

## Features

- 16-Mbit Flash and 2-Mbit/4-Mbit SRAM
- Single 66-ball 8 mm x 10 mm x 1.2 mm CBGA Package
- 2.7V to 3.3V Operating Voltage

## Flash

- 2.7V to 3.3V Read/Write
- Access Time – 85 ns
- Sector Erase Architecture
  - Thirty-one 32K Word (64K Byte) Sectors with Individual Write Lockout
  - Eight 4K Word (8K Byte) Sectors with Individual Write Lockout
- Fast Word Program Time – 20  $\mu$ s
- Fast Sector Erase Time – 300 ms
- Dual-plane Organization, Permitting Concurrent Read While Program/Erase
  - Memory Plane A: Eight 4K Word and Seven 32K Word Sectors
  - Memory Plane B: Twenty-four 32K Word Sectors
- Erase Suspend Capability
  - Supports Reading and Programming from Any Sector by Suspending Erase of a Different Sector
  - Supports Reading Any Word by Suspending Programming of Any Other Word
- Low-power Operation
  - 30 mA Active
  - 10  $\mu$ A Standby
- Data Polling, Toggle Bit, Ready/Busy for End of Program Detection
- VPP Pin for Accelerated Program/Erase Operations
- **RESET** Input for Device Initialization
- Sector Lockdown Support
- Top/Bottom Block Configuration
- 128-bit Protection Register

## SRAM

- 2-megabit (128K x 16)/4-megabit (256K x 16)
- 2.7V to 3.3V  $V_{CC}$  Operating Voltage
- 70 ns Access Time
- Fully Static Operation and Tri-state Output
- 1.2V (Min) Data Retention
- Industrial Temperature Range

Device Number	Flash Plane Architecture	Flash Configuration	SRAM Configuration
AT52BR1672(T)	12M + 4M	16M (1M x 16)	2M (128K x 16)
AT52BR1674(T)	12M + 4M	16M (1M x 16)	4M (256K x 16)



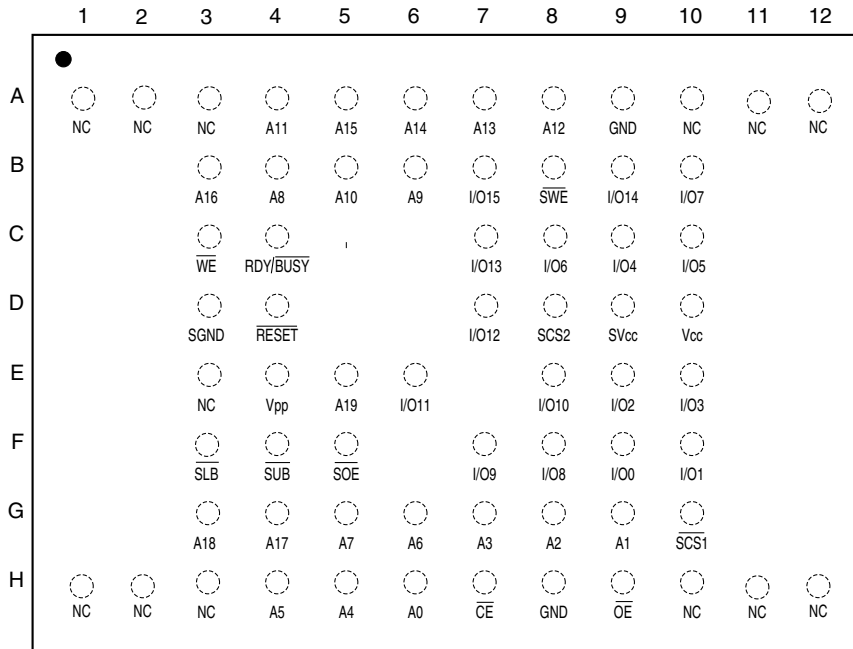
**16-megabit  
Flash and  
2-megabit/  
4-megabit  
SRAM Stack  
Memory**

**AT52BR1672(T)  
AT52BR1674(T)**

**Preliminary**



## CBGA Top View



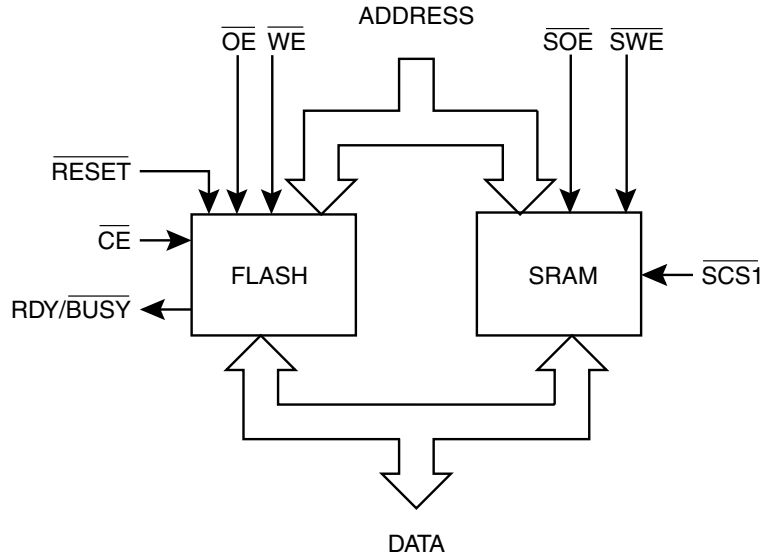
## Pin Configurations

Pin Name	Function
A0 - A16	Flash/SRAM Common Address Input for 2M SRAM
A0 - A17	Flash/SRAM Common Address Input for 4M SRAM
A18 - A19	Flash Address Input
$\overline{CE}$	Flash Chip Enable
$\overline{OE/SOE}$	Flash/SRAM, Output Enable
$\overline{WE/SWE}$	Flash/SRAM, Write Enable
VCC	Flash Power Supply
VPP	Optional Flash Power Supply for Faster Program/Erase Operations
I/O0-I/O15	Data Inputs/Outputs
$\overline{SCS1}$ , $\overline{SCS2}$	SRAM Chip Select
RDY/ $\overline{BUSY}$	Flash Ready/Busy Output
SVCC	SRAM Power Supply
GND/SGND	Flash/SRAM GND
$\overline{SUB}$	SRAM Upper Byte
$\overline{SLB}$	SRAM Lower Byte
NC	No Connect
$\overline{RESET}$	Flash Reset

## Description

The AT52BR1672(T) combines a 16-megabit Flash (1M x 16) and a 2-megabit SRAM (organized as 128K x 16) in a stacked CBGA package; while the AT52BR1674(T) combines a 16-megabit Flash (1M x 16) and a 4-megabit SRAM (organized as 256K x 16) in a stacked CBGA package. Both devices operate at 2.7V to 3.3V in the industrial temperature range. The modules use a 16-megabit Flash with dual plane architecture for concurrent read/write operations. The Flash is organized as 12M + 4M for planes B and A, respectively.

## Block Diagram



## Absolute Maximum Ratings

Temperature under Bias .....	-40°C to +85°C
Storage Temperature .....	-55°C to +150°C
All Input Voltages except $V_{PP}$ and $\overline{RESET}$ (including NC Pins) with Respect to Ground .....	-0.2V to +3.3V
Voltage on $V_{PP}$ with Respect to Ground .....	-0.2V to + 6.25V
Voltage on $\overline{RESET}$ with Respect to Ground .....	-0.2V to +13.5V
All Output Voltages with Respect to Ground .....	-0.2V to +0.2V

**\*NOTICE:** Stresses beyond those listed under “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 beyond those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

## DC and AC Operating Range

		AT52BR1672(T)/1674(T)
Operating Temperature (Case)	Industrial	-40°C - 85°C
$V_{CC}$ Power Supply		2.7V to 3.3V



## 16-megabit Flash Description

The 16-megabit Flash memory organized as 1,048,576 words of 16 bits each. The x16 data appears on I/O0 - I/O15. The memory is divided into 39 sectors for erase operations. The device has  $\overline{CE}$  and  $\overline{OE}$  control signals to avoid any bus contention. This device can be read or reprogrammed using a single 2.7V power supply, making it ideally suited for in-system programming.

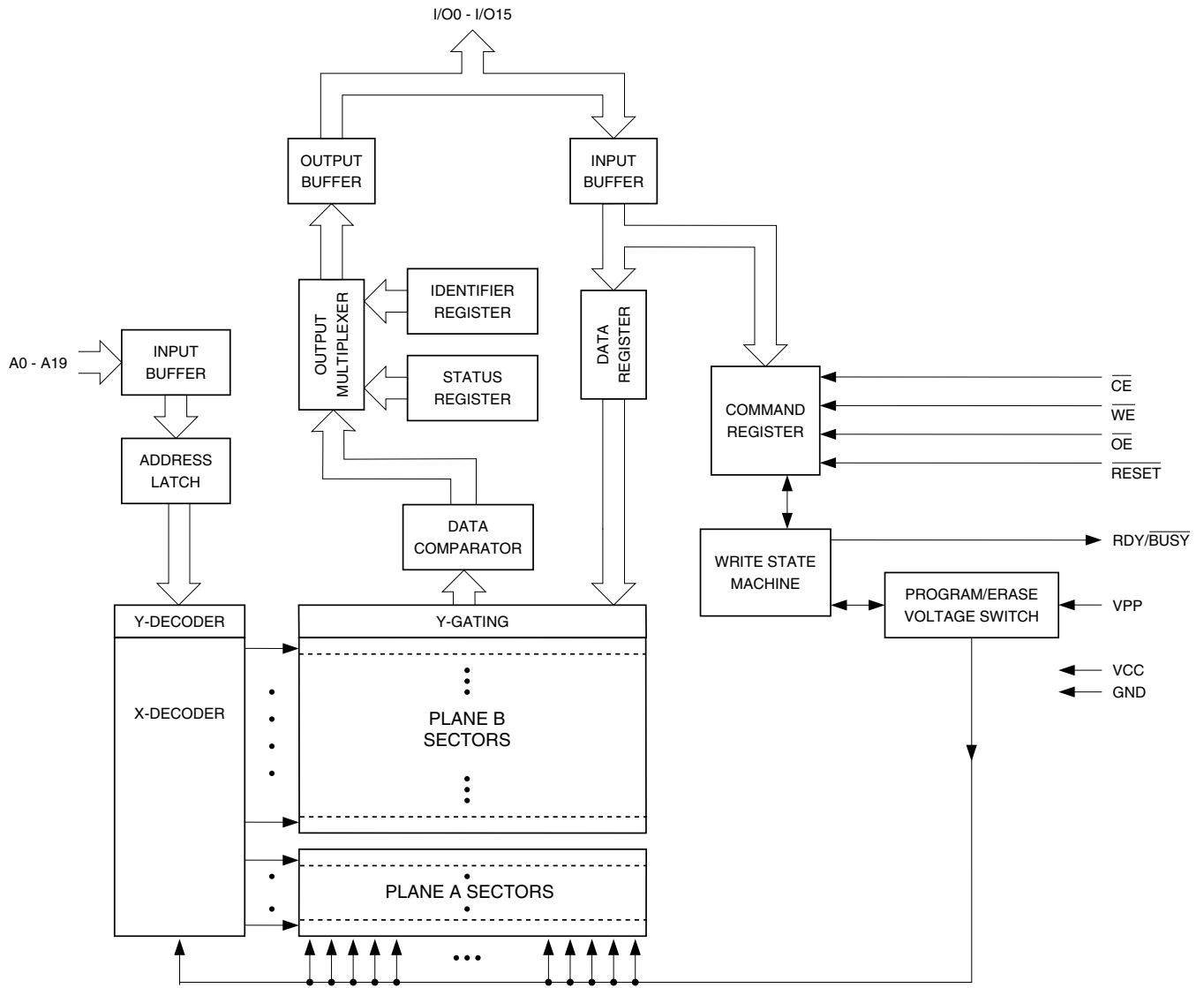
The device powers on in the read mode. Command sequences are used to place the device in other operation modes such as program and erase. The device has the capability to protect the data in any sector (see Sector Lockdown section).

The device is segmented into two memory planes. Reads from memory plane B may be performed even while program or erase functions are being executed in memory plane A and vice versa. This operation allows improved system performance by not requiring the system to wait for a program or erase operation to complete before a read is performed. To further increase the flexibility of the device, it contains an Erase Suspend feature. This feature will put the erase on hold for any amount of time and let the user read data from or program data to any of the remaining sectors within the same memory plane. There is no reason to suspend the erase operation if the data to be read is in the other memory plane. The end of a program or an erase cycle is detected by the Ready/Busy pin,  $\overline{Data}$  Polling or by the toggle bit.

The VPP pin provides faster program/erase times. With  $V_{PP}$  at 5.0V or 12.0V, the program and erase operations are accelerated.

A six-byte command (Enter Single Pulse Program Mode) sequence to remove the requirement of entering the three-byte program sequence is offered to further improve programming time. After entering the six-byte code, only single pulses on the write control lines are required for writing into the device. This mode (Single Pulse Word Program) is exited by powering down the device, or by pulsing the  $\overline{RESET}$  pin low for a minimum of 500 ns and then bringing it back to  $V_{CC}$ . Erase and Erase Suspend/Resume commands will not work while in this mode; if entered they will result in data being programmed into the device. It is not recommended that the six-byte code reside in the software of the final product but only exist in external programming code.

16-megabit Flash Memory Block Diagram



## Device Operation

**READ:** The 16-megabit Flash is accessed like an EPROM. When  $\overline{CE}$  and  $\overline{OE}$  are low and  $\overline{WE}$  is high, the data stored at the memory location determined by the address pins are asserted on the outputs. The outputs are put in the high-impedance state whenever  $\overline{CE}$  or  $\overline{OE}$  is high. This dual-line control gives designers flexibility in preventing bus contention.

**COMMAND SEQUENCES:** When the device is first powered on it will be reset to the read or standby mode, depending upon the state of the control line inputs. In order to perform other device functions, a series of command sequences are entered into the device. The command sequences are shown in the Command Definitions table (I/O8 - I/O15 are don't care inputs for the command codes). The command sequences are written by applying a low pulse on the  $\overline{WE}$  or  $\overline{CE}$  input with  $\overline{CE}$  or  $\overline{WE}$  low (respectively) and  $\overline{OE}$  high. The address is latched on the falling edge of  $\overline{CE}$  or  $\overline{WE}$ , whichever occurs last. The data is latched by the first rising edge of  $\overline{CE}$  or  $\overline{WE}$ . Standard microprocessor write timings are used. The address locations used in the command sequences are not affected by entering the command sequences.

**RESET:** A  $\overline{RESET}$  input pin is provided to ease some system applications. When  $\overline{RESET}$  is at a logic high level, the device is in its standard operating mode. A low level on the  $\overline{RESET}$  input halts the present device operation and puts the outputs of the device in a high-impedance state. When a high level is reasserted on the  $\overline{RESET}$  pin, the device returns to the read or standby mode, depending upon the state of the control inputs.

**ERASURE:** Before a word can be reprogrammed, it must be erased. The erased state of memory bits is a logical "1". The entire device can be erased by using the Chip Erase command or individual sectors can be erased by using the Sector Erase command.

**CHIP ERASE:** The entire device can be erased at one time by using the six-byte chip erase software code. After the chip erase has been initiated, the device will internally time the erase operation so that no external clocks are required. The maximum time to erase the chip is  $t_{EC}$ .

If the sector lockdown has been enabled, the chip erase will not erase the data in the sector that has been locked out; it will erase only the unprotected sectors. After the chip erase, the device will return to the read or standby mode.

**SECTOR ERASE:** As an alternative to a full chip erase, the device is organized into 39 sectors (SA0 - SA38) that can be individually erased. The Sector Erase command is a six-bus cycle operation. The sector address is latched on the falling  $\overline{WE}$  edge of the sixth cycle while the 30H data input command is latched on the rising edge of  $\overline{WE}$ . The sector erase starts after the rising edge of  $\overline{WE}$  of the sixth cycle. The erase operation is internally controlled; it will automatically time to completion. The maximum time to erase a section is  $t_{SEC}$ . When the sector programming lockdown feature is not enabled, the sector will erase (from the same Sector Erase command). An attempt to erase a sector that has been protected will result in the operation terminating in 2  $\mu$ s.

**WORD PROGRAMMING:** Once a memory block is erased, it is programmed (to a logical "0") on a word-by-word basis. Programming is accomplished via the internal device command register and is a four-bus cycle operation. The device will automatically generate the required internal program pulses.

Any commands written to the chip during the embedded programming cycle will be ignored. If a hardware reset happens during programming, the data at the location being programmed will be corrupted. Please note that a data "0" cannot be programmed back to a "1"; only erase operations can convert "0"s to "1"s. Programming is completed after the specified  $t_{BP}$  cycle time. The  $\overline{Data}$  Polling feature or the Toggle Bit feature may be used to indicate the end of a program cycle.

**VPP PIN:** The circuitry of the 16-megabit Flash is designed so that the device can be programmed or erased from the  $V_{CC}$  power supply or from the VPP input pin. When  $V_{PP}$  is less than or equal to the  $V_{CC}$  pin, the device selects the  $V_{CC}$  supply for programming and erase

operations. When the VPP pin is greater than the V<sub>CC</sub> supply, the device will select the V<sub>PP</sub> input as the power supply for programming and erase operations. The device will allow for some variations between the V<sub>PP</sub> input and the V<sub>CC</sub> power supply in its selection of V<sub>CC</sub> or V<sub>PP</sub> for program or erase operations. If the VPP pin is within 0.3V of V<sub>CC</sub> for 2.7V < V<sub>CC</sub> < 3.3V, then the program or erase operations will use V<sub>CC</sub> and disregard the V<sub>PP</sub> input signal. When the V<sub>PP</sub> signal is used to accelerate program and erase operations, the V<sub>PP</sub> must be in the 5V ± 0.5V or 12V ± 0.5V range to ensure proper operation. The V<sub>pp</sub> pin can be left unconnected.

**SECTOR LOCKDOWN:** Each sector has a programming lockdown feature. This feature prevents programming of data in the designated sectors once the feature has been enabled. These sectors can contain secure code that is used to bring up the system. Enabling the lockdown feature will allow the boot code to stay in the device while data in the rest of the device is updated. This feature does not have to be activated; any sector's usage as a write protected region is optional to the user.

At power-up or reset all sectors are unlocked. To activate the lockdown for a specific sector, the six-bus cycle Sector Lockdown command must be issued. Once a sector has been locked down, the contents of the sector is read-only and cannot be erased or programmed.

**SECTOR LOCKDOWN DETECTION:** A software method is available to determine if programming of a sector is locked down. When the device is in the software product identification mode (see Software Product Identification Entry and Exit sections) a read from address location 00002H within a sector will show if programming the sector is locked down. If the data on I/O0 is low, the sector can be programmed; if the data on I/O0 is high, the program lockdown feature has been enabled and the sector cannot be programmed. The software product identification exit code should be used to return to standard operation.

**SECTOR LOCKDOWN OVERRIDE:** The only way to unlock a sector that is locked down is through reset or power-up cycles. After power-up or reset, the content of a sector that is locked down can be erased and reprogrammed.

**ERASE SUSPEND/ERASE RESUME:** The Erase Suspend command allows the system to interrupt a sector erase operation and then program or read data from a different sector within the same plane. Since this device has a dual-plane architecture, there is no need to use the Erase Suspend feature while erasing a sector when you want to read data from a sector in the other plane. After the Erase Suspend command is given, the device requires a maximum time of 15 μs to suspend the erase operation. After the erase operation has been suspended, the plane that contains the suspended sector enters the erase-suspend-read mode. The system can then read data or program data to any other sector within the device. An address is not required during the Erase Suspend command. During a sector erase suspend, another sector cannot be erased. To resume the sector erase operation, the system must write the Erase Resume command. The Erase Resume command is a one-bus cycle command, which does require the plane address (determined by A18 and A19). The device also supports an erase suspend during a complete chip erase. While the chip erase is suspended, the user can read from any sector within the memory that is protected. The command sequence for a chip erase suspend and a sector erase suspend are the same.

**PRODUCT IDENTIFICATION:** The product identification mode identifies the device and manufacturer as Atmel. It may be accessed by hardware or software operation. The hardware operation mode can be used by an external programmer to identify the correct programming algorithm for the Atmel product.

For details, see "Operating Modes" on page 13 (for hardware operation) or "Software Product Identification Entry/Exit" on page 21. The manufacturer and device codes are the same for both modes.

**128-BIT PROTECTION REGISTER:** The 16-megabit Flash contains a 128-bit register that can be used for security purposes in system design. The protection register is divided into two 64-bit blocks. The two blocks are designated as block A and block B. The data in block A is non-changeable and is programmed at the factory with a unique number. The data in block B is programmed by the user and can be locked out such that data in the block cannot be reprogrammed. To program block B in the protection register, the four-bus cycle Program Protection Register command must be used as shown in the Command Definition table on page 9. To lock out block B, the four-bus cycle Lock Protection Register command must be used as shown in the Command Definition table. Data bit D1 must be zero during the fourth bus cycle. All other data bits during the fourth bus cycle are don't cares. Please see the "Protection Register Addressing Table" on page 10 for the address locations in the protection register. To read the protection register, the Product ID Entry command is given followed by a normal read operation from an address within the protection register. After reading the protection register, the Product ID Exit command must be given prior to performing any other operation.

**DATA POLLING:** The Flash features  $\overline{\text{Data}}$  Polling to indicate the end of a program cycle. During a program cycle an attempted read of the last word loaded will result in the complement of the loaded data on I/O7. Once the program cycle has been completed, true data is valid on all outputs and the next cycle may begin. During a chip or sector erase operation, an attempt to read the device will give a "0" on I/O7. Once the program or erase cycle has completed, true data will be read from the device.  $\overline{\text{Data}}$  Polling may begin at any time during the program cycle. Please see "Status Bit Table" on page 22 for more details.

**TOGGLE BIT:** In addition to  $\overline{\text{Data}}$  Polling, the 16-megabit Flash provides another method for determining the end of a program or erase cycle. During a program or erase operation, successive attempts to read data from the same memory plane will result in I/O6 toggling between one and zero. Once the program cycle has completed, I/O6 will stop toggling and valid data will be read. Examining the toggle bit may begin at any time during a program cycle.

An additional toggle bit is available on I/O2, which can be used in conjunction with the toggle bit that is available on I/O6. While a sector is erase suspended, a read or a program operation from the suspended sector will result in the I/O2 bit toggling. Please see "Status Bit Table" on page 22 for more details.

**RDY/ $\overline{\text{BUSY}}$ :** For the 16-megabit Flash, an open-drain Ready/ $\overline{\text{Busy}}$  output pin provides another method of detecting the end of a program or erase operation. RDY/ $\overline{\text{BUSY}}$  is actively pulled low during the internal program and erase cycles and is released at the completion of the cycle. The open-drain connection allows for OR-tying of several devices to the same RDY/ $\overline{\text{BUSY}}$  line.

**HARDWARE DATA PROTECTION:** The Hardware Data Protection feature protects against inadvertent programs to the Flash in the following ways: (a)  $V_{CC}$  sense: if  $V_{CC}$  is below 1.8V (typical), the program function is inhibited. (b)  $V_{CC}$  power-on delay: once  $V_{CC}$  has reached the  $V_{CC}$  sense level, the device will automatically time out 10 ms (typical) before programming. (c) Program inhibit: holding any one of  $\overline{\text{OE}}$  low,  $\overline{\text{CE}}$  high or  $\overline{\text{WE}}$  high inhibits program cycles. (d) Noise filter: pulses of less than 15 ns (typical) on the  $\overline{\text{WE}}$  or  $\overline{\text{CE}}$  inputs will not initiate a program cycle.

**INPUT LEVELS:** While operating with a 2.7V to 3.3V power supply, the address inputs and control inputs ( $\overline{\text{OE}}$ ,  $\overline{\text{CE}}$  and  $\overline{\text{WE}}$ ) may be driven from 0 to 5.5V without adversely affecting the operation of the device. The I/O lines can only be driven from 0 to  $V_{CC} + 0.6V$ .

**OUTPUT LEVELS:** For the 16-megabit Flash, output high levels ( $V_{OH}$ ) are equal to  $V_{CCQ} - 0.2V$  (not  $V_{CC}$ ). For 2.7V - 3.3V output levels,  $V_{CCQ}$  must be tied to  $V_{CC}$ . For 1.8V - 2.2V output levels,  $V_{CCQ}$  must be regulated to  $2.0V \pm 10\%$ , while  $V_{CC}$  must be regulated to 2.7V - 3.0V (for minimum power).



## Command Definition in Hex<sup>(1)</sup>

Command Sequence	Bus Cycles	1st Bus Cycle		2nd Bus Cycle		3rd Bus Cycle		4th Bus Cycle		5th Bus Cycle		6th Bus Cycle	
		Addr	Data	Addr	Data	Addr	Data	Addr	Data	Addr	Data	Addr	Data
Read	1	Addr	D <sub>OUT</sub>										
Chip Erase	6	555	AA	AAA <sup>(2)</sup>	55	555	80	555	AA	AAA	55	555	10
Sector Erase	6	555	AA	AAA	55	555	80	555	AA	AAA	55	SA <sup>(3)(4)</sup>	30
Word Program	4	555	AA	AAA	55	555	A0	Addr	D <sub>IN</sub>				
Enter Single Pulse Program Mode	6	555	AA	AAA	55	555	80	555	AA	AAA	55	555	A0
Single Pulse Word Program	1	Addr	D <sub>IN</sub>										
Sector Lockdown	6	555	AA	AAA	55	555	80	555	AA	AAA	55	SA <sup>(3)(4)</sup>	60
Erase Suspend	1	XXX	B0										
Erase Resume	1	PA <sup>(5)</sup>	30										
Product ID Entry	3	555	AA	AAA	55	555	90						
Product ID Exit <sup>(6)</sup>	3	555	AA	AAA	55	555	F0						
Product ID Exit <sup>(6)</sup>	1	XXX	F0										
Program Protection Register	4	555	AA	AAA	55	555	C0	Addr	D <sub>IN</sub>				
Lock Protection Register - Block B	4	555	AA	AAA	55	555	C0	080	X0				
Status of Block B Protection	4	555	AA	AAA	55	555	90	80	D <sub>OUT</sub> <sup>(7)</sup>				

- Notes:
1. The DATA FORMAT shown for each bus cycle is as follows; I/O7 - I/O0 (Hex). In word operation I/O15 - I/O8 are Don't Care. The ADDRESS FORMAT shown for each bus cycle is as follows: A11 - A0 (Hex). Address A19 through A11 are Don't Care.
  2. Since A11 is a Don't Care, AAA can be replaced with 2AA.
  3. SA = sector address. Any word address within a sector can be used to designate the sector address (see page 11 for details).
  4. Once a sector is in the lockdown mode, data in the protected sector cannot be changed unless the chip is reset or power cycled.
  5. PA is the plane address (A19-A18).
  6. Either one of the Product ID Exit commands can be used.
  7. If data bit D1 is "0", block B is locked. If data bit D1 is "1", block B can be reprogrammed.

## Absolute Maximum Ratings\*

Temperature under Bias .....	-55°C to +125°C
Storage Temperature .....	-65°C to +150°C
All Input Voltages (including NC Pins) with Respect to Ground .....	-0.6V to +6.25V
All Output Voltages with Respect to Ground .....	-0.6V to V <sub>CC</sub> + 0.6V
Voltage on $\overline{OE}$ and V <sub>PP</sub> with Respect to Ground .....	-0.6V to +13.0V

\*NOTICE: Stresses beyond those listed under "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 beyond those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

## Protection Register Addressing Table

Word	Use	Block	A7	A6	A5	A4	A3	A2	A1	A0
0	Factory	A	1	0	0	0	0	0	0	1
1	Factory	A	1	0	0	0	0	0	1	0
2	Factory	A	1	0	0	0	0	0	1	1
3	Factory	A	1	0	0	0	0	1	0	0
4	User	B	1	0	0	0	0	1	0	1
5	User	B	1	0	0	0	0	1	1	0
6	User	B	1	0	0	0	0	1	1	1
7	User	B	1	0	0	0	1	0	0	0

Note: 1. All address lines not specified in the above table must be 0 when accessing the protection register, i.e., A19 - A8 = 0.

## Top Boot 16-megabit Flash (12M + 4M) – Sector Address Table

Plane	Sector	Size (Words)	x16 Address Range (A19 - A0)
B	SA0	32K	00000 - 07FFF
B	SA1	32K	08000 - 0FFFF
B	SA2	32K	10000 - 17FFF
B	SA3	32K	18000 - 1FFFF
B	SA4	32K	20000 - 27FFF
B	SA5	32K	28000 - 2FFFF
B	SA6	32K	30000 - 37FFF
B	SA7	32K	38000 - 3FFFF
B	SA8	32K	40000 - 47FFF
B	SA9	32K	48000 - 4FFFF
B	SA10	32K	50000 - 57FFF
B	SA11	32K	58000 - 5FFFF
B	SA12	32K	60000 - 67FFF
B	SA13	32K	68000 - 6FFFF
B	SA14	32K	70000 - 77FFF
B	SA15	32K	78000 - 7FFFF
B	SA16	32K	80000 - 87FFF
B	SA17	32K	88000 - 8FFFF
B	SA18	32K	90000 - 97FFF
B	SA19	32K	98000 - 9FFFF
B	SA20	32K	A0000 - A7FFF
B	SA21	32K	A8000 - AFFFF
B	SA22	32K	B0000 - B7FFF
B	SA23	32K	B8000 - BFFFF
A	SA24	32K	C0000 - C7FFF
A	SA25	32K	C8000 - CFFFF
A	SA26	32K	D0000 - D7FFF
A	SA27	32K	D8000 - DFFFF
A	SA28	32K	E0000 - E7FFF
A	SA29	32K	E8000 - EFFFF
A	SA30	32K	F0000 - F7FFF
A	SA31	4K	F8000 - F8FFF
A	SA32	4K	F9000 - F9FFF
A	SA33	4K	FA000 - FAFFF
A	SA34	4K	FB000 - FBFFF
A	SA35	4K	FC000 - FCFFF
A	SA36	4K	FD000 - FDFFF
A	SA37	4K	FE000 - FEFFF
A	SA38	4K	FF000 - FFFFF



## Bottom Boot 16-megabit Flash (12M + 4M) – Sector Address Table

Plane	Sector	Size (Words)	x16 Address Range (A19 - A0)
A	SA0	4K	00000 - 00FFF
A	SA1	4K	01000 - 01FFF
A	SA2	4K	02000 - 02FFF
A	SA3	4K	03000 - 03FFF
A	SA4	4K	04000 - 04FFF
A	SA5	4K	05000 - 05FFF
A	SA6	4K	06000 - 06FFF
A	SA7	4K	07000 - 07FFF
A	SA8	32K	08000 - 0FFFF
A	SA9	32K	10000 - 17FFF
A	SA10	32K	18000 - 1FFFF
A	SA11	32K	20000 - 27FFF
A	SA12	32K	28000 - 2FFFF
A	SA13	32K	30000 - 37FFF
A	SA14	32K	38000 - 3FFFF
B	SA15	32K	40000 - 47FFF
B	SA16	32K	48000 - 4FFFF
B	SA17	32K	50000 - 57FFF
B	SA18	32K	58000 - 5FFFF
B	SA19	32K	60000 - 67FFF
B	SA20	32K	68000 - 6FFFF
B	SA21	32K	70000 - 77FFF
B	SA22	32K	78000 - 7FFFF
B	SA23	32K	80000 - 87FFF
B	SA24	32K	88000 - 8FFFF
B	SA25	32K	90000 - 97FFF
B	SA26	32K	98000 - 9FFFF
B	SA27	32K	A0000 - A7FFF
B	SA28	32K	A8000 - AFFFF
B	SA29	32K	B0000 - B7FFF
B	SA30	32K	B8000 - BFFFF
B	SA31	32K	C0000 - C7FFF
B	SA32	32K	C8000 - CFFFF
B	SA33	32K	D0000 - D7FFF
B	SA34	32K	D8000 - DFFFF
B	SA35	32K	E0000 - E7FFF
B	SA36	32K	E8000 - EFFFF
B	SA37	32K	F0000 - F7FFF
B	SA38	32K	F8000 - FFFFF

## DC and AC Operating Range

		AT52BR1672(T)-85	AT52BR1674(T)-85
Operating Temperature (Case)	Industrial	-40°C - 85°C	-40°C - 85°C
V <sub>CC</sub> Power Supply		2.7V to 3.3V	2.7V to 3.3V

## Operating Modes

Mode	$\overline{CE}$	$\overline{OE}$	$\overline{WE}$	$\overline{RESET}$	V <sub>PP</sub>	Ai	I/O
Read	V <sub>IL</sub>	V <sub>IL</sub>	V <sub>IH</sub>	V <sub>IH</sub>	X	Ai	D <sub>OUT</sub>
Program/Erase <sup>(2)</sup>	V <sub>IL</sub>	V <sub>IH</sub>	V <sub>IL</sub>	V <sub>IH</sub>	V <sub>PP</sub> <sup>(6)</sup>	Ai	D <sub>IN</sub>
Standby/Program Inhibit	V <sub>IH</sub>	X <sup>(1)</sup>	X	V <sub>IH</sub>	X	X	High-Z
Program Inhibit	X	X	V <sub>IH</sub>	V <sub>IH</sub>	X		
	X	V <sub>IL</sub>	X	V <sub>IH</sub>	X		
Output Disable	X	V <sub>IH</sub>	X	V <sub>IH</sub>	X		High-Z
Reset	X	X	X	V <sub>IL</sub>	X	X	High-Z
Product Identification							
Hardware	V <sub>IL</sub>	V <sub>IL</sub>	V <sub>IH</sub>	V <sub>IH</sub>		A1 - A19 = V <sub>IL</sub> , A9 = V <sub>H</sub> <sup>(3)</sup> , A0 = V <sub>IL</sub>	Manufacturer Code <sup>(4)</sup>
						A1 - A19 = V <sub>IL</sub> , A9 = V <sub>H</sub> <sup>(3)</sup> , A0 = V <sub>IH</sub>	Device Code <sup>(4)</sup>
Software <sup>(5)</sup>				V <sub>IH</sub>		A0 = V <sub>IL</sub> , A1 - A19 = V <sub>IL</sub>	Manufacturer Code <sup>(4)</sup>
						A0 = V <sub>IH</sub> , A1 - A19 = V <sub>IL</sub>	Device Code <sup>(4)</sup>

- Notes:
- X can be V<sub>IL</sub> or V<sub>IH</sub>.
  - Refer to AC programming waveforms on page 18.
  - V<sub>H</sub> = 12.0V ± 0.5V.
  - Manufacturer Code: 001FH. Device Code: 00C2H (Top Boot); 00C0H (Bottom Boot).
  - See details under "Software Product Identification Entry/Exit" on page 21.
  - V<sub>PP</sub> can be left unconnected or 0V ≤ V<sub>PP</sub> ≤ 3.3V. For faster erase/program operations, V<sub>PP</sub> can be set to 5.0V ± 0.5V or 12V ± 0.5V.

## DC Characteristics

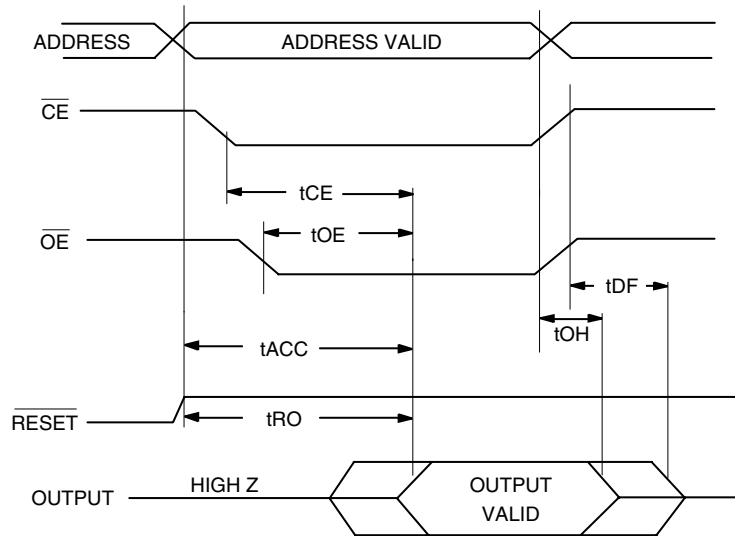
Symbol	Parameter	Condition	Min	Max	Units
$I_{LI}$	Input Load Current	$V_{IN} = 0V$ to $V_{CC}$		10	$\mu A$
$I_{LO}$	Output Leakage Current	$V_{IO} = 0V$ to $V_{CC}$		10	$\mu A$
$I_{SB1}$	$V_{CC}$ Standby Current CMOS	$\overline{CE} = V_{CC} - 0.3V$ to $V_{CC}$		10	$\mu A$
$I_{SB2}$	$V_{CC}$ Standby Current TTL	$\overline{CE} = 2.0V$ to $V_{CC}$		1	mA
$I_{SB3}$	$V_{CC}$ Standby Current TTL	$\overline{CE} = 2.0V$ to $V_{CC}$ , $V_{CC} = 2.85V$		10	$\mu A$
$I_{CC}^{(1)(2)}$	$V_{CC}$ Active Read Current	$f = 5$ MHz; $I_{OUT} = 0$ mA, $3.3V \leq V_{CC}$		30	mA
$I_{CC1}$	$V_{CC}$ Programming Current ( $V_{PP} = V_{CC}$ )			45	mA
$I_{PP1}$	$V_{PP}$ Input Load Current	$V_{PP} = 0V$ , $V_{CC} = 3.0V$		10	$\mu A$
		$V_{PP} = V_{CC} = 3.0V$		10	$\mu A$
$I_{CC2}$	$V_{CC}$ Programming Current ( $V_{PP} = 5.0V \pm 0.5V$ )			40	mA
$I_{PP2}$	$V_{PP}$ Programming Current ( $V_{PP} = 5.0V \pm 0.5V$ )			5	mA
$I_{CC3}$	$V_{CC}$ Programming Current ( $V_{PP} = 12.0V \pm 0.5V$ )			40	mA
$I_{PP3}$	$V_{PP}$ Programming Current ( $V_{PP} = 12.0V \pm 0.5V$ )			6	mA
$V_{IL}$	Input Low Voltage			0.6	V
$V_{IH}$	Input High Voltage		2.0		V
$V_{OL1}$	Output Low Voltage	$I_{OL} = 2.1$ mA		0.45	V
$V_{OL2}$	Output Low Voltage	$I_{OL} = 1.0$ mA		0.20	V
$V_{OH1}$	Output High Voltage	$I_{OH} = -400$ $\mu A$ $V_{CCQ} < 2.6V$		$V_{CCQ} - 0.2$	V
		$I_{OH} = -400$ $\mu A$ $V_{CCQ} \geq 2.6V$		2.4	V
$V_{OH2}$	Output High Voltage	$I_{OH} = -100$ $\mu A$ $V_{CCQ} < 2.6V$		$V_{CCQ} - 0.1$	V
		$I_{OH} = -100$ $\mu A$ $V_{CCQ} \geq 2.6V$		2.5	V

- Notes: 1. In the erase mode,  $I_{CC}$  is 50 mA.  
2. For  $3.3V < V_{CC} < 3.6V$ ,  $I_{CC}$  (max) = 35 mA.

## AC Read Characteristics

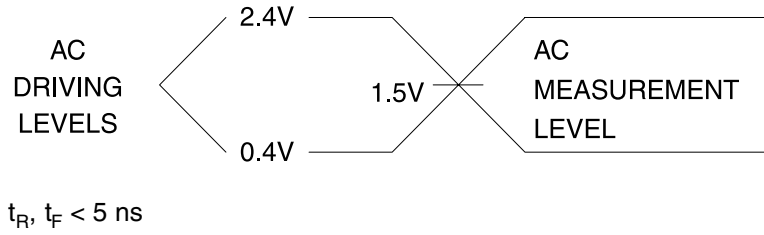
Symbol	Parameter	AT52BR1672(T)-85		AT52BR1674(T)-85		Units
		Min	Max	Min	Max	
$t_{ACC}$	Address to Output Delay		85		85	ns
$t_{CE}^{(1)}$	$\overline{CE}$ to Output Delay		85		85	ns
$t_{OE}^{(2)}$	$\overline{OE}$ to Output Delay	0	40	0	40	ns
$t_{DF}^{(3)(4)}$	$\overline{CE}$ or $\overline{OE}$ to Output Float	0	25	0	25	ns
$t_{OH}$	Output Hold from $\overline{OE}$ , $\overline{CE}$ or Address, whichever occurred first	0		0		ns
$t_{RO}$	$\overline{RESET}$ to Output Delay		100		100	ns

## AC Read Waveforms<sup>(1)(2)(3)(4)</sup>

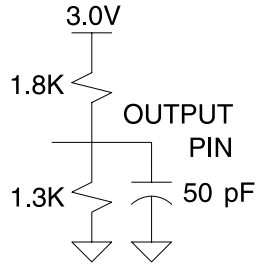


- Notes:
- $\overline{CE}$  may be delayed up to  $t_{ACC} - t_{CE}$  after the address transition without impact on  $t_{ACC}$ .
  - $\overline{OE}$  may be delayed up to  $t_{CE} - t_{OE}$  after the falling edge of  $\overline{CE}$  without impact on  $t_{CE}$  or by  $t_{ACC} - t_{OE}$  after an address change without impact on  $t_{ACC}$ .
  - $t_{DF}$  is specified from  $\overline{OE}$  or  $\overline{CE}$ , whichever occurs first (CL = 5 pF).
  - This parameter is characterized and is not 100% tested.

## Input Test Waveforms and Measurement Level



## Output Test Load



## Pin Capacitance

$f = 1 \text{ MHz}, T = 25^\circ\text{C}^{(1)}$

Symbol	Typ	Max	Units	Conditions
$C_{IN}$	4	6	pF	$V_{IN} = 0V$
$C_{OUT}$	8	12	pF	$V_{OUT} = 0V$

Note: 1. This parameter is characterized and is not 100% tested.

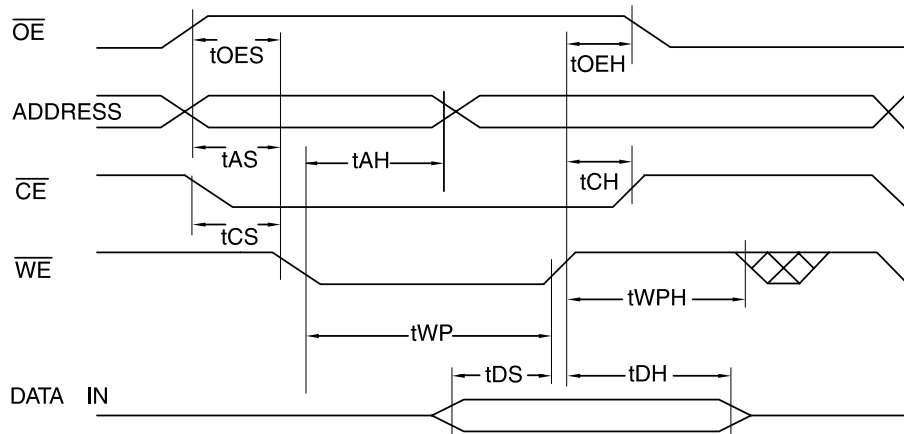


AC Word Load Characteristics

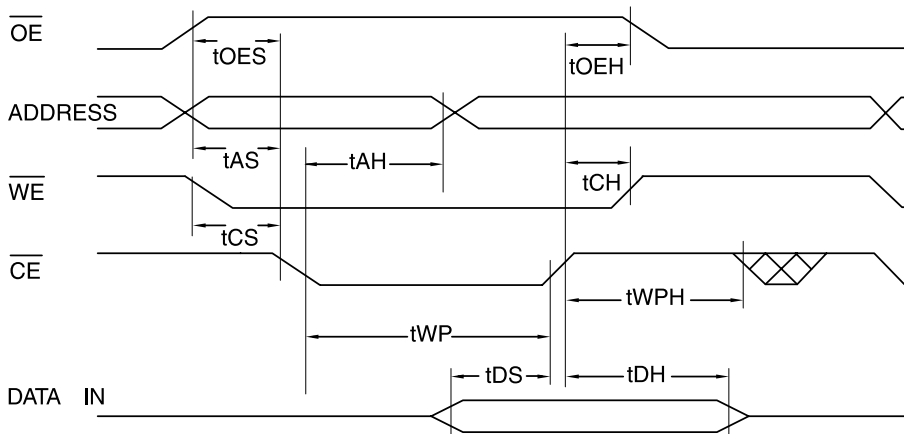
Symbol	Parameter	Min	Max	Units
$t_{AS}, t_{OES}$	Address, $\overline{OE}$ Setup Time	0		ns
$t_{AH}$	Address Hold Time	40		ns
$t_{CS}$	Chip Select Setup Time	0		ns
$t_{CH}$	Chip Select Hold Time	0		ns
$t_{WP}$	Write Pulse Width ( $\overline{WE}$ or $\overline{CE}$ )	40		ns
$t_{DS}$	Data Setup Time	30		ns
$t_{DH}, t_{OEH}$	Data, $\overline{OE}$ Hold Time	0		ns
$t_{WPH}$	Write Pulse Width High	30		ns

AC Word Load Waveforms

$\overline{WE}$  Controlled



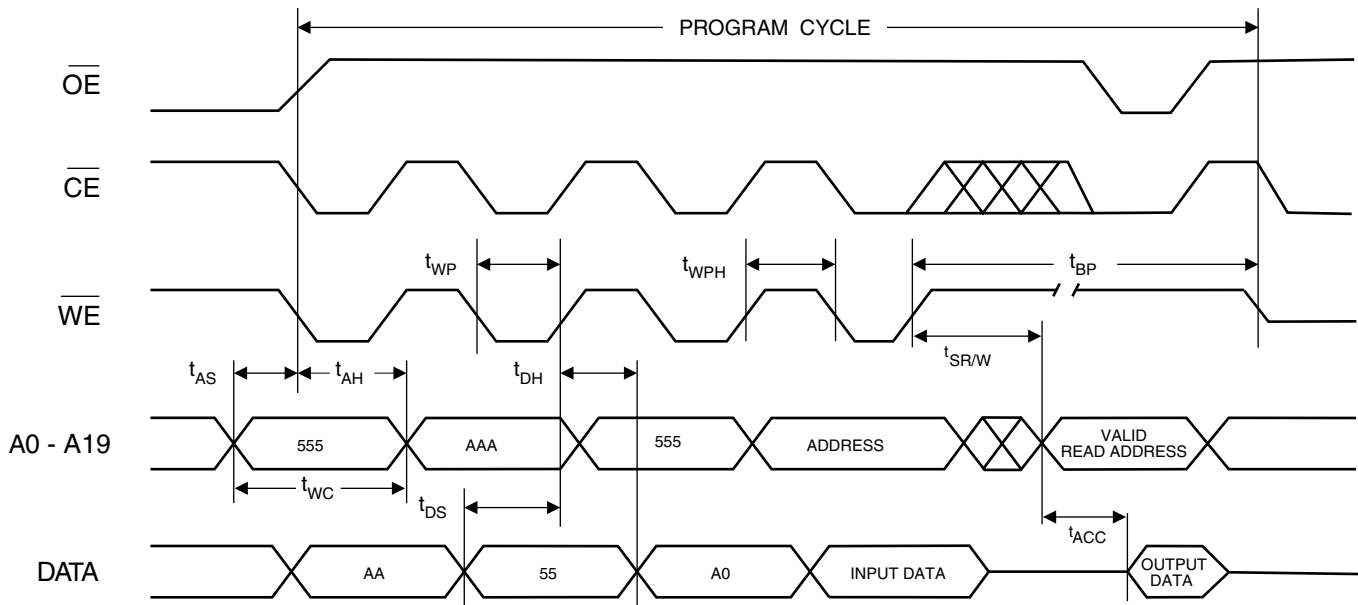
$\overline{CE}$  Controlled



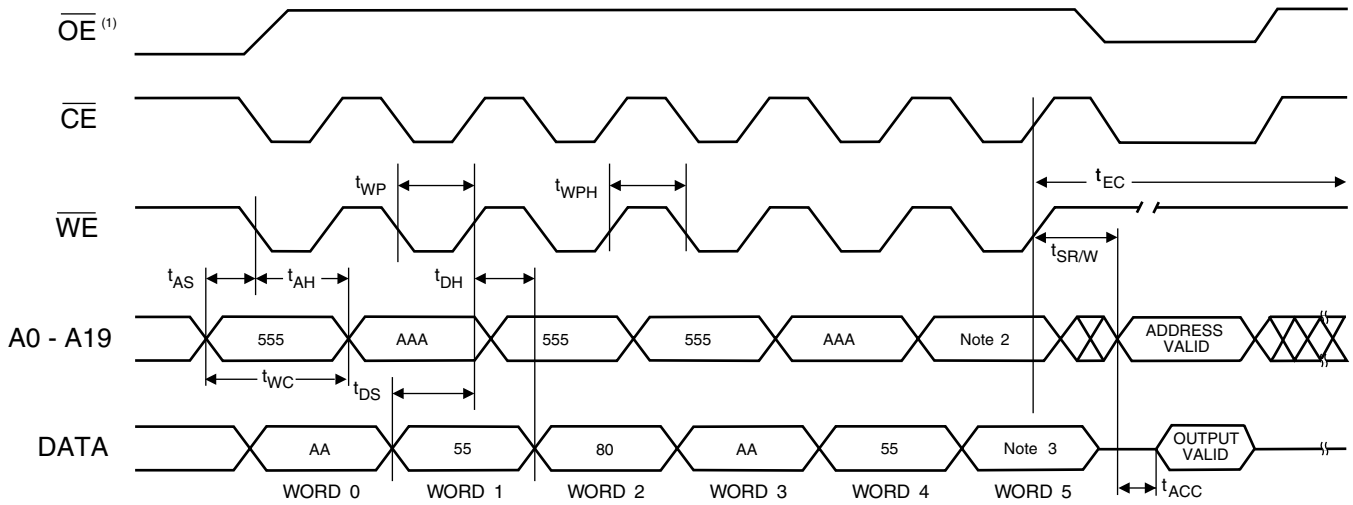
## Program Cycle Characteristics

Symbol	Parameter	Min	Typ	Max	Units
$t_{BP}$	Word Programming Time ( $0V < V_{PP} < 4.5V$ )		20	50	$\mu s$
$t_{BPVPP}$	Word Programming Time ( $V_{PP} \geq 4.5V$ )		10	25	$\mu s$
$t_{AS}$	Address Setup Time	0			ns
$t_{AH}$	Address Hold Time	40			ns
$t_{DS}$	Data Setup Time	30			ns
$t_{DH}$	Data Hold Time	0			ns
$t_{WP}$	Write Pulse Width	40			ns
$t_{WPH}$	Write Pulse Width High	30			ns
$t_{WC}$	Write Cycle Time	70			ns
$t_{SR/W}$	Latency between Read and Write Operations	50			ns
$t_{RP}$	$\overline{\text{Reset}}$ Pulse Width	500			ns
$t_{RH}$	$\overline{\text{Reset}}$ High Time before Read	50			ns
$t_{EC}$	Chip Erase Cycle Time ( $V_{PP} < 4.5V$ )			12	seconds
$t_{ECVPP}$	Chip Erase Cycle Time ( $V_{PP} \geq 4.5V$ )			6	seconds
$t_{SEC}$	Sector Erase Cycle Time ( $V_{PP} < 4.5V$ )		300	400	ms
$t_{EPS}$	Erase or Program Suspend Time			15	$\mu s$

## Program Cycle Waveforms



### Sector or Chip Erase Cycle Waveforms



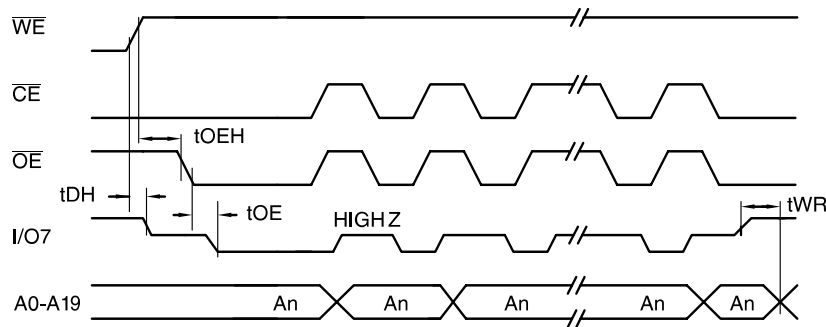
- Notes:
1.  $\overline{OE}$  must be high only when  $\overline{WE}$  and  $\overline{CE}$  are both low.
  2. For chip erase, the address should be 555. For sector erase, the address depends on what sector is to be erased. (See note 3 under Command Definitions.)
  3. For chip erase, the data should be 10H, and for sector erase, the data should be 30H.

## Data Polling Characteristics<sup>(1)</sup>

Symbol	Parameter	Min	Typ	Max	Units
$t_{DH}$	Data Hold Time	10			ns
$t_{OE\overline{H}}$	$\overline{OE}$ Hold Time	10			ns
$t_{OE}$	$\overline{OE}$ to Output Delay <sup>(2)</sup>				ns
$t_{WR}$	Write Recovery Time	0			ns

Notes: 1. These parameters are characterized and not 100% tested.  
2. See  $t_{OE}$  spec in "AC Read Characteristics" on page 15.

## Data Polling Waveforms

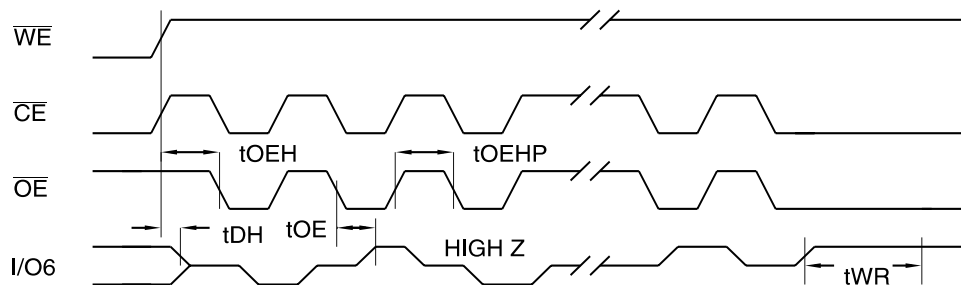


## Toggle Bit Characteristics<sup>(1)</sup>

Symbol	Parameter	Min	Typ	Max	Units
$t_{DH}$	Data Hold Time	10			ns
$t_{OE\overline{H}}$	$\overline{OE}$ Hold Time	10			ns
$t_{OE}$	$\overline{OE}$ to Output Delay <sup>(2)</sup>				ns
$t_{OEHP}$	$\overline{OE}$ High Pulse	50			ns
$t_{WR}$	Write Recovery Time	0			ns

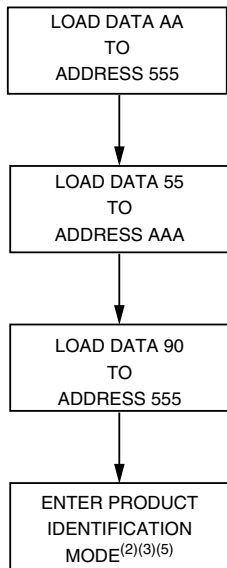
Notes: 1. These parameters are characterized and not 100% tested.  
2. See  $t_{OE}$  spec in "AC Read Characteristics" on page 15.

## Toggle Bit Waveforms<sup>(1)(2)(3)</sup>

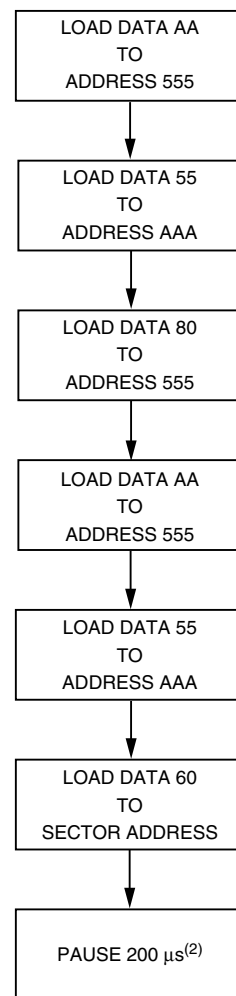


Notes: 1. Toggling either  $\overline{OE}$  or  $\overline{CE}$  or both  $\overline{OE}$  and  $\overline{CE}$  will operate toggle bit.  
The  $t_{OEHP}$  specification must be met by the toggling input(s).  
2. Beginning and ending state of I/O6 will vary.  
3. Any address location may be used but the address should not vary.

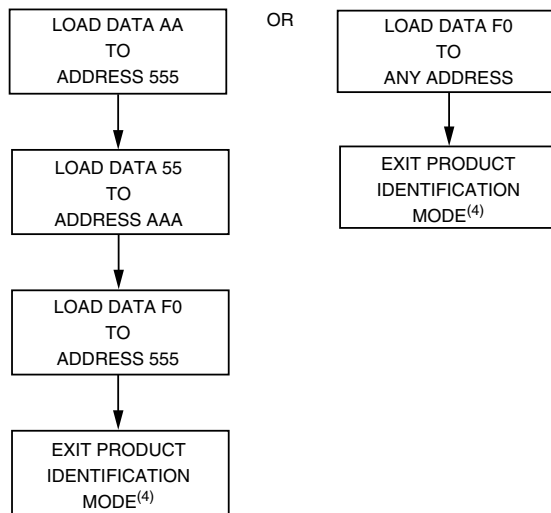
## Software Product Identification Entry<sup>(1)</sup>



## Sector Lockdown Enable Algorithm<sup>(1)</sup>



## Software Product Identification Exit<sup>(1)(6)</sup>



- Notes:
1. Data Format: I/O15 - I/O8 (Don't Care); I/O7 - I/O0 (Hex)  
Address Format: A11 - A0 (Hex) and A11 - A19 (Don't Care).
  2. Sector Lockdown feature enabled.

- Notes:
1. Data Format: I/O15 - I/O8 (Don't Care); I/O7 - I/O0 (Hex)  
Address Format: A11 - A0 (Hex) and A11 - A19 (Don't Care).
  2. A1 - A19 =  $V_{IL}$ . Manufacturer Code is read for A0 =  $V_{IL}$ ;  
Device Code is read for A0 =  $V_{IH}$ .  
Additional Device Code is read for address 0003H
  3. The device does not remain in identification mode if powered down.
  4. The device returns to standard operation mode.
  5. Manufacturer Code: 001FH.  
Device Code: 00C2H (Top Boot); 00C0H (Bottom Boot).  
Additional Device Code: 00C8H.
  6. Either one of the Product ID Exit commands can be used.

## Status Bit Table

	Status Bit					
	I/O7		I/O6		I/O2	
	Plane A	Plane B	Plane A	Plane B	Plane A	Plane B
Read Address In						
While						
Programming in Plane A	$\overline{I/O7}$	DATA	TOGGLE	DATA	1	DATA
Programming in Plane B	DATA	$\overline{I/O7}$	DATA	TOGGLE	DATA	1
Erasing in Plane A	0	DATA	TOGGLE	DATA	TOGGLE	DATA
Erasing in Plane B	DATA	0	DATA	TOGGLE	DATA	TOGGLE
Erase Suspended & Read Erasing Sector	1	1	1	1	TOGGLE	TOGGLE
Erase Suspended & Read Non-erasing Sector	DATA	DATA	DATA	DATA	DATA	DATA
Erase Suspended & Program Non-erasing Sector in Plane A	$\overline{I/O7}$	DATA	TOGGLE	DATA	TOGGLE	DATA
Erase Suspended & Program Non-erasing Sector in Plane B	DATA	$\overline{I/O7}$	DATA	TOGGLE	DATA	TOGGLE

## 2-megabit SRAM Description

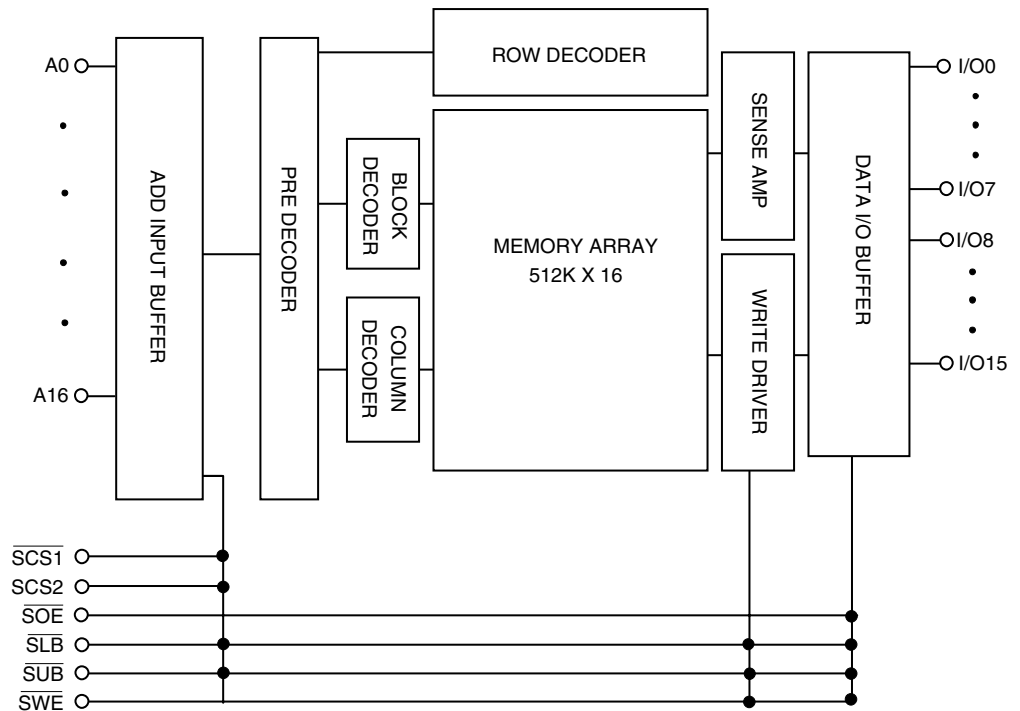
The 2-megabit SRAM is a high-speed, super low-power CMOS SRAM organized as 128K words by 16 bits. The SRAM uses high-performance full CMOS process technology and is designed for high-speed and low-power circuit technology. It is particularly well-suited for the high-density low-power system application. This device has a data retention mode that guarantees data to remain valid at a minimum power supply voltage of 1.2V.

## Features

- Fully Static Operation and Tri-state Output
- TTL Compatible Inputs and Outputs
- Battery Backup
  - 1.2V (Min) Data Retention

Voltage (V)	Speed (ns)	Operation Current/ $I_{CC}$ (mA) (Max)	Standby Current ( $\mu$ A) (Max)	Temperature ( $^{\circ}$ C)
2.7 - 3.3	70	10	10	-40 - 85

## Block Diagram



## Absolute Maximum Ratings<sup>(1)</sup>

Symbol	Parameter	Rating	Unit
$V_{IN}, V_{OUT}$	Input/Output Voltage	-0.3 to 3.6	V
$V_{CC}$	Power Supply	-0.3 to 4.6	V
$T_A$	Operating Temperature	-40 to 85	°C
$T_{STG}$	Storage Temperature	-55 to 150	°C
$P_D$	Power Dissipation	1.0	W

Note: 1. Stresses greater than those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. This is stress rating only and the functional operation of the device under these or any other conditions above those indicated in the operation of this specification is not implied. Exposure to the absolute maximum rating conditions for extended period may affect reliability.

## Truth Table

$\overline{SCS1}$	SCS2	$\overline{SWE}$	$\overline{SOE}$	$\overline{SLB}^{(2)}$	$\overline{SUB}^{(2)}$	Mode	I/O Pin		Power
							I/O0 - I/O7	I/O8 - I/O15	
H <sup>(1)</sup>	X	X	X	X	X	Deselected	High-Z	High-Z	Standby
X <sup>(1)</sup>	L			H	H				
X	X			L	H				
L <sup>(1)</sup>	H	H	H	L	H	Output Disabled	High-Z	High-Z	Active
				H	L				
				L	L				
L	H	L	X	L	H	Write	$D_{IN}$	High-Z	Active
				H	L		High-Z	$D_{IN}$	
				L	L		$D_{IN}$	$D_{IN}$	
L	H	H	L	L	H	Read	$D_{OUT}$	High-Z	Active
				H	L		High-Z	$D_{OUT}$	
				L	L		$D_{OUT}$	$D_{OUT}$	

Notes: 1. H =  $V_{IH}$ , L =  $V_{IL}$ , X = Don't Care ( $V_{IL}$  or  $V_{IH}$ )

2.  $\overline{SUB}$ ,  $\overline{SLB}$  (Upper, Lower Byte Enable). These active LOW inputs allow individual bytes to be written or read. When  $\overline{SLB}$  is LOW, data is written or read to the lower byte, I/O0 - I/O8. When  $\overline{SUB}$  is LOW, data is written or read to the upper byte, I/O9 - I/O16.

## Recommended DC Operating Condition

Symbol	Parameter	Min	Typ	Max	Unit
$V_{CC}$	Supply Voltage	2.3	3.0	3.3	V
$V_{SS}$	Ground	0	0	0	V
$V_{IH}$	Input High Voltage	2.2		$V_{CC} + 0.3$	V
$V_{IL}^{(1)}$	Input Low Voltage	-0.2 <sup>(1)</sup>		0.4	V

Note: 1. Undershoot:  $V_{IL} = -1.5V$  for pulse width less than 30 ns. Undershoot is sampled, not 100% tested.



## DC Electrical Characteristics

T<sub>A</sub> = -40°C to 85°C

Symbol	Parameter	Test Condition	Min	Typ <sup>(1)</sup>	Max	Unit
I <sub>LI</sub>	Input Leakage Current	V <sub>SS</sub> < V <sub>IN</sub> < V <sub>CC</sub>	-1		1	μA
I <sub>LO</sub>	Output Leakage Current	V <sub>SS</sub> < V <sub>OUT</sub> < V <sub>CC</sub> , SCS1 = V <sub>IH</sub> or SCS2 = V <sub>IL</sub> or SOE = V <sub>IH</sub> or SWE = V <sub>IL</sub> or SUB = V <sub>IH</sub> , SLB = V <sub>IH</sub>	-1		1	μA
I <sub>CC</sub>	Operating Power Supply Current	SCS1 = V <sub>IL</sub> , SCS2 = V <sub>IH</sub> , V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub> , I <sub>I/O</sub> = 0 mA		5	10	mA
I <sub>CC1</sub>	Average Operating Current	Cycle Time = 1 μs I <sub>I/O</sub> = 0 mA, SCS1 = 0.2V, SCS2 = V <sub>CC</sub> - 0.2V, V <sub>IN</sub> ≤ 0.2V or V <sub>IN</sub> ≥ V <sub>CC</sub> - 0.2V		4	6	mA
		Cycle Time = Min, 100% Duty, I <sub>I/O</sub> = 0 mA SCS1 = V <sub>IL</sub> , SCS2 = V <sub>IH</sub> , V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub>		30	45	mA
I <sub>SB</sub>	Standby Current (TTL Input)	SCS1 = V <sub>IH</sub> or SCS2 = V <sub>IL</sub>			0.5	mA
I <sub>SB1</sub>	Standby Current (CMOS Input)	SCS1 ≥ V <sub>CC</sub> - 0.2V	LL	0.4	10	μA
		SCS2 ≤ V <sub>SS</sub> + 0.2V	SL		2	μA
V <sub>OL</sub>	Output Low	I <sub>OL</sub> = 0.5 mA			0.4	V
V <sub>OH</sub>	Output High	I <sub>OH</sub> = -0.5 mA	2.0			V

Note: 1. Typical values are at V<sub>CC</sub> = 3.0V, T<sub>A</sub> = 25°C. Typical values are not 100% tested.

## Capacitance<sup>(1)</sup>

(Temp = 25°C, f = 1.0 MHz)

Symbol	Parameter	Condition	Max	Unit
C <sub>IN</sub>	Input Capacitance (Add, SCS1, SCS2, SLB, SUB, SWE, SOE)	V <sub>IN</sub> = 0 V	8	pF
C <sub>OUT</sub>	Output Capacitance (I/O)	V <sub>I/O</sub> = 0 V	10	pF

Note: 1. These parameters are sampled and not 100% tested.

## AC Characteristics

$T_A = -40^{\circ}\text{C}$  to  $85^{\circ}\text{C}$ , Unless Otherwise Specified

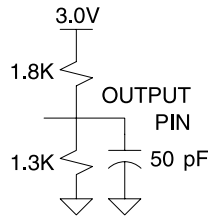
#	Symbol	Parameter	70 ns		Unit
			Min	Max	
1	$t_{RC}$	Read Cycle Time	70		ns
2	$t_{AA}$	Address Access Time		70	ns
3	$t_{ACS}$	Chip Select Access Time		70	ns
4	$t_{OE}$	Output Enable to Output Valid		35	ns
5	$t_{BA}$	$\overline{SLB}$ , $\overline{SUB}$ Access Time		35	ns
6	$t_{CLZ}$	Chip Select to Output in Low Z	5		ns
7	$t_{OLZ}$	Output Enable to Output in Low Z	0		ns
8	$t_{BLZ}$	$\overline{SLB}$ , $\overline{SUB}$ Enable to Output in Low Z	0		ns
9	$t_{CHZ}$	Chip Deselection to Output in High Z	0	30	ns
10	$t_{OHZ}$	Out Disable to Output in High Z	0	30	ns
11	$t_{BHZ}$	$\overline{SLB}$ , $\overline{SUB}$ Disable to Output in High Z	0	30	ns
12	$t_{OH}$	Output Hold from Address Change	10		ns
13	$t_{WC}$	Write Cycle Time	70		ns
14	$t_{CW}$	Chip Selection to End of Write	60		ns
15	$t_{AW}$	Address Valid to End of Write	60		ns
16	$t_{BW}$	$\overline{SLB}$ , $\overline{SUB}$ Valid to End of Write	60		ns
17	$t_{AS}$	Address Setup Time	0		ns
18	$t_{WP}$	Write Pulse Width	50		ns
19	$t_{WR}$	Write Recovery Time	0		ns
20	$t_{WHZ}$	Write to Output in High Z	0	25	ns
21	$t_{DW}$	Data to Write Time Overlap	30		ns
22	$t_{DH}$	Data Hold from Write Time	0		ns
23	$t_{OW}$	Output Active from End of Write	5		ns

## AC Test Conditions

$T_A = -40^{\circ}\text{C}$  to  $85^{\circ}\text{C}$ , Unless Otherwise Specified

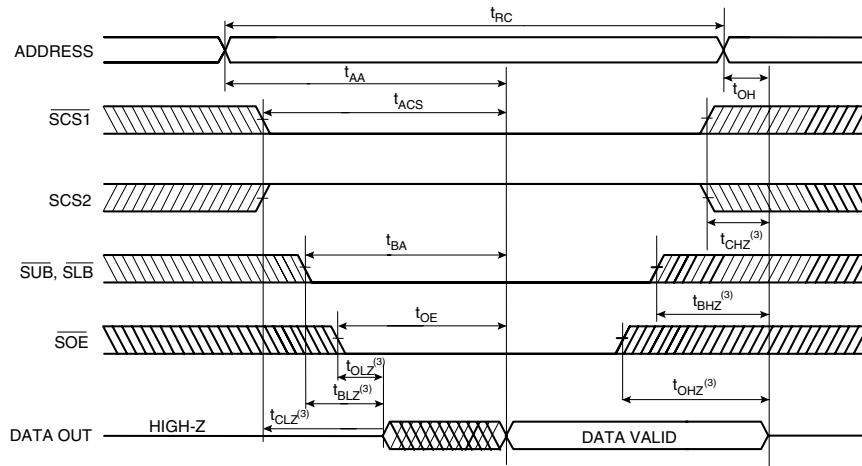
Parameter	Value
Input Pulse Level	0.4V to 2.2V
Input Rise and Fall Time	5 ns
Input and Output Timing Reference Level	1.5V
Output Load	CL = 5 pF + 1 TTL Load
	CL = 30 pF + 1 TTL Load

## Output Test Load

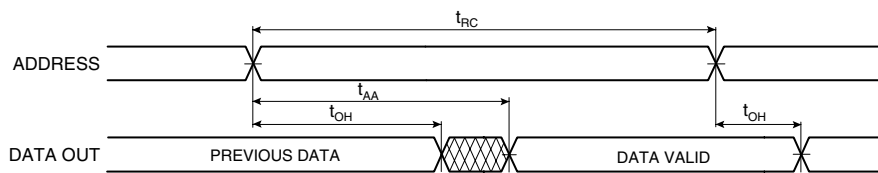


## Timing Diagrams

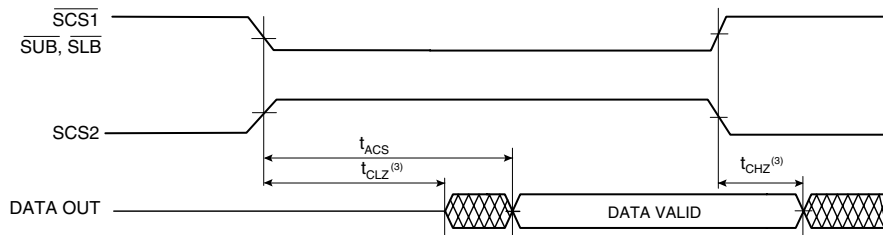
### Read Cycle 1<sup>(1),(4)</sup>



### Read Cycle 2<sup>(1),(2),(4)</sup>

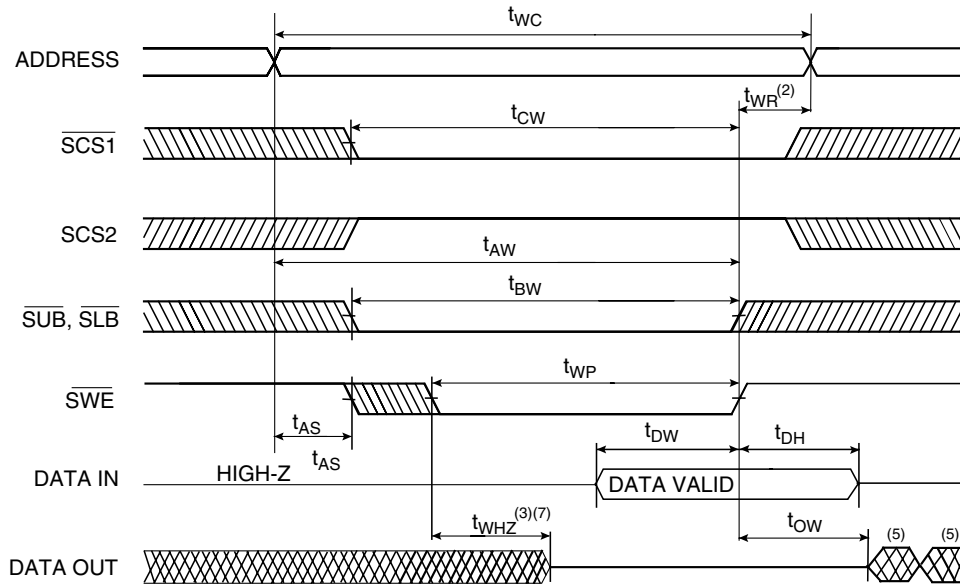


### Read Cycle 3<sup>(1),(2),(4)</sup>

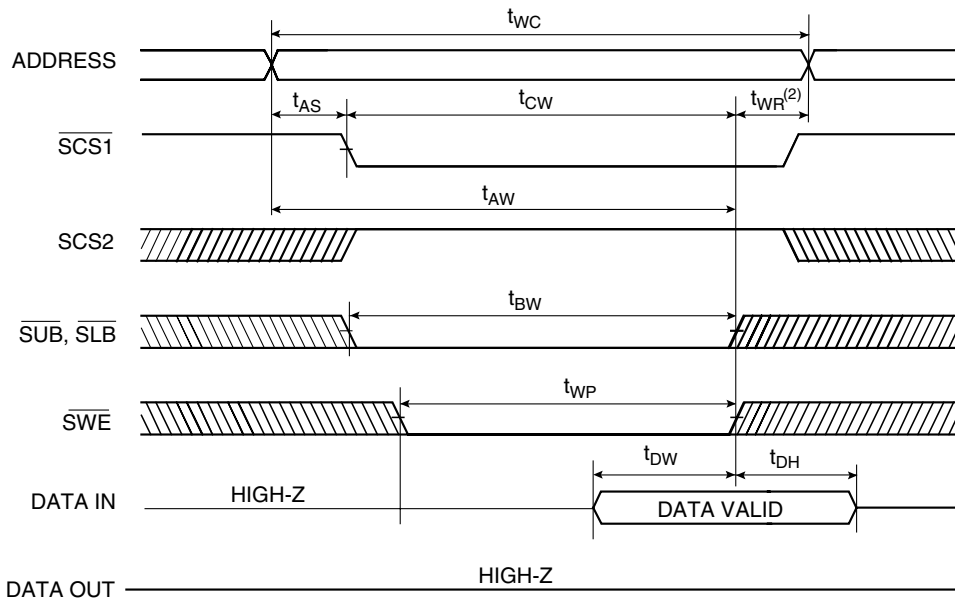


- Notes:
1. Read Cycle occurs whenever a high on the  $\overline{SWE}$  and  $\overline{SOE}$  is low, while  $\overline{SUB}$  and/or  $\overline{SLB}$  and  $\overline{SCS1}$  and  $SCS2$  are in active status.
  2.  $\overline{SOE} = V_{IL}$ .
  3. Transition is measured + 200 mV from steady state voltage. This parameter is sampled and not 100% tested.
  4.  $\overline{SCS1}$  in high for the standby, low for active.  $SCS2$  in low for the standby, high for active.  $\overline{SUB}$  and  $\overline{SLB}$  in high for the standby, low for active.

## Write Cycle 1 ( $\overline{\text{SWE}}$ Controlled)<sup>(1),(4),(8)</sup>



## Write Cycle 2 ( $\overline{\text{SCS1}}$ , $\overline{\text{SCS2}}$ Controlled)<sup>(1),(4),(8)</sup>



- Notes:
1. A write occurs during the overlap of a low  $\overline{\text{SWE}}$ , a low  $\overline{\text{SCS1}}$ , a high  $\overline{\text{SCS2}}$  and a low  $\overline{\text{SUB}}$  and/or  $\overline{\text{SLB}}$ .
  2.  $t_{\text{WR}}$  is measured from the earlier of  $\overline{\text{SCS1}}$ ,  $\overline{\text{SLB}}$ ,  $\overline{\text{SUB}}$ , or  $\overline{\text{SWE}}$  going high or  $\overline{\text{SCS2}}$  going low to the end of write cycle.
  3. During this period, I/O pins are in the output state so that the input signals of opposite phase to the output must not be applied.
  4. If the  $\overline{\text{SCS1}}$ ,  $\overline{\text{SLB}}$  and  $\overline{\text{SUB}}$  low transition and  $\overline{\text{SCS2}}$  high transition occur simultaneously with the  $\overline{\text{SWE}}$  low transition or after the  $\overline{\text{SWE}}$  transition, outputs remain in a high impedance state.
  5. Q (data out) is the same phase with the write data of this write cycle.
  6. Q (data out) is the read data of the next address.
  7. Transition is measured + 200 mV from steady state. This parameter is sampled and not 100% tested.
  8.  $\overline{\text{SCS1}}$  in high for the standby, low for active.  $\overline{\text{SCS2}}$  in low for the standby, high for active.  $\overline{\text{SUB}}$  and  $\overline{\text{SLB}}$  in high for the standby, low for active.

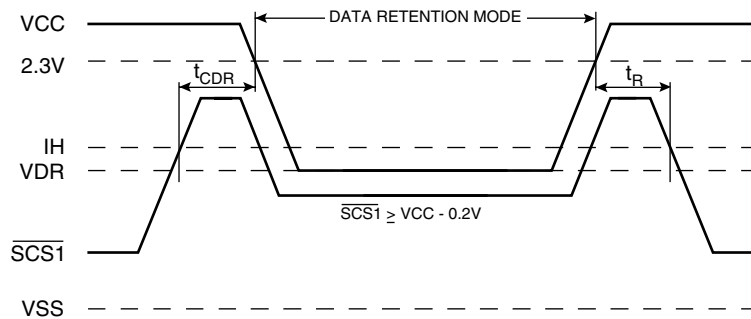
## Data Retention Electric Characteristic

$T_A = -40^\circ\text{C}$  to  $85^\circ\text{C}$

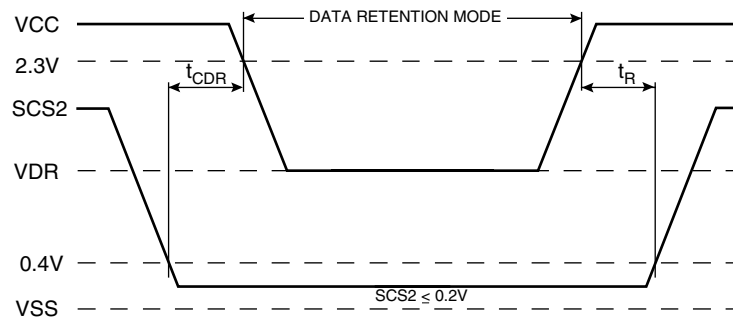
Symbol	Parameter	Test Condition	Min	Typ	Max	Unit
$V_{DR}$	$V_{CC}$ for Data Retention	$\overline{SCS1} > V_{CC} - 0.2V$ , $SCS2 \leq 0.2V$ or $V_{CC} - 0.2V$ , $V_{SS} \leq V_{IN} \leq V_{CC}$	1.2		3.3	V
$I_{CCDR}$	Data Retention Current	$V_{CC} = 3.0V$ , $\overline{SCS1} > V_{CC} - 0.2V$ or $SCS2 \leq V_{SS} + 0.2V$ or $V_{SS} \leq V_{IN} \leq V_{CC}$			9.5	$\mu\text{A}$
				0.4 <sup>(1)</sup>	0.7	$\mu\text{A}$
$t_{CDR}$	Chip Deselect to Data Retention Time	See Data Retention Timing Diagram	0			ns
$t_R$	Operating Recovery Time		$t_{RC}$ <sup>(2)</sup>			ns

Notes: 1. Typical values are under the condition of  $T_A = 25^\circ\text{C}$ . Typical values are sampled and not 100% tested.  
2.  $t_{RC}$  is read cycle time.

### Data Retention Timing Diagram 1



### Data Retention Timing Diagram 2



## 4-megabit SRAM Description

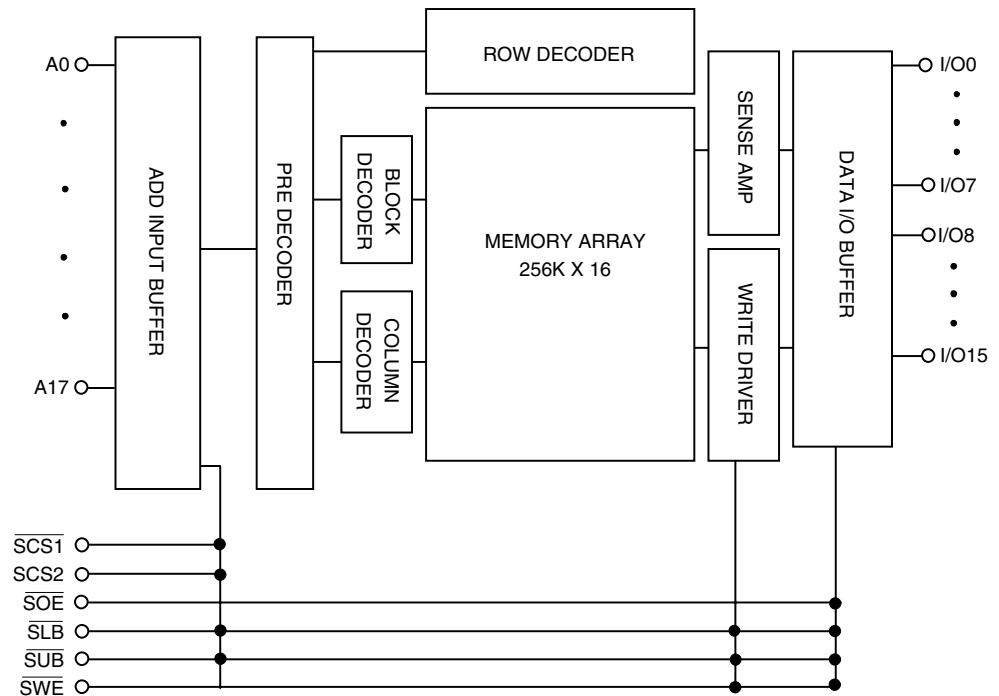
The 4-megabit SRAM is a high-speed, super low-power CMOS SRAM organized as 256K words by 16 bits. The SRAM uses high-performance full CMOS process technology and is designed for high-speed and low-power circuit technology. It is particularly well-suited for the high-density low-power system application. This device has a data retention mode that guarantees data to remain valid at a minimum power supply voltage of 1.2V.

## Features

- Fully Static Operation and Tri-state Output
- TTL Compatible Inputs and Outputs
- Battery Backup
  - 1.2V (Min) Data Retention

Voltage (V)	Speed (ns)	Operation Current/ $I_{CC}$ (mA) (Max)	Standby Current ( $\mu$ A) (Max)	Temperature ( $^{\circ}$ C)
2.7 - 3.3	70	5	15	-40 - 85

## Block Diagram



## Absolute Maximum Ratings<sup>(1)</sup>

Symbol	Parameter	Rating	Unit
$V_{IN}, V_{OUT}$	Input/Output Voltage	-0.3 to 3.6	V
$V_{CC}$	Power Supply	-0.3 to 4.6	V
$T_A$	Operating Temperature	-40 to 85	°C
$T_{STG}$	Storage Temperature	-55 to 150	°C
$P_D$	Power Dissipation	1.0	W

Note: 1. Stresses greater than those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. This is stress rating only and the functional operation of the device under these or any other conditions above those indicated in the operation of this specification is not implied. Exposure to the absolute maximum rating conditions for extended period may affect reliability.

## Truth Table

$\overline{SCS1}$	SCS2	$\overline{SWE}$	$\overline{SOE}$	$\overline{SLB}^{(2)}$	$\overline{SUB}^{(2)}$	Mode	I/O Pin		Power
							I/O0 - I/O7	I/O8 - I/O15	
H <sup>(1)</sup>	X	X	X	X	X	Deselected	High-Z	High-Z	Standby
X <sup>(1)</sup>	L			H	H				
X	X			L	H				
L <sup>(1)</sup>	H	H	H	L	H	Output Disabled	High-Z	High-Z	Active
				H	L				
				L	L				
L	H	L	X	L	H	Write	$D_{IN}$	High-Z	Active
				H	L		High-Z	$D_{IN}$	
				L	L		$D_{IN}$	$D_{IN}$	
				L	L		$D_{IN}$	High-Z	
L	H	H	L	L	H	Read	$D_{OUT}$	High-Z	Active
				H	L		High-Z	$D_{OUT}$	
				L	L		$D_{OUT}$	$D_{OUT}$	
				L	L		$D_{OUT}$	High-Z	

Notes: 1. H =  $V_{IH}$ , L =  $V_{IL}$ , X = Don't Care ( $V_{IL}$  or  $V_{IH}$ )  
 2.  $\overline{SUB}$ ,  $\overline{SLB}$  (Upper, Lower Byte Enable). These active LOW inputs allow individual bytes to be written or read. When  $\overline{SLB}$  is LOW, data is written or read to the lower byte, I/O0 - I/O7. When  $\overline{SUB}$  is LOW, data is written or read to the upper byte, I/O8 - I/O15.

## Recommended DC Operating Condition

Symbol	Parameter	Min	Typ	Max	Unit
$V_{CC}$	Supply Voltage	2.7	3.0	3.3	V
$V_{SS}$	Ground	0	0	0	V
$V_{IH}$	Input High Voltage	2.2		$V_{CC} + 0.3$	V
$V_{IL}^{(1)}$	Input Low Voltage	-0.31 <sup>(1)</sup>		0.6	V

Note: 1. Undershoot:  $V_{IL} = -1.5V$  for pulse width less than 30 ns. Undershoot is sampled, not 100% tested.

## DC Electrical Characteristics

$T_A = -40^\circ\text{C}$  to  $85^\circ\text{C}$

Symbol	Parameter	Test Condition	Min	Max	Unit
$I_{LI}$	Input Leakage Current	$V_{SS} < V_{IN} < V_{CC}$	-1	1	$\mu\text{A}$
$I_{LO}$	Output Leakage Current	$V_{SS} < V_{OUT} < V_{CC}$ , $\overline{SCS1} = V_{IH}$ or $SCS2 = V_{IL}$ or $\overline{SOE} = V_{IH}$ or $\overline{SWE} = V_{IL}$ or $\overline{SUB} = V_{IH}$ , $\overline{SLB} = V_{IH}$	-1	1	$\mu\text{A}$
$I_{CC}$	Operating Power Supply Current	$\overline{SCS1} = V_{IL}$ , $SCS2 = V_{IH}$ , $V_{IN} = V_{IH}$ or $V_{IL}$ , $I_{I/O} = 0$ mA		5	mA
$I_{CC1}$	Average Operating Current	$\overline{SCS1} = V_{IL}$ , $SCS2 = V_{IH}$ , $V_{IN} = V_{IH}$ or $V_{IL}$ , Cycle Time = Min 100% Duty, $I_{I/O} = 0$ mA		35	mA
		$\overline{SCS1} < 0.2\text{V}$ , $SCS2 > V_{CC} - 0.2\text{V}$ $V_{IN} < 0.2\text{V}$ or $V_{IN} > V_{CC} - 0.2\text{V}$ , Cycle Time = 1 $\mu\text{s}$ 100% Duty, $I_{I/O} = 0$ mA		5	mA
$I_{SB}$	Standby Current (TTL Input)	$\overline{SCS1} = V_{IH}$ or $SCS2 = V_{IL}$ or $\overline{SUB}$ , $\overline{SLB} = V_{IH}$ $V_{IN} = V_{IH}$ or $V_{IL}$		0.5	mA
$I_{SB1}$	Standby Current (CMOS Input)	$\overline{SCS1} > V_{CC} - 0.2\text{V}$ or $SCS2 < V_{SS} + 0.2\text{V}$ or $\overline{SUB}$ , $\overline{SLB} > V_{CC} - 0.2\text{V}$ $V_{IN} > V_{CC} - 0.2\text{V}$ or $V_{IN} < V_{SS} + 0.2\text{V}$	SL	4	$\mu\text{A}$
			LL	15	$\mu\text{A}$
$V_{OL}$	Output Low	$I_{OL} = 0.1$ mA		0.4	V
$V_{OH}$	Output High	$I_{OH} = -0.1$ mA	2.4		V

## Capacitance<sup>(1)</sup>

(Temp =  $25^\circ\text{C}$ , f = 1.0 MHz)

Symbol	Parameter	Condition	Max	Unit
$C_{IN}$	Input Capacitance (Add, $\overline{SCS1}$ , $SCS2$ , $\overline{SLB}$ , $\overline{SUB}$ , $\overline{SWE}$ , $\overline{SOE}$ )	$V_{IN} = 0$ V	8	pF
$C_{OUT}$	Output Capacitance (I/O)	$V_{I/O} = 0$ V	10	pF

Note: 1. These parameters are sampled and not 100% tested.



## AC Characteristics

$T_A = -40^{\circ}\text{C}$  to  $85^{\circ}\text{C}$ , Unless Otherwise Specified

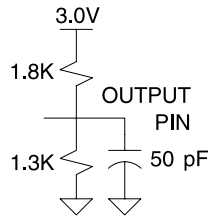
#	Symbol	Parameter	70 ns		Unit
			Min	Max	
1	$t_{RC}$	Read Cycle Time	70		ns
2	$t_{AA}$	Address Access Time		70	ns
3	$t_{ACS}$	Chip Select Access Time		70	ns
4	$t_{OE}$	Output Enable to Output Valid		35	ns
5	$t_{BA}$	$\overline{SLB}$ , $\overline{SUB}$ Access Time		70	ns
6	$t_{CLZ}$	Chip Select to Output in Low Z	10		ns
7	$t_{OLZ}$	Output Enable to Output in Low Z	5		ns
8	$t_{BLZ}$	$\overline{SLB}$ , $\overline{SUB}$ Enable to Output in Low Z	10		ns
9	$t_{CHZ}$	Chip Deselection to Output in High Z	0	30	ns
10	$t_{OHZ}$	Out Disable to Output in High Z	0	30	ns
11	$t_{BHZ}$	$\overline{SLB}$ , $\overline{SUB}$ Disable to Output in High Z	0	30	ns
12	$t_{OH}$	Output Hold from Address Change	10		ns
13	$t_{WC}$	Write Cycle Time	70		ns
14	$t_{CW}$	Chip Selection to End of Write	60		ns
15	$t_{AW}$	Address Valid to End of Write	60		ns
16	$t_{BW}$	$\overline{SLB}$ , $\overline{SUB}$ Valid to End of Write	60		ns
17	$t_{AS}$	Address Setup Time	0		ns
18	$t_{WP}$	Write Pulse Width	50		ns
19	$t_{WR}$	Write Recovery Time	0		ns
20	$t_{WHZ}$	Write to Output in High Z	0	20	ns
21	$t_{DW}$	Data to Write Time Overlap	30		ns
22	$t_{DH}$	Data Hold from Write Time	0		ns
23	$t_{OW}$	Output Active from End of Write	5		ns

## AC Test Conditions

$T_A = -40^{\circ}\text{C}$  to  $85^{\circ}\text{C}$ , Unless Otherwise Specified

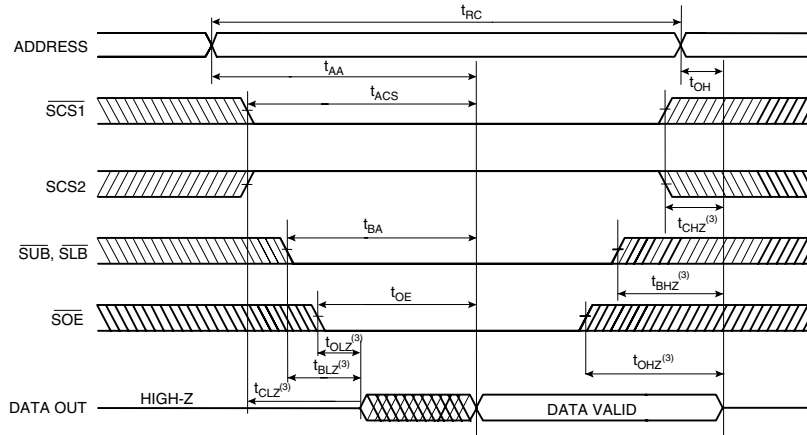
Parameter	Value
Input Pulse Level	0.4V to 2.2V
Input Rise and Fall Time	5 ns
Input and Output Timing Reference Level	1.5V
Output Load	CL = 5 pF + 1 TTL Load
	CL = 30 pF + 1 TTL Load

## Output Test Load

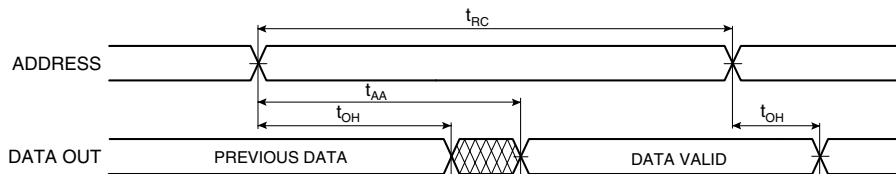


## Timing Diagrams

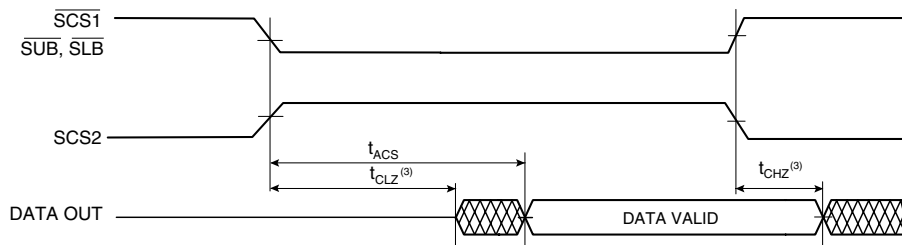
### Read Cycle 1<sup>(1),(4)</sup>



### Read Cycle 2<sup>(1),(2),(4)</sup>

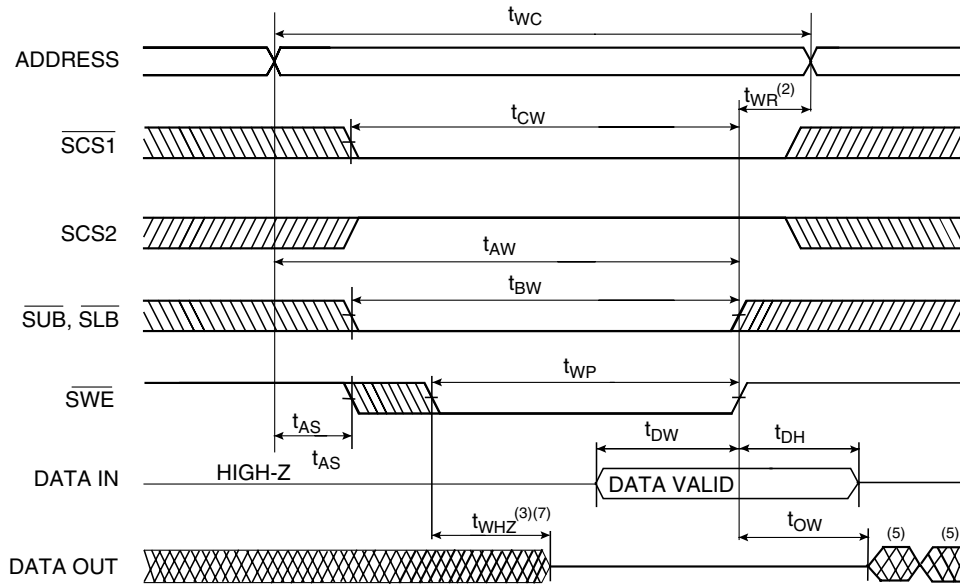


### Read Cycle 3<sup>(1),(2),(4)</sup>

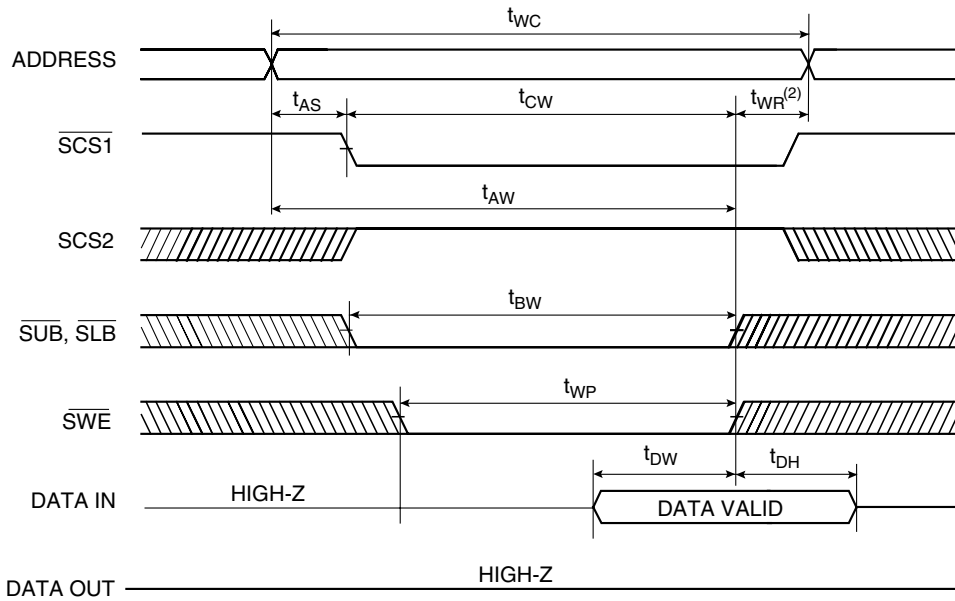


- Notes:
1. Read Cycle occurs whenever a high on the  $\overline{SWE}$  and  $\overline{SOE}$  is low, while  $\overline{SUB}$  and/or  $\overline{SLB}$  and  $\overline{SCS1}$  and SCS2 are in active status.
  2.  $\overline{SOE} = V_{IL}$ .
  3. Transition is measured + 200 mV from steady state voltage. This parameter is sampled and not 100% tested.
  4.  $\overline{SCS1}$  in high for the standby, low for active. SCS2 in low for the standby, high for active.  $\overline{SUB}$  and  $\overline{SLB}$  in high for the standby, low for active.

## Write Cycle 1 ( $\overline{\text{SWE}}$ Controlled)<sup>(1),(4),(8)</sup>



## Write Cycle 2 ( $\overline{\text{SCS1}}, \overline{\text{SCS2}}$ Controlled)<sup>(1),(4),(8)</sup>



- Notes:
1. A write occurs during the overlap of a low  $\overline{\text{SWE}}$ , a low  $\overline{\text{SCS1}}$ , a high  $\overline{\text{SCS2}}$  and a low  $\overline{\text{SUB}}$  and/or  $\overline{\text{SLB}}$ .
  2.  $t_{WR}$  is measured from the earlier of  $\overline{\text{SCS1}}$ ,  $\overline{\text{SLB}}$ ,  $\overline{\text{SUB}}$ , or  $\overline{\text{SWE}}$  going high or  $\overline{\text{SCS2}}$  going low to the end of write cycle.
  3. During this period, I/O pins are in the output state so that the input signals of opposite phase to the output must not be applied.
  4. If the  $\overline{\text{SCS1}}$ ,  $\overline{\text{SLB}}$  and  $\overline{\text{SUB}}$  low transition and  $\overline{\text{SCS2}}$  high transition occur simultaneously with the  $\overline{\text{SWE}}$  low transition or after the  $\overline{\text{SWE}}$  transition, outputs remain in a high impedance state.
  5. Q (data out) is the same phase with the write data of this write cycle.
  6. Q (data out) is the read data of the next address.
  7. Transition is measured + 200 mV from steady state. This parameter is sampled and not 100% tested.
  8.  $\overline{\text{SCS1}}$  in high for the standby, low for active.  $\overline{\text{SCS2}}$  in low for the standby, high for active.  $\overline{\text{SUB}}$  and  $\overline{\text{SLB}}$  in high for the standby, low for active.

## Data Retention Electric Characteristic

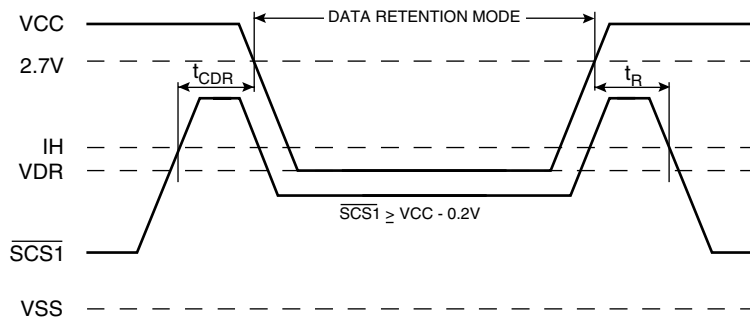
$T_A = -40^\circ\text{C}$  to  $85^\circ\text{C}$

Symbol	Parameter	Test Condition	Min	Typ <sup>(1)</sup>	Max	Unit
$V_{DR}$	$V_{CC}$ for Data Retention	$\overline{SCS1} > V_{CC} - 0.2\text{V}$ or $SCS2 < V_{SS} + 0.2\text{V}$ or $\overline{SUB}, \overline{SLB} > V_{CC} - 0.2\text{V}$ $V_{IN} > V_{CC} - 0.2\text{V}$ or $V_{IN} < V_{SS} + 0.2\text{V}$	1.2		3.3	V
$I_{CCDR}$	Data Retention Current	$V_{CC}=1.5\text{V}$ , $\overline{SCS1} > V_{CC} - 0.2\text{V}$ or $SCS2 < V_{SS} + 0.2\text{V}$ or $\overline{SUB}, \overline{SLB} > V_{CC} - 0.2\text{V}$ $V_{IN} > V_{CC} - 0.2\text{V}$ or $V_{IN} < V_{SS} + 0.2\text{V}$	SL	0.1	2	$\mu\text{A}$
			LL	0.1	10	$\mu\text{A}$
$t_{CDR}$	Chip Deselect to Data Retention Time	See Data Retention Timing Diagram	0			ns
$t_R$	Operating Recovery Time		$t_{RC}^{(2)}$			ns

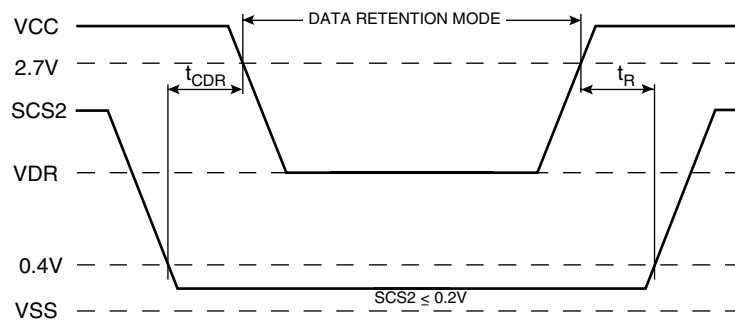
Note: 1. Typical values are under the condition of  $T_A = 25^\circ\text{C}$ . Typical values are sampled and not 100% tested.

2.  $t_{RC}$  is read cycle time.

### Data Retention Timing Diagram 1



### Data Retention Timing Diagram 2



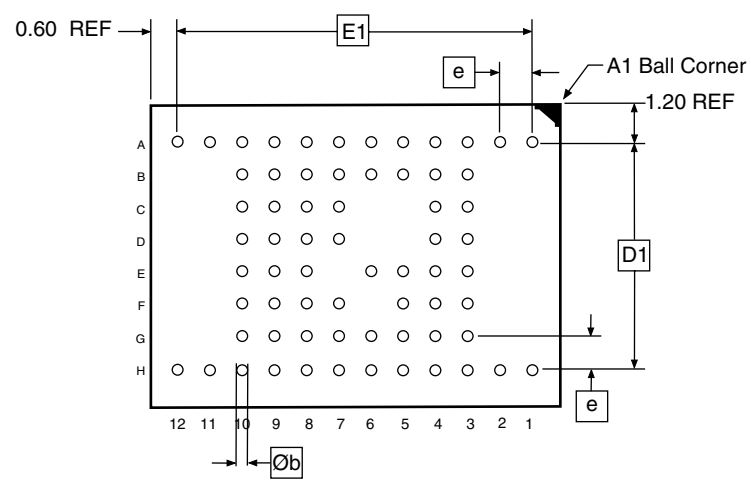
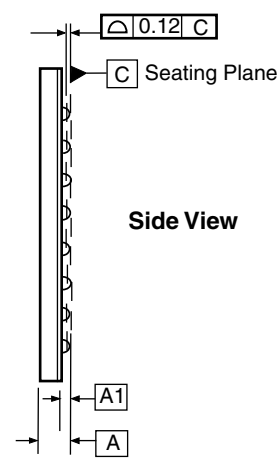
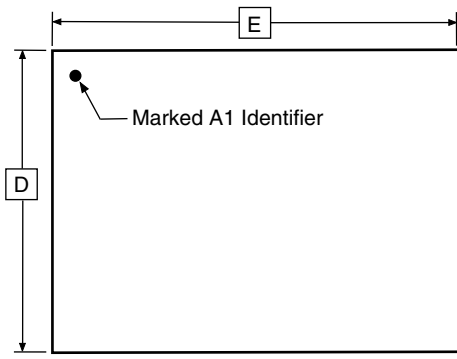
## Ordering Information

$t_{ACC}$ (ns)	Voltage Range	Ordering Code	Package	Operation Range
85	2.7V - 3.3V	AT52BR1672(T)-85CI	66C5	Industrial (-40° to 85°C)
85	2.7V - 3.3V	AT52BR1674(T)-85CI	66C5	Industrial (-40° to 85°C)
85	2.7V - 3.3V	AT52BR1672-85CI	66C5	Industrial (-40° to 85°C)
85	2.7V - 3.3V	AT52BR1674-85CI	66C5	Industrial (-40° to 85°C)

Package Type	
66C5	66-ball, Plastic Chip-scale Ball Grid Array Package (CBGA)

# Package Drawing

## 66C5 – CBGA



**COMMON DIMENSIONS**  
(Unit of Measure = mm)

SYMBOL	MIN	NOM	MAX	NOTE
E	9.90	10.00	10.10	
E1	–	8.80	–	
D	7.90	8.00	8.10	
D1	–	5.60	–	
A	–	–	1.20	
A1	0.25	–	–	
e	0.80 BSC			
Øb	–	0.40	–	

09/19/01

2325 Orchard Parkway San Jose, CA 95131	<b>TITLE</b>	<b>DRAWING NO.</b>	<b>REV.</b>
	<b>66C5</b> , 66-ball (12 x 8 Array), 10 x 8 x 1.2 mm Body, 0.8 mm Ball Pitch Chip-scale Ball Grid Array Package (CBGA)	66C5	A



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