TMS27C020 2097152-BIT UV ERASABLE PROGRAMMABLE
TMS27PC020 2097152-BIT PROGRAMMABLE
READ-ONLY MEMORY

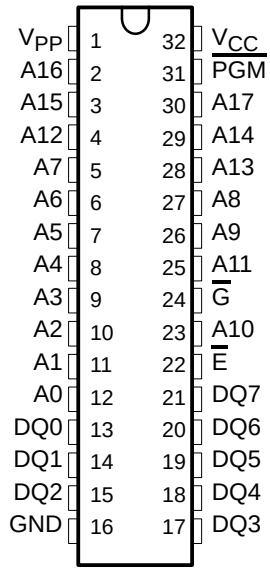
SMLS020B – NOVEMBER 1990 – REVISED JUNE 1995

- **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_{CC} Tolerance**
- **Max Access/Min Cycle Time V_{CC} ± 10%**

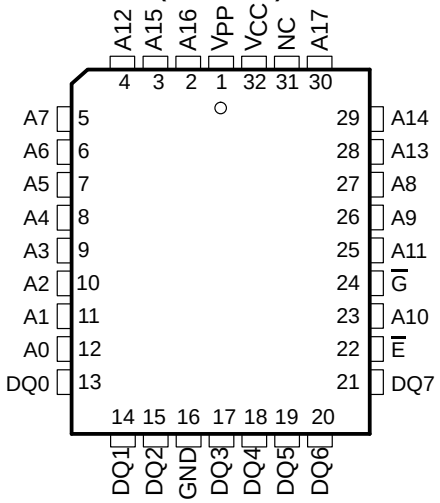
'27C/PC020-12	**120 ns**
'27C/PC020-15	**150 ns**
'27C/PC020-20	**200 ns**
'27C/PC020-25	**250 ns**

- **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_{CC} = 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**

J PACKAGE
(TOP VIEW)



TMS27PC020†
FM PACKAGE
(TOP VIEW)



PIN NOMENCLATURE	
A0–A17	Address Inputs
DQ0–DQ7	Inputs (programming)/Outputs
$\overline{E}$	Chip Enable
$\overline{G}$	Output Enable
GND	Ground
$\overline{PGM}$	Program
V_{CC}	5-V Power Supply
V_{PP}	13-V Power Supply‡

† The ADVANCE INFORMATION notice applies to this package.
‡ Only in program mode.

description

The TMS27C020 series are 2097152-bit, ultra-violet-light erasable, electrically programmable read-only memories.

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

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.

TEXAS INSTRUMENTS
POST OFFICE BOX 655303 • DALLAS, TEXAS 75265
POST OFFICE BOX 1443 • HOUSTON, TEXAS 77251–1443

description (continued)

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° 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_{IL}	V_{IL}	V_{IH}	V_{IL}	V_{IL}	V_{IH}	V_{IL}	
$\overline{G}$	V_{IL}	V_{IH}	X	V_{IH}	V_{IL}	X	V_{IL}	
$\overline{PGM}$	X	X	X	V_{IL}	V_{IH}	X	X	
V_{PP}	V_{CC}	V_{CC}	V_{CC}	V_{PP}	V_{PP}	V_{PP}	V_{CC}	
V_{CC}	V_{CC}	V_{CC}	V_{CC}	V_{CC}	V_{CC}	V_{CC}	V_{CC}	
A9	X	X	X	X	X	X	V_H‡	V_H‡
A0	X	X	X	X	X	X	V_{IL}	V_{IH}
DQ0–DQ7	Data Out	Hi-Z	Hi-Z	Data In	Data Out	Hi-Z	CODE	
							MFG	DEVICE
							97	32

† X can be V_{IL} or V_{IH}
‡ $V_H = 12\ V \pm 0.5\ V$

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 $\overline{E}$ and $\overline{G}$ pins. All other devices in the circuit should have their outputs disabled by applying a high level signal to one of these pins.

latchup immunity

Latchup immunity on the TMS27C020 and TMS72PC020 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 μA by applying a high TTL input on $\overline{E}$ and to 100 μA by applying a high CMOS input on $\overline{E}$. 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 × exposure time) is 15-W·s/cm^2. A typical 12-mW/cm^2, filterless UV lamp erases 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 varies as a function of the programmer used.

The SNAP! Pulse programming algorithm uses an initial pulse of 100 microseconds (μs) followed by a byte verification to determine when the addressed byte has been successfully programmed. Up to 10 (ten) 100-μs 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, $\overline{E} = V_{IL}$, $\overline{G} = V_{IH}$. 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 can be inhibited by maintaining a high level input on the $\overline{E}$ or $\overline{PGM}$ pins.

program verify

Programmed bits can be verified with V_{PP} = 13 V when $\overline{G} = V_{IL}$, $\overline{E} = V_{IL}$, 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_{IL}	1	0	0	1	0	1	1	1	97
DEVICE CODE	V_{IH}	0	0	1	1	0	0	1	0	32

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

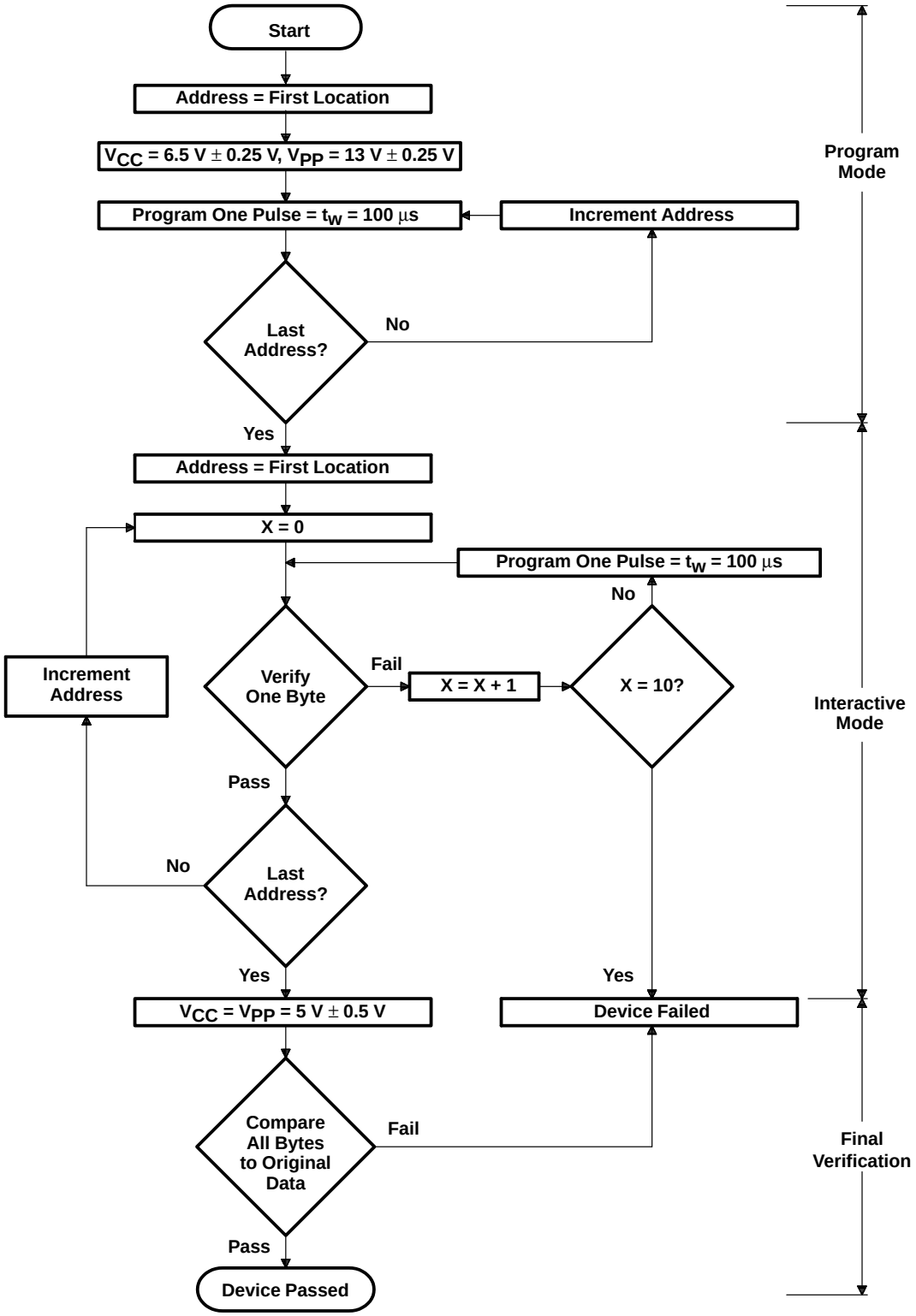
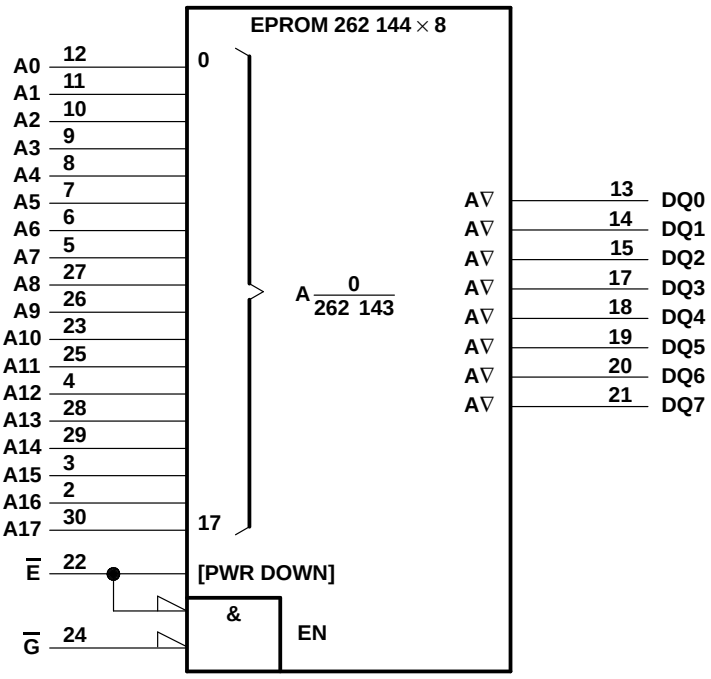


Figure 1. SNAP! Pulse Programming Flowchart

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.

absolute maximum ratings over operating free-air temperature range (unless otherwise noted)‡

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, T_{stg} . . . . . –65°C to 150°C

‡ 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_{IL}	Low-level dc input voltage		TTL	–0.5		0.8	V
			CMOS	–0.5		GND+0.2	
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.

electrical characteristics over full ranges of operating conditions

PARAMETER			TEST CONDITIONS	MIN	MAX	UNIT
V_{OH}	High-level dc output voltage		I_{OH} = –20 μA	V_{CC} – 0.2		V
			I_{OH} = – 2 mA	2.4		
V_{OL}	Low-level dc output voltage		I_{OL} = 2.1 mA		0.4	V
			I_{OL} = 20 μA		0.1	
I_I	Input current (leakage)		V_I = 0 V to 5.5 V		±1	μA
I_O	Output current (leakage)		V_O = 0 V to V_{CC}		±1	μA
I_{PP1}	V_{PP} supply current		V_{PP} = V_{CC} = 5.5 V		10	μA
I_{PP2}	V_{PP} supply current (during program pulse)		V_{PP} = 13 V		50	mA
I_{CC1}	V_{CC} supply current (standby)	TTL-input level	V_{CC} = 5.5 V, . . . $\overline{E}$ = V_{IH}		500	μA
		CMOS-input level	V_{CC} = 5.5 V, $\overline{E}$ = V_{CC} ± 0.2 V		100	
I_{CC2}	V_{CC} supply current (active)		V_{CC} = 5.5 V, $\overline{E}$ = V_{IL}, t_{cycle} = minimum cycle time, outputs open†		30	mA

† Minimum cycle time = maximum access time.

capacitance over recommended ranges of supply voltage and operating free-air temperature, f = 1 MHz‡

PARAMETER		TEST CONDITIONS	MIN	TYP§	MAX	UNIT
C_I	Input capacitance	V_I = 0 V, f = 1 MHz		4	8	pF
C_O	Output capacitance	V_O = 0 V, f = 1 MHz		6	10	pF

‡ Capacitance measurements are made on sample basis only.
§ All typical values are at T_A = 25°C and nominal voltages.

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

PARAMETER		TEST CONDITIONS	'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	
$t_{a(A)}$	Access time from address	CL = 100 pF, 1 Series 74 TTL load, Input $t_r \le 20$ ns, Input $t_f \le 20$ ns		120		150		200		250	ns
$t_{a(E)}$	Access time from chip enable			120		150		200		250	ns
$t_{en(G)}$	Output enable time from $\overline{G}$			55		75		75		100	ns
t_{dis}	Output disable time from $\overline{G}$ or $\overline{E}$, whichever occurs first†		0	50	0	60	0	60	0	80	ns
$t_{v(A)}$	Output data valid time after change of address, $\overline{E}$, or $\overline{G}$, whichever occurs first†		0		0		0		0		ns

† 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_{dis} except during programming.

switching characteristics for programming: V_{CC} = 6.5 V and V_{PP} = 13 V (SNAP! Pulse), T_A = 25°C (see Note 3)

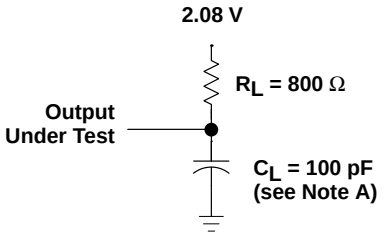
PARAMETER		MIN	MAX	UNIT
$t_{dis(G)}$	Output disable time from $\overline{G}$	0	100	ns
$t_{en(G)}$	Output enable time from $\overline{G}$		150	ns

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

			MIN	TYP	MAX	UNIT
$t_{w(PGM)}$	Pulse duration, program	SNAP! Pulse programming algorithm	95	100	105	µs
$t_{su(A)}$	Setup time, address		2			µs
$t_{su(E)}$	Setup time, $\overline{E}$		2			µs
$t_{su(G)}$	Setup time, $\overline{G}$		2			µs
$t_{su(D)}$	Setup time, data		2			µs
$t_{su(VPP)}$	Setup time, V_{PP}		2			µs
$t_{su(VCC)}$	Setup time, V_{CC}		2			µs
$t_{h(A)}$	Hold time, address		0			µs
$t_{h(D)}$	Hold time, data		2			µs

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)

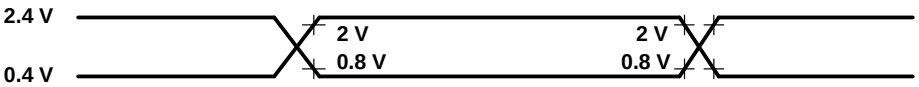
PARAMETER MEASUREMENT INFORMATION



NOTE A: C_L includes probe and fixture capacitance.

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.

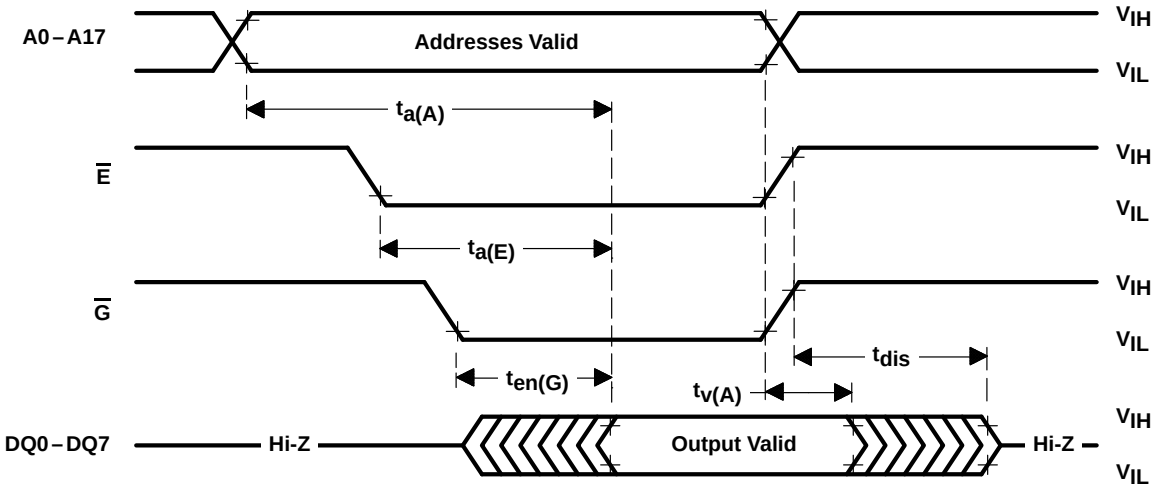
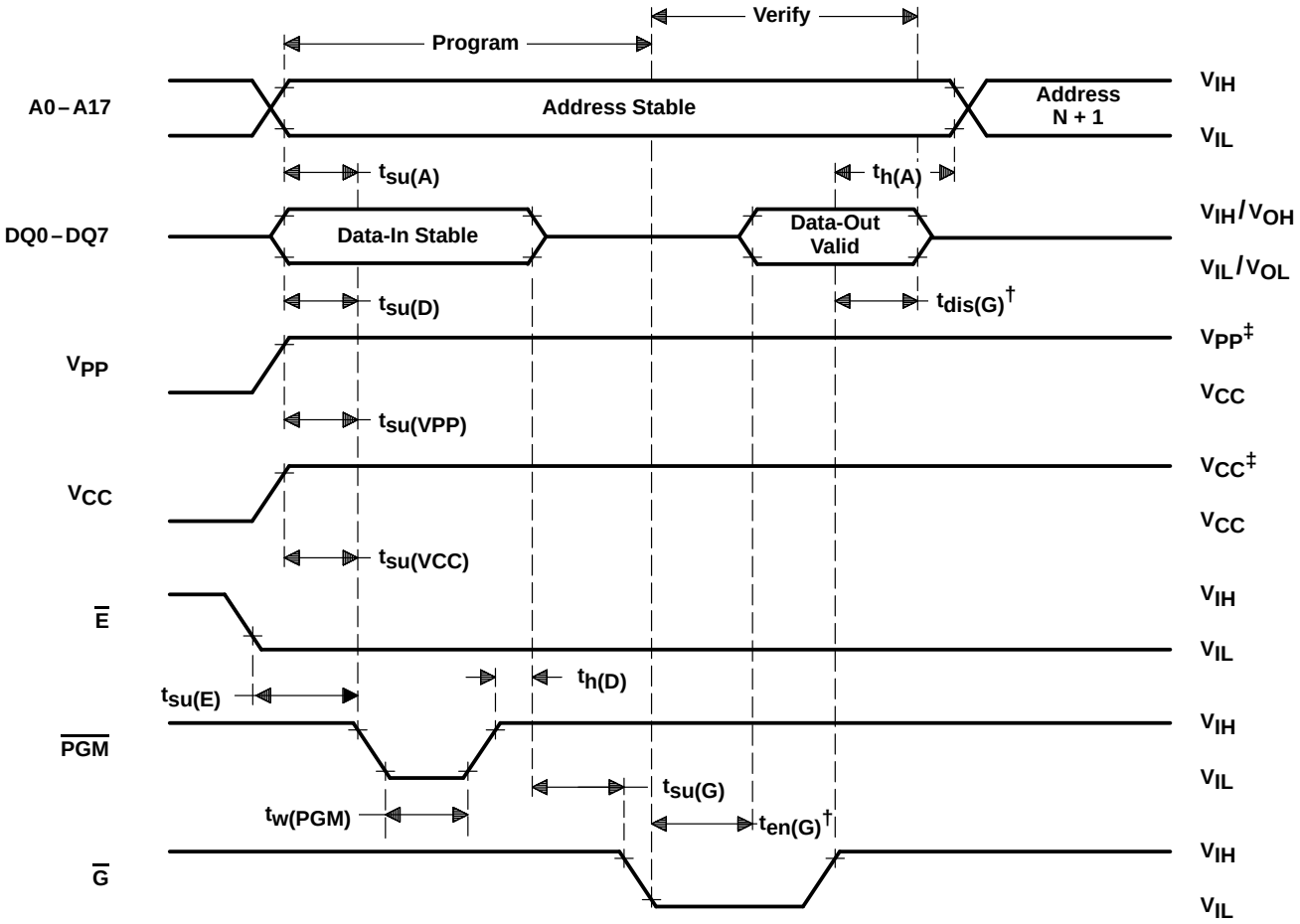


Figure 3. Read-Cycle Timing

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)

IMPORTANT NOTICE

Texas Instruments (TI) reserves the right to make changes to its products or to discontinue any semiconductor product or service without notice, and advises its customers to obtain the latest version of relevant information to verify, before placing orders, that the information being relied on is current.

TI warrants performance of its semiconductor products and related software to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are utilized to the extent TI deems necessary to support this warranty. Specific testing of all parameters of each device is not necessarily performed, except those mandated by government requirements.

Certain applications using semiconductor products may involve potential risks of death, personal injury, or severe property or environmental damage ("Critical Applications").

TI SEMICONDUCTOR PRODUCTS ARE NOT DESIGNED, INTENDED, AUTHORIZED, OR WARRANTED TO BE SUITABLE FOR USE IN LIFE-SUPPORT APPLICATIONS, DEVICES OR SYSTEMS OR OTHER CRITICAL APPLICATIONS.

Inclusion of TI products in such applications is understood to be fully at the risk of the customer. Use of TI products in such applications requires the written approval of an appropriate TI officer. Questions concerning potential risk applications should be directed to TI through a local SC sales office.

In order to minimize risks associated with the customer's applications, adequate design and operating safeguards should be provided by the customer to minimize inherent or procedural hazards.

TI assumes no liability for applications assistance, customer product design, software performance, or infringement of patents or services described herein. Nor does TI warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right of TI covering or relating to any combination, machine, or process in which such semiconductor products or services might be or are used.