



## 64K × 16 CMOS FLASH MEMORY

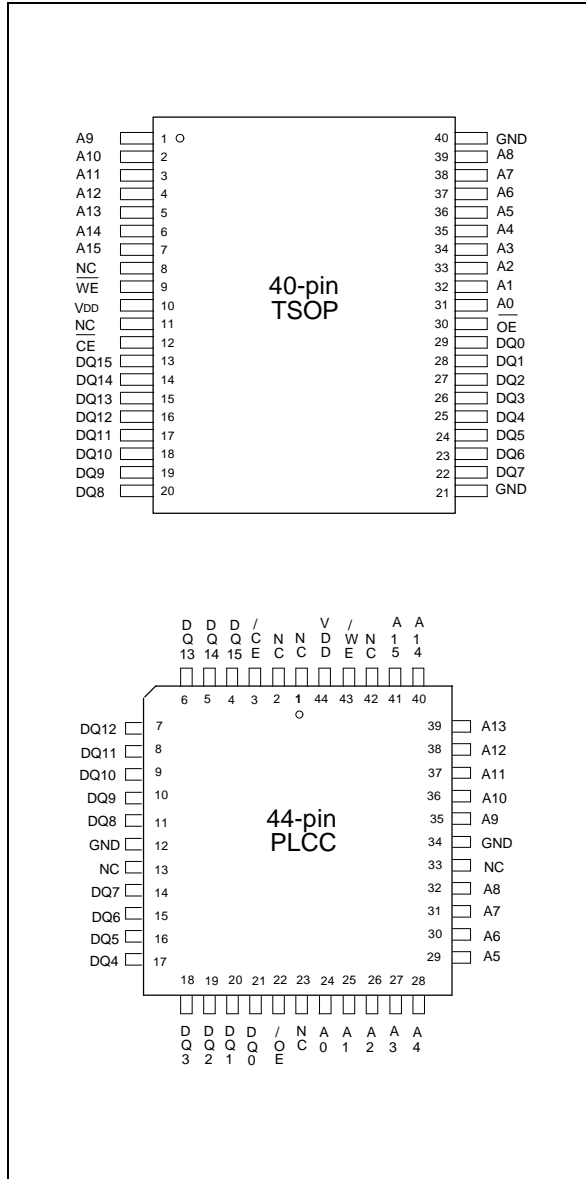
### GENERAL DESCRIPTION

The W29F102 is a 1-megabit, 5-volt only CMOS flash memory organized as 64K × 16 bits. The device can be programmed and erased in-system with a standard 5V power supply. A 12-volt V<sub>PP</sub> is not required. The unique cell architecture of the W29F102 results in fast program/erase operations with extremely low current consumption (compared to other comparable 5-volt flash memory products). The device can also be programmed and erased using standard EPROM programmers.

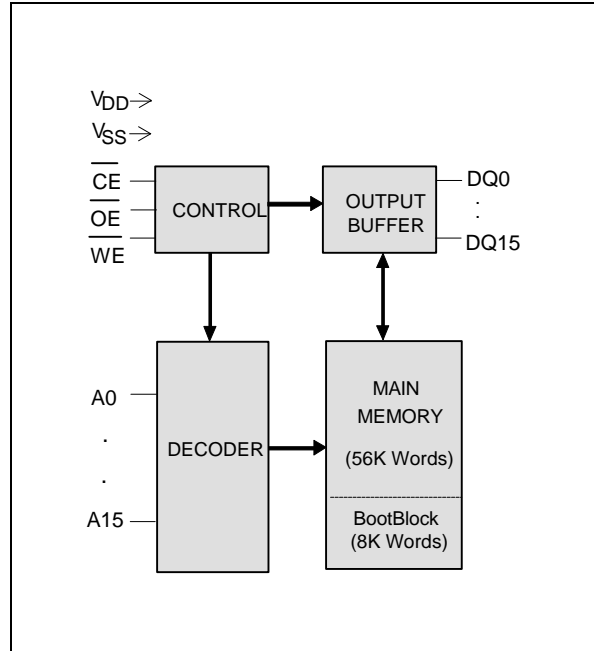
### FEATURES

- Single 5-volt operations:
  - 5-volt Read
  - 5-volt Erase
  - 5-volt Program
- Fast Program operation:
  - Word-by-Word programming: 50 μS (max.)
- Fast Erase operation: 100 mS (typ.)
- Fast Read access time: 45/50/55/70 nS
- Endurance: 1K/10K cycles (typ.)
- Ten-year data retention
- Hardware data protection
- 8K word Boot Block with Lockout protection
- Low power consumption
  - Active current: 25 mA (typ.)
  - Standby current: 20 μA (typ.)
- Automatic program and erase timing with internal V<sub>PP</sub> generation
- End of program or erase detection
  - Toggle bit
  - Data polling
- Latched address and data
- TTL compatible I/O
- JEDEC standard word-wide pinouts
- Available packages: 40-pin TSOP and 44-pin PLCC

## PIN CONFIGURATIONS



## BLOCK DIAGRAM



## PIN DESCRIPTION

SYMBOL	PIN NAME
A0–A15	Address Inputs
DQ0–DQ15	Data Inputs/Outputs
$\overline{CE}$	Chip Enable
$\overline{OE}$	Output Enable
$\overline{WE}$	Write Enable
VDD	Power Supply
GND	Ground
NC	No Connection



## FUNCTIONAL DESCRIPTION

### Read Mode

The read operation of the W29F102 is controlled by  $\overline{CE}$  and  $\overline{OE}$ , both of which have to be low for the host to obtain data from the outputs.  $\overline{CE}$  is used for device selection. When  $\overline{CE}$  is high, the chip is de-selected and only standby power will be consumed.  $\overline{OE}$  is the output control and is used to gate data from the output pins. The data bus is in high impedance state when either  $\overline{CE}$  or  $\overline{OE}$  is high. Refer to the timing waveforms for further details.

### Boot Block Operation

There is one 8K-word boot block in this device, which can be used to store boot code. It is located in the first 8K words of the memory with the address range from 0000 hex to 1FFF hex.

See Command Codes for Boot Block Lockout Enable for the specific code. Once this feature is set the data for the designated block cannot be erased or programmed (programming lockout); other memory locations can be changed by the regular programming method. Once the boot block programming lockout feature is activated, the chip erase function will only affect the main memory.

In order to detect whether the boot block feature is set on the 8K-words block, users can perform software command sequence: enter the product identification mode (see Command Codes for Identification/Boot Block Lockout Detection for specific code), and then read from address "0002 hex". If the output data is "FF hex," the boot block programming lockout feature is activated; if the output data is "FE hex," the lockout feature is inactivated and the block can be erased/programmed.

To return to normal operation, perform a three-byte command sequence (or an alternate single-word command) to exit the identification mode. For the specific code, see Command Codes for Identification/Boot Block Lockout Detection.

### Chip Erase Operation

The chip-erase mode can be initiated by a six-word command sequence. After the command loading cycle, the device enters the internal chip erase mode, which is automatically timed and will be completed in a fast 100 mS (typical). The host system is not required to provide any control or timing during this operation. If the boot block programming lockout is activated, only the data in the main memory will be erased to FF(hex), and the data in the boot block will not be erased (remains same as before the chip erase operation). The entire memory array (main memory and boot block) will be erased to FF hex. by the chip erase operation if the boot block programming lockout feature is not activated. The device will automatically return to normal read mode after the erase operation completed. Data polling and/or Toggle Bits can be used to detect end of erase cycle.

### Main Memory Erase Operation

The main memory erase mode can be initiated by a six-word command sequence. After the command loading cycle, the device enters the internal main-memory erase mode, which is automatically timed and will be completed in a fast 100 mS (typical). The host system is not required to provide any control or timing during this operation. The device will automatically return to normal read mode after the erase operation completed. Data polling and/or Toggle Bits can be used to detect end of erase cycle.



## Program Operation

The W29F102 is programmed on a word-by-word basis. Program operation can only change logical data "1" to logical data "0". The erase operation (changed entire data in main memory and/or boot block from "0" to "1" is needed before programming).

The program operation is initiated by a 4-word command cycle (see Command Codes for Word Programming). The device will internally enter the program operation immediately after the word-program command is entered. The internal program timer will automatically time-out (50  $\mu$ S max. - TBP) once completed and return to normal read mode. Data polling and/or Toggle Bits can be used to detect end of program cycle.

## Hardware Data Protection

The integrity of the data stored in the W29F102 is also hardware protected in the following ways:

- (1) Noise/Glitch Protection: A  $\overline{WE}$  pulse of less than 15 nS in duration will not initiate a write cycle.
- (2) VDD Power Up/Down Detection: The programming operation is inhibited when VDD is less than 2.5V typical.
- (3) Write Inhibit Mode: Forcing  $\overline{OE}$  low,  $\overline{CE}$  high, or  $\overline{WE}$  high will inhibit the write operation. This prevents inadvertent writes during power-up or power-down periods.
- (4) VDD power-on delay: When VDD has reached its sense level, the device will automatically time-out 5 mS before any write (erase/program) operation.

## Data Polling (DQ7 & DQ15)- Write Status Detection

The W29F102 includes a data polling feature to indicate the end of a program or erase cycle. When the W29F102 is in the internal program or erase cycle, any attempt to read DQ7 or DQ15 of the last word loaded will receive the complement of the true data. Once the program or erase cycle is completed, DQ7 or DQ15 will show the true data. Note that DQ7 or DQ15 will show logical "0" during the erase cycle, and become logical "1" or true data when the erase cycle has been completed.

## Toggle Bit (DQ6 & DQ14)- Write Status Detection

In addition to data polling, the W29F102 provides another method for determining the end of a program cycle. During the internal program or erase cycle, any consecutive attempts to read DQ6 or DQ14 will produce alternating 0's and 1's. When the program or erase cycle is completed, this toggling between 0's and 1's will stop. The device is then ready for the next operation.

## Product Identification

The product ID operation outputs the manufacturer code and device code. Programming equipment automatically matches the device with its proper erase and programming algorithms.

The manufacturer and device codes can be accessed by software or hardware operation. In the software access mode, a six-word (or JEDEC 3-word) command sequence can be used to access the product ID. A read from address 0000H outputs the manufacturer code (00DAh). A read from address 0001H outputs the device code (002Fh). The product ID operation can be terminated by a three-word command sequence or an alternate one-word command sequence (see Command Definition table).

In the hardware access mode, access to the product ID is activated by forcing  $\overline{CE}$  and  $\overline{OE}$  low,  $\overline{WE}$  high, and raising A9 to 12 volts.



**TABLE OF OPERATING MODES**

**Operating Mode Selection**

(V<sub>HH</sub> = 12V ± 0.5V)

MODE	PINS				
	$\overline{CE}$	$\overline{OE}$	$\overline{WE}$	ADDRESS	DQ.
Read	VIL	VIL	VIH	A <sub>IN</sub>	D <sub>out</sub>
Write	VIL	VIH	VIL	A <sub>IN</sub>	D <sub>in</sub>
Standby	VIH	X	X	X	High Z
Write Inhibit	X	VIL	X	X	High Z/DOUT
	X	X	VIH	X	High Z/DOUT
Output Disable	X	VIH	X	X	High Z
Product ID	VIL	VIL	VIH	A0 = VIL; A1–A15 = VIL; A9 = VHH	Manufacturer Code 00DA (Hex)
	VIL	VIL	VIH	A0 = VIH; A1–A15 = VIL; A9 = VHH	Device Code 002F (Hex)

**TABLE OF COMMAND DEFINITION**

Command Description	No. of Cycles	1st Cycle	2nd Cycle	3rd Cycle	4th Cycle	5th Cycle	6th Cycle
		Addr. Data	Addr. Data	Addr. Data	Addr. Data	Addr. Data	Addr. Data
Read	1	A <sub>IN</sub> D <sub>OUT</sub>					
Chip Erase	6	5555 AA	2AAA 55	5555 80	5555 AA	2AAA 55	5555 10
Main Memory Erase	6	5555 AA	2AAA 55	5555 80	5555 AA	2AAA 55	5555 30
Word Program	4	5555 AA	2AAA 55	5555 A0	A <sub>IN</sub> D <sub>IN</sub>		
Boot Block Lockout	6	5555 AA	2AAA 55	5555 80	5555 AA	2AAA 55	5555 40
Product ID Entry	3	5555 AA	2AAA 55	5555 90			
Product ID Exit <sup>(1)</sup>	3	5555 AA	2AAA 55	5555 F0			
Product ID Exit <sup>(1)</sup>	1	XXXX F0					

Note: Address Format: A14–A0 (Hex); Data Format: DQ15–DQ8 (Don't Care); DQ7–DQ0 (Hex)

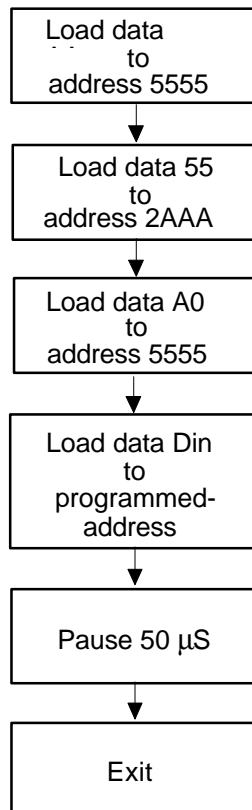
Either one of the two Product ID Exit commands can be used.

### Command Codes for Word Program

WORD SEQUENCE	ADDRESS	DATA
0 Write	5555H	AAH
1 Write	2AAAH	55H
2 Write	5555H	A0H
3 Write	Programmed-Address	Programmed-Data

### Word Program Flow Chart

#### Word Program Command Flow



Notes for software program code:

Data Format: DQ15–DQ0 (Hex); XX = Don't Care

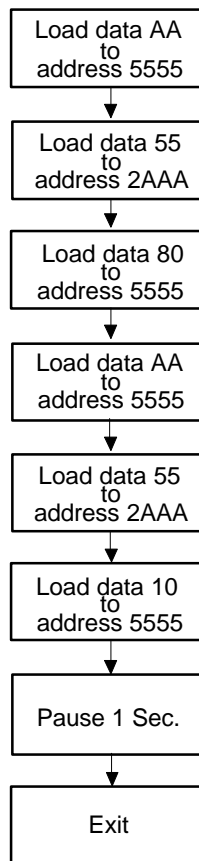
Address Format: A14–A0 (Hex)



## Command Codes for Chip Erase

BYTE SEQUENCE	ADDRESS	DATA
1 Write	5555H	AAH
2 Write	2AAAH	55H
3 Write	5555H	80H
4 Write	5555H	AAH
5 Write	2AAAH	55H
6 Write	5555H	10H

## Chip Erase Acquisition Flow



Notes for chip erase:

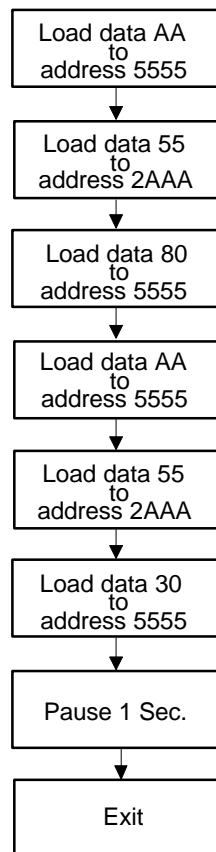
Data Format: DQ15-DQ8: Don't Care ; DQ7-DQ0 (Hex)

Address Format: A14-A0 (Hex)

### Command Codes for Main Memory Erase

BYTE SEQUENCE	ADDRESS	DATA
1 Write	5555H	AAH
2 Write	2AAAH	55H
3 Write	5555H	80H
4 Write	5555H	AAH
5 Write	2AAAH	55H
6 Write	5555H	30H

### Main Memory Erase Acquisition Flow



Notes for chip erase:

Data Format: DQ15-DQ8: Don't Care ; DQ7-DQ0 (Hex)

Address Format: A14-A0 (Hex)

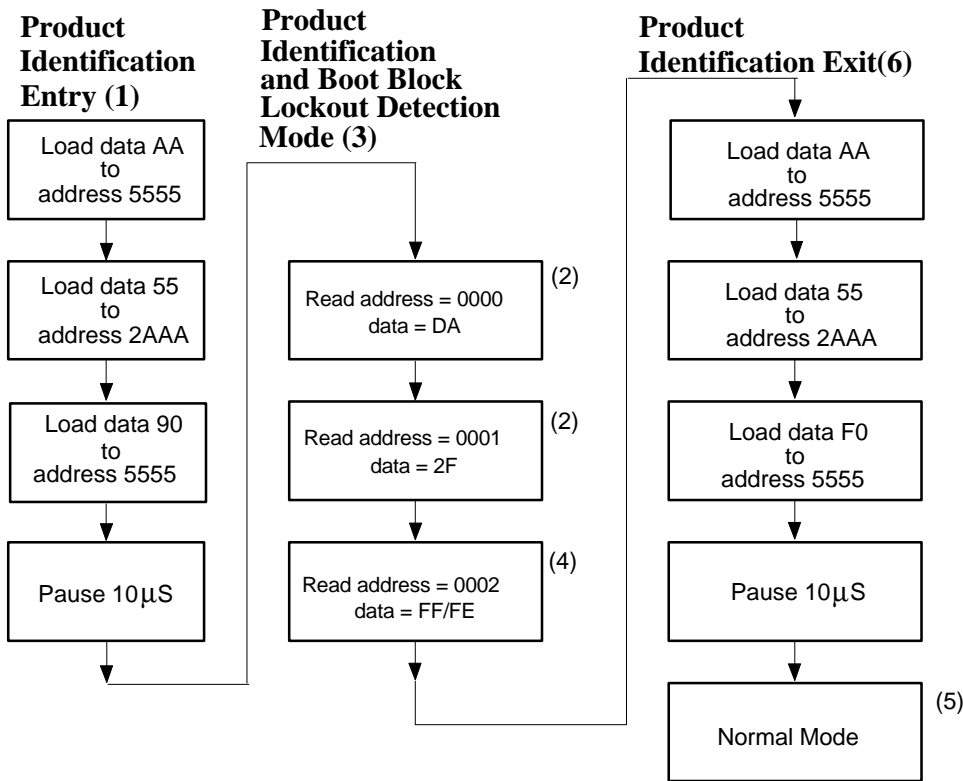




**Command Codes for Product Identification and Boot Block Lockout Detection**

BYTE SEQUENCE	PRODUCT IDENTIFICATION/BOOT BLOCK LOCKOUT DETECTION ENTRY		SOFTWARE PRODUCT IDENTIFICATION/BOOT BLOCK LOCKOUT DETECTION EXIT (6)	
	ADDRESS	DATA	ADDRESS	DATA
1 Write	5555	AA	5555H	AAH
2 Write	2AAA	55	2AAA H	55H
3 Write	5555	90	5555H	F0H
Pause 10 μS			Pause 10 μS	

**Software Product Identification and Boot Block Lockout Detection Acquisition Flow**



Notes for software product identification/boot block lockout detection:

- (1) Data Format: DQ15-DQ8 (Don't Care), DQ7-DQ0 (Hex); Address Format: A14-A0 (Hex)
- (2) A1-A15 = VIL; manufacture code is read for A0 = VIL; device code is read for A0 = VIH.
- (3) The device does not remain in identification and boot block lockout detection mode if power down.
- (4) If the output data is "FF Hex," the boot block programming lockout feature is activated; if the output data "FE Hex," the lockout feature is inactivated and the block can be programmed.
- (5) The device returns to standard operation mode.
- (6) Optional 1-write cycle (write F0 hex at XXXX address) can be used to exit the product identification/boot block lockout detection.

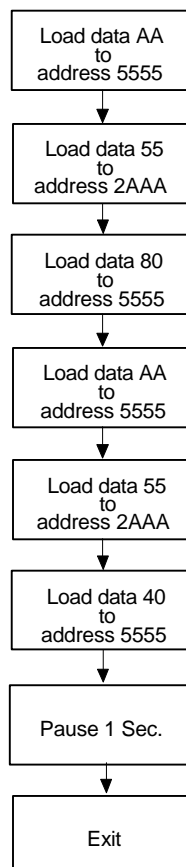


## Command Codes for Boot Block Lockout Enable

BYTE SEQUENCE	BOOT BLOCK LOCKOUT FEATURE SET	
	ADDRESS	DATA
1 Write	5555H	AAH
2 Write	2AAAH	55H
3 Write	5555H	80H
4 Write	5555H	AAH
5 Write	2AAAH	55H
6 Write	5555H	40H
Pause 1 Sec.		

## Boot Block Lockout Enable Acquisition Flow

### Boot Block Lockout Feature Set Flow



Notes for boot block lockout enable:  
 Data Format: DQ15-DQ8 Don't Care), DQ7-DQ0 (Hex)  
 Address Format: A14-A0 (Hex)

## DC CHARACTERISTICS

### Absolute Maximum Ratings

PARAMETER	RATING	UNIT
Power Supply Voltage to V <sub>SS</sub> Potential	-0.5 to +7.0	V
Operating Temperature	0 to +70	°C
Storage Temperature	-65 to +150	°C
D.C. Voltage on Any Pin to Ground Potential except $\overline{OE}$	-0.5 to V <sub>DD</sub> +1.0	V
Transient Voltage (<20 nS ) on Any Pin to Ground Potential	-1.0 to V <sub>DD</sub> +1.0	V
Voltage on $\overline{OE}$ Pin to Ground Potential	-0.5 to 12.5	V

Note: Exposure to conditions beyond those listed under Absolute Maximum Ratings may adversely affect the life and reliability of the device.

### DC Operating Characteristics

(V<sub>DD</sub> = 5.0V ±10%, V<sub>SS</sub> = 0V, T<sub>A</sub> = 0 to 70° C)

PARAMETER	SYM.	TEST CONDITIONS		LIMITS			UNIT
				MIN.	TYP.	MAX.	
Power Supply Current	I <sub>CC</sub>	$\overline{CE}=\overline{OE}=V_{IL}$ , $\overline{WE}=V_{IH}$ , all I/Os open Address inputs = V <sub>IL</sub> /V <sub>IH</sub> , at f = 5 MHz	50, 55, 70 nS	-	25	50	mA
			45 nS	-	25	70	mA
Standby V <sub>DD</sub> Current (TTL input)	ISB1	$\overline{CE}=V_{IH}$ , all I/Os open Other inputs = V <sub>IL</sub> /V <sub>IH</sub>		-	2	3	mA
Standby V <sub>DD</sub> Current (CMOS input)	ISB2	$\overline{CE}=V_{DD}-0.3V$ , all I/Os open Other inputs = V <sub>DD}-0.3V/GND</sub>		-	20	100	μA
Input Leakage Current	I <sub>LI</sub>	V <sub>IN</sub> = GND to V <sub>DD</sub>		-	-	10	μA
Output Leakage Current	I <sub>LO</sub>	V <sub>OUT</sub> = GND to V <sub>DD</sub>		-	-	10	μA
Input Low Voltage	V <sub>IL</sub>	-	50, 55, 70 nS	-0.3	-	0.8	V
			45 nS	-0.3	-	0.6	V
Input High Voltage	V <sub>IH</sub>	-		2.0	-	V <sub>DD</sub> +0.5	V
Output Low Voltage	V <sub>OL</sub>	I <sub>OL</sub> = 2.1 mA		-	-	0.45	V
Output High Voltage	V <sub>OH</sub>	I <sub>OH</sub> = -0.4 mA		2.4	-	-	V

## Power-up Timing

PARAMETER	SYMBOL	TYPICAL	UNIT
Power-up to Read Operation	TPU. READ	100	μS
Power-up to Write Operation	TPU. WRITE	5	mS

## CAPACITANCE

(V<sub>DD</sub> = 5.0V, T<sub>A</sub> = 25° C, f = 1 MHz)

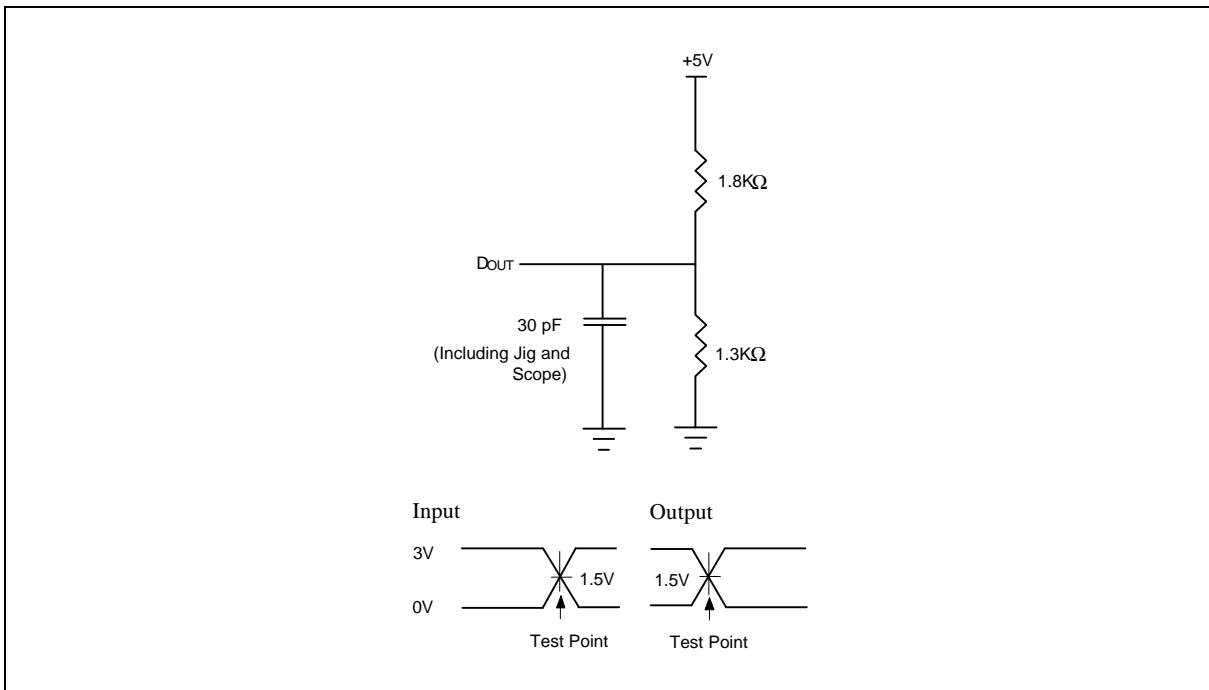
PARAMETER	SYMBOL	CONDITIONS	MAX.	UNIT
I/O Pin Capacitance	C <sub>I/O</sub>	V <sub>I/O</sub> = 0V	12	pf
Input Capacitance	C <sub>IN</sub>	V <sub>IN</sub> = 0V	6	pf

## AC CHARACTERISTICS

### AC Test Conditions

PARAMETER	CONDITIONS
Input Pulse Levels	0V to 3.0V
Input Rise/Fall Time	< 5 nS
Input/Output Timing Level	1.5V/1.5V
Output Load	1 TTL Gate and C <sub>L</sub> = 30 pF

### AC Test Load and Waveform





AC Characteristics, continued

## Read Cycle Timing Parameters

(V<sub>DD</sub> = 5.0V ±10%, T<sub>A</sub> = 0 to 70° C)

PARAMETER	SYM.	W29F102-45		W29F102-50		W29F102-55		W29F102-70		UNIT
		MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
Read Cycle Time	TRC	45	-	50	-	55	-	70	-	nS
Chip Enable Access Time	TCE	-	45	-	50	-	55	-	70	nS
Address Access Time	TAA	-	45	-	50	-	55	-	70	nS
Output Enable Access Time	TOE	-	25	-	25	-	30	-	35	nS
$\overline{CE}$ Low to Active Output	TCLZ	0	-	0	-	0	-	0	-	nS
$\overline{OE}$ Low to Active Output	TOLZ	0	-	0	-	0	-	0	-	nS
$\overline{CE}$ High to High-Z Output	TCHZ	-	20	-	20	-	25	-	25	nS
$\overline{OE}$ High to High-Z Output	TOHZ	-	20	-	20	-	25	-	25	nS
Output Hold from Address Change	TOH	0	-	0	-	0	-	0	-	nS

## Write Cycle Timing Parameters

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT
Address Setup Time	TAS	0	-	-	nS
Address Hold Time	TAH	50	-	-	nS
$\overline{WE}$ and $\overline{CE}$ Setup Time	TCS	0	-	-	nS
$\overline{WE}$ and $\overline{CE}$ Hold Time	TCH	0	-	-	nS
$\overline{OE}$ High Setup Time	TOES	0	-	-	nS
$\overline{OE}$ High Hold Time	TOEH	0	-	-	nS
$\overline{CE}$ Pulse Width	TCP	70	-	-	nS
$\overline{WE}$ Pulse Width	TWP	70	-	-	nS
$\overline{WE}$ High Width	TWPH	70	-	-	nS
Data Setup Time	TDS	50	-	-	nS
Data Hold Time	TDH	0	-	-	nS
Word Programming Time	TBP	-	10	50	μS
Erase Cycle Time	TEC	-	0.1	1	Sec.

Note: All AC timing signals observe the following guidelines for determining setup and hold times:

(a) High level signal's reference level is V<sub>IH</sub> and (b) low level signal's reference level is V<sub>IL</sub>.

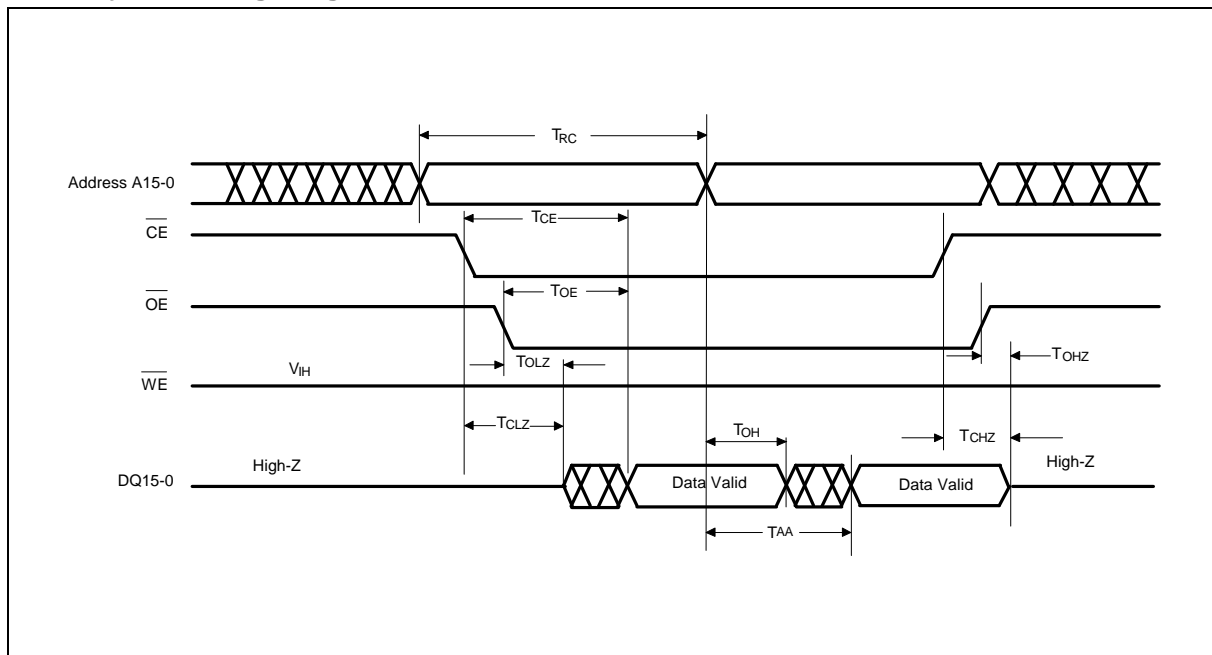
AC Characteristics, continued

## Data Polling and Toggle Bit Timing Parameters

PARAMETER	SYM.	W29F102-45		W29F102-50		W29F102-55		W29F102-70		UNIT
		MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	
$\overline{\text{OE}}$ to Data Polling Output Delay	TOEP	-	25	-	25	-	30	-	35	nS
$\overline{\text{CE}}$ to Data Polling Output Delay	TCEP	-	45	-	50	-	55	-	70	nS
$\overline{\text{OE}}$ to Toggle Bit Output Delay	TOET	-	25	-	25	-	30	-	35	nS
$\overline{\text{CE}}$ to Toggle Bit Output Delay	TCET	-	45	-	50	-	55	-	70	nS

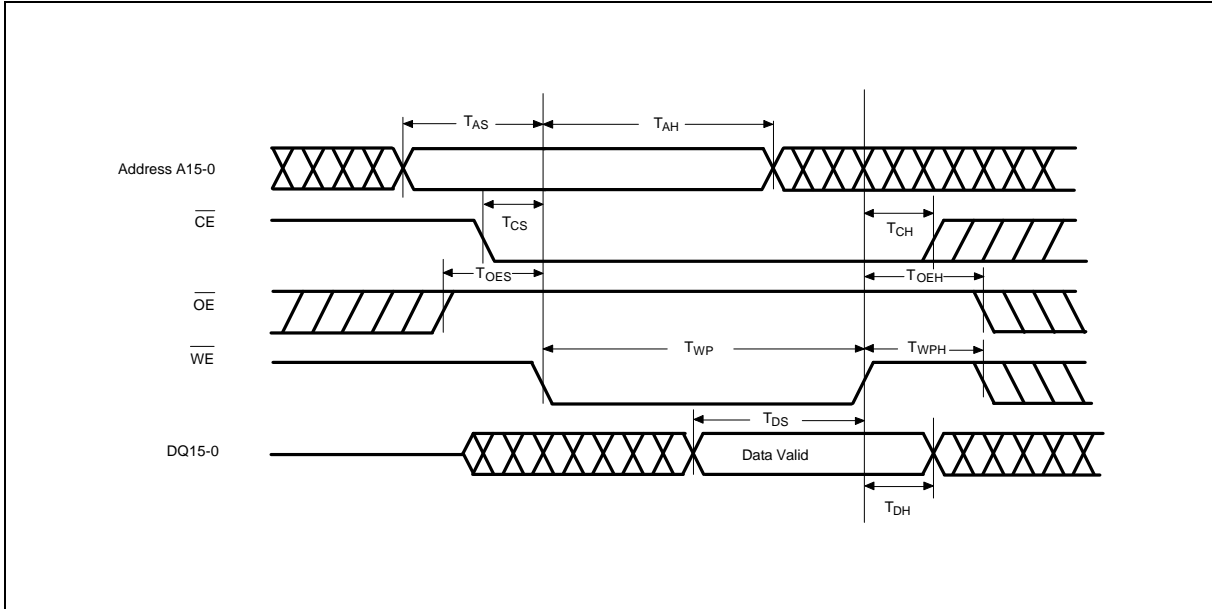
## TIMING WAVEFORMS

### Read Cycle Timing Diagram

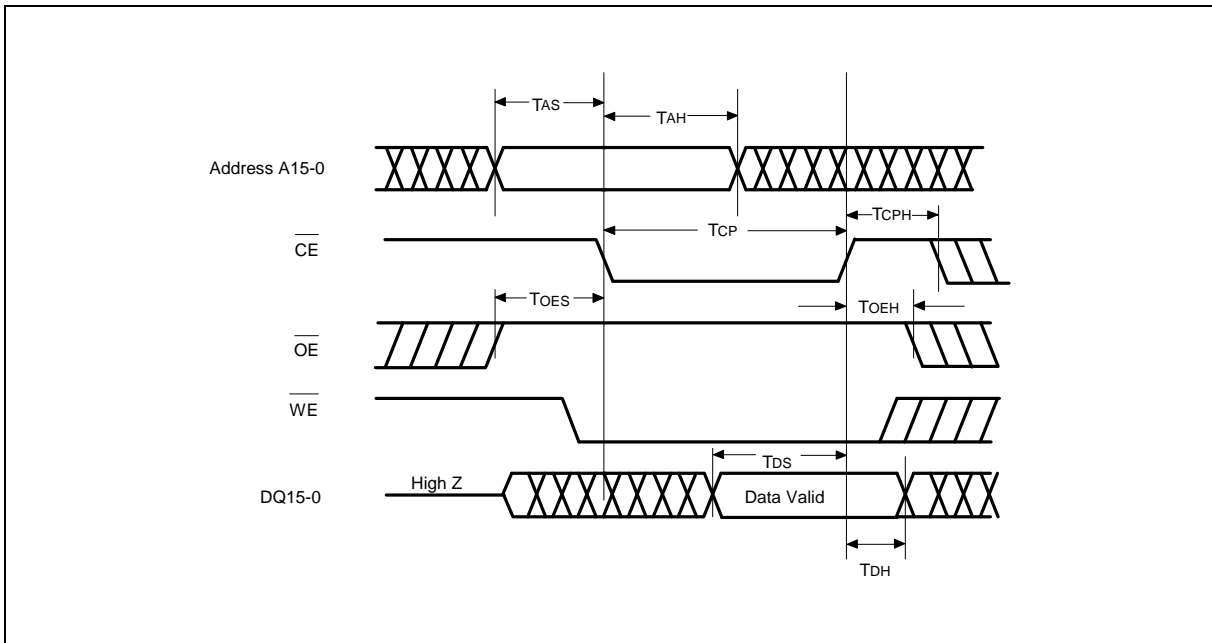


Timing Waveforms, continued

**WE Controlled Command Write Cycle Timing Diagram**

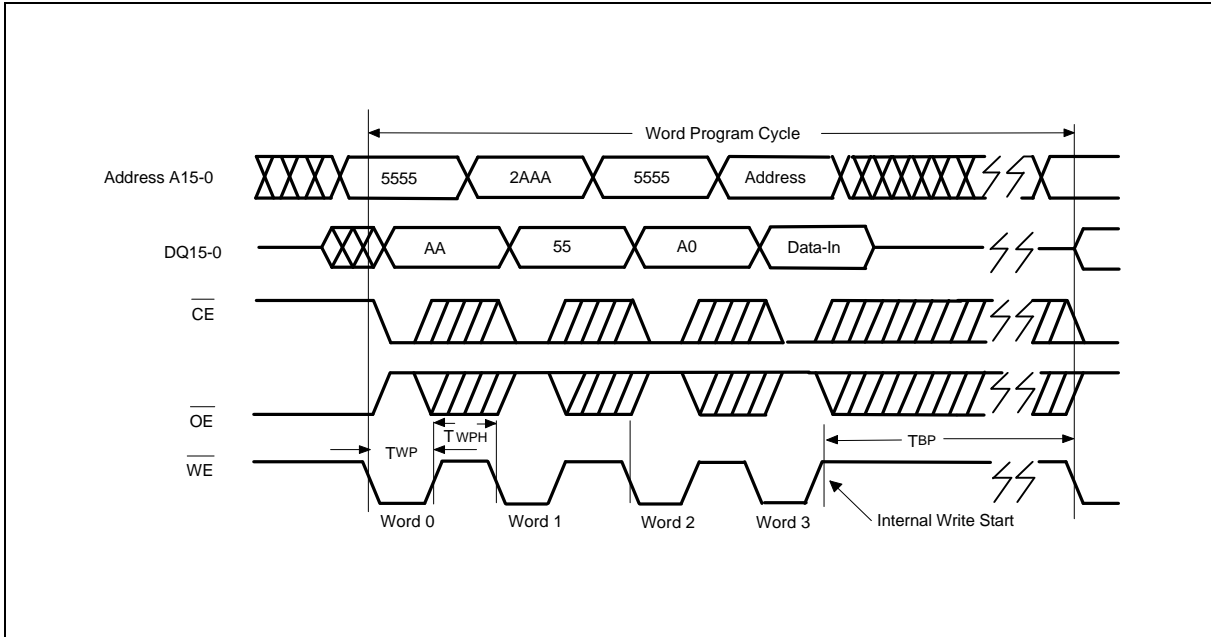


**$\overline{\text{CE}}$  Controlled Command Write Cycle Timing Diagram**

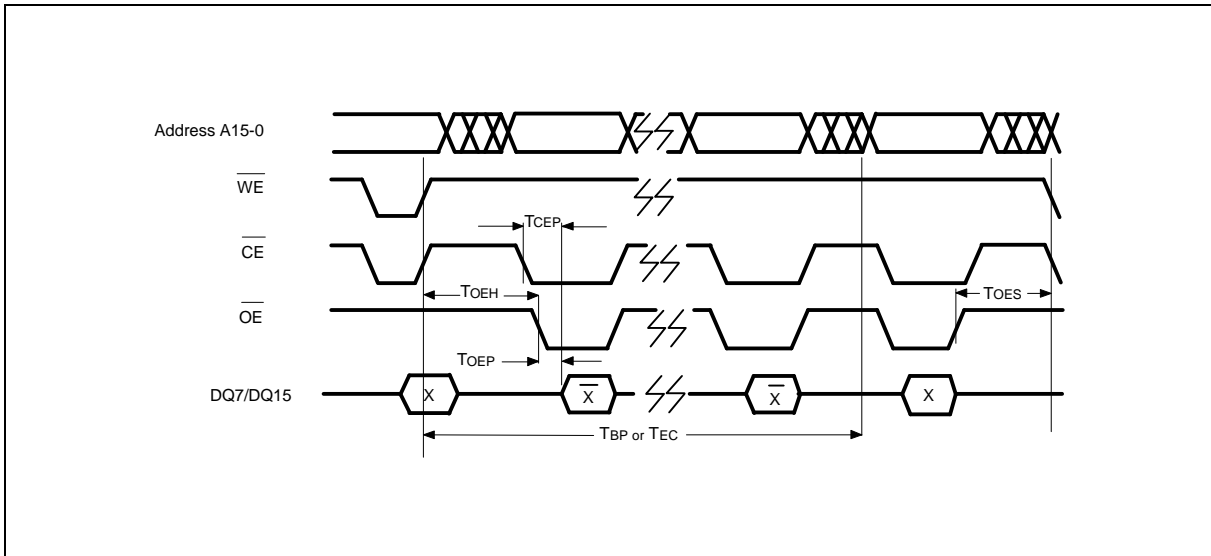


Timing Waveforms, continued

## Program Cycle Timing Diagram



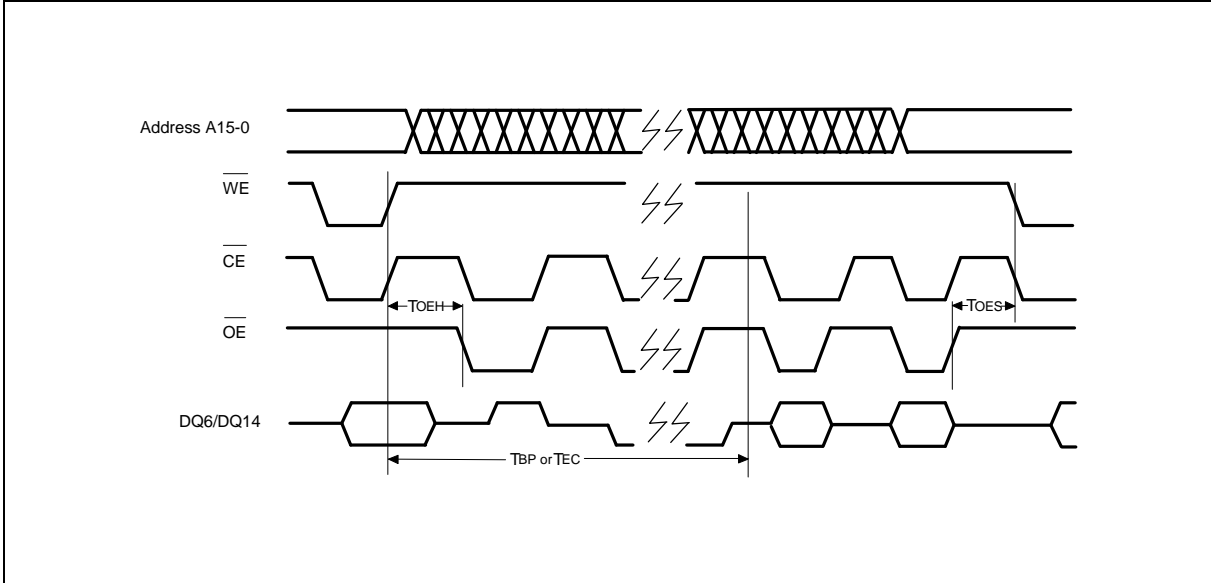
## DATA Polling Timing Diagram



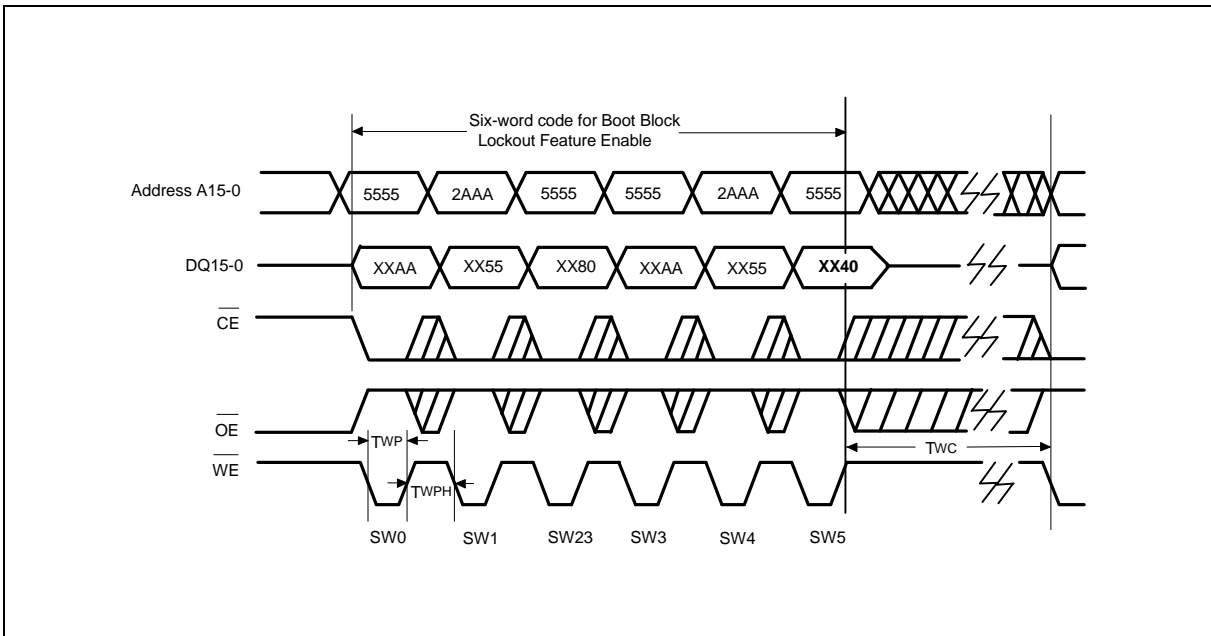


Timing Waveforms, continued

**Toggle Bit Timing Diagram**

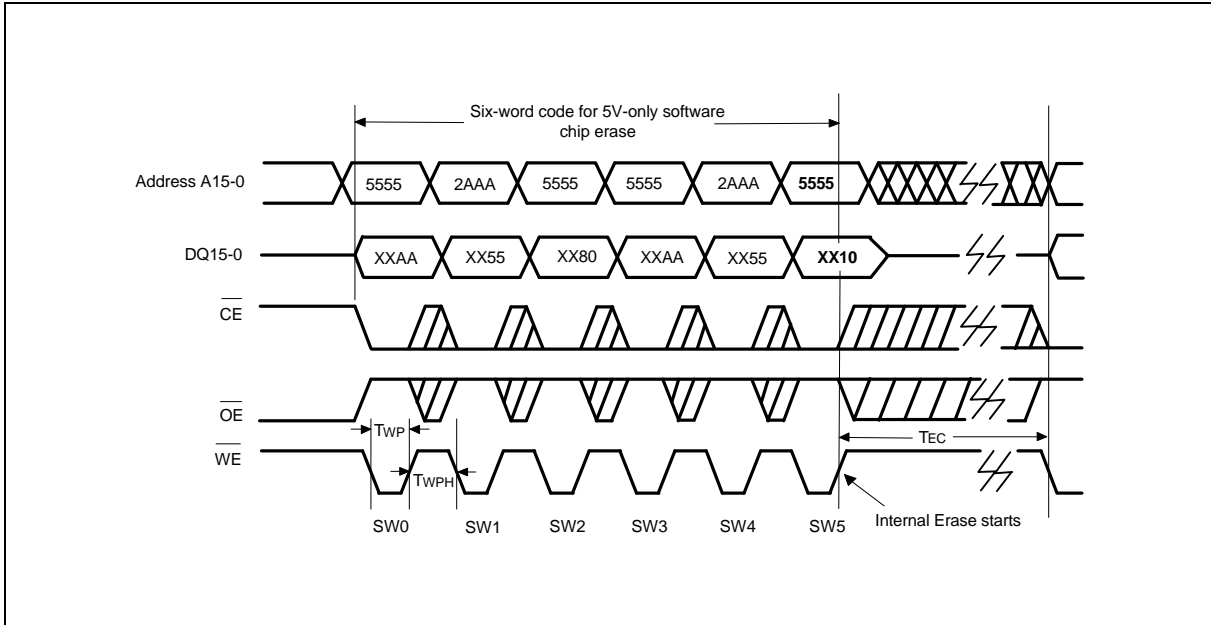


**Boot Block Lockout Enable Timing Diagram**

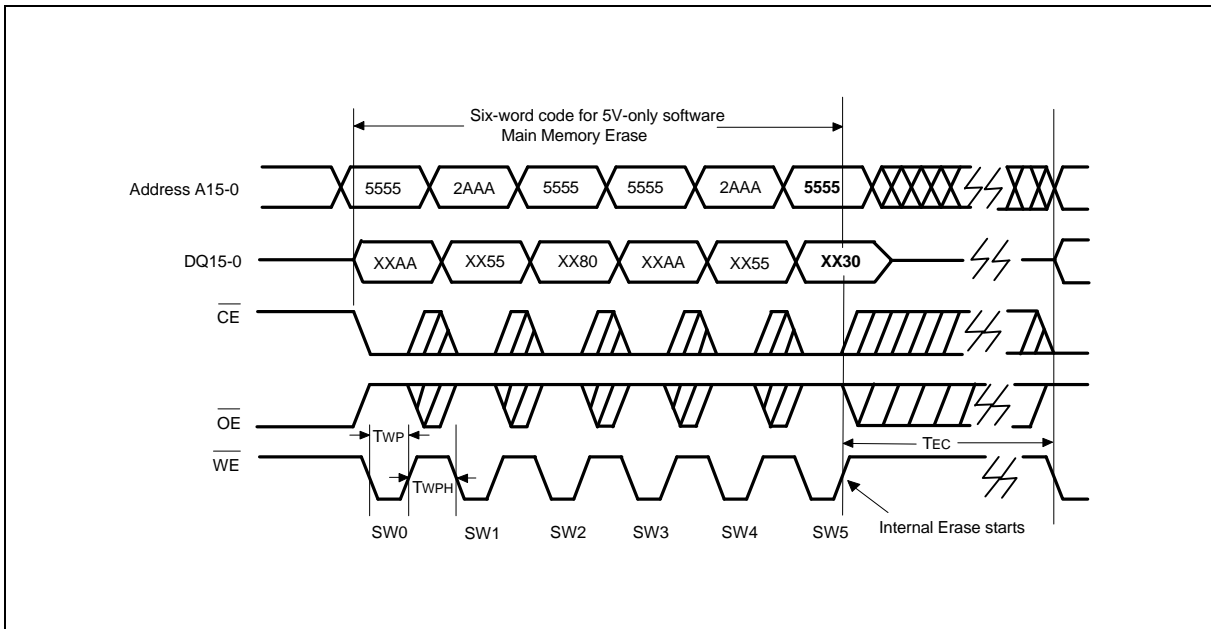


Timing Waveforms, continued

### Chip Erase Timing Diagram



### Main Memory Erase Timing Diagram



## ORDERING INFORMATION

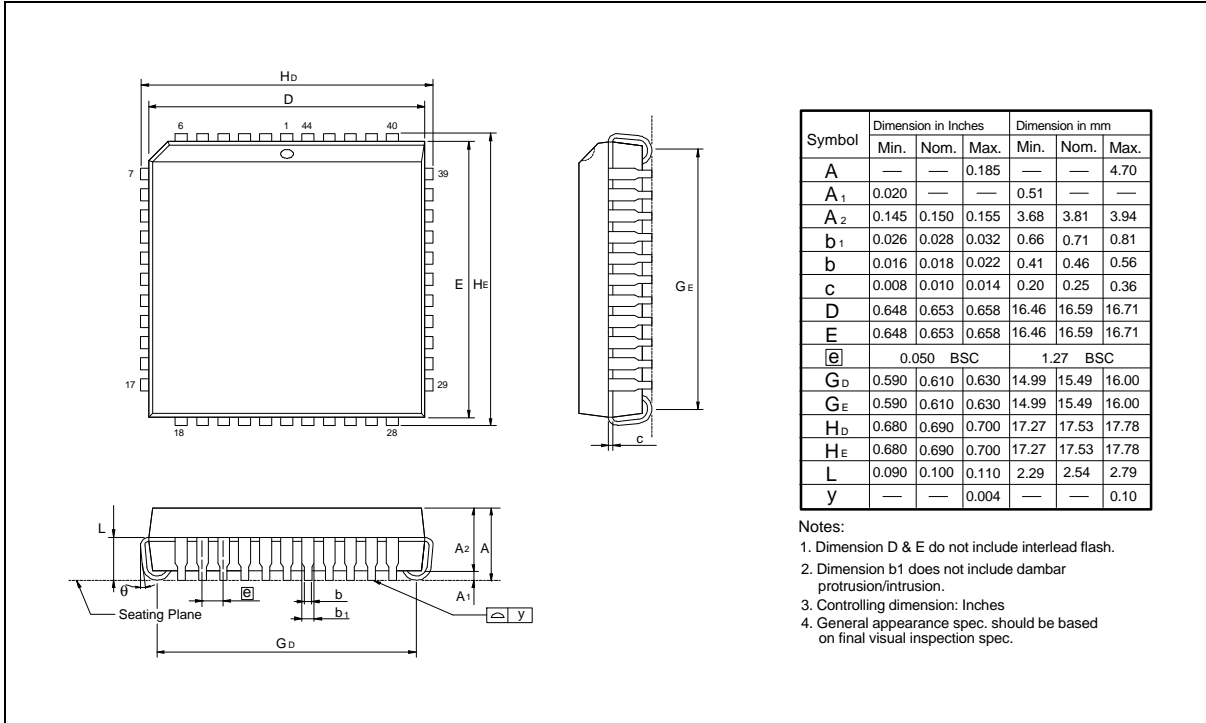
PART NO.	ACCESS TIME (nS)	POWER SUPPLY CURRENT MAX. (mA)	STANDBY V <sub>DD</sub> CURRENT MAX. (mA)	PACKAGE	CYCLE
W29F102Q-45	45	70	100 (CMOS)	40-pin TSOP (10 mm × 14 mm)	1K
W29F102Q-50	50	50	100 (CMOS)	40-pin TSOP (10 mm × 14 mm)	1K
W29F102Q-55	55	50	100 (CMOS)	40-pin TSOP (10 mm × 14 mm)	1K
W29F102Q-70	70	50	100 (CMOS)	40-pin TSOP (10 mm × 14 mm)	1K
W29F102P-45	45	70	100 (CMOS)	44-pin PLCC	1K
W29F102P-50	50	50	100 (CMOS)	44-pin PLCC	1K
W29F102P-55	55	50	100 (CMOS)	44-pin PLCC	1K
W29F102P-70	70	50	100 (CMOS)	44-pin PLCC	1K
W29F102Q-45B	45	70	100 (CMOS)	40-pin TSOP (10 mm × 14 mm)	10K
W29F102Q-50B	50	50	100 (CMOS)	40-pin TSOP (10 mm × 14 mm)	10K
W29F102Q-55B	55	50	100 (CMOS)	40-pin TSOP (10 mm × 14 mm)	10K
W29F102Q-70B	70	50	100 (CMOS)	40-pin TSOP (10 mm × 14 mm)	10K
W29F102P-45B	45	70	100 (CMOS)	44-pin PLCC	10K
W29F102P-50B	50	50	100 (CMOS)	44-pin PLCC	10K
W29F102P-55B	55	50	100 (CMOS)	44-pin PLCC	10K
W29F102P-70B	70	50	100 (CMOS)	44-pin PLCC	10K

Notes:

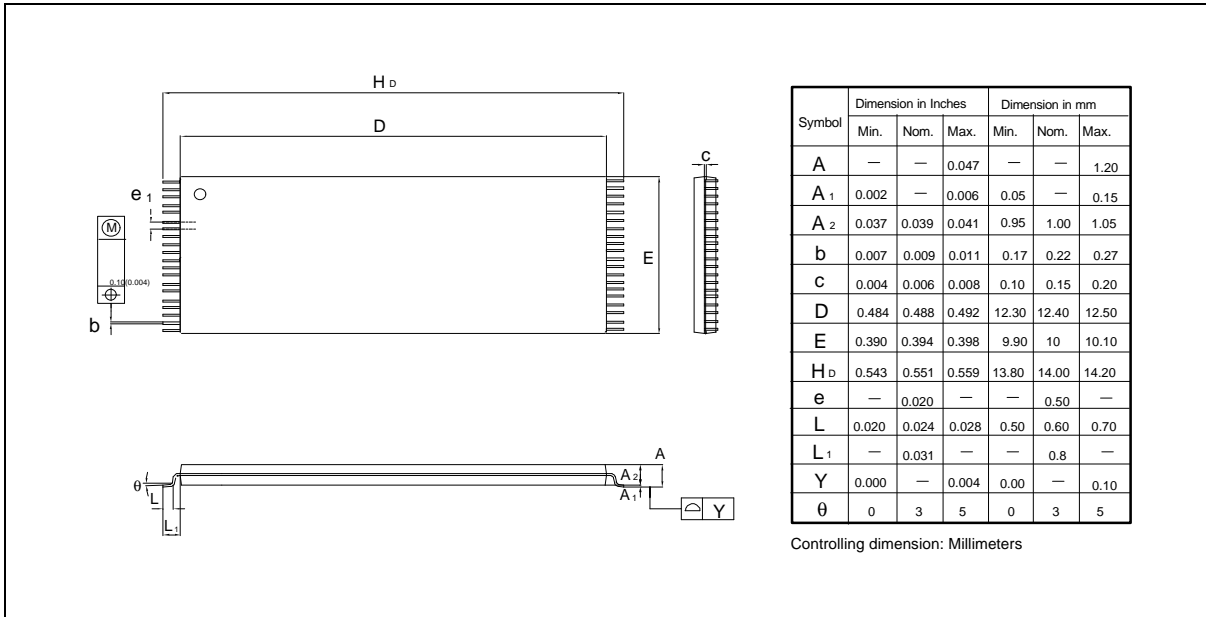
1. Winbond reserves the right to make changes to its products without prior notice.
2. Purchasers are responsible for performing appropriate quality assurance testing on products intended for use in applications where personal injury might occur as a consequence of product failure.

## PACKAGE DIMENSIONS

### 44-pin PLCC



### 40-pin TSOP (10 mm · 14 mm)





## VERSION HISTORY

VERSION	DATE	PAGE	DESCRIPTION
A1	Feb. 1998		Initial Issued
A2	Apr. 1998	1, 13, 14, 19	Add 35 nS item and delete 50 nS item
		6, 7, 8, 9, 10	Change address format from A15 to A14
		6, 7, 8, 9	Add the pause time
		18	Correct the address from 2000 to 5555
A3	Mar. 1999	1, 13, 14, 19	Add 50/70 nS binning Delete 35 nS binning
A4	Jun. 1999	11, 19	Change Icc 50 mA to 70 mA (only for 45 nS) Change VIL 0.8V to 0.6V (only for 45 nS)
		5	V <sub>HH</sub> = 12V ±0.5V
		11, 13	V <sub>DD</sub> = 5.0V ±10%



### Headquarters

No. 4, Creation Rd. III,  
Science-Based Industrial Park,  
Hsinchu, Taiwan  
TEL: 886-3-5770066  
FAX: 886-3-5796096  
<http://www.winbond.com.tw/>  
Voice & Fax-on-demand: 886-2-27197006

### Taipei Office

11F, No. 115, Sec. 3, Min-Sheng East Rd.,  
Taipei, Taiwan  
TEL: 886-2-27190505  
FAX: 886-2-27197502

### Winbond Electronics (H.K.) Ltd.

Rm. 803, World Trade Square, Tower II,  
123 Hoi Bun Rd., Kwun Tong,  
Kowloon, Hong Kong  
TEL: 852-27513100  
FAX: 852-27552064

### Winbond Electronics North America Corp.

**Winbond Memory Lab.**  
**Winbond Microelectronics Corp.**  
**Winbond Systems Lab.**  
2727 N. First Street, San Jose,  
CA 95134, U.S.A.  
TEL: 408-9436666  
FAX: 408-5441798

Note: All data and specifications are subject to change without notice.

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