1M x 4 DRAM
DYNAMIC RANDOM-ACCESS MEMORY

AVAILABLE AS MILITARY SPECIFICATIONS
- SMD 5962-90847
- MIL-STD-883

FEATURES
- Organized 1,048,576 x 4
- Single +5V ±10% power supply
- Enhanced Page-Mode operation for faster memory access
  ✓ Higher data bandwidth than conventional page-mode parts
  ✓ Random Single-Bit Access within a row with a column address
- CAS\-Before-RAS\ (CBR) Refresh
- Long Refresh period: 1024-cycle Refresh in 16ms (Max)
- 3-State unlatched Output
- Low Power Dissipation
- All Inputs/Outputs and Clocks are TTL Compatible
- Processing to MIL-STD-883, Class B available

OPTIONS MARKING
- **Timing**

80ns access	-80
100ns access	-10
120ns access	-12

- **Package(s)**

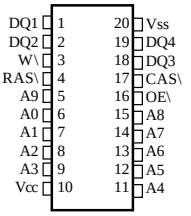
Ceramic DIP (400mils)	JD	No. 113
Ceramic Flatpack	HR	No. 308

- **Operating Temperature Ranges**

Military (-55°C to +125°C)	M

PIN ASSIGNMENT
(Top View)

20-Pin DIP (JD)
20-Pin Flatpack (HR)
(400 MIL)



Pin Name	Function
A0 - A9	Address Inputs
CAS\	Column-Address Strobe
DQ1 - DQ4	Data Inputs/Outputs
OE\	Output Enable
RAS\	Row-Address Strobe
W\	Write Enable
Vcc	5V Supply
Vss	Ground

GENERAL DESCRIPTION
The SMJ44400 is a series of 4,194,304-bit dynamic random-access memories (DRAMs), organized as 1,048,576 words of four bits each. This series employs state-of-the-art technology for high performance, reliability, and low-power operation.

The SMJ44400 features maximum row access times of 80ns, 100ns, and 120ns. Maximum power dissipation is as low as 360mW operating and 22mW standby.

All inputs and outputs, including clocks, are compatible with Series 54 TTL. All addressses and data-in lines are latched on-chip to simplify system design. Data out is unlatched to allow greater system flexibility.

The SMJ44400 is offered in a 400-mil, 20-pin ceramic side-brazed dual-in-line package (JD suffix) and a 20-pin ceramic flatpack (HR suffix) that are characterized for operation from -55°C to +125°C.

OPERATION

Enhanced Page Mode
Enhanced page-mode operation allows faster memory access by keeping the same row address while selecting random column addresses. The time for row-address setup and hold and address multiplex is eliminated. The maximum number of columns that can be accessed is determined by the maximum RAS\ low time and the CAS\ page cycle time used. With minimum CAS\ page cycle time, all 1024 columns specified by column addresses A0 through A9 can be accessed without intervening RAS\ cycles.

Unlike conventional page-mode DRAMs, the column-address buffers in this device are activated on the

(continued)

Enhanced Paga Mode (continued)

falling edge of RAS\. The buffers act as transparent or flow-through latches while CAS\ is high. The falling edge of CAS\ latches the column addresses. This feature allows the SMJ44400 to operate at a higher data bandwidth then conventional page-mode parts, since data retrieval begins as soon as column address is valid rather than when CAS\ goes low. This performance improvement is referred to as enhanced page mode. Valid column address can be presented immediately after row address hold time has been satisfied, usually well in advance of the maximum (access time from column address) has been satisfied. In the event that column addresses for the next cycle are valid at the time CAS\ goes high, access time for the next cycle is determined by the later occurrence of t_{CAC} or t_{CPA} (access time form rising edge of CAS\).

Address (A0-A9)

Twenty address bits are required to decode 1 of 1,048,576 storage cell locations. Ten row-address bits are set up on inputs A0 through A9 and latched onto the chip by RAS\. The ten column-address bits are set up on pins A0 through A9 and latched onto the chip by CAS\. All addresses must be stable on or before the falling edges of RAS\ and CAS\. RAS\ is similar to a chip enable in that it activates the sense amplifiers as well as the row decoder. CAS\ is used as a chip select, activating the output buffer as well as latching the address bits into the column-address buffer.

Write Enable (W\)

The read or write mode is selected through W\. A logic high on the W\ input selects the read mode and a logic low selects the write mode. The write-enable terminal can be driven from standard TTL circuits without a pullup resistor. The data input is disabled when the read mode is selected. When W\ goes low prior to CAS\ (early write), data out reamins in the high-impedance state for the entire cycle permitting a write operation independent of the state of OE\. This permits early-write operation to be completed with OE\ grounded.

Data In/Out (DQ1 - DQ4)

The high-impedance output buffer provides direct TTL compatibility (no pullup resistor required) with a fanout of two Series 54 TTL loads. Data out is the same polarity as data in. The output is in the high-impedance (floating) state until CAS\ and OE\ are brought low. In a read cycle the output becomes valid after all access times are satisfied. The output remains valid while CAS\ and OE\ are low. CAS\ or OE\ going high returns it to the high-impedance state.

Output Enable (OE\)

OE\ controls the impedance of the output buffers. When OE\ is high, the buffers remain in the high-impedance state. Bringing OE\ low during a normal cycle activates the output buffers, putting them in the low-impedance state. It is necessary for both RAS\ and CAS\ to be brought low for the output buffers to go into the low-impedance state. Once in the low-ompedance state, they remain in the low-impedance state until either OE\ or CAS\ is brought high.

Refresh

A refresh operation must be performed at least once every 16ms to retain data. This can be achieved by strobing each of the 1024 rows (A0-A9). A normal read or write cycle refreshes all bits in each row that is selected. A RAS\-only operation can be used by holding CAS\ at the high (inactive) level, conserving power as the output buffer remains in the high-impedance state. Externally generated addresses must be used for a RAS\-only refresh. Hidden refresh can be performed while maintaining valid data at teh output pin. This is accomplished by holding CAS\ at V_{IL} after a read operation and cycling RAS\ after a specified precharge period, similar to a RAS\-only refresh cycle. The external address is ignored during the hidden refresh cycles.

CAS\-before-RAS\ (CBR) and hidden refresh

CBR refresh is utilized by bringing CAS\ low earlier than RAS\ (see parameter t_{CSR}) and holding it low after RAS\ falls (see parameter t_{CSR}). For successive CBR refresh cycles, CAS\ can remain low while cycling RAS\. The external address is ignored and the refresh address is generated internally. During CBR refresh cycles the outputs remain in the high-impedance state.

Hidden refresh can be performed while maintaining valid data at the output pins. Thsi is accomplished by holding CAS\ at VIL after a read operation. RAS\ is cycled after the specified read cycle parameters are met. Hidden refresh can also be used in conjuction with an early-write cycle. CAS\ is maintained at VIL while RAS\ is cycled, once all the specified early-write parameters are met. Externally generated addresses must be used to specify the location to be accessed during the initial RAS\ cycle of a hidden refresh operation. Subsequent RAS\ cycles (refresh cycles) use the internally-generated addresses and the external address is ignored.

Power Up

To achieve proper device operation, an initial pause of 200µs followed by a minimum of eight initialization cycles is

(continued)

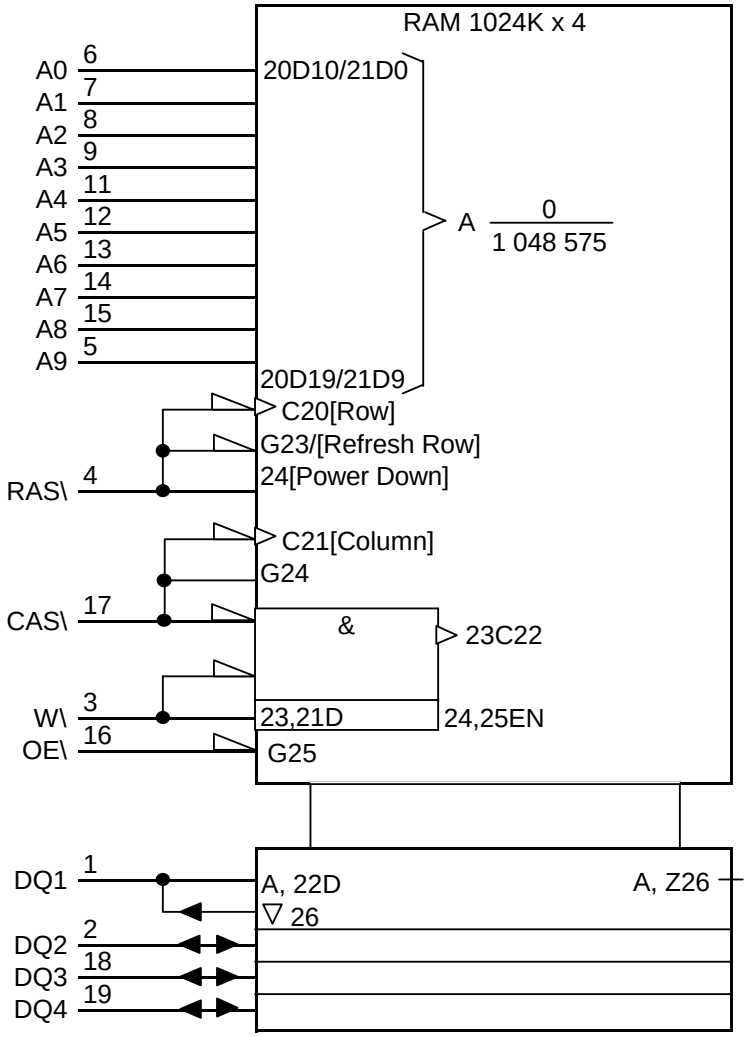
Power Up (continued)

required after full Vcc level is achieved. These eight initialization cycles need to include at least one refresh (RAS\-only or CBR) cycle.

Test Mode

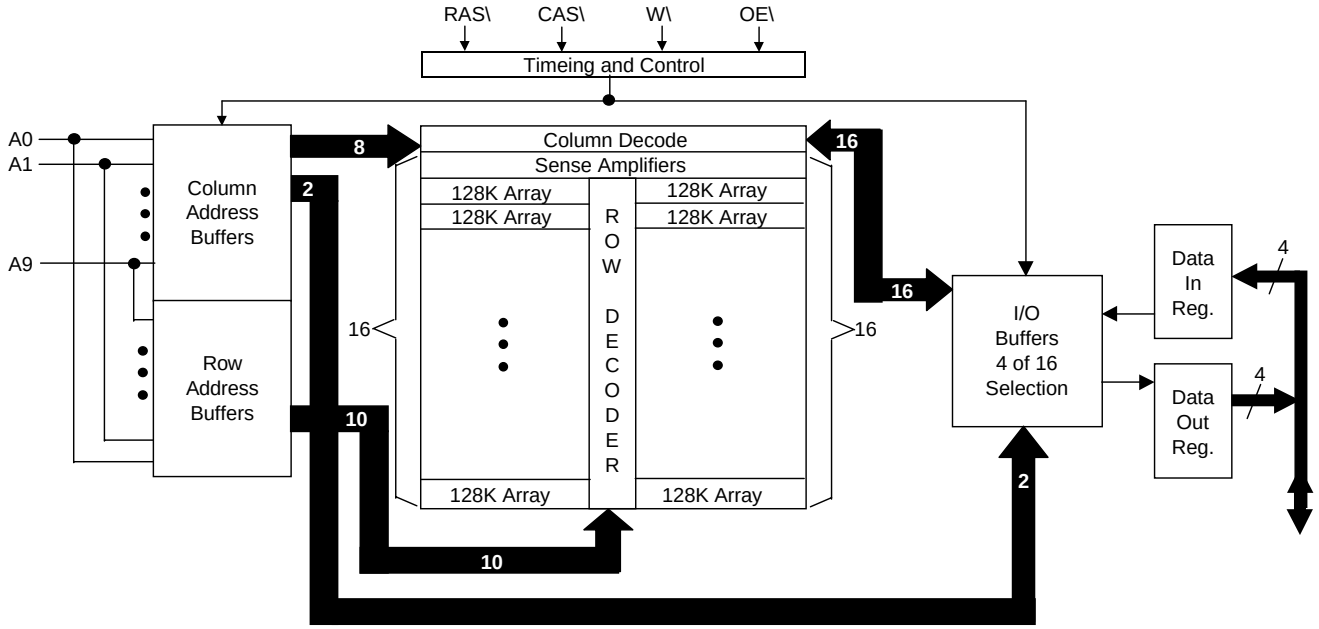
An industry standard Design For Test (DFT) mode is incorporated in the SMJ44400. A CBR with W\ low (WCBR) cycle is used to enter test mode. In the test mode, data is written into and read from eight sections of the array in parallel. All data is written into the array through DQ1. Data is comparted upon reading and if all bits are equal, all DQ pins go high. If any one bit is different, all the DQ pins go low. Any combination read, write, read-write, or page-mode can be used in the test mode. The test mode function reduces test times by enabling the 1M x 4-bit DRAM to be tested as if it were a 512K DRAM where column address 0 is not used. A RAS\-only or CBR refresh cycle is used to exit the DFT mode.

LOGIC SYMBOL[1]



1. This symbol is in accordance with ANSI/IEEE Std. 91-1984 and IEC Publication 617-12. The pinouts illustrated are for the JD package.

FUNCTIONAL BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS*

Voltage on Vcc Supply Relative to Vss.....-1V to +7.0V
Voltage Range on Any Pin Relative to Vss.....-1V to +7.0V
Short Circuit Output Current (per I/O)….....50mA
Power Dissipation.....1W
Storage Temperature Range.....-65°C to +150°C
Operating Temperature Range.....-55°C to +125°C

*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 operation section of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.
** Junction temperature depends upon package type, cycle time, loading, ambient temperature and airflow.

RECOMMENDED OPERATING CONDITIONS

SYM	DESCRIPTION	MIN	NOM	MAX	UNIT
V_{CC}	Supply Voltage	4.5	5	5.5	V
V_{IH}	High-Level Input Voltage	2.4		6.5	V
V_{IL}	Low-Level Input Voltage[1]	-1		0.8	V
T_A	Minimum Operating Temperature	-55			°C
T_C	Maximum Operating Case Temperature			125	°C

1. The algebraic convention, where the more negative (less positive) limit is designated as minimum, is used for logic-voltage levels only.

ELECTRICAL CHARACTERISTICS AND RECOMMENDED OPERATING CONDITIONS

($-55^oC \leq T_A \leq 125^oC$ or -40^oC to $+85^oC$; Vcc = 5V ±10%)

			-8		-10		-12		
SYM	PARAMETER	TEST CONDITIONS	MIN	MAX	MIN	MAX	MIN	MAX	UNIT
V_{OH}	High-level output voltage	I_{OH} = -5mA	2.4		2.4		2.4		V
V_{OL}	Low-level output voltage	I_{OL} = 4.2mA		0.4		0.4		0.4	V
I_I	Input current (leakage)	V_{CC} = 5.5V, V_I = 0V to 6.5V, All other pins = 0V to V_{CC}		±10		±10		±10	µA
I_O	Output current (leakage)	V_{CC} = 5.5V, V_O = 0V to V_{CC}, CAS\ High		±10		±10		±10	µA
I_{CC1}	Read - or write-cycle current[1]	V_{CC} = 5.5V, Minimum cycle		85		80		70	mA
I_{CC2}	Standby current	After 1 memory cycle, RAS\ and CAS\ High, V_{IH} = 2.4V		4		4		4	mA
I_{CC3}	Average refresh current (RAS\ only, or CBR\)[1]	V_{CC} = 5.5V, Minimum cycle, RAS\ cycling, CAS\ High (RAS\ only), RAS\ Low after CAS\ Low (CBR)		85		75		65	mA
I_{CC4}	Average page current[2]	V_{CC} = 5.5V, t_{PC} = minimum, RAS\ Low, CAS\ cycling		50		40		35	mA

CAPACITANCE (f = 1MHz)[3]

SYM	PARAMETER	MAX	UNIT
$C_{i(A)}$	Input capacitance, address inputs	7	pF
$C_{i(RC)}$	Input capacitance, strobe inputs	10	pF
$C_{i(W)}$	Input capacitance, write-enable inputs	10	pF
C_O	Output capacitance	10	pF

SWITCHING CHARACTERISTICS ($-55^oC \leq T_A \leq 125^oC$ or -40^oC to $+85^oC$; Vcc = 5V ±10%)

		-8	-10	-12	
SYM	PARAMETERS	MAX	MAX	MAX	UNIT
t_{AA}	Access time from column address	40	45	55	ns
t_{CAC}	Access time from CAS\ low	20	25	30	ns
t_{CPA}	Access time from column precharge	45	50	55	ns
t_{RAC}	Access time from RAS\ low	80	100	120	ns
t_{OEA}	Access time from OE\ low	20	25	30	ns
t_{OFF}	Output disable time after CAS\ High[4]	20	25	30	ns
t_{OEZ}	Output disable tiem after OE\ High[4]	20	25	30	ns

NOTES:

1. Measured with a maximum of one address change while RAS\ = V_{IL}.
2. Measured with a maximum of one address change while CAS\ = V_{IH}.
3. V_{CC} = 5V ±0.5V and the bias on the pins under test is 0V. Capacitance is sampled only at initial design and after any major change.
4. t_{OFF} and t_{OEZ} are specified when the output is no longer driven. The outputs are disabled by bringing either OE\ or CAS\ High.

TIMING REQUIREMENTS (-55°C≤T_A≤125°C or -40°C to +85°C; Vcc = 5V ±10%)

		-8		-10		-12		
SYM	PARAMETER	MIN	MAX	MIN	MAX	MIN	MAX	UNIT
t_{RC}	Cycle time, random read or write[1]	150		180		210		ns
t_{RWC}	Cycle time, read-write	205		245		285		ns
t_{PC}	Cycle time, page-mode read or write[2]	50		60		65		ns
t_{PRWC}	Cycle time, page-mode read-write	100		120		135		ns
t_{RASP}	Pulse duration, page mode, RAS\ low[3]	80	100000	100	100000	120	100000	ns
t_{RAS}	Pulse duration, nonpage mode, RAS\ low[3]	80	10000	100	10000	120	10000	ns
t_{CAS}	Pulse duration, CAS\ low[4]	20	10000	25	10000	30	10000	ns
t_{CP}	Pulse duration, CAS\ High	10		10		15		ns
t_{RP}	Pulse duration, RAS\ High (precharge)	60		70		80		ns
t_{WP}	Pulse duration, write	15		20		25		ns
t_{ASC}	Setup time, column address before CAS\ low	0		0		0		ns
t_{ASR}	Setup time, row address before RAS\ low	0		0		0		ns
t_{DS}	Setup time, data[5]	0		0		0		ns
t_{RCS}	Setup time, read before CAS\ low	0		0		0		ns
t_{CWL}	Setup time, W\ low before CAS\ high	20		25		30		ns
t_{RWL}	Setup time, W\ low before RAS\ high	20		25		30		ns
t_{WCS}	Setup time, W\ low before CAS\ low (early-write operation only)	0		0		0		ns
t_{WSR}	Setup time, W\ High (CBR refresh only)	10		10		10		ns
t_{CAH}	Hold time, column address after CAS\ low	15		20		20		ns
t_{DHR}	Hold time, data after RAS\ low	60		75		90		ns
t_{DH}	Hold time, data[5]	15		20		25		ns
t_{AR}	Hold time, column address after CAS\ low[4]	60		75		90		ns
t_{RAH}	Hold time, row address after RAS\ low	10		15		15		ns
t_{RCH}	Hold time, read after CAS\ High[6]	0		0		0		ns
t_{RRH}	Hold time, read after RAS\ High[6]	0		0		0		ns
t_{WCH}	Hold time, write after CAS\ low (early-write operation only)	15		20		25		ns
t_{WCR}	Hold time, write after RAS\ low[4]	60		75		90		ns
t_{WHR}	Hold time, W\ High (CBR refresh only)	10		10		10		ns
t_{OEH}	Hold time, OE\ command	20		25		30		ns
t_{ROH}	Hold time, RAS\ referenced to OE\	20		25		30		ns
t_{AWD}	Delay time, column address to W\ low (read-write operation only)	70		80		90		ns
t_{CHR}	Delay time, RAS\ low to CAS\ High (CBR refresh only)	20		20		25		ns
t_{CRP}	Delay time, CAS\ High to RAS\ low	0		0		0		ns
t_{CSH}	Delay time, RAS\ low to CAS\ High	80		100		120		ns
t_{CSR}	Delay time, CAS\ low to RAS\ low (CBR refresh only)	10		10		10		ns
t_{CWD}	Delay time, CAS\ low to W\ low (read-write operation only)	50		60		70		ns

NOTES:

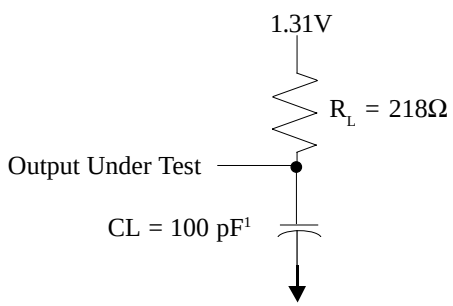
1. All cycle times assume t_T = 5ns.
2. To assure t_{PC} min, t_{ASC} should be ≥ t_{CP}.
3. In a read-write cycle, t_{RWD} and t_{RWL} must be observed.
4. In a read-write cycle, t_{CWD} and t_{CWL} must be observed.
5. Referenced to the later of CAS\ or W\ in write operations.
6. Either t_{RRH} or t_{RCH} must be satisfied for a read cycle.

TIMING REQUIREMENTS (continued)

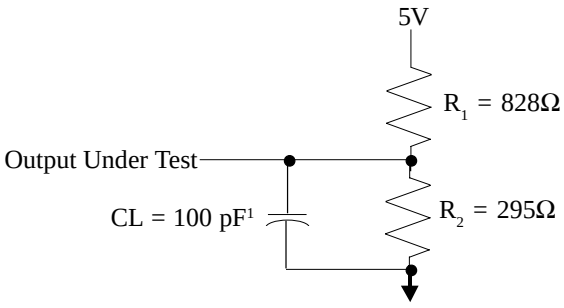
		-8		-10		-12		
SYM	PARAMETER	MIN	MAX	MIN	MAX	MIN	MAX	UNIT
t_{RAD}	Delay time, RAS\ low to column address[1]	15	40	20	50	20	65	ns
t_{RAL}	Delay time, column addresss to RAS\ High	40		50		55		ns
t_{CAL}	Delay time, column addresss to CAS\ High	40		50		55		ns
t_{RCD}	Delay time, RAS\ low to CAS\ low[1]	20	60	25	75	25	90	ns
t_{RPC}	Delay time, RAS\ High to CAS\ low	0		0		0		ns
t_{RSH}	Delay time, CAS\ low to RAS\ High	20		25		30		ns
t_{RWD}	Delay time, RAS\ low to W\ low (read-write operation only)	110		135		160		ns
t_{CLZ}	CAS\ to output in low Z[2]	0		0		0		ns
t_{OED}	OE\ to data delay	20		25		30		ns
t_{REF}	Refresh time interval		16		16		16	ms
t_T	Tranistion time[3]							

NOTES:
1. Maximum value specified only to assure access time.
2. Valid data is presented at the outputs after all access times are satisfied but can go from the high-impedance state to an invalid-data state prior to the specified access times as the outputs are driven when CAS\ and OE\ are low.
3. Transition times (rise and fall) for RAS\ and CAS\ are to be a minimum of 3ns and a maximum of 50ns.

PARAMETER MEASUREMENT INFORMATION
Figure 1. Load Circuit for Timing Parameters



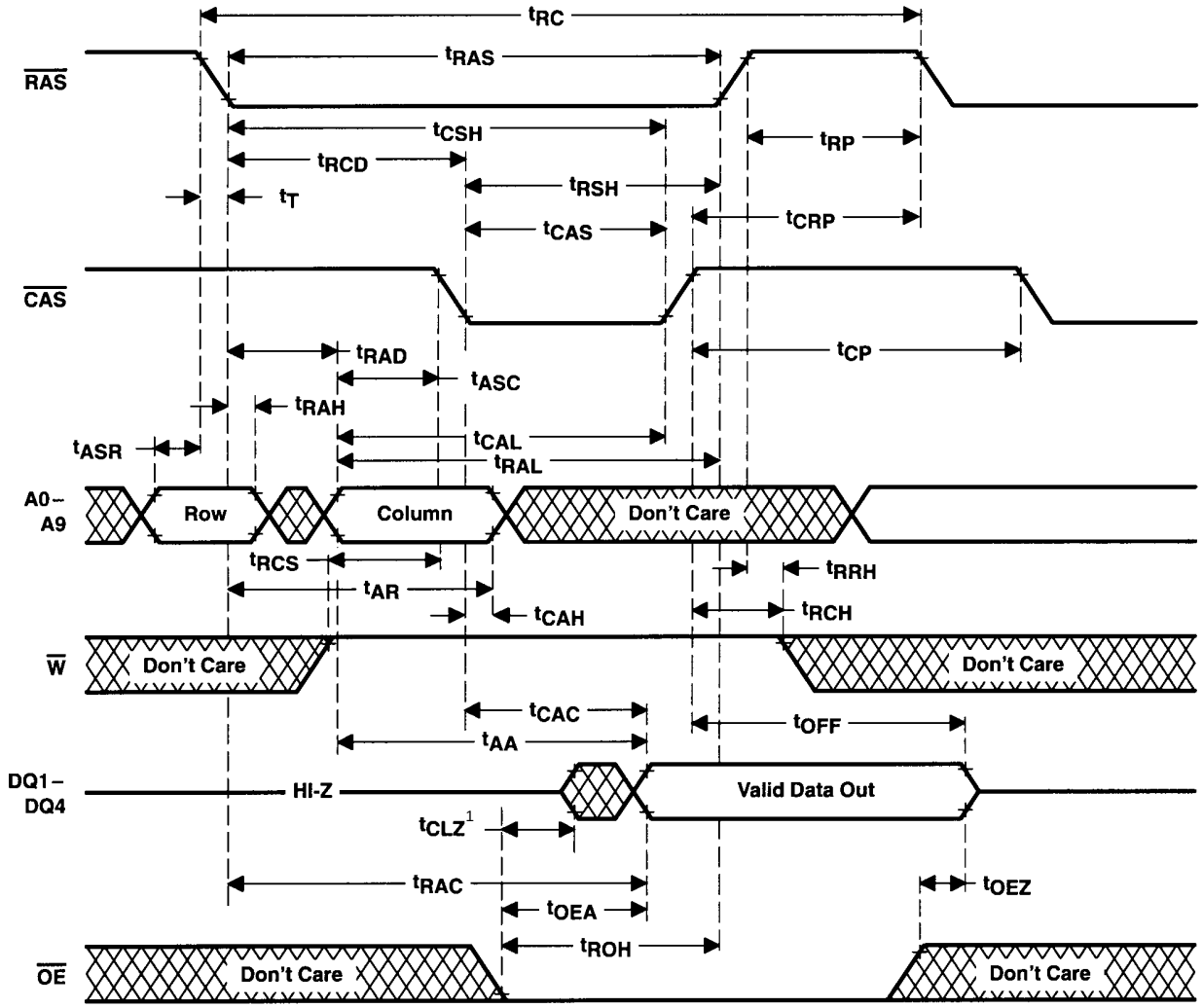
(a) LOAD CIRCUIT



(b) ALTERNATE LOAD CIRCUIT

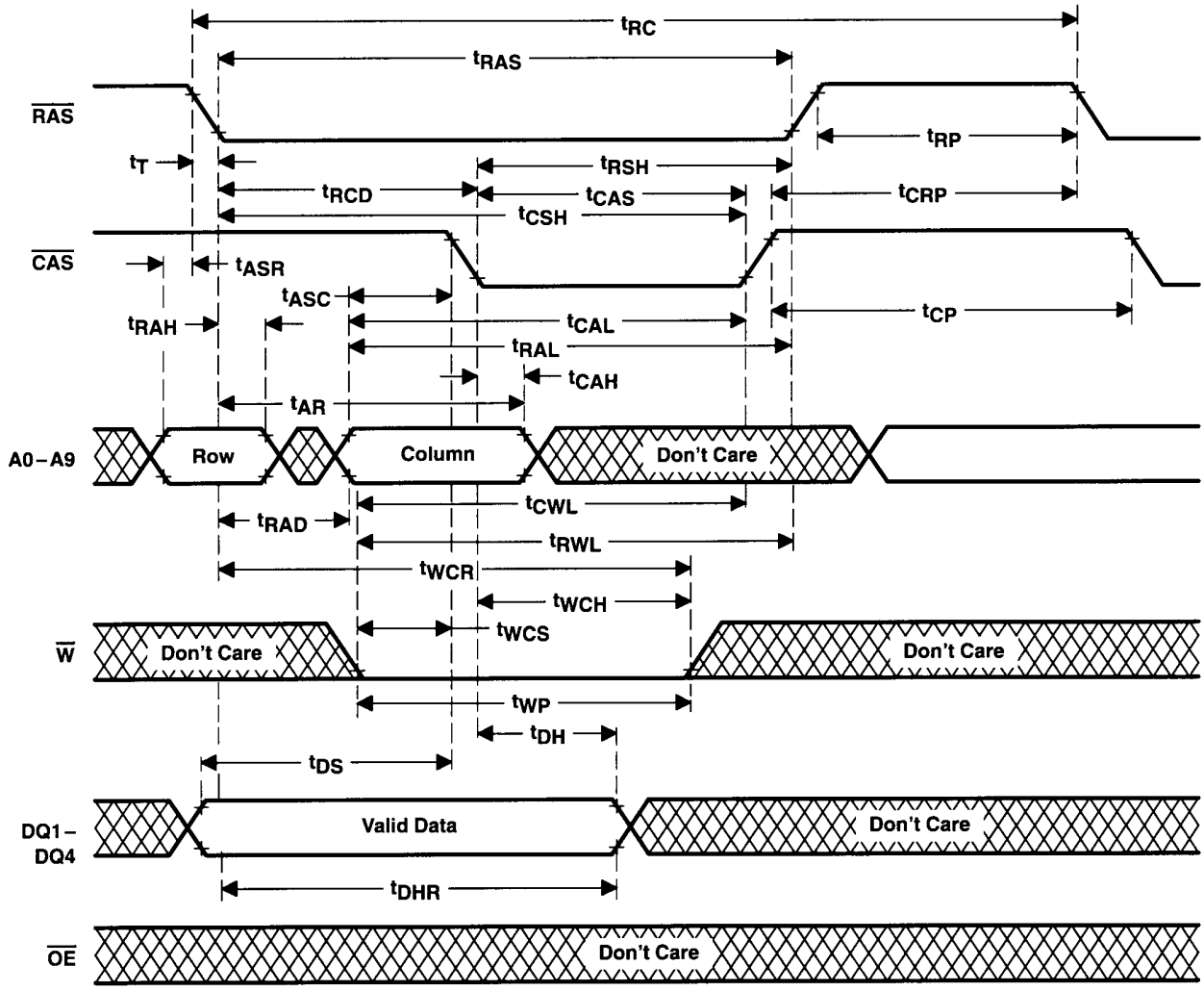
NOTES:
1. C_L includes probe and fixture capacitance.

READ-CYCLE TIMING

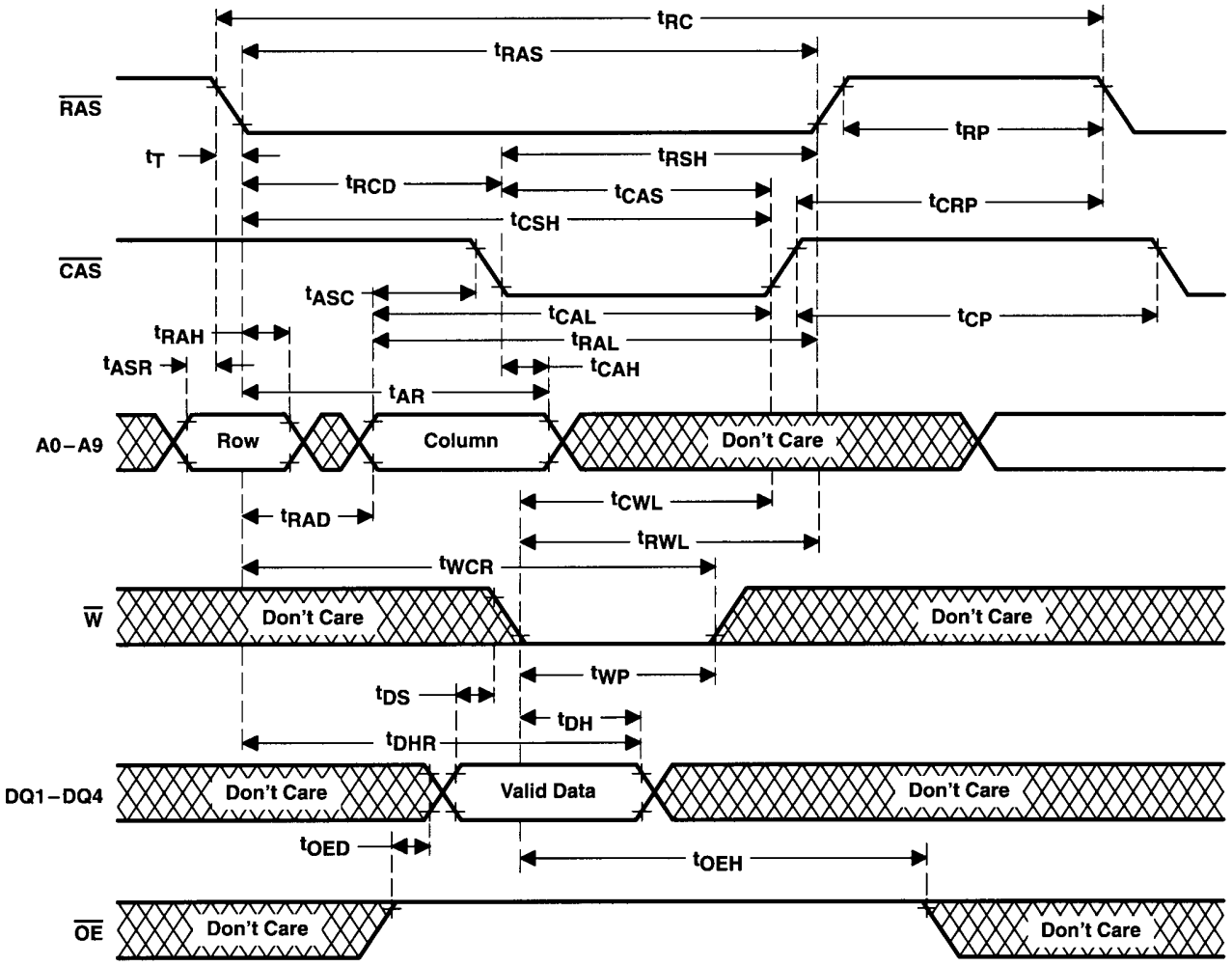


NOTES:
1. Valid data is presented at the outputs after all access times are satisfied but can go from the high-impedance state to an invalid-data state prior to the specified access tiems as the outputs are driven when CAS\ and OE\ are low.

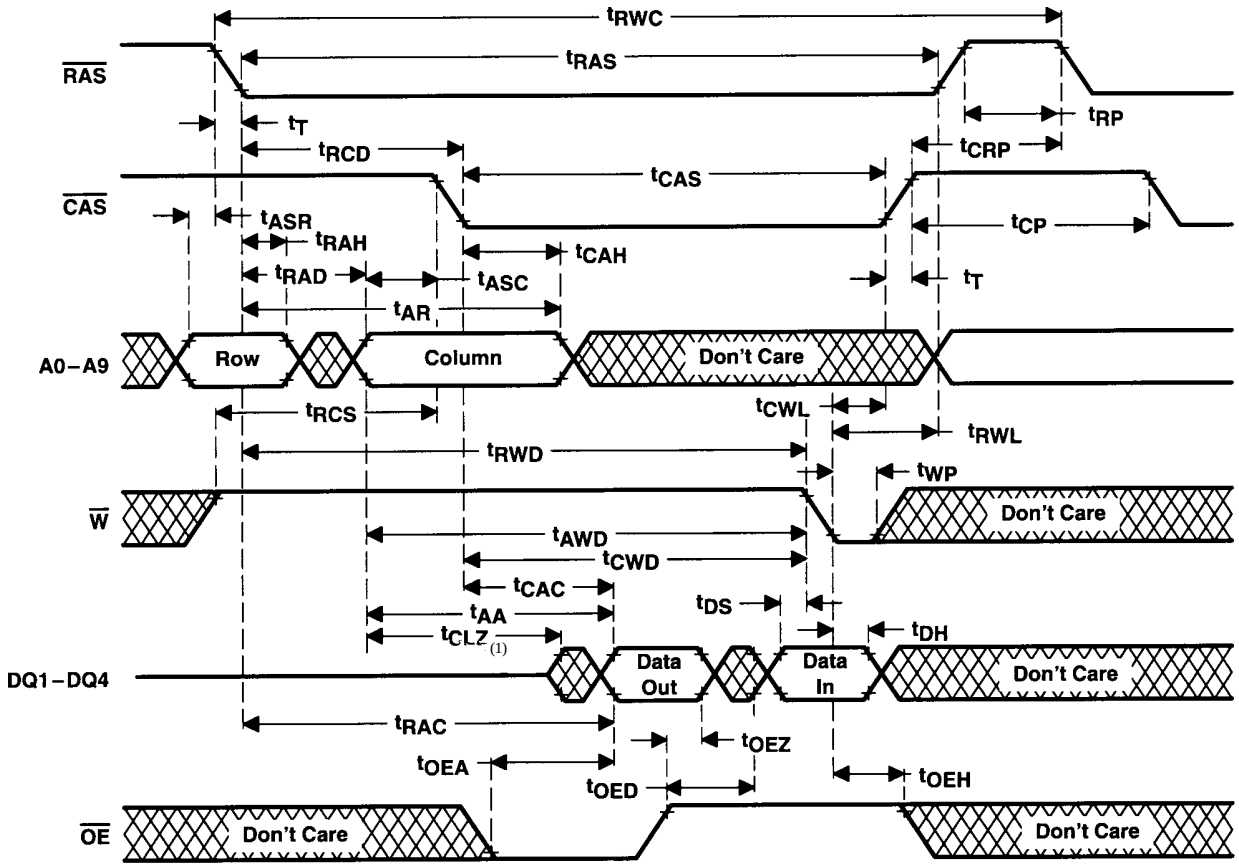
EARLY-WRITE-CYCLE TIMING



WRITE-CYCLE TIMING

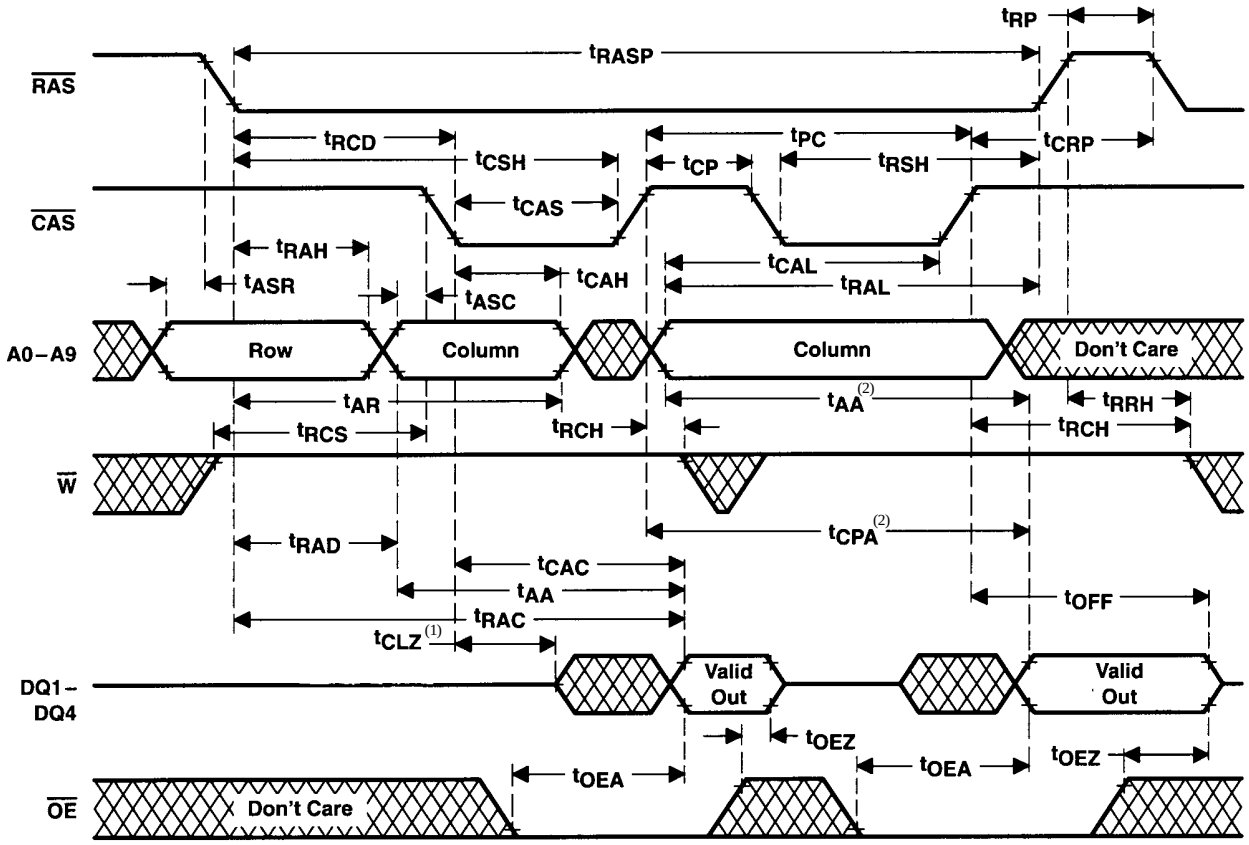


READ-WRITE CYCLE TIMING



NOTES:
1. Valid data is presented at the outputs after all access times are satisfied but can go from the high-impedance state to an invalid-data state prior to the specified access tiems as the outputs are driven when CAS\ and OE\ are low.

ENHANCED-PAGE-MODE READ-CYCLE TIMING

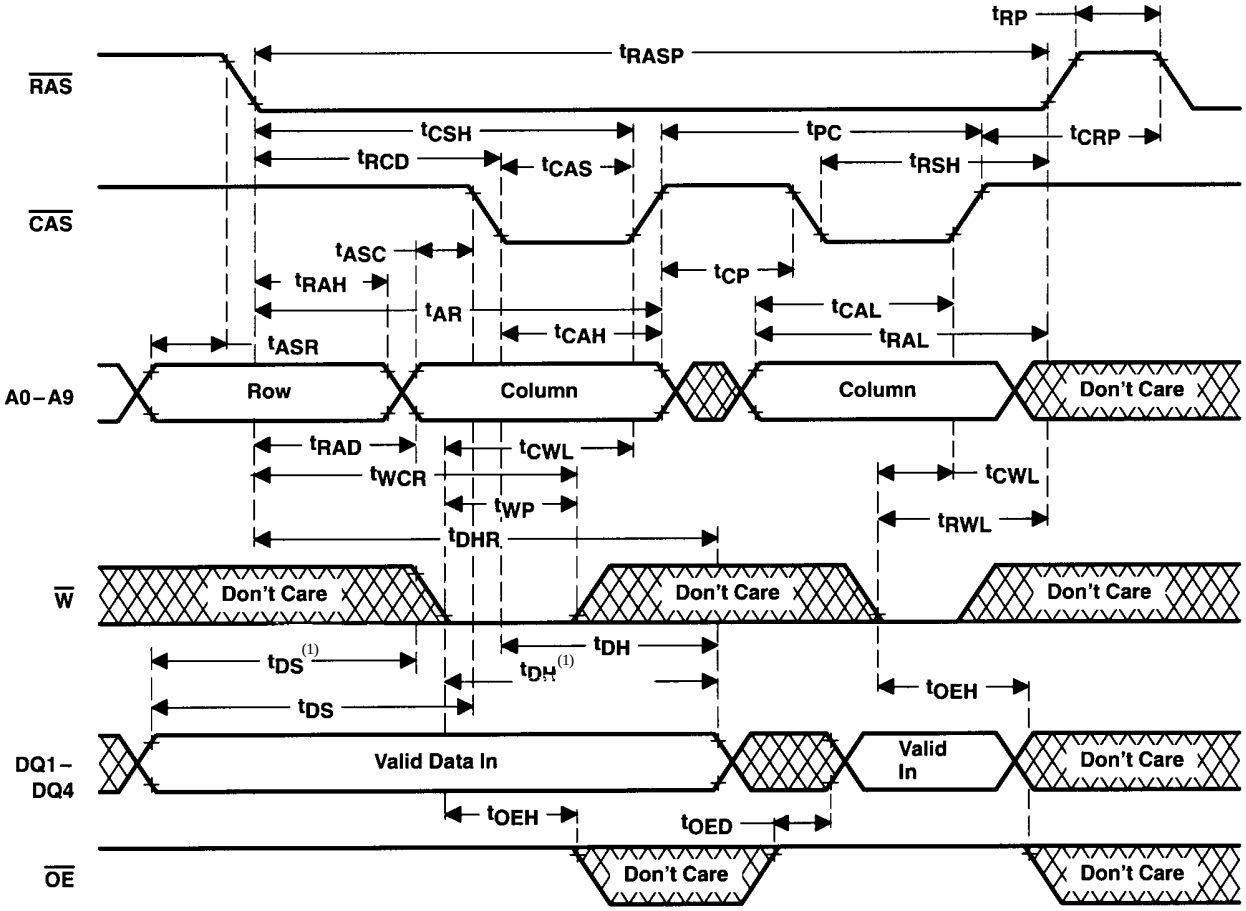


NOTES:

1. Valid data is presented at the outputs after all access times are satisfied but can go from the high-impedance state to an invalid-data state prior to the specified access tiems as the outputs are driven when CAS\ and OE\ are low.

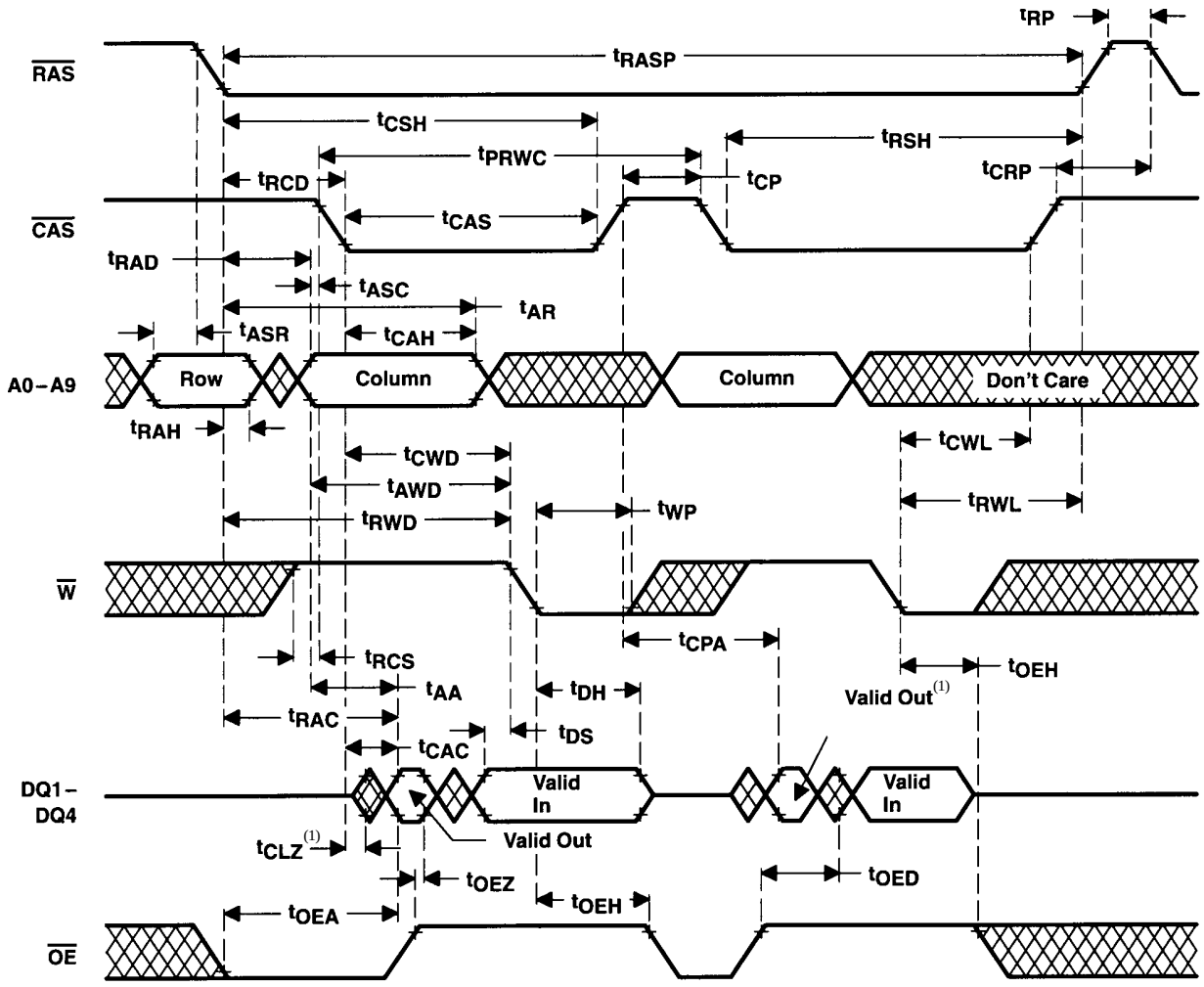
2. Access time is t_{CPA} or t_{AA} dependent.

ENHANCED-PAGE-MODE WRITE-CYCLE TIMING[2]



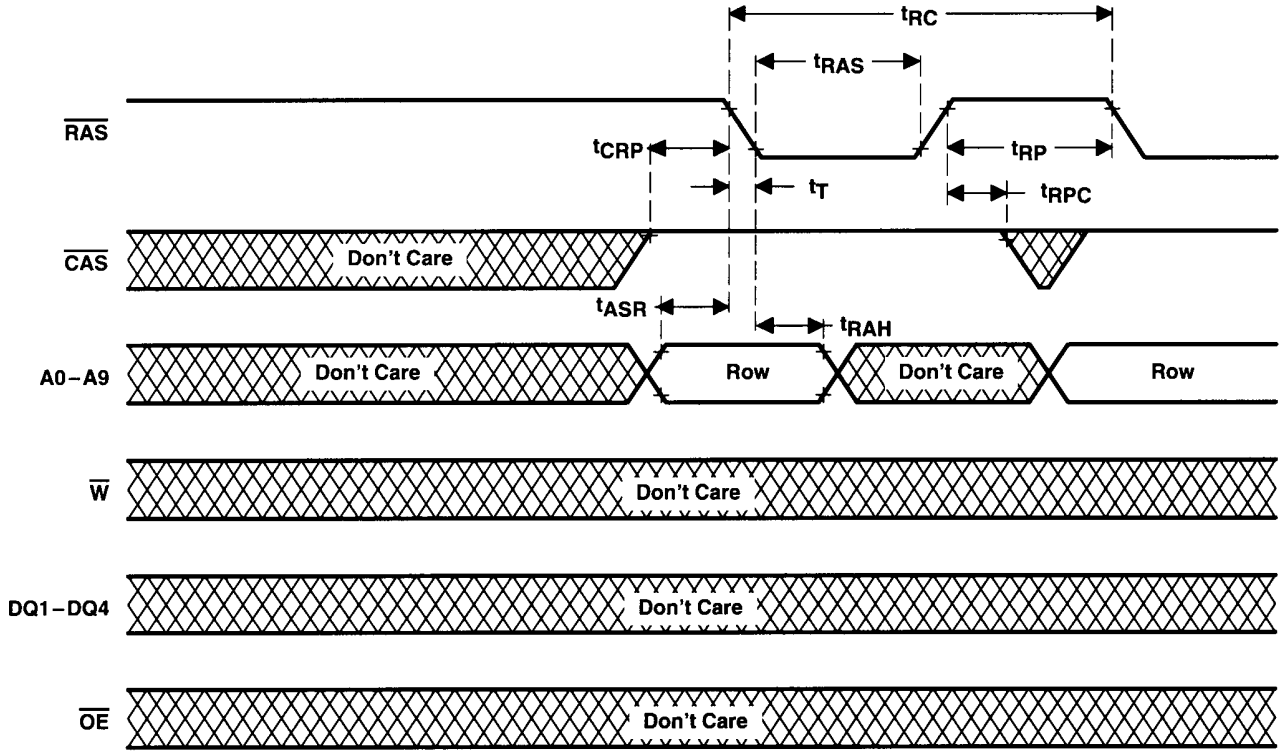
NOTES:
1. Referenced to CAS\ or W\, whichever occurs last.
2. A read cycle or a read-write cycle can be intermixed with write cycles as long as read and read-write timing specifications are not violated.

ENHANCED-PAGE-MODE READ-WRITE-CYCLE TIMING[2]

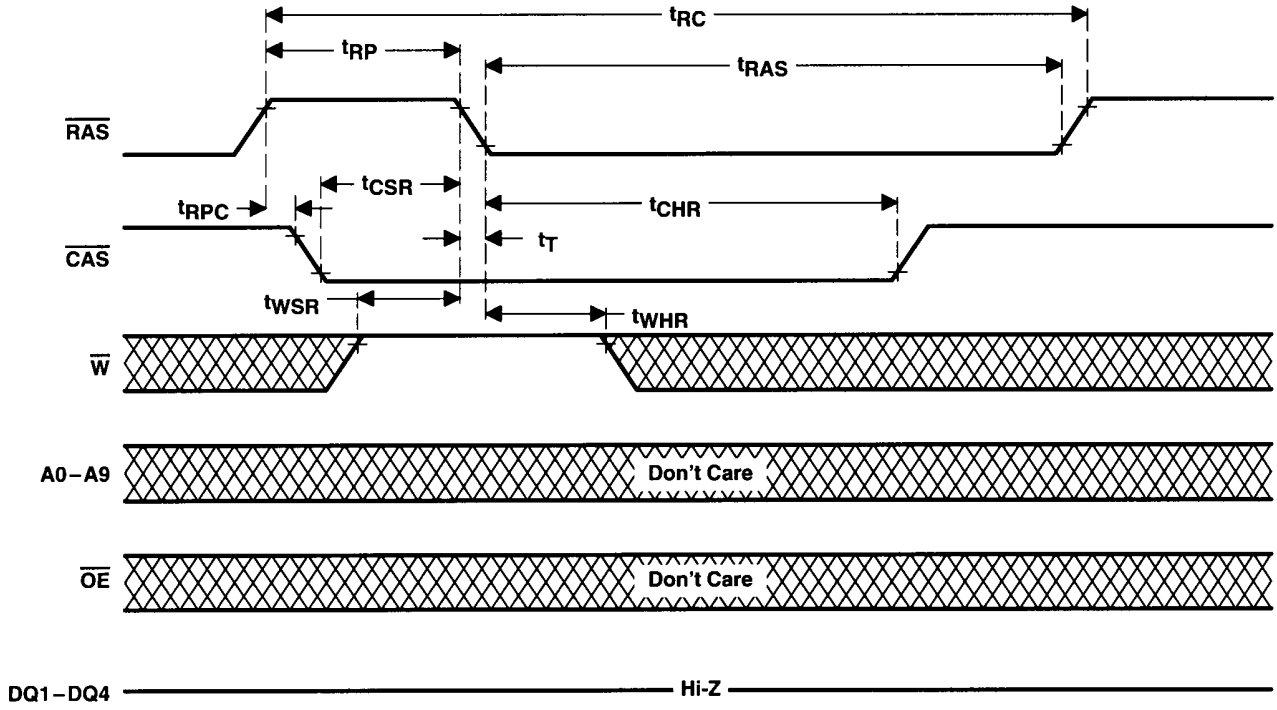


NOTES:
1. Valid data is presented at the outputs after all access times are satisfied but can go from the high-impedance state to an invalid-data state prior to the specified access times as the outputs are driven when CAS\ and OE\ are low.
2. A read or write cycle can be intermixed with read-write cycles as long as the read and write timing specifications are not violated.

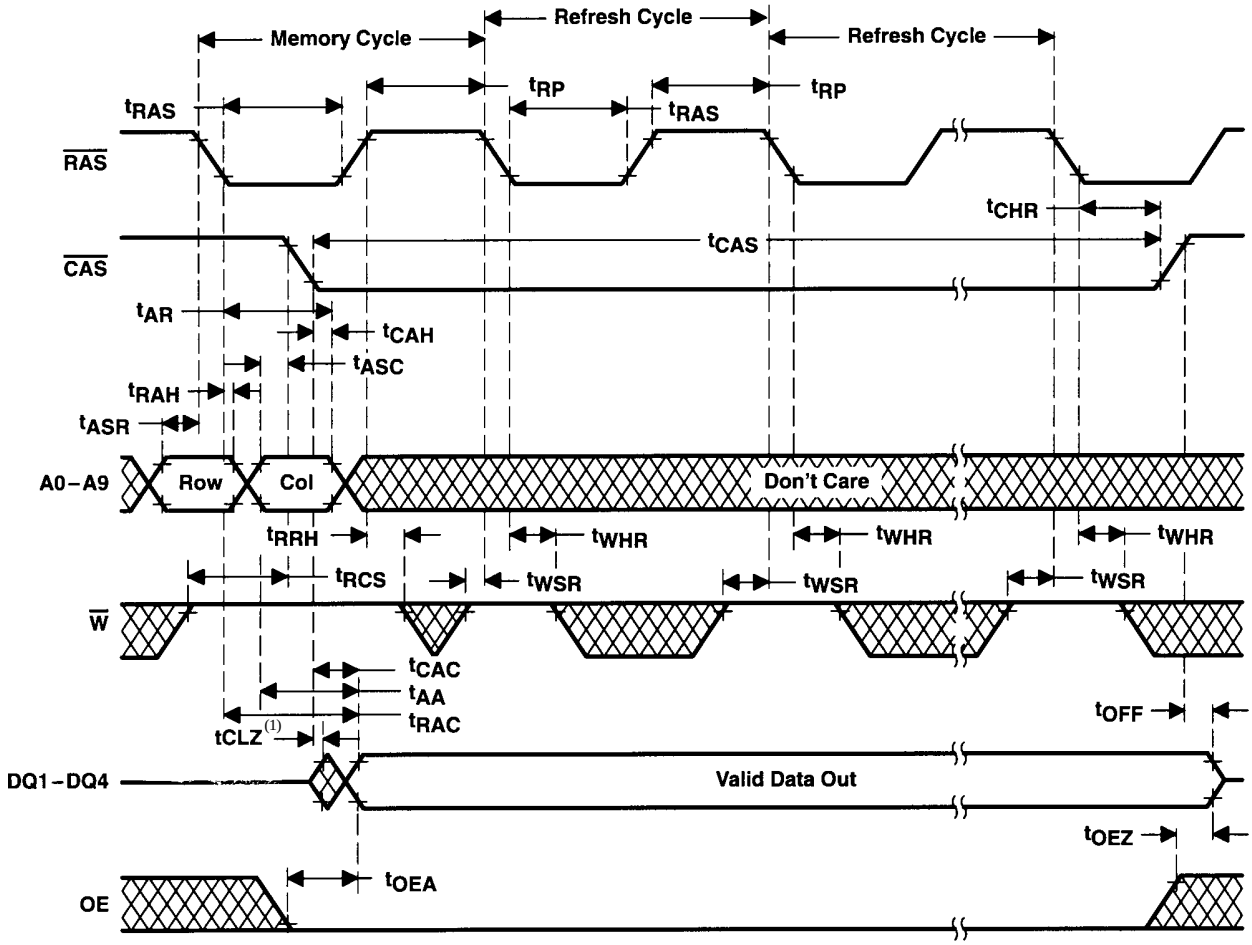
RAS\-ONLY REFRESH TIMING



AUTOMATIC-CBR-REFRESH-CYCLE TIMING



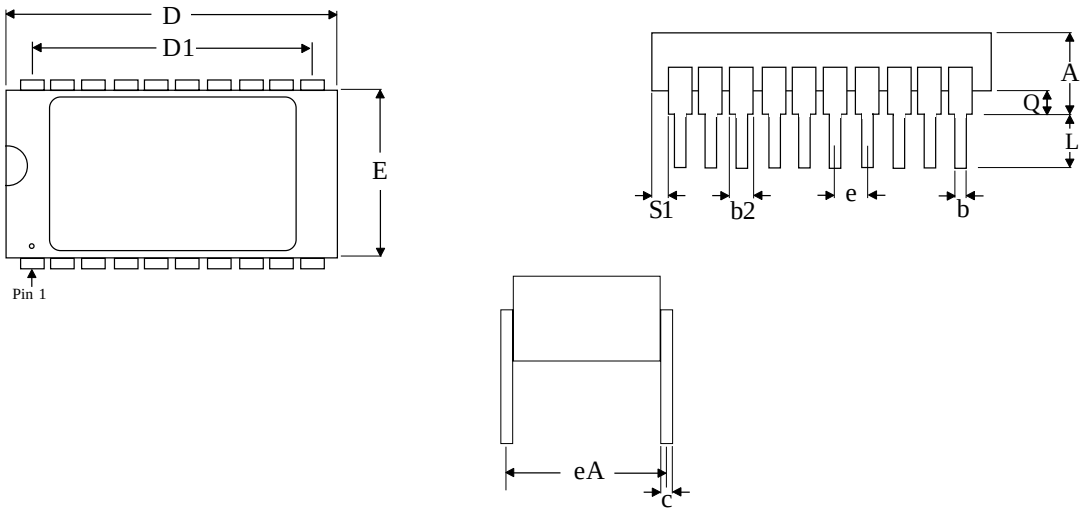
HIDDEN-REFRESH-CYCLE (READ) TIMING



NOTES:
1. Valid data is presented at the outputs after all access times are satisfied but can go from the high-impedance state to an invalid-data state prior to the specified access times as the outputs are driven when CAS\ and OE\ are low.

MECHANICAL DEFINITIONS*

ASI Case #113 (Package Designator JD)
SMD 5962-90847, Case Outline U



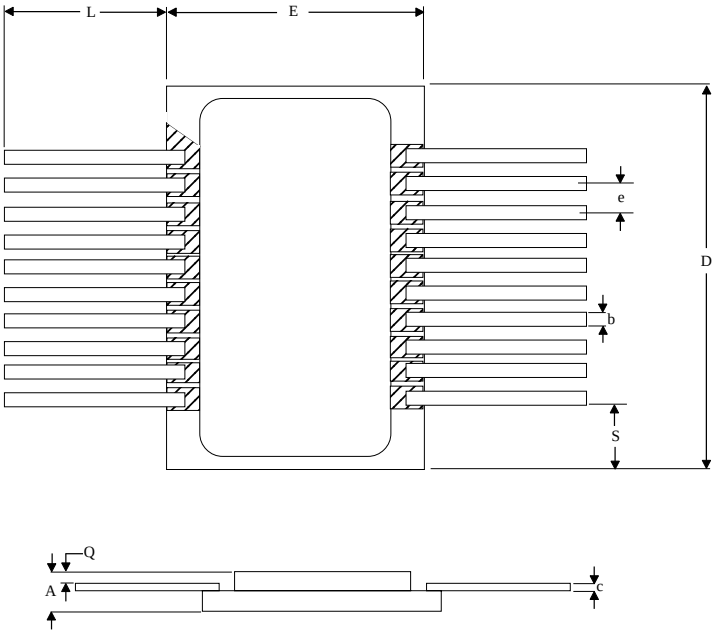
SYMBOL	SMD Specifications	
	MIN	MAX
A	---	0.175
b	0.015	0.021
b2	0.045	0.065
c	0.008	0.014
D	0.980	1.030
D1	0.890	0.910
E	0.380	0.410
eA	0.385	0.420
e	0.100 BSC	
Q	0.015	0.060
L	0.125	0.200
S1	---	0.070

NOTE: *These dimensions are per the SMD. ASI's package dimensional limits may differ, but they will be within the SMD limits.*

**** All measurements are in inches.***

MECHANICAL DEFINITIONS*

ASI Case #308 (Package Designator HR)
SMD 5962-90847, Case Outline X



SYMBOL	SMD Specifications	
	MIN	MAX
A	0.080	0.100
b	0.015	0.021
c	0.004	0.010
D	0.690	0.710
E	0.483	0.497
e	0.050 TYP	
L	0.340	0.370
Q	0.025	0.035
S	0.101	0.133

NOTE: *These dimensions are per the SMD. ASI's package dimensional limits may differ, but they will be within the SMD limits.*

**** All measurements are in inches.***

ORDERING INFORMATION

EXAMPLE: SMJ44400-12JDM

Device Number	Speed ns	Package Type	Process
SMJ44400	-80	JD	/*
SMJ44400	-10	JD	/*
SMJ44400	-12	JD	/*

EXAMPLE: SMJ44400-80HRM

Device Number	Speed ns	Package Type	Process
SMJ44400	-80	HR	/*
SMJ44400	-10	HR	/*
SMJ44400	-12	HR	/*

***AVAILABLE PROCESSES**

M = Extended Temperature Range -55°C to +125°C

ASI TO DSCC PART NUMBER CROSS REFERENCE*

ASI Package Designator JD

TI Part #**	SMD Part #
SMJ44400-12/JDM	5962-9084701MUA
SMJ44400-10/JDM	5962-9084702MUA
SMJ44400-80/JDM	5962-9084703MUA

ASI Package Designator HR

TI Part #**	SMD Part #
SMJ44400-12/HRM	5962-9084701MXA
SMJ44400-10/HRM	5962-9084702MXA
SMJ44400-80/HRM	5962-9084703MXA

** ASI part number is for reference only. Orders received referencing the SMD part number will be processed per the SMD.*
*** Parts are listed on SMD under the old Texas Instruments part number. ASI purchased this product line in November of 1999.*