$t_{CE}$	Chip Enable to Output Delay	$\overline{OE} = V_{IL}$	Max	55	70	90	120	150	200	250	ns
$t_{GLQV}$	$t_{OE}$	Output Enable to Output Delay	$\overline{CE} = V_{IL}$	Max	40	40	40	50	65	75	100	ns
$t_{EHQZ}$ $t_{GHQZ}$	$t_{DF}$ (Note 3)	Chip Enable High or Output Enable High to Output Float, Whichever Occurs First		Max	25	25	25	30	30	40	60	ns
$t_{AXQX}$	$t_{OH}$	Output Hold Time from Addresses, $\overline{CE}$ or $\overline{OE}$ , Whichever Occurs First		Min	0	0	0	0	0	0	0	ns

**Notes:**

1. **Caution:** Do not remove the Am27C020 from (or insert it into) a socket or board that has  $V_{PP}$  or  $V_{CC}$  applied.
2.  $V_{CC}$  must be applied simultaneously or before  $V_{PP}$  and removed simultaneously or after  $V_{PP}$
3. This parameter is sampled and not 100% tested.
4. Switching characteristics are over operating range, unless otherwise specified.
5. Test Conditions for Am27C020-55:

Output Load: 1 TTL gate and  $C_L = 30$  pF

Input rise and fall times: 20 ns

Input pulse levels: 0.0 V to 3.0 V

Timing measurement reference level Inputs and Outputs: 1.5 V

Test Conditions for all others:

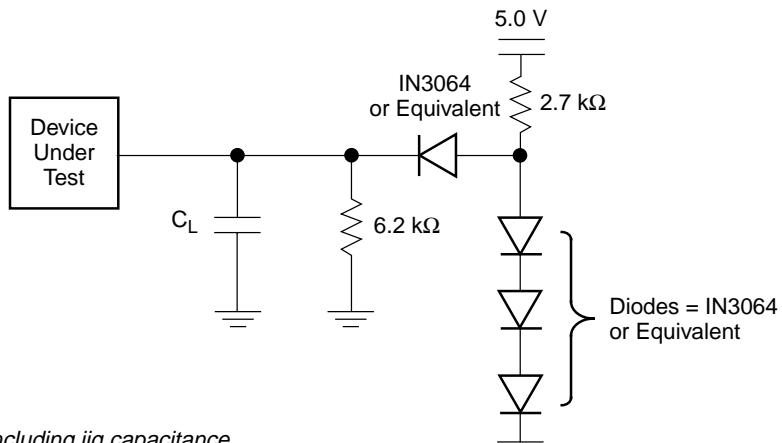
Output Load: 1 TTL gate and  $C_L = 100$  pF

Input rise and fall times: 20 ns

Input pulse levels: 0.45 V to 2.4 V

Timing measurement reference level Inputs and Outputs: 0.8 and 2.0 V

## SWITCHING TEST CIRCUIT

**Notes:**

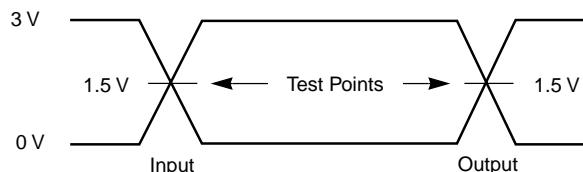
For -55:  $C_L = 30 \text{ pF}$  including jig capacitance

For all others:  $C_L = 100 \text{ pF}$  including jig capacitance

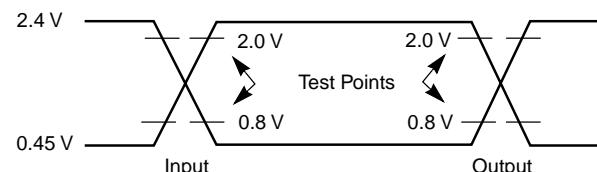
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## Test Conditions

## SWITCHING TEST WAVEFORM



AC Testing for -55 devices: 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  $\leq 20 \text{ ns}$ .



AC Testing (except for -55 devices): 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  $\leq 20 \text{ ns}$ .

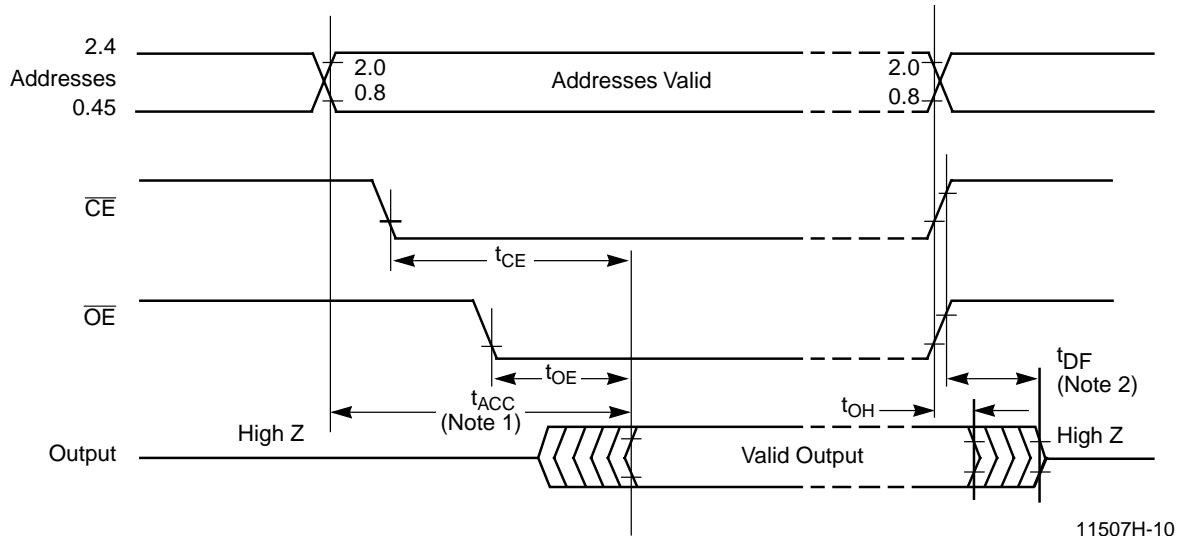
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## KEY TO SWITCHING WAVEFORMS

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
XXXX	Don't Care, Any Change Permitted	Changing, State Unknown
\\ \\	Does Not Apply	Center Line is High-Impedance "Off" State

KS000010

## SWITCHING WAVEFORM

**Notes:**

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

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## REVISION SUMMARY FOR AM27C020

**Distinctive Characteristics:**

The fastest speed grade available is now 55 ns.

**Product Selector Guide:**

Corrected family part number.

Added 55 ns column.

**Connection Diagrams**

PLCC Package: Corrected pin 30 to A17.

**Ordering Information, UV EPROM Products:**

The 55 ns part number is now listed in the example. The nomenclature now has a method of clearly designating the voltage operating range and speed grade.

*Valid Combinations:* The 55 ns speed grade is now also available in the industrial temperature range, and can be burned in.

**Ordering Information, OTP EPROM Products:**

Changed the part number example from -75 to -55. The nomenclature now has a method of clearly designating the voltage operating range and speed grade.

*Valid Combinations:* Added the 55 ns speed grade to the table.

**Operating Ranges:**

Changed Supply Read Voltages listings to match those in the Product Selector Guide.

**AC Characteristics:**

Added column for 55 ns speed grade, rearranged notes, moved text from table title to Note 4, renamed table.

**Switching Test Circuit:**

Added 55 ns to the  $C_L$  note on 30 pF test condition.

**Switching Test Waveform:**

Added the 3 V test waveform.