

# 4-Mbit (128 K × 36) Flow-Through SRAM with NoBL™ Architecture

## Features

- Can support up to 133-MHz bus operations with zero wait states
  - Data is transferred on every clock
- Pin compatible and functionally equivalent to ZBT™ devices
- Internally self-timed output buffer control to eliminate the need to use  $\overline{OE}$
- Registered inputs for flow-through operation
- Byte write capability
- 128 K × 36 common I/O architecture
- 2.5 V/3.3 V I/O power supply ( $V_{DDQ}$ )
- Fast clock-to-output times
  - 6.5 ns (for 133-MHz device)
- Clock enable ( $\overline{CEN}$ ) pin to suspend operation
- Synchronous self-timed writes
- Asynchronous output enable
- Available in Pb-free 100-pin TQFP package
- Burst capability – linear or interleaved burst order
- Low standby power

## Functional Description

The CY7C1351G is a 3.3 V, 128 K × 36 synchronous flow-through burst SRAM designed specifically to support unlimited true back-to-back read/write operations without the insertion of wait states. The CY7C1351G is equipped with the advanced No Bus Latency™ (NoBL™) logic required to enable consecutive Read/Write operations with data being transferred on every clock cycle. This feature dramatically improves the throughput of data through the SRAM, especially in systems that require frequent write-read transitions.

All synchronous inputs pass through input registers controlled by the rising edge of the clock. The clock input is qualified by the clock enable ( $\overline{CEN}$ ) signal, which when deasserted suspends operation and extends the previous clock cycle. Maximum access delay from the clock rise is 6.5 ns (133-MHz device).

Write operations are controlled by the four byte write select ( $BW_{[A:D]}$ ) and a write enable ( $\overline{WE}$ ) input. All writes are conducted with on-chip synchronous self-timed write circuitry.

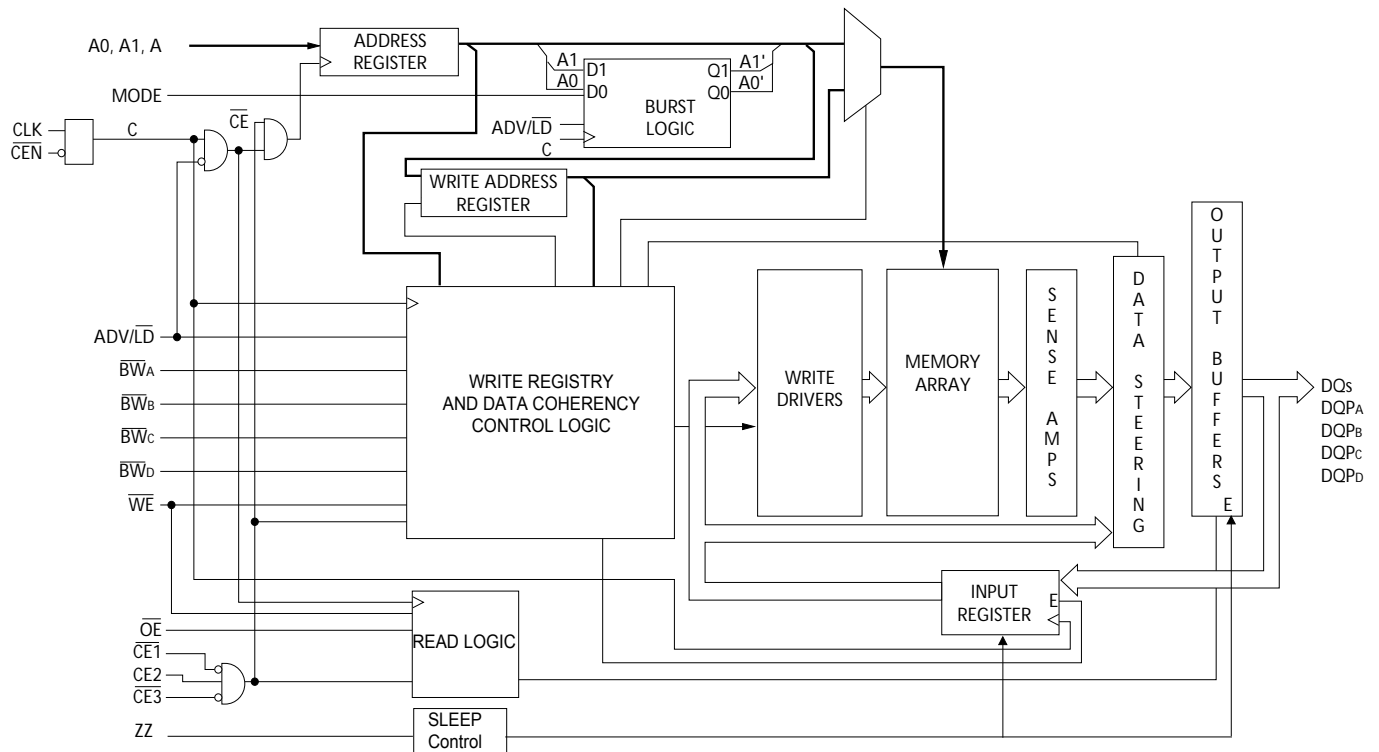
Three synchronous chip enables ( $\overline{CE}_1$ ,  $\overline{CE}_2$ ,  $\overline{CE}_3$ ) and an asynchronous output enable ( $\overline{OE}$ ) provide for easy bank selection and output tristate control. In order to avoid bus contention, the output drivers are synchronously tristated during the data portion of a write sequence.

## Selection Guide

| Description                  | 133 MHz | 100 MHz | Unit |
|------------------------------|---------|---------|------|
| Maximum access time          | 6.5     | 8.0     | ns   |
| Maximum operating current    | 225     | 205     | mA   |
| Maximum CMOS standby current | 40      | 40      | mA   |

**Errata:** For information on silicon errata, see "Errata" on page 19. Details include trigger conditions, devices affected, and proposed workaround.

## Logic Block Diagram

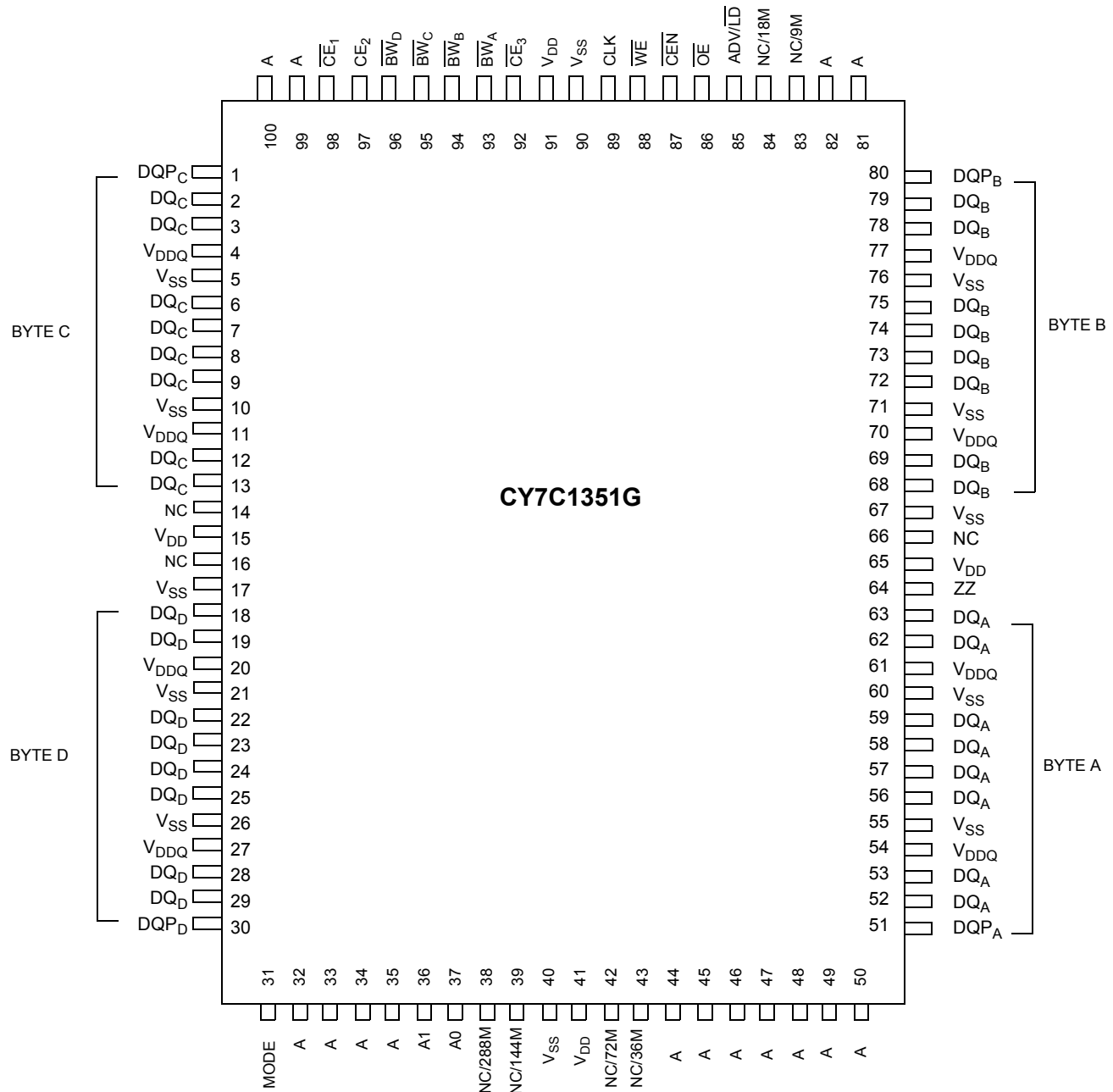


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## Pin Configurations

Figure 1. 100-pin TQFP (14 × 20 × 1.4 mm) pinout <sup>[1]</sup>



**Note**

1. **Errata:** The ZZ pin (Pin 64) needs to be externally connected to ground. For more information, see "Errata" on page 19.

## Pin Definitions

| Name                                | I/O                | Description  |
|-------------------------------------|--------------------|--|
| A <sub>0</sub> , A <sub>1</sub> , A | Input-synchronous  | <b>Address inputs used to select one of the 128 K address locations.</b> Sampled at the rising edge of the CLK. A <sub>[1:0]</sub> are fed to the two-bit burst counter.   |
| BW <sub>[A:D]</sub>                 | Input-synchronous  | <b>Byte write inputs, active LOW.</b> Qualified with $\overline{WE}$ to conduct writes to the SRAM. Sampled on the rising edge of CLK.   |
| $\overline{WE}$                     | Input-synchronous  | <b>Write enable input, active LOW.</b> Sampled on the rising edge of CLK if $\overline{CEN}$ is active LOW. This signal must be asserted LOW to initiate a write sequence.   |
| ADV/LD                              | Input-synchronous  | <b>Advance/load input.</b> Used to advance the on-chip address counter or load a new address. When HIGH (and $\overline{CEN}$ is asserted LOW) the internal burst counter is advanced. When LOW, a new address can be loaded into the device for an access. After being deselected, ADV/LD should be driven LOW in order to load a new address.  |
| CLK                                 | Input-clock        | <b>Clock input.</b> Used to capture all synchronous inputs to the device. CLK is qualified with $\overline{CEN}$ . CLK is only recognized if $\overline{CEN}$ is active LOW.   |
| $\overline{CE}_1$                   | Input-synchronous  | <b>Chip enable 1 input, active LOW.</b> Sampled on the rising edge of CLK. Used in conjunction with $\overline{CE}_2$ and $\overline{CE}_3$ to select/deselect the device.   |
| $\overline{CE}_2$                   | Input-synchronous  | <b>Chip enable 2 input, active HIGH.</b> Sampled on the rising edge of CLK. Used in conjunction with $\overline{CE}_1$ and $\overline{CE}_3$ to select/deselect the device.  |
| $\overline{CE}_3$                   | Input-synchronous  | <b>Chip enable 3 input, active LOW.</b> Sampled on the rising edge of CLK. Used in conjunction with $\overline{CE}_1$ and $\overline{CE}_2$ to select/deselect the device.   |
| $\overline{OE}$                     | Input-asynchronous | <b>Output enable, asynchronous input, active LOW.</b> Combined with the synchronous logic block inside the device to control the direction of the I/O pins. When LOW, the I/O pins are allowed to behave as outputs. When deasserted HIGH, I/O pins are tristated, and act as input data pins. $\overline{OE}$ is masked during the data portion of a write sequence, during the first clock when emerging from a deselected state, when the device has been deselected. |
| $\overline{CEN}$                    | Input-synchronous  | <b>Clock enable input, active LOW.</b> When asserted LOW the clock signal is recognized by the SRAM. When deasserted HIGH the clock signal is masked. Since deasserting $\overline{CEN}$ does not deselect the device, $\overline{CEN}$ can be used to extend the previous cycle when required.  |
| ZZ <sup>[2]</sup>                   | Input-asynchronous | <b>ZZ “sleep” input.</b> This active HIGH input places the device in a non-time critical “sleep” condition with data integrity preserved. During normal operation, this pin has to be low or left floating. ZZ pin has an internal pull-down.  |

### Note

2. **Errata:** The ZZ pin (Pin 64) needs to be externally connected to ground. For more information, see “Errata” on page 19.

**Pin Definitions** (continued)

| Name   | I/O              | Description   |
|--|------------------|---|
| DQ <sub>s</sub>  | I/O-synchronous  | <b>Bidirectional data I/O lines.</b> As inputs, they feed into an on-chip data register that is triggered by the rising edge of CLK. As outputs, they deliver the data contained in the memory location specified by address during the clock rise of the read cycle. The direction of the pins is controlled by OE and the internal control logic. When OE is asserted LOW, the pins can behave as outputs. When HIGH, DQ <sub>s</sub> and DQP <sub>[A:D]</sub> are placed in a tristate condition. The outputs are automatically tristated during the data portion of a write sequence, during the first clock when emerging from a deselected state, and when the device is deselected, regardless of the state of OE. |
| DQP <sub>[A:D]</sub>   | I/O-synchronous  | <b>Bidirectional data parity I/O lines.</b> Functionally, these signals are identical to DQ <sub>s</sub> . During write sequences, DQP <sub>[A:D]</sub> is controlled by BW <sub>[A:D]</sub> correspondingly.   |
| MODE   | Input strap pin  | <b>Mode input. Selects the burst order of the device.</b> When tied to GND selects linear burst sequence. When tied to V <sub>DD</sub> or left floating selects interleaved burst sequence.   |
| V <sub>DD</sub>  | Power supply     | <b>Power supply inputs to the core of the device.</b>   |
| V <sub>DDQ</sub>   | I/O power supply | <b>Power supply for the I/O circuitry.</b>  |
| V <sub>SS</sub>  | Ground           | <b>Ground for the device.</b>   |
| NC   | –                | <b>No connects.</b> Not Internally connected to the die.  |
| NC/9M,<br>NC/18M,<br>NC/36M,<br>NC/72M,<br>NC/144M,<br>NC/288M,<br>NC/576M,<br>NC/1G | –                | <b>No connects.</b> Not internally connected to the die. NC/9M, NC/18M, NC/36M, NC/72M, NC/144M, NC/288M, NC/576M and NC/1G are address expansion pins are not internally connected to the die.   |

## Functional Overview

The CY7C1351G is a synchronous flow-through burst SRAM designed specifically to eliminate wait states during write-read transitions. All synchronous inputs pass through input registers controlled by the rising edge of the clock. The clock signal is qualified with the clock enable input signal (CEN). If CEN is HIGH, the clock signal is not recognized and all internal states are maintained. All synchronous operations are qualified with CEN. Maximum access delay from the clock rise ( $t_{CDV}$ ) is 6.5 ns (133-MHz device).

Accesses can be initiated by asserting all three chip enables ( $\overline{CE}_1$ ,  $\overline{CE}_2$ ,  $\overline{CE}_3$ ) active at the rising edge of the clock. If clock enable (CEN) is active LOW and ADV/LD is asserted LOW, the address presented to the device will be latched. The access can either be a read or write operation, depending on the status of the write enable (WE).  $BW_{[A:D]}$  can be used to conduct byte write operations.

Write operations are qualified by the write enable ( $\overline{WE}$ ). All writes are simplified with on-chip synchronous self-timed write circuitry.

Three synchronous chip enables ( $\overline{CE}_1$ ,  $\overline{CE}_2$ ,  $\overline{CE}_3$ ) and an asynchronous output enable ( $\overline{OE}$ ) simplify depth expansion. All operations (reads, writes, and deselections) are pipelined. ADV/LD should be driven LOW once the device has been deselected in order to load a new address for the next operation.

### Single Read Accesses

A read access is initiated when the following conditions are satisfied at clock rise: (1) CEN is asserted LOW, (2)  $\overline{CE}_1$ ,  $\overline{CE}_2$ , and  $\overline{CE}_3$  are all asserted active, (3) the write enable input signal WE is deasserted HIGH, and (4) ADV/LD is asserted LOW. The address presented to the address inputs is latched into the address register and presented to the memory array and control logic. The control logic determines that a read access is in progress and allows the requested data to propagate to the output buffers. The data is available within 6.5 ns (133-MHz device) provided  $\overline{OE}$  is active LOW. After the first clock of the read access, the output buffers are controlled by  $\overline{OE}$  and the internal control logic.  $\overline{OE}$  must be driven LOW in order for the device to drive out the requested data. On the subsequent clock, another operation (read/write/deselect) can be initiated. When the SRAM is deselected at clock rise by one of the chip enable signals, its output will be tristated immediately.

### Burst Read Accesses

The CY7C1351G has an on-chip burst counter that allows the user the ability to supply a single address and conduct up to four reads without reasserting the address inputs. ADV/LD must be driven LOW in order to load a new address into the SRAM, as described in the [Single Read Accesses](#) section above. The sequence of the burst counter is determined by the MODE input signal. A LOW input on MODE selects a linear burst mode, a HIGH selects an interleaved burst sequence. Both burst counters use A0 and A1 in the burst sequence, and will wrap around when incremented sufficiently. A HIGH input on ADV/LD will increment the internal burst counter regardless of the state of chip enable inputs or WE. WE is latched at the beginning of a burst cycle. Therefore, the type of access (read or write) is maintained throughout the burst sequence.

### Single Write Accesses

Write access are initiated when the following conditions are satisfied at clock rise: (1) CEN is asserted LOW, (2)  $\overline{CE}_1$ ,  $\overline{CE}_2$ , and  $\overline{CE}_3$  are all asserted active, and (3) the write signal WE is asserted LOW. The address presented to the address bus is loaded into the address register. The write signals are latched into the control logic block. The data lines are automatically tristated regardless of the state of the  $\overline{OE}$  input signal. This allows the external logic to present the data on DQs and  $DQP_{[A:D]}$ .

On the next clock rise the data presented to DQs and  $DQP_{[A:D]}$  (or a subset for byte write operations, see truth table for details) inputs is latched into the device and the write is complete. Additional accesses (read/write/deselect) can be initiated on this cycle.

The data written during the write operation is controlled by  $BW_{[A:D]}$  signals. The CY7C1351G provides byte write capability that is described in the truth table. Asserting the write enable input (WE) with the selected byte write select input will selectively write to only the desired bytes. Bytes not selected during a byte write operation will remain unaltered. A synchronous self-timed write mechanism has been provided to simplify the write operations. Byte write capability has been included in order to greatly simplify read/modify/write sequences, which can be reduced to simple byte write operations.

Because the CY7C1351G is a common I/O device, data should not be driven into the device while the outputs are active. The output enable ( $\overline{OE}$ ) can be deasserted HIGH before presenting data to the DQs and  $DQP_{[A:D]}$  inputs. Doing so will tristate the output drivers. As a safety precaution, DQs and  $DQP_{[A:D]}$  are automatically tristated during the data portion of a write cycle, regardless of the state of  $\overline{OE}$ .

### Burst Write Accesses

The CY7C1351G has an on-chip burst counter that allows the user the ability to supply a single address and conduct up to four Write operations without reasserting the address inputs. ADV/LD must be driven LOW in order to load the initial address, as described in the [Single Write Accesses](#) section above. When ADV/LD is driven HIGH on the subsequent clock rise, the chip enables ( $\overline{CE}_1$ ,  $\overline{CE}_2$ , and  $\overline{CE}_3$ ) and WE inputs are ignored and the burst counter is incremented. The correct  $BW_{[A:D]}$  inputs must be driven in each cycle of the burst write, in order to write the correct bytes of data.

### Sleep Mode

The ZZ input pin is an asynchronous input. Asserting ZZ places the SRAM in a power conservation "sleep" mode. Two clock cycles are required to enter into or exit from this "sleep" mode. While in this mode, data integrity is guaranteed. Accesses pending when entering the "sleep" mode are not considered valid nor is the completion of the operation guaranteed. The device must be deselected prior to entering the "sleep" mode.  $\overline{CE}_1$ ,  $\overline{CE}_2$ , and  $\overline{CE}_3$ , must remain inactive for the duration of  $t_{ZZREC}$  after the ZZ input returns LOW.

**Linear Burst Address Table**

(MODE = GND)

| First Address<br>A1:A0 | Second Address<br>A1:A0 | Third Address<br>A1:A0 | Fourth Address<br>A1:A0 |
|------------------------|-------------------------|------------------------|-------------------------|
| 00                     | 01                      | 10                     | 11                      |
| 01                     | 10                      | 11                     | 00                      |
| 10                     | 11                      | 00                     | 01                      |
| 11                     | 00                      | 01                     | 10                      |

**Interleaved Burst Address Table**

(MODE = Floating or  $V_{DD}$ )

| First Address<br>A1:A0 | Second Address<br>A1:A0 | Third Address<br>A1:A0 | Fourth Address<br>A1:A0 |
|------------------------|-------------------------|------------------------|-------------------------|
| 00                     | 01                      | 10                     | 11                      |
| 01                     | 00                      | 11                     | 10                      |
| 10                     | 11                      | 00                     | 01                      |
| 11                     | 10                      | 01                     | 00                      |

**ZZ Mode Electrical Characteristics**

| Parameter   | Description                       | Test Conditions                  | Min        | Max        | Unit |
|-------------|-----------------------------------|----------------------------------|------------|------------|------|
| $I_{DDZZ}$  | Sleep mode standby current        | $ZZ \geq V_{DD} - 0.2 \text{ V}$ | –          | 40         | mA   |
| $t_{ZZS}$   | Device operation to ZZ            | $ZZ \geq V_{DD} - 0.2 \text{ V}$ | –          | $2t_{CYC}$ | ns   |
| $t_{ZZREC}$ | ZZ recovery time                  | $ZZ \leq 0.2 \text{ V}$          | $2t_{CYC}$ | –          | ns   |
| $t_{ZZI}$   | ZZ active to sleep current        | This parameter is sampled        | –          | $2t_{CYC}$ | ns   |
| $t_{RZZI}$  | ZZ inactive to exit sleep current | This parameter is sampled        | 0          | –          | ns   |



## Truth Table

The truth table for CY7C1351G follows. [3, 4, 5, 6, 7, 8, 9]

| Operation                     | Address Used | CE <sub>1</sub> | CE <sub>2</sub> | CE <sub>3</sub> | ZZ | ADV/LD | WE | BW <sub>X</sub> | OE | CEN | CLK  | DQ           |
|-------------------------------|--------------|-----------------|-----------------|-----------------|----|--------|----|-----------------|----|-----|------|--------------|
| Deselect cycle                | None         | H               | X               | X               | L  | L      | X  | X               | X  | L   | L->H | Tristate     |
| Deselect cycle                | None         | X               | X               | H               | L  | L      | X  | X               | X  | L   | L->H | Tristate     |
| Deselect cycle                | None         | X               | L               | X               | L  | L      | X  | X               | X  | L   | L->H | Tristate     |
| Continue deselect cycle       | None         | X               | X               | X               | L  | H      | X  | X               | X  | L   | L->H | Tristate     |
| READ cycle (begin burst)      | External     | L               | H               | L               | L  | L      | H  | X               | L  | L   | L->H | Data out (Q) |
| READ cycle (continue burst)   | Next         | X               | X               | X               | L  | H      | X  | X               | L  | L   | L->H | Data out (Q) |
| NOP/DUMMY READ (begin burst)  | External     | L               | H               | L               | L  | L      | H  | X               | H  | L   | L->H | Tristate     |
| DUMMY READ (continue burst)   | Next         | X               | X               | X               | L  | H      | X  | X               | H  | L   | L->H | Tristate     |
| WRITE cycle (begin burst)     | External     | L               | H               | L               | L  | L      | L  | L               | X  | L   | L->H | Data in (D)  |
| WRITE cycle (continue burst)  | Next         | X               | X               | X               | L  | H      | X  | L               | X  | L   | L->H | Data in (D)  |
| NOP/WRITE ABORT (begin burst) | None         | L               | H               | L               | L  | L      | L  | H               | X  | L   | L->H | Tristate     |
| WRITE ABORT (continue burst)  | Next         | X               | X               | X               | L  | H      | X  | H               | X  | L   | L->H | Tristate     |
| IGNORE CLOCK EDGE (stall)     | Current      | X               | X               | X               | L  | X      | X  | X               | X  | H   | L->H | –            |
| SLEEP MODE                    | None         | X               | X               | X               | H  | X      | X  | X               | X  | X   | X    | Tristate     |

## Partial Truth Table for Read/Write

The Partial Truth Table for Read/Write for CY7C1351G follows. [3, 4, 10]

| Function   | $\overline{WE}$ | $\overline{BW}_A$ | $\overline{BW}_B$ | $\overline{BW}_C$ | $\overline{BW}_D$ |
|--|-----------------|-------------------|-------------------|-------------------|-------------------|
| Read   | H               | X                 | X                 | X                 | X                 |
| Read   | H               | X                 | X                 | X                 | X                 |
| Write – no bytes written                               | L               | H                 | H                 | H                 | H                 |
| Write byte A – (DQ <sub>A</sub> and DQP <sub>A</sub> ) | L               | L                 | H                 | H                 | H                 |
| Write byte B – (DQ <sub>B</sub> and DQP <sub>B</sub> ) | L               | H                 | L                 | H                 | H                 |
| Write byte C – (DQ <sub>C</sub> and DQP <sub>C</sub> ) | L               | H                 | H                 | L                 | H                 |
| Write byte D – (DQ <sub>D</sub> and DQP <sub>D</sub> ) | L               | H                 | H                 | H                 | L                 |
| Write all bytes  | L               | L                 | L                 | L                 | L                 |

### Notes

- X = "Don't Care." H = Logic HIGH, L = Logic LOW.  $\overline{BW}_X$  = L signifies at least one byte write select is active,  $\overline{BW}_X$  = valid signifies that the desired byte write selects are asserted, see truth table for details.
- Write is defined by  $\overline{BW}_X$  and WE. See truth table for read/write.
- When a write cycle is detected, all I/Os are tristated, even during byte writes.
- The DQs and DQP<sub>[A:D]</sub> pins are controlled by the current cycle and the OE signal. OE is asynchronous and is not sampled with the clock.
- CEN = H, inserts wait states.
- Device will power-up deselected and the I/Os in a tristate condition, regardless of OE.
- OE is asynchronous and is not sampled with the clock rise. It is masked internally during write cycles. During a read cycle DQs and DQP<sub>[A:D]</sub> = tristate when OE is inactive or when the device is deselected, and DQs and DQP<sub>[A:D]</sub> = data when OE is active.
- Table only lists a partial listing of the byte write combinations. Any combination of  $\overline{BW}_X$  is valid. Appropriate write will be done based on which byte write is active.

## Maximum Ratings

Exceeding maximum ratings may shorten the useful life of the device. User guidelines are not tested.

Storage temperature ..... -65 °C to +150 °C

Ambient temperature with power applied ..... -55 °C to +125 °C

Supply voltage on  $V_{DD}$  relative to GND ..... -0.5 V to +4.6 V

Supply voltage on  $V_{DDQ}$  relative to GND ..... -0.5 V to + $V_{DD}$

DC voltage applied to outputs in tristate ..... -0.5 V to  $V_{DDQ} + 0.5 V$

DC input voltage ..... -0.5 V to  $V_{DD} + 0.5 V$

Current into outputs (LOW) ..... 20 mA

Static discharge voltage (per MIL-STD-883, method 3015) ..... > 2001 V

Latch up current ..... > 200 mA

## Operating Range

| Range      | Ambient Temperature ( $T_A$ ) | $V_{DD}$           | $V_{DDQ}$              |
|------------|-------------------------------|--------------------|------------------------|
| Commercial | 0 °C to +70 °C                | 3.3 V – 5% / + 10% | 2.5 V – 5% to $V_{DD}$ |

## Electrical Characteristics

Over the Operating Range

| Parameter <sup>[11, 12]</sup> | Description                                   | Test Conditions  | Min   | Max            | Unit    |
|-------------------------------|---|--|-------|----------------|---------|
| $V_{DD}$                      | Power supply voltage                          |  | 3.135 | 3.6            | V       |
| $V_{DDQ}$                     | I/O supply voltage                            | For 3.3 V I/O  | 3.135 | $V_{DD}$       | V       |
|                               |   | For 2.5 V I/O  | 2.375 | 2.625          | V       |
| $V_{OH}$                      | Output HIGH voltage                           | For 3.3 V I/O, $I_{OH} = -4.0$ mA  | 2.4   | –              | V       |
|                               |   | For 2.5 V I/O, $I_{OH} = -1.0$ mA  | 2.0   | –              | V       |
| $V_{OL}$                      | Output LOW voltage                            | For 3.3 V I/O, $I_{OL} = 8.0$ mA   | –     | 0.4            | V       |
|                               |   | For 2.5 V I/O, $I_{OL} = 1.0$ mA   | –     | 0.4            | V       |
| $V_{IH}$                      | Input HIGH voltage                            | For 3.3 V I/O  | 2.0   | $V_{DD} + 0.3$ | V       |
|                               |   | For 2.5 V I/O  | 1.7   | $V_{DD} + 0.3$ | V       |
| $V_{IL}$                      | Input LOW voltage <sup>[11]</sup>             | For 3.3 V I/O  | –0.3  | 0.8            | V       |
|                               |   | For 2.5 V I/O  | –0.3  | 0.7            | V       |
| $I_X$                         | Input leakage current except ZZ and MODE      | $GND \leq V_I \leq V_{DDQ}$  | –5    | 5              | $\mu A$ |
|                               | Input current of MODE                         | Input = $V_{SS}$   | –30   | –              | $\mu A$ |
|                               |   | Input = $V_{DD}$   | –     | 5              | $\mu A$ |
|                               | Input current of ZZ                           | Input = $V_{SS}$   | –5    | –              | $\mu A$ |
|                               |   | Input = $V_{DD}$   | –     | 30             | $\mu A$ |
| $I_{OZ}$                      | Output leakage current                        | $GND \leq V_I \leq V_{DDQ}$ , output disabled  | –5    | 5              | $\mu A$ |
| $I_{DD}$                      | $V_{DD}$ operating supply current             | $V_{DD} = \text{Max}$ , $I_{OUT} = 0$ mA, $f = f_{MAX} = 1/t_{CYC}$  | –     | 225            | mA      |
|                               |   |  | –     | 205            | mA      |
| $I_{SB1}$                     | Automatic CE power-down current – TTL inputs  | $V_{DD} = \text{Max}$ , device deselected, $V_{IN} \geq V_{IH}$ or $V_{IN} \leq V_{IL}$ , $f = f_{MAX}$ , inputs switching | –     | 90             | mA      |
|                               |   |  | –     | 80             | mA      |
| $I_{SB2}$                     | Automatic CE power-down current – CMOS inputs | $V_{DD} = \text{Max}$ , device deselected, $V_{IN} \geq V_{DD} - 0.3$ V or $V_{IN} \leq 0.3$ V, $f = 0$ , inputs static    | –     | 40             | mA      |

### Notes

11. Overshoot:  $V_{IH(AC)} < V_{DD} + 1.5$  V (Pulse width less than  $t_{CYC}/2$ ), undershoot:  $V_{IL(AC)} > -2$  V (Pulse width less than  $t_{CYC}/2$ ).

12.  $T_{Power-up}$ : Assumes a linear ramp from 0 V to  $V_{DD(min)}$  within 200 ms. During this time  $V_{IH} < V_{DD}$  and  $V_{DDQ} \leq V_{DD}$ .

## Electrical Characteristics *(continued)*

Over the Operating Range

| Parameter <sup>[11, 12]</sup> | Description                                   | Test Conditions  |                       | Min | Max | Unit |
|-------------------------------|---|--|-----------------------|-----|-----|------|
| I <sub>SB3</sub>              | Automatic CE power-down current – CMOS inputs | V <sub>DD</sub> = Max, device deselected, V <sub>IN</sub> ≥ V <sub>DDQ</sub> – 0.3 V or V <sub>IN</sub> ≤ 0.3 V, f = f <sub>MAX</sub> , inputs switching | 7.5-ns cycle, 133 MHz | –   | 75  | mA   |
|                               |   |  | 10-ns cycle, 100 MHz  | –   | 65  | mA   |
| I <sub>SB4</sub>              | Automatic CE power-down current – TTL inputs  | V <sub>DD</sub> = Max, device deselected, V <sub>IN</sub> ≥ V <sub>IH</sub> or V <sub>IN</sub> ≤ V <sub>IL</sub> , f = 0, inputs static                  | All speeds            | –   | 45  | mA   |

## Capacitance

| Parameter <sup>[13]</sup> | Description             | Test Conditions  | 100-pin TQFP Max | Unit |
|---------------------------|-------------------------|--|------------------|------|
| $C_{IN}$                  | Input capacitance       | $T_A = 25^\circ\text{C}$ , $f = 1 \text{ MHz}$ ,<br>$V_{DD} = 3.3 \text{ V}$ , $V_{DDQ} = 3.3 \text{ V}$ | 5                | pF   |
| $C_{CLOCK}$               | Clock input capacitance |  | 5                | pF   |
| $C_{I/O}$                 | I/O capacitance         |  | 5                | pF   |

## Thermal Resistance

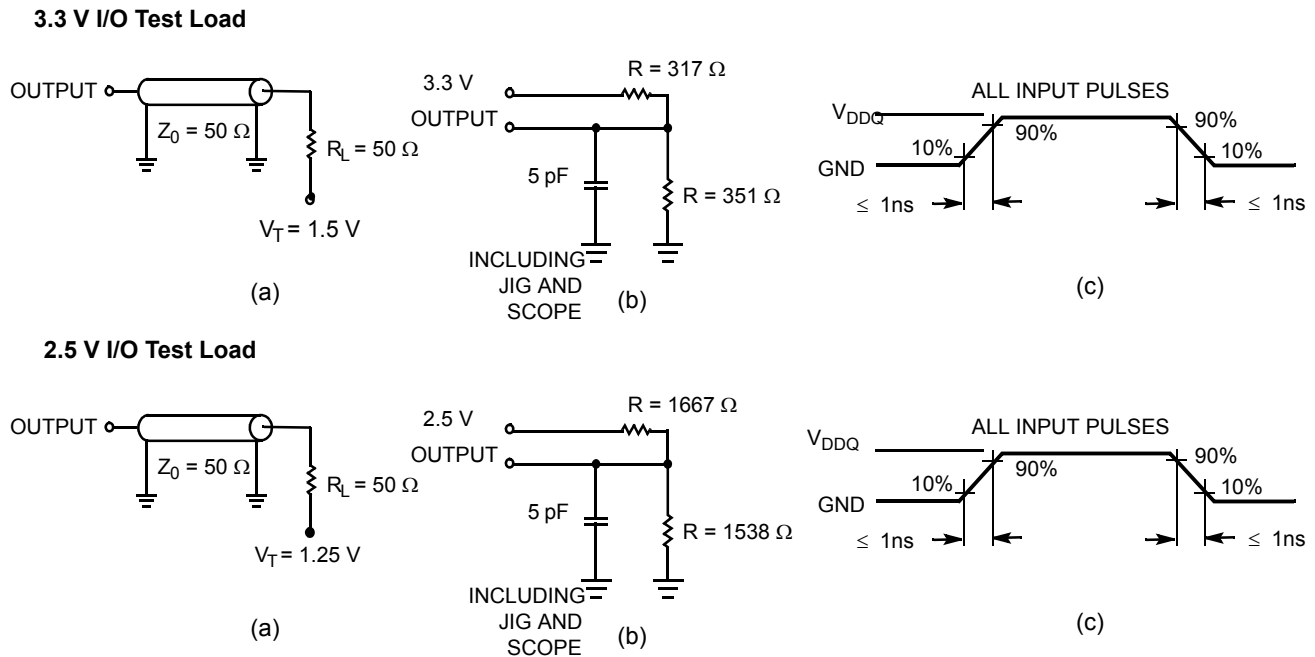
| Parameter <sup>[13]</sup> | Description                              | Test Conditions  | 100-pin TQFP Package | Unit               |
|---------------------------|--|--|----------------------|--------------------|
| $\Theta_{JA}$             | Thermal resistance (junction to ambient) | Test conditions follow standard test methods and procedures for measuring thermal impedance, per EIA/JESD51. | 30.32                | $^\circ\text{C/W}$ |
| $\Theta_{JC}$             | Thermal resistance (junction to case)    |  | 6.85                 | $^\circ\text{C/W}$ |

### Note

13. Tested initially and after any design or process changes that may affect these parameters.

## AC Test Loads and Waveforms

Figure 2. AC Test Loads and Waveforms



## Switching Characteristics

Over the Operating Range

| Parameter <sup>[14, 15]</sup> | Description   | -133 |     | -100 |     | Unit |
|-------------------------------|---|------|-----|------|-----|------|
|                               |   | Min  | Max | Min  | Max |      |
| $t_{POWER}$                   | $V_{DD}$ (typical) to the first access <sup>[16]</sup>        | 1    | –   | 1    | –   | ms   |
| <b>Clock</b>                  |   |      |     |      |     |      |
| $t_{CYC}$                     | Clock cycle time  | 7.5  | –   | 10   | –   | ns   |
| $t_{CH}$                      | Clock HIGH  | 2.5  | –   | 4.0  | –   | ns   |
| $t_{CL}$                      | Clock LOW   | 2.5  | –   | 4.0  | –   | ns   |
| <b>Output Times</b>           |   |      |     |      |     |      |
| $t_{CDV}$                     | Data output valid after CLK rise                              | –    | 6.5 | –    | 8.0 | ns   |
| $t_{DOH}$                     | Data output hold after CLK rise                               | 2.0  | –   | 2.0  | –   | ns   |
| $t_{CLZ}$                     | Clock to low Z <sup>[17, 18, 19]</sup>                        | 0    | –   | 0    | –   | ns   |
| $t_{CHZ}$                     | Clock to high Z <sup>[17, 18, 19]</sup>                       | –    | 3.5 | –    | 3.5 | ns   |
| $t_{OE\overline{V}}$          | $\overline{OE}$ LOW to output valid                           | –    | 3.5 | –    | 3.5 | ns   |
| $t_{OELZ}$                    | $\overline{OE}$ LOW to output low Z <sup>[17, 18, 19]</sup>   | 0    | –   | 0    | –   | ns   |
| $t_{OE\overline{H}Z}$         | $\overline{OE}$ HIGH to output high Z <sup>[17, 18, 19]</sup> | –    | 3.5 | –    | 3.5 | ns   |
| <b>Set-up Times</b>           |   |      |     |      |     |      |
| $t_{AS}$                      | Address set-up before CLK rise                                | 1.5  | –   | 2.0  | –   | ns   |
| $t_{ALS}$                     | ADV/ $\overline{LD}$ set-up before CLK rise                   | 1.5  | –   | 2.0  | –   | ns   |
| $t_{WES}$                     | $\overline{WE}$ , $\overline{BW}_X$ set-up before CLK rise    | 1.5  | –   | 2.0  | –   | ns   |
| $t_{CENS}$                    | $\overline{CEN}$ set-up before CLK rise                       | 1.5  | –   | 2.0  | –   | ns   |
| $t_{DS}$                      | Data input set-up before CLK rise                             | 1.5  | –   | 2.0  | –   | ns   |
| $t_{CES}$                     | Chip enable set-up before CLK rise                            | 1.5  | –   | 2.0  | –   | ns   |
| <b>Hold Times</b>             |   |      |     |      |     |      |
| $t_{AH}$                      | Address hold after CLK rise                                   | 0.5  | –   | 0.5  | –   | ns   |
| $t_{ALH}$                     | ADV/ $\overline{LD}$ hold after CLK rise                      | 0.5  | –   | 0.5  | –   | ns   |
| $t_{WEH}$                     | $\overline{WE}$ , $\overline{BW}_X$ hold after CLK rise       | 0.5  | –   | 0.5  | –   | ns   |
| $t_{CENH}$                    | $\overline{CEN}$ hold after CLK rise                          | 0.5  | –   | 0.5  | –   | ns   |
| $t_{DH}$                      | Data input hold after CLK rise                                | 0.5  | –   | 0.5  | –   | ns   |
| $t_{CEH}$                     | Chip enable hold after CLK rise                               | 0.5  | –   | 0.5  | –   | ns   |

### Notes

14. Timing reference level is 1.5 V when  $V_{DDQ} = 3.3$  V and is 1.25 V when  $V_{DDQ} = 2.5$  V.

15. Test conditions shown in (a) of [Figure 2 on page 12](#), unless otherwise noted.

16. This part has a voltage regulator internally;  $t_{POWER}$  is the time that the power needs to be supplied above  $V_{DD(minimum)}$  initially before a read or write operation can be initiated.

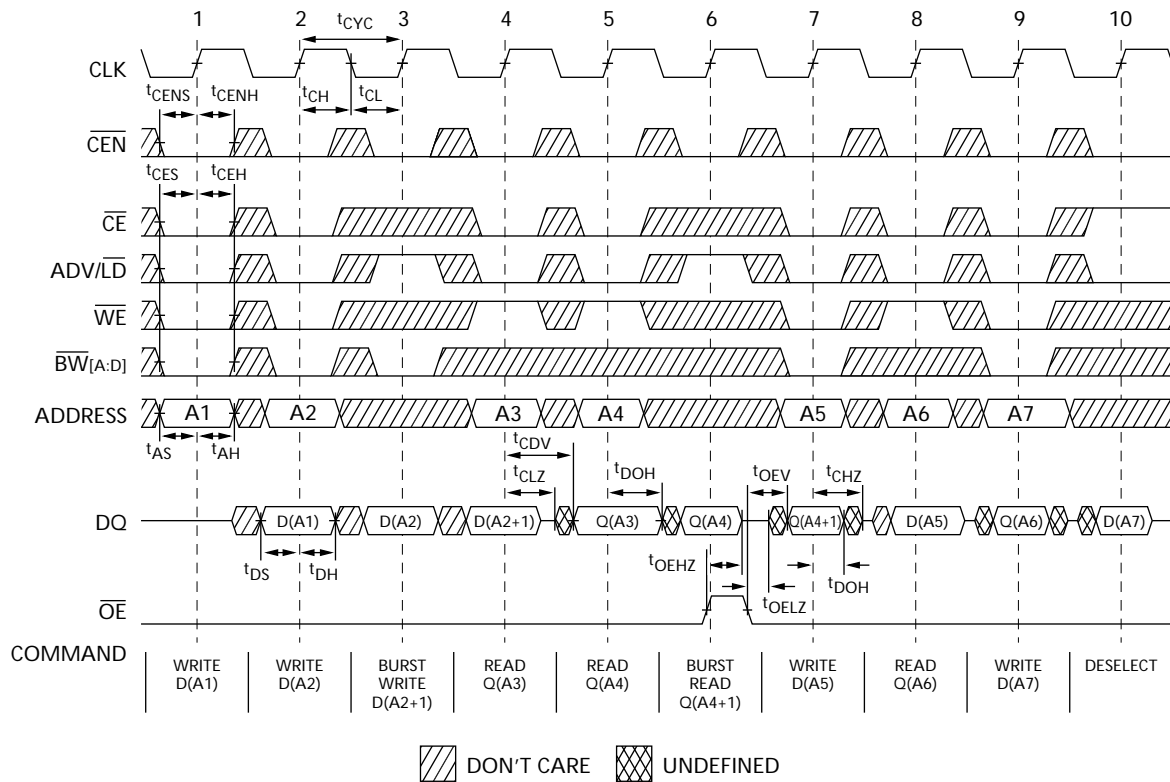
17.  $t_{CHZ}$ ,  $t_{CLZ}$ ,  $t_{OELZ}$ , and  $t_{OE\overline{H}Z}$  are specified with AC test conditions shown in part (b) of [Figure 2 on page 12](#). Transition is measured  $\pm 200$  mV from steady-state voltage.

18. At any given voltage and temperature,  $t_{OE\overline{H}Z}$  is less than  $t_{OELZ}$  and  $t_{CHZ}$  is less than  $t_{CLZ}$  to eliminate bus contention between SRAMs when sharing the same data bus. These specifications do not imply a bus contention condition, but reflect parameters guaranteed over worst case user conditions. Device is designed to achieve tristate prior to low Z under the same system conditions.

19. This parameter is sampled and not 100% tested.

## Switching Waveforms

Figure 3. Read/Write Waveforms [20, 21, 22]



### Notes

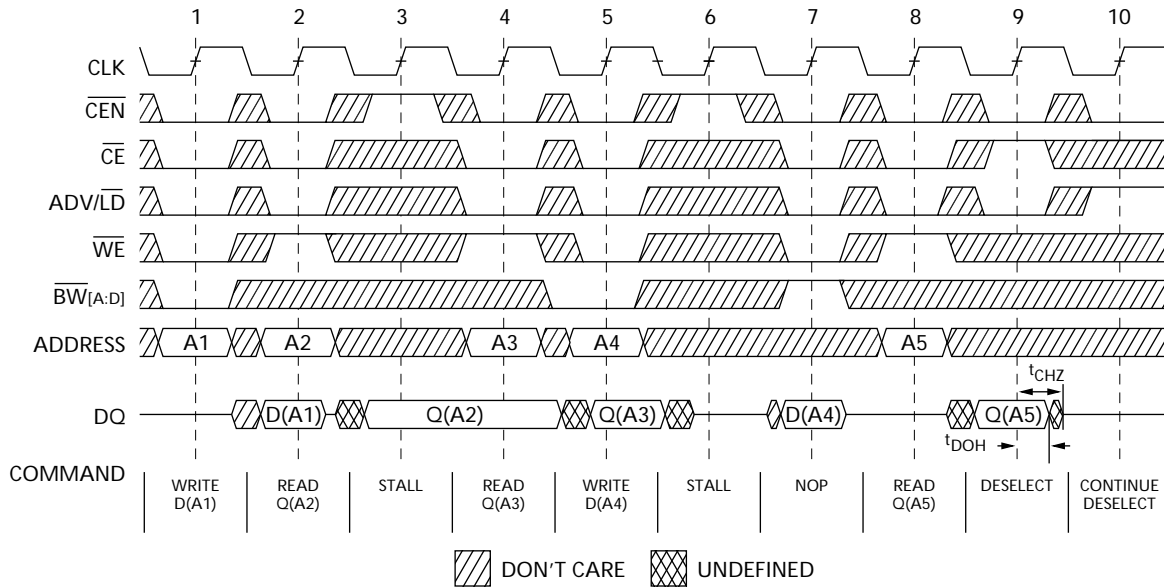
20. For this waveform  $\overline{ZZ}$  is tied LOW.

21. When  $\overline{CE}$  is LOW,  $\overline{CE}_1$  is LOW,  $\overline{CE}_2$  is HIGH and  $\overline{CE}_3$  is LOW. When  $\overline{CE}$  is HIGH,  $\overline{CE}_1$  is HIGH or  $\overline{CE}_2$  is LOW or  $\overline{CE}_3$  is HIGH.

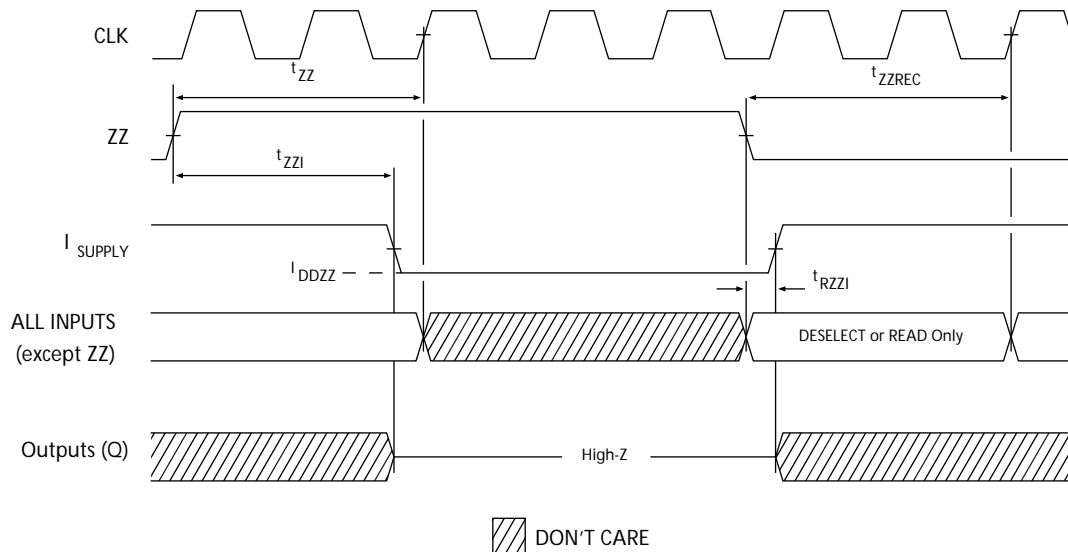
22. Order of the burst sequence is determined by the status of the MODE (0 = Linear, 1 = Interleaved). Burst operations are optional.

## Switching Waveforms (continued)

**Figure 4. NOP, STALL and DESELECT Cycles** [23, 24, 25]



**Figure 5. ZZ Mode Timing** [26, 27]



### Notes

23. For this waveform  $\overline{ZZ}$  is tied LOW.
24. When  $\overline{CE}$  is LOW,  $\overline{CE}_1$  is LOW,  $\overline{CE}_2$  is HIGH and  $\overline{CE}_3$  is LOW. When  $\overline{CE}$  is HIGH,  $\overline{CE}_1$  is HIGH or  $\overline{CE}_2$  is LOW or  $\overline{CE}_3$  is HIGH.
25. The IGNORE CLOCK EDGE or STALL cycle (Clock 3) illustrates  $\overline{CEN}$  being used to create a pause. A write is not performed during this cycle.
26. Device must be deselected when entering ZZ mode. See truth table for all possible signal conditions to deselect the device.
27. DQs are in high Z when exiting ZZ sleep mode.

## Ordering Information

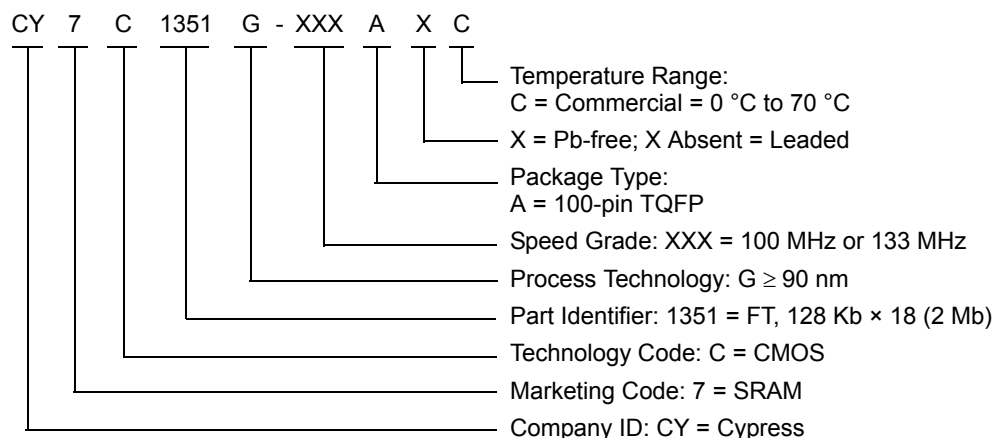
Cypress offers other versions of this type of product in many different configurations and features. The following table contains only the list of parts that are currently available.

For a complete listing of all options, visit the Cypress website at [www.cypress.com](http://www.cypress.com) and refer to the product summary page at <http://www.cypress.com/products> or contact your local sales representative.

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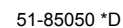
| Speed (MHz) | Ordering Code    | Package Diagram | Part and Package Type                   | Operating Range |
|-------------|------------------|-----------------|---|-----------------|
| 100         | CY7C1351G-100AXC | 51-85050        | 100-pin TQFP (14 × 20 × 1.4 mm) Pb-free | Commercial      |
| 133         | CY7C1351G-133AXC | 51-85050        | 100-pin TQFP (14 × 20 × 1.4 mm) Pb-free |                 |

## Ordering Code Definitions





**Figure 6. 100-pin TQFP (14 × 20 × 1.4 mm) A100RA Package Outline, 51-85050**



## Acronyms

| Acronym                 | Description                                |
|-------------------------|--|
| CMOS                    | Complementary Metal Oxide Semiconductor    |
| $\overline{\text{CE}}$  | Chip Enable                                |
| $\overline{\text{CEN}}$ | Clock Enable                               |
| EIA                     | Electronics Industries Alliance            |
| I/O                     | Input/Output                               |
| JEDEC                   | Joint Electron Devices Engineering Council |
| NoBL                    | No Bus Latency                             |
| $\overline{\text{OE}}$  | Output Enable                              |
| SRAM                    | Static Random Access Memory                |
| TQFP                    | Thin Quad Flat Pack                        |
| TTL                     | Transistor-Transistor Logic                |
| $\overline{\text{WE}}$  | Write Enable                               |

## Document Conventions

### Units of Measure

| Symbol | Unit of Measure |
|--------|-----------------|
| °C     | degree Celsius  |
| MHz    | megahertz       |
| μA     | microampere     |
| mA     | milliampere     |
| mm     | millimeter      |
| ms     | millisecond     |
| ns     | nanosecond      |
| %      | percent         |
| pF     | picofarad       |
| V      | volt            |
| W      | watt            |

## Errata

This section describes the Ram9 NoBL ZZ pin issue. Details include trigger conditions, the devices affected, proposed workaround and silicon revision applicability. Please contact your local Cypress sales representative if you have further questions.

### Part Numbers Affected

| Density & Revision              | Package Type | Operating Range |
|---------------------------------|--------------|-----------------|
| 4Mb-Ram9 NoBL™ SRAMs: CY7C135*G | 100-pin TQFP | Commercial      |

### Product Status

All of the devices in the Ram9 4Mb NoBL family are qualified and available in production quantities.

### Ram9 NoBL ZZ Pin Issues Errata Summary

The following table defines the errata applicable to available Ram9 4Mb NoBL family devices.

| Item | Issues | Description  | Device         | Fix Status   |
|------|--------|--|----------------|--|
| 1.   | ZZ Pin | When asserted HIGH, the ZZ pin places device in a "sleep" condition with data integrity preserved. The ZZ pin currently does not have an internal pull-down resistor and hence cannot be left floating externally by the user during normal mode of operation. | 4M-Ram9 (90nm) | For the 4M Ram9 (90 nm) devices, there is no plan to fix this issue. |

#### 1. ZZ Pin Issue

##### ■ PROBLEM DEFINITION

The problem occurs only when the device is operated in the normal mode with ZZ pin left floating. The ZZ pin on the SRAM device does not have an internal pull-down resistor. Switching noise in the system may cause the SRAM to recognize a HIGH on the ZZ input, which may cause the SRAM to enter sleep mode. This could result in incorrect or undesirable operation of the SRAM.

##### ■ TRIGGER CONDITIONS

Device operated with ZZ pin left floating.

##### ■ SCOPE OF IMPACT

When the ZZ pin is left floating, the device delivers incorrect data.

##### ■ WORKAROUND

Tie the ZZ pin externally to ground.

##### ■ FIX STATUS

For the 4M Ram9 (90 nm) devices, there is no plan to fix this issue.

## Document History Page

| Document Title: CY7C1351G, 4-Mbit (128 K × 36) Flow-Through SRAM with NoBL™ Architecture<br>Document Number: 38-05513 |         |            |                 |   |
|---|---------|------------|-----------------|---|
| Rev.  | ECN No. | Issue Date | Orig. of Change | Description of Change   |
| **  | 224360  | See ECN    | RKF             | New data sheet.   |
| *A  | 276690  | See ECN    | VBL             | Deleted 66 MHz<br>Updated <a href="#">Ordering Information</a> (Changed TQFP package in Ordering Information section to lead-free TQFP, added comment of availability of BG lead-free package).   |
| *B  | 333626  | See ECN    | SYT             | Updated <a href="#">Features</a> (Removed 117 MHz frequency related information).<br>Updated <a href="#">Selection Guide</a> (Removed 117 MHz frequency related information).<br>Updated <a href="#">Pin Configurations</a> (Modified Address Expansion balls in the pinouts for 100-pin TQFP and 119-ball BGA Packages as per JEDEC standards).<br>Updated <a href="#">Pin Definitions</a> .<br>Updated <a href="#">Functional Overview</a> (Updated <a href="#">ZZ Mode Electrical Characteristics</a> (Replaced “Snore” with “Sleep”)).<br>Updated <a href="#">Electrical Characteristics</a> (Updated Test Conditions of $V_{OL}$ , $V_{OH}$ parameters, removed 117 MHz frequency related information).<br>Updated <a href="#">Truth Table</a> (Replaced “Snore” with “Sleep”).<br>Updated <a href="#">Thermal Resistance</a> (Replaced values of $\Theta_{JA}$ and $\Theta_{JC}$ parameters from TBD to respective Thermal Values for all Packages).<br>Updated <a href="#">Switching Characteristics</a> (Removed 117 MHz frequency related information).<br>Updated <a href="#">Ordering Information</a> (By shading and unshading MPNs as per availability, changed the package name for 100-pin TQFP from A100RA to A101).  |
| *C  | 418633  | See ECN    | R XU            | Changed status from Preliminary to Final.<br>Changed address of Cypress Semiconductor Corporation from “3901 North First Street” to “198 Champion Court”.<br>Updated <a href="#">Electrical Characteristics</a> (Updated Note 12 (Modified test condition from $V_{DDQ} < V_{DD}$ to $V_{DDQ} \leq V_{DD}$ ), splitted $V_{DDQ}$ parameter into two rows (one for 3.3 V I/O, another for 2.5 V I/O),<br>Updated Test Conditions of $V_{OL}$ , $V_{OH}$ parameters<br>(Changed Typo in Test Condition of $V_{OH}$ parameter from “for 3.3 V I/O” to “for 3.3 V I/O, $I_{OH} = -4.0$ mA” and from “for 2.5 V I/O” to “for 2.5 V I/O, $I_{OH} = -1.0$ mA”,<br>changed Typo in Test Condition of $V_{OL}$ parameter from “for 3.3 V I/O, $I_{OH} = -4.0$ mA” to “for 3.3 V I/O, $I_{OH} = 8.0$ mA” and from “for 2.5 V I/O, $I_{OH} = -1.0$ mA” to “for 2.5 V I/O, $I_{OH} = 1.0$ mA”),<br>updated Test Conditions of $V_{IH}$ parameter<br>(Changed Typo in Test Condition of $V_{IH}$ parameter from “for 3.3 V I/O, $I_{OH} = 8.0$ mA” to “for 3.3 V I/O” and from “for 2.5 V I/O, $I_{OH} = 1.0$ mA” to “for 2.5 V I/O”),<br>changed “Input Load Current except ZZ and MODE” to “Input Leakage Current except ZZ and MODE”,<br>updated Test Conditions of $I_X$ parameter<br>(Changed Typo in Test Condition of $I_X$ parameter (Corresponding to Input Load Current except ZZ and MODE) from “for 3.3 V” to “ $GND \leq V_I \leq V_{DDQ}$ ”,<br>changed Typo in Test Condition of $I_X$ parameter (Corresponding to Input Current of Mode) from “for 2.5 V I/O and “ $GND \leq V_I \leq V_{DDQ}$ ” to Input = $V_{SS}$ and Input = $V_{DD}$ respectively),<br>updated Test Conditions of $I_{SB4}$ parameter<br>(Changed Typo in Test Condition of $I_{SB4}$ parameter from “ $V_{IN} \geq V_{DDQ} - 0.3$ V or $V_{IN} \leq 0.3$ V” to “ $V_{IN} \geq V_{IH}$ or $V_{IN} \leq V_{IL}$ ”).<br>Updated <a href="#">Ordering Information</a> (Updated part numbers, replaced Package Name column with Package Diagram in the Ordering Information table).<br>Updated <a href="#">Package Diagrams</a> (spec 51-85050 (changed revision from *A to *B)). |

**Document History Page** *(continued)*

| Document Title: CY7C1351G, 4-Mbit (128 K × 36) Flow-Through SRAM with NoBL™ Architecture<br>Document Number: 38-05513 |         |            |                 |   |
|---|---------|------------|-----------------|---|
| Rev.  | ECN No. | Issue Date | Orig. of Change | Description of Change   |
| *D  | 480124  | See ECN    | VKN             | Updated <a href="#">Maximum Ratings</a> (Added the Maximum Rating for Supply Voltage on V <sub>DDQ</sub> Relative to GND).<br>Updated <a href="#">Ordering Information</a> (Updated part numbers).  |
| *E  | 2896584 | 03/20/2010 | NJY             | Updated <a href="#">Ordering Information</a> (Removed obsolete part numbers from Ordering Information table).<br>Updated <a href="#">Package Diagrams</a> .   |
| *F  | 3033272 | 09/19/2010 | NJY             | Added <a href="#">Ordering Code Definitions</a> .<br>Added <a href="#">Acronyms</a> and <a href="#">Units of Measure</a> .<br>Minor edits and updated in new template.  |
| *G  | 3067198 | 10/20/2010 | NJY             | Updated <a href="#">Ordering Information</a> (Updated part numbers).  |
| *H  | 3096309 | 11/28/2010 | NJY             | Updated <a href="#">Functional Description</a> .  |
| *I  | 3353119 | 08/24/2011 | PRIT            | Updated <a href="#">Functional Description</a> (Updated the Note as "For best practice recommendations, refer to <a href="#">SRAM System Guidelines</a> .").<br>Updated <a href="#">Package Diagrams</a> (spec 51-85050 (changed revision from *C to *D)).  |
| *J  | 3616656 | 05/14/2012 | PRIT            | Updated <a href="#">Features</a> (Removed 119-ball BGA package related information).<br>Updated <a href="#">Functional Description</a> (Removed the Note "For best practice recommendations, refer to <a href="#">SRAM System Guidelines</a> ." and its reference).<br>Updated <a href="#">Pin Configurations</a> (Removed 119-ball BGA package related information).<br>Updated <a href="#">Operating Range</a> (Removed Industrial Temperature Range).<br>Updated <a href="#">Capacitance</a> (Removed 119-ball BGA package related information).<br>Updated <a href="#">Thermal Resistance</a> (Removed 119-ball BGA package related information).<br>Updated <a href="#">Package Diagrams</a> (Removed 119-ball BGA package related information (spec 51-85115)). |
| *K  | 3767562 | 10/05/2012 | PRIT            | No technical updates. Completing sunset review.   |
| *L  | 3980362 | 04/24/2013 | PRIT            | Added <a href="#">Errata</a> .  |
| *M  | 4038283 | 06/25/2013 | PRIT            | Added Errata Footnotes.<br>Updated in new template.   |
| *N  | 4146701 | 10/04/2013 | PRIT            | Updated <a href="#">Errata</a> .  |

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