V29LC51000
512 KILOBIT (65,536 x 8 BIT)
5 VOLT CMOS FLASH MEMORY

Features

- 64Kx8-bit Organization
- Address Access Time: 90 ns
- Single 5V ± 10% Power Supply
- Sector Erase Mode Operation
- 512 bytes per Sector, 128 Sectors
  - Sector-Erase Cycle Time: 10ms (Max)
  - Byte-Program Cycle Time: 30µs (Max)
- Minimum 1,000 Erase-Program Cycles
- Low power dissipation
  - Active Read Current: 20mA (Typ)
  - Active Program Current: 30mA (Typ)
  - Standby Current: 100µA (Max)
- Low V_{CC} Program Inhibit Below 3.2V
- Self-timed program/erase operations
- CMOS and TTL Interface
- Packages:
  - 32-pin Plastic DIP
  - 32-pin PLCC

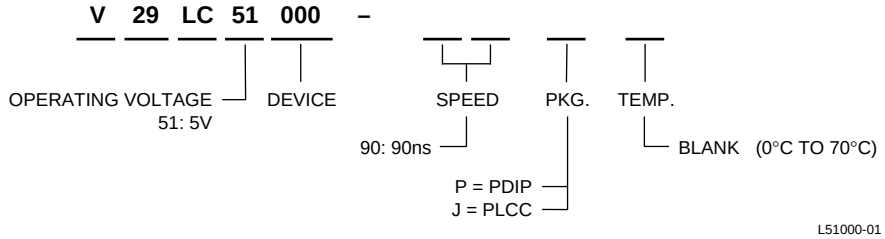
Description

The V29LC51000 is a high speed 65,536 x 8 bit CMOS flash memory. Programming or erasing the device is done with a single 5 Volt power supply. The device has separate chip enable $\overline{CE}$, program enable $\overline{WE}$, and output enable $\overline{OE}$ controls to eliminate bus contention.

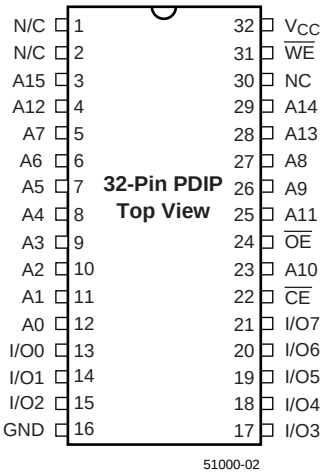
The V29LC51000 features a sector erase operation which allows each sector to be erased and reprogrammed without affecting data stored in other sectors. The device also supports full chip erase.

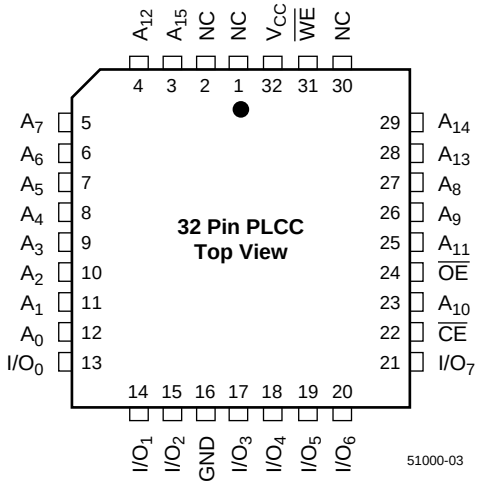
Device Usage Chart

Operating Temperature Range	Package Outline		Access Time (ns)	Temperature Mark
	P	J	90	
0°C to 70°C	•	•	•	Blank



Pin Configurations

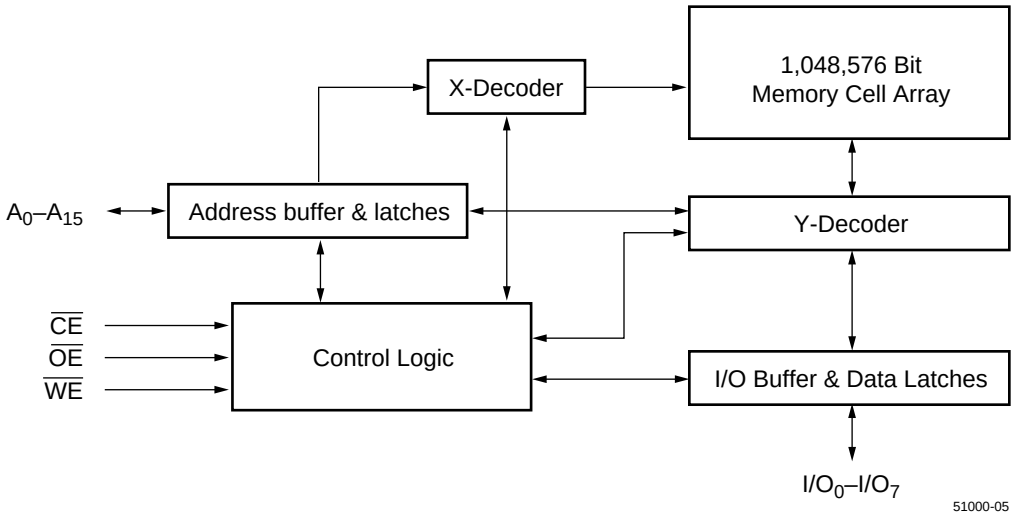




Pin Names

A_0–A_{15}	Address Inputs
I/O_0–I/O_7	Data Input/Output
$\overline{CE}$	Chip Enable
$\overline{OE}$	Output Enable
$\overline{WE}$	Program Enable
V_{CC}	5V ± 10% Power Supply
GND	Ground
NC	No Connect

Functional Block Diagram



Capacitance (1,2)

Symbol	Parameter	Test mSetup	Typ.	Max.	Units
C_{IN}	Input Capacitance	V_{IN} = 0	6	8	pF
C_{OUT}	Output Capacitance	V_{OUT} = 0	8	12	pF
C_{IN2}	Control Pin Capacitance	V_{IN} = 0	8	10	pF

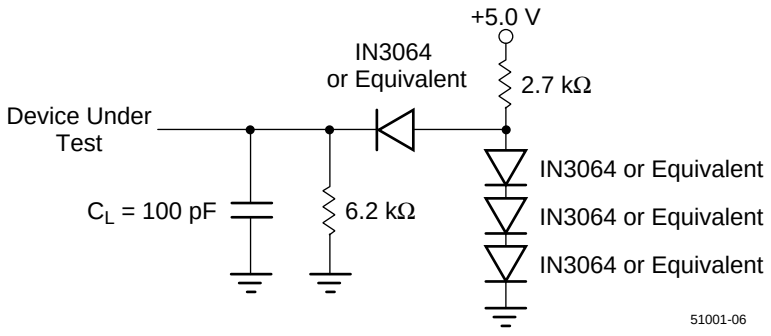
NOTE:
1. Capacitance is sampled and not 100% tested.
2. T_A = 25°C, V_{CC} = 5V ± 10%, f = 1 MHz.

Latch Up Characteristics(1)

Parameter	Min.	Max.	Unit
Input Voltage with Respect to GND on A_9, $\overline{OE}$	-1	+13	V
Input Voltage with Respect to GND on I/O, address or control pins	-1	V_{CC} + 1	V
V_{CC} Current	-100	+100	mA

NOTE:
1. Includes all pins except V_{CC}. Test conditions: V_{CC} = 5V, one pin at a time.

AC Test Load



Absolute Maximum Ratings[1]

Symbol	Parameter	Commercial	Unit
V_{IN}	Input Voltage (input or I/O pins)	-2 to +7	V
V_{IN}	Input Voltage (A_9 pin, $\overline{OE}$)	-2 to +13	V
V_{CC}	Power Supply Voltage	-0.5 to +5.5	V
T_{STG}	Storage Temerpature (Plastic)	-65 to +125	°C
T_{OPR}	Operating Temperature	0 to +70	°C
I_{OUT}	Short Circuit Current[2]	200 (Max.)	mA

NOTE:
1. Stress greater than those listed unders “Absolute Maximum Ratings” may cause permanent damage to the device. This is a stress rating only and 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 rating conditions for extended periods may affect reliability.
2. No more than one output maybe shorted at a time and not exceeding one second long.

DC Electrical Characteristics

(over the commercial operating range)

Parameter Name	Parameter	Test Conditions	Min.	Max.	Unit
V_{IL}	Input LOW Voltage	$V_{CC} = V_{CC}$ Min.	—	0.8	V
V_{IH}	Input HIGH Voltage	$V_{CC} = V_{CC}$ Max.	2	—	V
I_{IL}	Input Leakage Current	V_{IN} = GND to V_{CC}, $V_{CC} = V_{CC}$ Max.	—	±1	µA
I_{OL}	Output Leakage Current	V_{OUT} = GND to V_{CC}, $V_{CC} = V_{CC}$ Max.	—	±10	µA
V_{OL}	Output LOW Voltage	$V_{CC} = V_{CC}$ Min., I_{OL} = 2.1mA	—	0.4	V
V_{OH}	Output HIGH Voltage	$V_{CC} = V_{CC}$ Min, I_{OH} = -400µA	2.4	—	V
I_{CC1}	Read Current	$\overline{CE} = \overline{OE} = V_{IL}$, $\overline{WE} = V_{IH}$, all I/Os open, Address input = V_{IL}/V_{IH}, at f = $1/t_{RC}$ Min., $V_{CC} = V_{CC}$ Max.	—	40	mA
I_{CC2}	Program Current	$\overline{CE} = \overline{WE}$ = VIL, $\overline{OE} = V_{IH}$, $V_{CC} = V_{CC}$ Max.	—	50	mA
I_{SB}	TTL Standby Current	$\overline{CE} = \overline{OE} = \overline{WE} = V_{IH}$, $V_{CC} = V_{CC}$ Max.	—	2	mA
I_{SB1}	CMOS Standby Current	$\overline{CE} = \overline{OE} = \overline{WE} = V_{CC} - 0.3V$, $V_{CC} = V_{CC}$ Max.	—	100	µA
V_H	Device ID Voltage for A_9	$\overline{CE} = \overline{OE} = V_{IL}$, $\overline{WE} = V_{IH}$	11.5	12.5	V
I_H	Device ID Current for A_9	$\overline{CE} = \overline{OE} = V_{IL}$, $\overline{WE} = V_{IH}$, A9 = V_H Max.	—	50	µA

AC Electrical Characteristics

(over all temperature ranges)

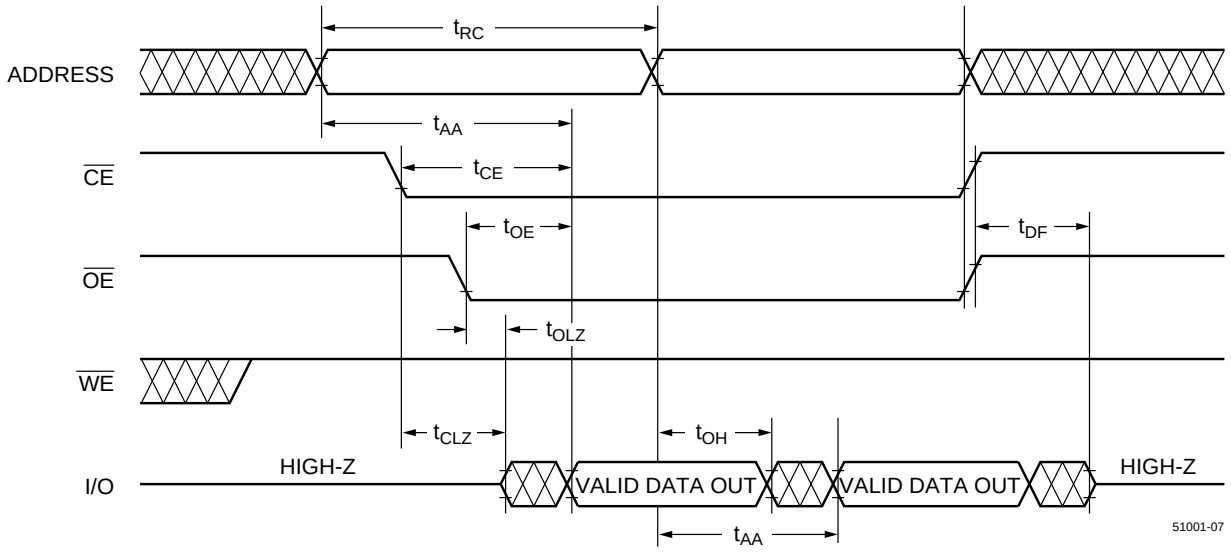
Read Cycle

Parameter Name	Parameter	-90		Unit
		Min.	Max.	
t_{RC}	Read Cycle Time	90	—	ns
t_{AA}	Address Access Time	—	90	ns
t_{ACS}	Chip Enable Access Time	—	90	ns
t_{OE}	Output Enable Access Time	—	40	ns
t_{CLZ}	$\overline{CE}$ Low to Output Active	0	—	ns
t_{OLZ}	$\overline{OE}$ Low to Output Active	0	—	ns
t_{DF}	Output Enable or Chip Disable to Output in High Z	0	20	ns
t_{OH}	Output Hold from Address Change	0	—	ns

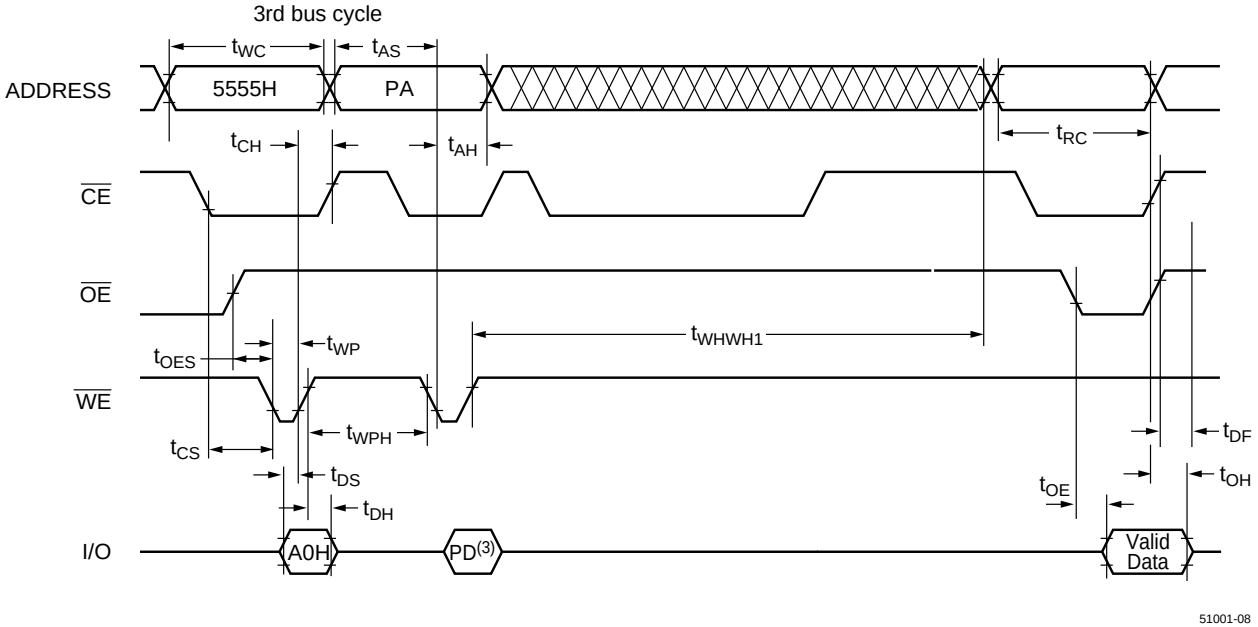
Program (Erase/Program) Cycle

Parameter Name	Parameter	-90			Unit
		Min.	Typ.	Max.	
t_{WC}	Program Cycle Time	90	—	—	ns
t_{AS}	Address Setup Time	0	—	—	ns
t_{AH}	Address Hold Time	45	—	—	ns
t_{CS}	$\overline{CE}$ Setup Time	0	—	—	ns
t_{CH}	$\overline{CE}$ Hold Time	0	—	—	ns
t_{OES}	$\overline{OE}$ Setup Time	0	—	—	ns
t_{OEH}	$\overline{OE}$ High Hold Time	0	—	—	ns
t_{WP}	$\overline{WE}$ Pulse Width	45	—	—	ns
t_{WPH}	$\overline{WE}$ Pulse Width High	35	—	—	ns
t_{DS}	Data Setup Time	30	—	—	ns
t_{DH}	Data Hold Time	0	—	—	ns
t_{WHWH1}	Programming Cycle	—	—	30	µs
t_{WHWH2}	Sector Erase Cycle	—	—	10	ms
t_{WHWH3}	Chip Erase Cycle	—	2	—	sec

Waveforms of Read Cycle



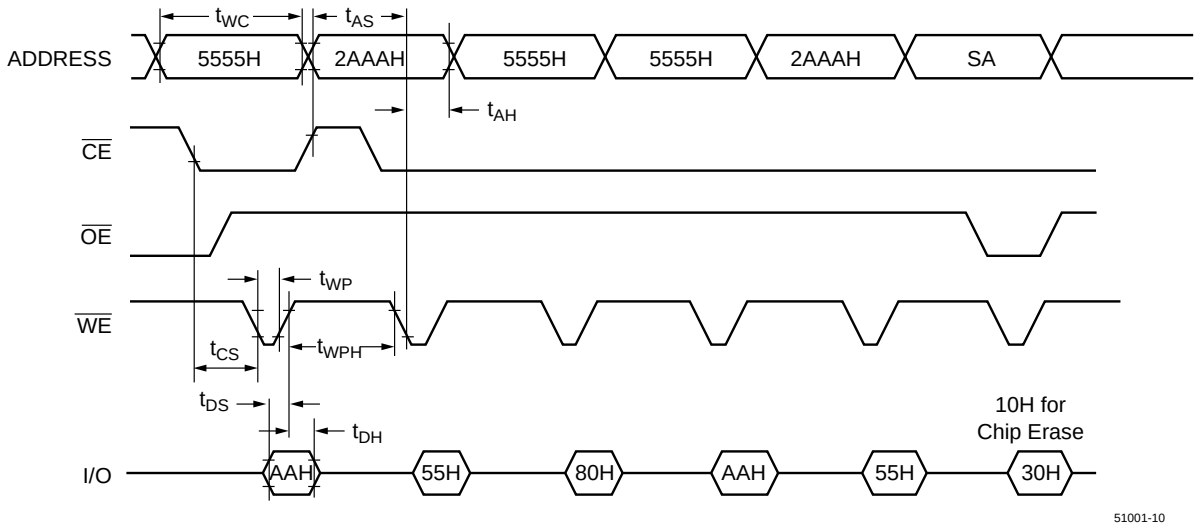
Waveforms of $\overline{WE}$ Controlled-Program Cycle



NOTES:

1. PA: The address of the memory location to be programmed.
2. PD: The data at the byte address to be programmed.

Waveforms of Erase Cycle(1)



NOTES:

1. PA: The address of the memory location to be programmed.
2. PD: The data at the byte address to be programmed.
3. SA: The sector address for Sector Erase. Address = don't care for Chip Erase.

FUNCTIONAL DESCRIPTION

Read Cycle

A read cycle is performed by holding both $\overline{CE}$ and $\overline{OE}$ signals LOW. Data Out becomes valid only when these conditions are met. During a read cycle $\overline{WE}$ must be HIGH prior to $\overline{CE}$ and $\overline{OE}$ going LOW. $\overline{WE}$ must remain HIGH during the read operation for the read to complete (see Table 1).

Output Disable

Returning $\overline{OE}$ or $\overline{CE}$ HIGH, whichever occurs first will terminate the read operation and place the I/O pins in the HIGH-Z state.

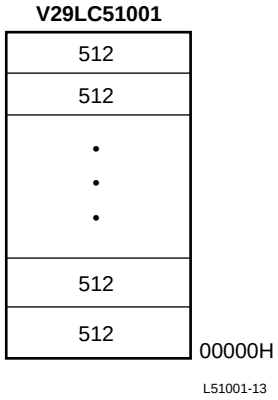
Standby

The device will enter standby mode when the $\overline{CE}$ signal is HIGH. The I/O pins are placed in the HIGH-Z, independent of the $\overline{OE}$ signal.

Byte Program Cycle

The V29LC51000 is programmed on a byte-by-byte basis. The byte program operation is initiated by using a specific four-bus-cycle sequence: two unlock program cycles, a program setup command and program data program cycles (see Table 2).

During the byte program cycle, addresses are latched on the falling edge of either $\overline{CE}$ or $\overline{WE}$, whichever is last. Data is latched on the rising edge of $\overline{CE}$ or $\overline{WE}$, whichever is first. The byte program cycle can be $\overline{CE}$ controlled or $\overline{WE}$ controlled.



Sector Erase Cycle

The V29LC51000 features a sector erase operation which allows each sector to be erased and reprogrammed without affecting data stored in other sectors. Sector erase operation is initiated by using a specific six-bus-cycle sequence: Two unlock program cycles, a setup command, two additional unlock program cycles, and the sector erase command (see Table 2). A sector must be first erased before it can be reprogrammed. While in the internal erase mode, the device ignores any program attempt into the device. Sector erase is completed in 10ms max. The V29LC51000 is shipped with pre-erased sectors (all bits = 1).

Table 1. Operation Modes Decoding

Decoding Mode	$\overline{CE}$	$\overline{OE}$	$\overline{WE}$	A_0	A_1	A_9	I/O
Read	V_{IL}	V_{IL}	V_{IH}	A_0	A_1	A_9	READ
Byte Write	V_{IL}	V_{IH}	V_{IL}	A_0	A_1	A_9	PD
Standby	V_{IH}	X	X	X	X	X	HIGH-Z
Output Disable	V_{IL}	V_{IH}	V_{IH}	X	X	X	HIGH-Z

NOTES:
1. X = Don't Care, V_{IH} = HIGH, V_{IL} = LOW. V_H = 12.5V Max.
2. PD: The data at the byte address to be programmed.

Table 2. Command Codes

Command Sequence	First Bus Program Cycle		Second Bus Program Cycle		Third Bus Program Cycle		Fourth Bus Program Cycle		Fifth Bus Program Cycle		Six Bus Program Cycle	
	Address	Data	Address	Data	Address	Data	Address	Data	Address	Data	Address	Data
Read	XXXXH	F0H										
Read	5555H	AAH	2AAAH	55H	5555H	F0H	RA	RD				
Autoselect	5555H	AAH	2AAAH	55H	5555H	90H	00H	40H(3)				
							01H	20H(4)				
Byte Program	5555H	AAH	2AAAH	55H	5555H	A0H	PA	PD(2)				
Chip Erase	5555H	AAH	2AAAH	55H	5555H	80H	5555H	AAH	2AAAH	55H	5555H	10H
Sector Erase	5555H	AAH	2AAAH	55H	5555H	80H	5555H	AAH	2AAAH	55H	PA(1)	30H

NOTES:
1. PA: The address of the memory location to be programmed.
2. PD: The data at the byte address to be programmed.
3. 40H: Manufacturing ID
4. 20H: Device ID

Chip Erase Cycle

The V29LC51000 features a chip-erase operation. The chip erase operation is initiated by using a specific six-bus-cycle sequence: two unlock program cycles, a setup command, two additional unlock program cycles, and the chip erase command (see Table 2).

The chip erase operation is performed sequentially, one sector at a time. When the automated on chip erase algorithm is requested with the chip erase command sequence, the device automatically programs and verifies the entire memory array for an all zero pattern prior to erasure

The automatic erase begins on the rising edge of the last $\overline{WE}$ or $\overline{CE}$ pulse in the command sequence and terminates 500ms later.

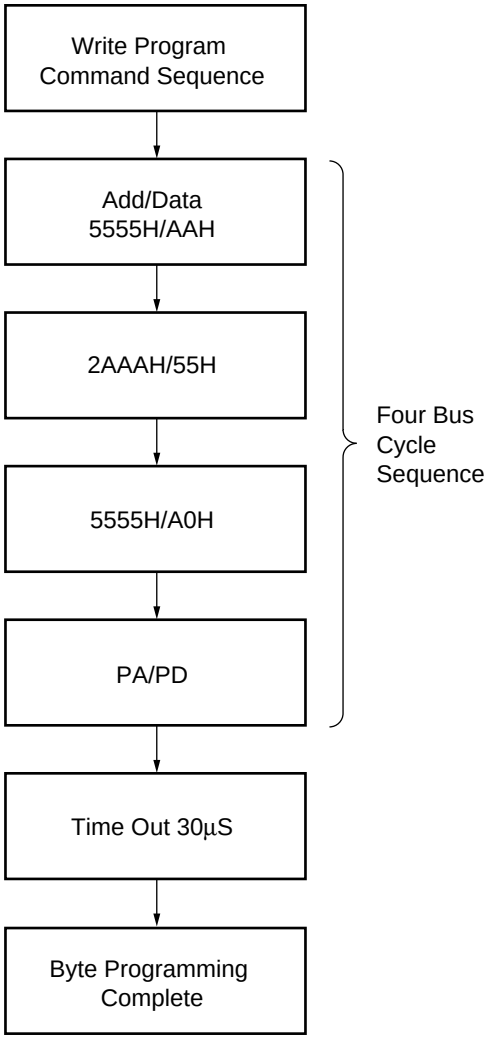
Hardware Data Protection

V_{CC} Sense Protection: the program operation is inhibited when VCC is less than 2.5V.

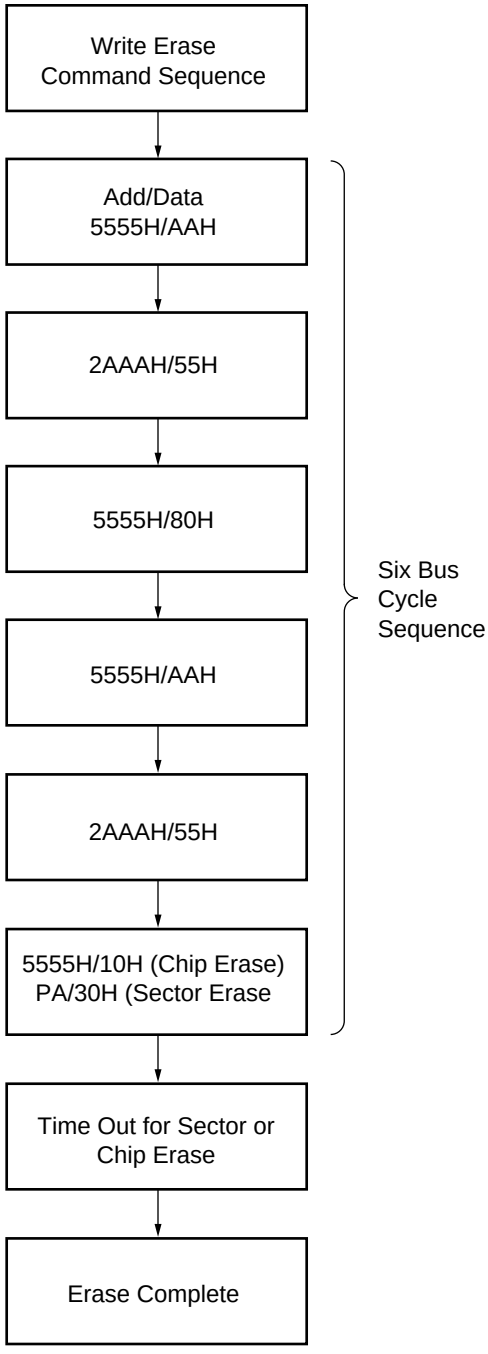
Noise Protection: a CE or WE pulse of less than 5ns will not initiate a program cycle.

Program Inhibit Protection: holding any one of OE LOW, CE HIGH or WE HIGH inhibits a program cycle.

Byte Program Algorithm



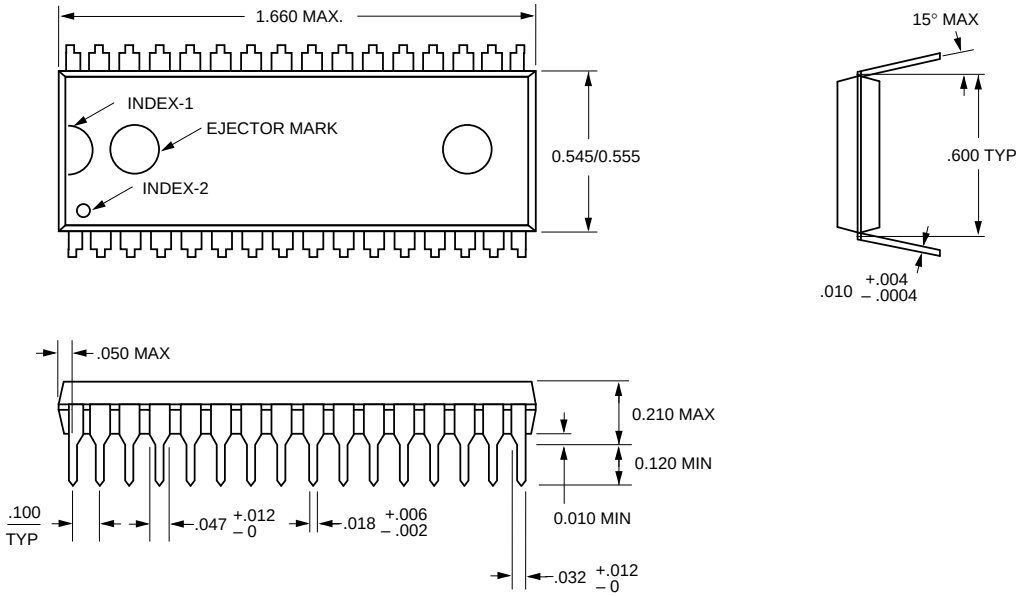
Chip/Sector Erase Algorithm



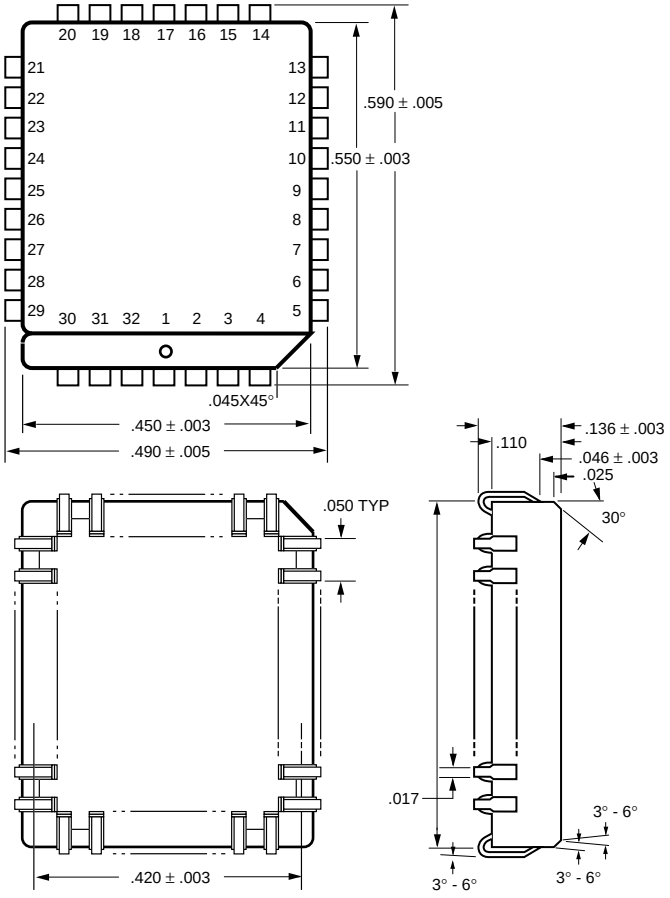
L51000-14

Package Diagrams

32-pin Plastic DIP



32-pin PLCC



U.S.A.
3910 NORTH FIRST STREET
SAN JOSE, CA 95134
PHONE: 408-433-6000
FAX: 408-433-0952

HONG KONG
19 DAI FU STREET
TAIPO INDUSTRIAL ESTATE
TAIPO, NT, HONG KONG
PHONE: 852-2666-3307
FAX: 852-2770-8011

TAIWAN
7F, NO. 102
MIN-CHUAN E. ROAD, SEC. 3
TAIPEI
PHONE: 886-2-2545-1213
FAX: 886-2-2545-1209

NO 19 LI HSIN RD.
SCIENCE BASED IND. PARK
HSIN CHU, TAIWAN, R.O.C.
PHONE: 886-3-578-3344
FAX: 886-3-579-2838

SINGAPORE
10 ANSON ROAD #23-13
INTERNATIONAL PLAZA
SINGAPORE 079903
PHONE: 65-3231801
FAX: 65-3237013

JAPAN
WBG MARINE WEST 25F
6, NAKASE 2-CHOME
MIHAMA-KU, CHIBA-SHI
CHIBA 261-71
PHONE: 81-43-299-6000
FAX: 81-43-299-6555

IRELAND & UK
BLOCK A UNIT 2
BROOMFIELD BUSINESS PARK
MALAHIDE
CO. DUBLIN, IRELAND
PHONE: +353 1 8038020
FAX: +353 1 8038049

GERMANY (CONTINENTAL EUROPE & ISRAEL)
71083 HERRENBERG
BENZSTR. 32
GERMANY
PHONE: +49 7032 2796-0
FAX: +49 7032 2796 22

U.S. SALES OFFICES

NORTHWESTERN
3910 NORTH FIRST STREET
SAN JOSE, CA 95134
PHONE: 408-433-6000
FAX: 408-433-0952

NORTHEASTERN
SUITE 436
20 TRAFALGAR SQUARE
NASHUA, NH 03063
PHONE: 603-889-4393
FAX: 603-889-9347

SOUTHWESTERN
SUITE 200
5150 E. PACIFIC COAST HWY.
LONG BEACH, CA 90804
PHONE: 562-498-3314
FAX: 562-597-2174

CENTRAL & SOUTHEASTERN
604 FIELDWOOD CIRCLE
RICHARDSON, TX 75081
PHONE: 972-690-1402
FAX: 972-690-0341

NORTHEASTERN
SUITE 436
20 TRAFALGAR SQUARE
NASHUA, NH 03063
PHONE: 603-889-4393
FAX: 603-889-9347

7/99
Printed in U.S.A.