

# TMS27C020 2 097 152 BIT UV ERASABLE PROGRAMMABLE READ-ONLY MEMORY TMS27PC020 2 097 152 BIT PROGRAMMABLE READ-ONLY MEMORY

SMS020A—NOVEMBER 1990—REVISED JANUARY 1993

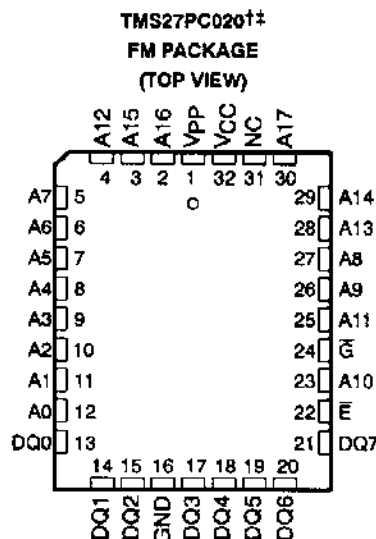
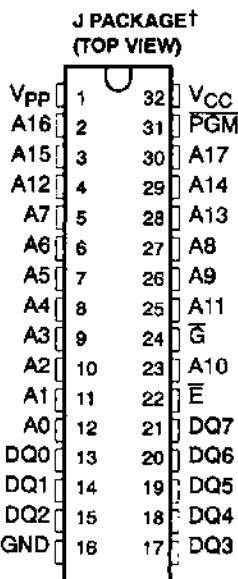
- Organization . . . 256K × 8
- Single 5-V Power Supply
- Operationally Compatible With Existing Megabit EPROMs
- Industry Standard 32-Pin Dual-In-line Package and 32-Lead Plastic Leaded Chip Carrier
- All Inputs/Outputs Fully TTL Compatible
- ±10% V<sub>CC</sub> Tolerance
- Max Access/Min Cycle Time  
V<sub>CC</sub> ± 10%  

'27C/PC020-12	120 ns
'27C/PC020-15	150 ns
'27C/PC020-20	200 ns
'27C/PC020-25	250 ns
- 8-Bit Output For Use in Microprocessor-Based Systems
- Very High-Speed SNAP! Pulse Programming
- Power Saving CMOS Technology
- 3-State Output Buffers
- 400 mV Minimum DC Noise Immunity With Standard TTL Loads
- Latchup Immunity of 250 mA on All Input and Output Pins
- No Pullup Resistors Required
- Low Power Dissipation (V<sub>CC</sub> = 5.5 V)  
 — Active . . . 165 mW Worst Case  
 — Standby . . . 0.55 mW Worst Case (CMOS-Input Levels)
- PEP4 Version Available With 168-Hour Burn-In, and Choices of Operating Temperature Ranges

## description

The TMS27C020 series are 2 097 152-bit, ultraviolet-light erasable, electrically programmable read-only memories.

The TMS27PC020 series are one-time electrically programmable read-only memories.



PIN NOMENCLATURE	
A0–A17	Address Inputs
E	Chip Enable
$\bar{O}$	Output Enable
GND	Ground
PGM	Program
DQ0–DQ7	Inputs (programming)/Outputs
VCC	5-V Supply
Vpp	13-V Power Supply§

† Packages are shown for pinout reference only.  
 ‡ The ADVANCE INFORMATION notice applies to this package.  
 § Only in program mode.

ADVANCE INFORMATION

TEXAS INSTR (ASIC/MEMORY) 62E D 8961725 0080665 380 T115

UNLESS OTHERWISE NOTED this document contains PRODUCTION DATA information current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

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# TMS27C020 2 097 152 BIT UV ERASABLE PROGRAMMABLE READ-ONLY MEMORY

## TMS27PC020 2 097 152 BIT PROGRAMMABLE READ-ONLY MEMORY

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These devices are fabricated using power-saving CMOS technology for high speed and simple interface with MOS and bipolar circuits. All inputs (including program data inputs) can be driven by Series 74 TTL circuits without the use of external pullup resistors. Each output can drive one Series 74 TTL circuit without external resistors.

The TMS27C020 EPROM is offered in a dual-in-line ceramic package (J suffix) designed for insertion in mounting hole rows on 15.2-mm (600-mil) centers. The TMS27C020 is also offered with two choices of temperature ranges of 0°C to 70°C (JL suffix) and -40°C to 85°C (JE suffix). The TMS27C020 is also offered with 168 hour burn-in on both temperature ranges (JL4 and JE4 suffixes). (See table below.)

The TMS27PC020 is offered in a 32-lead plastic leaded chip carrier using 1.25 mm (50 mil) lead spacing (FM suffix). The TMS27PC020 is offered with a temperature range of 0°C to 70°C.

EPROM	SUFFIX FOR OPERATING TEMPERATURE RANGES WITHOUT PEP4 BURN-IN		SUFFIX FOR PEP4 168 HR. BURN-IN VS. TEMPERATURE RANGES	
	0°C to 70°C	-40°C to 85°C	0°C to 70°C	-40°C to 85°C
TMS27C020-XXX	JL	JE	JL4	JE4
TMS27PC020-XXX	FML			

These EPROMs operate from a single 5-V supply (in the read mode), they are ideal for use in microprocessor-based systems. One other (13 V) supply is needed for programming. All programming signals are TTL level. For programming outside the system, existing EPROM programmers can be used.

### operation

The seven modes of operation for the TMS27C020 and TMS27PC020 are listed in the following table. The read mode requires a single 5-V supply. All inputs are TTL level except for  $V_{PP}$  during programming (13 V), and  $V_H$  (12 V) on A9 for the signature mode.

FUNCTION	MODE						
	READ	OUTPUT DISABLE	STANDBY	PROGRAMMING	VERIFY	PROGRAM INHIBIT	SIGNATURE MODE
E	V <sub>IL</sub>	V <sub>IL</sub>	V <sub>IH</sub>	V <sub>IL</sub>	V <sub>IL</sub>	V <sub>IH</sub>	V <sub>IL</sub>
$\bar{G}$	V <sub>IL</sub>	V <sub>IH</sub>	X†	V <sub>IH</sub>	V <sub>IL</sub>	X	V <sub>IL</sub>
PGM	X	X	X	V <sub>IL</sub>	V <sub>IH</sub>	X	X
V <sub>PP</sub>	V <sub>CC</sub>	V <sub>CC</sub>	V <sub>CC</sub>	V <sub>PP</sub>	V <sub>PP</sub>	V <sub>PP</sub>	V <sub>CC</sub>
V <sub>CC</sub>	V <sub>CC</sub>	V <sub>CC</sub>	V <sub>CC</sub>	V <sub>CC</sub>	V <sub>CC</sub>	V <sub>CC</sub>	V <sub>CC</sub>
A9	X	X	X	X	X	X	V <sub>H</sub> ‡
A0	X	X	X	X	X	X	V <sub>IL</sub>
DQ0-DQ7	Data Out	HI-Z	HI-Z	Data In	Data Out	HI-Z	CODE
							MFG
							97
							32

† X can be V<sub>IL</sub> or V<sub>IH</sub>

‡ V<sub>H</sub> = 12 V ± 0.5 V

### read/output disable

When the outputs of two or more TMS27C020s or TMS27PC020s are connected in parallel on the same bus, the output of any particular device in the circuit can be read with no interference from competing outputs of the other devices. To read the output of a single device, a low level signal is applied to the  $\bar{E}$  and  $\bar{G}$  pins. All other devices in the circuit should have their outputs disabled by applying a high level signal to one of these pins.



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### latchup immunity

Latchup immunity on the TMS27C020 and TMS27PC020 is a minimum of 250 mA on all inputs and outputs. This feature provides latchup immunity beyond any potential transients at the P.C. board level when the EPROM is interfaced to industry standard TTL or MOS logic devices. The input/output layout approach controls latchup without compromising performance or packing density.

### power down

Active  $I_{CC}$  supply current can be reduced from 30 mA to 500  $\mu$ A by applying a high TTL input on  $\bar{E}$  and to 100  $\mu$ A by applying a high CMOS input on  $\bar{E}$ . In this mode all outputs are in the high impedance state.

### erasure

Before programming, the TMS27C020 is erased by exposing the chip through the transparent lid to a high intensity ultraviolet light (wavelength 2537 Å). The recommended minimum exposure dose (UV intensity  $\times$  exposure time) is 15-W-s/cm<sup>2</sup>. A typical 12-mW/cm<sup>2</sup>, filterless UV lamp will erase the device in 21 minutes. The lamp should be located about 2.5 cm above the chip during erasure. After erasure, all bits are in the high state. It should be noted that normal ambient light contains the correct wavelength for erasure. Therefore, when using the TMS27C020, the window should be covered with an opaque label. After erasure (all bits in logic high state), logic lows are programmed into the desired locations. A programmed low can be erased only by ultraviolet light.

### SNAP! Pulse programming

The TMS27C020 and TMS27PC020 are programmed using the TI SNAP! Pulse programming algorithm, illustrated by the flowchart in Figure 1, which programs in a nominal time of twenty-six seconds. Actual programming time will vary as a function of the programmer used.

The SNAP! Pulse programming algorithm uses an initial pulse of 100 microseconds ( $\mu$ s) followed by a byte verification to determine when the addressed byte has been successfully programmed. Up to 10 (ten) 100- $\mu$ s pulses per byte are provided before a failure is recognized.

The programming mode is achieved when  $V_{PP} = 13$  V,  $V_{CC} = 6.5$  V,  $\bar{E} = V_{IL}$ ,  $\bar{G} = V_{IH}$ . Data is presented in parallel (eight bits) on pins DQ0 through DQ7. Once addresses and data are stable,  $\overline{PGM}$  is pulsed low.

More than one device can be programmed when the devices are connected in parallel. Locations can be programmed in any order. When the SNAP! Pulse programming routine is complete, all bits are verified with  $V_{CC} = V_{PP} = 5$  V  $\pm$  10%.

### program inhibit

Programming may be inhibited by maintaining a high level input on the  $\bar{E}$  or  $\overline{PGM}$  pins.

### program verify

Programmed bits may be verified with  $V_{PP} = 13$  V when  $\bar{G} = V_{IL}$ ,  $\bar{E} = V_{IL}$ , and  $\overline{PGM} = V_{IH}$ .

### signature mode

The signature mode provides access to a binary code identifying the manufacturer and type. This mode is activated when A9 (pin 26) is forced to 12 V. Two identifier bytes are accessed by toggling A0. All addresses must be held low. The signature code for the TMS27C020 is 9732. A0 low selects the manufacturer's code 97 (Hex), and A0 high selects the device code 32 (Hex), as shown by the signature mode table below.

IDENTIFIER†	PINS									
	A0	DQ7	DQ6	DQ5	DQ4	DQ3	DQ2	DQ1	DQ0	HEX
MANUFACTURER CODE	V <sub>IL</sub>	1	0	0	1	0	1	1	1	97
DEVICE CODE	V <sub>IH</sub>	0	0	1	1	0	0	1	0	32

†  $\bar{E} = \bar{G} = V_{IL}$ , A1–A8 =  $V_{IL}$ , A9 =  $V_{IH}$ , A10–A17 =  $V_{IL}$ ,  $V_{PP} = V_{CC}$ .

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TEXAS INSTR (ASIC/MEMORY) 62E D 896J725 0080667 153 TIIS

# TMS27C020 2 097 152 BIT UV ERASABLE PROGRAMMABLE READ-ONLY MEMORY TMS27PC020 2 097 152 BIT PROGRAMMABLE READ-ONLY MEMORY

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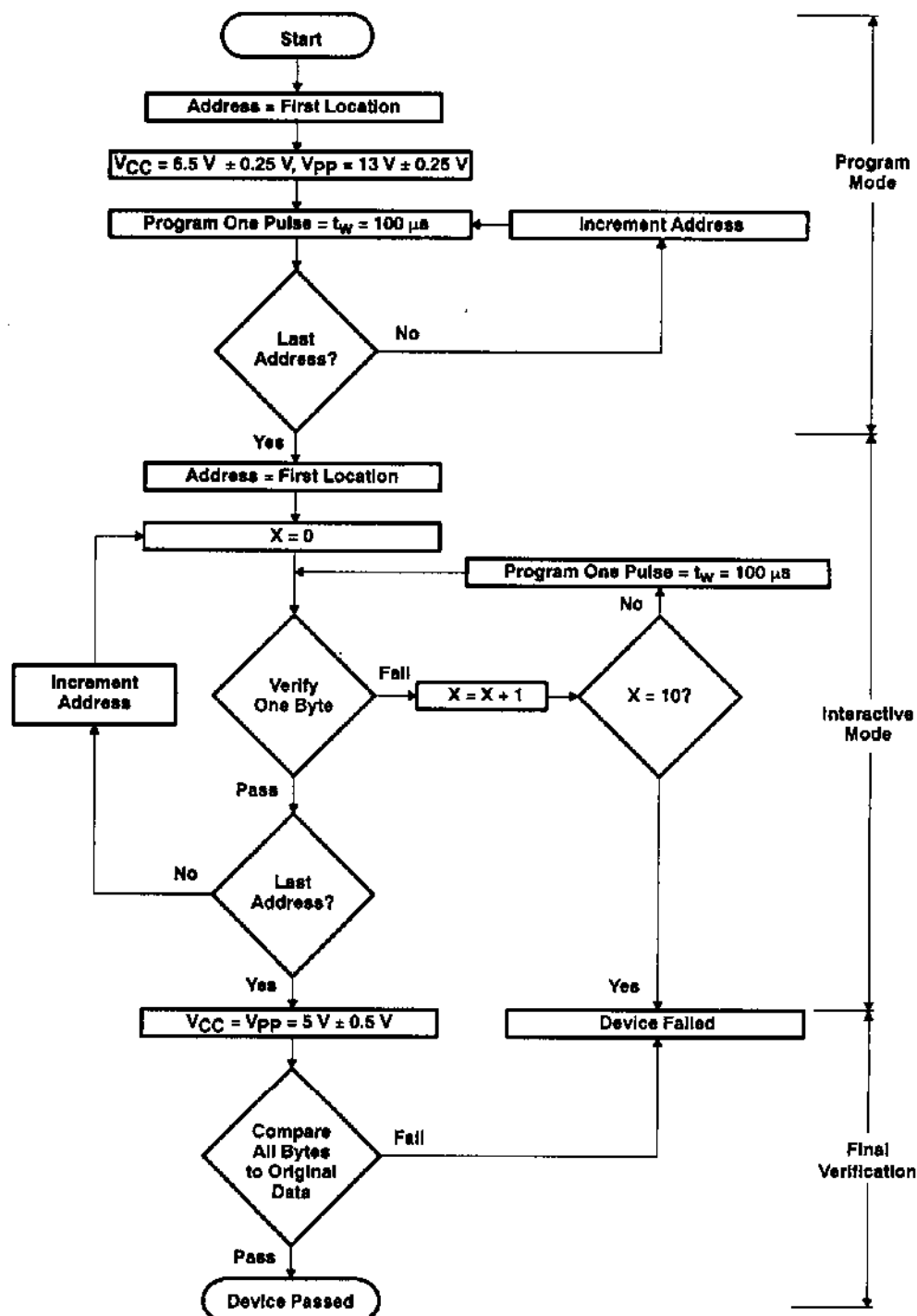


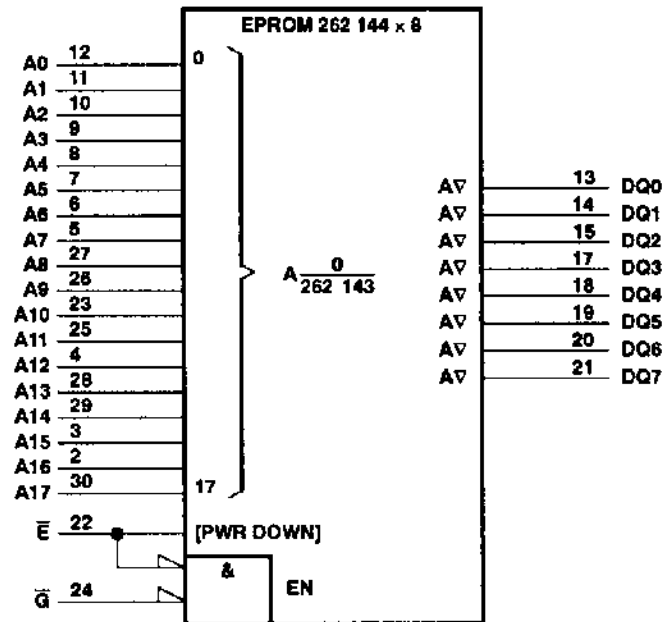
Figure 1. SNAP! Pulse Programming Flowchart

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**TMS27C020 2 097 152 BIT UV ERASABLE PROGRAMMABLE READ-ONLY MEMORY**  
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logic symbol†



† This symbol is in accordance with ANSI/IEEE Std 91-1984 and IEC Publication 617-12.  
 Pin numbers are for the J package.

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# TMS27C020 2 097 152 BIT UV ERASABLE PROGRAMMABLE READ-ONLY MEMORY

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### absolute maximum ratings over operating free-air temperature range (unless otherwise noted)<sup>†</sup>

Supply voltage range, $V_{CC}$ (see Note 1)	–0.6 V to 7 V
Supply voltage range, $V_{pp}$	–0.6 V to 14 V
Input voltage range (see Note 1), All inputs except A9	–0.6 V to $V_{CC} + 1$ V
A9	–0.6 V to 13.5 V
Output voltage range, with respect to $V_{SS}$ (see Note 1)	–0.6 V to $V_{CC} + 1$ V
Operating free-air temperature range ('27C020-__JL and JL4)	0°C to 70°C
Operating free-air temperature range ('27C020-__JE and JE4)	–40°C to 85°C
Storage temperature range	–65°C to 150°C

<sup>†</sup> Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

NOTE 1: All voltage values are with respect to GND.

### recommended operating conditions

			MIN	TYP	MAX	UNIT
$V_{CC}$	Supply voltage	Read mode (see Note 2)	4.5	5	5.5	V
		SNAP! Pulse programming algorithm	6.25	6.5	6.75	V
$V_{pp}$	Supply voltage	Read mode	$V_{CC}-0.6$	$V_{CC}$	$V_{CC}+0.6$	V
		SNAP! Pulse programming algorithm	12.75	13	13.25	V
$V_{IH}$	High-level dc input voltage	TTL	2		$V_{CC}+0.5$	V
		CMOS	$V_{CC}-0.2$		$V_{CC}+0.5$	V
$V_{IL}$	Low-level dc input voltage	TTL	–0.5		0.8	V
		CMOS	–0.5		GND+0.2	V
$T_A$	Operating free-air temperature	'27C020-__JL, JL4	0		70	°C
$T_A$	Operating free-air temperature	'27C020-__JE, JE4	–40		85	°C

NOTE 2:  $V_{CC}$  must be applied before or at the same time as  $V_{pp}$  and removed after or at the same time as  $V_{pp}$ . The device must not be inserted into or removed from the board when  $V_{pp}$  or  $V_{CC}$  is applied.



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## electrical characteristics over full ranges of operating conditions

PARAMETER		TEST CONDITIONS	MIN	MAX	UNIT
V <sub>OH</sub>	High-level dc output voltage	I <sub>OH</sub> = -20 $\mu$ A	V <sub>CC</sub> - 0.2		V
		I <sub>OH</sub> = -2 mA	2.4		
V <sub>OL</sub>	Low-level dc output voltage	I <sub>OL</sub> = 2.1 mA		0.4	V
		I <sub>OL</sub> = 20 $\mu$ A		0.1	
I <sub>I</sub>	Input current (leakage)	V <sub>I</sub> = 0 to 5.5 V		$\pm 1$	$\mu$ A
I <sub>O</sub>	Output current (leakage)	V <sub>O</sub> = 0 to V <sub>CC</sub>		$\pm 1$	$\mu$ A
I <sub>PP1</sub>	V <sub>PP</sub> supply current	V <sub>PP</sub> = V <sub>CC</sub> = 5.5 V		10	$\mu$ A
I <sub>PP2</sub>	V <sub>PP</sub> supply current (during program pulse)	V <sub>PP</sub> = 13 V		50	mA
I <sub>CC1</sub>	V <sub>CC</sub> supply current (standby)	TTL-input level	$\bar{E}$ = V <sub>IH</sub> , V <sub>CC</sub> = 5.5 V	500	$\mu$ A
		CMOS-input level	$\bar{E}$ = V <sub>CC</sub> $\pm$ 0.2 V, V <sub>CC</sub> = 5.5 V	100	
I <sub>CC2</sub>	V <sub>CC</sub> supply current (active)	$\bar{E}$ = V <sub>IL</sub> , V <sub>CC</sub> = 5.5 V t <sub>cycle</sub> = minimum cycle time, outputs open <sup>†</sup>		30	mA

<sup>†</sup> Minimum cycle time = maximum access time.

## capacitance over recommended ranges of supply voltage and operating free-air temperature, f = 1 MHz<sup>‡</sup>

PARAMETER	TEST CONDITIONS	MIN	TYP <sup>§</sup>	MAX	UNIT
C <sub>I</sub>	Input capacitance	V <sub>I</sub> = 0, f = 1 MHz	4	8	pF
C <sub>O</sub>	Output capacitance	V <sub>O</sub> = 0, f = 1 MHz	8	10	pF

<sup>‡</sup> Capacitance measurements are made on sample basis only.

<sup>§</sup> All typical values are at T<sub>A</sub> = 25°C and nominal voltages.

## switching characteristics over full ranges of recommended operating conditions (see Notes 3 and 4)

PARAMETER	TEST CONDITIONS (SEE NOTES 3 & 4)	'27C020-12 '27PC020-12		'27C020-15 '27PC020-15		27C020-20 27PC020-20		'27C020-25 '27PC020-25		UNIT
		MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
t <sub>a</sub> (A)	Access time from address	120		150		200		250		ns
t <sub>a</sub> (E)	Access time from chip enable	120		150		200		250		ns
t <sub>en</sub> (G)	Output enable time from $\bar{G}$	55		75		75		100		ns
t <sub>dis</sub>	Output disable time from $\bar{G}$ or $\bar{E}$ , whichever occurs first <sup>¶</sup>	0	50	0	60	0	60	0	80	ns
t <sub>v</sub> (A)	Output data valid time after change of address, $\bar{E}$ , or $\bar{G}$ , whichever occurs first	0		0		0		0		ns

<sup>¶</sup> Value calculated from 0.5-V delta to measured output level. This parameter is sampled and not 100% tested.

NOTES: 3. For all switching characteristics the input pulse levels are 0.4 V to 2.4 V. Timing measurements are made at 2 V for logic high and 0.8 V for logic low. (reference AC Testing Wave Form)

4. Common test conditions apply for t<sub>dis</sub> except during programming.



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**switching characteristics for programming:  $V_{CC} = 6.5$  V and  $V_{PP} = 13$  V (SNAP! Pulse),  $T_A = 25^\circ\text{C}$  (see Note 3)**

PARAMETER		MIN	NOM	MAX	UNIT
$t_{dis}(\bar{G})$	Output disable time from $\bar{G}$	0		100	ns
$t_{en}(\bar{G})$	Output enable time from $\bar{G}$			150	ns

**recommended timing requirements for programming:  $V_{CC} = 6.5$  V and  $V_{PP} = 13$  V (SNAP! Pulse),  $T_A = 25^\circ\text{C}$ , (see Note 3)**

			MIN	TYP	MAX	UNIT
$t_w(\text{PGM})$	Program pulse duration	SNAP! Pulse programming algorithm	95	100	105	$\mu\text{s}$
$t_{su}(A)$	Address setup time		2			$\mu\text{s}$
$t_{su}(\bar{E})$	$\bar{E}$ setup time		2			$\mu\text{s}$
$t_{su}(\bar{G})$	$\bar{G}$ setup time		2			$\mu\text{s}$
$t_{su}(D)$	Data setup time		2			$\mu\text{s}$
$t_{su}(V_{PP})$	$V_{PP}$ setup time		2			$\mu\text{s}$
$t_{su}(V_{CC})$	$V_{CC}$ setup time		2			$\mu\text{s}$
$t_h(A)$	Address hold time		0			$\mu\text{s}$
$t_h(D)$	Data hold time		2			$\mu\text{s}$

NOTE 3: For all switching characteristics the input pulse levels are 0.4 V to 2.4 V. Timing measurements are made at 2 V for logic high and 0.8 V for logic low. (reference AC Testing Wave Form)

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# TMS27C020 2 097 152 BIT UV ERASABLE PROGRAMMABLE READ-ONLY MEMORY TMS27PC020 2 097 152 BIT PROGRAMMABLE READ-ONLY MEMORY

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## PARAMETER MEASUREMENT INFORMATION

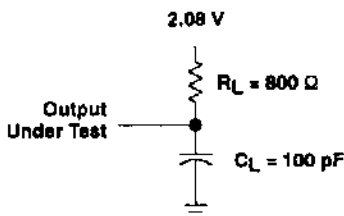
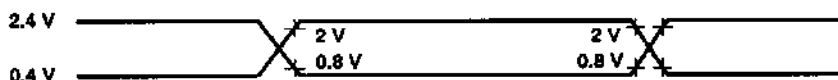


Figure 2. AC Testing Output Load Circuit

### AC testing input/output wave forms



AC testing inputs are driven at 2.4 V for logic high and 0.4 V for logic low. Timing measurements are made at 2 V for logic high and 0.8 V for logic low for both inputs and outputs.

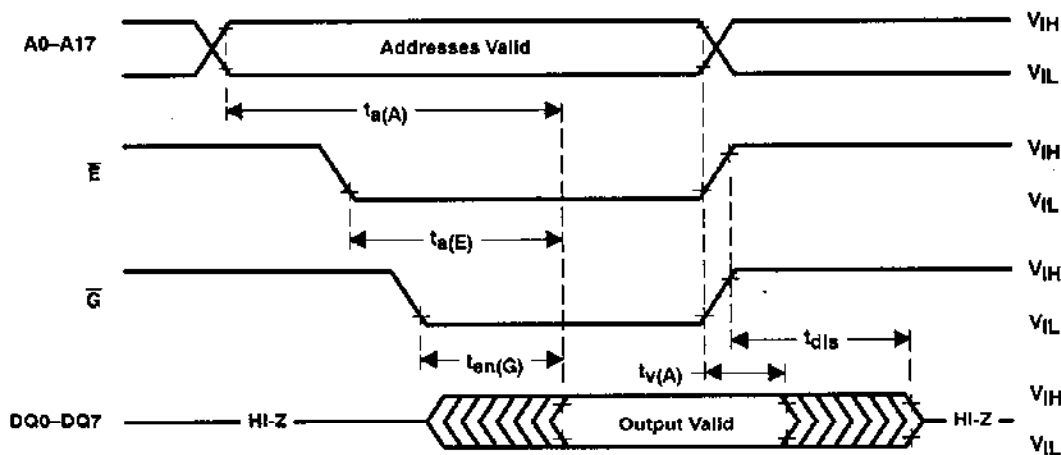
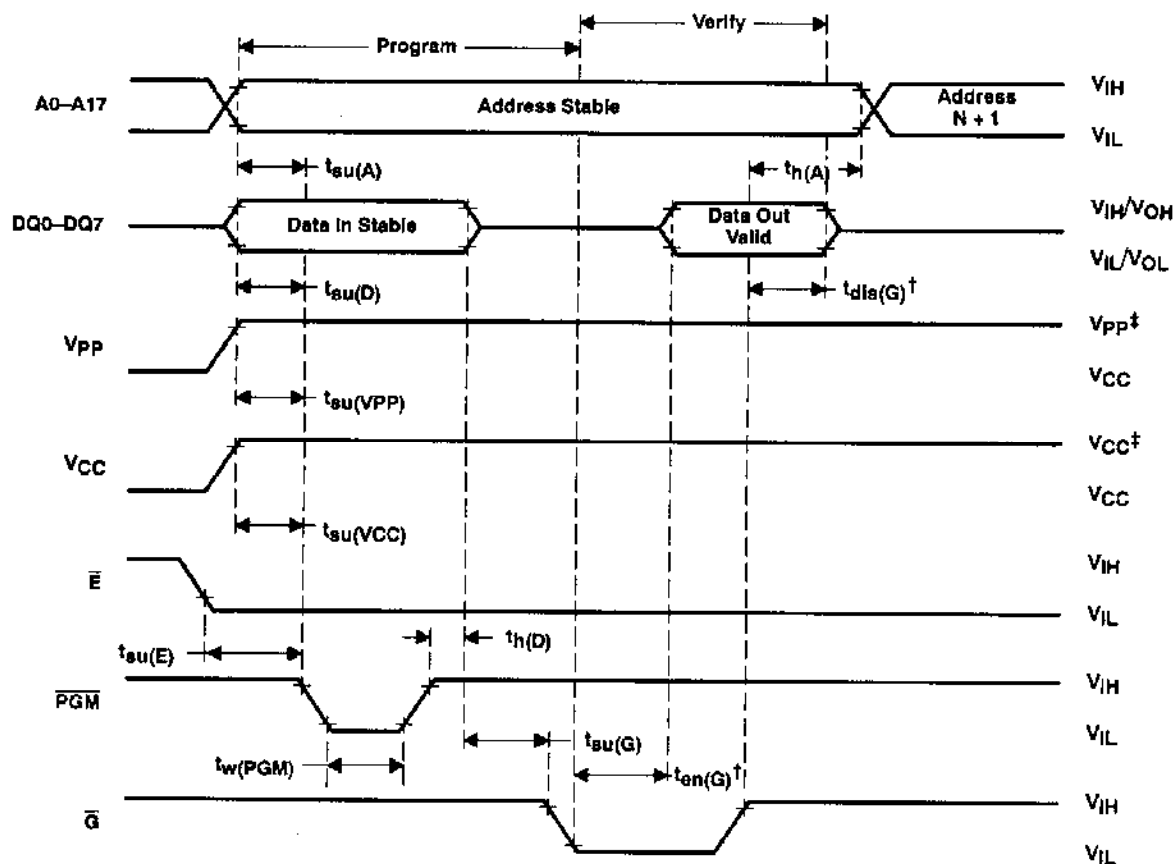


Figure 3. Read Cycle Timing

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## PARAMETER MEASUREMENT INFORMATION



†  $t_{dis}(G)$  and  $t_{en}(G)$  are characteristics of the device but must be accommodated by the programmer.  
‡ 13-V  $V_{pp}$  and 6.5-V  $V_{CC}$  for SNAP! Pulse programming.

Figure 4. Program Cycle Timing (SNAP! Pulse Programming)