TMS27C512 524288-BIT UV ERSABLE PROGRAMMABLE
TMS27PC512 524288-BIT PROGRAMMABLE
READ-ONLY MEMORY

SMLS512F – NOVEMBER 1985 – REVISED JUNE 1995

This Data Sheet is Applicable to All TMS27C512s and TMS27PC512s Symbolized with Code "B" as Described on Page 182.

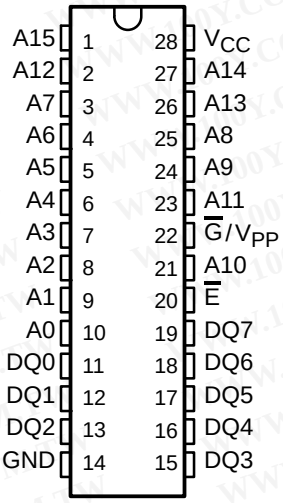
- **Organization . . . 64K × 8**
- **Single 5-V Power Supply**
- **Pin Compatible With Existing 512K MOS ROMs, PROMs, and EPROMs**
- **All Inputs/Outputs Fully TTL Compatible**
- **Max Access/Min Cycle Time**

  V_{CC} ± 10%

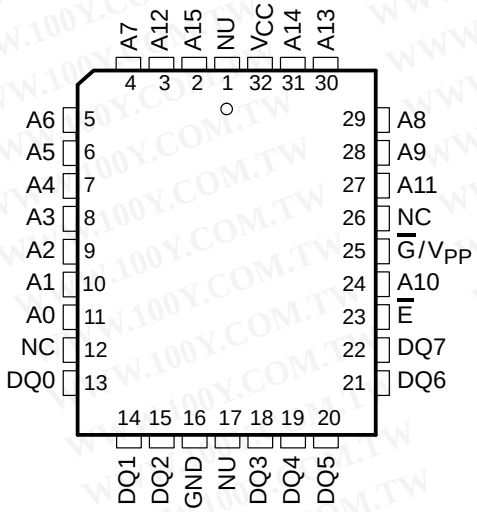
'27C/PC512-10	**100 ns**
'27C/PC512-12	**120 ns**
'27C/PC512-15	**150 ns**
'27C/PC512-20	**200 ns**
'27C/PC512-25	**250 ns**

- **Power Saving CMOS Technology**
- **Very High-Speed SNAP! Pulse Programming**
- **3-State Output Buffers**
- **400-mV Minimum DC Noise Immunity With Standard TTL Loads**
- **Latchup Immunity of 250 mA on All Input and Output Lines**
- **Low Power Dissipation (V_{CC} = 5.25 V)**
  - **Active . . . 158 mW Worst Case**
  - **Standby . . . 1.4 mW Worst Case (CMOS Input Levels)**
- **PEP4 Version Available With 168-Hour Burn-In, and Choices of Operating Temperature Ranges**
- **512K EPROM Available With MIL-STD-883C Class B High Reliability Processing (SMJ27C512)**

J AND N PACKAGES
(TOP VIEW)



FM PACKAGE
(TOP VIEW)



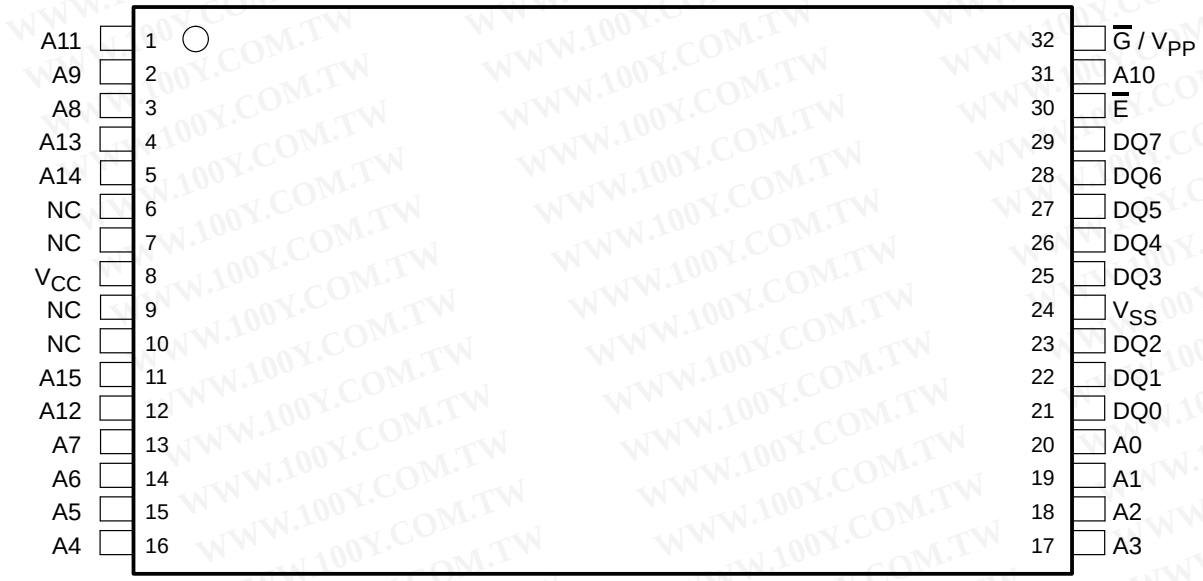
description

The TMS27C512 series are 524288-bit, ultraviolet-light erasable, electrically programmable read-only memories.

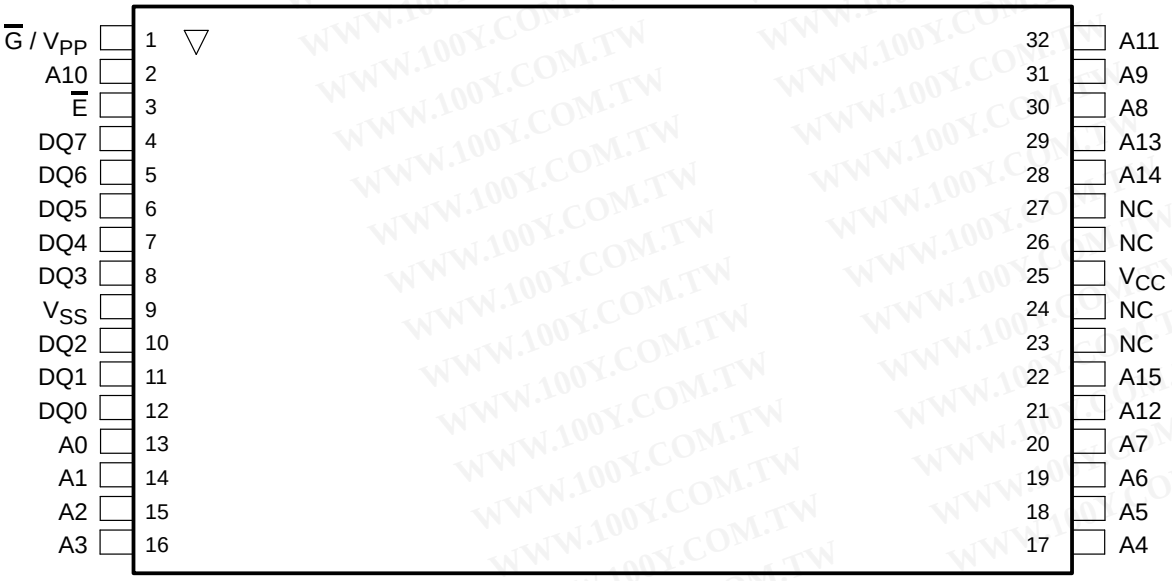
The TMS27PC512 series are 524288-bit, one-time electrically programmable read-only memories.

PIN NOMENCLATURE	
A0–A15	Address Inputs
$\overline{E}$	Chip Enable/Powerdown
DQ0–DQ7	Inputs (programming)/Outputs
$\overline{G}/V_{PP}$	13-V Programming Power Supply
GND	Ground
NC	No Internal Connection
NU	Make No External Connection
V_{CC}	5-V Power Supply

TMS27PC512
DD PACKAGE
(TOP VIEW)



TMS27PC512
DU PACKAGE
REVERSE PINOUT
(TOP VIEW)



description (continued)

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 pull-up resistors. Each output can drive one Series 74 TTL circuit without external resistors.

The data outputs are three-state for connecting multiple devices to a common bus. The TMS27C512 and the TMS27PC512 are pin compatible with 28-pin 512K MOS ROMs, PROMs, and EPROMs.

The TMS27C512 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 TMS27PC512 OTP PROM is offered in a dual-in-line plastic package (N suffix) designed for insertion in mounting hole rows on 15,2-mm (600-mil) centers. The TMS27PC512 OTP PROM is also supplied in a 32-lead plastic leaded chip carrier package using 1,25-mm (50-mil) lead spacing (FM suffix), and in a 32-lead thin small-outline package (DD and DU suffixes).

The TMS27C512 and TMS27PC512 are offered with two choices of temperature ranges of 0°C to 70°C (JL, NL, FML, and DDL suffixes) and – 40°C to 85°C (JE, NE, FME, and DDE suffixes). The TMS27C512 and TMS27PC512 are also offered with a 168-hour burn-in on both temperature ranges (JL4, NL4, FML4, DDL4, JE4, NE4, FME4, and DDE4 suffixes); see table below.

All package styles conform to JEDEC standards.

EPROM AND OTP PROM	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
TMS27C512-xxx	JL	JE	JL4	JE4
TMS27PC512-xxx	NL	NE	NL4	NE4
TMS27PC512-xxx	FML	FME	FML4	FME4
TMS27PC512-xxx	DDL	DDE	DDL4	DDE4
TMS27PC512-xxx	DUL	DUE	DUL4	DUE4

These EPROMs and OTP PROMs operate from a single 5-V supply (in the read mode), thus are ideal for use in microprocessor-based systems. One other 13-V supply is needed for programming. All programming signals are TTL level. The device is programmed using the SNAP! Pulse programming algorithm. The SNAP! Pulse programming algorithm uses a V_{PP} of 13 V and a V_{CC} of 6.5 V for a nominal programming time of seven seconds. For programming outside the system, existing EPROM programmers can be used. Locations can be programmed singly, in blocks, or at random.

operation

The seven modes of operation 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 for SNAP! Pulse) and 12 V on A9 for signature mode.

FUNCTION	MODE†							
	READ	OUTPUT DISABLE	STANDBY	PROGRAMMING	VERIFY	PROGRAM INHIBIT	SIGNATURE MODE	
$\overline{E}$	V_{IL}	V_{IL}	V_{IH}	V_{IL}	V_{IL}	V_{IH}	V_{IL}	
$\overline{G}/V_{PP}$	V_{IL}	V_{IH}	X	V_{PP}	V_{IL}	V_{PP}	V_{IL}	
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	85

† X can be V_{IL} or V_{IH}.
‡ V_H = 12 V ± 0.5 V.

read/output disable

When the outputs of two or more TMS27C512s or TMS27PC512s are connected in parallel on the same bus, the output of any particular device in the circuit can be read with no interference from the 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 $\overline{G}/V_{PP}$ pins. All other devices in the circuit should have their outputs disabled by applying a high-level signal to one of these pins. Output data is accessed at pins DQ0 through DQ7.

latchup immunity

Latchup immunity on the TMS27C512 and TMS27PC512 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 devices are interfaced to industry-standard TTL or MOS logic devices. 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 (TTL-level inputs) or 250 μA (CMOS-level inputs) by applying a high TTL/CMOS signal to the $\overline{E}$ pin. In this mode all outputs are in the high-impedance state.

erasure (TMS27C512)

Before programming, the TMS27C512 EPROM is erased by exposing the chip through the transparent lid to a high intensity ultraviolet light (wavelength 2537 angstroms). EPROM erasure before programming is necessary to assure that all bits are in the logic high state. Logic lows are programmed into the desired locations. A programmed logic low can be erased only by ultraviolet light. 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. It should be noted that normal ambient light contains the correct wavelength for erasure. Therefore, when using the TMS27C512, the window should be covered with an opaque label.

initializing (TMS27PC512)

The one-time programmable TMS27PC512 PROM is provided with all bits in the logic high state, then logic lows are programmed into the desired locations. Logic lows programmed into a PROM cannot be erased.

SNAP! Pulse programming

The 512K EPROM and OTP PROM are programmed using the TI SNAP! Pulse programming algorithm illustrated by the flowchart in Figure 1, which programs in a nominal time of seven seconds. Actual programming time varies as a function of the programmer used.

The SNAP! Pulse programming algorithm uses initial pulses 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 with $\overline{G}/V_{PP}$ = 13 V, V_{CC} = 6.5 V, and $\overline{E} = V_{IL}$. Data is presented in parallel (eight bits) on pins DQ0 to DQ7. Once addresses and data are stable, $\overline{E}$ is pulsed.

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} = 5 V, $\overline{G}/V_{PP} = V_{IL}$, and $\overline{E} = V_{IL}$.

program inhibit

Programming can be inhibited by maintaining a high level input on the $\overline{E}$ pin.

program verify

Programmed bits can be verified when $\overline{G}/V_{PP}$ and $\overline{E} = V_{IL}$.

signature mode

The signature mode provides access to a binary code identifying the manufacturer and type. This mode is activated when A9 is forced to 12 V ± 0.5 V. Two identifier bytes are accessed by A0; i.e., A0 = V_{IL} accesses the manufacturer code, which is output on DQ0–DQ7; A0 = V_{IH} accesses the device code, which is output on DQ0–DQ7. All other addresses must be held at V_{IL}. The manufacturer code for these devices is 97, and the device code is 85.

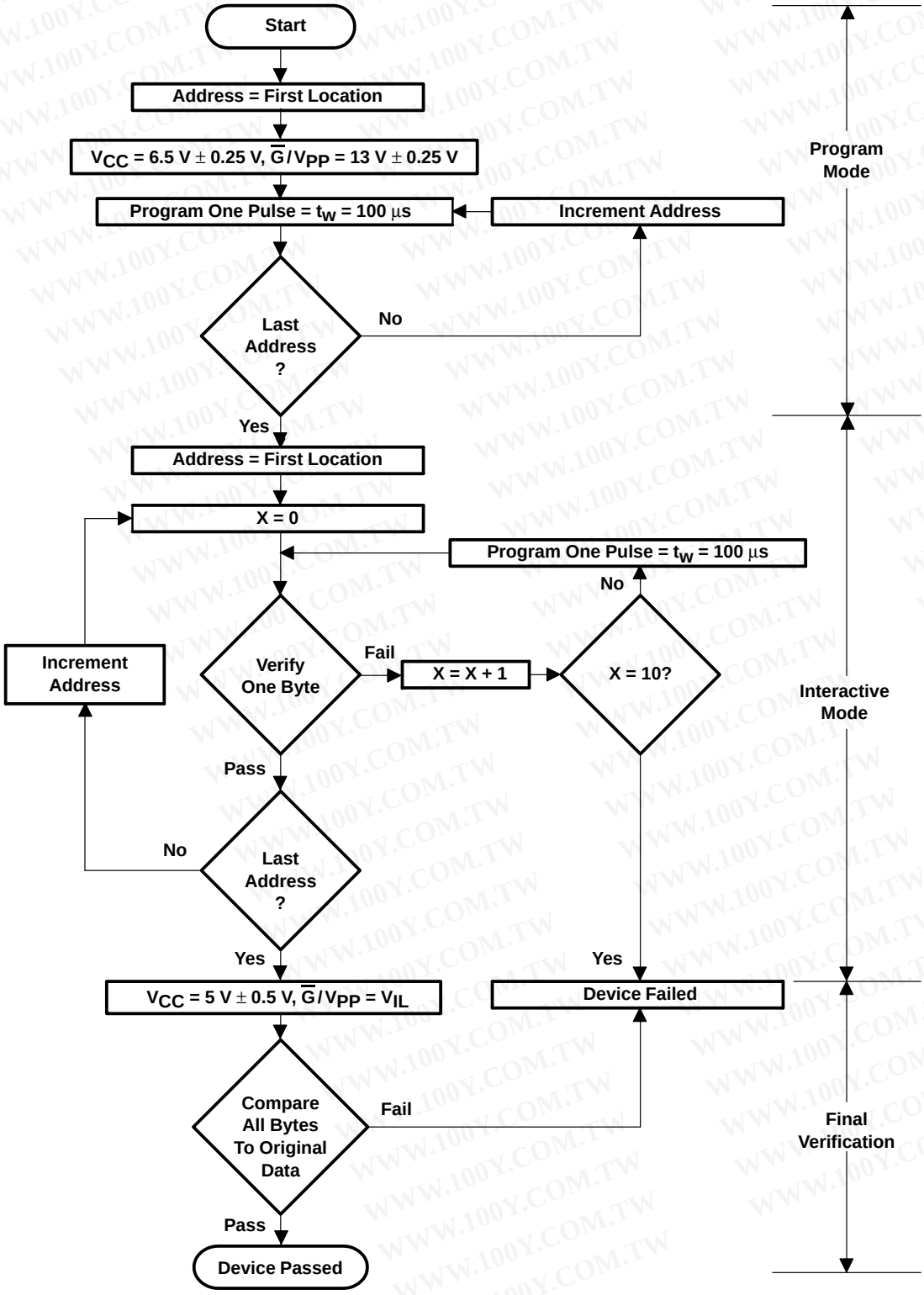
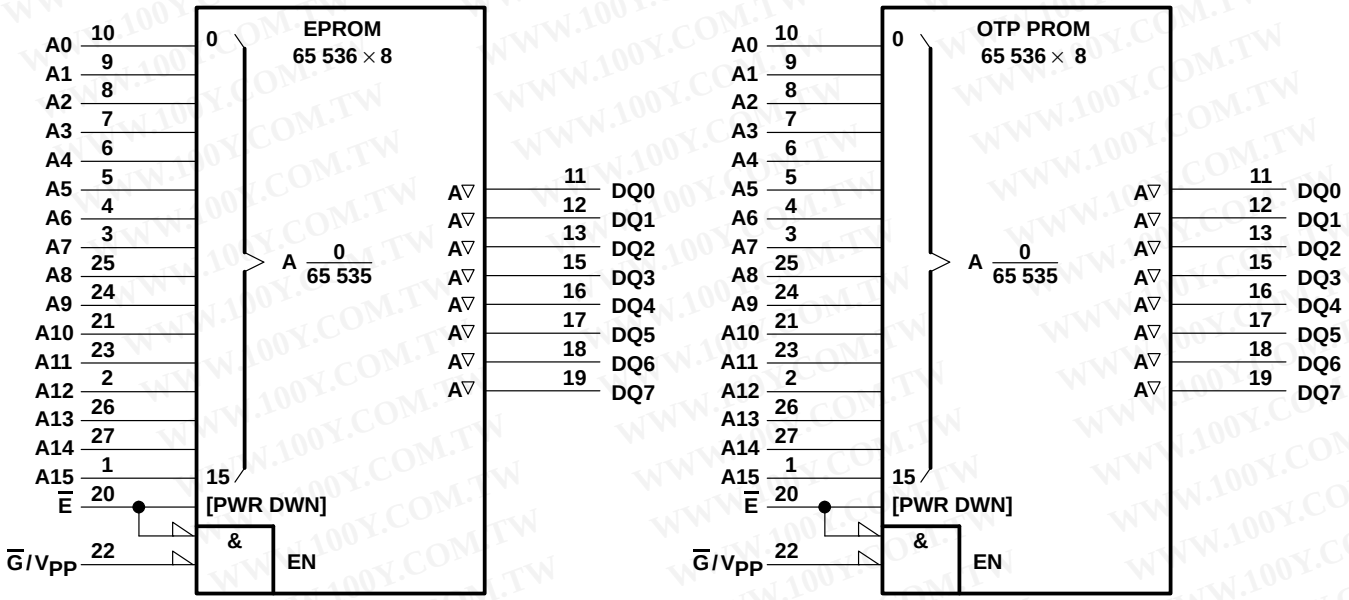


Figure 1. SNAP! Pulse Programming Flowchart

logic symbols†



† These symbols are in accordance with ANSI/IEEE Std 91-1984 and IEC Publication 617-12.
Pin numbers shown are for J and N packages.

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 (see Note 1) . . . . . –0.6 V to V_{CC} + 1 V
Operating free-air temperature range ('27C512-_ _JL and JL4, '27PC512-_ _NL and NL4,
FML and FML4, DDL and DDL4) . . . . . 0°C to 70°C
Operating free-air temperature range ('27C512-_ _JE and JE4, '27PC512-_ _NE and NE4,
FME and FME4, DDE and DDE4) . . . . . –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	NOM	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	
$\overline{G}/V_{PP}$	Supply voltage	SNAP! Pulse programming algorithm	12.75	13	13.25	V
V_{IH}	High-level dc input voltage	TTL	2		V_{CC}+1	V
		CMOS	V_{CC} – 0.2		V_{CC}+1	
V_{IL}	Low-level dc input voltage	TTL	– 0.5		0.8	V
		CMOS	– 0.5		0.2	
T_A	Operating free-air temperature	TMS27C512-_ _JL, JL4 TMS27PC512-_ _NL, NL4, FML, FML4, DDL, DDL4	0		70	°C
T_A	Operating free-air temperature	TMS27C512-_ _JE, JE4 TMS27PC512-_ _NE, NE4, FME, FME4, DDE, DDE4	– 40		85	°C

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

electrical characteristics over recommended ranges of supply voltage and operating free-air temperature

PARAMETER			TEST CONDITIONS	MIN	TYP†	MAX	UNIT
V_{OH}	High-level dc output voltage		I_{OH} = – 2.5 mA	3.5			V
			I_{OH} = – 20 µA	V_{CC} – 0.1			
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_{PP}	$\overline{G}/V_{PP}$ supply current (during program pulse)		$\overline{G}/V_{PP}$ = 13 V		35	50	mA
I_{CC1}	V_{CC} supply current (standby)	TTL-input level	V_{CC} = 5.5 V, ... $\overline{E}$ = V_{IH}		250	500	µA
		CMOS-input level	V_{CC} = 5.5 V, ... $\overline{E}$ = V_{CC}		100	250	
I_{CC2}	V_{CC} supply current (active)		V_{CC} = 5.5 V, $\overline{E}$ = V_{IL}, t_{cycle} = minimum cycle time, outputs open		15	30	mA

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		6	10	pF
C_O	Output capacitance	V_O = 0 V, f = 1 MHz		10	14	pF
$C_{G/VPP}$	$\overline{G}/V_{PP}$ input capacitance	$\overline{G}/V_{PP}$ = 0 V, f = 1 MHz		20	25	pF

† Typical values are at T_A = 25°C and nominal voltages.
‡ Capacitance measurements are made on a sample basis only.

switching characteristics over recommended ranges of operating conditions

PARAMETER		TEST CONDITIONS (SEE NOTES 3 AND 4)	'27C512-10 '27PC512-10		'27C512-12 '27PC512-12		UNIT
			MIN	MAX	MIN	MAX	
$t_{a(A)}$	Access time from address	C_L = 100 pF, 1 Series 74 TTL Load, Input $t_r \le 20$ ns, Input $t_f \le 20$ ns		100		120	ns
$t_{a(E)}$	Access time from chip enable			100		120	ns
$t_{en(G)}$	Output enable time from $\overline{G}/V_{PP}$			55		55	ns
t_{dis}	Output disable time from $\overline{G}/V_{PP}$ or $\overline{E}$, whichever occurs first†		0	45	0	45	ns
$t_{v(A)}$	Output data valid time after change of address, $\overline{E}$, or $\overline{G}/V_{PP}$, whichever occurs first†		0		0		ns

PARAMETER		TEST CONDITIONS (SEE NOTES 3 AND 4)	'27C512-15 '27PC512-15		UNIT
			MIN	MAX	
$t_{a(A)}$	Access time from address	C_L = 100 pF, 1 Series 74 TTL Load, Input $t_r \le 20$ ns, Input $t_f \le 20$ ns		150	ns
$t_{a(E)}$	Access time from chip enable			150	ns
$t_{en(G)}$	Output enable time from $\overline{G}/V_{PP}$			75	ns
t_{dis}	Output disable time from $\overline{G}/V_{PP}$ or $\overline{E}$, whichever occurs first†		0	60	ns
$t_{v(A)}$	Output data valid time after change of address, $\overline{E}$, or $\overline{G}/V_{PP}$, whichever occurs first†		0		ns

PARAMETER		TEST CONDITIONS (SEE NOTES 3 AND 4)	'27C512-20 '27PC512-20		'27C512-25 '27PC512-25		UNIT
			MIN	MAX	MIN	MAX	
$t_{a(A)}$	Access time from address	C_L = 100 pF, 1 Series 74 TTL Load, Input $t_r \le 20$ ns, Input $t_f \le 20$ ns		200		250	ns
$t_{a(E)}$	Access time from chip enable			200		250	ns
$t_{en(G)}$	Output enable time from $\overline{G}/V_{PP}$			75		100	ns
t_{dis}	Output disable time from $\overline{G}/V_{PP}$ or $\overline{E}$, whichever occurs first†		0	60	0	60	ns
$t_{v(A)}$	Output data valid time after change of address, $\overline{E}$, or $\overline{G}/V_{PP}$, whichever occurs first†		0		0		ns

† Value calculated from 0.5 V delta to measured output level. This parameter is only sampled and not 100% tested.

switching characteristics for programming: V_{CC} = 6.50 V and $\overline{G}/V_{PP}$ = 13 V (SNAP! Pulse), T_A = 25°C (see Note 3)

PARAMETER		MIN	MAX	UNIT
$t_{dis(G)}$	Disable time, output from $\overline{G}/V_{PP}$	0	130	ns

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 page 10.)
4. Common test conditions apply for t_{dis} except during programming.

recommended timing requirements for programming: V_{CC} = 6.50 V and $\overline{G}/V_{PP}$ = 13 V (SNAP! Pulse), T_A = 25°C (see Note 3)

		MIN	TYP	MAX	UNIT
$t_{w(IPGM)}$	Pulse duration, initial program	95	100	105	µs
$t_{su(A)}$	Setup time, address	2			µs
$t_{su(D)}$	Setup time, data	2			µs
$t_{su(VPP}$	Setup time, $\overline{G}/V_{PP}$	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
$t_{h(VPP)}$	Hold time, $\overline{G}/V_{PP}$	2			µs
$t_{rec(PG)}$	Recovery time, $\overline{G}/V_{PP}$	2			µs
t_{EHD}	Data valid from $\overline{E}$ low			1	µs
$t_{r(PG)G}$	Rise time, $\overline{G}/V_{PP}$	50			ns

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 below.)

PARAMETER MEASUREMENT INFORMATION

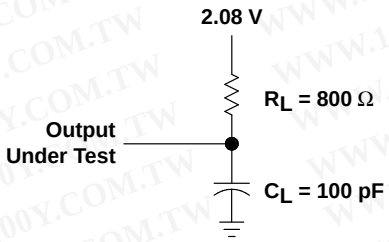


Figure 2. AC Testing Output Load Circuit

AC testing input/output wave forms

A.C. 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.

PARAMETER MEASUREMENT INFORMATION

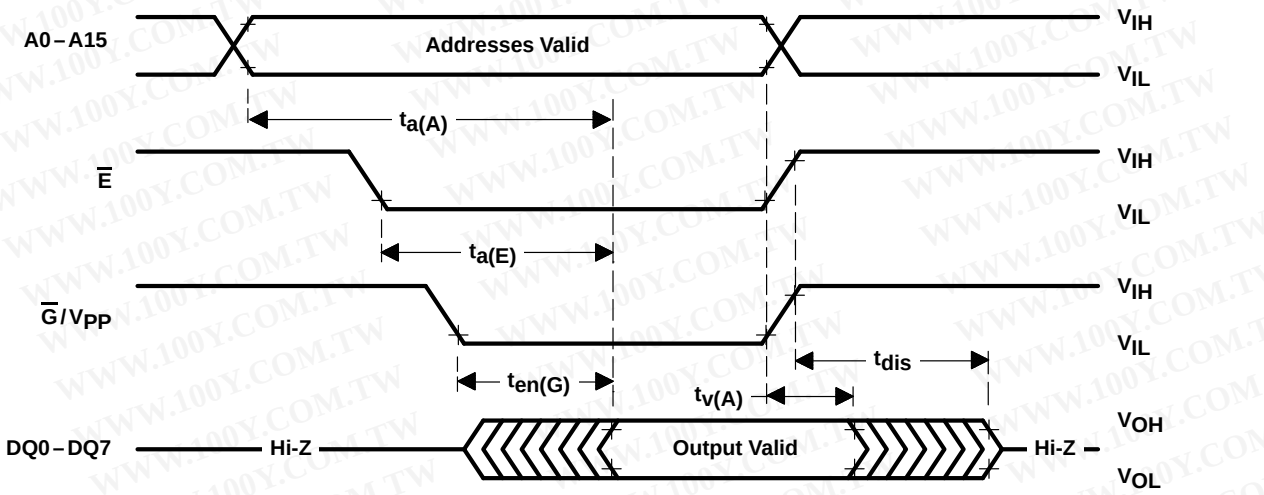
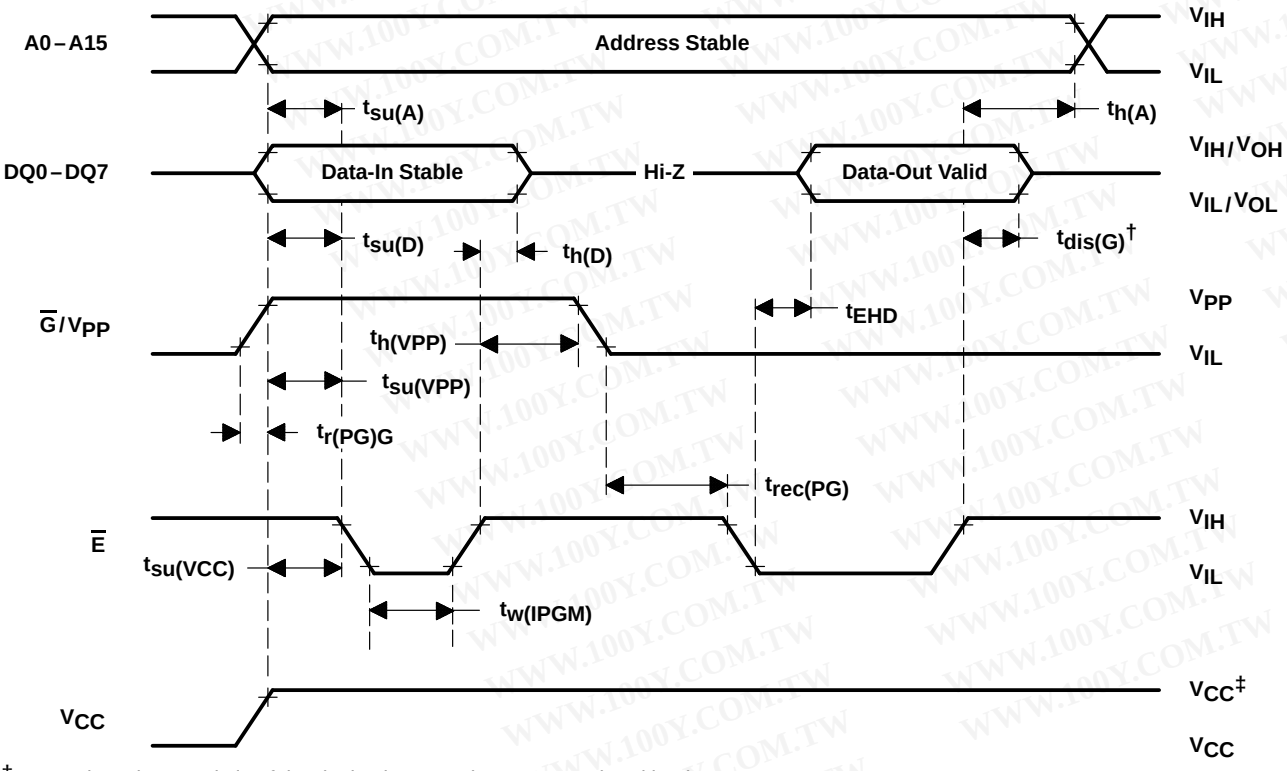


Figure 3. Read-Cycle Timing

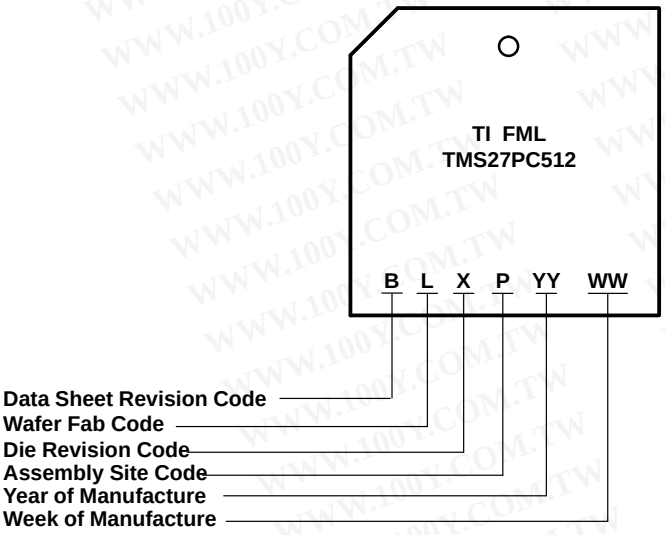


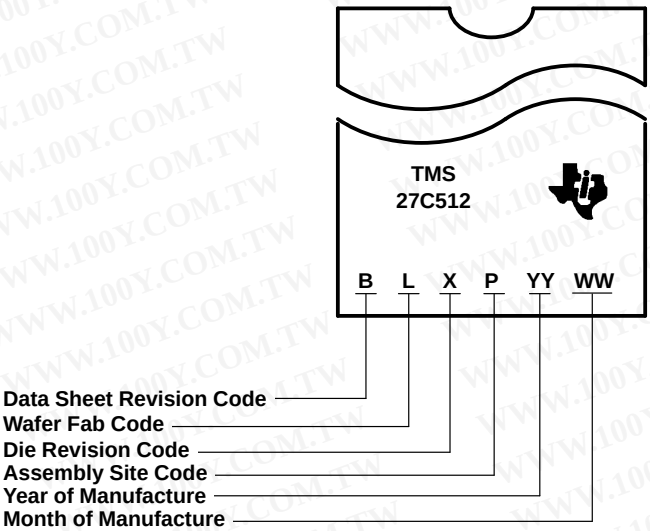
† $t_{dis(G)}$ is a characteristic of the device but must be accommodated by the programmer.
‡ 13-V $\overline{G}/V_{PP}$ and 6.5-V V_{CC} for SNAP! Pulse programming.

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

device symbolization

This data sheet is applicable to all TI TMS27C512 CMOS EPROMs and TMS27PC512 CMOS OTP PROMs with the data sheet revision code “B” as shown below.





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