



**CY7C024E, CY7C0241E  
CY7C025E, CY7C0251E**

## 4K x 16/18 and 8K x 16/18 Dual-Port Static RAM with SEM, INT, BUSY

### Features

- True dual-ported memory cells that allow simultaneous reads of the same memory location
- 4K x 16 organization (CY7C024E)
- 4K x 18 organization (CY7C0241E)
- 8K x 16 organization (CY7C025E)
- 8K x 18 organization (CY7C0251E)
- 0.35-μ complementary metal oxide semiconductor (CMOS) for optimum speed and power
- High-speed access: 15 ns
- Low operating power:  $I_{CC} = 180 \text{ mA (typ)}$ ,  $I_{SB3} = 0.05 \text{ mA (typ)}$
- Fully asynchronous operation
- Automatic power-down
- Expandable data bus to 32/36 bits or more using master/slave chip select when using more than one device
- On-chip arbitration logic
- Semaphores included to permit software handshaking between ports
- $\overline{\text{INT}}$  flag for port-to-port communication
- Separate upper-byte and lower-byte control
- Pin select for master or slave
- Available in Pb-free 100-pin thin quad flatpack (TQFP) package

### Functional Description

The CY7C024E/CY7C0241E and CY7C025E/CY7C0251E are low-power CMOS 4K x 16/18 and 8K x 16/18 dual-port static RAMs. Various arbitration schemes are included on the CY7C024E/CY7C0241E and CY7C025E/CY7C0251E to handle situations when multiple processors access the same piece of data. Two ports are provided, permitting independent, asynchronous access for reads and writes to any location in memory. The CY7C024E/CY7C0241E and CY7C025E/CY7C0251E can be used as standalone 16 or 18-bit dual-port static RAMs or multiple devices can be combined to function as a 32-/36-bit or wider master/ slave dual-port static RAM. An M/S pin is provided for implementing 32-/36-bit or wider memory applications without the need for separate master and slave devices or additional discrete logic. Application areas include interprocessor/multiprocessor designs, communications status buffering, and dual-port video/graphics memory.

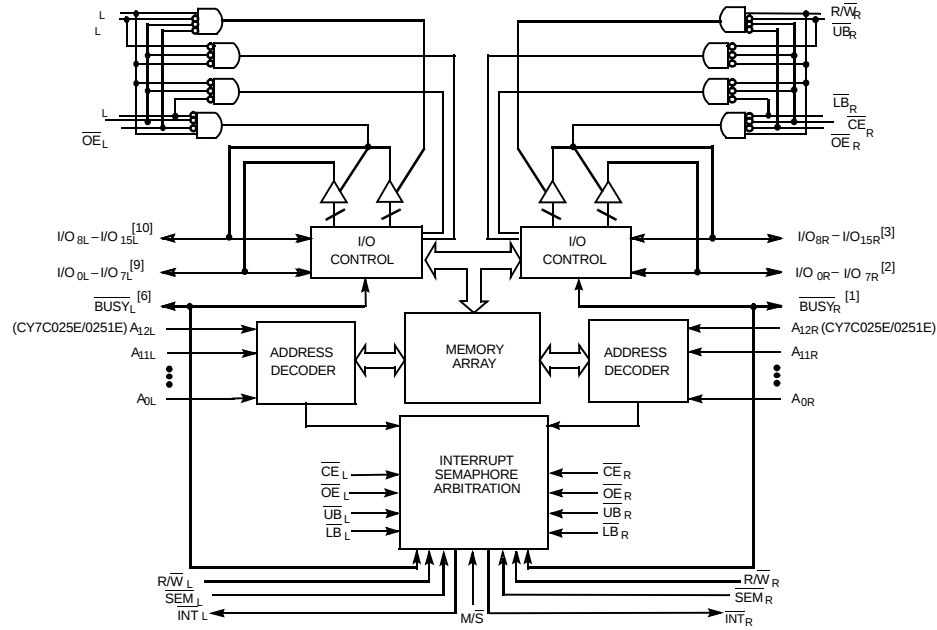
Each port has independent control pins: Chip Enable ( $\overline{\text{CE}}$ ), Read or Write Enable (R/W), and Output Enable ( $\overline{\text{OE}}$ ). Two flags are provided on each port (BUSY and INT). BUSY signals that the port is trying to access the same location currently being accessed by the other port. The Interrupt Flag (INT) permits communication between ports or systems by means of a mail box. The semaphores are used to pass a flag, or token, from one port to the other to indicate that a shared resource is in use. The semaphore logic is comprised of eight shared latches. Only one side can control the latch (semaphore) at any time. Control of a semaphore indicates that a shared resource is in use. An automatic power-down feature is controlled independently on each port by a  $\overline{\text{CE}}$  pin.

The CY7C024E/CY7C0241E and CY7C025E/CY7C0251E are available in 100-pin Pb-free TQFP.

### Selection Guide

| Parameter                                  | -15 | -25 | -55 |
|--------------------------------------------|-----|-----|-----|
| Maximum access time (ns)                   | 15  | 25  | 55  |
| Typical operating current (mA)             | 190 | 170 | 150 |
| Typical standby current for $I_{SB1}$ (mA) | 50  | 40  | 20  |

## Logic Block Diagram



### Notes

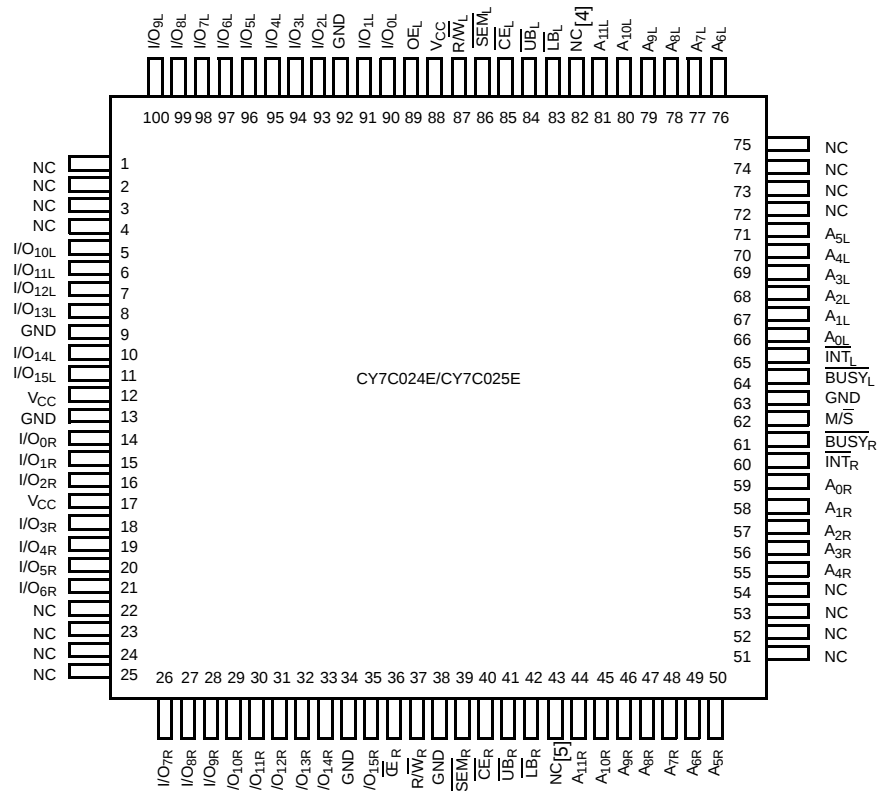
1.  $BUSY$  is an output in master mode and an input in slave mode.
2.  $I/O_0-I/O_8$  on the CY7C0241E/CY7C0251E.
3.  $I/O_9-I/O_{17}$  on the CY7C0241E/CY7C0251E.

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## Pin Configurations

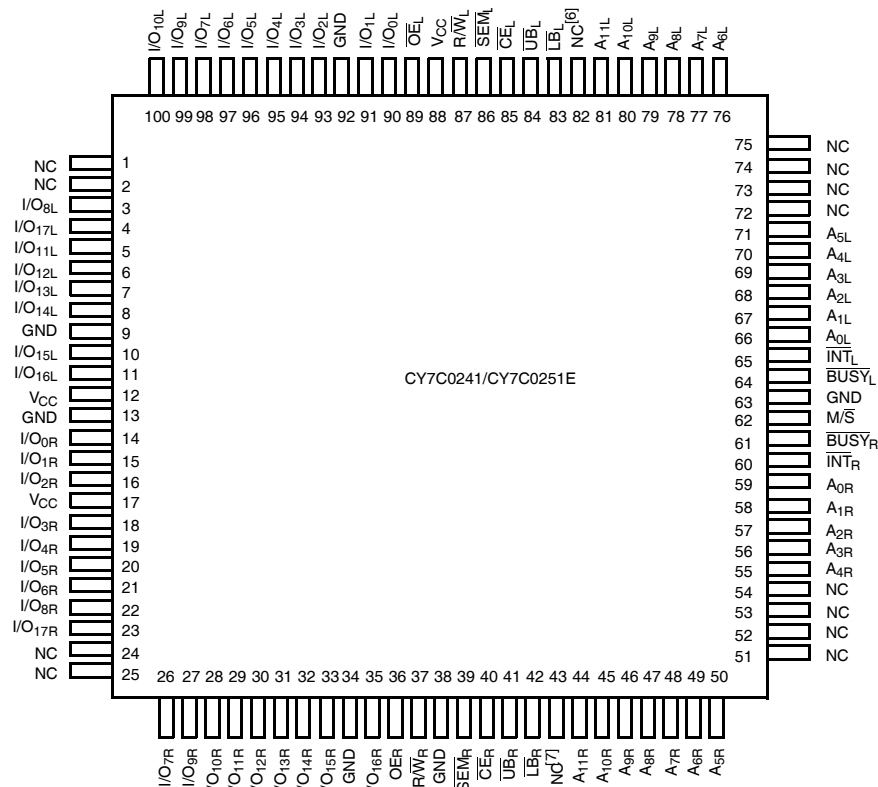
**Figure 1. 100-Pin TQFP (Top View)**



### Notes

- A<sub>12L</sub> on the CY7C025E/CY7C0251E.
- A<sub>12R</sub> on the CY7C025E/CY7C0251E.

**Figure 2. 100-Pin TQFP (Top View)**



## Pin Definitions

| Left Port                                | Right Port                               | Description            |
|------------------------------------------|------------------------------------------|------------------------|
| CE <sub>L</sub>                          | CE <sub>R</sub>                          | Chip enable            |
| R/W <sub>L</sub>                         | R/W <sub>R</sub>                         | Read/write enable      |
| OE <sub>L</sub>                          | OE <sub>R</sub>                          | Output enable          |
| A <sub>0L</sub> –A <sub>11/12L</sub>     | A <sub>0R</sub> –A <sub>11/12R</sub>     | Address                |
| I/O <sub>0L</sub> –I/O <sub>15/17L</sub> | I/O <sub>0R</sub> –I/O <sub>15/17R</sub> | Data bus input/output  |
| SEM <sub>L</sub>                         | SEM <sub>R</sub>                         | Semaphore enable       |
| UB <sub>L</sub>                          | UB <sub>R</sub>                          | Upper byte select      |
| LB <sub>L</sub>                          | LB <sub>R</sub>                          | Lower byte select      |
| INT <sub>L</sub>                         | INT <sub>R</sub>                         | Interrupt flag         |
| BUSY <sub>L</sub> <sup>[8]</sup>         | BUSY <sub>R</sub> <sup>[8]</sup>         | Busy flag              |
| M/S                                      |                                          | Master or slave select |
| V <sub>CC</sub>                          |                                          | Power                  |
| GND                                      |                                          | Ground                 |

### Notes

6. A<sub>12L</sub> on the CY7C025E/CY7C0251E.
7. A<sub>12R</sub> on the CY7C025E/CY7C0251E.
8. BUSY is an output in master mode and an input in slave mode.

## Architecture

The CY7C024E/CY7C0241E and CY7C025E/CY7C0251E consist of an array of 4 K words of 16/18 bits each and 8 K words of 16/18 bits each of dual-port RAM cells, I/O and address lines, and control signals (CE, OE, R/W). These control pins permit independent access for reads or writes to any location in memory. To handle simultaneous writes/reads to the same location, a BUSY pin is provided on each port. Two interrupt (INT) pins can be used for port-to-port communication. Two semaphore (SEM) control pins are used for allocating shared resources. With the M/S pin, the CY7C024E/CY7C0241E and CY7C025E/CY7C0251E can function as a master (BUSY pins are outputs) or as a slave (BUSY pins are inputs). The CY7C024E/CY7C0241E and CY7C025E/CY7C0251E have an automatic power-down feature controlled by  $\overline{\text{CE}}$ . Each port is provided with its own output enable control ( $\overline{\text{OE}}$ ), which allows data to be read from the device.

## Functional Description

### Write Operation

Data must be set up for a duration of  $t_{SD}$  before the rising edge of R/W to guarantee a valid write. A write operation is controlled by either the R/W pin (see Figure 7) or the CE pin (see Figure 8). Required inputs for non-contention operations are summarized in Table 1.

If a location is being written to by one port and the opposite port attempts to read that location, a port-to-port flowthrough delay must occur before the data is read on the output; otherwise the data read is not deterministic. Data is valid on the port  $t_{DD}$  after the data is presented on the other port.

### Read Operation

When reading the device, the user must assert both the  $\overline{\text{OE}}$  and CE pins. Data is available  $t_{ACE}$  after CE or  $t_{DOE}$  after OE is asserted. If the user of the CY7C024E/CY7C0241E and CY7C025E/CY7C0251E wishes to access a semaphore flag, then the SEM pin must be asserted instead of the CE pin, and  $\overline{\text{OE}}$  must also be asserted.

### Interrupts

The upper two memory locations may be used for message passing. The highest memory location (FFF for the CY7C024E/CY7C0241E, 1FFF for the CY7C025E/CY7C0251E) is the mailbox for the right port and the second-highest memory location (FFE for the CY7C024E/CY7C0241E, 1FFE for the CY7C025E/CY7C0251E) is the mailbox for the left port. When one port writes to the other port's mailbox, an interrupt is generated to the owner. The interrupt is reset when the owner reads the contents of the mailbox. The message is user-defined.

Each port can read the other port's mailbox without resetting the interrupt. The active state of the BUSY signal (to a port) prevents the port from setting the interrupt to the winning port. Also, an active BUSY to a port prevents that port from reading its own mailbox and thus resetting the interrupt to it.

If your application does not require message passing, do not connect the interrupt pin to the processor's interrupt request input pin.

The operation of the interrupts and their interaction with Busy are summarized in Table 2 on page 8.

### Busy

The CY7C024E/CY7C0241E and CY7C025E/CY7C0251E provide on-chip arbitration to resolve simultaneous memory location access (contention). If both ports' CEs are asserted and an address match occurs within  $t_{PS}$  of each other, the busy logic determines which port has access. If  $t_{PS}$  is violated, one port definitely gains permission to the location, but which one is not predictable. BUSY is asserted  $t_{BLA}$  after an address match or  $t_{BLC}$  after CE is taken LOW.

### Master/Slave

A M/S pin is provided to expand the word width by configuring the device as either a master or a slave. The BUSY output of the master is connected to the BUSY input of the slave. This allows the device to interface to a master device with no external components. Writing to slave devices must be delayed until after the BUSY input has settled ( $t_{BLC}$  or  $t_{BLA}$ ). Otherwise, the slave chip may begin a write cycle during a contention situation. When tied HIGH, the M/S pin allows the device to be used as a master and, therefore, the BUSY line is an output. BUSY can then be used to send the arbitration outcome to a slave.

### Semaphore Operation

The CY7C024E/CY7C0241E and CY7C025E/CY7C0251E provide eight semaphore latches, which are separate from the dual-port memory locations. Semaphores are used to reserve resources that are shared between the two ports. The state of the semaphore indicates that a resource is in use. For example, if the left port wants to request a given resource, it sets a latch by writing a zero to a semaphore location. The left port then verifies its success in setting the latch by reading it. After writing to the semaphore, SEM or OE must be deasserted for  $t_{SOP}$  before attempting to read the semaphore. The semaphore value is available  $t_{SWRD} + t_{DOE}$  after the rising edge of the semaphore write. If the left port was successful (reads a zero), it assumes control of the shared resource, otherwise (reads a one) it assumes the right port has control and continues to poll the semaphore. When the right side has relinquished control of the semaphore (by writing a one), the left side succeeds in gaining control of the semaphore. If the left side no longer requires the semaphore, a one is written to cancel its request.

Semaphores are accessed by asserting SEM LOW. The SEM pin functions as a chip select for the semaphore latches (CE must remain HIGH during SEM LOW). A0–2 represents the semaphore address. OE and R/W are used in the same manner as a normal memory access. When writing or reading a semaphore, the other address pins have no effect.

When writing to the semaphore, only  $I/O_0$  is used. If a zero is written to the left port of an available semaphore, a one appears at the same semaphore address on the right port. That semaphore can now only be modified by the side showing zero (the left port in this case). If the left port now relinquishes control by writing a one to the semaphore, the semaphore is set to one for both sides. However, if the right port had requested the semaphore (written a zero) while the left port had control, the right port immediately owns the semaphore as soon as the left

port releases it. [Table 3](#) on page 8 shows sample semaphore operations.

When reading a semaphore, all 16/18 data lines output the semaphore value. The read value is latched in an output register to prevent the semaphore from changing state during a write from the other port. If both ports attempt to access the semaphore within  $t_{SPS}$  of each other, the semaphore is definitely obtained by one side or the other, but there is no guarantee which side controls the semaphore.

**Table 1. Non-Contending Read/Write**

| Inputs |                                                                                     |    |    |    |     | Outputs             |                         | Operation                           |
|--------|-------------------------------------------------------------------------------------|----|----|----|-----|---------------------|-------------------------|-------------------------------------|
| CE     | R/W                                                                                 | OE | UB | LB | SEM | $I/O_0-I/O_7^{[9]}$ | $I/O_8-I/O_{15}^{[10]}$ |                                     |
| H      | X                                                                                   | X  | X  | X  | H   | High Z              | High Z                  | Deselected: power-down              |
| X      | X                                                                                   | X  | H  | H  | H   | High Z              | High Z                  | Deselected: power-down              |
| L      | L                                                                                   | X  | L  | H  | H   | High Z              | Data in                 | Write to upper byte only            |
| L      | L                                                                                   | X  | H  | L  | H   | Data in             | High Z                  | Write to lower byte only            |
| L      | L                                                                                   | X  | L  | L  | H   | Data in             | Data in                 | Write to both bytes                 |
| L      | H                                                                                   | L  | L  | H  | H   | High Z              | Data out                | Read upper byte only                |
| L      | H                                                                                   | L  | H  | L  | H   | Data out            | High Z                  | Read lower byte only                |
| L      | H                                                                                   | L  | L  | L  | H   | Data out            | Data out                | Read both bytes                     |
| X      | X                                                                                   | H  | X  | X  | X   | High Z              | High Z                  | Outputs disabled                    |
| H      | H                                                                                   | L  | X  | X  | L   | Data out            | Data out                | Read data in semaphore flag         |
| X      | H                                                                                   | L  | H  | H  | L   | Data out            | Data out                | Read data in semaphore flag         |
| H      |  | X  | X  | X  | L   | Data in             | Data in                 | Write $D_{IN0}$ into semaphore flag |
| X      |  | X  | H  | H  | L   | Data in             | Data in                 | Write $D_{IN0}$ into semaphore flag |
| L      | X                                                                                   | X  | L  | X  | L   |                     |                         | Not allowed                         |
| L      | X                                                                                   | X  | X  | L  | L   |                     |                         | Not allowed                         |

**Notes**

9.  $I/O_0-I/O_8$  on the CY7C0241E/CY7C0251E.

10.  $I/O_9-I/O_{17}$  on the CY7C0241E/CY7C0251E.

Table 2. Interrupt Operation Example (Assumes  $\overline{\text{BUSY}}_L = \overline{\text{BUSY}}_R = \text{HIGH}$ )<sup>[11]</sup>

| Function                                   | Left Port                 |                          |                          |                     |                           | Right Port                |                          |                          |                     |                           |
|--------------------------------------------|---------------------------|--------------------------|--------------------------|---------------------|---------------------------|---------------------------|--------------------------|--------------------------|---------------------|---------------------------|
|                                            | $\overline{\text{R/W}}_L$ | $\overline{\text{CE}}_L$ | $\overline{\text{OE}}_L$ | $\text{A}_{0L-11L}$ | $\overline{\text{INT}}_L$ | $\overline{\text{R/W}}_R$ | $\overline{\text{CE}}_R$ | $\overline{\text{OE}}_R$ | $\text{A}_{0R-11R}$ | $\overline{\text{INT}}_R$ |
| Set right $\overline{\text{INT}}_R$ flag   | L                         | L                        | X                        | (1)FFF              | X                         | X                         | X                        | X                        | X                   | $\text{L}^{[12]}$         |
| Reset right $\overline{\text{INT}}_R$ flag | X                         | X                        | X                        | X                   | X                         | X                         | L                        | L                        | (1)FFF              | $\text{H}^{[13]}$         |
| Set left $\overline{\text{INT}}_L$ flag    | X                         | X                        | X                        | X                   | $\text{L}^{[13]}$         | L                         | L                        | X                        | (1)FFE              | X                         |
| Reset left $\overline{\text{INT}}_L$ flag  | X                         | L                        | L                        | (1)FFE              | $\text{H}^{[12]}$         | X                         | X                        | X                        | X                   | X                         |

Table 3. Semaphore Operation Example

| Function                         | $\text{I/O}_0\text{--I/O}_{15/17}$<br>Left | $\text{I/O}_0\text{--I/O}_{15/17}$<br>Right | Status                                                  |
|----------------------------------|--------------------------------------------|---------------------------------------------|---------------------------------------------------------|
| No action                        | 1                                          | 1                                           | Semaphore-free                                          |
| Left port writes 0 to semaphore  | 0                                          | 1                                           | Left port has semaphore token                           |
| Right port writes 0 to semaphore | 0                                          | 1                                           | No change. Right side has no write access to semaphore. |
| Left port writes 1 to semaphore  | 1                                          | 0                                           | Right port obtains semaphore token                      |
| Left port writes 0 to semaphore  | 1                                          | 0                                           | No change. Left port has no write access to semaphore   |
| Right port writes 1 to semaphore | 0                                          | 1                                           | Left port obtains semaphore token                       |
| Left port writes 1 to semaphore  | 1                                          | 1                                           | Semaphore-free                                          |
| Right port writes 0 to semaphore | 1                                          | 0                                           | Right port has semaphore token                          |
| Right port writes 1 to semaphore | 1                                          | 1                                           | Semaphore-free                                          |
| Left port writes 0 to semaphore  | 0                                          | 1                                           | Left port has semaphore token                           |
| Left port writes 1 to semaphore  | 1                                          | 1                                           | Semaphore-free                                          |

**Notes**

11.  $\text{A}_{0L-12L}$  and  $\text{A}_{0R-12R}$ , 1FFF/1FFE for the CY7C025E/CY7C0251E.

12. If  $\overline{\text{BUSY}}_L = \text{L}$ , then no change.

13.  $\overline{\text{BUSY}}_R = \text{L}$ , then no change.

## Maximum Ratings

Exceeding maximum ratings may shorten the useful life of the device. User guidelines are not tested.<sup>[14]</sup>

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

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

Supply voltage to ground potential ..... -0.3 V to +7.0 V

DC voltage applied to outputs in high Z state ..... -0.5 V to +7.0 V

DC input voltage<sup>[15]</sup> ..... -0.5 V to +7.0 V

Output current into outputs (LOW) ..... 20 mA

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

Latch-up current ..... > 200 mA

## Operating Range

| Range      | Ambient Temperature | V <sub>CC</sub> |
|------------|---------------------|-----------------|
| Commercial | 0 °C to +70 °C      | 5 V ± 10%       |
| Industrial | -40 °C to +85 °C    | 5 V ± 10%       |

## Electrical Characteristics Over the Operating Range

| Parameter        | Description                                 | Test Conditions                                                                                                                                                                                                 |            | -15  |      |     | -25  |      |      | -55  |      |      | Unit |
|------------------|---------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|------|------|-----|------|------|------|------|------|------|------|
|                  |                                             |                                                                                                                                                                                                                 |            | Min  | Typ  | Max | Min  | Typ  | Max  | Min  | Typ  | Max  |      |
| V <sub>OH</sub>  | Output HIGH voltage                         | V <sub>CC</sub> = Min, I <sub>OH</sub> = -4.0 mA                                                                                                                                                                |            | 2.4  | -    | -   | 2.4  | -    | -    | 2.4  | -    | -    | V    |
| V <sub>OL</sub>  | Output LOW voltage                          | V <sub>CC</sub> = Min, I <sub>OL</sub> = 4.0 mA                                                                                                                                                                 |            | -    | -    | 0.4 | -    | -    | 0.4  | -    | -    | 0.4  | V    |
| V <sub>IH</sub>  | Input HIGH voltage                          |                                                                                                                                                                                                                 |            | 2.2  | -    |     | 2.2  | -    |      | 2.2  | -    |      | V    |
| V <sub>IL</sub>  | Input LOW voltage                           |                                                                                                                                                                                                                 |            | -0.7 | -    | 0.8 | -0.7 | -    | 0.8  | -0.7 | -    | 0.8  | V    |
| I <sub>IX</sub>  | Input leakage current                       | GND ≤ V <sub>I</sub> ≤ V <sub>CC</sub>                                                                                                                                                                          |            | -10  | -    | +10 | -10  | -    | +10  | -10  | -    | +10  | μA   |
| I <sub>OZ</sub>  | Output leakage current                      | Output disabled,<br>GND ≤ V <sub>O</sub> ≤ V <sub>CC</sub>                                                                                                                                                      |            | -10  | -    | +10 | -10  | -    | +10  | -10  | -    | +10  | μA   |
| I <sub>CC</sub>  | Operating current                           | V <sub>CC</sub> = Max, I <sub>OUT</sub> = 0 mA,<br>Outputs Disabled                                                                                                                                             | Commercial | -    | 190  | 285 | -    | 170  | 250  | -    | 150  | 230  | mA   |
|                  |                                             |                                                                                                                                                                                                                 | Industrial | -    | 215  | 305 | -    | 180  | 290  | -    | 180  | 290  |      |
| I <sub>SB1</sub> | Standby current<br>(both ports TTL levels)  | CE <sub>L</sub> and CE <sub>R</sub> ≥ V <sub>IH</sub> ,<br>f = f <sub>MAX</sub> <sup>[16]</sup>                                                                                                                 | Commercial | -    | 50   | 70  | -    | 40   | 60   | -    | 20   | 50   | mA   |
|                  |                                             |                                                                                                                                                                                                                 | Industrial | -    | 65   | 95  | -    | 55   | 80   | -    | 55   | 80   |      |
| I <sub>SB2</sub> | Standby current<br>(one port TTL level)     | CE <sub>L</sub> or CE <sub>R</sub> ≥ V <sub>IH</sub> ,<br>f = f <sub>MAX</sub> <sup>[16]</sup>                                                                                                                  | Commercial | -    | 120  | 180 | -    | 100  | 150  | -    | 75   | 135  | mA   |
|                  |                                             |                                                                                                                                                                                                                 | Industrial | -    | 135  | 205 | -    | 120  | 175  | -    | 120  | 175  |      |
| I <sub>SB3</sub> | Standby current<br>(both ports CMOS levels) | Both Ports CE and CE <sub>R</sub> ≥<br>V <sub>CC</sub> - 0.2 V, V <sub>IN</sub> ≥ V <sub>CC</sub> - 0.2 V<br>or V <sub>IN</sub> ≤ 0.2 V, f = 0 <sup>[16]</sup>                                                  | Commercial | -    | 0.05 | 0.5 | -    | 0.05 | 0.50 | -    | 0.05 | 0.50 | mA   |
|                  |                                             |                                                                                                                                                                                                                 | Industrial | -    | 0.05 | 0.5 | -    | 0.05 | 0.50 | -    | 0.05 | 0.50 |      |
| I <sub>SB4</sub> | Standby current<br>(both ports CMOS levels) | One Port CE <sub>L</sub> or<br>CE <sub>R</sub> ≥ V <sub>CC</sub> - 0.2 V,<br>V <sub>IN</sub> ≥ V <sub>CC</sub> - 0.2 V or V <sub>IN</sub> ≤ 0.2 V,<br>Active Port Outputs, f = f <sub>MAX</sub> <sup>[16]</sup> | Commercial | -    | 110  | 160 | -    | 90   | 130  | -    | 70   | 120  | mA   |
|                  |                                             |                                                                                                                                                                                                                 | Industrial | -    | 125  | 175 | -    | 110  | 150  | -    | 110  | 150  |      |

## Capacitance

| Parameter <sup>[17]</sup> | Description        | Test Conditions                                            | Max | Unit |
|---------------------------|--------------------|------------------------------------------------------------|-----|------|
| C <sub>IN</sub>           | Input capacitance  | T <sub>A</sub> = 25 °C, f = 1 MHz, V <sub>CC</sub> = 5.0 V | 10  | pF   |
| C <sub>OUT</sub>          | Output capacitance |                                                            | 10  | pF   |

### Notes

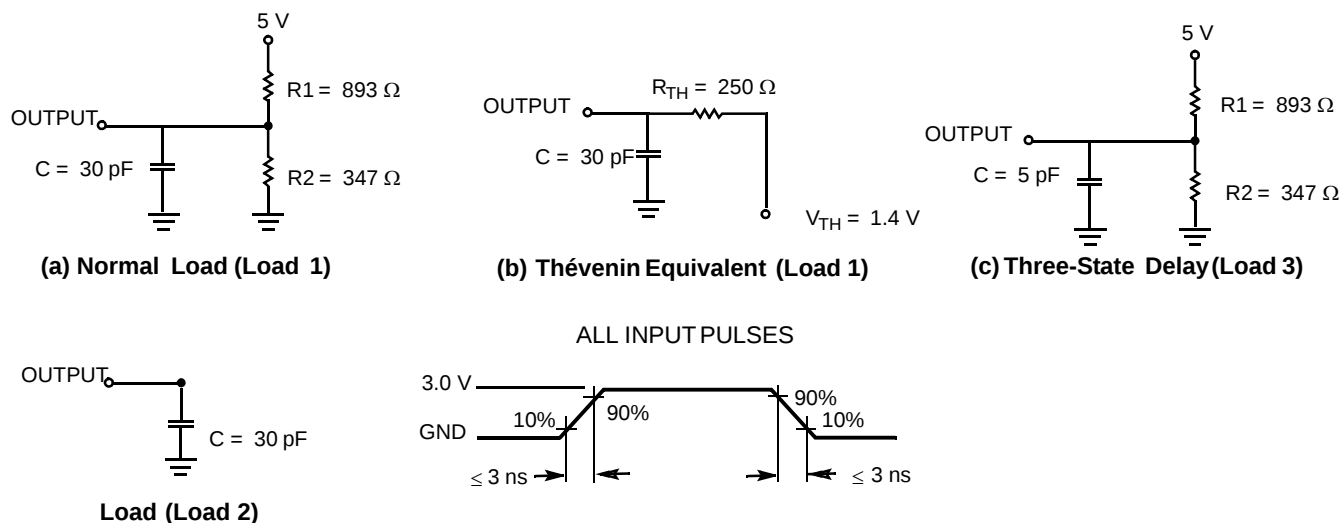
14. The voltage on any input or I/O pin cannot exceed the power pin during power-up.

15. Pulse width < 20 ns.

16. f<sub>MAX</sub> = 1/t<sub>RC</sub> = All inputs cycling at f = 1/t<sub>RC</sub> (except output enable). f = 0 means no address or control lines change. This applies only to inputs at CMOS level standby I<sub>SB3</sub>.

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

Figure 3. AC Test Loads and Waveforms



## Switching Characteristics Over the Operating Range <sup>[18]</sup>

| Parameter                                 | Description                        | −15 |     | −25 |     | −55 |     | Unit |
|-------------------------------------------|------------------------------------|-----|-----|-----|-----|-----|-----|------|
|                                           |                                    | Min | Max | Min | Max | Min | Max |      |
| Read Cycle                                |                                    |     |     |     |     |     |     |      |
| t <sub>RC</sub>                           | Read cycle time                    | 15  | –   | 25  | –   | 55  | –   | ns   |
| t <sub>AA</sub>                           | Address to data valid              | –   | 15  | –   | 25  | –   | 55  | ns   |
| t <sub>OHA</sub>                          | Output hold from address change    | 3   | –   | 3   | –   | 3   | –   | ns   |
| t <sub>ACE</sub> <sup>[19]</sup>          | $\overline{CE}$ LOW to data valid  | –   | 15  | –   | 25  | –   | 55  | ns   |
| t <sub>DOE</sub>                          | $\overline{OE}$ LOW to data valid  | –   | 10  | –   | 13  | –   | 25  | ns   |
| t <sub>LZOE</sub> <sup>[20, 21, 22]</sup> | $\overline{OE}$ low to low Z       | 3   | –   | 3   | –   | 3   | –   | ns   |
| t <sub>HZOE</sub> <sup>[20, 21, 22]</sup> | $\overline{OE}$ HIGH to high Z     | –   | 10  | –   | 15  | –   | 25  | ns   |
| t <sub>LZCE</sub> <sup>[20, 21, 22]</sup> | $\overline{CE}$ LOW to low Z       | 3   | –   | 3   | –   | 3   | –   | ns   |
| t <sub>HZCE</sub> <sup>[20, 21, 22]</sup> | $\overline{CE}$ HIGH to High Z     | –   | 10  | –   | 15  | –   | 25  | ns   |
| t <sub>PU</sub> <sup>[22]</sup>           | $\overline{CE}$ LOW to power-up    | 0   | –   | 0   | –   | 0   | –   | ns   |
| t <sub>PD</sub> <sup>[22]</sup>           | $\overline{CE}$ HIGH to power-down | –   | 15  | –   | 25  | –   | 55  | ns   |
| t <sub>ABE</sub> <sup>[19]</sup>          | Byte enable access time            | –   | 15  | –   | 25  | –   | 55  | ns   |
| Write Cycle                               |                                    |     |     |     |     |     |     |      |
| t <sub>WC</sub>                           | Write cycle time                   | 15  | –   | 25  | –   | 55  | –   | ns   |
| t <sub>SCE</sub> <sup>[19]</sup>          | $\overline{CE}$ LOW to write end   | 12  | –   | 20  | –   | 35  | –   | ns   |

### Notes

18. Test conditions assume signal transition time of 3 ns or less, timing reference levels of 1.5 V, input pulse levels of 0 to 3.0 V, and output loading of the specified  $I_{OL}/I_{OH}$  and 30 pF load capacitance.

19. To access RAM,  $\overline{CE}=L$ ,  $\overline{UB}=L$ ,  $\overline{SEM}=H$ . To access semaphore,  $\overline{CE}=H$  and  $\overline{SEM}=L$ . Either condition must be valid for the entire  $t_{SCE}$  time.

20. At any given temperature and voltage condition for any given device,  $t_{HZCE}$  is less than  $t_{LZCE}$  and  $t_{HZOE}$  is less than  $t_{LZOE}$ .

21. Test conditions used are Load 3.

22. This parameter is guaranteed but not tested.

**Switching Characteristics** Over the Operating Range (continued)<sup>[18]</sup>

| Parameter                               | Description                                                   | -15 |         | -25 |         | -55 |         | Unit |
|-----------------------------------------|---------------------------------------------------------------|-----|---------|-----|---------|-----|---------|------|
|                                         |                                                               | Min | Max     | Min | Max     | Min | Max     |      |
| t <sub>AW</sub>                         | Address setup to write end                                    | 12  | –       | 20  | –       | 35  | –       | ns   |
| t <sub>HA</sub>                         | Address hold from write end                                   | 0   | –       | 0   | –       | 0   | –       | ns   |
| t <sub>SA</sub> <sup>[23]</sup>         | Address setup to write start                                  | 0   | –       | 0   | –       | 0   | –       | ns   |
| t <sub>PWE</sub>                        | Write pulse width                                             | 12  | –       | 20  | –       | 35  | –       | ns   |
| t <sub>SD</sub>                         | Data setup to write end                                       | 10  | –       | 15  | –       | 20  | –       | ns   |
| t <sub>HD</sub>                         | Data hold from write end                                      | 0   | –       | 0   | –       | 0   | –       | ns   |
| t <sub>HZWE</sub> <sup>[24, 25]</sup>   | R $\overline{W}$ LOW to high Z                                | –   | 10      | –   | 15      | –   | 25      | ns   |
| t <sub>LZWE</sub> <sup>[24, 25]</sup>   | R $\overline{W}$ HIGH to low Z                                | 3   | –       | 3   | –       | 3   | –       | ns   |
| t <sub>WDD</sub> <sup>[26]</sup>        | Write pulse to data delay                                     | –   | 30      | –   | 50      | –   | 70      | ns   |
| t <sub>DDD</sub> <sup>[26]</sup>        | Write data valid to read data valid                           | –   | 25      | –   | 35      | –   | 45      | ns   |
| <b>Busy Timing</b> <sup>[27]</sup>      |                                                               |     |         |     |         |     |         |      |
| t <sub>BLA</sub>                        | BUS $\overline{Y}$ LOW from Address Match                     | –   | 15      | –   | 20      | –   | 45      | ns   |
| t <sub>BHA</sub>                        | BUS $\overline{Y}$ HIGH from Address Mismatch                 | –   | 15      | –   | 20      | –   | 40      | ns   |
| t <sub>BLC</sub>                        | BUS $\overline{Y}$ LOW from $\overline{CE}$ LOW               | –   | 15      | –   | 20      | –   | 40      | ns   |
| t <sub>BHC</sub>                        | BUS $\overline{Y}$ HIGH from $\overline{CE}$ HIGH             | –   | 15      | –   | 20      | –   | 35      | ns   |
| t <sub>PS</sub>                         | Port Setup for Priority                                       | 5   | –       | 5   | –       | 5   | –       | ns   |
| t <sub>WB</sub>                         | R $\overline{W}$ HIGH after BUS $\overline{Y}$ (Slave)        | 0   | –       | 0   | –       | 0   | –       | ns   |
| t <sub>WH</sub>                         | R $\overline{W}$ HIGH after BUS $\overline{Y}$ HIGH (Slave)   | 13  | –       | 20  | –       | 40  | –       | ns   |
| t <sub>BDD</sub> <sup>[28]</sup>        | BUS $\overline{Y}$ HIGH to Data Valid                         | –   | Note 28 |     | Note 28 |     | Note 28 | ns   |
| <b>Interrupt Timing</b> <sup>[27]</sup> |                                                               |     |         |     |         |     |         |      |
| t <sub>INS</sub>                        | INT $\overline{N}$ Set Time                                   | –   | 15      | –   | 20      | –   | 30      | ns   |
| t <sub>INR</sub>                        | INT $\overline{N}$ Reset Time                                 | –   | 15      | –   | 20      | –   | 30      | ns   |
| <b>Semaphore Timing</b>                 |                                                               |     |         |     |         |     |         |      |
| t <sub>SOP</sub>                        | SEM Flag Update Pulse ( $\overline{OE}$ or $\overline{SEM}$ ) | 10  | –       | 12  | –       | 20  | –       | ns   |
| t <sub>SWRD</sub>                       | SEM Flag Write to Read Time                                   | 5   | –       | 10  | –       | 15  | –       | ns   |
| t <sub>SPS</sub>                        | SEM Flag Contention Window                                    | 5   | –       | 10  | –       | 15  | –       | ns   |
| t <sub>SAA</sub>                        | SEM Address Access Time                                       | –   | 15      |     | 25      | –   | 55      | ns   |

**Notes**

23. To access RAM,  $\overline{CE}$ =L,  $\overline{UB}$ =L,  $\overline{SEM}$ =H. To access semaphore,  $\overline{CE}$ =H and  $\overline{SEM}$ =L. Either condition must be valid for the entire t<sub>SCE</sub> time.

24. Test conditions used are Load 3.

25. This parameter is guaranteed but not tested.

26. For information on port-to-port delay through RAM cells from writing port to reading port, refer to Figure 11 on page 16.

27. Test conditions used are Load 2.

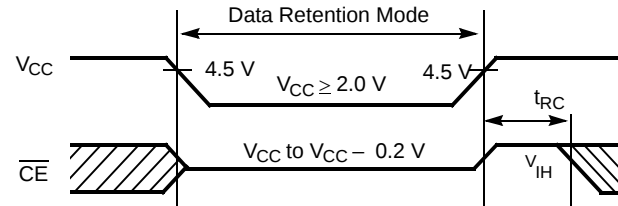
28. t<sub>BDD</sub> is a calculated parameter and is the greater of t<sub>WDD</sub> – t<sub>PWE</sub> (actual) or t<sub>DDD</sub> – t<sub>SD</sub> (actual).

## Data Retention Mode

The CY7C024E/CY7C0241E is designed with battery backup in mind. Data retention voltage and supply current are guaranteed over temperature. The following rules insure data retention:

1. Chip enable ( $\overline{CE}$ ) must be held HIGH during data retention, within  $V_{CC}$  to  $V_{CC} - 0.2$  V.
2.  $\overline{CE}$  must be kept between  $V_{CC} - 0.2$  V and 70% of  $V_{CC}$  during the power up and power down transitions.
3. The RAM can begin operation  $>t_{RC}$  after  $V_{CC}$  reaches the minimum operating voltage (4.5 V).

## Data Retention Timing



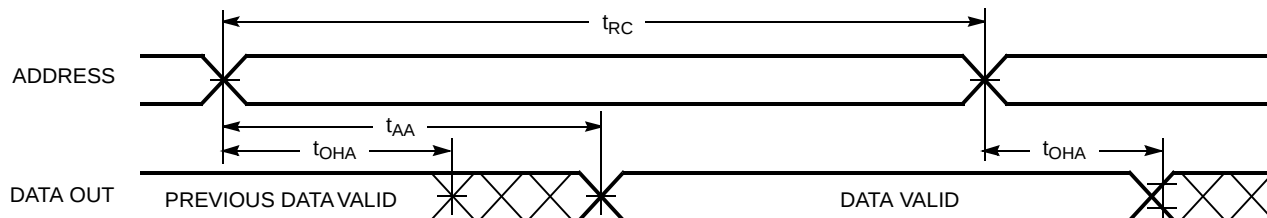
| Parameter   | Test Conditions <sup>[29]</sup> | Max | Unit |
|-------------|---------------------------------|-----|------|
| $ICC_{DR1}$ | At $V_{CC_{DR}} = 2$ V          | 1.5 | mA   |

### Note

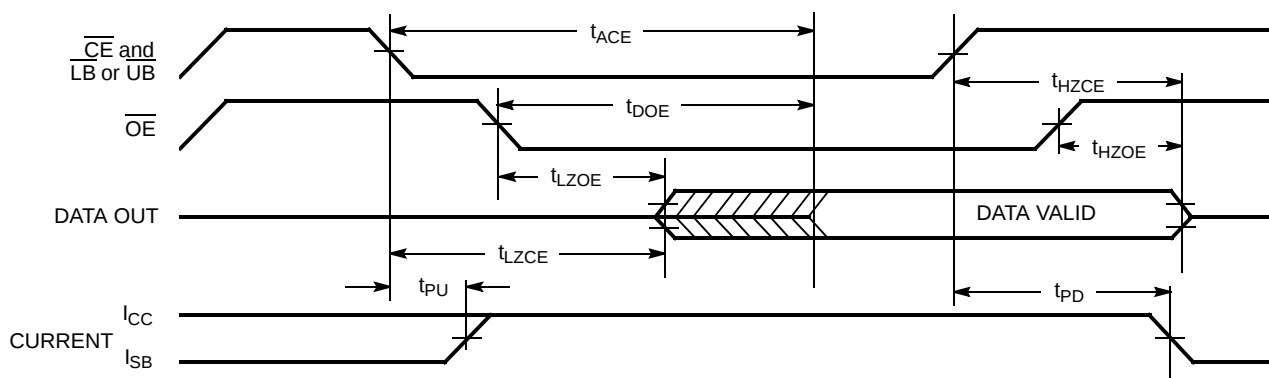
29.  $\overline{CE} = V_{CC}$ ,  $V_{in} = GND$  to  $V_{CC}$ ,  $T_A = 25^\circ C$ . This parameter is guaranteed but not tested.

## Switching Waveforms

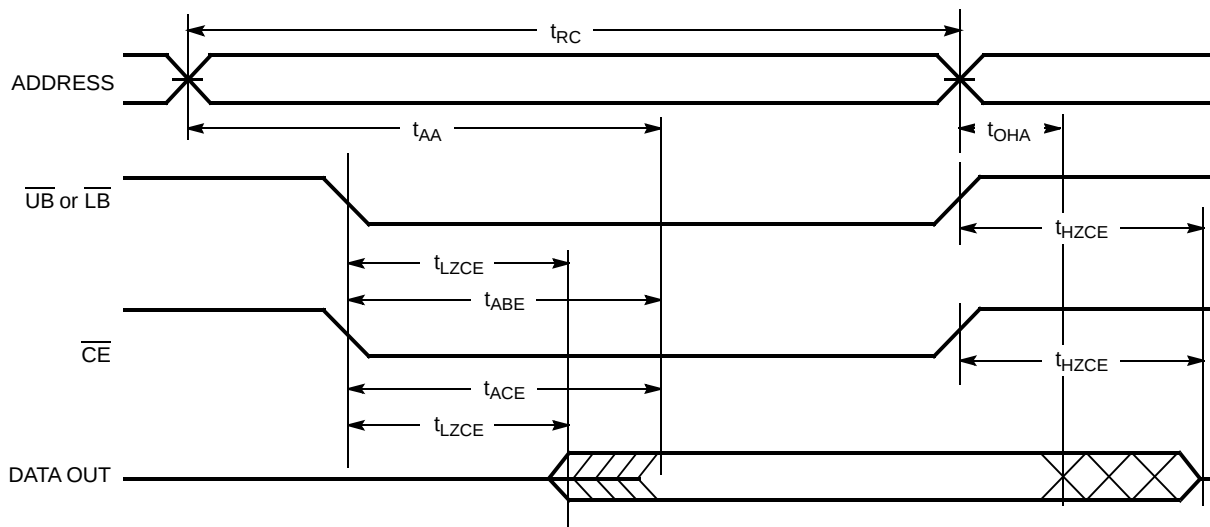
**Figure 4. Read Cycle No. 1 (Either Port Address Access)**<sup>[30, 31, 32]</sup>



**Figure 5. Read Cycle No. 2 (Either Port  $\overline{\text{CE}}/\overline{\text{OE}}$  Access)**<sup>[30, 33, 34]</sup>



**Figure 6. Read Cycle No. 3 (Either Port)**<sup>[30, 32, 33, 33, 34]</sup>



### Notes

30. R/W is HIGH for read cycles.
31. Device is continuously selected  $\overline{\text{CE}} = V_{IL}$  and  $\overline{\text{UB}}$  or  $\overline{\text{LB}} = V_{IL}$ . This waveform cannot be used for semaphore reads.
32.  $\overline{\text{OE}} = V_{IL}$ .
33. Address valid prior to or coincident with  $\overline{\text{CE}}$  transition LOW.
34. To access RAM,  $\overline{\text{CE}} = V_{IL}$ ,  $\overline{\text{UB}}$  or  $\overline{\text{LB}} = V_{IL}$ ,  $\overline{\text{SEM}} = V_{IH}$ . To access semaphore,  $\overline{\text{CE}} = V_{IH}$ ,  $\overline{\text{SEM}} = V_{IL}$ .

## Switching Waveforms (continued)

Figure 7. Write Cycle No. 1:  $\overline{R/\overline{W}}$  Controlled Timing<sup>[35, 36, 37, 38]</sup>

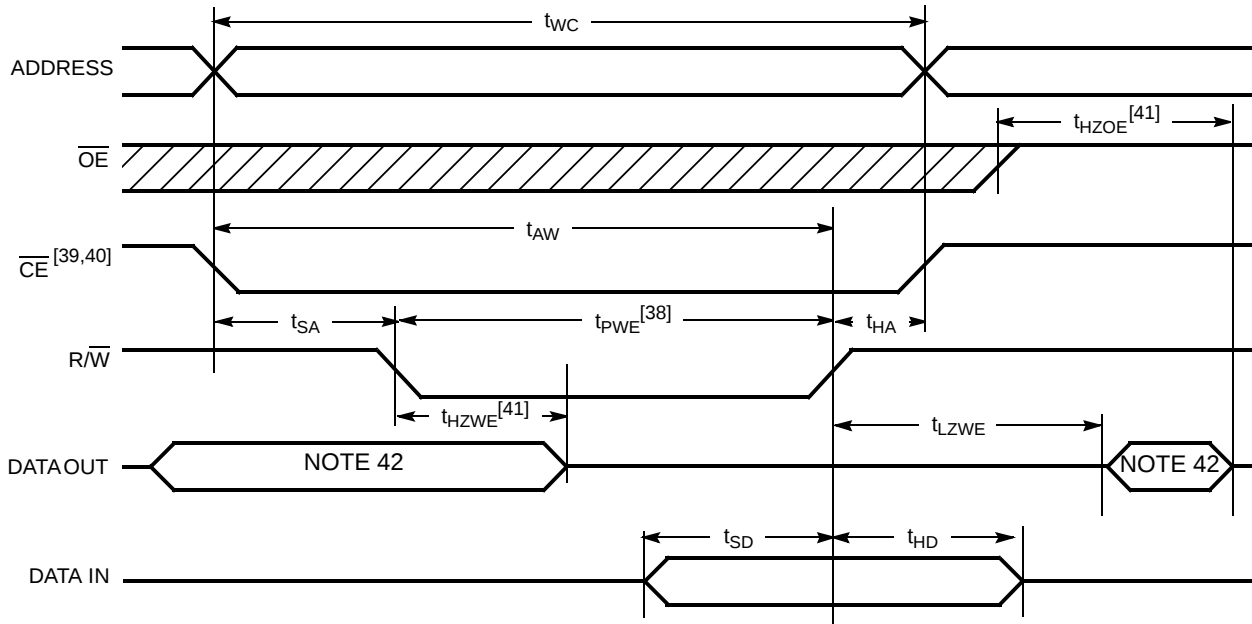
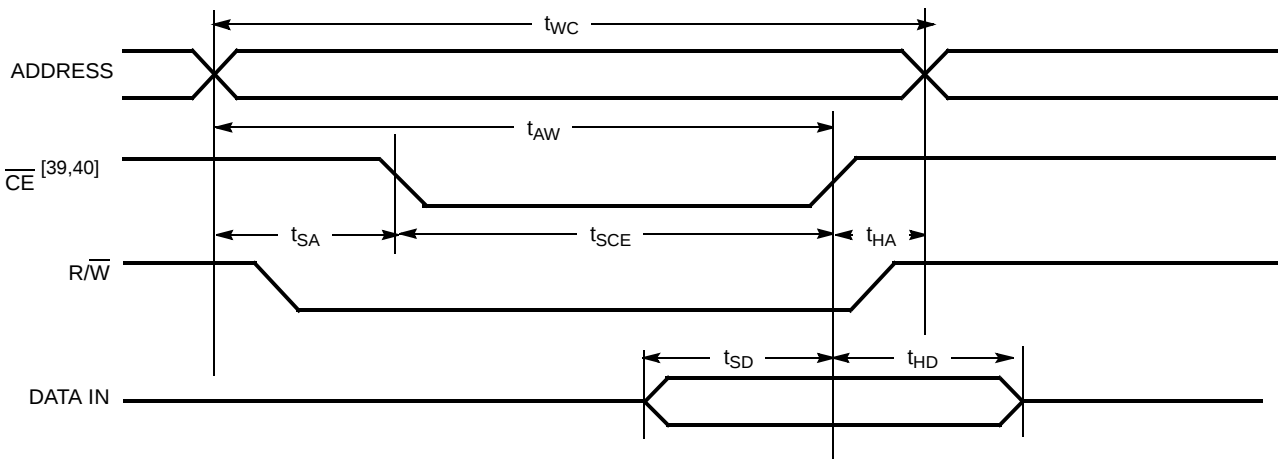


Figure 8. Write Cycle No. 2:  $\overline{CE}$  Controlled Timing<sup>[35, 36, 37, 43]</sup>



### Notes

35.  $\overline{R/\overline{W}}$  must be HIGH during all address transitions.

36. A write occurs during the overlap ( $t_{SCE}$  or  $t_{PWE}$ ) of a LOW  $\overline{CE}$  or  $\overline{SEM}$  and a LOW  $\overline{UB}$  or  $\overline{LB}$ .

37.  $t_{HA}$  is measured from the earlier of  $\overline{CE}$  or  $\overline{R/\overline{W}}$  or ( $\overline{SEM}$  or  $\overline{R/\overline{W}}$ ) going HIGH at the end of write cycle.

38. If  $\overline{OE}$  is LOW during a  $\overline{R/\overline{W}}$  controlled write cycle, the write pulse width must be the larger of  $t_{PWE}$  or ( $t_{HZWE} + t_{SD}$ ) to allow the I/O drivers to turn off and data to be placed on the bus for the required  $t_{SD}$ . If  $\overline{OE}$  is HIGH during an  $\overline{R/\overline{W}}$  controlled write cycle, this requirement does not apply and the write pulse can be as short as the specified  $t_{PWE}$ .

39. To access RAM,  $\overline{CE} = V_{IL}$ ,  $\overline{SEM} = V_{IH}$ .

40. To access upper byte,  $\overline{CE} = V_{IL}$ ,  $\overline{UB} = V_{IL}$ ,  $\overline{SEM} = V_{IH}$ .

To access lower byte,  $\overline{CE} = V_{IL}$ ,  $\overline{LB} = V_{IL}$ ,  $\overline{SEM} = V_{IH}$ .

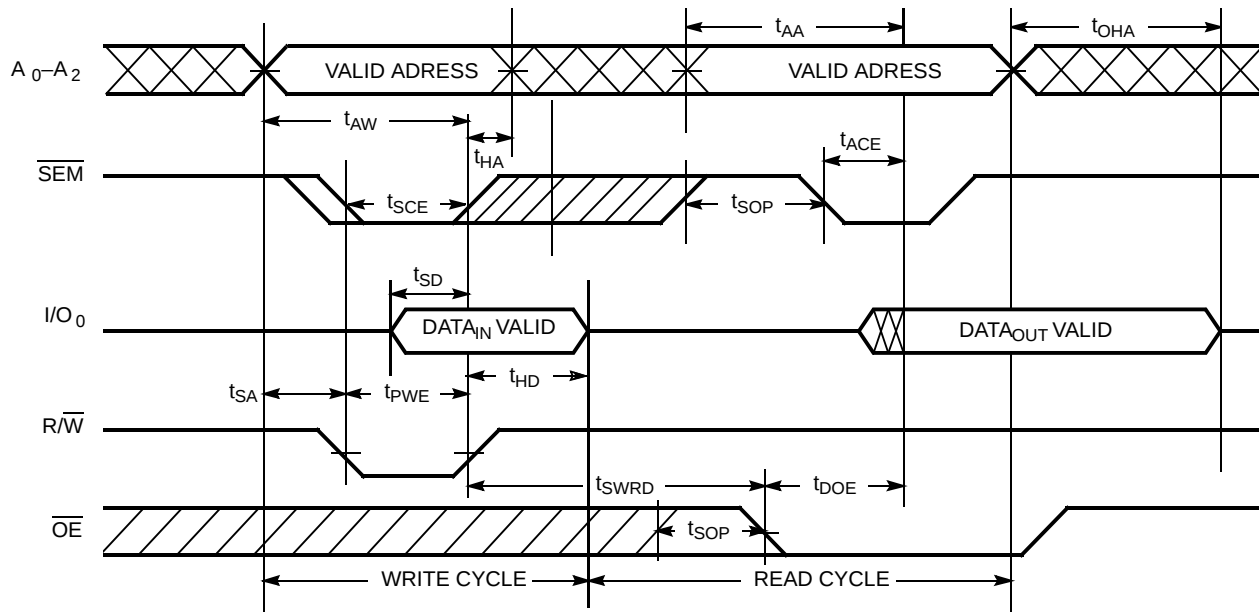
41. Transition is measured  $\pm 500$  mV from steady state with a 5 pF load (including scope and jig). This parameter is sampled and not 100% tested.

42. During this period, the I/O pins are in the output state, and input signals must not be applied.

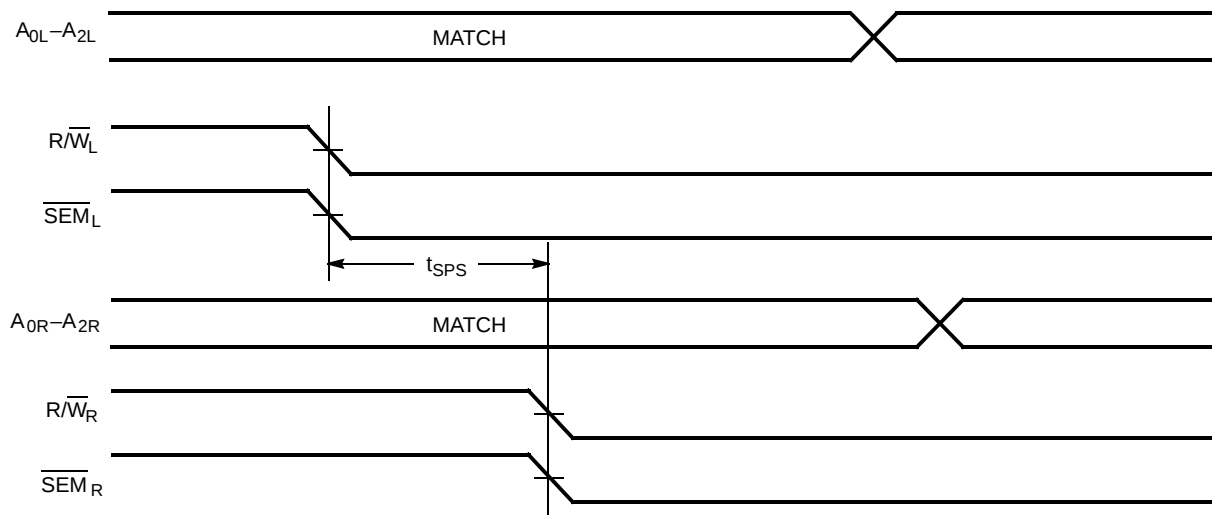
43. If the  $\overline{CE}$  or  $\overline{SEM}$  LOW transition occurs simultaneously with or after the  $\overline{R/\overline{W}}$  LOW transition, the outputs remain in the high impedance state.

## Switching Waveforms (continued)

**Figure 9. Semaphore Read After Write Timing, Either Side<sup>[44]</sup>**



**Figure 10. Timing Diagram of Semaphore Contention<sup>[45, 46, 47]</sup>**



### Notes

44. CE = HIGH for the duration of the above timing (both write and read cycle).

45. I/O<sub>0R</sub> = I/O<sub>0L</sub> = LOW (request semaphore); CE<sub>R</sub> = CE<sub>L</sub> = HIGH.

46. Semaphores are reset (available to both ports) at cycle start.

47. If t<sub>SPS</sub> is violated, the semaphore is definitely obtained by one side or the other, but which side gets the semaphore is unpredictable.

## Switching Waveforms (continued)

Figure 11. Timing Diagram of Read with  $\overline{\text{BUSY}}$  ( $\overline{\text{M}}/\overline{\text{S}}=\text{HIGH}$ )<sup>[48]</sup>

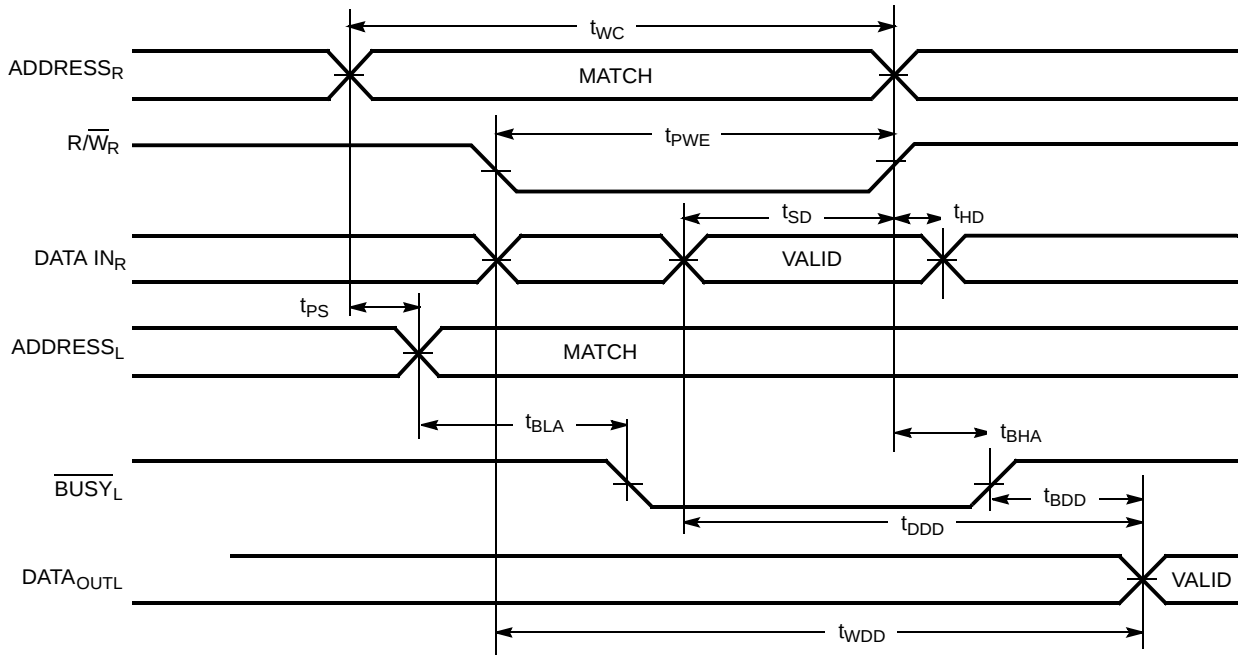
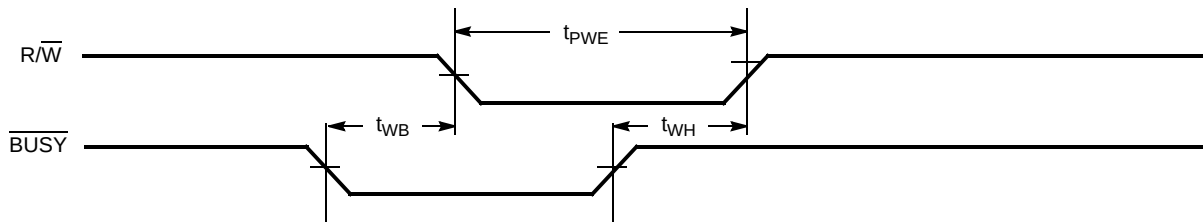


Figure 12. Write Timing with Busy Input ( $\overline{\text{M}}/\overline{\text{S}}=\text{LOW}$ )

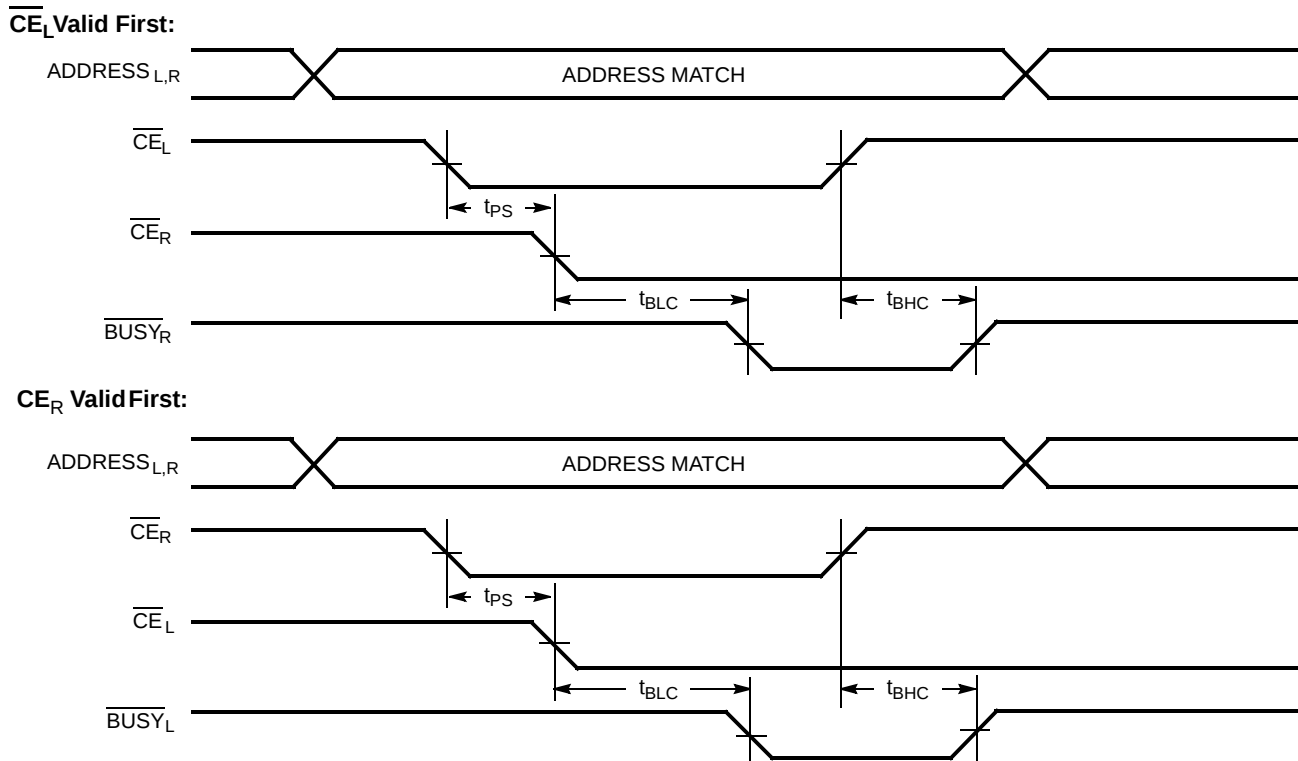


### Note

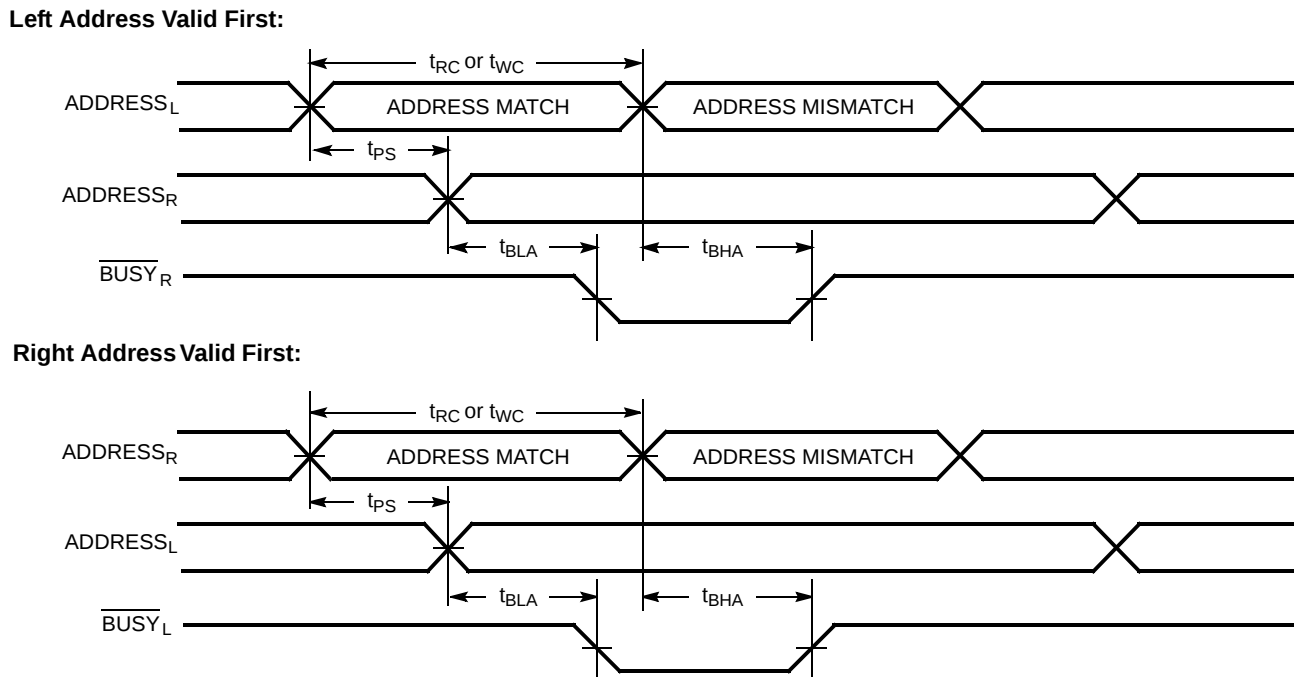
48.  $\overline{\text{CE}}_L = \overline{\text{CE}}_R = \text{LOW}$ .

## Switching Waveforms (continued)

**Figure 13. Busy Timing Diagram No.1 ( $\overline{\text{CE}}$  Arbitration)<sup>[49]</sup>**



**Figure 14. Busy Timing Diagram No.2 (Address Arbitration)<sup>[49]</sup>**



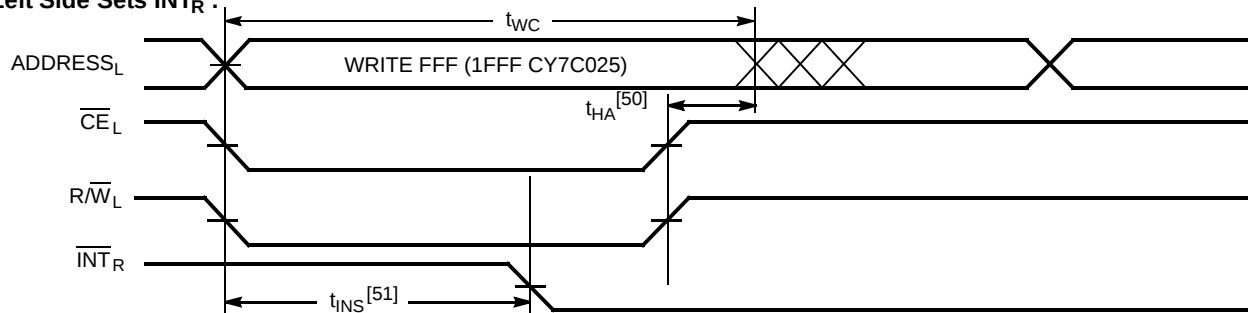
**Note**

49. If  $t_{PS}$  is violated, the busy signal is asserted on one side or the other, but there is no guarantee to which side  $\overline{\text{BUSY}}$  is asserted.

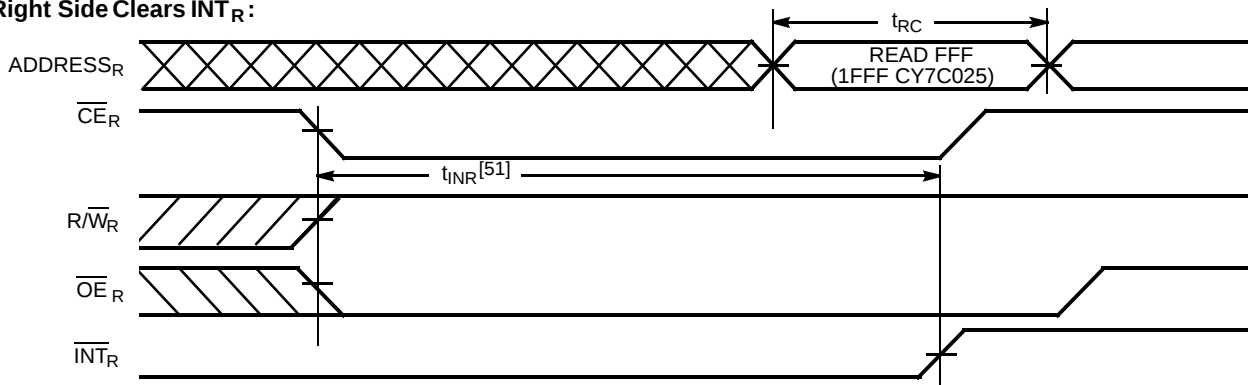
## Switching Waveforms (continued)

Figure 15. Interrupt Timing Diagrams

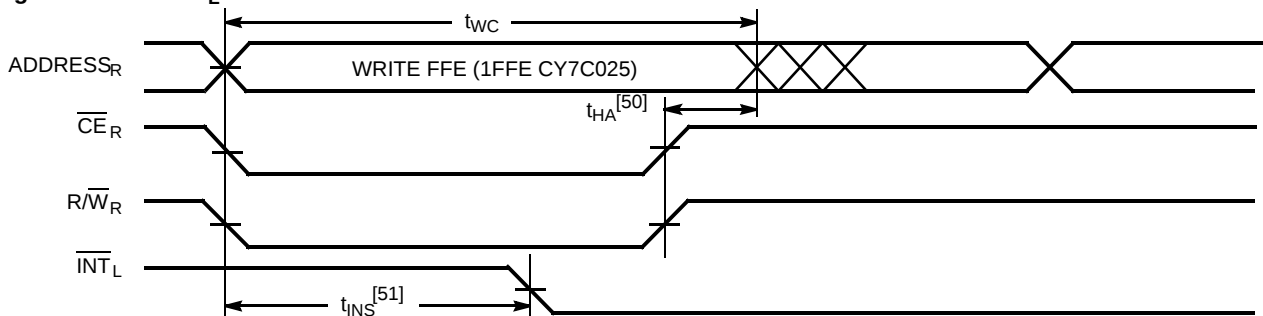
Left Side Sets  $\overline{\text{INT}}_R$  :



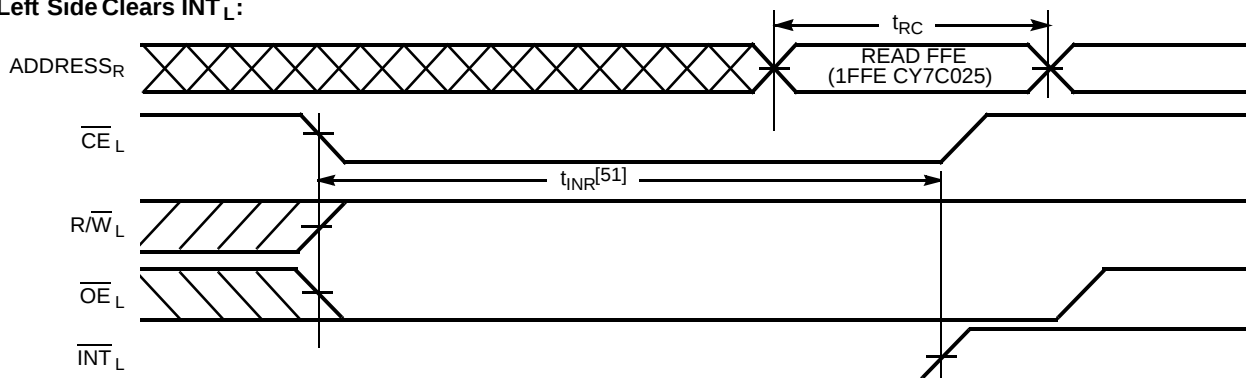
Right Side Clears  $\text{INT}_R$  :



Right Side Sets  $\text{INT}_L$  :



Left Side Clears  $\text{INT}_L$  :



### Notes

50.  $t_{HA}$  depends on which enable pin ( $\overline{\text{CE}}_L$  or  $\overline{\text{R}}/\overline{\text{W}}_L$ ) is deasserted first.  
51.  $t_{INS}$  or  $t_{INR}$  depends on which enable pin ( $\overline{\text{CE}}_L$  or  $\overline{\text{R}}/\overline{\text{W}}_L$ ) is asserted last.

### Ordering Information (4K x16 Dual-Port SRAM)

| Speed (ns) | Ordering Code  | Package Name | Package Type         | Operating Range |
|------------|----------------|--------------|----------------------|-----------------|
| 15         | CY7C024E-15AXC | A100         | 100-Pin Pb-free TQFP | Commercial      |
| 25         | CY7C024E-25AXC | A100         | 100-Pin Pb-free TQFP | Commercial      |
|            | CY7C024E-25AXI | A100         | 100-Pin Pb-free TQFP | Industrial      |
| 55         | CY7C024E-55AXC | A100         | 100-Pin Pb-free TQFP | Commercial      |

### Ordering Information (8K x 16 Dual-Port SRAM)

| Speed (ns) | Ordering Code  | Package Name | Package Type         | Operating Range |
|------------|----------------|--------------|----------------------|-----------------|
| 25         | CY7C025E-25AXC | A100         | 100-Pin Pb-free TQFP | Commercial      |
|            | CY7C025E-25AXI | A100         | 100-Pin Pb-free TQFP | Industrial      |
| 55         | CY7C025E-55AXC | A100         | 100-Pin Pb-free TQFP | Commercial      |

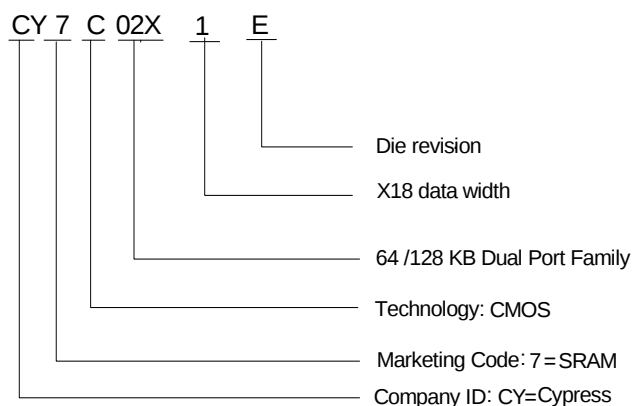
### Ordering Information (4K x 18 Dual-Port SRAM)

| Speed (ns) | Ordering Code   | Package Name | Package Type         | Operating Range |
|------------|-----------------|--------------|----------------------|-----------------|
| 15         | CY7C0241E-15AXC | A100         | 100-Pin Pb-free TQFP | Commercial      |
|            | CY7C0241E-15AXI | A100         | 100-Pin Pb-free TQFP | Industrial      |
| 25         | CY7C0241E-25AXC | A100         | 100-Pin Pb-free TQFP | Commercial      |

### Ordering Information (8K x 18 Dual-Port SRAM )

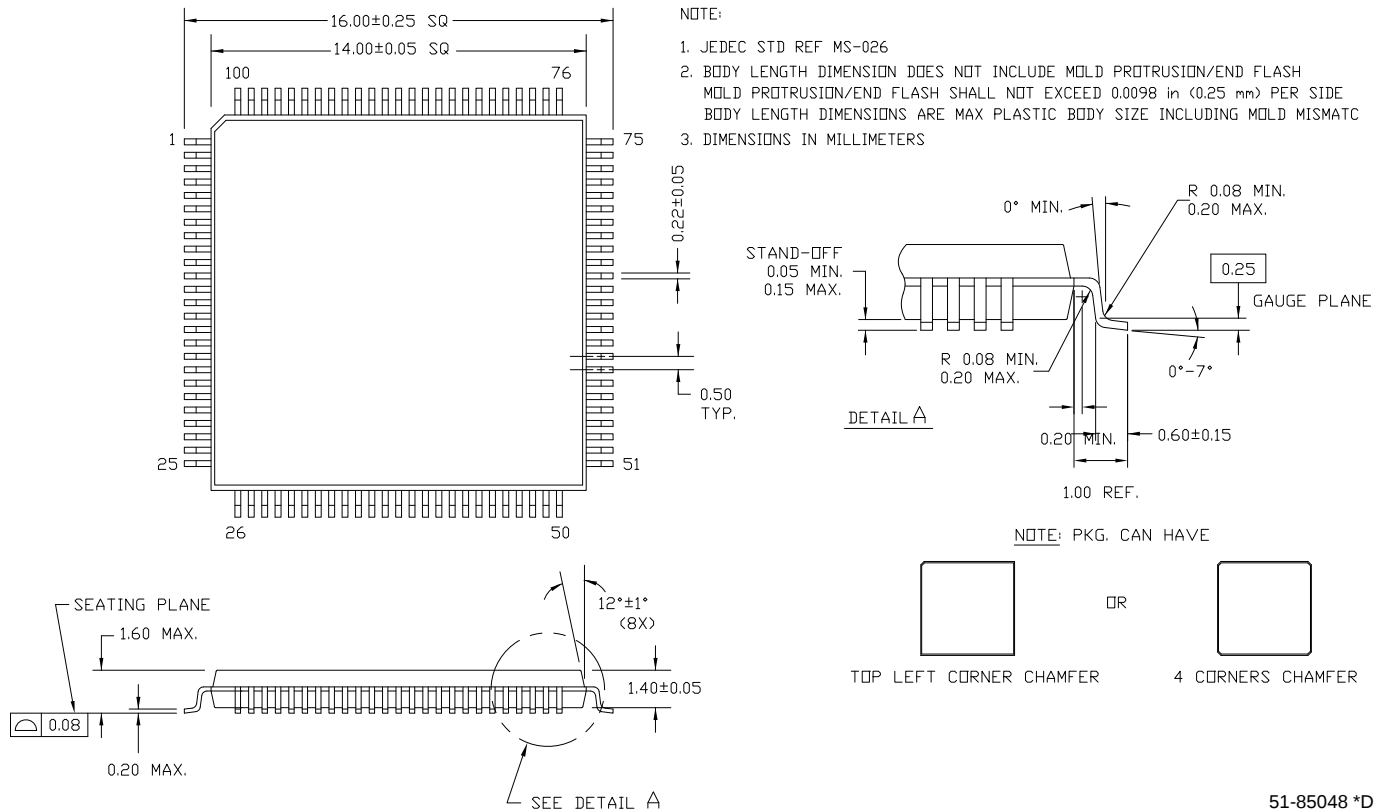
| Speed (ns) | Ordering Code   | Package Name | Package Type         | Operating Range |
|------------|-----------------|--------------|----------------------|-----------------|
| 15         | CY7C0251E-15AXC | A100         | 100-Pin Pb-free TQFP | Commercial      |

### Ordering Code Definition



## Package Diagrams

**Figure 16. 100-Pin Pb-free Thin Quad Flat Pack (TQFP) A100**



51-85048 \*D

## Acronyms

| Acronym | Description                             |
|---------|-----------------------------------------|
| CMOS    | Complementary metal oxide semiconductor |
| CE      | Chip enable                             |
| OE      | Output enable                           |
| RAM     | Random access memory                    |
| TQFP    | Thin quad plastic flatpack              |

## Document History Page

| Document Title: CY7C024E, CY7C0241E, CY7C025E, CY7C0251E, 4K x 16/18 and 8K x 16/18 Dual-Port Static RAM with SEM, INT, BUSY<br>Document Number: 001-62932 |         |                 |                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|-----------------|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Rev.                                                                                                                                                       | ECN No. | Orig. of Change | Submission Date | Description of Change                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| **                                                                                                                                                         | 2975554 | RAME            | 07/09/2010      | New Datasheet                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| *A                                                                                                                                                         | 3056347 | ADMU            | 10/28/2010      | <p>Updated "<a href="#">Selection Guide</a>" on page 1:<br/>           For speed bin -25: Typical Operating current(mA) changed from 180 to 170, Typical standby current for ISB1 (mA) changed from 45 to 40<br/>           For speed bin -55: Typical Operating current(mA) changed from 180 to 150, Typical standby current for ISB1 (mA) changed from 45 to 20</p> <p>Updated "<a href="#">Electrical Characteristics Over the Operating Range</a>" on page 9:<br/>           The values for the speed bins -25 and -55 have been put into separate columns. The values for Commercial parts have been modified for the following parameters: (no degradation of spec)<br/>           Operating Current ICC: "180(typ) / 275(max)" changed to "170(typ) / 250(max) for speed bin -25" and "150(typ) / 230(max) for speed bin -55"<br/>           Standby Current ISB1 (both ports TTL levels): "45(typ) / 65(max)" changed to "40(typ) / 60(max) for speed bin -25", and "20(typ) / 50(max) for speed bin -55"<br/>           Standby Current ISB2 (one port TTL level) : "110(typ) / 160(max)" changed to "100(typ) / 150(max) for speed bin -25", and "75(typ) / 135(max) for speed bin -55"<br/>           Standby Current ISB4 (both ports CMOS Levels) : "100(typ) / 140(max)" changed to "90(typ) / 130(max) for speed bin -25", and "70(typ) / 120(max) for speed bin -55"</p> <p>Updated "<a href="#">Ordering Information (4K x 18 Dual-Port SRAM)</a>" on page 19:<br/>           Removed part CY7C0241E - 55AXI from ordering information.</p> |

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