

HIGH-SPEED 16K X 9 DUAL-PORT STATIC RAM

IDT7016S/L

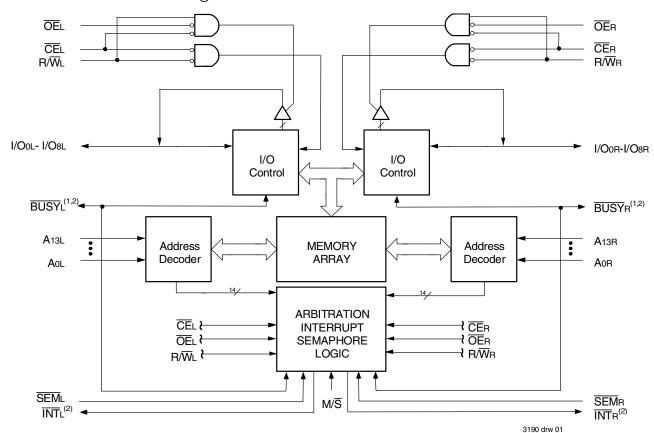
Features

- True Dual-Ported memory cells which allow simultaneous reads of the same memory location
- High-speed access
 - Commercial: 12/15/20/25/35ns (max.)
 - Industrial: 20ns (max.)
 - Military: 20/25/35ns (max.)
- Low-power operation
 - IDT7016S
 - Active: 750mW (typ.) Standby: 5mW (typ.)
 - IDT7016L

Active: 750mW (typ.) Standby: 1mW (typ.)

- IDT7016 easily expands data bus width to 18 bits or more using the Master/Slave select when cascading more than one device
- ◆ M/S = VIH for BUSY output flag on Master M/S = VIL for BUSY input on Slave
- Busy and Interrupt Flag
- On-chip port arbitration logic
- Full on-chip hardware support of semaphore signaling between ports
- Fully asynchronous operation from either port
- TTL-compatible, single 5V (±10%) power supply
- Available in ceramic 68-pin PGA, 68-pin PLCC, and an 80-pin TQFP
- Industrial temperature range (-40°C to +85°C) is available for selected speeds
- Green parts available, see ordering information

Functional Block Diagram



NOTES:

- In MASTER mode: BUSY is an output and is a push-pull driver In SLAVE mode: BUSY is input.
- 2. BUSY outputs and INT outputs are non-tri-stated push-pull drivers.

OCTOBER 2014

Description

The IDT7016 is a high-speed 16K x 9 Dual-Port Static RAM. The IDT7016 is designed to be used as stand-alone Dual-Port RAMs or as a combination MASTER/SLAVE Dual-Port RAM for 18-bit-ormore wider systems. Using the IDT MASTER/SLAVE Dual-Port RAM approach in 18-bit or wider memory system applications results in full-speed, error-free operation without the need for additional discrete logic.

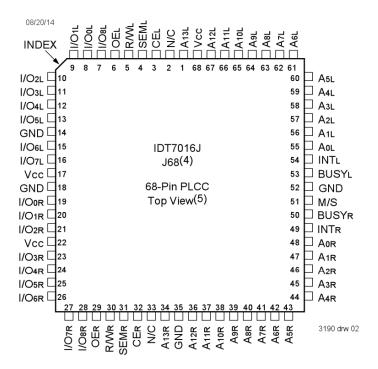
This device provides two independent ports with separate control, address, and I/O pins that permit independent, asynchronous

access for reads or writes to any location in memory. An automatic power down feature controlled by $\overline{\text{CE}}$ permits the on-chip circuitry of each port to enter a very low standby power mode.

Fabricated using IDT's CMOS high-performance technology, these devices typically operate on only 750mW of power.

The IDT7016 is packaged in a ceramic 68-pin PGA, a 64-pin PLCC and an 80-pinTQFP (Thin Quad Flatpack). Military grade product is manufactured in compliance with the latest revision of MIL-PRF-38535 QML, making it ideally suited to military temperature applications demanding the highest level of performance and reliability.

Pin Configurations^(1,2,3)



NOTES:

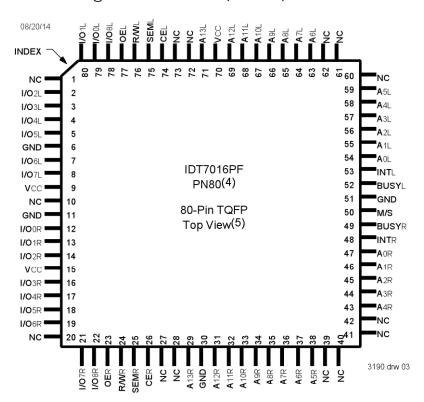
- 1. All Vcc pins must be connected to power supply.
- 2. All GND pins must be connected to ground supply.
- 3. Package body is approximately .95 in x .95 in x .17 in.
- 4. This package code is used to reference the package diagram.
- 5. This text does not imply orientation of Part-marking.

Pin Names

Left Port	Right Port	Names		
CEL	C ER	Chip Enable		
R/WL	R/W̄R	Read/Write Enable		
ŌĒL	OE R	Output Enable		
A0L - A13L	AOR - A13R	Address		
I/Ool - I/O8L	I/O0R - I/O8R	Data Input/Output		
SEML	<u>SEM</u> R	Semaphore Enable		
ĪNTL	Ī NT r	Interrupt Flag		
BUSYL	BUSYR	Busy Flag		
N	ı/ S	Master or Slave Select		
V	CC	Power		
G	ND	Ground		

3190 tbl 01

Pin Configurations^(1,2,3) (con't.)



08/20/14											
11		51 A 5L	50 A 4L	48 A 2L	46 A 0L	44 BUSYL	42 M/S	40 INTR	38 A 1R	36 A 3R	
10	53 A7L	52 A 6L	49 A 3L	47 A 1L	45 INT∟	43 GND	41 BUSYR	39 A 0R	37 A 2R	35 A 4R	34 A 5R
09	55 A 9L	54 A 8L			32 A 7R	33 A 6R					
08	57 A11L	56 A 10L								30 A 9R	31 A 8R
07	59 V CC	58 A 12L				28 A 11R	29 A10R				
06	61 N/C	60 A 13L		68-Pin PGA Top View ⁽⁵⁾							27 A12R
05	63 SEML	62 CEL			24 N/C	25 A 13R					
04	65 OEL	64 R/WL								22 SEMR	23 CER
03	67 I/O ₀ L	66 I/O8L								20 OER	21 R/WR
02	68 I/O1L	1 1/02L	3 I/O4L	5 GND	7 1/07L	9 GND	11 I/O1R	13 VCC	15 I/O4R	18 I/O7R	19 I/O8R
01	<u></u>	2 I/O3L	4 I/O5L	6 I/O6L	8 VCC	10 I/O0R	12 I/O2R	14 I/ 0 3R	16 I/O5R	17 I/O6R	
INDEX	A	В	С	D	E	F	G	Н	J	К	L

3190 drw 04

NOTES:

- 1. All Vcc pins must be connected to power supply.
- 2. All GND pins must be connected to ground supply.
- PN80-1 package body is approximately 14mm x 14mm x 1.4mm.
 G68-1 package body is approximately 1.18 in x 1.18 in x .16 in.
- 4. This package code is used to reference the package diagram.
- 5. This text does not indicate orientation of the actual part-marking.

Truth Table I: Non-Contention Read/Write Control

	Inpu	Inputs ⁽¹⁾		Outputs					
ΖĒ	R/W	Œ	SEM	I/O ₀₋₈	Mode				
Н	Χ	Х	Н	High-Z	Deselcted: Power-Down				
L	L	Х	Н	DATAIN	Write to Memory				
L	Н	L	Н	DATAout	Read Memory				
Х	Х	Н	Χ	High-Z	Outputs Disabled				

NOTE: 3190 tol 02

1. Condition: A_{0L} — $A_{13L} \neq A_{0R}$ — A_{13R}

Truth Table II: Semaphore Read/Write Control⁽¹⁾

	Inputs			Outputs					
CE	R/W	Œ	SEM	I/O ₀₋₈	Mode				
Н	Н	L	L	DATAоит	Read Semaphore Flag Data Out (I/O ₀ - I/O ₈)				
Н	1	Χ	L	DATAIN	Write I/Oo into Semaphore Flag				
L	X	X	L	_	Not Allowed				

NOTE: 3190 tbl 03

1. There are eight semaphore flags written to via I/Oo and read from all I/Os (I/Oo-I/Os). These eight semaphores are addressed by Ao - A2.

Absolute Maximum Ratings(1)

Symbol	Rating	Commercial & Industrial	Military	Unit
VTERM ⁽²⁾	Terminal Voltage with Respect to GND	-0.5 to +7.0	-0.5 to +7.0	٧
TBIAS	Temperature Under Bias	-55 to +125	-65 to +135	°C
Tstg	Storage Temperature	-65 to +150	-65 to +150	°C
Іоит	DC Output Current	50	50	mA

3190 tbl 04

- NOTES:

 1. 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.
- 2. VTERM must not exceed Vcc+10% for more than 25% of the cycle time or 10ns maximum, and is limited to ≤20mA for the period of VTERM≥ Vcc+10%.

Maximum Operating Temperature and Supply Volt-

age ^(†) Grade	Ambient Temperature	GND	Vcc
Military	-55°C to +125°C	0V	5.0V <u>+</u> 10%
Commercial	0°C to +70°C	0V	5.0V <u>+</u> 10%
Industrial	-40°C to +85°C	0V	5.0V <u>+</u> 10%

3190 tbl 05

 $1. \quad \text{This is the parameter Ta. This is the "instant on" case temperature}.$

Recommended DC Operating Conditions

Symbol	Parameter	Min.	Тур.	Max.	Unit
Vcc	Supply Voltage	4.5	5.0	5.5	V
GND	Ground	0	0	0	V
VIH	Input High Voltage	2.2	_	6.0(2)	V
VIL	Input Low Voltage	-0.5 ⁽¹⁾	_	0.8	V

3190 tbl 06

NOTES:

NOTES:

- 1. $V_{IL} \ge -1.5V$ for pulse width less than 10ns.
- 2. VTERM must not exceed Vcc + 10%.

3190 tbl 08

Capacitance⁽¹⁾

(TA = +25°C, f = 1.0mhz, for TQFP ONLY)

Symbol	Parameter	Conditions ⁽²⁾	Max.	Unit
CIN	Input Capacitance	VIN = 3dV	9	pF
Соит	Output Capacitance	Vout = 3dV	10	pF

NOTES:

- 1. This parameter is determined by device characteristics but is not production tested.
- $2. \quad 3 dV references the interpolated capacitance when the input and output signals switch$ from 0V to 3V or from 3V to 0V.

DC Electrical Characteristics Over the Operating Temperature and Supply Voltage Range (Vcc = 5.0V ± 10%)

			7016S		70		
Symbol	Parameter	Test Conditions	Min.	Max.	Min.	Max.	Unit
ILI	Input Leakage Current ⁽¹⁾	Vcc = 5.5V, $Vin = 0V$ to Vcc	_	10		5	μΑ
ILO	Output Leakage Current	$\overline{CE} = V_{IH}$, Vout = 0V to Vcc	_	10	_	5	μA
Vol	Output Low Voltage	IoL = +4mA	_	0.4	_	0.4	V
Voh	Output High Voltage	IOH = -4mA	2.4	-	2.4	_	٧

1. At $Vcc \le 2.0V$, Input leakages are undefined.

Output Loads and AC Test Conditions

Input Pulse Levels	GND to 3.0V
Input Rise/Fall Times	3ns Max.
Input Timing Reference Levels	1.5V
Output Reference Levels	1.5V
Output Load	Figures 1 and 2

3190 tbl 09

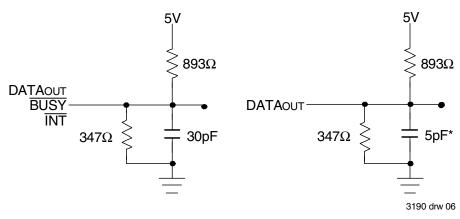


Figure 1. AC Output Test Load

Figure 2. Output Test Load (for tLz, tHz, twz, tow) *Including scope and jig.

DC Electrical Characteristics Over the Operating Temperature and Supply Voltage Range $^{(1)}$ (con't.) (Vcc = 5.0V ± 10%)

			Version			SX12 Only		SX15 I Only	
Symbol	Parameter	Test Condition			Typ. ⁽²⁾	Max.	Typ. ⁽²⁾	Max.	Unit
Icc	Dynamic Operating Current (Path Ports Astive)		COM'L	S L	170 170	325 275	170 170	310 260	mA
(Both Ports Active)	I = IMAX ^e /	MIL & IND	S L	_			1 1		
ISB1	Standby Current (Both Ports - TTL	$\overline{CER} = \overline{CEL} = VIH$ $\overline{SEMR} = \overline{SEML} = VIH$ $f = f_{MAX}^{(S)}$	COM'L	S L	25 25	70 60	25 25	60 50	mA
Level Inputs)	Level Ilipus)	T = IMAX ^E	MIL & IND	S L		11		11	
ISB2	Standby Current (One Port - TTL	$ \overline{CE}'a^* = Vil \text{ and } \overline{CE}'b^* = Vih^{(5)} $ Active Port Outputs Disabled, $ \underline{f=Max}^{(5)} $ $\overline{SEMR} = \overline{SEML} = Vih $	COM'L	S L	105 105	200 170	105 105	190 160	mA
	Level Inputs)		MIL & IND	S L		11			
ISB3	Full Standby Current (Both Ports - All CMOS	Both Ports CEL and CER > Vcc - 0.2V	COM'L	S L	1.0 0.2	15 5	1.0 0.2	15 5	mA
	Level Inputs)	$\begin{array}{l} V_{N} \geq V_{CC} - 0.2V \text{ or} \\ V_{N} \leq 0.2V, f = 0^{(4)} \\ \overline{\text{SEMR}} = \overline{\text{SEML}} \geq V_{CC} - 0.2V \end{array}$	MIL & IND	S L		_		_	
ISB4	Full Standby Current (One Port - All CMOS	\overline{CE} 's $\leq 0.2V$ and \overline{CE} 's $\geq V_{CC} \cdot 0.2V^{(5)}$	COM'L	S L	100 100	180 150	100 100	170 140	mA
Level Inputs)	Level Ilipuis)	Inputs $\overline{SEMR} = \overline{SEML} \ge Vcc - 0.2V$ $VN \ge Vcc - 0.2\overline{V}$ or $VIN \le 0.2V$ Active Port Outputs Disabled $f = \frac{Max^{(0)}}{2}$	MIL & IND	S L	_		_	_	

3190 tbl 10

						6X20 'I, Ind ilitary	Con	6X25 n'I & itary	Con	6X35 n'l & itary	
Symbol	Parameter	Test Condition	Versio	on	Typ. ⁽²⁾	Max.	Typ. ⁽²⁾	Max.	Typ. ⁽²⁾	Max.	Unit
Icc	Dynamic Operating Current (Both Ports Active) $\overline{\overline{CE}} = V_{IL}$, Outputs Disabled $\overline{\overline{SEM}} = V_{IH}$ $f = f_{MAX}(3)$		COM'L	S L	160 160	290 240	155 155	265 220	150 150	250 210	mA
		I = IMAX [®] 7	MIL & IND	S L	160 160	380 310	155 155	340 280	150 150	300 250	
ISB1	(Both Ports - TTL		COM'L	S L	20 20	60 50	16 16	60 50	13 13	60 50	mA
	Lever inpus)		MIL & IND	S L	20 20	80 65	16 16	80 65	13 13	80 65	
ISB2	Standby Current (One Port - TTL		COM'L	S L	95 95	180 150	90 90	170 140	85 85	155 130	mA
	Level inpuls)		MIL & IND	S L	95 95	240 210	90 90	215 180	85 85	190 160	
ISB3	Full Standby Current (Both Ports - All CMOS	Both Ports CEL and CER > Vcc - 0.2V Vn > Vcc - 0.2V or	COM'L	S L	1.0 0.2	15 5	1.0 0.2	15 5	1.0 0.2	15 5	mA
	Level Inputs)	$\begin{array}{l} VIN \geq VCC - 0.2V \text{ of } \\ VIN \leq 0.2V, f = 0^{(4)} \\ \hline SEMR = \overline{SEML} \geq VCC - 0.2V \end{array}$	MIL & IND	S L	1.0 0.2	30 10	1.0 0.2	30 10	1.0 0.2	30 10	
ISB4	Full Standby Current (One Port - All CMOS Level	<u>CE</u> 'a" ≤ 0.2V and <u>CE'B" ≥ Vcc - 0.2V⁽⁵⁾</u>	COM'L	S L	90 90	155 130	85 85	145 120	80 80	135 110	mA
	Inputs)		MIL & IND	S L	90 90	230 200	85 85	200 170	80 80	175 150	

- 1. 'X' in part numbers indicates power rating (S or L)
- Vcc = 5V, Ta = +25°C, and are not production tested. lccpc = 120mA(typ.)
 Atf = fmax, address and I/Os are cycling at the maximum frequency read cycle of 1/trc.
- 4. f = 0 means no address or control lines change.
- 5. Port "A" may be either left or right port. Port "B" is the opposite of Port "A".

3190 tbl 11

AC Electrical Characteristics Over the Operating Temperature and Supply Voltage Range⁽⁴⁾

			6X12 I Only	7016X15 Com'l Only		
Symbol	Parameter	Min.	Max.	Min.	Max.	Unit
READ CYCLE						
trc	Read Cycle Time	12	_	15	_	ns
taa	Address Access Time	_	12	_	15	ns
tace	Chip Enable Access Time ⁽³⁾	_	12	_	15	ns
taoe	Output Enable Access Time	_	8	_	10	ns
tон	Output Hold from Address Change	3	-	3	_	ns
t_z	Output Low-Z Time ^(1,2)	3	_	3	_	ns
tHZ	Output High-Z Time ^(1,2)	_	10	_	10	ns
tru	Chip Enable to Power Up Time (2)	0	_	0	_	ns
tPD	Chip Disable to Power Down Time ⁽²⁾		12	_	15	ns
tsop	Semaphore Flag Update Pulse (OE or SEM)	10	_	10	_	ns
tsaa	Semaphore Address Access Time		12	_	15	ns

3190 tbl 12a

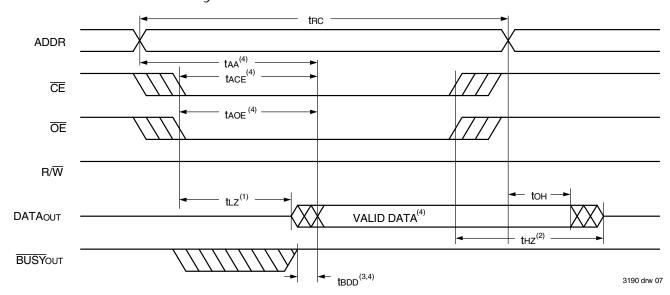
		7016X20 Com'l, Ind & Military		7016X25 Com'l & Military		7016X35 Com'l & Military		
Symbol	Parameter	Min.	Max.	Min.	Max.	Min.	Max.	Unit
READ CYCLE								
trc	Read Cycle Time	20	_	25	1	35		ns
taa	Address Access Time		20	_	25	1	35	ns
tace	Chip Enable Access Time ⁽³⁾	_	20	_	25	-	35	ns
taoe	Output Enable Access Time	_	12	_	13		20	ns
tон	Output Hold from Address Change	3	_	3	1	3		ns
t_z	Output Low-Z Time ^(1,2)	3	_	3	-	3	_	ns
tHZ	Output High-Z Time ^(1,2)	_	12	_	15	_	20	ns
tpu	Chip Enable to Power Up Time ⁽²⁾	0	_	0	-	0	_	ns
tPD	Chip Disable to Power Down Time ⁽²⁾	_	20	_	25		35	ns
tsop	Semaphore Flag Update Pulse (OE or SEM)	10	_	10		10	_	ns
tsaa	Semaphore Address Access Time		20	_	25	_	35	ns

NOTES:

3190 tbl 12b

- 1. Transition is measured 0mV from Low- or High-impedance voltage with Output Test Load (Figure 2).
- This parameter is guaranteed by device characterization but not production tested.
 To access RAM, CE = VIL and SEM = VIH. To access semaphore, CE = VIH and SEM = VIL.
- 4. 'X' in part numbers indicates power rating (S or L).

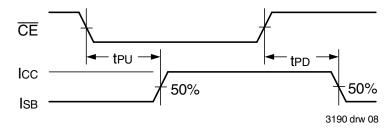
Waveform of Read Cycles⁽⁵⁾



NOTES:

- 1. Timing depends on which signal is asserted last, \overline{OE} or \overline{CE} .
- 2. Timing depends on which signal is de-asserted first, \overline{CE} or \overline{OE} .
- 3. tabodelay is required only in cases where the opposite port is completing a write operation to the same address location. For simultaneous read operations BUSY has no relation to valid output data.
- 4. Start of valid data depends on which timing becomes effective last: tAOE, tACE, tAA Or tBDD.
- 5. $\overline{SEM} = VIH$.

Timing of Power-Up / Power-Down



AC Electrical Characteristics Over the Operating Temperature and Supply Voltage⁽⁵⁾

-		7016X12 Com'l Only			7016X15 Com'l Only		
Symbol	Parameter	Min.	Max.	Min.	Max.	Unit	
WRITE CYCLE							
twc	Write Cycle Time	12	_	15	_	ns	
tew	Chip Enable to End-of-Write ⁽³⁾	10	_	12	_	ns	
taw	Address Valid to End-of-Write	10	_	12	_	ns	
tas	Address Set-up Time ⁽³⁾	0	_	0	_	ns	
twp	Write Pulse Width	10	_	12	_	ns	
twr	Write Recovery Time	2	_	2	_	ns	
tow	Data Valid to End-of-Write	10	_	10	_	ns	
tHZ	Output High-Z Time ^(1,2)	_	10	_	10	ns	
toн	Data Hold Time ⁽⁴⁾	0	_	0	_	ns	
twz	Write Enable to Output in High-Z ^(1,2)	_	10	_	10	ns	
tow	Output Active from End-of-Write ^(1,2,4)	3	_	3	_	ns	
tswrd	SEM Flag Write to Read Time	5	_	5	_	ns	
tsps	SEM Flag Contention Window	5		5	_	ns	

3190 tbl 13a

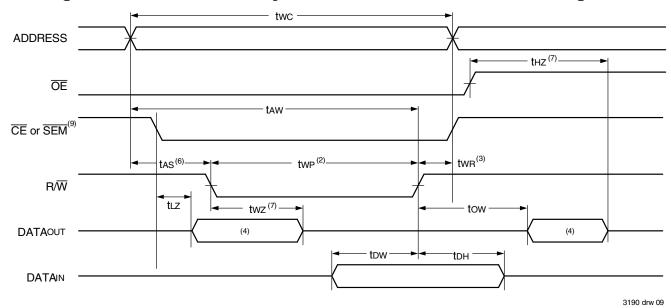
		Com	6X20 'I, Ind ilitary	7016X25 Com'l & Military		7016X35 Com'l & Military		
Symbol	Parameter	Min.	Max.	Min.	Max.	Min.	Max.	Unit
WRITE CYCLE		•						
twc	Write Cycle Time	20		25		35	_	ns
tew	Chip Enable to End-of-Write ⁽³⁾	15	_	20	_	30	_	ns
taw	Address Valid to End-of-Write	15	_	20	_	30	_	ns
tas	Address Set-up Time ⁽³⁾	0		0		0	_	ns
twp	Write Pulse Width	15	_	20	_	25	_	ns
twr	Write Recovery Time	2	_	2	_	2	_	ns
tow	Data Valid to End-of-Write	15	_	15	_	15	_	ns
tHZ	Output High-Z Time ^(1,2)	_	12		15	_	20	ns
toн	Data Hold Time ⁽⁴⁾	0	_	0	_	0	_	ns
twz	Write Enable to Output in High-Z ^(1,2)	_	12	_	15	_	20	ns
tow	Output Active from End-of-Write ^(1,2,4)	3		3		3		ns
tswrd	SEM Flag Write to Read Time	5	_	5	_	5	_	ns
tsps	SEM Flag Contention Window	5		5	_	5		ns

NOTES:

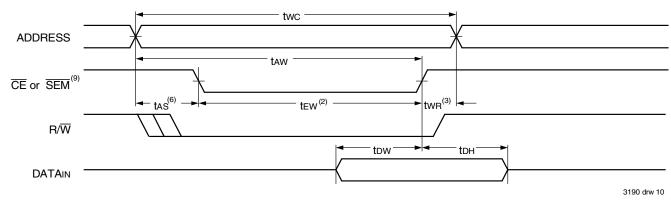
3190 tbl 13b

- $1. \quad Transition is measured 0 mV from Low or High-impedance voltage with the Output Test Load (Figure 2).$
- 2. This parameter is guaranteed by device characterization but not production tested.
- 3. To access RAM, \overline{CE} = VIL and \overline{SEM} = VIH. To access semaphore, \overline{CE} = VIH and \overline{SEM} = VIL. Either condition must be valid for the entire tew time.
- 4. The specification for toH must be met by the device supplying write data to the RAM under all operating conditions. Although toH and tow values will vary over voltage and temperature, the actual toH will always be smaller than the actual tow.
- 5. 'X' in part numbers indicates power rating (S or L).

Timing Waveform of Write Cycle No. 1, R/W Controlled Timing (1,5,8)

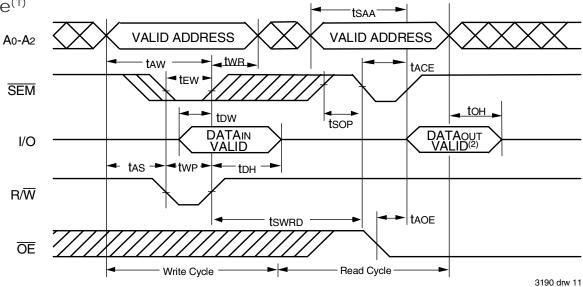


Timing Waveform of Write Cycle No. 2, **CE** Controlled Timing^(1,5)



NOTES

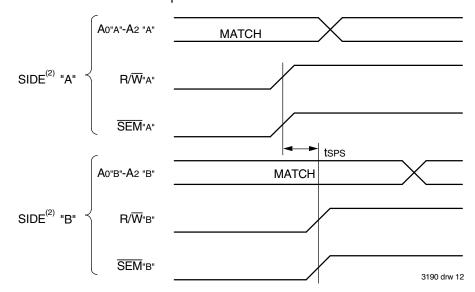
- 1. $R\overline{W}$ or \overline{CE} must be HIGH during all address transitions.
- 2. A write occurs during the overlap (tew or twp) of a LOW $\overline{\text{CE}}$ and a LOW $R\overline{W}$ for memory array writing cycle.
- 3. twn is measured from the earlier of $\overline{\text{CE}}$ or R/\overline{W} (or $\overline{\text{SEM}}$ or R/\overline{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 not be applied.
- $5. \quad \text{If the $\overline{\text{CE}}$ or $\overline{\text{SEM}}$ LOW transition occurs simultaneously with or after the R/\overline{W} LOW transition, the outputs remain in the High-impedance state.}$
- 6. Timing depends on which enable signal is asserted last, \overline{CE} or R/\overline{W} .
- 7. This parameter is guaranteed by device characterization but is not production tested. Transition is measured 0mV from steady state with the Output Test Load (Figure 2).
- 8. If \overline{OE} is LOW during R/\overline{W} controlled write cycle, the write pulse width must be the larger of twp or (twz + tow) to allow the I/O drivers to turn off and data to be placed on the bus for the required tow. 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 twp.
- 9. To access RAM, $\overline{\text{CE}} = \text{VIL}$ and $\overline{\text{SEM}} = \text{VIH}$. To access Semaphore, $\overline{\text{CE}} = \text{VIH}$ and $\overline{\text{SEM}} = \text{VIL}$. tew must be met for either condition.



NOTES:

- 1. \overline{CE} = VIH for the duration of the above timing (both write and read cycle).
- 2. "DATAOUT VALID" represents all I/O's (I/Oo-I/O8) equal to the semaphore value.

Timing Waveform of Semaphore Write Condition (1,3,4)



NOTES:

- 1. Dor = Dol =Vih, $\overline{CE}R = \overline{CE}L = Vih$.
- 2. All timing is the same for left and right ports. Port"A" may be either left or right port. "B" is the opposite port from "A".
- 3. This parameter is measured from R/W*A* or SEM*A* going HIGH to R/W*B* or SEM*B* going HIGH.
- 4. If tsps is not satisfied, there is no guarantee which side will obtain the semaphore flag.

AC Electrical Characteristics Over the Operating Temperature and Supply Voltage Range⁽⁶⁾

			6X12 I Only	7016X15 Com'l Only		
Symbol	Parameter	Min.	Max.	Min.	Max.	Unit
BUSY TIMING	$(M/\overline{S} = V_{IH})$					
T BAA	BUSY Access Time from Address Match	—	12		15	ns
t BDA	BUSY Disable Time from Address Not Matched		12		15	ns
t BAC	BUSY Access Time from Chip Enable Low	_	12	_	15	ns
tBDC	BUSY Disable Time from Chip Enable High	_	12	_	15	ns
taps	Arbitration Priority Set-up Time ⁽²⁾	5	_	5	_	ns
tBDD	BUSY Disable to Valid Data ⁽⁵⁾	_	15	_	18	ns
twн	Write Hold After BUSY ⁽⁵⁾	11	_	13	_	ns
BUSY INPUT	TIMING (M/S = VIL)					
twB	BUSY Input to Write ⁽⁴⁾	0		0	_	ns
twн	Write Hold After BUSY ⁽⁵⁾	11		13	_	ns
PORT-TO-POR	PORT-TO-PORT DELAY TIMING					
twdd	Write Pulse to Data Delay ⁽¹⁾	_	25		30	ns
tooo	Write Data Valid to Read Data Delay ⁽¹⁾	_	20		25	ns

3190 tbl 14a

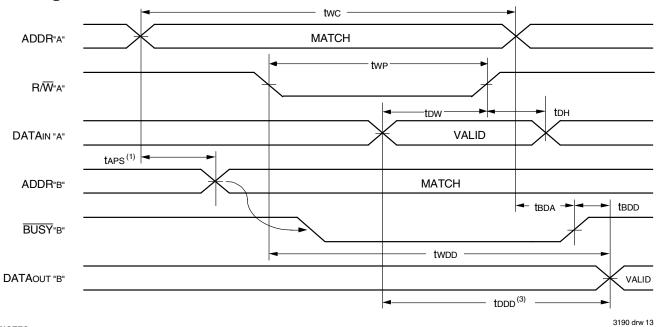
		7016X20 Com'l, Ind & Military		Con	5X25 n'l & tary	7016X35 Com'l & Military		
Symbol	Parameter	Min.	Max.	Min.	Max.	Min.	Max.	Unit
BUSY TIMING	$(M/\overline{S} = V_{IH})$						-	
T BAA	BUSY Access Time from Address Match	_	20		20	_	20	ns
t BDA	BUSY Disable Time from Address Not Matched	_	20	_	20	_	20	ns
t BAC	BUSY Access Time from Chip Enable Low	_	20	_	20	_	20	ns
tBDC	BUSY Disable Time from Chip Enable High	_	17	_	17	_	20	ns
taps	Arbitration Priority Set-up Time ⁽²⁾	5	_	5	_	5	_	ns
tBDD	BUSY Disable to Valid Data ⁽³⁾	_	30		30		35	ns
twн	Write Hold After BUSY ⁽⁵⁾	15	_	17	_	25	_	ns
BUSY INPUT	FIMING (M/S = VIL)							
twB	BUSY Input to Write ⁽⁴⁾	0		0		0		ns
twн	Write Hold After BUSY(5)	15	1	17	_	25	_	ns
PORT-TO-POR	T DELAY TIMING							
twdd	Write Pulse to Data Delay ⁽¹⁾	_	45		50		60	ns
todo	Write Data Valid to Read Data Delay ⁽¹⁾		30	_	35	_	45	ns

NOTES:

3190 tbl 14b

- 1. Port-to-port delay through RAM cells from writing port to reading port, refer to "Timing Waveformof Write with Port-to-Port Read and BUSY (W/S = VI+))".
- 2. To ensure that the earlier of the two ports wins.
- 3. tBDD is a calculated parameter and is the greater of 0, $\mathsf{tWDD} \mathsf{tWP}$ (actual) or $\mathsf{tDDD} \mathsf{tDW}$ (actual).
- 4. To ensure that the write cycle is inhibited on Port "B" during contention on Port "A".
- 5. To ensure that a write cycle is completed on Port "B" after contention on Port "A".
- 6. 'X' in part numbers indicates power rating (S or L).

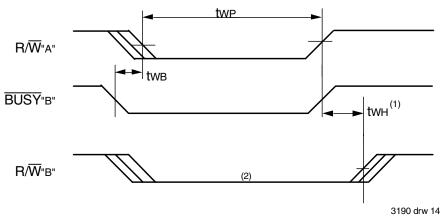
Timing Waveform of Read with $\overline{BUSY}^{(2,4,5)}$ (M/ \overline{S} = VIH)



NOTES:

- 1. To ensure that the earlier of the two ports wins. taps is ignored for $M/\overline{S}=VIL$.
- 2. $\overline{CE}L = \overline{CE}R = VIL$.
- 3. $\overline{OE} = V_{IL}$ for the reading port.
- 4. If $M/\overline{S}=VIL$ (SLAVE), \overline{BUSY} is an input. Then for this example $\overline{BUSY}^*A^*=VIH$ and \overline{BUSY}^*B^* input is shown above.
- 5. 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 Port "A".

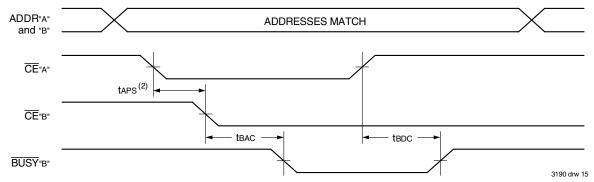
Timing Waveform of Write with **BUSY**(3)



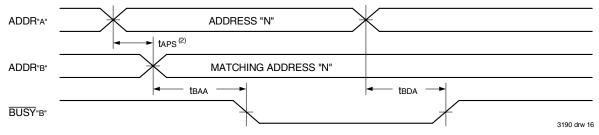
NOTES:

- 1. $\underline{\text{tw}}$ must be met for both $\overline{\text{BUSY}}$ input (SLAVE) and output (MASTER).
- BUSY is asserted on port "B" blocking R/W"B", until BUSY"B" goes HIGH.
- 3. 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 Port "A".

Waveform of $\overline{\textbf{BUSY}}$ Arbitration Controlled by $\overline{\textbf{CE}}$ Timing⁽¹⁾ (M/ $\overline{\textbf{S}}$ = VIH)



Waveform of **BUSY** Arbitration Cycle Controlled by Address Match $Timing^{(1)}$ (M/ \overline{S} = VIH)



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. If taps is not satisfied, the BUSY signal will be asserted on one side or another but there is no guarantee on which side BUSY will be asserted.

AC Electrical Characteristics Over the Operating Temperature and Supply Voltage Range⁽¹⁾

	7016X12 7016X15 Com'l Only Com'l Or						
Symbol	Parameter	Min.	Max.	Min.	Max.	Unit	
INTERRUPT T	INTERRUPT TIMING						
tas	Address Set-up Time	0	_	0	_	ns	
twr	Write Recovery Time	0	_	0	_	ns	
tins	Interrupt Set Time		12	_	15	ns	
tinr	Interrupt Reset Time	_	12	_	15	ns	

3190 tbl 15a

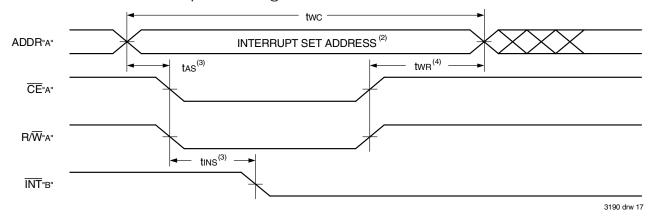
			7016X20 Com'l, Ind & Military		7016X25 Com'l & Military		7016X35 Com'l & Military	
Symbol	Parameter	Min.	Max.	Min.	Max.	Min.	Max.	Unit
INTERRUPT TIMING								
tas	Address Set-up Time	0		0	_	0		ns
twr	Write Recovery Time	0	_	0	_	0		ns
tins	Interrupt Set Time	_	20	_	20	_	25	ns
tinr	Interrupt Reset Time	_	20		20		25	ns

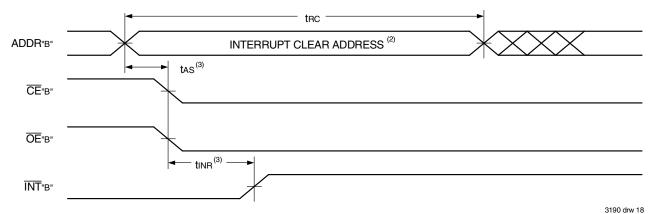
NOTE:

1. 'X' in part numbers indicates power rating (S or L).

3190 tbl 15b

Waveform of Interrupt Timing(1)





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 $(\overline{CE} \text{ or } R\overline{W})$ is asserted last.
- 4. Timing depends on which enable signal $(\overline{CE} \text{ or } R/\overline{W})$ is de-asserted first.

Truth Table III — Interrupt Flag⁽¹⁾

	Left Port									
R/₩L	ĒΕ	ŌĒL	A13L-A0L	ΪΝΤ̈́L	R/ W R	CER	OE R	A13R-A0R	Ī NT R	Function
L	L	Х	3FFF	Х	Х	Х	Х	Х	L ⁽²⁾	Set Right INTR Flag
Х	Х	Х	Х	Х	Х	L	L	3FFF	H ⁽³⁾	Reset Right INTR Flag
Х	Х	Х	Х	L ⁽³⁾	L	L	Х	3FFE	Х	Set Left INTL Flag
Х	L	L	3FFE	H ⁽²⁾	Х	Х	Х	X	Х	Reset Left INTL Flag

NOTES:

3190 tbl 16

- 1. Assumes $\overline{BUSY}L = \overline{BUSY}R = VIH$.
- 2. If $\overline{BUSY}L = VIL$, then no change.
- 3. If $\overline{BUSY}R = VIL$, then no change.

Truth Table IV — Address **BUSY** Arbitration

	In	puts	Out	puts	
ŒL	C ER	Aol-A13L Aor-A13R	BUSY _L (1)	BUSY _R (1)	Function
Χ	Х	NO MATCH	Н	Н	Normal
Н	Χ	MATCH	Н	Н	Normal
Х	Н	MATCH	Н	Н	Normal
L	L	MATCH	(2)	(2)	Write Inhibit ⁽³⁾

3190 tbl 17

NOTES:

- 1. Pins BUSYL and BUSYR are both outputs when the part is configured as a master. Both are inputs when configured as a slave. BUSYx outputs on the IDT7016 are push-pull, not open drain outputs. On slaves the BUSYx input internally inhibits writes.
- 2. "L" if the inputs to the opposite port were stable prior to the address and enable inputs of this port. "H" if the inputs to the opposite port became stable after the address and enable inputs of this port. If the inputs to the opposite port became stable after the address and enable inputs of this port. If the inputs to the opposite port became stable after the address and enable inputs of this port. "H" if the inputs to the opposite port became stable after the address and enable inputs of this port. "H" if the inputs to the opposite port became stable after the address and enable inputs of this port. "H" if the inputs to the opposite port became stable after the address and enable inputs of this port. "H" if the inputs to the opposite port became stable after the address and enable inputs of this port. "H" if the inputs to the opposite port became stable after the address and enable inputs of this port. "H" if the inputs to the opposite port became stable after the address and enable inputs of this port. "H" if the inputs to the opposite port became stable after the address and enable inputs of this port. "H" if the inputs to the opposite port became stable after the address and enable inputs of this port. "H" if the inputs to the opposite port became stable after the address and enable inputs of this port. "H" if the inputs to the opposite port became stable after the address and enable inputs of this port. "H" if the inputs to the opposite port became stable after the address and enable inputs of this port. "H" if the inputs to the opposite port became stable after the address and enable inputs of this port. "H" if the inputs to the opposite port became stable after the address and enable inputs of the address and enable inputs of this port. "H" if the inputs to the opposite port became stable after the address and enable inputs of the addre
- 3. Writes to the left port are internally ignored when BUSYL outputs are driving LOW regardless of actual logic level on the pin. Writes to the right port are internally ignored when BUSYR outputs are driving LOW regardless of actual logic level on the pin.

Truth Table V — Example of Semaphore Procurement Sequence (1,2,3)

Functions	Do - Da Left	Do - De 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

3190 tbl 18

NOTES:

- 1. This table denotes a sequence of events for only one of the eight semaphores on the IDT7016.
- 2. There are eight semaphore flags written to via I/O₀ and read from all I/O₃ (I/O₀ I/O₈). These eight semaphores are addressed by A₀ A₂.
- e. $\overline{CE} = VIH$, $\overline{SEM} = VIL$ to access the semaphores. Refer to the semaphore Read/Write Truth Table.

Functional Description

The IDT7016 provides two ports with separate control, address and I/O pins that permit independent access for reads or writes to any location in memory. The IDT7016 has an automatic power down feature controlled by $\overline{\text{CE}}$. The $\overline{\text{CE}}$ controls on-chip power down circuitry that permits the respective port to go into a standby mode when not selected ($\overline{\text{CE}}$ HIGH). When a port is enabled, access to the entire memory array is permitted.

Interrupts

If the user chooses the interrupt function, a memory location (mail box or message center) is assigned to each port. The left port

interrupt flag ($\overline{\text{INTL}}$) is asserted when the right port writes to memory location 3FFE where a write is defined as the $\overline{\text{CE}}$ = R/\overline{W} = V_{IL} per Truth Table III. The left port clears the interrupt by an address location 3FFE access when $\overline{\text{CE}}_R = \overline{\text{OE}}_R = V_{\text{IL}}$, R/\overline{W} is a "don't care". Likewise, the right port interrupt flag (INTR) is asserted when the left port writes to memory location 3FFF and to clear the interrupt flag (INTR), the right port must access memory location 3FFF. The message (9 bits) at 3FFE or 3FFF is user-defined since it is in an addressable SRAM location. If the interrupt function is not used, address locations 3FFE and 3FFF are not used as mail boxes but are still part of the random access memory. Refer to Truth Table III for the interrupt operation.

Busy Logic

Busy Logic provides a hardware indication that both ports of the RAM have accessed the same location at the same time. It also allows one of the two accesses to proceed and signals the other side that the RAM is "busy". The BUSY pin can then be used to stall the access until the operation on the other side is completed. If a write operation has been attempted from the side that receives a BUSY indication, the write signal is gated internally to prevent the write from proceeding.

The use of BUSY logic is not required or desirable for all applications. In some cases it may be useful to logically OR the BUSY outputs together and use any BUSY indication as an interrupt source to flag the event of an illegal or illogical operation. If the write inhibit function of BUSY logic is not desirable, the BUSY logic can be disabled by placing the part in slave mode with the M/S pin. Once in slave mode the BUSY pin operates solely as a write inhibit input pin. Normal operation can be programmed by tying the BUSY pins HIGH. If desired, unintended write operations can be prevented to a port by tying the BUSY pin for that port LOW.

The BUSY outputs on the IDT7016 RAM in master mode, are push-pull type outputs and do not require pull up resistors to operate. If these RAMs are being expanded in depth, then the BUSY indication for the resulting array requires the use of an external AND gate.

Width Expansion Busy Logic Master/Slave Arrays

When expanding an IDT7016 RAM array in width while using $\overline{\text{BUSY}}$ logic, one master part is used to decide which side of the RAM array will receive a $\overline{\text{BUSY}}$ indication, and to output that indication. Any number of slaves to be addressed in the same address range as the master use the $\overline{\text{BUSY}}$ signal as a write inhibit signal. Thus on the IDT7016 RAM the $\overline{\text{BUSY}}$ pin is an output if the part is used as a master (M/ $\overline{\text{S}}$ pin = H), and the $\overline{\text{BUSY}}$ pin is an input if the part used as a slave (M/ $\overline{\text{S}}$ pin = L) as shown in Figure 3.

If two or more master parts were used when expanding in width, a split decision could result with one master indicating $\overline{\text{BUSY}}$ on one side of the array and another master indicating $\overline{\text{BUSY}}$ on one other side of the array. This would inhibit the write operations from one port for part of a word and inhibit the write operations from the other port for the other part of the word.

The BUSY arbitration, on a master, is based on the chip enable and address signals only. It ignores whether an access is a read or write. In a master/slave array, both address and chip enable must be valid long enough for a BUSY flag to be output from the master before the actual write pulse can be initiated with the R/W signal. Failure to observe this timing can result in a glitched internal write inhibit signal and corrupted data in the slave.

Semaphores

The IDT7016 are extremely fast Dual-Port 16Kx9 Static RAMs with an additional 8 address locations dedicated to binary semaphore flags. These flags allow either processor on the left or right side of the Dual-Port RAM to claim a privilege over the other processor for functions defined by the system designer's software. As an

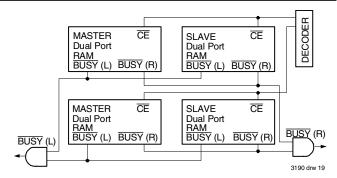


Figure 3. Busy and chip enable routing for both width and depth expansion with IDT7016 RAMs.

example, the semaphore can be used by one processor to inhibit the other from accessing a portion of the Dual-Port RAM or any other shared resource.

The Dual-Port RAM features a fast access time, and both ports are completely independent of each other. This means that the activity on the left port in no way slows the access time of the right port. Both ports are identical in function to standard CMOS Static RAM and can be read from, or written to, at the same time with the only possible conflict arising from the simultaneous writing of, or a simultaneous READ/WRITE of, a non-semaphore location. Semaphores are protected against such ambiguous situations and may be used by the system program to avoid any conflicts in the non-semaphore portion of the Dual-Port RAM. These devices have an automatic power-down feature controlled by $\overline{\text{CE}}$, the Dual-Port RAM enable, and $\overline{\text{SEM}}$, the semaphore enable. The $\overline{\text{CE}}$ and $\overline{\text{SEM}}$ pins control on-chip power down circuitry that permits the respective port to go into standby mode when not selected. This is the condition which is shown in Truth Table I where $\overline{\text{CE}}$ and $\overline{\text{SEM}}$ are both HIGH.

Systems which can best use the IDT7016 contain multiple processors or controllers and are typically very high-speed systems which are software controlled or software intensive. These systems can benefit from a performance increase offered by the IDT7016's hardware semaphores, which provide a lockout mechanism without requiring complex programming.

Software handshaking between processors offers the maximum in system flexibility by permitting shared resources to be allocated in varying configurations. The IDT7016 does not use its semaphore flags to control any resources through hardware, thus allowing the system designer total flexibility in system architecture.

An advantage of using semaphores rather than the more common methods of hardware arbitration is that wait states are never incurred in either processor. This can prove to be a major advantage in very high-speed systems.

How the Semaphore Flags Work

The semaphore logic is a set of eight latches which are independent of the Dual-Port RAM. These latches can be used to pass a flag, or token, from one port to the other to indicate that a shared resource is in use. The semaphores provide a hardware assist for a use assignment method called "Token Passing Allocation." In this method, the state of a semaphore latch is used as a token indicating that shared resource is in use. If the left processor wants to use this

resource, it requests the token by setting the latch. This processor then verifies its success in setting the latch by reading it. If it was successful, it proceeds to assume control over the shared resource. If it was not successful in setting the latch, it determines that the right side processor has set the latch first, has the token and is using the shared resource. The left processor can then either repeatedly request that semaphore's status or remove its request for that semaphore to perform another task and occasionally attempt again to gain control of the token via the set and test sequence. Once the right side has relinquished the token, the left side should succeed in gaining control.

The semaphore flags are active LOW. A token is requested by writing a zero into a semaphore latch and is released when the same side writes a one to that latch.

The eight semaphore flags reside within the IDT7016 in a separate memory space from the Dual-Port RAM. This address space is accessed by placing a LOW input on the $\overline{\text{SEM}}$ pin (which acts as a chip select for the semaphore flags) and using the other control pins (Address, $\overline{\text{OE}}$, and $\overline{\text{R/W}}$) as they would be used in accessing a standard static RAM. Each of the flags has a unique address which can be accessed by either side through address pins A0 – A2. When accessing the semaphores, none of the other address pins has any effect.

When writing to a semaphore, only data pin Do is used. If a low level is written into an unused semaphore location, that flag will be set to a zero on that side and a one on the other side (see Truth Table V). That semaphore can now only be modified by the side showing the zero. When a one is written into the same location from the same side, the flag will be set to a one for both sides (unless a semaphore request from the other side is pending) and then can be written to by both sides. The fact that the side which is able to write a zero into a semaphore subsequently locks out writes from the other side is what makes semaphore flags useful in interprocessor communications. (A thorough discussion on the use of this feature follows shortly.) A zero written into the same location from the other side will be stored in the semaphore request latch for that side until the semaphore is freed by the first side.

When a semaphore flag is read, its value is spread into all data bits so that a flag that is a one reads as a one in all data bits and a flag containing a zero reads as all zeros. The read value is latched into one side's output register when that side's semaphore select (\overline{SEM}) and output enable (\overline{OE}) signals go active. This serves to disallow the semaphore from changing state in the middle of a read cycle due to a write cycle from the other side. Because of this latch, a repeated read of a semaphore in a test loop must cause either signal (\overline{SEM}) or \overline{OE} to go inactive or the output will never change.

A sequence WRITE/READ must be used by the semaphore in order to guarantee that no system level contention will occur. A processor requests access to shared resources by attempting to write a zero into a semaphore location. If the semaphore is already in use, the semaphore request latch will contain a zero, yet the semaphore flag will appear as one, a fact which the processor will verify by the subsequent read (see Truth Table V). As an example, assume a processor writes a zero to the left port at a free semaphore location. On a subsequent read, the processor will verify that it has written successfully to that location and will assume control over the

resource in question. Meanwhile, if a processor on the right side attempts to write a zero to the same semaphore flag it will fail, as will be verified by the fact that a one will be read from that semaphore on the right side during subsequent read. Had a sequence of READ/WRITE been used instead, system contention problems could have occurred during the gap between the read and write cycles.

It is important to note that a failed semaphore request must be followed by either repeated reads or by writing a one into the same location. The reason for this is easily understood by looking at the simple logic diagram of the semaphore flag in Figure 4.Two semaphore request latches feed into a semaphore flag. Whichever latch is first to present a zero to the semaphore flag will force its side of the semaphore flag LOW and the other side HIGH. This condition will continue until a one is written to the same semaphore request latch. Should the other side's semaphore request latch have been written to a zero in the meantime, the semaphore flag will flip over to the other side as soon as a one is written into the first side's request latch. The second side's flag will now stay LOW until its semaphore request latch is written to a one. From this it is easy to understand that, if a semaphore is requested and the processor which requested it no longer needs the resource, the entire system can hang up until a one is written into that semaphore request latch.

The critical case of semaphore timing is when both sides request a single token by attempting to write a zero into it at the same time. The semaphore logic is specially designed to resolve this problem. If simultaneous requests are made, the logic guarantees that only one side receives the token. If one side is earlier than the other in making the request, the first side to make the request will receive the token. If both requests arrive at the same time, the assignment will be arbitrarily made to one port or the other.

One caution that should be noted when using semaphores is that semaphores alone do not guarantee that access to a resource is secure. As with any powerful programming technique, if semaphores are misused or misinterpreted, a software error can easily happen.

Initialization of the semaphores is not automatic and must be handled via the initialization program at power-up. Since any semaphore request flag which contains a zero must be reset to a one, all semaphores on both sides should have a one written into them at initialization from both sides to assure that they will be free when needed.

Using Semaphores-Some Examples

Perhaps the simplest application of semaphores is their application as resource markers for the IDT7016's Dual-Port RAM. Say the 16K x 9 RAM was to be divided into two 8K x 9 blocks which were to be dedicated at any one time to servicing either the left or right port. Semaphore 0 could be used to indicate the side which would control the lower section of memory, and Semaphore 1 could be defined as the indicator for the upper section of memory.

To take a resource, in this example the lower 8K of Dual-Port RAM, the processor on the left port could write and then read a zero in to Semaphore 0. If this task were successfully completed (a zero was read back rather than a one), the left processor would assume control of the lower 8K. Meanwhile the right processor was attempt-

ing to gain control of the resource after the left processor, it would read back a one in response to the zero it had attempted to write into Semaphore 0. At this point, the software could choose to try and gain control of the second 8K section by writing, then reading a zero into Semaphore 1. If it succeeded in gaining control, it would lock out the left side.

Once the left side was finished with its task, it would write a one to Semaphore 0 and may then try to gain access to Semaphore 1. If Semaphore 1 was still occupied by the right side, the left side could undo its semaphore request and perform other tasks until it was able to write, then read a zero into Semaphore 1. If the right processor performs a similar task with Semaphore 0, this protocol would allow the two processors to swap 8K blocks of Dual-Port RAM with each other.

The blocks do not have to be any particular size and can even be variable, depending upon the complexity of the software using the semaphore flags. All eight semaphores could be used to divide the Dual-Port RAM or other shared resources into eight parts. Semaphores can even be assigned different meanings on different sides rather than being given a common meaning as was shown in the example above.

Semaphores are a useful form of arbitration in systems like disk

interfaces where the CPU must be locked out of a section of memory during a transfer and the I/O device cannot tolerate any wait states. With the use of semaphores, once the two devices has determined which memory area was "off-limits" to the CPU, both the CPU and the I/O devices could access their assigned portions of memory continuously without any wait states.

Semaphores are also useful in applications where no memory "WAIT" state is available on one or both sides. Once a semaphore handshake has been performed, both processors can access their assigned RAM segments at full speed.

Another application is in the area of complex data structures. In this case, block arbitration is very important. For this application one processor may be responsible for building and updating a data structure. The other processor then reads and interprets that data structure. If the interpreting processor reads an incomplete data structure, a major error condition may exist. Therefore, some sort of arbitration must be used between the two different processors. The building processor arbitrates for the block, locks it and then is able to go in and update the data structure. When the update is completed, the data structure block is released. This allows the interpreting processor to come back and read the complete data structure, thereby guaranteeing a consistent data structure.

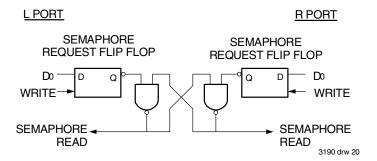
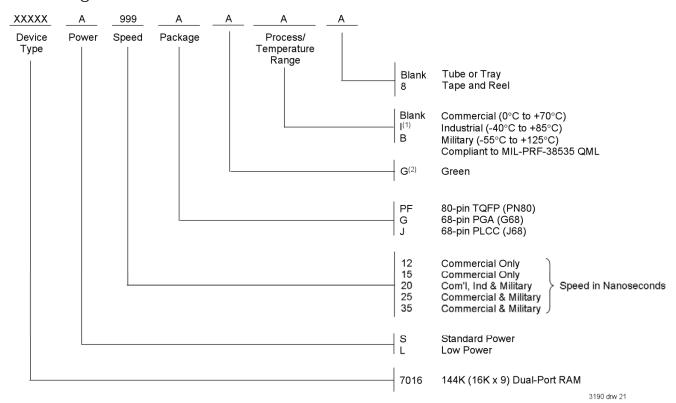


Figure 4. IDT7016 Semaphore Logic

Ordering Information



NOTES:

- 1. Contact your local sales office for industrial temp range for other speeds, packages and powers.
- 2. Green parts available. For specific speeds, packages and powers contact your local sales office.

Datasheet Document History

01/11/99:		Initiated datasheet document history Converted to new format
		Cosmetic and typographical corrections
	Pages 2 and 3	Added additional notes to pin configurations
06/03/99	. .	Changed drawing format
	Page 1	Corrected DSC number
11/10/99:	· ·	Replaced IDT logo
05/19/00:	Page 4	Increased storage temperature parameter
		Clarified TA parameter
	Page 6	DC Electrical parameters-changed wording from open to disabled
		Changed ±200mV to 0mV in notes
01/10/02:	Pages 2 & 3	Added date revision for pin configurations
	Pages 4, 6, 7, 9 & 12	Removed Industrial temp footnote from all tables
	Pages 6, 7, 9, 12 & 14	Added Industrial temp for 20ns speed to DC and AC Electrical Characteristics
	Page 20	Added Industrial temp offering to 20ns ordering information
	Pages 1 & 20	Replaced тм logo with ® logo
04/04/06:	Page 1	Added green availability to features
	Page 20	Added indicator to ordering information
01/09/09:	Page 20	Removed "IDT" from orderable part number

Datasheet Document History (con't)

10/03/14: Added Tape and Reel to Ordering Information Page 20

> The package codes PN80-1, G68-1 & J68-1 changed to PN80, G68 & J68 respectively Page 2, 3, 4 & 20

> > to match standard package codes

10/10/14: Page 20 Corrected two typos



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Компания «Океан Электроники» предлагает заключение долгосрочных отношений при поставках импортных электронных компонентов на взаимовыгодных условиях!

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- Поставка электронных компонентов под контролем ВП;
- Система менеджмента качества сертифицирована по Международному стандарту ISO 9001;
- При необходимости вся продукция военного и аэрокосмического назначения проходит испытания и сертификацию в лаборатории (по согласованию с заказчиком);
- Поставка специализированных компонентов военного и аэрокосмического уровня качества (Xilinx, Altera, Analog Devices, Intersil, Interpoint, Microsemi, Actel, Aeroflex, Peregrine, VPT, Syfer, Eurofarad, Texas Instruments, MS Kennedy, Miteq, Cobham, E2V, MA-COM, Hittite, Mini-Circuits, General Dynamics и др.);

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