CY7C024E
CY7C025E
CY7C0251E

4K × 16 and 8K × 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 × 16 organization (CY7C024E)
- 8K × 16 organization (CY7C025E)
- 8K × 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 mA (typ), I_{SB3} = 0.05 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
- $\overline{INT}$ 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 and CY7C025E/CY7C0251E are low-power CMOS 4K × 16 and 8K × 16/18 dual-port static RAMs. Various arbitration schemes are included on the CY7C024E 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 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/$\overline{S}$ 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 ($\overline{CE}$), Read or Write Enable (R/$\overline{W}$), and Output Enable ($\overline{OE}$). Two flags are provided on each port ($\overline{BUSY}$ and $\overline{INT}$). $\overline{BUSY}$ signals that the port is trying to access the same location currently being accessed by the other port. The Interrupt Flag ($\overline{INT}$) 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 $\overline{CE}$ pin.

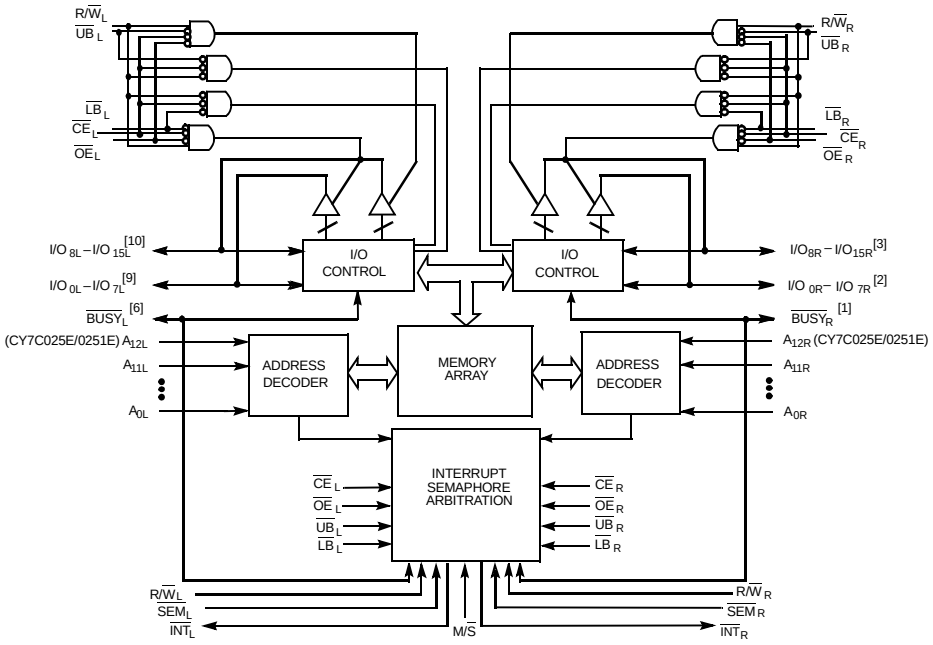
The CY7C024E and CY7C025E/CY7C0251E are available in 100-pin Pb-free TQFP.

For a complete list of related documentation, click here.

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



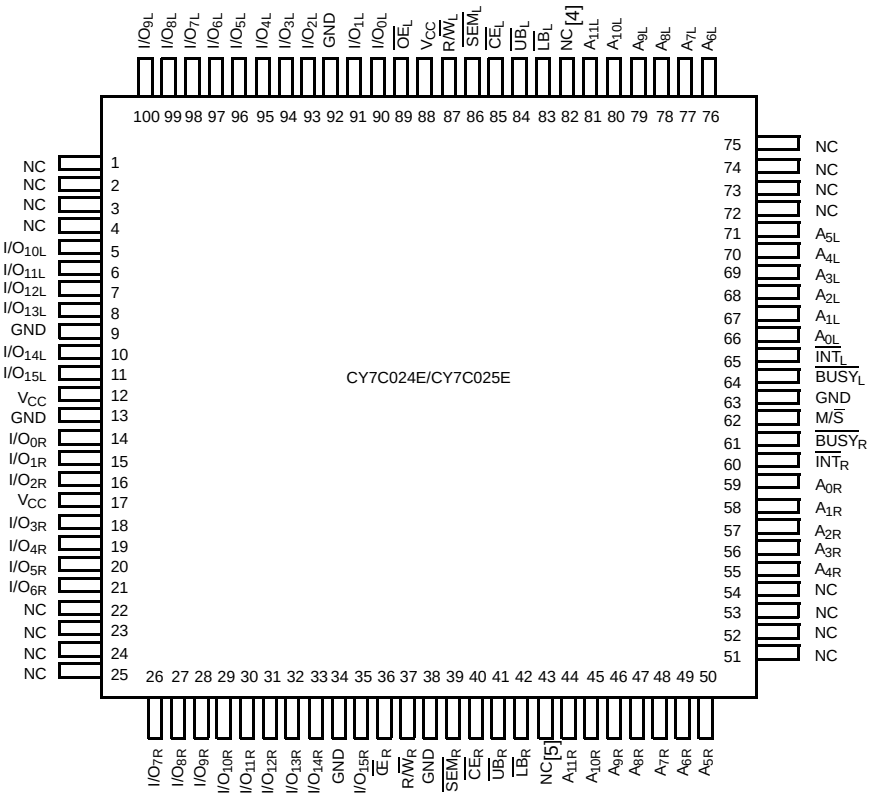
Notes
1. $\overline{BUSY}$ is an output in master mode and an input in slave mode.
2. I/O_0–I/O_8 on the CY7C0251E.
3. I/O_9–I/O_{17} on the CY7C0251E.

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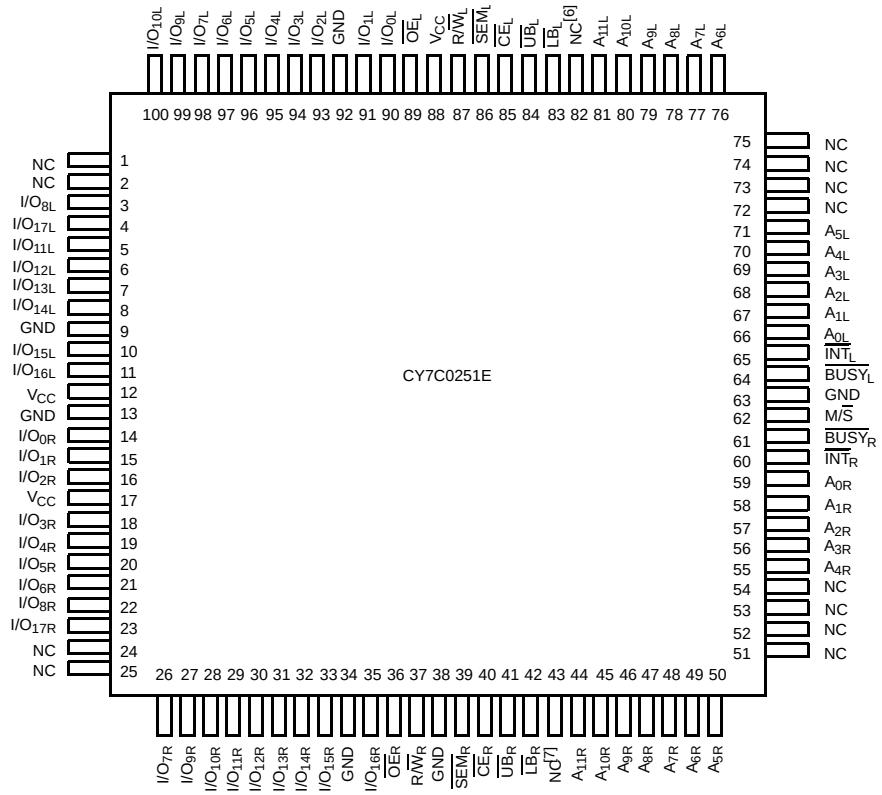
Pin Configurations

Figure 1. 100-pin TQFP pinout (Top View)



Notes
4. A_{12L} on the CY7C025E/CY7C0251E.
5. A_{12R} on the CY7C025E/CY7C0251E.

Figure 2. 100-pin TQFP pinout (Top View)



Pin Definitions

Left Port	Right Port	Description
$\overline{CE}_L$	$\overline{CE}_R$	Chip enable
R/$\overline{W}_L$	R/$\overline{W}_R$	Read/write enable
$\overline{OE}_L$	$\overline{OE}_R$	Output enable
A_{0L}–$A_{11/12L}$	A_{0R}–$A_{11/12R}$	Address
I/O_{0L}–$I/O_{15/17L}$	I/O_{0R}–$I/O_{15/17R}$	Data bus input/output
$\overline{SEM}_L$	$\overline{SEM}_R$	Semaphore enable
$\overline{UB}_L$	$\overline{UB}_R$	Upper byte select
$\overline{LB}_L$	$\overline{LB}_R$	Lower byte select
$\overline{INT}_L$	$\overline{INT}_R$	Interrupt flag
$\overline{BUSY}_L$ [8]	$\overline{BUSY}_R$ [8]	Busy flag
M/$\overline{S}$		Master or slave select
V_{CC}		Power
GND		Ground

Notes
6. A_{12L} on the CY7C025E/CY7C0251E.
7. A_{12R} on the CY7C025E/CY7C0251E.
8. $\overline{BUSY}$ is an output in master mode and an input in slave mode.

Architecture

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

Functional Overview

Write Operation

Data must be set up for a duration of t_{SD} before the rising edge of R/$\overline{W}$ to guarantee a valid write. A write operation is controlled by either the R/$\overline{W}$ pin (see Figure 7) or the $\overline{CE}$ 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_{DDD} after the data is presented on the other port.

Table 1. Non-Contending Read/Write

Inputs						Outputs		Operation
$\overline{CE}$	R/$\overline{W}$	$\overline{OE}$	$\overline{UB}$	$\overline{LB}$	$\overline{SEM}$	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 CY7C0251E.
10. I/O_9–I/O_{17} on the CY7C0251E.

Read Operation

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

Interrupts

The upper two memory locations may be used for message passing. The highest memory location (FFF for the CY7C024E, 1FFF for the CY7C025E/CY7C0251E) is the mailbox for the right port and the second-highest memory location (FFE for the CY7C024E, 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 $\overline{BUSY}$ signal (to a port) prevents the port from setting the interrupt to the winning port. Also, an active $\overline{BUSY}$ 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.

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

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

Notes
11. A_{0L-12L} and A_{0R-12R}, 1FFF/1FFE for the CY7C025E/CY7C0251E.
12. If $\overline{BUSY}_L$ = L, then no change.
13. If $\overline{BUSY}_R$ = L, then no change.

Busy

The CY7C024E and CY7C025E/CY7C0251E provide on-chip arbitration to resolve simultaneous memory location access (contention). If both ports' $\overline{CE}$s 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. $\overline{BUSY}$ is asserted t_{BLA} after an address match or t_{BLC} after $\overline{CE}$ is taken LOW.

Master/Slave

A M/$\overline{S}$ pin is provided to expand the word width by configuring the device as either a master or a slave. The $\overline{BUSY}$ output of the master is connected to the $\overline{BUSY}$ 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 $\overline{BUSY}$ 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/$\overline{S}$ pin allows the device to be used as a master and, therefore, the $\overline{BUSY}$ line is an output. $\overline{BUSY}$ can then be used to send the arbitration outcome to a slave.

Semaphore Operation

The CY7C024E 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, $\overline{SEM}$ or $\overline{OE}$ 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 $\overline{SEM}$ LOW. The $\overline{SEM}$ pin functions as a chip select for the semaphore latches ($\overline{CE}$ must remain HIGH during $\overline{SEM}$ LOW). $A_{0–2}$ represents the semaphore address. $\overline{OE}$ and R/$\overline{W}$ 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 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 3. Semaphore Operation Example

Function	I/O_0–$I/O_{15/17}$ Left	I/O_0–$I/O_{15/17}$ 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

Maximum Ratings

Exceeding maximum ratings[14] 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 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[15] .....–0.5 V to +7.0 V

Output 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	V_{CC}
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_{OH}	Output HIGH voltage	V_{CC} = Min, I_{OH} = –4.0 mA		2.4	–	–	2.4	–	–	2.4	–	–	V
V_{OL}	Output LOW voltage	V_{CC} = Min, I_{OL} = 4.0 mA		–	–	0.4	–	–	0.4	–	–	0.4	V
V_{IH}	Input HIGH voltage			2.2	–	–	2.2	–	–	2.2	–	–	V
V_{IL}	Input LOW voltage			–	–	0.8	–	–	0.8	–	–	0.8	V
I_{IX}	Input leakage current	GND ≤ V_I ≤ V_{CC}		–10	–	+10	–10	–	+10	–10	–	+10	µA
I_{OZ}	Output leakage current	Output disabled, GND ≤ V_O ≤ V_{CC}		–10	–	+10	–10	–	+10	–10	–	+10	µA
I_{CC}	Operating current	V_{CC} = Max, I_{OUT} = 0 mA, Outputs Disabled	Commercial	–	190	285	–	170	250	–	150	230	mA
			Industrial	–	215	305	–	180	290	–	180	290	
I_{SB1}	Standby current (both ports TTL levels)	$\overline{CE}_L$ and $\overline{CE}_R$ ≥ V_{IH}, f = f_{MAX}[16]	Commercial	–	50	70	–	40	60	–	20	50	mA
			Industrial	–	65	95	–	55	80	–	55	80	
I_{SB2}	Standby current (one port TTL level)	$\overline{CE}_L$ or $\overline{CE}_R$ ≥ V_{IH}, f = f_{MAX}[16]	Commercial	–	120	180	–	100	150	–	75	135	mA
			Industrial	–	135	205	–	120	175	–	120	175	
I_{SB3}	Standby current (both ports CMOS levels)	Both Ports $\overline{CE}$ and $\overline{CE}_R$ ≥ V_{CC} – 0.2 V, V_{IN} ≥ V_{CC} – 0.2 V or V_{IN} ≤ 0.2 V, f = 0[16]	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_{SB4}	Standby current (both ports CMOS levels)	One Port $\overline{CE}_L$ or $\overline{CE}_R$ ≥ V_{CC} – 0.2 V, V_{IN} ≥ V_{CC} – 0.2 V or V_{IN} ≤ 0.2 V, Active Port Outputs, f = f_{MAX}[16]	Commercial	–	110	160	–	90	130	–	70	120	mA
			Industrial	–	125	175	–	110	150	–	110	150	

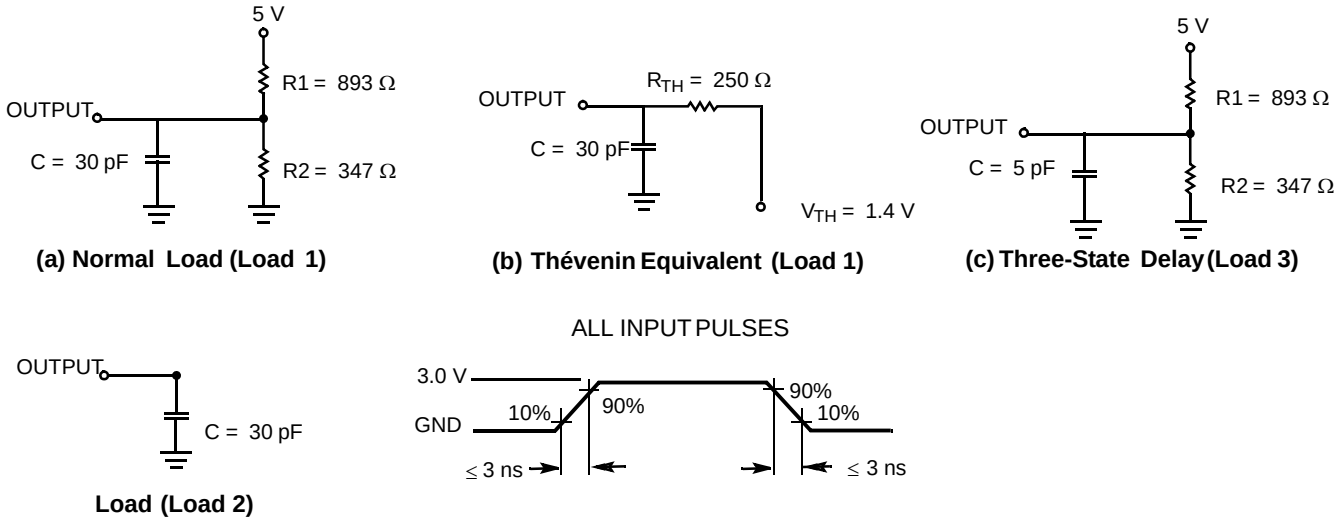
Notes
14. The voltage on any input or I/O pin cannot exceed the power pin during power-up.
15. Pulse width < 20 ns.
16. f_{MAX} = 1/t_{RC} = All inputs cycling at f = 1/t_{RC} (except output enable). f = 0 means no address or control lines change. This applies only to inputs at CMOS level standby I_{SB3}.

Capacitance

Parameter [17]	Description	Test Conditions	Max	Unit
C_{IN}	Input capacitance	T_A = 25 °C, f = 1 MHz, V_{CC} = 5.0 V	10	pF
C_{OUT}	Output capacitance		10	pF

AC Test Loads and Waveforms

Figure 3. AC Test Loads and Waveforms

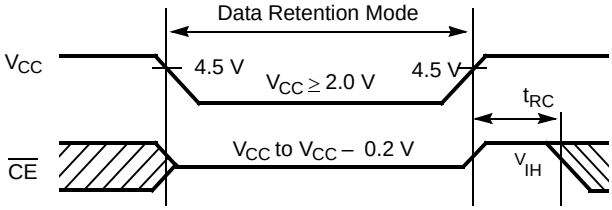


Data Retention Mode

The CY7C024E 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[18]	Max	Unit
ICC_{DR1}	At VCC_{DR} = 2 V	1.5	mA

Notes
17. Tested initially and after any design or process changes that may affect these parameters.
18. $\overline{CE}$ = V_{CC}, V_{in} = GND to V_{CC}, T_A = 25°C. This parameter is guaranteed but not tested.

Switching Characteristics

Over the Operating Range

Parameter [19]	Description	-15		-25		-55		Unit
		Min	Max	Min	Max	Min	Max	
Read Cycle								
t_{RC}	Read cycle time	15	–	25	–	55	–	ns
t_{AA}	Address to data valid	–	15	–	25	–	55	ns
t_{OHA}	Output hold from address change	3	–	3	–	3	–	ns
t_{ACE}[20]	$\overline{CE}$ LOW to data valid	–	15	–	25	–	55	ns
t_{DOE}	$\overline{OE}$ LOW to data valid	–	10	–	13	–	25	ns
t_{LZOE}[21, 22, 23]	$\overline{OE}$ low to low Z	3	–	3	–	3	–	ns
t_{HZOE}[21, 22, 23]	$\overline{OE}$ HIGH to high Z	–	10	–	15	–	25	ns
t_{LZCE}[21, 22, 23]	$\overline{CE}$ LOW to low Z	3	–	3	–	3	–	ns
t_{HZCE}[21, 22, 23]	$\overline{CE}$ HIGH to High Z	–	10	–	15	–	25	ns
t_{PU}[23]	$\overline{CE}$ LOW to power-up	0	–	0	–	0	–	ns
t_{PD}[23]	$\overline{CE}$ HIGH to power-down	–	15	–	25	–	55	ns
t_{ABE}[20]	Byte enable access time	–	15	–	25	–	55	ns
Write Cycle								
t_{WC}	Write cycle time	15	–	25	–	55	–	ns
t_{SCE}[20]	$\overline{CE}$ LOW to write end	12	–	20	–	35	–	ns
t_{AW}	Address setup to write end	12	–	20	–	35	–	ns
t_{HA}	Address hold from write end	0	–	0	–	0	–	ns
t_{SA}[24]	Address setup to write start	0	–	0	–	0	–	ns
t_{PWE}	Write pulse width	12	–	20	–	35	–	ns
t_{SD}	Data setup to write end	10	–	15	–	20	–	ns
t_{HD}	Data hold from write end	0	–	0	–	0	–	ns
t_{HZWE}[25, 26]	R/$\overline{W}$ LOW to high Z	–	10	–	15	–	25	ns
t_{LZWE}[25, 26]	R/$\overline{W}$ HIGH to low Z	3	–	3	–	3	–	ns
t_{WDD}[27]	Write pulse to data delay	–	30	–	50	–	70	ns
t_{DDD}[27]	Write data valid to read data valid	–	25	–	35	–	45	ns

Notes

19. 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.
20. 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.
21. 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}.
22. Test conditions used are Load 3.
23. This parameter is guaranteed but not tested.
24. 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.
25. Test conditions used are Load 3.
26. This parameter is guaranteed but not tested.
27. For information on port-to-port delay through RAM cells from writing port to reading port, refer to Figure 11 on page 16.

Switching Characteristics (continued)

Over the Operating Range

Parameter [19]	Description	-15		-25		-55		Unit
		Min	Max	Min	Max	Min	Max	
Busy Timing[28]								
t_{BLA}	$\overline{BUSY}$ LOW from Address Match	–	15	–	20	–	45	ns
t_{BHA}	$\overline{BUSY}$ HIGH from Address Mismatch	–	15	–	20	–	40	ns
t_{BLC}	$\overline{BUSY}$ LOW from $\overline{CE}$ LOW	–	15	–	20	–	40	ns
t_{BHC}	$\overline{BUSY}$ HIGH from $\overline{CE}$ HIGH	–	15	–	20	–	35	ns
t_{PS}	Port Setup for Priority	5	–	5	–	5	–	ns
t_{WB}	R/$\overline{W}$ HIGH after $\overline{BUSY}$ (Slave)	0	–	0	–	0	–	ns
t_{WH}	R/$\overline{W}$ HIGH after $\overline{BUSY}$ HIGH (Slave)	13	–	20	–	40	–	ns
t_{BDD}[29]	$\overline{BUSY}$ HIGH to Data Valid	–	Note 29		Note 29		Note 29	ns
Interrupt Timing[28]								
t_{INS}	$\overline{INT}$ Set Time	–	15	–	20	–	30	ns
t_{INR}	$\overline{INT}$ Reset Time	–	15	–	20	–	30	ns
Semaphore Timing								
t_{SOP}	SEM Flag Update Pulse ($\overline{OE}$ or $\overline{SEM}$)	10	–	12	–	20	–	ns
t_{SWRD}	SEM Flag Write to Read Time	5	–	10	–	15	–	ns
t_{SPS}	SEM Flag Contention Window	5	–	10	–	15	–	ns
t_{SAA}	SEM Address Access Time	–	15		25	–	55	ns

Notes
28. Test conditions used are Load 2.
29. t_{BDD} is a calculated parameter and is the greater of t_{WDD}– t_{PWE} (actual) or t_{DDD}– t_{SD} (actual).

Switching Waveforms

Figure 4. Read Cycle No. 1 (Either Port Address Access) [30, 31, 32]

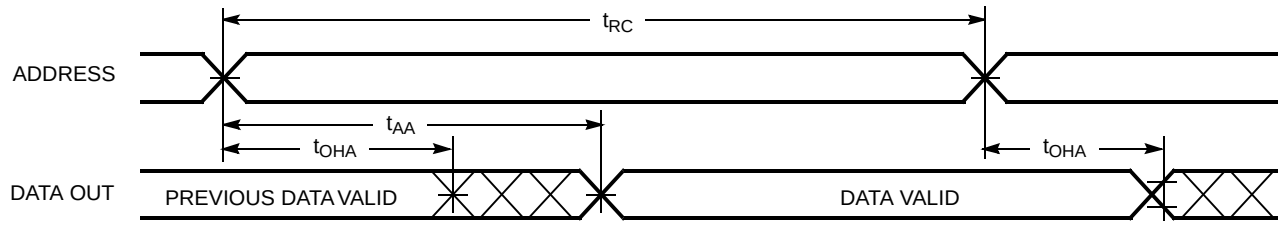


Figure 5. Read Cycle No. 2 (Either Port $\overline{CE}$/$\overline{OE}$ Access) [30, 33, 34]

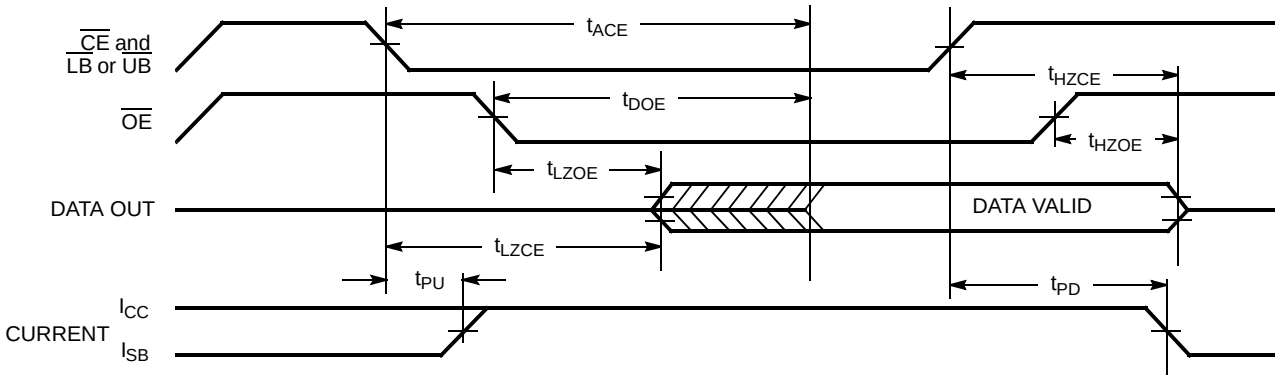
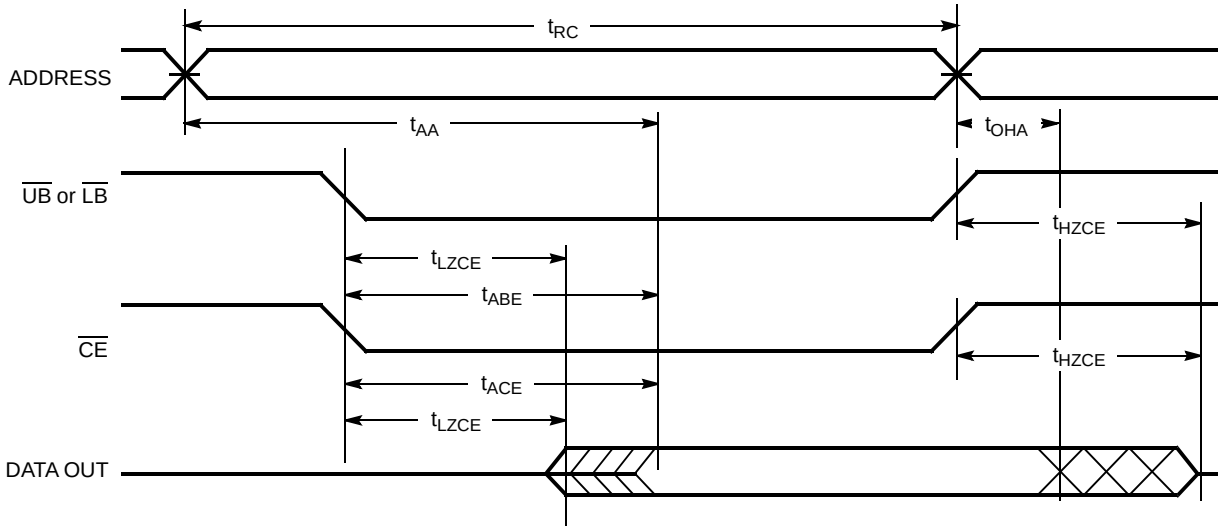


Figure 6. Read Cycle No. 3 (Either Port) [30, 32, 33, 34]



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

Switching Waveforms (continued)

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

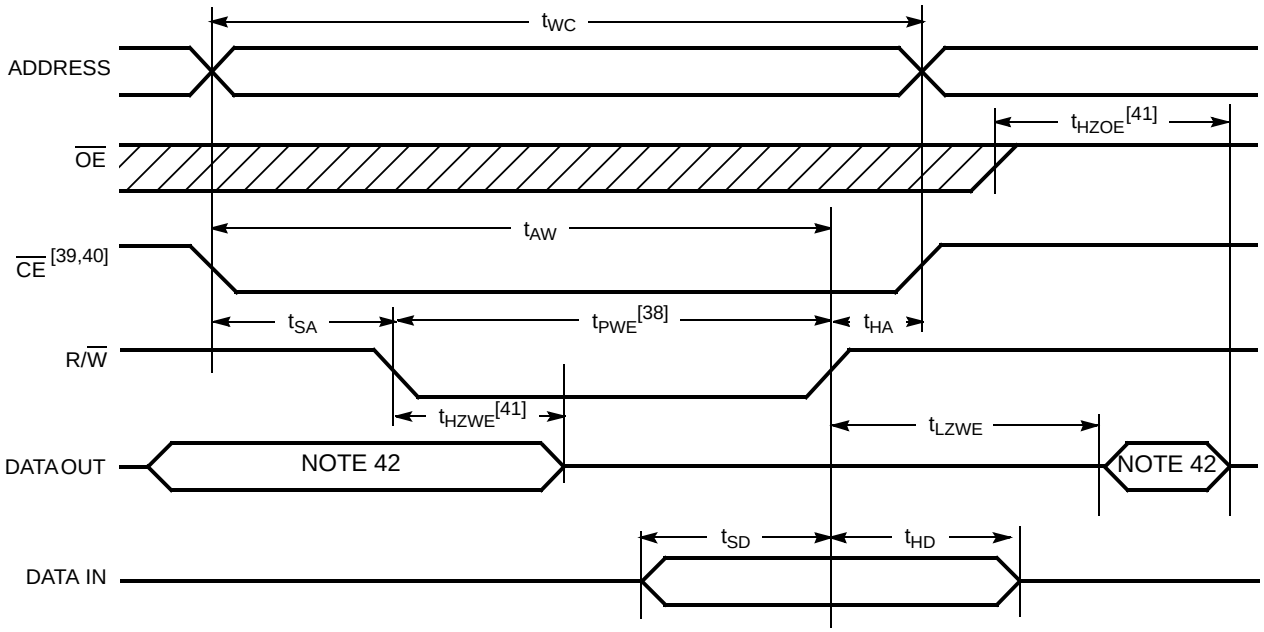
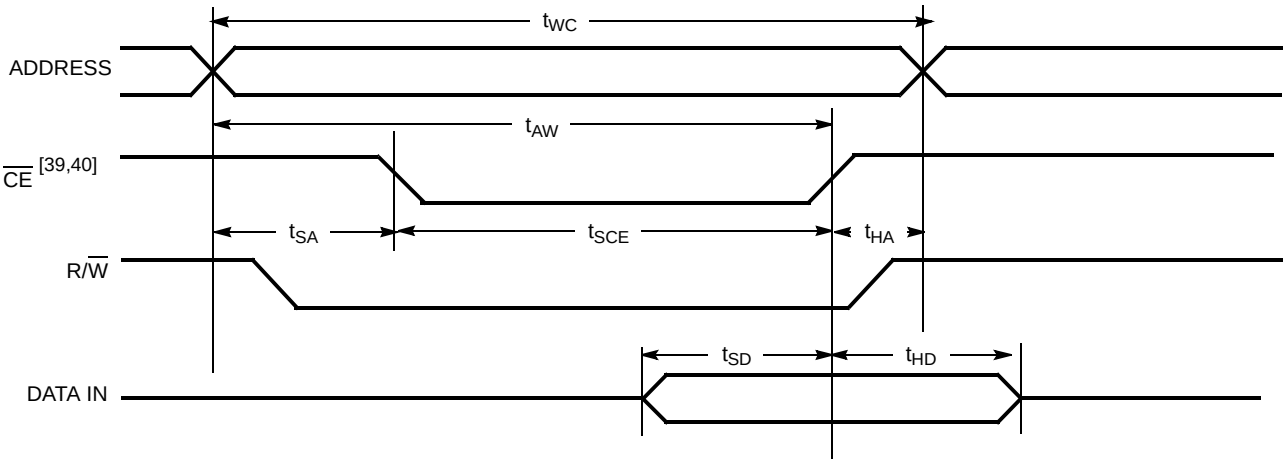


Figure 8. Write Cycle No. 2 ($\overline{CE}$ Controlled Timing) [35, 36, 37, 43]



Notes
35. 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 R/$\overline{W}$ or ($\overline{SEM}$ or R/$\overline{W}$) going HIGH at the end of write cycle.
38. If $\overline{OE}$ is LOW during a 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 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 ±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 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 [44]

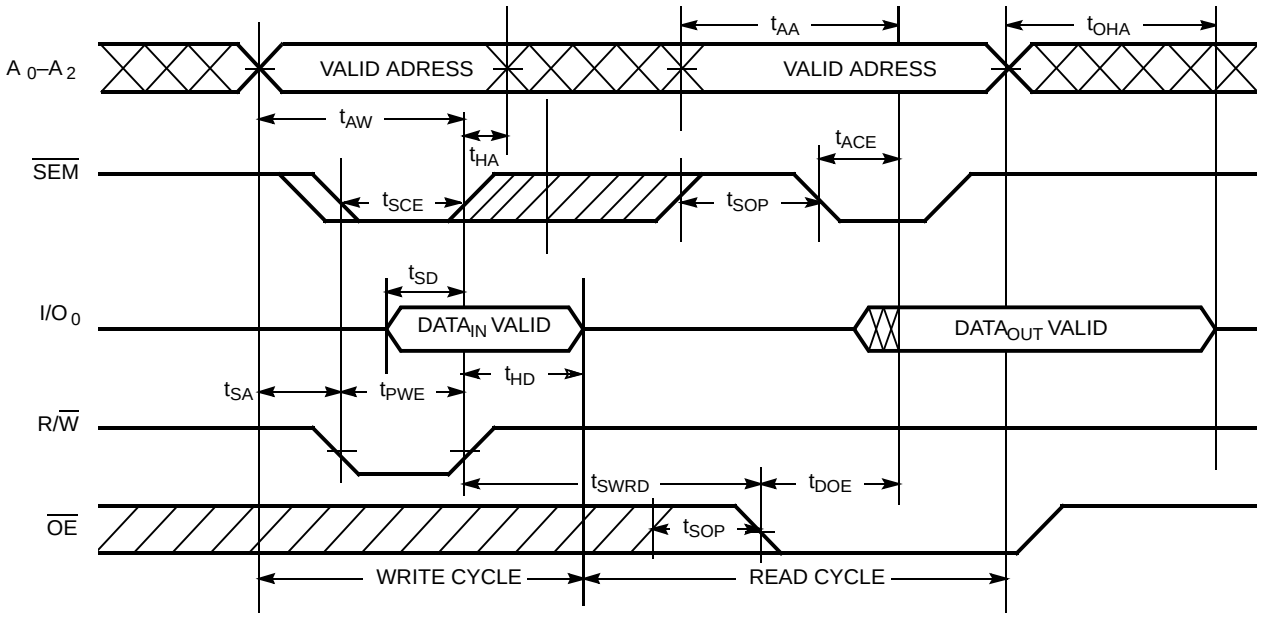
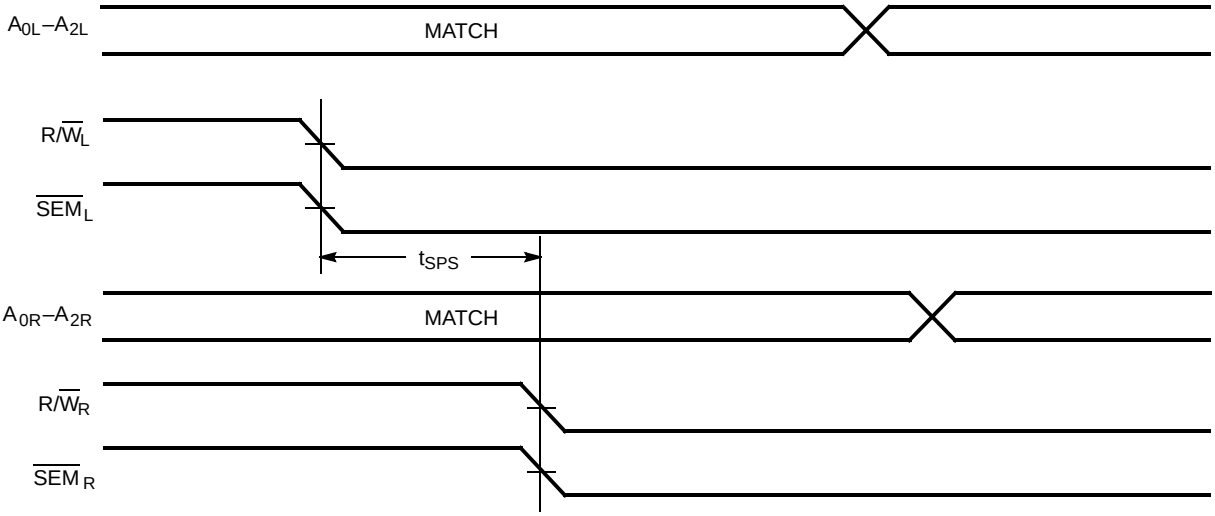


Figure 10. Timing Diagram of Semaphore Contention [45, 46, 47]



Notes
44. $\overline{CE}$ = HIGH for the duration of the above timing (both write and read cycle).
45. $I/O_{0R} = I/O_{0L}$ = LOW (request semaphore); $\overline{CE}_R = \overline{CE}_L$ = HIGH.
46. Semaphores are reset (available to both ports) at cycle start.
47. If t_{SPS} 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 $\overline{BUSY}$ (M/$\overline{S}$ = HIGH) [48]

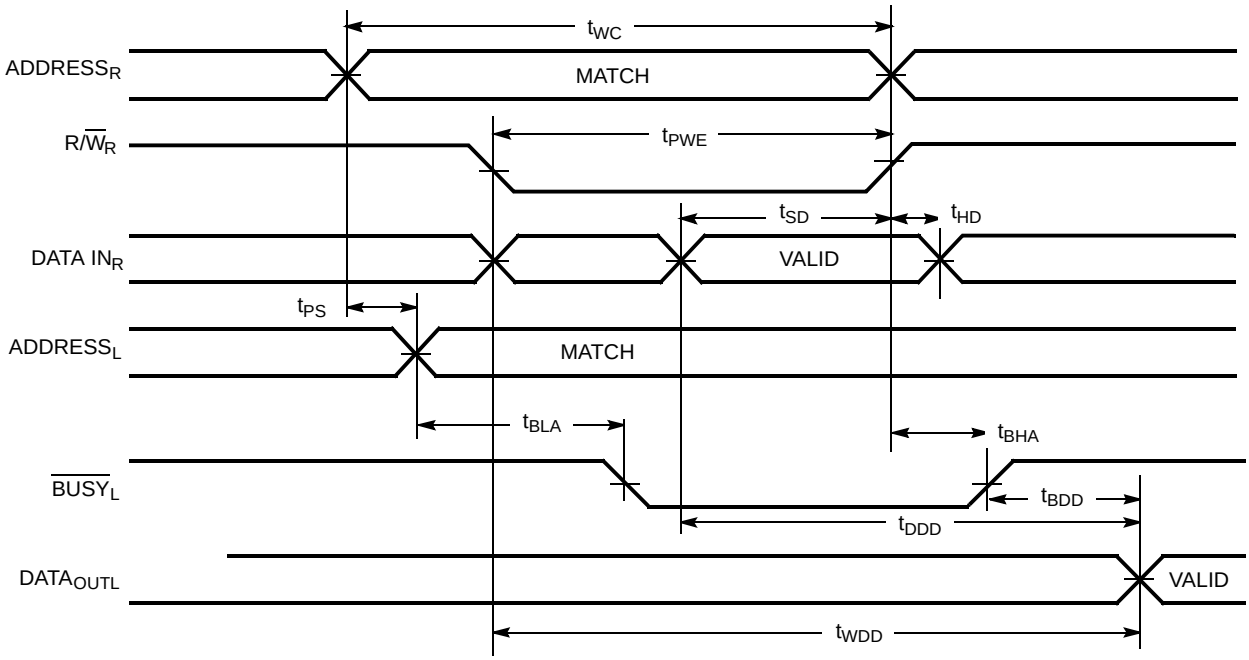
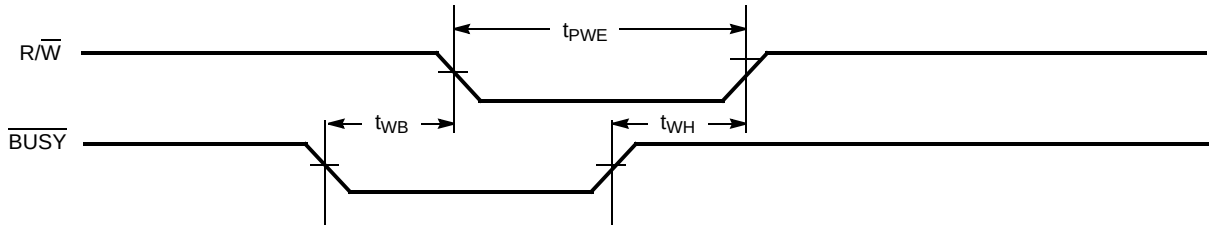


Figure 12. Write Timing with Busy Input (M/$\overline{S}$ = LOW)

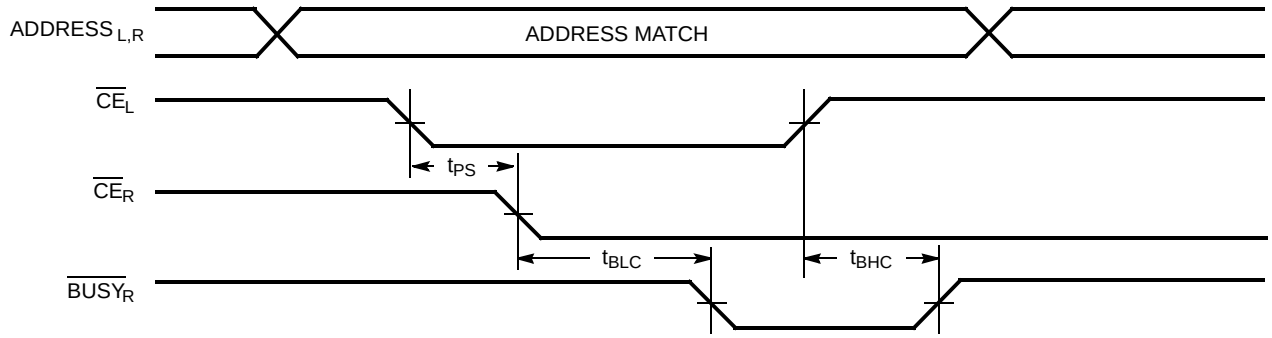


Note
48. $\overline{CE}_L$ = $\overline{CE}_R$ = LOW.

Switching Waveforms (continued)

Figure 13. Busy Timing Diagram No. 1 ($\overline{CE}$ Arbitration) [49]

$\overline{CE}_L$ Valid First:



CE_R Valid First:

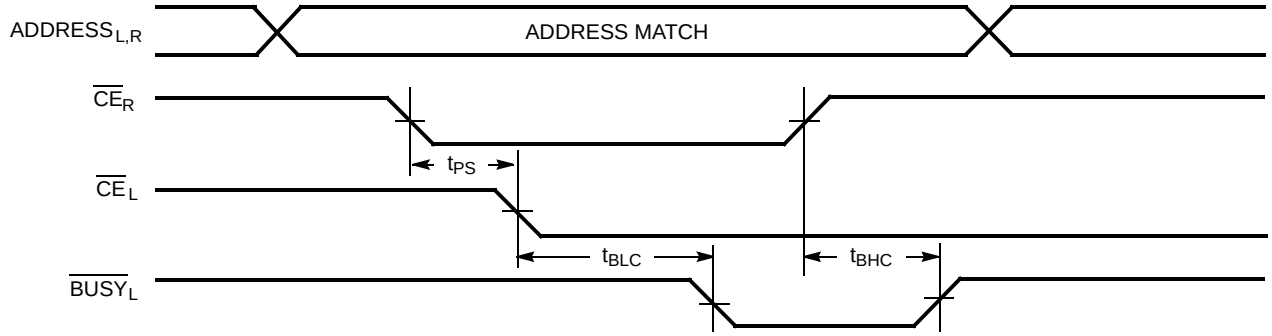
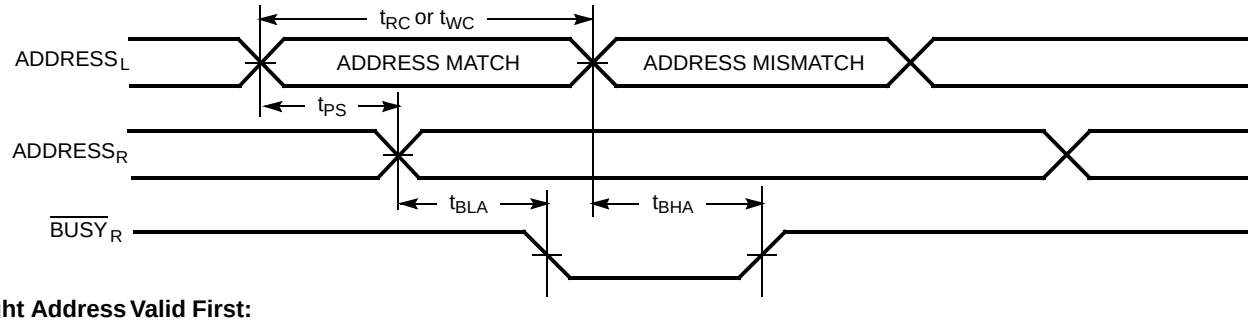
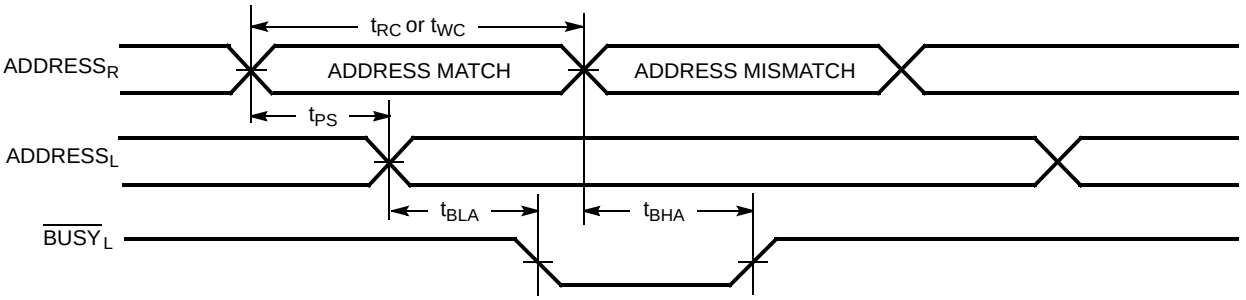


Figure 14. Busy Timing Diagram No. 2 (Address Arbitration) [49]

Left Address Valid First:



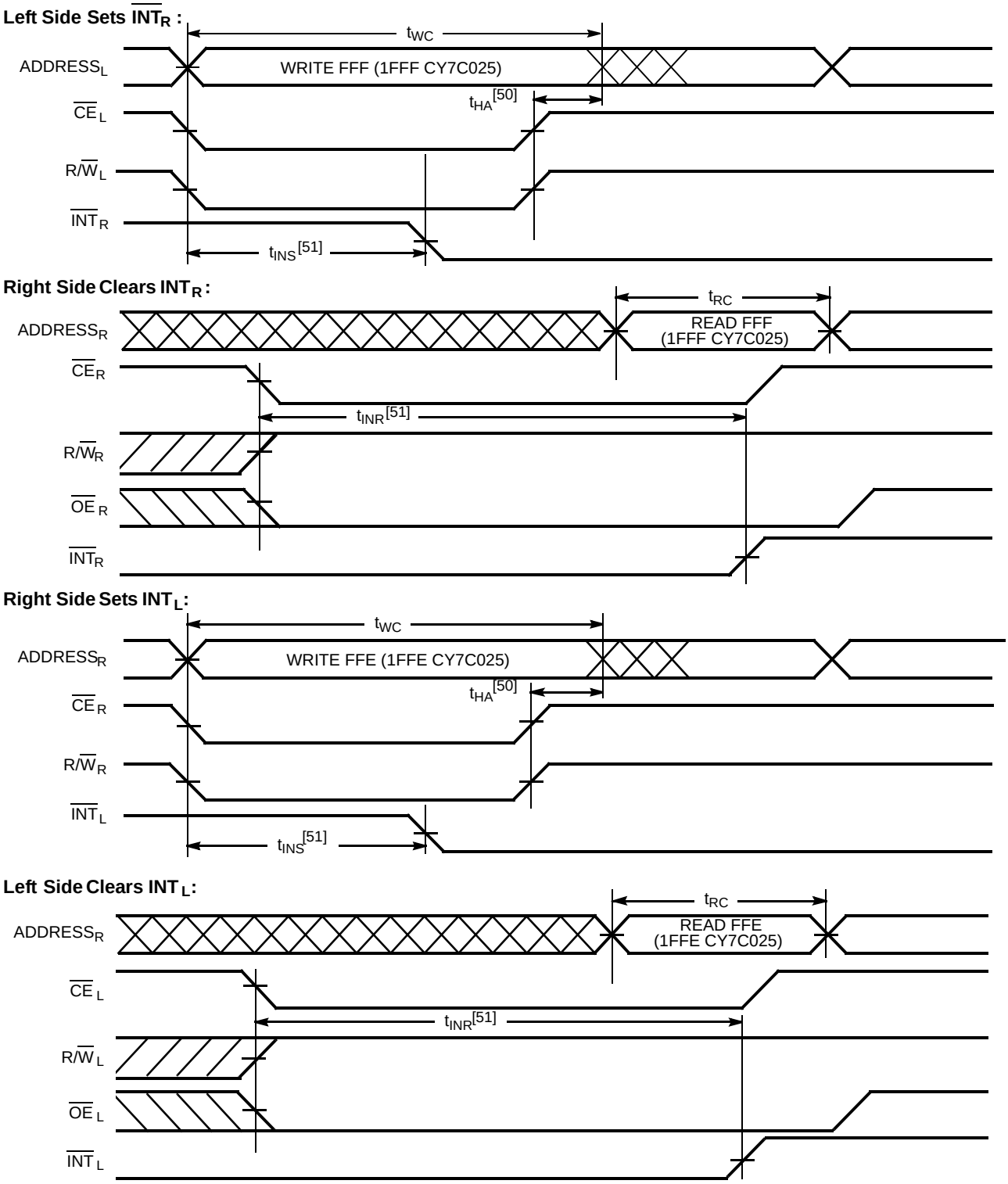
Right Address Valid First:



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 $\overline{BUSY}$ is asserted.

Switching Waveforms (continued)

Figure 15. Interrupt Timing Diagrams



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

Ordering Information

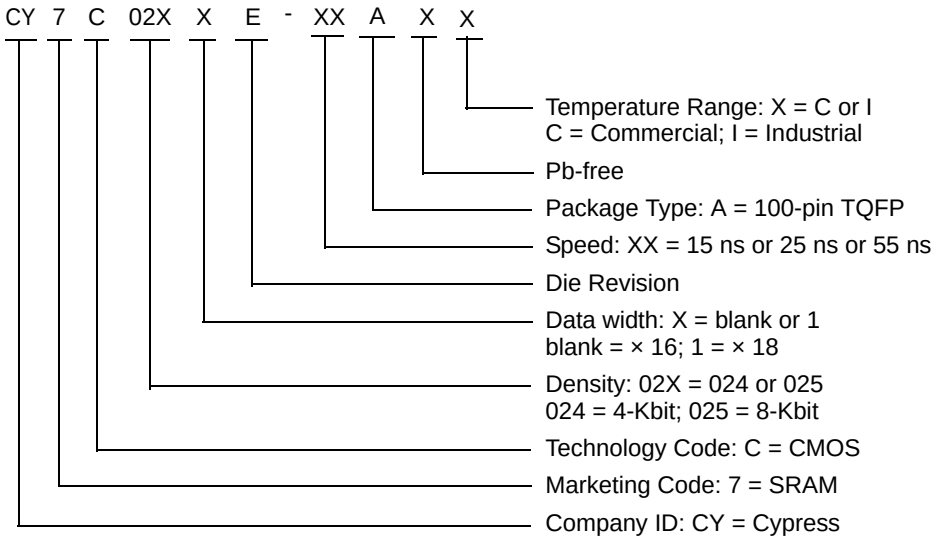
4K × 16 Dual-Port SRAM

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

8K × 16 Dual-Port SRAM

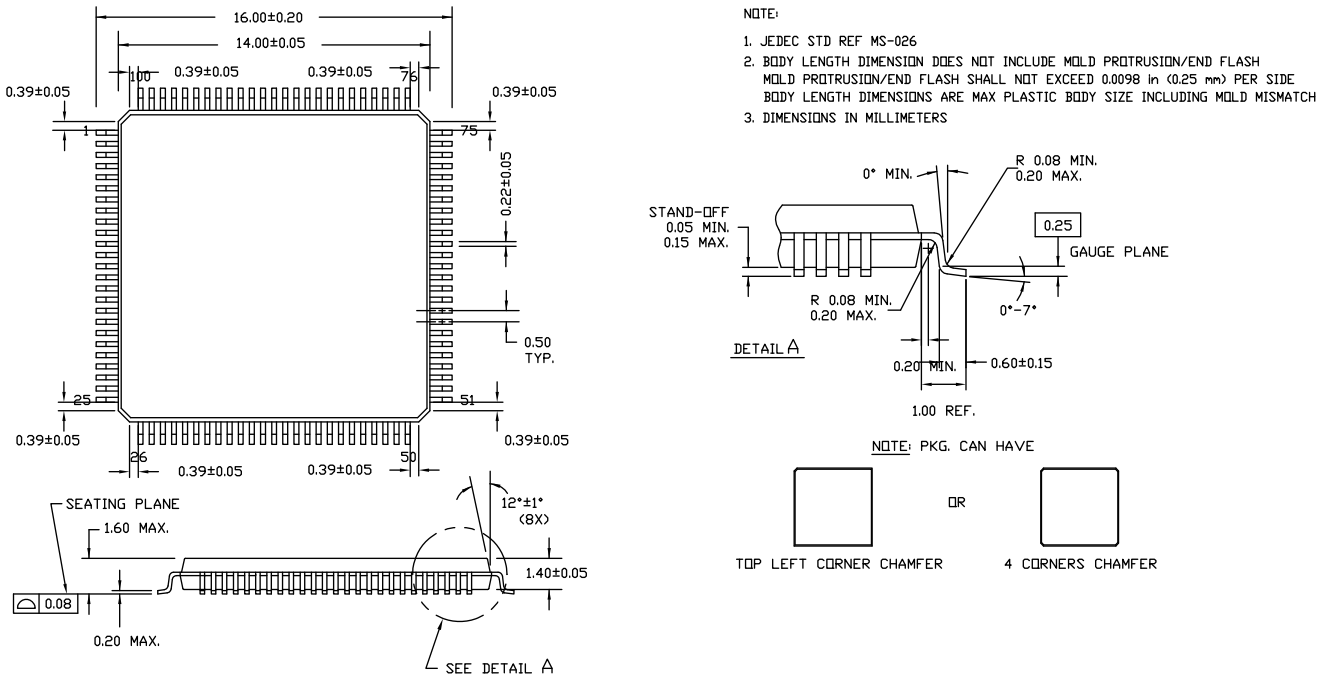
Speed (ns)	Ordering Code	Package Name	Package Type	Operating Range
25	CY7C025E-25AXC	A100	100-pin TQFP (Pb-free)	Commercial
	CY7C025E-25AXI	A100	100-pin TQFP (Pb-free)	Industrial

Ordering Code Definitions



Package Diagrams

Figure 16. 100-pin TQFP (14 × 14 × 1.4 mm) A100SA Package Outline, 51-85048



51-85048 *J

Acronyms

Acronym	Description
$\overline{CE}$	Chip Enable
CMOS	Complementary Metal Oxide Semiconductor
I/O	Input/Output
$\overline{OE}$	Output Enable
SRAM	Static Random Access Memory
TQFP	Thin Quad Flat Pack

Document Conventions

Units of Measure

Symbol	Unit of Measure
°C	degree Celsius
MHz	megahertz
µA	microampere
mA	milliampere
ns	nanosecond
Ω	ohm
%	percent
pF	picofarad
V	volt
W	watt

Document History Page

Document Title: CY7C024E/CY7C025E/CY7C0251E, 4K × 16 and 8K × 16/18 Dual-Port Static RAM with SEM, INT, BUSY Document Number: 001-62932				
Rev.	**ECN No.**	**Orig. of Change**	**Submission Date**	**Description of Change**
**	2975554	RAME	07/09/2010	New data sheet.
*A	3056347	ADMU	10/28/2010	Updated Selection Guide: Changed Typical Operating current (mA) from 180 mA to 170 mA (corresponding to speed bin -25). Changed Typical standby current for I_{SB1} (mA) from 45 mA to 40 mA (corresponding to speed bin -25). Changed Typical Operating current (mA) from 180 mA to 150 mA (corresponding to speed bin -55). Changed Typical standby current for I_{SB1} (mA) from 45 mA to 20 mA (corresponding to speed bin -55). Updated Electrical Characteristics: Separated values corresponding to speed bins -25 and -55 into two separate columns. Changed typical value of I_{CC} parameter from 180 mA to 170 mA (corresponding to speed bin -25 and test condition “Commercial”). Changed maximum value of I_{CC} parameter from 275 mA to 250 mA (corresponding to speed bin -25 and test condition “Commercial”). Changed typical value of I_{CC} parameter from 180 mA to 150 mA (corresponding to speed bin -55 and test condition “Commercial”). Changed maximum value of I_{CC} parameter from 275 mA to 230 mA (corresponding to speed bin -55 and test condition “Commercial”). Changed typical value of I_{SB1} parameter from 45 mA to 40 mA (corresponding to speed bin -25 and test condition “Commercial”). Changed maximum value of I_{SB1} parameter from 65 mA to 60 mA (corresponding to speed bin -25 and test condition “Commercial”). Changed typical value of I_{SB1} parameter from 45 mA to 20 mA (corresponding to speed bin -55 and test condition “Commercial”). Changed maximum value of I_{SB1} parameter from 65 mA to 50 mA (corresponding to speed bin -55 and test condition “Commercial”). Changed typical value of I_{SB2} parameter from 110 mA to 100 mA (corresponding to speed bin -25 and test condition “Commercial”). Changed maximum value of I_{SB2} parameter from 160 mA to 150 mA (corresponding to speed bin -25 and test condition “Commercial”). Changed typical value of I_{SB2} parameter from 110 mA to 75 mA (corresponding to speed bin -55 and test condition “Commercial”). Changed maximum value of I_{SB2} parameter from 160 mA to 135 mA (corresponding to speed bin -55 and test condition “Commercial”). Changed typical value of I_{SB4} parameter from 100 mA to 90 mA (corresponding to speed bin -25 and test condition “Commercial”). Changed maximum value of I_{SB4} parameter from 140 mA to 130 mA (corresponding to speed bin -25 and test condition “Commercial”). Changed typical value of I_{SB4} parameter from 100 mA to 70 mA (corresponding to speed bin -55 and test condition “Commercial”). Changed maximum value of I_{SB4} parameter from 140 mA to 120 mA (corresponding to speed bin -55 and test condition “Commercial”). Updated Ordering Information: Updated part numbers.
*B	3247559	ADMU	05/04/2011	Updated Electrical Characteristics: Removed minimum value of V_{IL} parameter (for all speed bins). Updated Ordering Code Definitions under Ordering Information. Updated Package Diagrams: spec 51-85048 – Changed revision from *D to *E.

Document History Page (continued)

Document Title: CY7C024E/CY7C025E/CY7C0251E, 4K × 16 and 8K × 16/18 Dual-Port Static RAM with SEM, INT, BUSY Document Number: 001-62932				
Rev.	**ECN No.**	**Orig. of Change**	**Submission Date**	**Description of Change**
*C	3864478	ADMU	01/10/2013	Updated Ordering Information: Updated part numbers. Updated Package Diagrams: spec 51-85048 – Changed revision from *E to *G.
*D	4075480	ADMU	07/24/2013	Updated Logic Block Diagram. Updated Pin Configurations. Updated to new template. Completing Sunset Review.
*E	4093991	ADMU	08/13/2013	Updated Package Diagrams: spec 51-85048 – Changed revision from *G to *H. Added Units of Measure.
*F	4447806	ADMU	07/18/2014	Removed CY7C0241E related information in all instances across the document. Updated Ordering Information: Updated part numbers. Updated Package Diagrams: spec 51-85048 – Changed revision from *H to *I.
*G	4580426	ADMU	11/24/2014	Updated Functional Description: Added “For a complete list of related documentation, click here.” at the end.
*H	5856565	VINI	08/17/2017	Updated Ordering Information: Updated part numbers. Updated Package Diagrams: spec 51-85048 – Changed revision from *I to *J. Updated to new template. Completing Sunset Review.

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