



Integrated Device Technology, Inc.

# 16K x 32 CMOS DUAL-PORT STATIC RAM MODULE

IDT7M1002

## FEATURES

- High-density 512K CMOS Dual-Port RAM module
- Fast access times
  - Commercial: 30, 35ns
  - Military: 40, 45ns
- Fully asynchronous read/write operation from either port
- Easy to expand data bus width to 64 bits or more using the Master/Slave function
- Separate byte read/write signals for byte control
- On-chip port arbitration logic
- $\overline{INT}$  flag for port-to-port communication
- Full on-chip hardware support of semaphore signaling between ports
- Surface mounted fine pitch (25 mil) LCC packages allow through-hole module to fit into 121 pin PGA footprint
- Single 5V ( $\pm 10\%$ ) power supply
- Inputs/outputs directly TTL-compatible

## DESCRIPTION

The IDT7M1002 is a 16K x 32 high-speed CMOS Dual-Port Static RAM Module constructed on a co-fired ceramic substrate using four 16K x 8 (IDT7006) Dual-Port Static RAMs in surface-mounted LCC packages. The IDT7M1002 module is designed to be used as stand-alone 512K Dual-Port RAM or as a combination Master/Slave Dual-Port RAM for 64-bit or more word width systems. Using the IDT Master/Slave approach in such system applications results in full-speed, error-free operation without the need for additional discrete logic.

The module provides two independent ports with separate control, address, and I/O pins that permit independent and asynchronous access for reads or writes to any location in memory. System performance is enhanced by facilitating port-to-port communication via additional control signals  $\overline{SEM}$  and  $\overline{INT}$ .

The IDT7M1002 module is packaged in a ceramic 121 pin PGA (Pin Grid Array) 1.35 inches on a side. Maximum access times as fast as 30ns are available over the commercial temperature range and 40ns over the military temperature range.

All IDT military modules are constructed with semiconductor components manufactured in compliance with the latest revision of MIL-STD-883, Class B making them ideally suited to applications demanding the highest level of performance and reliability.

## PIN CONFIGURATION

	1	2	3	4	5	6	7	8	9	10	11	12	13
A	L_I/O(24)	L_I/O(26)	L_I/O(28)	L_I/O(30)	L_C $\overline{S}$	L_O $\overline{E}$	L_R $\overline{W}$ (3)	R_O $\overline{E}$	R_C $\overline{S}$	R_I/O(30)	R_I/O(28)	R_I/O(26)	R_I/O(24)
B	L_I/O(23)	L_I/O(25)	L_I/O(27)	L_I/O(29)	L_I/O(31)	L_A(0)	L_R $\overline{W}$ (4)	R_A(0)	R_I/O(31)	R_I/O(29)	R_I/O(27)	R_I/O(25)	R_I/O(23)
C	L_I/O(21)	L_I/O(22)	VCC	L_A(3)	L_A(2)	L_A(1)	GND	R_A(1)	R_A(2)	R_A(3)	GND	R_I/O(22)	R_I/O(21)
D	L_I/O(19)	L_I/O(20)	L_A(4)	GND	PGA TOP VIEW						R_A(4)	R_I/O(20)	R_I/O(19)
E	L_I/O(17)	L_I/O(18)	L_A(5)								R_A(5)	R_I/O(18)	R_I/O(17)
F	L_SEM	L_I/O(16)	L_A(6)								R_A(6)	R_I/O(16)	R_SEM
G	L_BUSY	L_INT	GND								GND	R_INT	R_BUSY
H	L_R $\overline{W}$ (1)	L_R $\overline{W}$ (2)	L_A(7)								R_A(7)	R_R $\overline{W}$ (2)	R_R $\overline{W}$ (1)
I	L_I/O(15)	L_I/O(14)	L_A(8)								R_A(8)	R_I/O(14)	R_I/O(15)
J	L_I/O(13)	L_I/O(12)	L_A(9)								R_A(9)	R_I/O(12)	R_I/O(13)
K	L_I/O(11)	M $\overline{S}$	GND	L_A(10)	L_A(11)	L_A(12)	GND	R_A(12)	R_A(11)	R_A(10)	VCC	GND	R_I/O(11)
L	L_I/O(10)	L_I/O(8)	L_I/O(6)	L_I/O(4)	L_I/O(2)	L_A(13)	R_R $\overline{W}$ (4)	R_A(13)	R_I/O(2)	R_I/O(4)	R_I/O(6)	R_I/O(8)	R_I/O(10)
M	L_I/O(9)	L_I/O(7)	L_I/O(5)	L_I/O(3)	L_I/O(1)	L_I/O(0)	R_R $\overline{W}$ (3)	R_I/O(0)	R_I/O(1)	R_I/O(3)	R_I/O(5)	R_I/O(7)	R_I/O(9)

2795 drw 01

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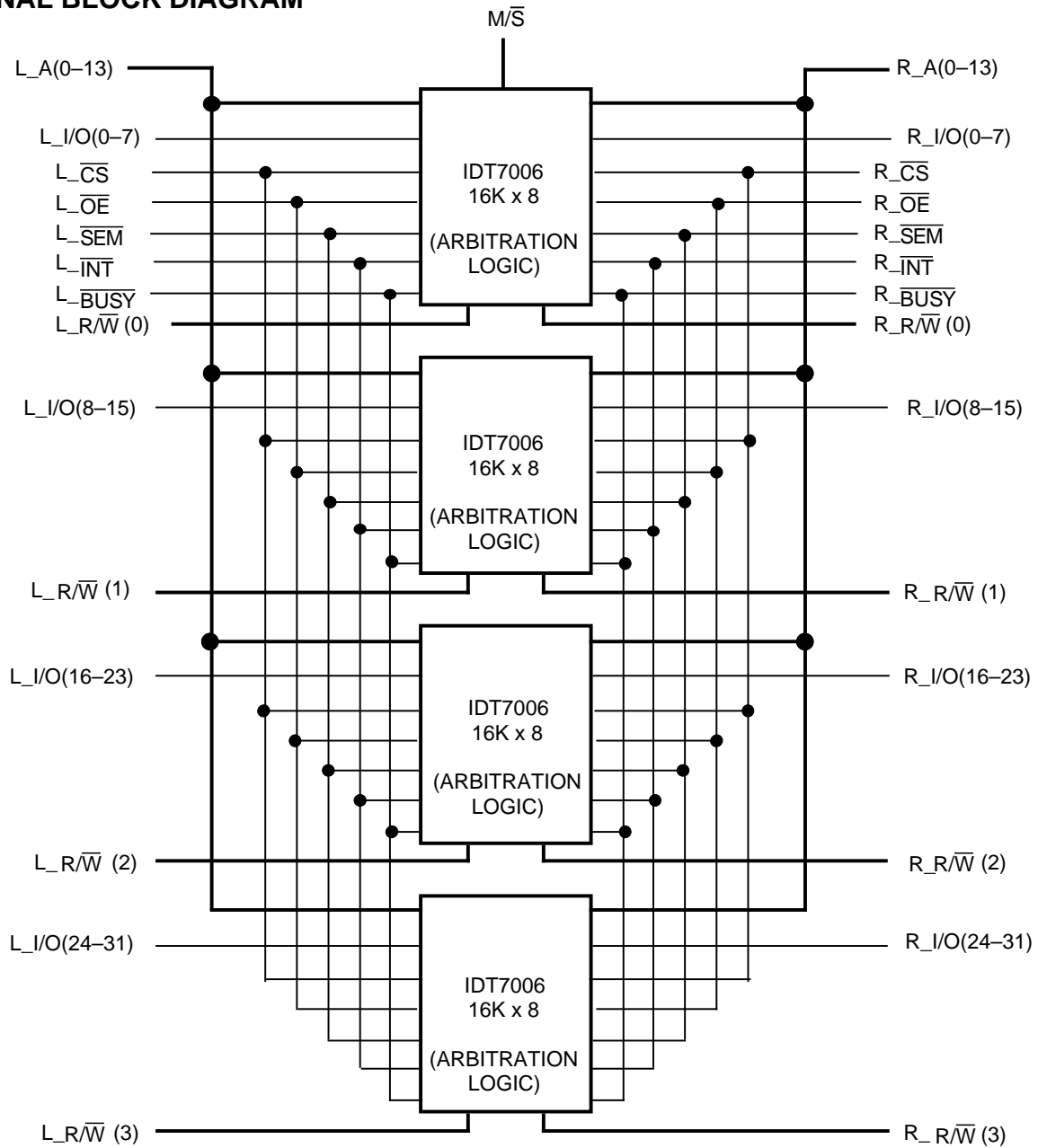
**MILITARY AND COMMERCIAL TEMPERATURE RANGES**

**DECEMBER 1995**

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DSC-2795/5

## FUNCTIONAL BLOCK DIAGRAM



## PIN NAMES

2795 drw 02

Left Port	Right Port	Description
L_A (0-13)	R_A (0-13)	Address Inputs
L_I/O (0-31)	R_I/O (0-31)	Data Inputs/Outputs
L_R/W (1-4)	R_R/W (1-4)	Read/Write Enables
L_CS	R_CS	Chip Select
L_OE	R_OE	Output Enable
L_BUSY	R_BUSY	Busy Flag
L_INT	R_INT	Interrupt Flag
L_SEM	R_SEM	Semaphore Control
M/S		Master/Slave Control
Vcc		Power
GND		Ground

2795 tbl 01

### ABSOLUTE MAXIMUM RATINGS<sup>(1)</sup>

Symbol	Rating	Commerical	Military	Unit
VTERM	Terminal Voltage with Respect to GND	-0.5 to +7.0	-0.5 to +7.0	V
TA	Operating Temperature	0 to +70	-55 to +125	°C
TBIAS	Temperature Under Bias	-55 to +125	-65 to +135	°C
TSTG	Storage Temperature	-55 to +125	-65 to +150	°C
IOUT	DC Output Current	50	50	mA

**NOTE:**

Stresses greater than those listed under ABSOLUTE MAXIMUM RATINGS may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.

2795 tbl 02

### RECOMMENDED OPERATING TEMPERATURE AND SUPPLY VOLTAGE

Grade	Ambient Temperature	GND	VCC
Military	-55°C to +125°C	0V	5.0V ± 10%
Commercial	0°C to +70°C	0V	5.0V ± 10%

2795 tbl 03

### RECOMMENDED DC OPERATING CONDITIONS

Symbol	Parameter	Min.	Typ.	Max.	Unit
Vcc	Supply Voltage	4.5	5.0	5.5	V
GND	Supply Voltage	0	0	0	V
VIH	Input High Voltage	2.2	—	6.0	V
VIL	Input Low Voltage	-0.5 <sup>(1)</sup>	—	0.8	V

2795 tbl 04

**NOTE:**

- VIL ≥ -3.0V for pulse width less than 20ns

### DC ELECTRICAL CHARACTERISTICS

(Vcc = 5V ± 10%, TA = -55°C to +125°C or 0°C to +70°C)

Symbol	Parameter	Test Conditions	Min.	Max.	Units
ILI	Input Leakage (Address & Control)	Vcc = Max. VIN = GND to Vcc	—	40	µA
LI	Input Leakage (Data)	Vcc = Max. VIN = GND to Vcc	—	10	µA
ILO	Output Leakage (Data)	Vcc = Max. CS ≥ VIH, VOUT = GND to Vcc	—	10	µA
VOL	Output Low	Vcc = Min. IOL = 4mA Voltage	—	0.4	V
VOH	Output High Voltage	Vcc = Min, IOH = -4mA	2.4	—	V

2795 tbl 05

### DC ELECTRICAL CHARACTERISTICS

(Vcc = 5V ± 10%, TA = -55°C to +125°C or 0°C to +70°C)

Symbol	Parameter	Test Conditions	Commercial		Military		Units
			Min.	Max.	Min.	Max.	
ICC2	Dynamic Operating Current (Both Ports Active)	Vcc = Max., CS ≤ VIL, SEM = Don't Care Outputs Open, f = fMAX	—	1360	—	1600	mA
ISB	Standby Supply Current (Both Ports Inactive)	Vcc = Max., L_CS and R_CS ≥ VIH Outputs Open, f = fMAX	—	280	—	340	mA
ISB1	Standby Supply Current (One Port Inactive)	Vcc = Max., L_CS or R_CS ≥ VIH Outputs Open, f = fMAX	—	1000	—	1160	mA
ISB2	Full Standby Supply Current (Both Ports Inactive)	L_CS and R_CS ≥ Vcc - 0.2V VIN > Vcc - 0.2V or < 0.2V L_SEM and R_SEM ≥ Vcc - 0.2V	—	60	—	120	mA

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**CAPACITANCE<sup>(1)</sup>** (TA = +25°C, f = 1.0MHz)

Symbol	Parameter	Condition	Max.	Unit
CIN(1)	Input Capacitance (CS, OE, SEM, Address)	VIN = 0V	40	pF
CIN(2)	Input Capacitance (R/W, I/O, INT)	VIN = 0V	12	pF
CIN(3)	Input Capacitance (BUSY, M/S)	VIN = 0V	45	pF
COUT	Output Capacitance (I/O)	VOUT = 0V	12	pF

2795 tbl 07

**NOTE:**

1. This parameter is guaranteed by design but not tested.

**AC TEST CONDITIONS**

Input Pulse Levels	GND to 3.0V
Input Rise/Fall Times	5ns
Input Timing Reference Levels	1.5V
Output Reference Levels	1.5V
Output Load	See Figures 1 and 2

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**AC ELECTRICAL CHARACTERISTICS**

(VCC = 5V ± 10%, TA = -55°C to +125°C or 0°C to +70°C)

Symbol	Parameter	7M1002SxxG				7M1002SxxGB				Unit
		30		-35		-40		-45		
		Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
<b>Read Cycle</b>										
tRC	Read Cycle Time	30	—	35	—	40	—	45	—	ns
tAA	Address Access Time	—	30	—	35	—	40	—	45	ns
tACS <sup>(2)</sup>	Chip Select Access Time	—	30	—	35	—	40	—	45	ns
tOE	Output Enable Access Time	—	17	—	20	—	22	—	25	ns
tOH	Output Hold from Address Change	3	—	3	—	3	—	3	—	ns
tLZ <sup>(1)</sup>	Output to Low-Z	3	—	3	—	3	—	5	—	ns
tHZ <sup>(1)</sup>	Output to High-Z	—	15	—	15	—	17	—	20	ns
tPU <sup>(1)</sup>	Chip Select to Power Up Time	0	—	0	—	0	—	0	—	ns
tPD <sup>(1)</sup>	Chip Deselect to Power Up Time	—	50	—	50	—	50	—	50	ns
tSOP	Sem. Flag Update Pulse (OE or SEM)	15	—	15	—	15	—	15	—	ns
<b>Write Cycle</b>										
tWC	Write Cycle Time	30	—	35	—	40	—	45	—	ns
tCW <sup>(2)</sup>	Chip Select to End-of-Write	25	—	30	—	35	—	40	—	ns
tAW	Address Valid to End-of-Write	25	—	30	—	35	—	40	—	ns
tAS	Address Set-Up Time	0	—	0	—	0	—	0	—	ns
tWP	Write Pulse Width	25	—	30	—	35	—	35	—	ns
tWR	Write Recovery Time	0	—	0	—	0	—	0	—	ns

(Continued on next page)

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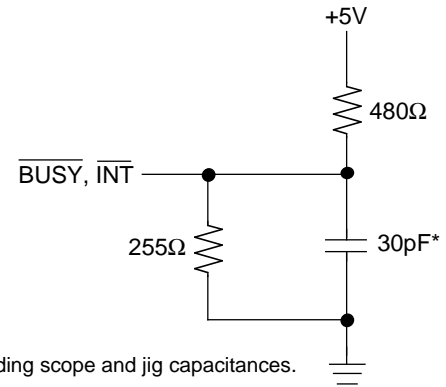


Figure 1. Output Load

2795 drw 03

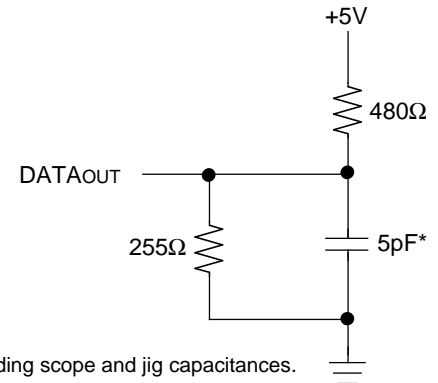


Figure 2. Output Load

2795 drw 04

(For tCHZ, tCLZ, tOHZ, tOLZ, tWHZ, tOW)

## AC ELECTRICAL CHARACTERISTICS

( $V_{CC} = 5V \pm 10\%$ ,  $T_A = 55^\circ\text{C}$  to  $+125^\circ\text{C}$  or  $0^\circ\text{C}$  to  $+70^\circ\text{C}$ )

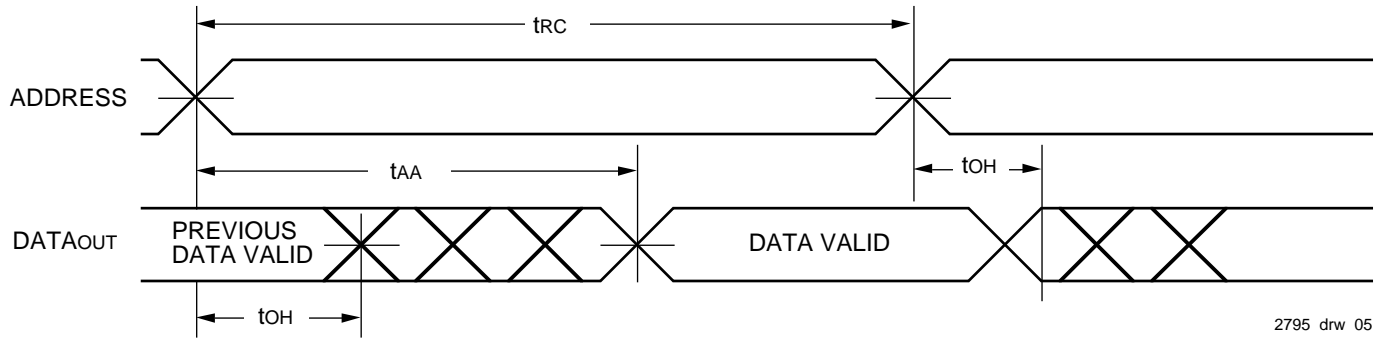
Symbol	Parameter	7M1002SxxG				7M1002SxxGB				Unit
		30		-35		-40		-45		
		Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
<b>Write Cycle (continued)</b>										
tDW	Data Valid to End-of-Write	22	—	25	—	25	—	25	—	ns
tDH	Data Hold Time	0	—	0	—	0	—	0	—	ns
tHZ <sup>(1)</sup>	Output to High-Z	—	15	—	15	—	17	—	20	ns
tOW <sup>(1)</sup>	Output Active from End-of-Write	0	—	0	—	0	—	0	—	ns
tSWRD	$\overline{\text{SEM}}$ Flag Write to Read Time	10	—	10	—	10	—	10	—	ns
tSPS	$\overline{\text{SEM}}$ Flag Contention Window	10	—	10	—	10	—	10	—	ns
<b>Busy Cycle-Master Mode<sup>(3)</sup></b>										
tBAA	$\overline{\text{BUSY}}$ Access Time to Address	—	30	—	35	—	35	—	35	ns
tBDA	$\overline{\text{BUSY}}$ Disable Time to Address	—	25	—	30	—	30	—	30	ns
tBAC	$\overline{\text{BUSY}}$ Access Time to Chip Select	—	25	—	30	—	30	—	30	ns
tBDC	$\overline{\text{BUSY}}$ Disable Time to Chip Deselect	—	25	—	25	—	25	—	25	ns
tWDD <sup>(5)</sup>	Write Pulse to Data Delay	—	55	—	60	—	65	—	70	ns
tDDD	Write Data Valid to Read Data Delay	—	40	—	45	—	50	—	55	ns
tAPS <sup>(6)</sup>	Arbitration Priority Set-Up Time	5	—	5	—	5	—	5	—	ns
tBDD	$\overline{\text{BUSY}}$ Disable to Valid Time	—	NOTE 9	—	NOTE 9	—	NOTE 9	—	NOTE 9	ns
<b>Busy Cycle-Slave Mode<sup>(4)</sup></b>										
tWB <sup>(7)</sup>	Write to $\overline{\text{BUSY}}$ Input	0	—	0	—	0	—	0	—	ns
tWH <sup>(8)</sup>	Write Hold after $\overline{\text{BUSY}}$	25	—	25	—	25	—	25	—	ns
tWDD <sup>(5)</sup>	Write Pulse to Data Delay	—	55	—	60	—	65	—	70	ns
<b>Interrupt Timing</b>										
tAS	Address Set-Up Time	0	—	0	—	0	—	0	—	ns
tWR	Write Recovery Time	0	—	0	—	0	—	0	—	ns
tINS	Interrupt Set Time	—	25	—	30	—	32	—	35	ns
tINR	Interrupt Reset Time	—	25	—	30	—	32	—	35	ns

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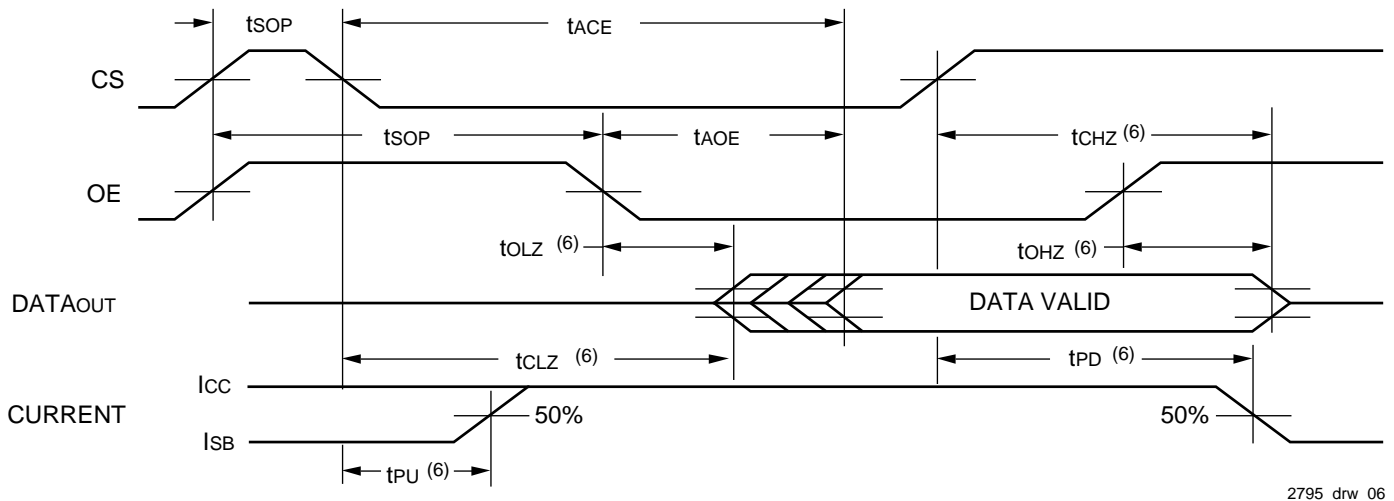
### NOTES:

1. This parameter is guaranteed by design but not tested.
2. To access RAM,  $\overline{\text{CS}} \leq V_{IL}$  and  $\overline{\text{SEM}} \geq V_{IH}$ . To access semaphore,  $\overline{\text{CS}} \geq V_{IH}$  and  $\overline{\text{SEM}} \leq V_{IL}$ .
3. When the module is being used in the Master Mode ( $M/\overline{\text{S}} \geq V_{IH}$ ).
4. When the module is being used in the Slave Mode ( $M/\overline{\text{S}} \leq V_{IL}$ ).
5. Port-to-Port delay through the RAM cells from the writing port to the reading port.
6. To ensure that the earlier of the two ports wins.
7. To ensure that the write cycle is inhibited during contention.
8. To ensure that a write cycle is completed after contention.
9. tBDD is a calculated parameter and is the greater of 0, tWDD - tWP (actual), or tDDD - tWP (actual).

**TIMING WAVEFORM OF READ CYCLE NO. 1, EITHER SIDE (1, 2, 4)**



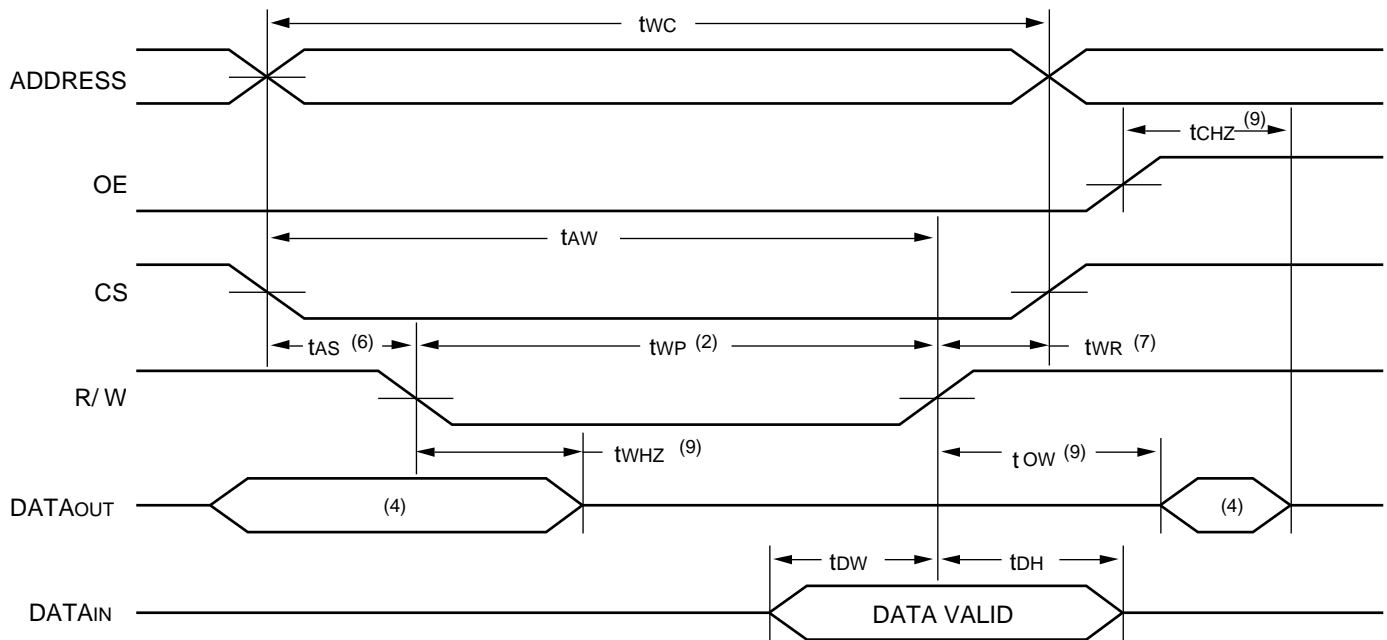
**TIMING WAVEFORM OF READ CYCLE NO. 2, EITHER SIDE (1, 3, 5)**



**NOTES:**

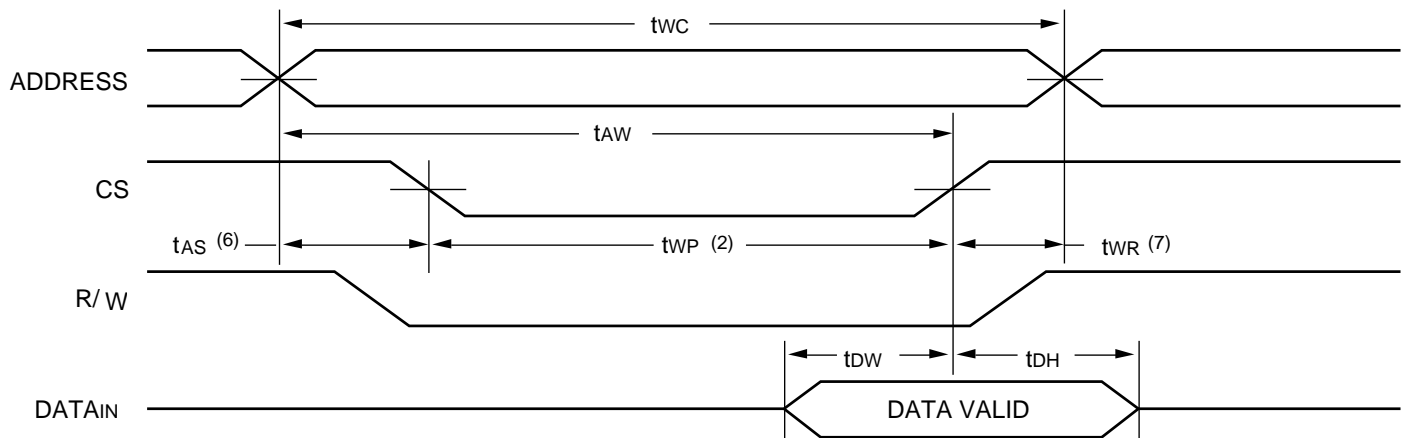
1.  $\overline{R/\overline{W}}$  is HIGH for Read Cycles
2. Device is continuously enabled  $\overline{CS} \leq V_{IL}$ . This waveform cannot be used for semaphore reads.
3. Addresses valid prior to or coincident with  $\overline{CS}$  transition LOW.
4.  $\overline{OE} \leq V_{IL}$
5. To access RAM,  $\overline{CS} \leq V_{IL}$  and  $\overline{SEM} \geq V_{IH}$ . To access semaphore,  $\overline{CS} \geq V_{IH}$  and  $\overline{SEM} \leq V_{IL}$ .
6. This parameter is guaranteed by design but not tested.

**TIMING WAVEFORM OF WRITE CYCLE NO. 1 ( $\overline{R/W}$  CONTROLLED TIMING)<sup>(1, 2, 4)</sup>**



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**TIMING WAVEFORM OF WRITE CYCLE NO. 2 ( $\overline{CS}$  CONTROLLED TIMING)<sup>(1, 2, 4)</sup>**

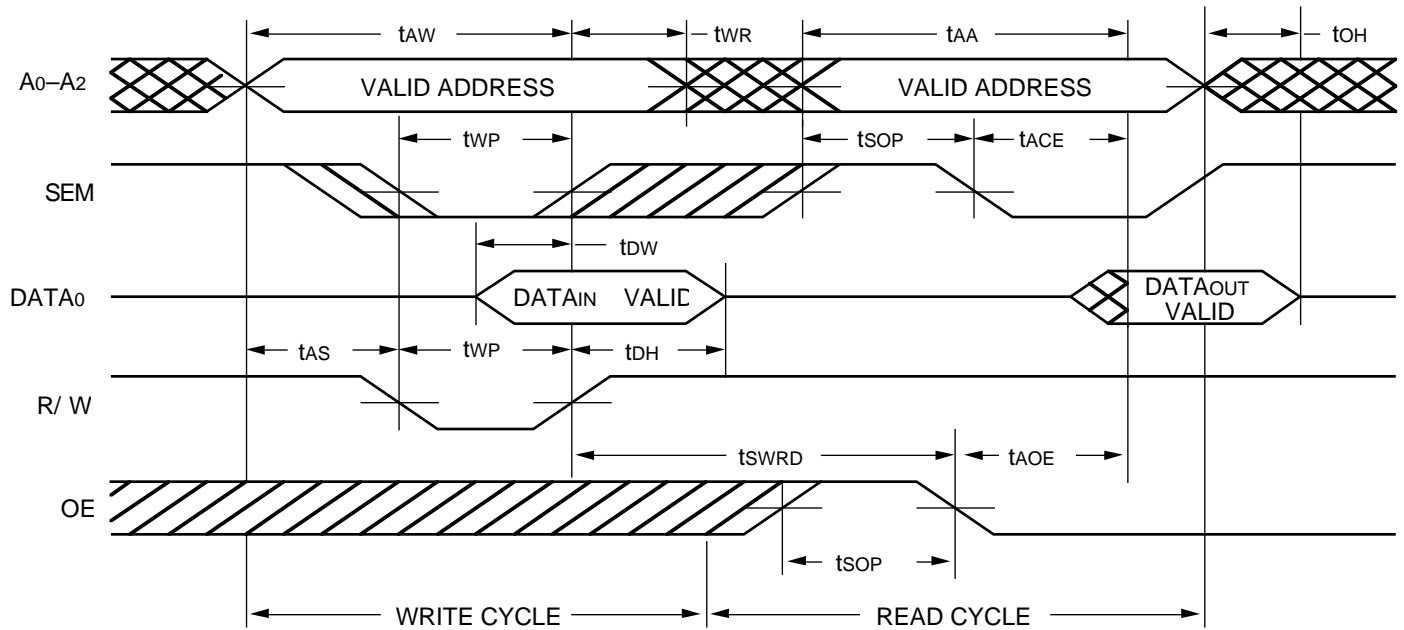


2795 drw 08

**NOTES:**

1.  $\overline{R/W}$  must be HIGH during all address transitions.
2. A write occurs during the overlap ( $t_{WP}$ ) of a LOW  $\overline{CS}$  and a LOW  $\overline{R/W}$ .
3.  $t_{WR}$  is measured from the earlier of  $\overline{CS}$  or  $\overline{R/W}$  (or  $\overline{SEM}$  or  $\overline{R/W}$ ) going HIGH to the end of write cycle.
4. During this period, the I/O pins are in the output state and input signals must be applied.
5. If the  $\overline{CS}$  or  $\overline{SEM}$  low transition occurs simultaneously with or after the  $\overline{R/W}$  low transition, the outputs remain in the high impedance state.
6. Timing depends on which enable signal is asserted last.
7. Timing depends on which enable signal is de-asserted first.
8. If  $\overline{OE}$  is LOW during a  $\overline{R/W}$  controlled write cycle, the write pulse width must be the larger of  $t_{WP}$  or  $(t_{WZ} + t_{DW})$  to allow the I/O drivers to turn off and data to be placed on the bus for the required  $t_{DW}$ . If  $\overline{OE}$  is HIGH during an  $\overline{R/W}$  controlled write cycle, this requirement does not apply and the write pulse can be as short as the specified  $t_{WP}$ .

### TIMING WAVEFORM OF SEMAPHORE READ AFTER WRITE, EITHER SIDE<sup>(1)</sup>

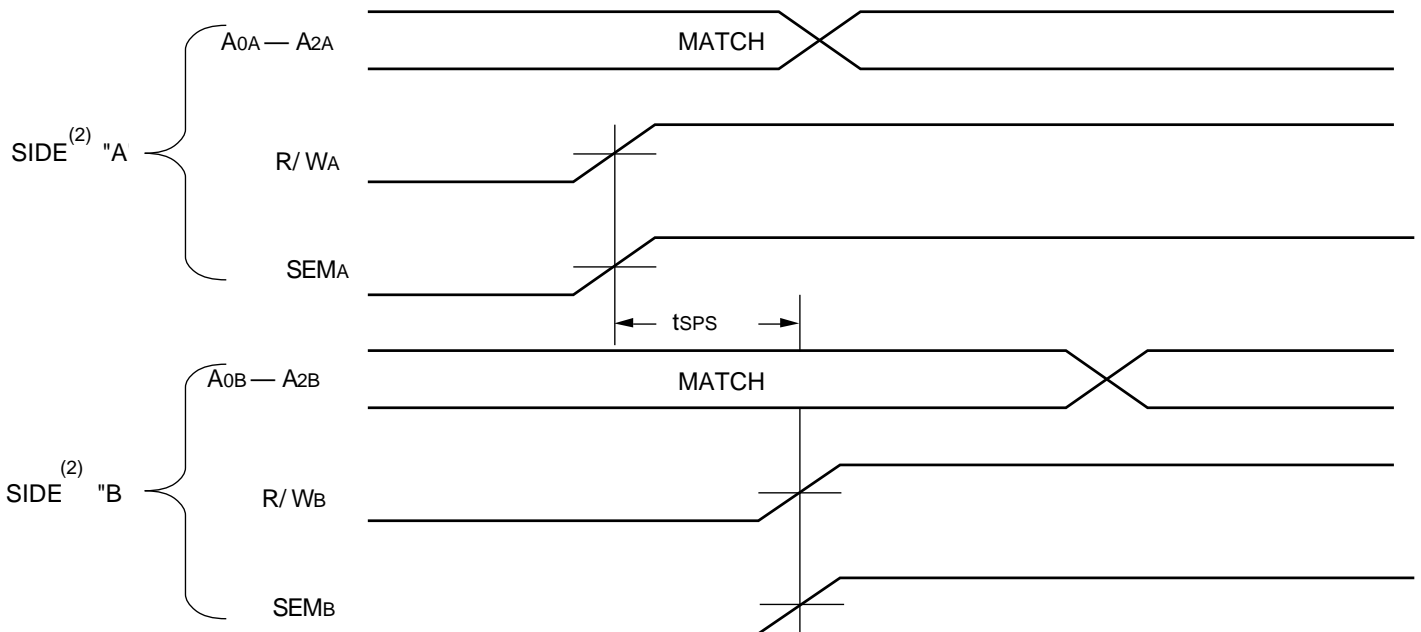


2795 drw 09

**NOTE:**

1.  $\overline{CS} \geq V_{IH}$  for the duration of the above timing (both write and read cycle).

### TIMING WAVEFORM OF SEMAPHORE CONTENTION<sup>(1, 3, 4)</sup>



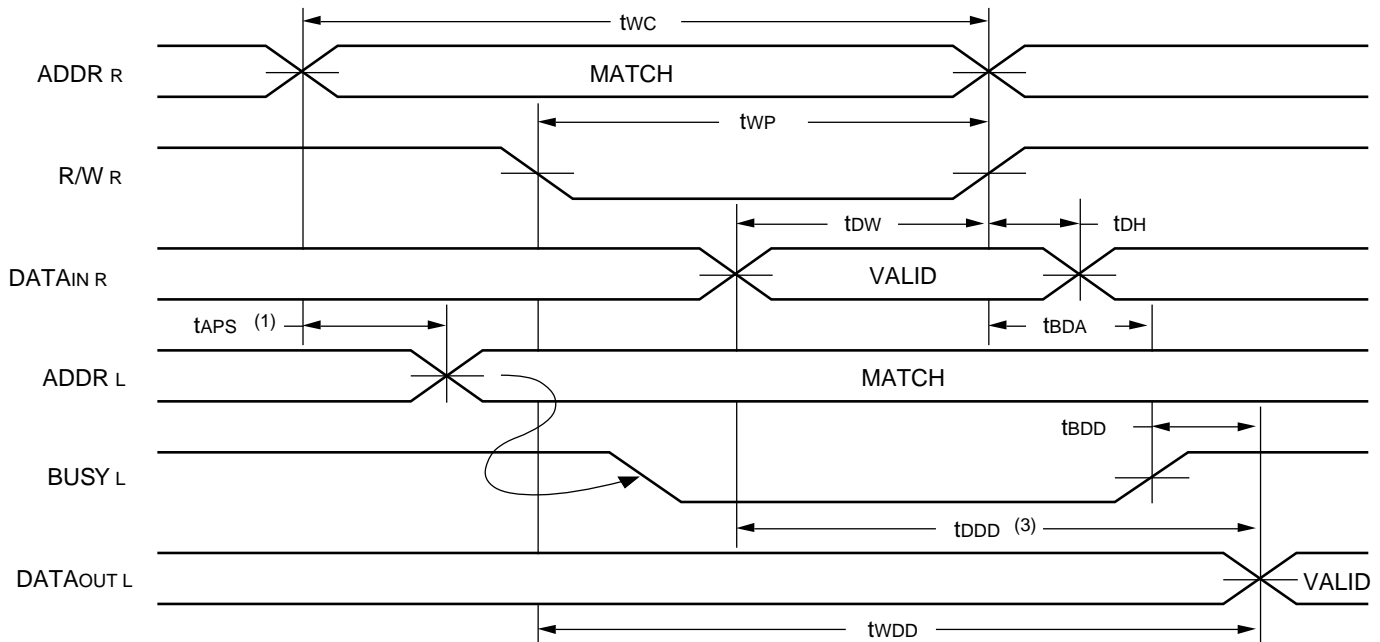
2795 drw 10

**NOTES:**

1.  $DOR = DOL \leq V_{IL}$ ,  $(L\_ \overline{CS} = R\_ \overline{CS}) \geq V_{IH}$  Semaphore Flag is released from both sides (reads as ones from both sides) at cycle start.
2. "A" may be either left or right port. "B" is the opposite port from "A".
3. This parameter is measured from  $R/\overline{W}_A$  or  $\overline{SEM}_A$  going HIGH to  $R/\overline{W}_B$  or  $\overline{SEM}_B$  going HIGH.
4. If  $tSPS$  is violated, the semaphore will fall positively to one side or the other, but there is no guarantee which side will obtain the flag.



**TIMING WAVEFORM OF READ WITH  $\overline{\text{BUSY}} (\text{M}/\overline{\text{S}} \geq \text{VIH})^{(2)}$**

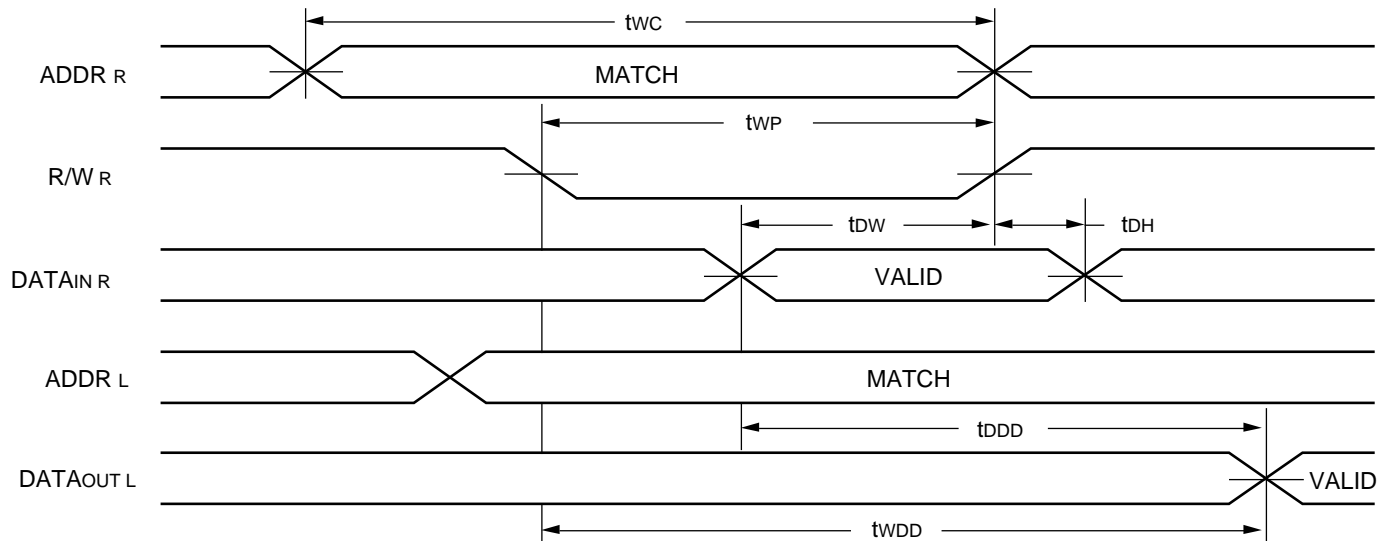


2795 drw 11

**NOTES:**

1. To ensure that the earlier of the two ports wins.
2.  $(\overline{\text{L\_CS}} = \overline{\text{R\_CS}}) \leq \text{VIL}$
3.  $\text{OE} \leq \text{VIL}$  for the reading port.

**TIMING WAVEFORM OF WRITE WITH PORT-TO-PORT DELAY ( $\text{M}/\overline{\text{S}} \leq \text{VIH})^{(1, 2)}$**

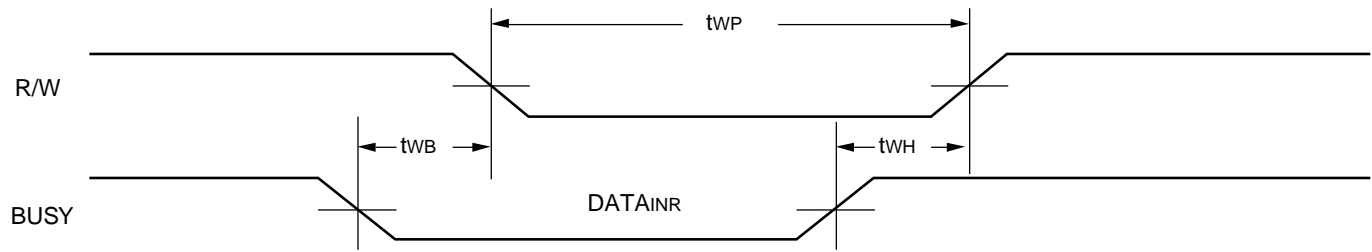


2795 drw 12

**NOTES:**

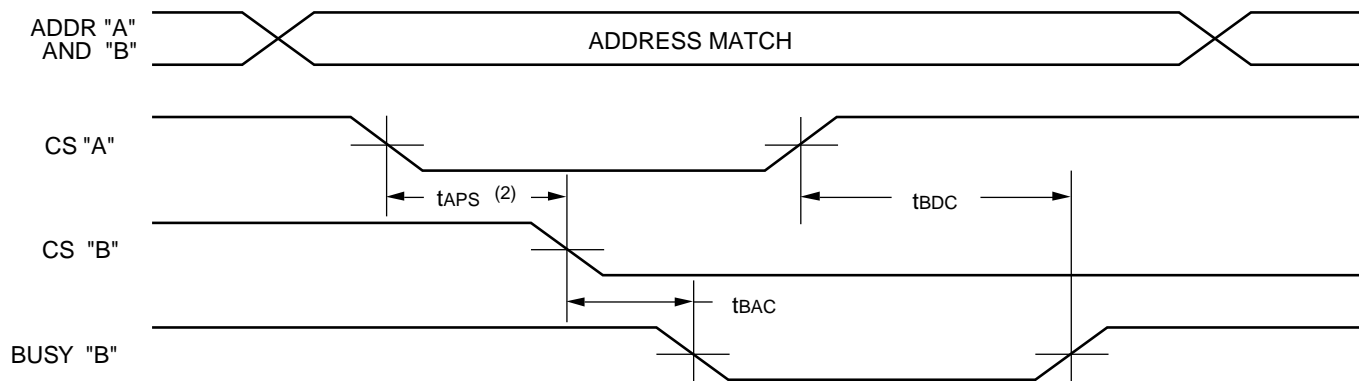
1.  $\overline{\text{BUSY}}$  input equals HIGH for the writing port.
2.  $(\overline{\text{L\_CS}} = \overline{\text{R\_CS}}) \leq \text{VIL}$

**TIMING WAVEFORM OF WRITE WITH  $\overline{\text{BUSY}}$  INPUT ( $M/\overline{\text{S}} \leq \text{VIL}$ )**



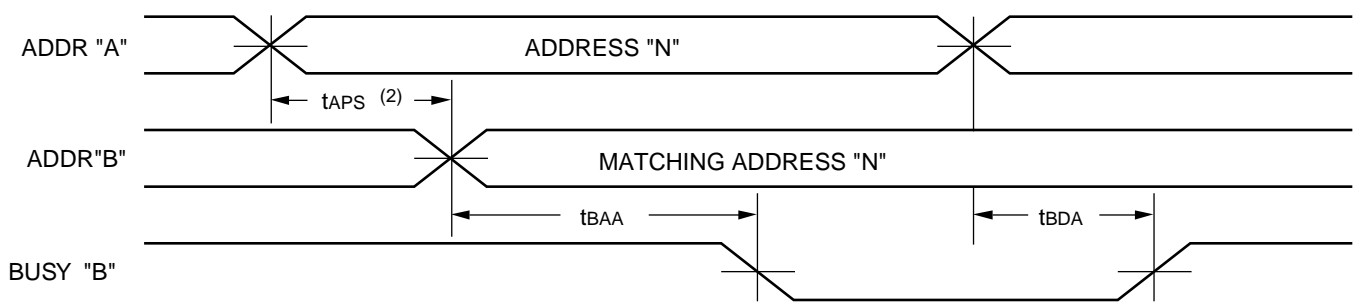
2795 drw 13

**TIMING WAVEFORM OF BUSY ARBITRATION ( $\overline{\text{CS}}$  CONTROLLED TIMING)<sup>(1)</sup>**



2795 drw 14

**TIMING WAVEFORM OF BUSY ARBITRATION (CONTROLLED BY ADDRESS MATCH TIMING)<sup>(1)</sup>**

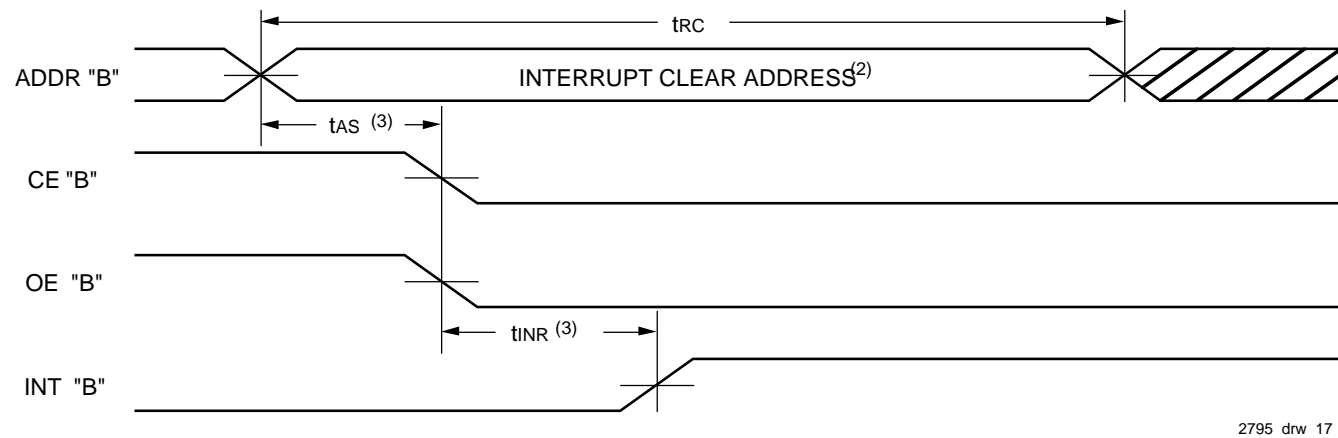
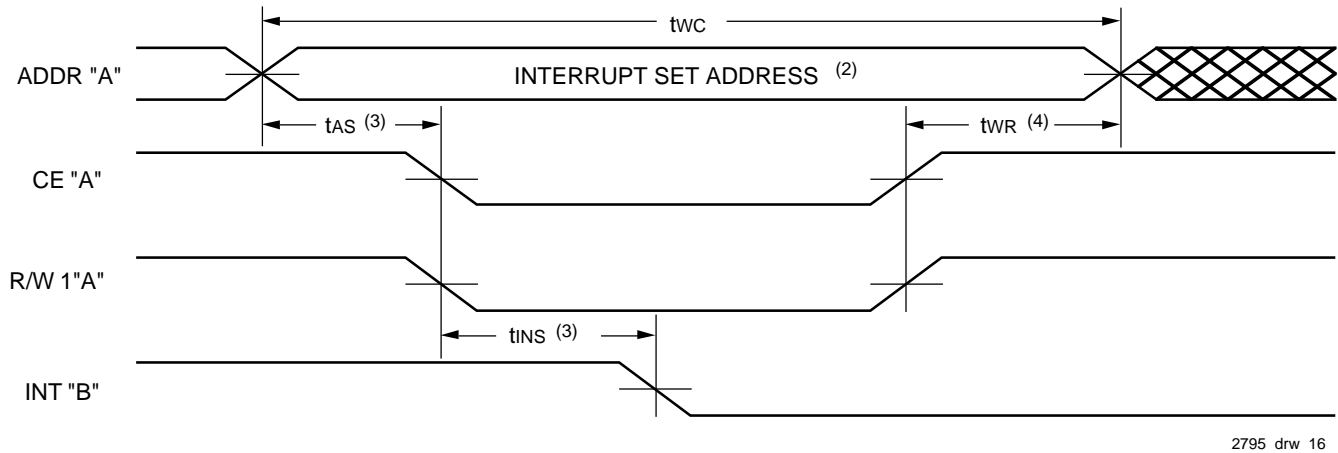


2795 drw 15

**NOTES:**

1. All timing is the same for the left and right ports. Port "A" may be either the left or right port. Port "B" is the port opposite from "A".
2. If tAPS is violated, the busy signal will be asserted on one side or another but there is no guarantee on which side busy will be asserted.

### TIMING WAVEFORM OF INTERRUPT CYCLE<sup>(1)</sup>



**NOTES:**

1. All timing is the same for left and right ports. Port "A" may be either the left or right port. Port "B" is the port opposite from "A".
2. See Interrupt truth table.
3. Timing depends on which enable signal is asserted last.
4. Timing depends on which enable signal is de-asserted first.

### TRUTH TABLE I: Non-Contention Read/Write Control<sup>(1)</sup>

Inputs				Outputs	Mode
$\overline{CS}$	R/W	$\overline{OE}$	$\overline{SEM}$	I/O	Description
H	X	X	H	High-Z	Deselected or Power Down
L	L	X	H	Data_In	Write
L	H	L	H	Data_OUT	Read
X	X	H	X	High-Z	Outputs Disabled

**NOTE:**

1. The conditions for non-contention are L\_A (0–13) ≠ R\_A (0–13).
2.  $\nearrow$  denotes a LOW to HIGH waveform transition.

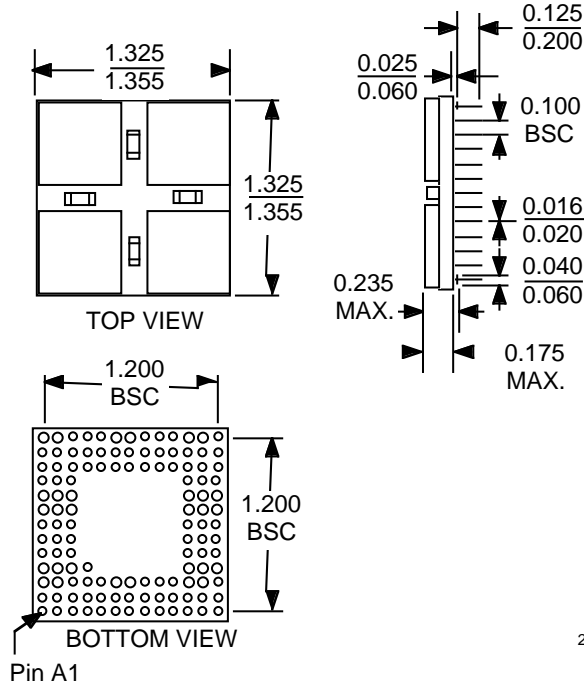
### TRUTH TABLE II: Semaphore Read/Write Control

Inputs <sup>(2)</sup>				Outputs	Mode
$\overline{CS}$	R/W	$\overline{OE}$	$\overline{SEM}$	I/O	Description
H	H	L	L	Data_OUT	Read Data in Semaphore Flag
H	$\nearrow$	X	L	Data_IN	Write Data_IN (0, 8, 16, 24)
L	X	X	L	—	Not Allowed

## INTERRUPT/BUSY FLAGS, DEPTH & WIDTH EXPANSION, MASTER/SLAVE CONTROL, SEMAPHORES

For more details regarding Interrupt/Busy flags, depth and/or width expansion, master/slave control, or semaphore operations, please consult the IDT7006 data sheet.

## PACKAGE DIMENSIONS



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## ORDERING INFORMATION

IDT	XXXX	A	999	A	A	
	Device Type	Power	Speed	Package	Process/ Temperature Range	
					BLANK	Commercial (0°C to +70°C)
					B	Military (-55°C to +125°C) Semiconductor Components compliant to MIL-STD-883, Class B
					G	Ceramic PGA (Pin Grid Array)
					30	Speed in Nanoseconds
					35	
					40	
					45	
					S	Standard Power
					7M1002	16K x 32 CMOS Dual-Port Static RAM Module

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