

# SMALL-OUTLINE DRAM MODULE

MT4LDT164H(X)(S),  
MT8LDT264H(X)(S)

For the latest data sheet revisions, please refer to the Micron Web site: [www.micron.com/mti/msp/html/datasheet.html](http://www.micron.com/mti/msp/html/datasheet.html)

## FEATURES

- JEDEC pinout in a 144-pin, small-outline, dual in-line memory module (DIMM)
- 8MB (1 Meg x 64) and 16MB (2 Meg x 64)
- High-performance CMOS silicon-gate process
- Single +3.3V ±0.3V power supply
- All inputs, outputs and clocks are TTL-compatible
- Refresh modes: RAS#-ONLY, CAS#-BEFORE-RAS# (CBR) and HIDDEN
- Optional Self Refresh Mode (S)
- 1,024-cycle refresh distributed across 16ms (8MB) or 2,048-cycle refresh distributed across 32ms (16MB) or self refresh distributed across 128ms
- FAST-PAGE-MODE (FPM) or Extended Data-Out (EDO) PAGE MODE access cycles
- Serial presence-detect (SPD)

## OPTIONS

- Package  
144-pin Small-Outline DIMM (gold)      **G**
- Timing  
50ns access      **-5\***  
60ns access      **-6**
- Access Cycles  
FAST PAGE MODE      **None**  
EDO PAGE MODE      **X**
- Refresh Rates  
Standard Refresh      **None**  
Self Refresh (128ms period)      **S**

## MARKING

\*EDO version only

## KEY TIMING PARAMETERS

EDO Operating Mode

SPEED	t <sub>RC</sub>	t <sub>RAC</sub>	t <sub>PC</sub>	t <sub>AA</sub>	t <sub>CAC</sub>	t <sub>CAS</sub>
-5	84ns	50ns	20ns	25ns	13/15**ns	8ns
-6	104ns	60ns	25ns	30ns	15ns	10ns

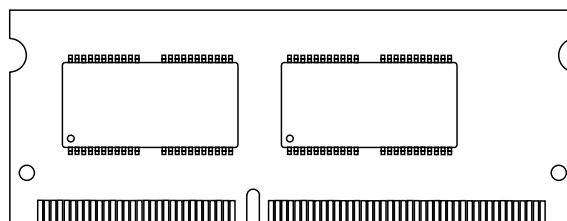
\*\*8MB DIMM

FPM Operating Mode

SPEED	t <sub>RC</sub>	t <sub>RAC</sub>	t <sub>PC</sub>	t <sub>AA</sub>	t <sub>CAC</sub>	t <sub>RP</sub>
-6	110ns	60ns	35ns	30ns	15ns	40ns

## PIN ASSIGNMENT (Front View)

### 144-Pin Small-Outline DIMM



PIN	FRONT	PIN	BACK	PIN	FRONT	PIN	BACK
1	V <sub>SS</sub>	2	V <sub>SS</sub>	73	OE#	74	RFU
3	DQ0	4	DQ32	75	V <sub>SS</sub>	76	V <sub>SS</sub>
5	DQ1	6	DQ33	77	RSVD	78	RSVD
7	DQ2	8	DQ34	79	RSVD	80	RSVD
9	DQ3	10	DQ35	81	V <sub>DD</sub>	82	V <sub>DD</sub>
11	V <sub>DD</sub>	12	V <sub>DD</sub>	83	DQ16	84	DQ48
13	DQ4	14	DQ36	85	DQ17	86	DQ49
15	DQ5	16	DQ37	87	DQ18	88	DQ50
17	DQ6	18	DQ38	89	DQ19	90	DQ51
19	DQ7	20	DQ39	91	V <sub>SS</sub>	92	V <sub>SS</sub>
21	V <sub>SS</sub>	22	V <sub>SS</sub>	93	DQ20	94	DQ52
23	CAS0#	24	CAS4#	95	DQ21	96	DQ53
25	CAS1#	26	CAS5#	97	DQ22	98	DQ54
27	V <sub>DD</sub>	28	V <sub>DD</sub>	99	DQ23	100	DQ55
29	A0	30	A3	101	V <sub>DD</sub>	102	V <sub>DD</sub>
31	A1	32	A4	103	A6	104	A7
33	A2	34	A5	105	A8	106	NC (A11)
35	V <sub>SS</sub>	36	V <sub>SS</sub>	107	V <sub>SS</sub>	108	V <sub>SS</sub>
37	DQ8	38	DQ40	109	A9	110	NC (A12)
39	DQ9	40	DQ41	111	A10	112	NC (A13)
41	DQ10	42	DQ42	113	V <sub>DD</sub>	114	V <sub>DD</sub>
43	DQ11	44	DQ43	115	CAS2#	116	CAS6#
45	V <sub>DD</sub>	46	V <sub>DD</sub>	117	CAS3#	118	CAS7#
47	DQ12	48	DQ44	119	V <sub>SS</sub>	120	V <sub>SS</sub>
49	DQ13	50	DQ45	121	DQ24	122	DQ56
51	DQ14	52	DQ46	123	DQ25	124	DQ57
53	DQ15	54	DQ47	125	DQ26	126	DQ58
55	V <sub>SS</sub>	56	V <sub>SS</sub>	127	DQ27	128	DQ59
57	RSVD	58	RSVD	129	V <sub>DD</sub>	130	V <sub>DD</sub>
59	RSVD	60	RSVD	131	DQ28	132	DQ60
61	RFU	62	RFU	133	DQ29	134	DQ61
63	V <sub>DD</sub>	64	V <sub>DD</sub>	135	DQ30	136	DQ62
65	RFU	66	RFU	137	DQ31	138	DQ63
67	WE#	68	RFU	139	V <sub>SS</sub>	140	V <sub>SS</sub>
69	RAS0#	70	NC	141	SDA	142	SCL
71	NC	72	NC	143	V <sub>DD</sub>	144	V <sub>DD</sub>

NOTE: Symbols in parentheses are not used on these modules but may be used for other modules in this product family. They are for reference only.

## PART NUMBERS

### EDO Operating Mode

PART NUMBER	CONFIGURATION	REFRESH
MT4LDT164HG-x X	1 Meg x 64	Standard
MT4LDT164HG-x XS	1 Meg x 64	Self
MT8LDT264HG-x X	2 Meg x 64	Standard
MT8LDT264HG-x XS	2 Meg x 64	Self

x = speed

### FPM Operating Mode

PART NUMBER	CONFIGURATION	REFRESH
MT4LDT164HG-x	1 Meg x 64	Standard
MT4LDT164HG-x S	1 Meg x 64	Self
MT8LDT264HG-x	2 Meg x 64	Standard
MT8LDT264HG-x S	2 Meg x 64	Self

x = speed

## GENERAL DESCRIPTION

The MT4LDT164H(X)(S) and MT8LDT264H(X)(S) are randomly accessed 8MB and 16MB memories organized in a small-outline x64 configuration. They are specially processed to operate from 3V to 3.6V for low-voltage memory systems.

During READ or WRITE cycles, each bit is uniquely addressed through the 20/21 address bits which are entered 10 bits (A0-A10) at a time. RAS# is used to latch the first 11 bits and CAS# the latter 10 bits.

READ and WRITE cycles are selected with the WE# input. A logic HIGH on WE# dictates read mode, while a logic LOW on WE# dictates write mode. During a WRITE cycle, data-in (D) is latched by the falling edge of WE# or CAS#, whichever occurs last. If WE# goes LOW prior to CAS# going LOW, the output pin(s) remain open (High-Z) until the next CAS# cycle.

## FAST PAGE MODE

FAST-PAGE-MODE operations allow faster data operations (READ or WRITE) within a row-address-defined page boundary. The FAST-PAGE-MODE cycle is always initiated with a row address strobed in by RAS#, followed by a column address strobed in by CAS#. Additional columns may be accessed by providing valid column addresses, strobing CAS# and holding RAS# LOW, thus executing faster memory cycles. Returning RAS# HIGH terminates the FAST-PAGE-MODE operation.

## EDO PAGE MODE

EDO PAGE MODE, designated by the "X" option, is an accelerated FAST-PAGE-MODE cycle. The primary advantage of EDO is the availability of data-out even after CAS# goes back HIGH. EDO provides for CAS# precharge time (<sup>t</sup>CP) to occur without the output data going invalid. This elimination of CAS# output control provides for pipeline READs.

FAST-PAGE-MODE modules have traditionally turned the output buffers off (High-Z) with the rising edge of CAS#. EDO operates as any DRAM READ or FAST-PAGE-MODE READ, except data will be held valid after CAS# goes HIGH, as long as RAS# and OE# are held LOW and WE# is held HIGH. (Refer to the 1 Meg x 16 (MT4LC1M16E5) DRAM data sheet for additional information on EDO functionality.)

## REFRESH

Memory cell data is retained in its correct state by maintaining power and executing any RAS# cycle (READ, WRITE) or RAS# REFRESH cycle (RAS#-ONLY, CBR or HIDDEN) so that all combinations of RAS# addresses are executed at least every <sup>t</sup>REF, regardless of sequence. The CBR Refresh cycle will invoke the internal refresh counter for automatic RAS# addressing.

An optional self refresh mode is also available. The "S" option allows the user the choice of a fully static, low-power data retention mode or a dynamic refresh mode at the extended refresh period of 128ms. The optional self refresh feature is initiated by performing a CBR REFRESH cycle and holding RAS# LOW for the specified <sup>t</sup>RASS.

The self refresh mode is terminated by driving RAS# HIGH for a minimum time of <sup>t</sup>RPS. This delay allows for the completion of any internal refresh cycles that may be in process at the time of the RAS# LOW-to-HIGH transition. If the DRAM controller uses a distributed refresh sequence, a burst refresh is not required upon exiting self refresh. However, if the DRAM controller utilizes a RAS#-ONLY or burst refresh sequence, all rows must be refreshed within the average internal refresh rate, prior to the resumption of normal operation.

## STANDBY

Returning RAS# and CAS# HIGH terminates a memory cycle and decreases chip current to a reduced standby level. Also, the chip is preconditioned for the next cycle during the RAS# HIGH time.

**SERIAL PRESENCE-DETECT OPERATION**

This module family incorporates serial presence-detect (SPD). The SPD function is implemented using a 2,048-bit EEPROM. This nonvolatile storage device contains 256 bytes. The first 128 bytes can be programmed by Micron to identify the module type and various DRAM organizations and timing parameters. The remaining 128 bytes of storage are available for use by the customer. System READ/ WRITE operations between the master (system logic) and the slave EEPROM device (DIMM) occur via a standard IIC bus using the DIMM's SCL (clock) and SDA (data) signals.

**SPD CLOCK AND DATA CONVENTIONS**

Data states on the SDA line can change only during SCL LOW. SDA state changes during SCL HIGH are reserved for indicating start and stop conditions (Figures 1 and 2).

**SPD START CONDITION**

All commands are preceded by the start condition, which is a HIGH-to-LOW transition of SDA when SCL is HIGH. The SPD device continuously monitors the SDA and SCL lines for the start condition and will not respond to any command until this condition has been met.

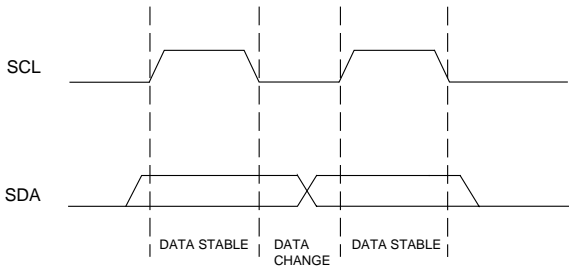
**SPD STOP CONDITION**

All communications are terminated by a stop condition, which is a LOW-to-HIGH transition of SDA when SCL is HIGH. The stop condition is also used to place the SPD device into standby power mode.

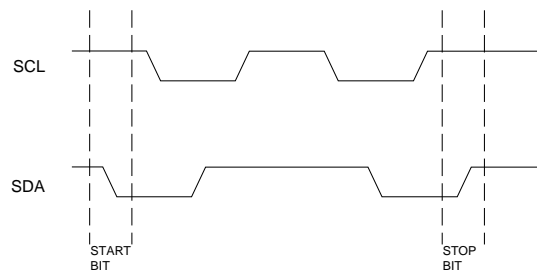
**SPD ACKNOWLEDGE**

Acknowledge is a software convention used to indicate successful data transfers. The transmitting device, either master or slave, will release the bus after transmitting eight bits. During the ninth clock cycle, the receiver will pull the SDA line LOW to acknowledge that it received the eight bits of data (Figure 3).

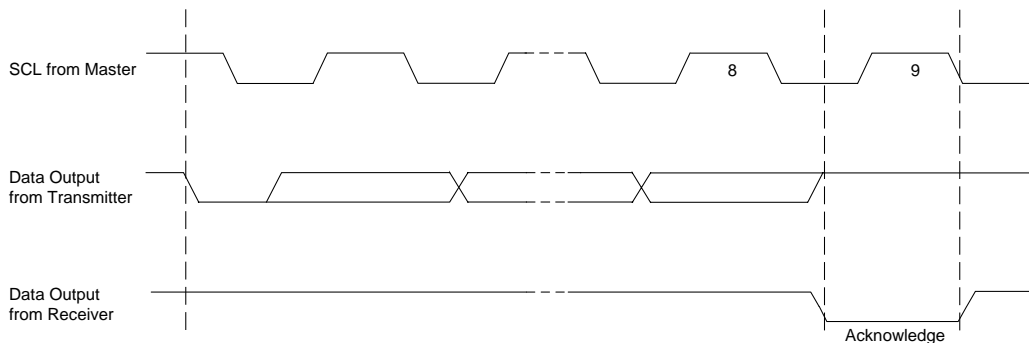
The SPD device will always respond with an acknowledge after recognition of a start condition and its slave address. If both the device and a WRITE operation have been selected, the SPD device will respond with an acknowledge after the receipt of each subsequent eight-bit word. In the read mode the SPD device will transmit eight bits of data, release the SDA line and monitor the line for an acknowledge. If an acknowledge is detected and no stop condition is generated by the master, the slave will continue to transmit data. If an acknowledge is not detected, the slave will terminate further data transmissions and await the stop condition to return to standby power mode.



**Figure 1  
DATA VALIDITY**

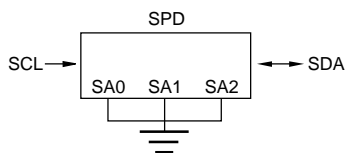
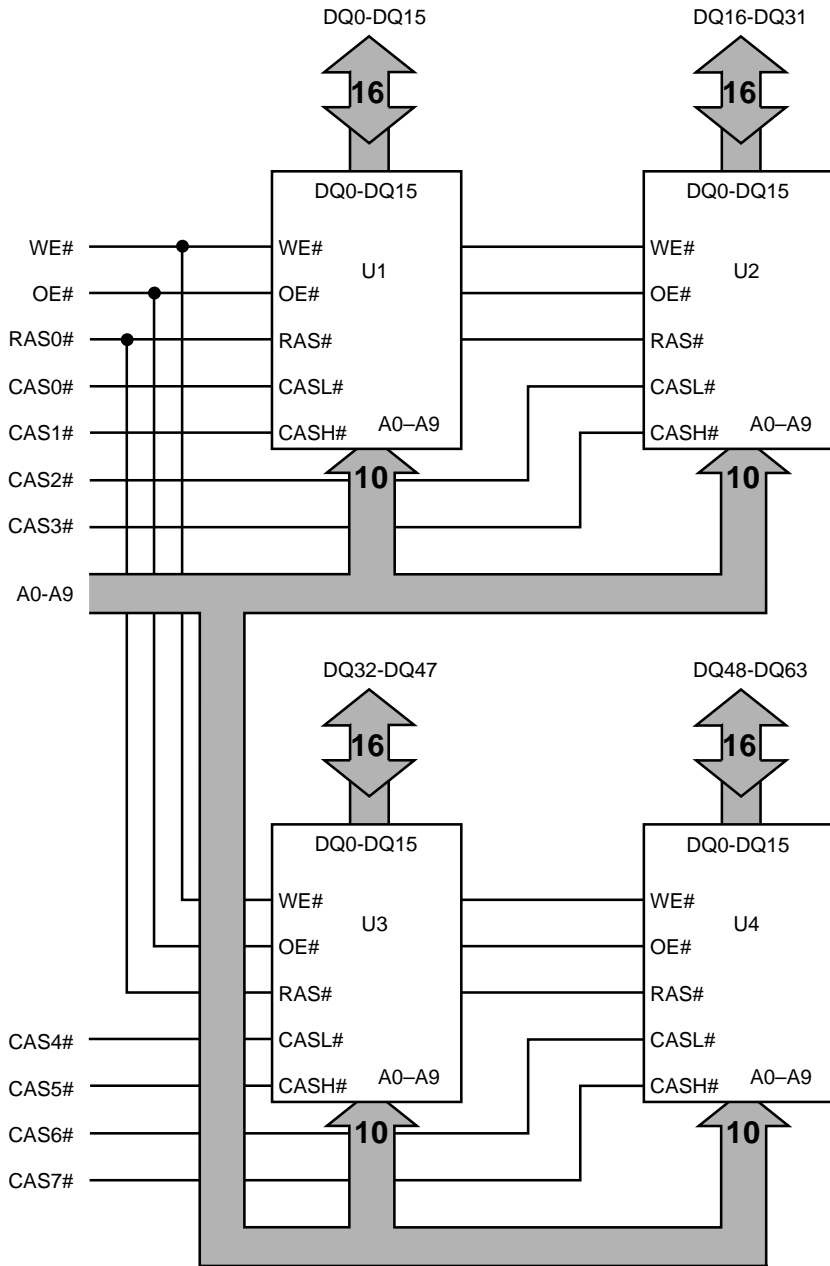


**Figure 2  
DEFINITION OF START AND STOP**



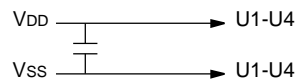
**Figure 3  
ACKNOWLEDGE RESPONSE FROM RECEIVER**

**FUNCTIONAL BLOCK DIAGRAM  
MT4LDT164H (8MB)**



U1-U4 = MT4LC1M16C3(S) FAST PAGE MODE

U1-U4 = MT4LC1M16E5(S) EDO PAGE MODE

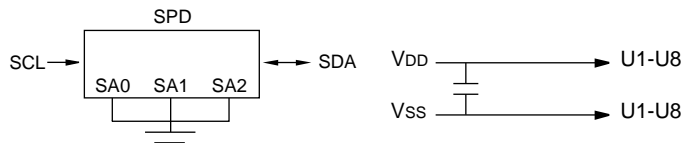
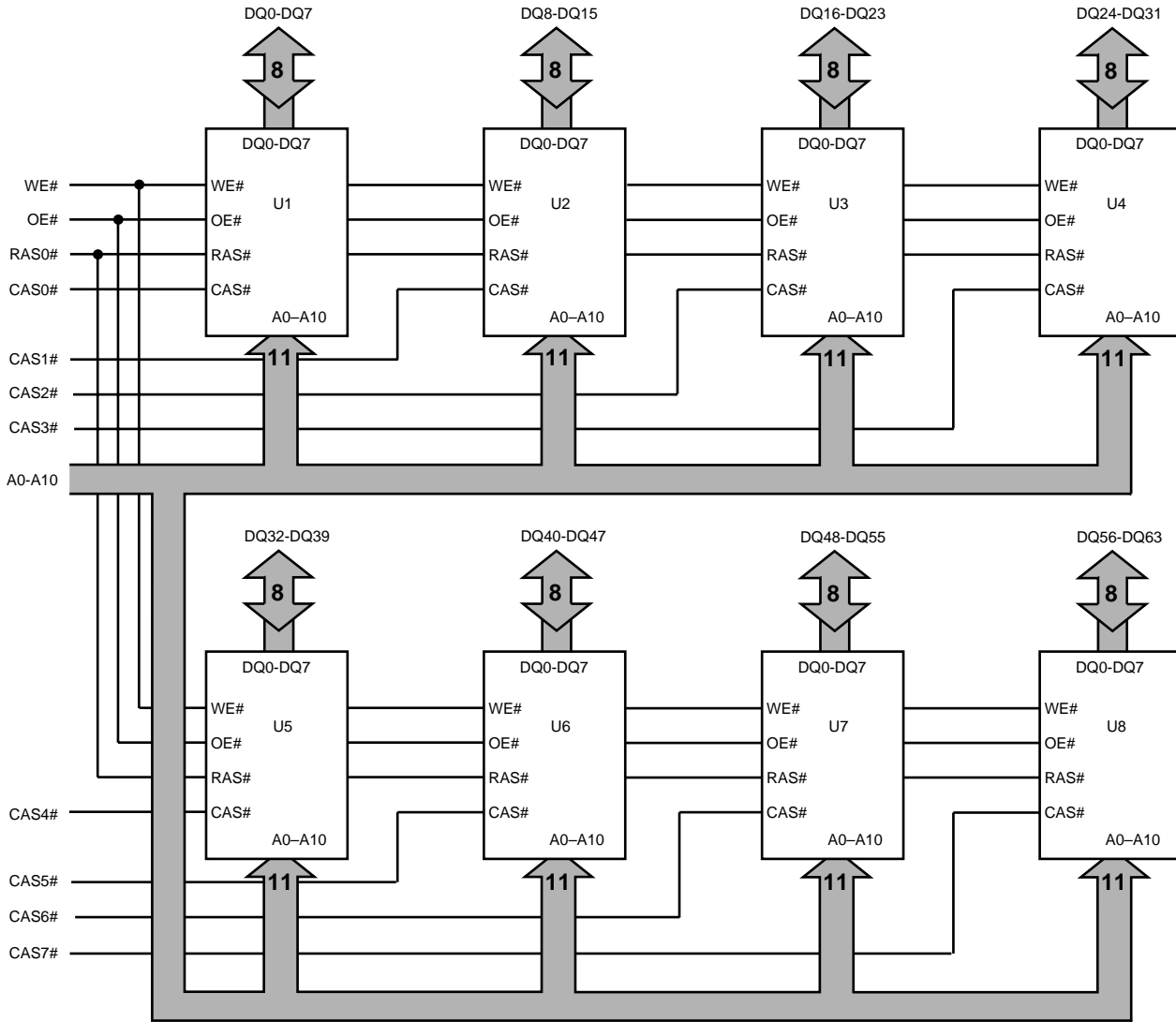


OBSOLETE



1, 2 MEG x 64  
DRAM SODIMMs

**FUNCTIONAL BLOCK DIAGRAM  
MT8LDT264H (16MB)**



U1-U8 = MT4LC2M8B1(S) FAST PAGE MODE

U1-U8 = MT4LC2M8E7(S) EDO PAGE MODE

**SERIAL PRESENCE-DETECT MATRIX**

BYTE	DESCRIPTION	ENTRY (VERSION)	BIT7	BIT6	BIT5	BIT4	BIT3	BIT2	BIT1	BIT0	HEX
0	NUMBER OF BYTES USED BY MICRON	128	1	0	0	0	0	0	0	0	80
1	TOTAL NUMBER OF SPD MEMORY BYTES	256	0	0	0	0	1	0	0	0	08
2	MEMORY TYPE	FAST PAGE MODE	0	0	0	0	0	0	0	1	01
		EDO PAGE MODE	0	0	0	0	0	0	0	0	02
3	NUMBER OF ROW ADDRESSES	10 (8MB)	0	0	0	0	1	0	1	0	0A
		11 (16MB)	0	0	0	0	1	0	1	1	0B
4	NUMBER OF COLUMN ADDRESSES	10	0	0	0	0	1	0	1	0	0A
5	NUMBER OF BANKS	1	0	0	0	0	0	0	0	1	01
6	DATA WIDTH	x64	0	1	0	0	0	0	0	0	40
7	DATA WIDTH (continued)	NONE	0	0	0	0	0	0	0	0	00
8	VOLTAGE INTERFACE	LVTTTL	0	0	0	0	0	0	0	1	01
9	RAS# ACCESS TIME (t <sub>RAC</sub> )	50ns	0	0	1	1	0	0	1	0	32
		60ns	0	0	1	1	1	1	0	0	3C
10	CAS# ACCESS TIME (t <sub>CAC</sub> )	13ns	0	0	0	0	1	1	0	1	0D
		15ns	0	0	0	0	1	1	1	1	0F
11	MODULE CONFIGURATION TYPE	NONPARITY	0	0	0	0	0	0	0	0	00
12	REFRESH RATES	15.625μs/NORMAL	0	0	0	0	0	0	0	0	00
		8X-125μs/SELF (8MB)	1	0	0	0	0	1	0	1	85
		4X-62.5μs/SELF (16MB)	1	0	0	0	0	1	0	0	84
13	DRAM WIDTH (PRIMARY DRAM)	x16 (8MB)	0	0	0	1	0	0	0	0	10
		x8 (16MB)	0	0	0	0	1	0	0	0	08
14	ERROR CHECKING DRAM DATA WIDTH	NONE	0	0	0	0	0	0	0	0	00
15-61	RESERVED		0	0	0	0	0	0	0	0	00
62	SPD REVISION	REV. 0	0	0	0	0	0	0	0	0	00
63	CHECKSUM FOR BYTES 0-62		x	x	x	x	x	x	x	x	xx
64	MANUFACTURER'S JEDEC ID CODE	MICRON	0	0	1	0	1	1	0	0	2C
65-71	MANUFACTURER'S JEDEC CODE (CONT.)		1	1	1	1	1	1	1	1	FF
72	MANUFACTURING LOCATION		0	0	0	0	0	0	0	1	01
			0	0	0	0	0	0	1	0	02
			0	0	0	0	0	0	1	1	03
			0	0	0	0	0	1	0	0	04
73-90	MODULE PART NUMBER (ASCII)		x	x	x	x	x	x	x	x	xx
91	PCB IDENTIFICATION CODE	1	0	0	0	0	0	0	0	1	01
		2	0	0	0	0	0	0	1	0	02
		3	0	0	0	0	0	0	1	1	03
		4	0	0	0	0	0	1	0	0	04
92	IDENTIFICATION CODE (CONT.)	0	0	0	0	0	0	0	0	0	00
93	YEAR OF MANUFACTURE IN BCD		x	x	x	x	x	x	x	x	xx
94	WEEK OF MANUFACTURE IN BCD		x	x	x	x	x	x	x	x	xx
95-98	MODULE SERIAL NUMBER		x	x	x	x	x	x	x	x	xx
99-125	MANUFACTURE SPECIFIC DATA (RSVD)		-	-	-	-	-	-	-	-	-

**NOTE:** 1. "1"/"0": Serial Data, "driven to HIGH"/"driven to LOW."  
2. x = Variable Data.

**ABSOLUTE MAXIMUM RATINGS\***

 Voltage on V<sub>DD</sub> Supply Relative to V<sub>SS</sub> ..... -1V to +4.6V

Voltage on Inputs or I/O Pins

 Relative to V<sub>SS</sub> ..... -1V to +4.6V

 Operating Temperature, T<sub>A</sub> (ambient) ..... 0°C to +70°C

Storage Temperature (plastic) ..... -55°C to +125°C

Power Dissipation ..... 4W

\*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.

**DC ELECTRICAL CHARACTERISTICS AND OPERATING CONDITIONS**

 (Notes: 1) (V<sub>DD</sub> = +3.3V ±0.3V)

PARAMETER/CONDITION	SYMBOL	MIN	MAX	UNITS	NOTES	
SUPPLY VOLTAGE	V <sub>DD</sub>	3	3.6	V		
INPUT HIGH VOLTAGE: Logic 1; All inputs	V <sub>IH</sub>	2	V <sub>DD</sub> + 0.3	V	31	
INPUT LOW VOLTAGE: Logic 0; All inputs	V <sub>IL</sub>	-0.5	0.8	V	31	
INPUT LEAKAGE CURRENT: Any input 0V ≤ V <sub>IN</sub> ≤ V <sub>DD</sub> + 0.3V (All other pins not under test = 0V)	RAS0#	I <sub>I1</sub>	-16	16	μA	23
	A0-A10, WE#, OE#	I <sub>I2</sub>	-16	16	μA	23
	CAS0#-CAS7#	I <sub>I3</sub>	-2	2	μA	
OUTPUT LEAKAGE CURRENT: DQ is disabled; 0V ≤ V <sub>OUT</sub> ≤ V <sub>DD</sub> + 0.3V	DQ0-DQ63	I <sub>OZ</sub>	-5	5	μA	
OUTPUT LEVELS: Output High Voltage (I <sub>OUT</sub> = -2mA) Output Low Voltage (I <sub>OUT</sub> = 2mA)	V <sub>OH</sub>	2.4	–	V		
	V <sub>OL</sub>	–	0.4	V		

**I<sub>CC</sub> OPERATING CONDITIONS AND MAXIMUM LIMITS**
(Notes: 1, 5, 6) ( $V_{DD} = +3.3V \pm 0.3V$ )

PARAMETER/CONDITION	SYMBOL	SIZE	MAX		UNITS	NOTES
			-5*	-6		
STANDBY CURRENT: TTL (RAS# = CAS# = $V_{IH}$ )	I <sub>CC1</sub>	8MB 16MB	4 8	4 8	mA	
STANDBY CURRENT: CMOS (RAS# = CAS# = $V_{DD} - 0.2V$ )	I <sub>CC2</sub>	8MB 16MB	2 8	2 8	mA	26
	I <sub>CC2</sub> (S only)	8MB 16MB	0.6 1.2	0.6 1.2	mA	
OPERATING CURRENT: Random READ/WRITE Average power supply current (RAS#, CAS#, address cycling: $t_{RC} = t_{RC} [MIN]$ )	I <sub>CC3</sub>	8MB 16MB	720 880	680 800	mA	3, 22
OPERATING CURRENT: FAST PAGE MODE Average power supply current (RAS# = $V_{IL}$ , CAS#, address cycling: $t_{PC} = t_{PC} [MIN]$ ; $t_{CP}$ , $t_{ASC} = 10ns$ )	I <sub>CC4</sub>	8MB 16MB	– –	360 640	mA	3, 22
OPERATING CURRENT: EDO PAGE MODE Average power supply current (RAS# = $V_{IL}$ , CAS#, address cycling: $t_{PC} = t_{PC} [MIN]$ )	I <sub>CC5</sub> (X only)	8MB 16MB	560 880	520 800	mA	3, 22
REFRESH CURRENT: RAS#-ONLY Average power supply current (RAS# cycling, CAS# = $V_{IH}$ : $t_{RC} = t_{RC} [MIN]$ )	I <sub>CC6</sub>	8MB 16MB	720 880	680 800	mA	3, 22
REFRESH CURRENT: CBR Average power supply current (RAS#, CAS#, address cycling: $t_{RC} = t_{RC} [MIN]$ )	I <sub>CC7</sub>	8MB 16MB	720 880	680 800	mA	3, 4
REFRESH CURRENT: Self ("S" version only) Average power supply current: CBR cycling with RAS# $\geq$ $t_{RASS} (MIN)$ and CAS# held LOW; WE# = $V_{DD} - 0.2V$ ; A0-A10 OE# and DIN = $V_{DD} - 0.2V$ or 0.2V (DIN may be left open)	I <sub>CC8</sub> (S only)	8MB 16MB	1.2 2.4	1.2 2.4	mA	3, 4

\* EDO version only

**CAPACITANCE**

PARAMETER	SYMBOL	MAX		UNITS	NOTES
		8MB	16MB		
Input Capacitance: A0-A10	C <sub>I1</sub>	24	46	pF	2
Input Capacitance: WE#, OE#, RAS0#	C <sub>I2</sub>	32	62	pF	2
Input Capacitance: CAS0#-CAS7#	C <sub>I3</sub>	10	20	pF	2
Input/Output Capacitance: DQ0-DQ63	C <sub>IO1</sub>	10	18	pF	2
Input/Output Capacitance: SDA, SCL	C <sub>IO2</sub>	10	10	pF	2



**FAST PAGE MODE  
AC ELECTRICAL CHARACTERISTICS**

 (Notes: 5, 6, 7, 8, 9, 12, 19) ( $V_{DD} = +3.3V \pm 0.3V$ )

AC CHARACTERISTICS - FAST PAGE MODE OPTION		-6			
PARAMETER	SYMBOL	MIN	MAX	UNITS	NOTES
Access time from column address	$t_{AA}$		30	ns	
Column-address hold time (referenced to RAS#)	$t_{AR}$	45		ns	
Column-address setup time	$t_{ASC}$	0		ns	
Row-address setup time	$t_{ASR}$	0		ns	
Column address to WE# delay time	$t_{AWD}$	55		ns	28
Access time from CAS#	$t_{CAC}$		15	ns	
Column-address hold time	$t_{CAH}$	10		ns	
CAS# pulse width	$t_{CAS}$	15	10,000	ns	
CAS# LOW to "Don't Care" during Self Refresh	$t_{CHD}$	15		ns	27
CAS# hold time (CBR Refresh)	$t_{CHR}$	10		ns	4
CAS# to output in Low-Z	$t_{CLZ}$	3		ns	21
CAS# precharge time	$t_{CP}$	10		ns	13
Access time from CAS# precharge	$t_{CPA}$		35	ns	
CAS# to RAS# precharge time	$t_{CRP}$	5		ns	
CAS# hold time	$t_{CSH}$	60		ns	
CAS# setup time (CBR Refresh)	$t_{CSR}$	5		ns	
CAS# to WE# delay time	$t_{CWD}$	40		ns	28
WRITE command to CAS# lead time	$t_{CWL}$	15		ns	
Data-in hold time	$t_{DH}$	10		ns	18
Data-in setup time	$t_{DS}$	0		ns	18
Output disable	$t_{OD}$	3	15	ns	
Output enable	$t_{OE}$		15	ns	
OE# hold time from WE# during READ-MODIFY-WRITE cycle	$t_{OEH}$	15		ns	29
Output buffer turn-off delay	$t_{OFF}$	3	15	ns	17, 24
OE# setup prior to RAS# during HIDDEN REFRESH cycle	$t_{ORD}$	0		ns	
FAST-PAGE-MODE READ or WRITE cycle time	$t_{PC}$	35		ns	
FAST-PAGE-MODE READ or WRITE cycle time	$t_{PRWC}$	85		ns	
Access time from RAS#	$t_{RAC}$		60	ns	
RAS# to column-address delay time	$t_{RAD}$	15		ns	15
Row-address hold time	$t_{RAH}$	10		ns	
RAS# pulse width	$t_{RAS}$	60	10,000	ns	
RAS# pulse width (FAST PAGE MODE)	$t_{RASP}$	60	125,000	ns	

**FAST PAGE MODE  
AC ELECTRICAL CHARACTERISTICS**

 (Notes: 5, 6, 7, 8, 9, 12, 19) ( $V_{DD} = +3.3V \pm 0.3V$ )

AC CHARACTERISTICS - FAST PAGE MODE OPTION		-6			
PARAMETER	SYMBOL	MIN	MAX	UNITS	NOTES
RAS# pulse width during Self Refresh	$t_{RASS}$	100		$\mu s$	27
Random READ or WRITE cycle time	$t_{RC}$	110		ns	
RAS# to CAS# delay time	$t_{RCD}$	20		ns	14
READ command hold time (referenced to CAS#)	$t_{RCH}$	0		ns	16
READ command setup time	$t_{RCS}$	0		ns	
Refresh period (1,024 cycles)	$t_{REF}$		16	ms	
Refresh period (2,048 cycles)	$t_{REF}$		32	ms	
Refresh period "S" version	$t_{REF}$		128	ms	27
RAS# precharge time	$t_{RP}$	40		ns	
RAS# to CAS# precharge time	$t_{RPC}$	0		ns	
RAS# precharge time exiting Self Refresh	$t_{RPS}$	110		ns	27
READ command hold time (referenced to RAS#)	$t_{RRH}$	0		ns	16
RAS# hold time	$t_{RSH}$	15		ns	
READ-WRITE cycle time	$t_{RWC}$	155		ns	
RAS# to WE# delay time	$t_{RWD}$	85		ns	28
WRITE command to RAS# lead time	$t_{RWL}$	15		ns	
Transition time (rise or fall)	$t_T$	2	50	ns	
WRITE command hold time	$t_{WCH}$	10		ns	
WRITE command hold time (referenced to RAS#)	$t_{WCR}$	45		ns	
WE# command setup time	$t_{WCS}$	0		ns	28
WRITE command pulse width	$t_{WP}$	10		ns	
WE# hold time (CBR Refresh)	$t_{WRH}$	10		ns	
WE# setup time (CBR Refresh)	$t_{WRP}$	10		ns	

**EDO PAGE MODE  
AC ELECTRICAL CHARACTERISTICS**
(Notes: 5, 6, 7, 8, 9, 12, 19) ( $V_{DD} = +3.3V \pm 0.3V$ )

AC CHARACTERISTICS - EDO PAGE MODE OPTION		-5		-6		UNITS	NOTES
PARAMETER	SYMBOL	MIN	MAX	MIN	MAX		
Access time from column address	$t_{AA}$		25		30	ns	
Column-address setup to CAS# precharge	$t_{ACH}$	12		15		ns	
Column-address hold time (referenced to RAS#)	$t_{AR}$	38		45		ns	
Column-address setup time	$t_{ASC}$	0		0		ns	
Row-address setup time	$t_{ASR}$	0		0		ns	
Column address to WE# delay time	$t_{AWD}$	42		49		ns	28
Access time from CAS#	$t_{CAC}$		13/15*		15*	ns	
Column-address hold time	$t_{CAH}$	8		10		ns	
CAS# pulse width	$t_{CAS}$	8	10,000	10	10,000	ns	
CAS# LOW to "Don't Care" during Self Refresh	$t_{CHD}$	15		15		ns	27
CAS# hold time (CBR Refresh)	$t_{CHR}$	8		10		ns	4
CAS# to output in Low-Z	$t_{CLZ}$	0		0		ns	
Data output hold after next CAS# LOW	$t_{COH}$	3		3		ns	
CAS# precharge time	$t_{CP}$	8		10		ns	13
Access time from CAS# precharge	$t_{CPA}$		28		35	ns	
CAS# to RAS# precharge time	$t_{CRP}$	5		5		ns	
CAS# hold time	$t_{CSH}$	38		45		ns	
CAS# setup time (CBR Refresh)	$t_{CSR}$	5		5		ns	
CAS# to WE# delay time	$t_{CWD}$	28		35		ns	28
WRITE command to CAS# lead time	$t_{CWL}$	8		10		ns	
Data-in hold time	$t_{DH}$	8		10		ns	18
Data-in setup time	$t_{DS}$	0		0		ns	18
Output disable	$t_{OD}$	0	12	0	15	ns	
Output enable	$t_{OE}$		12		15	ns	
OE# hold time from WE# during READ-MODIFY-WRITE cycle	$t_{OEH}$	8		10/12**		ns	29
OE# HIGH hold from CAS# HIGH	$t_{OEHC}$	5		10		ns	29
OE# HIGH pulse width	$t_{OEP}$	5		5		ns	
OE# LOW to CAS# HIGH setup time	$t_{OES}$	4		5		ns	
Output buffer turn-off delay	$t_{OFF}$	0	12	0	15	ns	17, 24

\* 8MB DIMM

\*\*16MB DIMM

**EDO PAGE MODE  
AC ELECTRICAL CHARACTERISTICS**
(Notes: 5, 6, 7, 8, 9, 12, 19) ( $V_{DD} = +3.3V \pm 0.3V$ )

AC CHARACTERISTICS - EDO PAGE MODE OPTION		-5		-6		UNITS	NOTES
PARAMETER	SYMBOL	MIN	MAX	MIN	MAX		
OE# setup prior to RAS# during HIDDEN REFRESH cycle	$t^{\text{ORD}}$	0		0		ns	
EDO-PAGE-MODE READ or WRITE cycle time	$t^{\text{PC}}$	20		25		ns	
EDO-PAGE-MODE READ-WRITE cycle time	$t^{\text{PRWC}}$	47		56		ns	
Access time from RAS#	$t^{\text{RAC}}$		50		60	ns	
RAS# to column-address delay time	$t^{\text{RAD}}$	9		12		ns	15
Row-address hold time	$t^{\text{RAH}}$	9		10		ns	
RAS# pulse width	$t^{\text{RAS}}$	50	10,000	60	10,000	ns	
RAS# pulse width (EDO PAGE MODE)	$t^{\text{RASP}}$	50	125,000	60	125,000	ns	
RAS# pulse width during Self Refresh	$t^{\text{RASS}}$	100		100		$\mu\text{s}$	27
Random READ or WRITE cycle time	$t^{\text{RC}}$	84		104		ns	
RAS# to CAS# delay time	$t^{\text{RCD}}$	11		14		ns	14
READ command hold time (referenced to CAS#)	$t^{\text{RCH}}$	0		0		ns	16
READ command setup time	$t^{\text{RCS}}$	0		0		ns	
Refresh period (1,024 cycles) (8MB)	$t^{\text{REF}}$		16		16	ms	
Refresh period (2,048 cycles) (16MB)	$t^{\text{REF}}$		32		32	ms	
Refresh period "S" version	$t^{\text{REF}}$		128		128	ms	
RAS# precharge time	$t^{\text{RP}}$	30		40		ns	
RAS# to CAS# precharge time	$t^{\text{RPC}}$	5		5		ns	
RAS# precharge time exiting Self Refresh	$t^{\text{RPS}}$	90		105		ns	27
READ command hold time (referenced to RAS#)	$t^{\text{RRH}}$	0		0		ns	16
RAS# hold time	$t^{\text{RSH}}$	13		15		ns	
READ-WRITE cycle time	$t^{\text{RWC}}$	116		140		ns	
RAS# to WE# delay time	$t^{\text{RWD}}$	67		79		ns	28
WRITE command to RAS# lead time	$t^{\text{RWL}}$	13		15		ns	
Transition time (rise or fall)	$t^{\text{T}}$	2	50	2	50	ns	
WRITE command hold time	$t^{\text{WCH}}$	8		10		ns	
WRITE command hold time (referenced to RAS#)	$t^{\text{WCR}}$	38		45		ns	
WE# command setup time	$t^{\text{WCS}}$	0		0		ns	28
Output disable delay from WE#	$t^{\text{WHZ}}$	0	12	0	15	ns	
WRITE command pulse width	$t^{\text{WP}}$	5		5		ns	
WE# pulse to disable at CAS# HIGH	$t^{\text{WPZ}}$	10		10		ns	
WE# hold time (CBR Refresh)	$t^{\text{WRH}}$	8		10		ns	
WE# setup time (CBR Refresh)	$t^{\text{WRP}}$	8		10		ns	

**SERIAL PRESENCE-DETECT EEPROM DC OPERATING CONDITIONS**
(Notes: 1) ( $V_{DD} = +3.3V \pm 0.3V$ )

PARAMETER/CONDITION	SYMBOL	MIN	MAX	UNITS	NOTES
SUPPLY VOLTAGE	$V_{DD}$	3	3.6	V	
INPUT HIGH VOLTAGE: Logic 1; All inputs	$V_{IH}$	$V_{DD} \times 0.7$	$V_{DD} + 0.5$	V	
INPUT LOW VOLTAGE: Logic 0; All inputs	$V_{IL}$	-1	$V_{DD} \times 0.3$	V	
OUTPUT LOW VOLTAGE: $I_{OUT} = 3mA$	$V_{OL}$	-	0.4	V	
INPUT LEAKAGE CURRENT: $V_{IN} = GND$ to $V_{DD}$	$I_{LI}$	-	10	$\mu A$	
OUTPUT LEAKAGE CURRENT: $V_{OUT} = GND$ to $V_{DD}$	$I_{LO}$	-	10	$\mu A$	
STANDBY CURRENT: SCL = SDA = $V_{DD} - 0.3V$ ; All other inputs = GND or $3.3V + 10\%$	$I_{SB}$	-	30	$\mu A$	
POWER SUPPLY CURRENT: SCL clock frequency = 100 KHz	$I_{CC}$	-	2	mA	

**SERIAL PRESENCE-DETECT EEPROM AC ELECTRICAL CHARACTERISTICS**
(Notes: 1) ( $V_{DD} = +3.3V \pm 0.3V$ )

PARAMETER/CONDITION	SYMBOL	MIN	MAX	UNITS	NOTES
SCL LOW to SDA data-out valid	$t_{AA}$	0.3	3.5	$\mu s$	
Time the bus must be free before a new transition can start	$t_{BUF}$	4.7		$\mu s$	
Data-out hold time	$t_{DH}$	300		ns	
SDA and SCL fall time	$t_F$		300	ns	
Data-in hold time	$t_{HD:DAT}$	0		$\mu s$	
Start condition hold time	$t_{HD:STA}$	4		$\mu s$	
Clock HIGH period	$t_{HIGH}$	4		$\mu s$	
Noise suppression time constant at SCL, SDA inputs	$t_I$		100	ns	
Clock LOW period	$t_{LOW}$	4.7		$\mu s$	
SDA and SCL rise time	$t_R$		1	$\mu s$	
SCL clock frequency	$f_{SCL}$		100	KHz	
Data-in setup time	$t_{SU:DAT}$	250		ns	
Start condition setup time	$t_{SU:STA}$	4.7		$\mu s$	
Stop condition setup time	$t_{SU:STO}$	4.7		$\mu s$	
WRITE cycle time	$t_{WR}$		10	ms	30

## NOTES

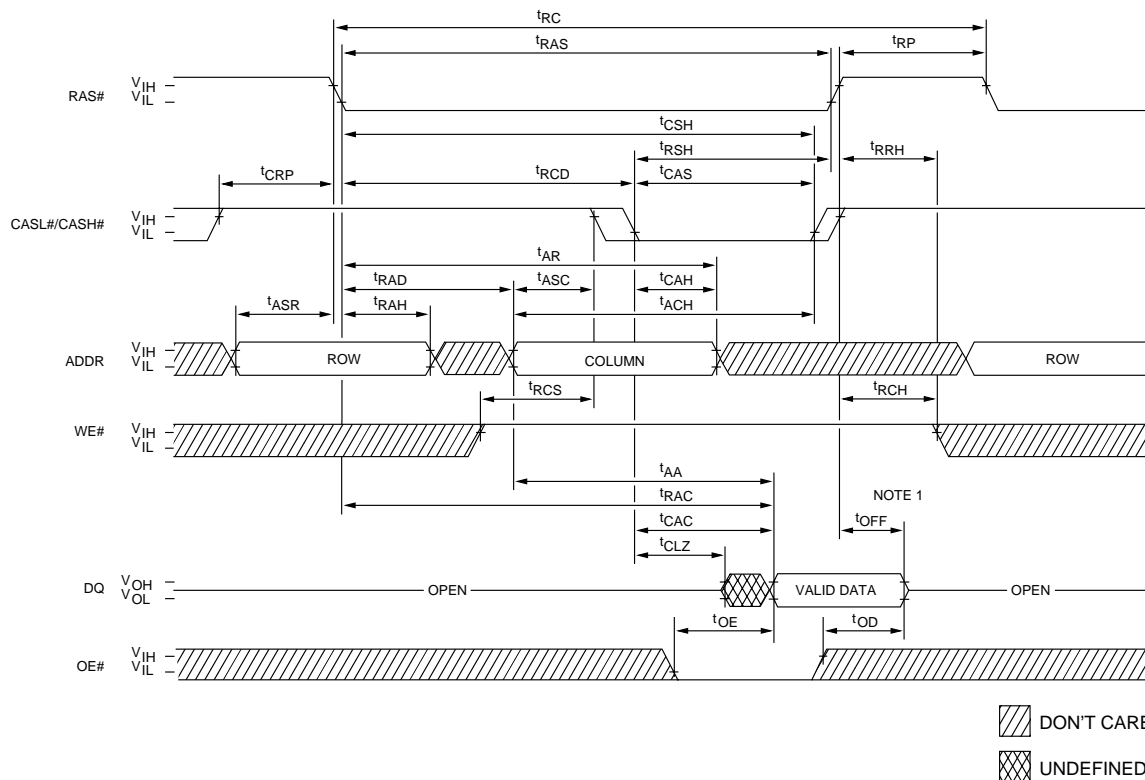
1. All voltages referenced to  $V_{SS}$ .
2. This parameter is sampled.  $V_{DD} = +3.3V$ ;  $f = 1$  MHz.
3.  $I_{CC}$  is dependent on output loading and cycle rates. Specified values are obtained with minimum cycle time and the outputs open.
4. Enables on-chip refresh and address counters.
5. The minimum specifications are used only to indicate cycle time at which proper operation over the full temperature range is ensured.
6. An initial pause of  $100\mu s$  is required after power-up, followed by eight RAS# REFRESH cycles (RAS#-ONLY or CBR with WE# HIGH), before proper device operation is ensured. The eight RAS# cycle wake-ups should be repeated any time the  $t_{REF}$  refresh requirement is exceeded.
7. AC characteristics assume  $t_T = 5ns$  for FPM and  $t_T = 2.5ns$  for EDO.
8.  $V_{IH}$  (MIN) and  $V_{IL}$  (MAX) are reference levels for measuring timing of input signals. Transition times are measured between  $V_{IH}$  and  $V_{IL}$  (or between  $V_{IL}$  and  $V_{IH}$ ).
9. In addition to meeting the transition rate specification, all input signals must transit between  $V_{IH}$  and  $V_{IL}$  (or between  $V_{IL}$  and  $V_{IH}$ ) in a monotonic manner.
10. If  $CAS\# = V_{IH}$ , data output is High-Z.
11. If  $CAS\# = V_{IL}$ , data output may contain data from the last valid READ cycle.
12. Measured with a load equivalent to two TTL gates and  $100pF$  and  $V_{OL} = 0.8V$  and  $V_{OH} = 2V$ .
13. If  $CAS\#$  is LOW at the falling edge of RAS#, Q will be maintained from the previous cycle. To initiate a new cycle and clear the data-out buffer,  $CAS\#$  must be pulsed HIGH for  $t_{CP}$ .
14. The  $t_{RCD}$  (MAX) limit is no longer specified.  $t_{RCD}$  (MAX) was specified as a reference point only. If  $t_{RCD}$  was greater than the specified  $t_{RCD}$  (MAX) limit, then access time was controlled exclusively by  $t_{CAC}$  ( $t_{RAC}$  [MIN] no longer applied). With or without the  $t_{RCD}$  (MAX) limit,  $t_{AA}$  and  $t_{CAC}$  must always be met.
15. The  $t_{RAD}$  (MAX) limit is no longer specified.  $t_{RAD}$  (MAX) was specified as a reference point only. If  $t_{RAD}$  was greater than the specified  $t_{RAD}$  (MAX) limit, then access time was controlled exclusively by  $t_{AA}$  ( $t_{RAC}$  and  $t_{CAC}$  no longer applied). With or without the  $t_{RAD}$  (MAX) limit,  $t_{AA}$ ,  $t_{RAC}$  and  $t_{CAC}$  must always be met.
16. Either  $t_{RCH}$  or  $t_{RRH}$  must be satisfied for a READ cycle.
17.  $t_{OFF}$  (MAX) defines the time at which the output achieves the open circuit condition and is not referenced to  $V_{OH}$  or  $V_{OL}$ .
18. These parameters are referenced to CAS# leading edge in EARLY WRITE cycles and WE# leading edge in LATE WRITE or READ-MODIFY-WRITE cycles.
19. If OE# is tied permanently LOW, LATE WRITE or READ-MODIFY-WRITE operations are not permissible and should not be attempted. Additionally, with EDO, WE# must be pulsed during CAS# HIGH time in order to place I/O buffers in High-Z.
20. A HIDDEN REFRESH may also be performed after a WRITE cycle. In this case, WE# = LOW and OE# = HIGH.
21. The 3ns minimum is a parameter guaranteed by design.
22. Column address changed once each cycle.
23. 8MB module values will be half of those shown.
24. For the FPM option,  $t_{OFF}$  is determined by the first RAS# or CAS# signal to transition HIGH. In comparison,  $t_{OFF}$  on an EDO option is determined by the latter of the RAS# and CAS# signals to transition HIGH.
25. Applies to both EDO and FPM operating modes.
26. All other inputs at  $0.2V$  or  $V_{DD} - 0.2V$ .
27. "S" version only.
28.  $t_{WCS}$ ,  $t_{RWD}$ ,  $t_{AWD}$  and  $t_{CWD}$  are not restrictive operating parameters.  $t_{WCS}$  applies to EARLY WRITE cycles.  $t_{RWD}$ ,  $t_{AWD}$  and  $t_{CWD}$  apply to READ-MODIFY-WRITE cycles. If  $t_{WCS} \geq t_{WCS}$  (MIN), the cycle is an EARLY WRITE cycle and the data output will remain an open circuit throughout the entire cycle. If  $t_{WCS} < t_{WCS}$  (MIN) and  $t_{RWD} \geq t_{RWD}$  (MIN),  $t_{AWD} \geq t_{AWD}$  (MIN) and  $t_{CWD} \geq t_{CWD}$  (MIN), the cycle is a READ-MODIFY-WRITE and the data output will contain data read from the selected cell. If neither of the above conditions is met, the state of data-out is indeterminate. OE# held HIGH and WE# taken LOW after CAS# goes LOW result in a LATE WRITE (OE#-controlled) cycle.  $t_{WCS}$ ,  $t_{RWD}$ ,  $t_{CWD}$  and  $t_{AWD}$  are not applicable in a LATE WRITE cycle.
29. LATE WRITE and READ-MODIFY-WRITE cycles

**NOTES (continued)**

must have both  $t_{OD}$  and  $t_{OE\#}$  met (OE# HIGH during WRITE cycle) in order to ensure that the output buffers will be open during the WRITE cycle. The DQs will provide the previously read data if CAS# remains LOW and OE# is taken back LOW after  $t_{OE\#}$  is met. If CAS# goes HIGH prior to OE# going back LOW, the DQs will remain open.

30. The SPD EEPROM WRITE cycle time ( $t_{WR}$ ) is the time from a valid stop condition of a write sequence to the end of the EEPROM internal erase/program cycle. During the WRITE cycle, the EEPROM bus interface circuit is disabled, SDA remains HIGH due to pull-up resistor, and the EEPROM does not respond to its slave address.
31.  $V_{IH}$  overshoot:  $V_{IH} (MAX) = V_{DD} + 2V$  for a pulse width  $\leq 10ns$ , and the pulse width cannot be greater than one third of the cycle rate.  $V_{IL}$  undershoot:  $V_{IL} (MIN) = -2V$  for a pulse width  $\leq 10ns$ , and the pulse width cannot be greater than one third of the cycle rate.

**READ CYCLE 25**



**FAST PAGE MODE AND EDO PAGE MODE  
TIMING PARAMETERS**

SYMBOL	-5*		-6		UNITS
	MIN	MAX	MIN	MAX	
tAA		25		30	ns
tACH (EDO)	12		15		ns
tAR	38		45		ns
tASC	0		0		ns
tASR	0		0		ns
tCAC (EDO)		13/15**		15	ns
tCAH	8		10		ns
tCAS (EDO)	8	10,000	10	10,000	ns
tCAS (FPM)	-	-	15	10,000	ns
tCLZ (EDO)	0		0		ns
tCLZ (FPM)	-	-	3		ns
tCRP	5		5		ns
tCSH (EDO)	38		45		ns
tCSH (FPM)	-	-	60		ns
tOD (EDO)	0	12	0	15	ns
tOD (FPM)	-	-	3	15	ns
tOE		12		15	ns

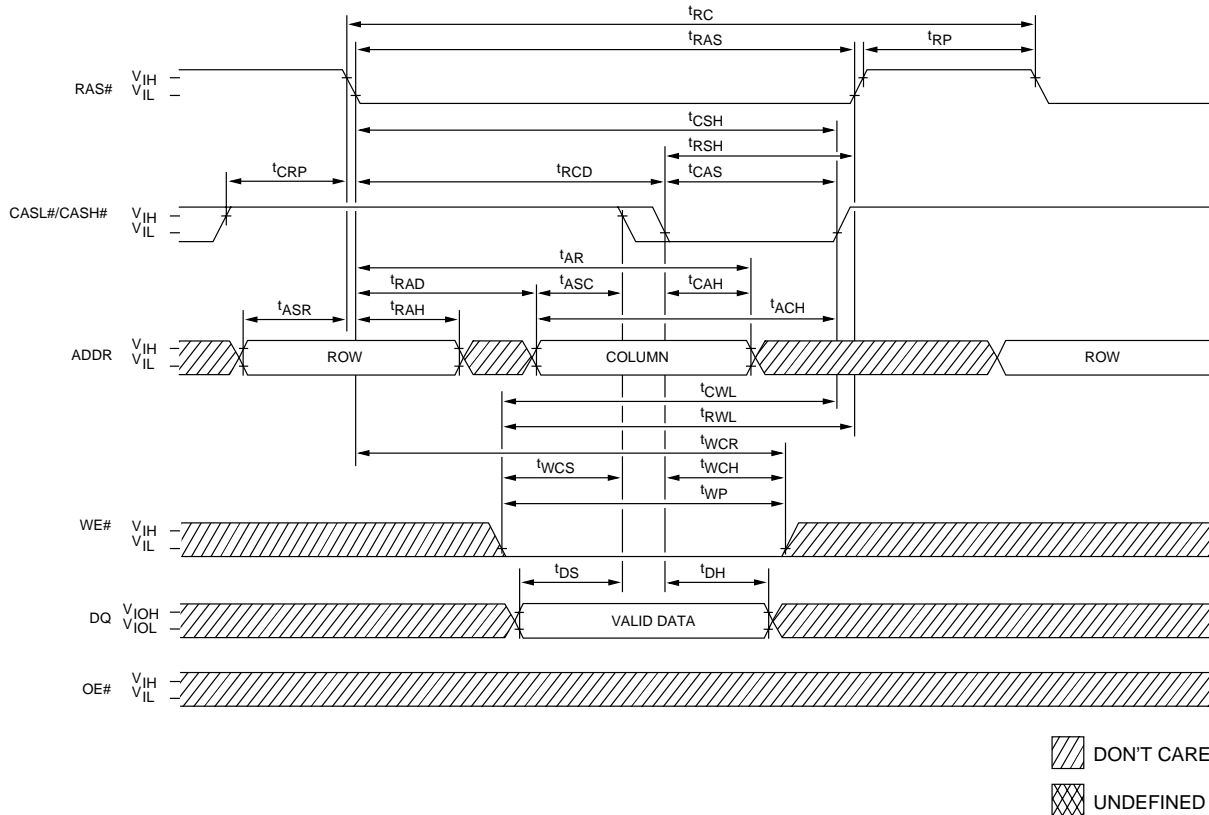
SYMBOL	-5*		-6		UNITS
	MIN	MAX	MIN	MAX	
tOFF (EDO)	0	12	0	15	ns
tOFF (FPM)	-	-	3	15	ns
tRAC		50		60	ns
tRAD (EDO)	9		12		ns
tRAD (FPM)	-	-	15		ns
tRAH	9		10		ns
tRAS	50	10,000	60	10,000	ns
tRC (EDO)	84		104		ns
tRC (FPM)	-	-	110		ns
tRCD (EDO)	11		14		ns
tRCD (FPM)	-	-	20		ns
tRCH	0		0		ns
tRCS	0		0		ns
tRP	30		40		ns
tRRH	0		0		ns
tRSH	13		15		ns

\*EDO version only  
\*\*8MB DIMM

**NOTE:** 1. For EDO, tOFF is referenced from rising edge of RAS# or CAS#, whichever occurs last. For FPM, tOFF is referenced from rising edge of RAS# or CAS#, whichever occurs first.



**EARLY WRITE CYCLE <sup>25</sup>**



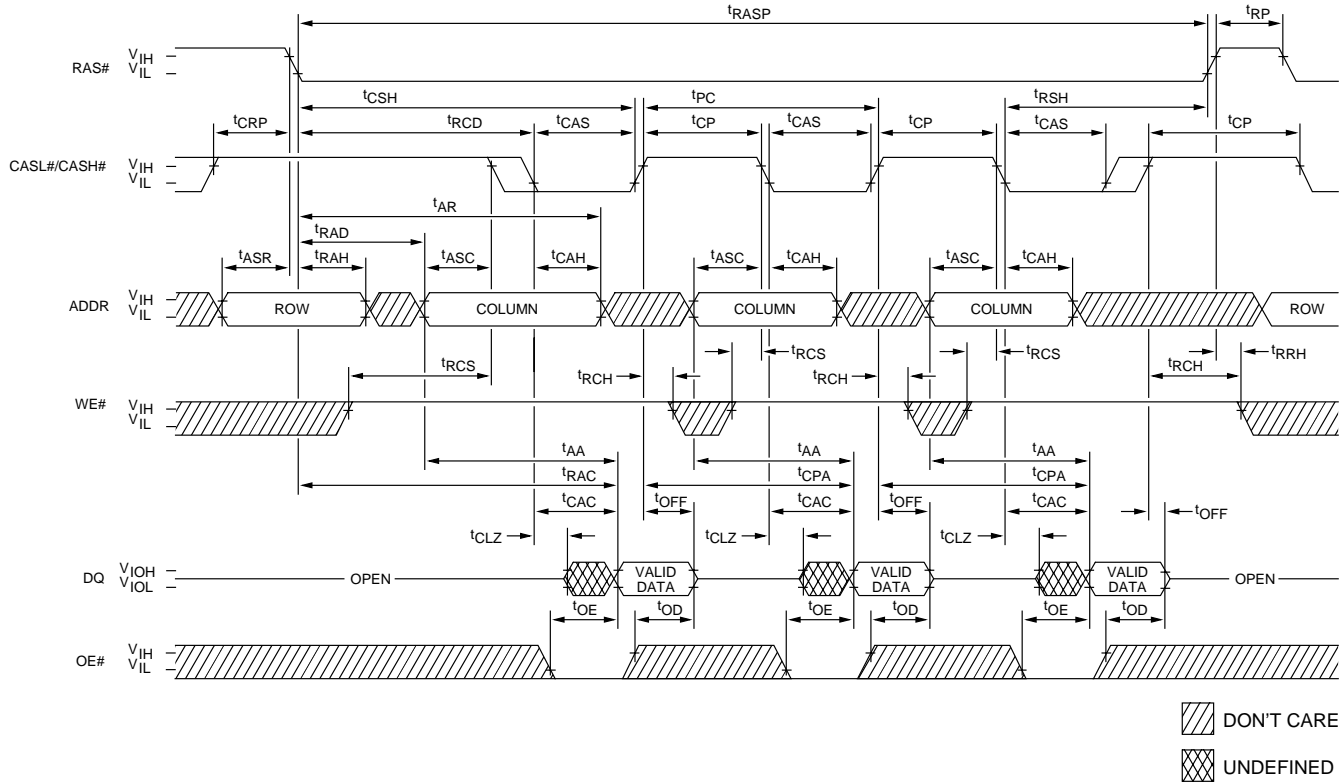
**FAST PAGE MODE AND EDO PAGE MODE  
TIMING PARAMETERS**

SYMBOL	-5*		-6		UNITS
	MIN	MAX	MIN	MAX	
$t_{ACH}$ (EDO)	12		15		ns
$t_{AR}$	38		45		ns
$t_{ASC}$	0		0		ns
$t_{ASR}$	0		0		ns
$t_{CAH}$	8		10		ns
$t_{CAS}$ (FPM)	-	-	15	10,000	ns
$t_{CAS}$ (EDO)	8	10,000	10	10,000	ns
$t_{CRP}$	5		5		ns
$t_{CSH}$ (FPM)	-		60		ns
$t_{CSH}$ (EDO)	38		45		ns
$t_{CWL}$ (FPM)	-		15		ns
$t_{CWL}$ (EDO)	8		10		ns
$t_{DH}$	8		10		ns
$t_{DS}$	0		0		ns
$t_{RAD}$ (FPM)	-		15		ns

SYMBOL	-5*		-6		UNITS
	MIN	MAX	MIN	MAX	
$t_{RAD}$ (EDO)	9		12		ns
$t_{RAH}$	9		10		ns
$t_{RAS}$	50	10,000	60	10,000	ns
$t_{RC}$ (FPM)	-		110		ns
$t_{RC}$ (EDO)	84		104		ns
$t_{RCD}$ (FPM)	-		20		ns
$t_{RCD}$ (EDO)	11		14		ns
$t_{RP}$	30		40		ns
$t_{RSH}$	13		15		ns
$t_{RWL}$	13		15		ns
$t_{WCH}$	8		10		ns
$t_{WCR}$	38		45		ns
$t_{WCS}$	0		0		ns
$t_{WP}$ (FPM)	-		10		ns
$t_{WP}$ (EDO)	5		5		ns

\*EDO version only

**FAST-PAGE-MODE READ CYCLE**

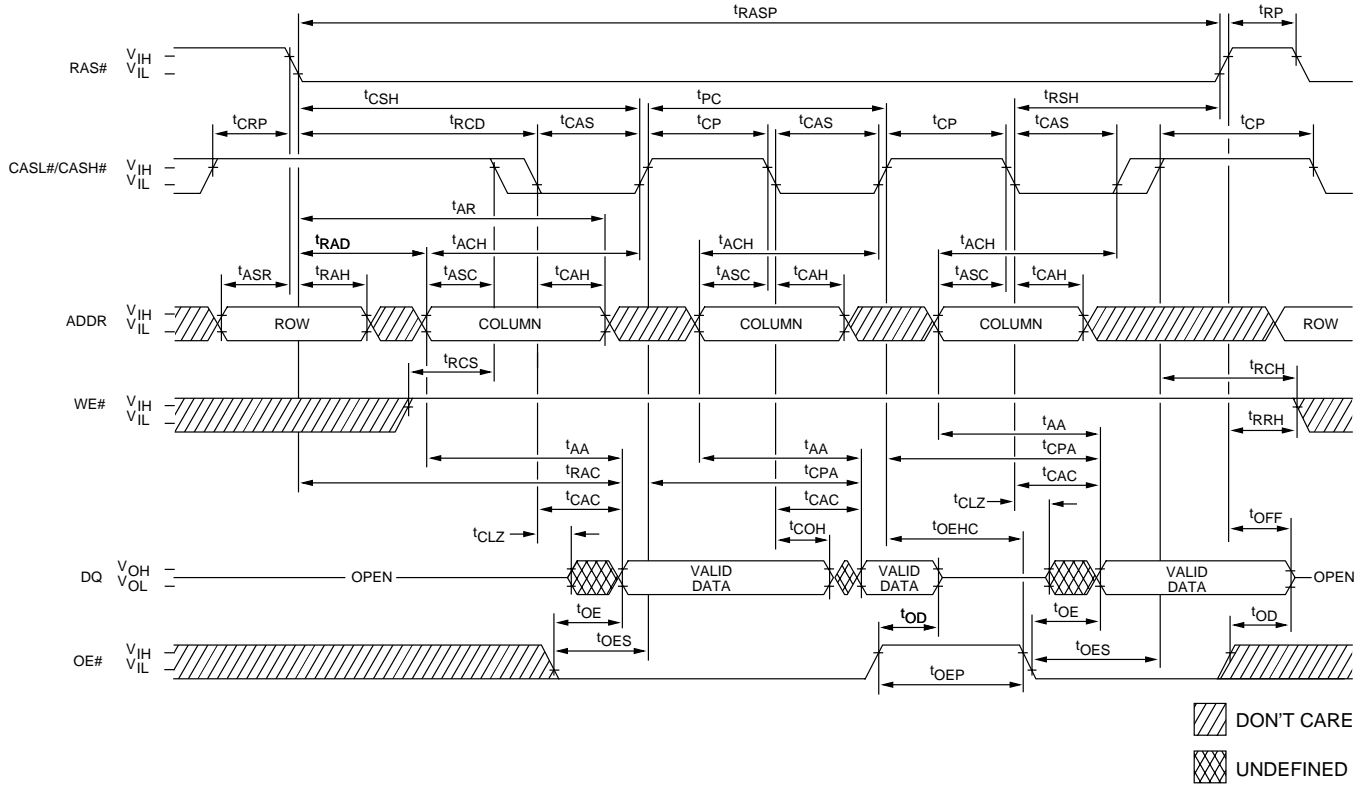


**FAST PAGE MODE  
TIMING PARAMETERS**

SYMBOL	-6		UNITS
	MIN	MAX	
$t_{AA}$		30	ns
$t_{AR}$	45		ns
$t_{ASC}$	0		ns
$t_{ASR}$	0		ns
$t_{CAC}$		15	ns
$t_{CAH}$	10		ns
$t_{CAS}$	15	10,000	ns
$t_{CLZ}$	3		ns
$t_{CP}$	10		ns
$t_{CPA}$		35	ns
$t_{CRP}$	5		ns
$t_{CSH}$	60		ns
$t_{OD}$	3	15	ns

SYMBOL	-6		UNITS
	MIN	MAX	
$t_{OE}$		15	ns
$t_{OFF}$	3	15	ns
$t_{PC}$	35		ns
$t_{RAC}$		60	ns
$t_{RAD}$	15		ns
$t_{RAH}$	10		ns
$t_{RASP}$	60	125,000	ns
$t_{RCD}$	20		ns
$t_{RCH}$	0		ns
$t_{RCS}$	0		ns
$t_{RP}$	40		ns
$t_{RRH}$	0		ns
$t_{RSH}$	15		ns

EDO-PAGE-MODE READ CYCLE



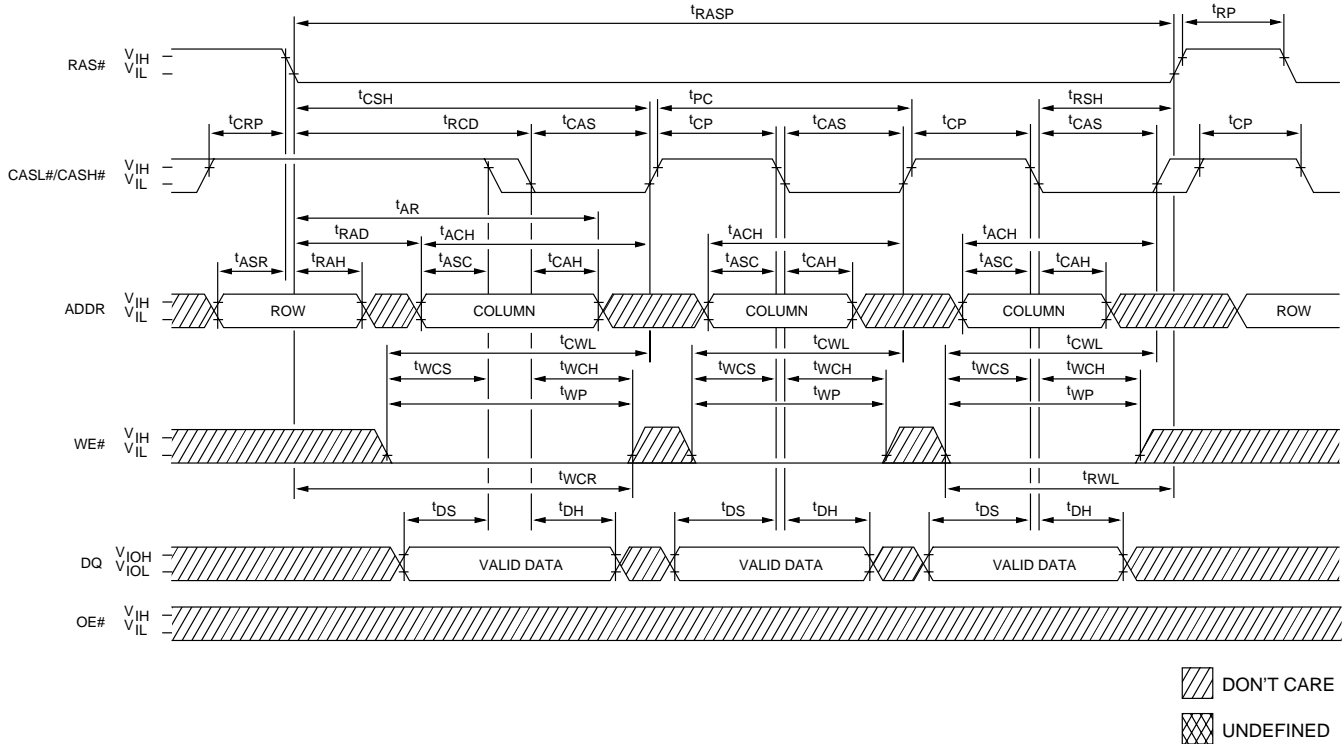
EDO PAGE MODE  
TIMING PARAMETERS

SYMBOL	-5		-6		UNITS
	MIN	MAX	MIN	MAX	
$t_{AA}$		25		30	ns
$t_{ACH}$	12		15		ns
$t_{AR}$	38		45		ns
$t_{ASC}$	0		0		ns
$t_{ASR}$	0		0		ns
$t_{CAC}$		13/15*		15	ns
$t_{CAH}$	8		10		ns
$t_{CAS}$	8	10,000	10	10,000	ns
$t_{CLZ}$	0		0		ns
$t_{COH}$	3		3		ns
$t_{CP}$	8		10		ns
$t_{CPA}$		28		35	ns
$t_{CRP}$	5		5		ns
$t_{CSH}$	38		45		ns
$t_{OD}$	0	12	0	15	ns
$t_{OE}$		12		15	ns

SYMBOL	-5		-6		UNITS
	MIN	MAX	MIN	MAX	
$t_{OEHC}$	5		10		ns
$t_{OEP}$	5		5		ns
$t_{OES}$	4		5		ns
$t_{OFF}$	0	12	0	15	ns
$t_{PC}$	20		25		ns
$t_{RAC}$		50		60	ns
$t_{RAD}$	9		12		ns
$t_{RAH}$	9		10		ns
$t_{RASP}$	50	125,000	60	125,000	ns
$t_{RCD}$	11		14		ns
$t_{RCH}$	0		0		ns
$t_{RCS}$	0		0		ns
$t_{RP}$	30		40		ns
$t_{RRH}$	0		0		ns
$t_{RSH}$	13		15		ns

\*8MB DIMM

**FAST/EDO-PAGE-MODE EARLY WRITE CYCLE 25**



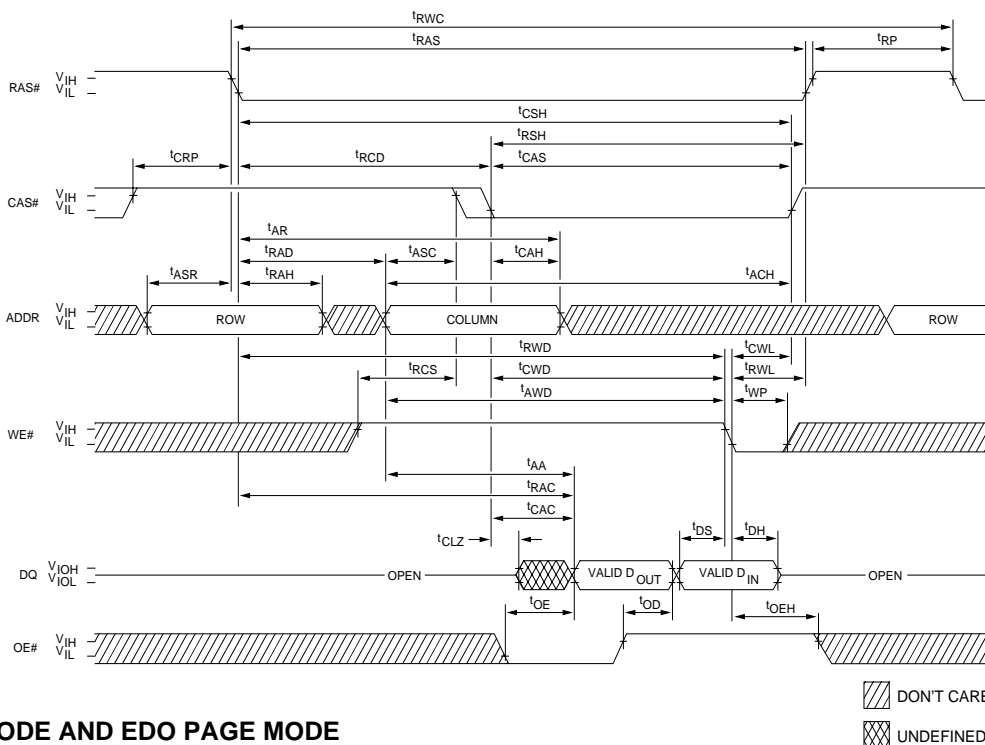
**FAST PAGE MODE AND EDO PAGE MODE  
TIMING PARAMETERS**

SYMBOL	-5*		-6		UNITS
	MIN	MAX	MIN	MAX	
t <sub>ACH</sub> (EDO)	12		15		ns
t <sub>AR</sub>	38		45		ns
t <sub>ASC</sub>	0		0		ns
t <sub>ASR</sub>	0		0		ns
t <sub>CAH</sub>	8		10		ns
t <sub>CAS</sub> (EDO)	8	10,000	10	10,000	ns
t <sub>CAS</sub> (FPM)	-	-	15	10,000	ns
t <sub>CP</sub>	8		10		ns
t <sub>CRP</sub>	5		5		ns
t <sub>CSH</sub> (EDO)	38		45		ns
t <sub>CSH</sub> (FPM)	-		60		ns
t <sub>CWL</sub> (EDO)	8		10		ns
t <sub>CWL</sub> (FPM)	-		15		ns
t <sub>DH</sub>	8		10		ns
t <sub>DS</sub>	0		0		ns
t <sub>PC</sub> (EDO)	20		25		ns

SYMBOL	-5*		-6		UNITS
	MIN	MAX	MIN	MAX	
t <sub>PC</sub> (FPM)	-		35		ns
t <sub>RAD</sub> (EDO)	9		12		ns
t <sub>RAD</sub> (FPM)	-		15		ns
t <sub>RAH</sub>	9		10		ns
t <sub>RASP</sub>	50	125,000	60	125,000	ns
t <sub>RCD</sub> (EDO)	11		14		ns
t <sub>RCD</sub> (FPM)	-		20		ns
t <sub>RP</sub>	30		40		ns
t <sub>RSH</sub>	13		15		ns
t <sub>RWL</sub>	13		15		ns
t <sub>WCH</sub>	8		10		ns
t <sub>WCR</sub>	38		45		ns
t <sub>WCS</sub>	0		0		ns
t <sub>WP</sub> (EDO)	5		5		ns
t <sub>WP</sub> (FPM)	-		10		ns

\*EDO version only

### READ-WRITE CYCLE <sup>25</sup> (LATE WRITE and READ-MODIFY-WRITE cycles)



### FAST PAGE MODE AND EDO PAGE MODE TIMING PARAMETERS

SYMBOL	-5*		-6		UNITS
	MIN	MAX	MIN	MAX	
tAA		25		30	ns
tACH (EDO)	12		15		ns
tAR	38		45		ns
tASC	0		0		ns
tASR	0		0		ns
tAWD	42		49		ns
tCAC		13/15**		15	ns
tCAH	8		10		ns
tCAS (EDO)	8	10,000	10	10,000	ns
tCAS (FPM)	-	-	15	10,000	ns
tCLZ (EDO)	0		0		ns
tCLZ (FPM)	-		3		ns
tCRP	5		5		ns
tCSH (EDO)	38		45		ns
tCSH (FPM)	-		60		ns
tCWD (EDO)	28		35		ns
tCWD (FPM)	-		40		ns
tCWL (EDO)	8		10		ns
tCWL (FPM)	-		15		ns
tDH	8		10		ns
tDS	0		0		ns
tOD (EDO)	0	12	0	15	ns

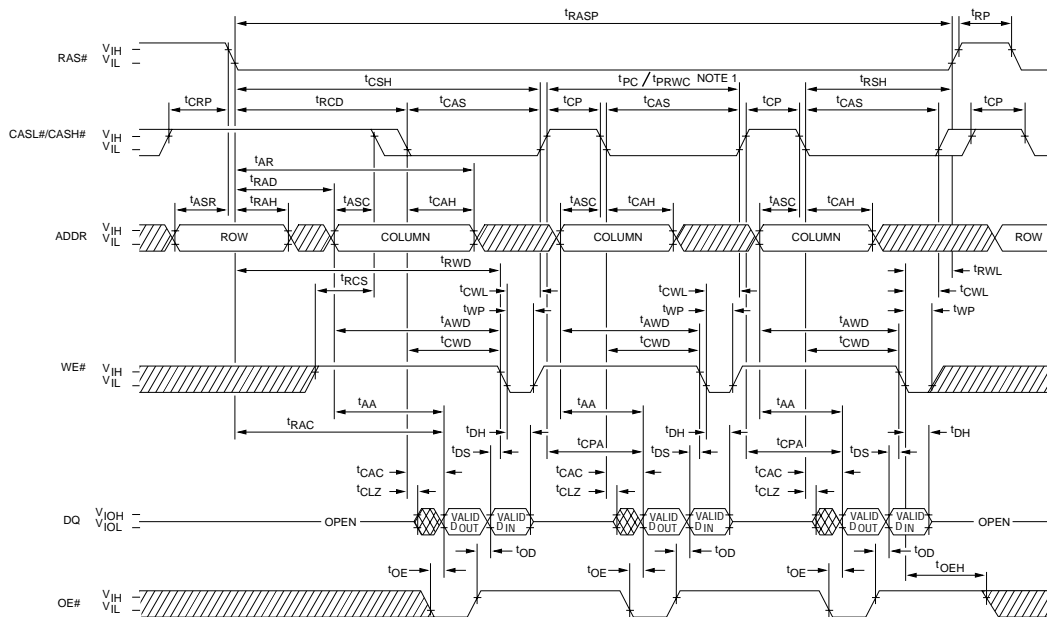
SYMBOL	-5*		-6		UNITS
	MIN	MAX	MIN	MAX	
tOD (FPM)	-	-	3	15	ns
tOE		12		15	ns
tOEH (EDO)	8		10/12***		ns
tOEH (FPM)	-		15		ns
tRAC		50		60	ns
tRAD (EDO)	9		12		ns
tRAD (FPM)	-		15		ns
tRAH	9		10		ns
tRAS	50	10,000	60	10,000	ns
tRCD (EDO)	11		14		ns
tRCD (FPM)	-		20		ns
tRCS	0		0		ns
tRP	30		40		ns
tRSH	13		15		ns
tRWC (EDO)	116		140		ns
tRWC (FPM)	-		155		ns
tRWD (EDO)	67		79		ns
tRWD (FPM)	-		85		ns
tRWL	13		15		ns
tWP (EDO)	5		5		ns
tWP (FPM)	-		10		ns

\* EDO version only

\*\* 8MB DIMM

\*\*\* 16MB DIMM

**FAST/EDO-PAGE-MODE READ-WRITE CYCLE <sup>25</sup>**  
(LATE WRITE and READ-MODIFY-WRITE cycles)



**FAST PAGE MODE AND EDO PAGE MODE  
TIMING PARAMETERS**

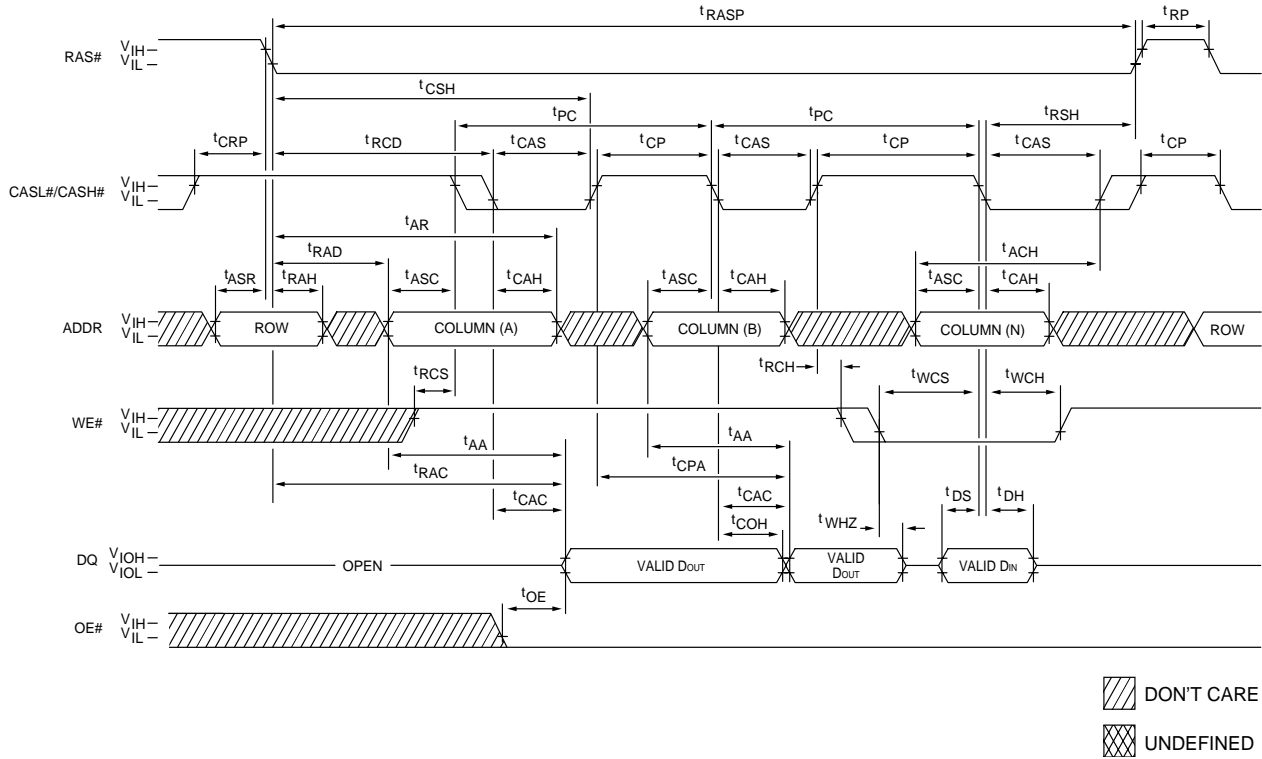
SYMBOL	-5*		-6		UNITS
	MIN	MAX	MIN	MAX	
tAA		25		30	ns
tAR	38		45		ns
tASC	0		0		ns
tASR	0		0		ns
tAWD	42		49		ns
tCAC		13/15**		15	ns
tCAH	8		10		ns
tCAS (EDO)	8	10,000	10	10,000	ns
tCAS (FPM)	-	-	15	10,000	ns
tCLZ (EDO)	0		0		ns
tCLZ (FPM)	-	-	3		ns
tCP	8		10		ns
tCPA		28		35	ns
tCRP	5		5		ns
tCSH (EDO)	38		45		ns
tCSH (FPM)	-	-	60		ns
tCWD (EDO)	28		35		ns
tCWD (FPM)	-	-	40		ns
tCWL (EDO)	8		10		ns
tCWL (FPM)	-	-	15		ns
tDH	8		10		ns
tDS	0		0		ns
tOD (EDO)	0	12	0	15	ns

SYMBOL	-5*		-6		UNITS
	MIN	MAX	MIN	MAX	
tOD (FPM)	-	-	3	15	ns
tOE		12		15	ns
tOE (EDO)	8		10/12***		ns
tOE (FPM)	-	-	15		ns
tPC (EDO)	20		25		ns
tPC (FPM)	-	-	35		ns
tPRWC (EDO)	47		56		ns
tPRWC (FPM)	-	-	85		ns
tRAC		50		60	ns
tRAD (EDO)	9		12		ns
tRAD (FPM)	-	-	15		ns
tRAH	9		10		ns
tRASP	50	125,000	60	125,000	ns
tRCD (EDO)	11		14		ns
tRCD (FPM)	-	-	20		ns
tRCS	0		0		ns
tRP	30		40		ns
tRSH	13		15		ns
tRWD (EDO)	67		79		ns
tRWD (FPM)	-	-	85		ns
tRWL	13		15		ns
tWP (EDO)	5		5		ns
tWP (FPM)	-	-	10		ns

NOTE: 1. tPC is for LATE WRITE cycles only.

\* EDO version only  
\*\* 8MB DIMM  
\*\*\* 16MB DIMM

**EDO-PAGE-MODE READ EARLY WRITE CYCLE**  
(Pseudo READ-MODIFY-WRITE)



**EDO PAGE MODE  
TIMING PARAMETERS**

SYMBOL	-5		-6		UNITS
	MIN	MAX	MIN	MAX	
tAA		25		30	ns
tACH	12		15		ns
tAR	38		45		ns
tASC	0		0		ns
tASR	0		0		ns
tCAC		13/15*		15	ns
tCAH	8		10		ns
tCAS	8	10,000	10	10,000	ns
tCOH	3		3		ns
tCP	8		10		ns
tCPA		28		35	ns
tCRP	5		5		ns
tCSH	38		45		ns
tDH	8		10		ns
tDS	0		0		ns

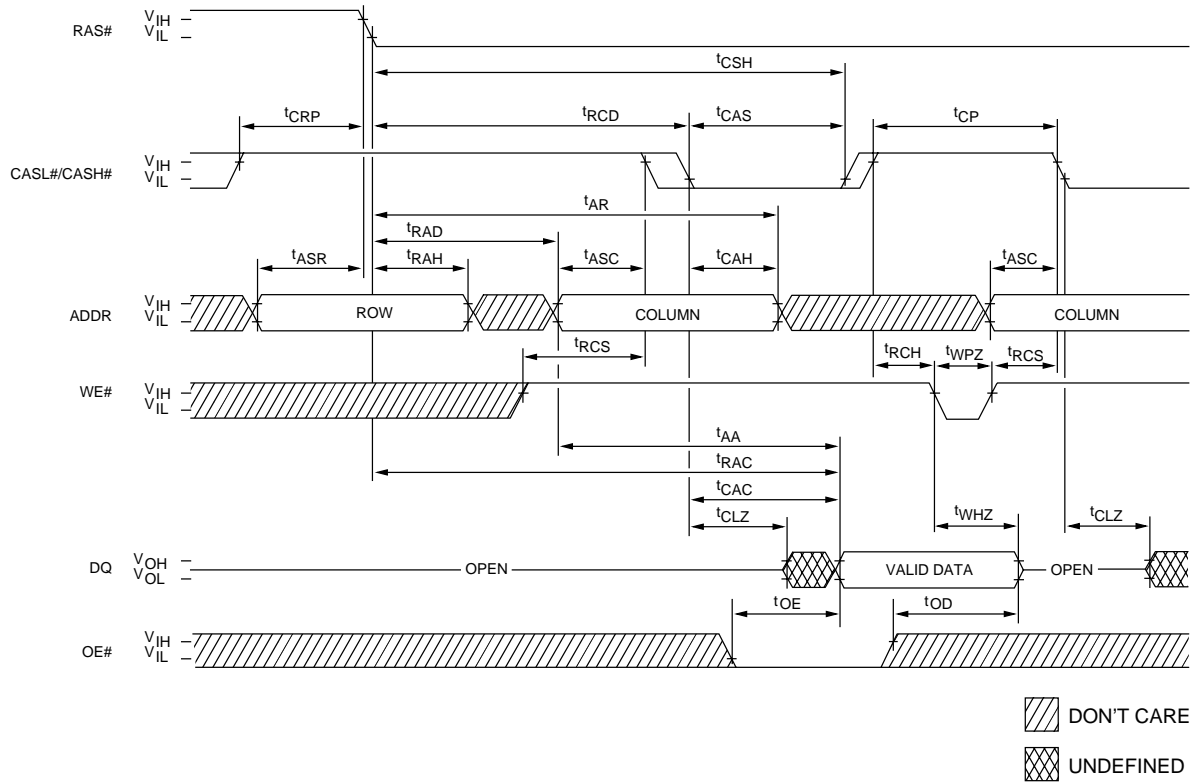
SYMBOL	-5		-6		UNITS
	MIN	MAX	MIN	MAX	
tOE		12		15	ns
tPC	20		25		ns
tRAC		50		60	ns
tRAD	9		12		ns
tRAH	9		10		ns
tRASP	50	125,000	60	125,000	ns
tRCD	11		14		ns
tRCH	0		0		ns
tRCS	0		0		ns
tRP	30		40		ns
tRSH	13		15		ns
tWCH	8		10		ns
tWCS	0		0		ns
tWHZ	0	12	0	15	ns

\*8MB DIMM





**EDO READ CYCLE**  
(with WE#-controlled disable)



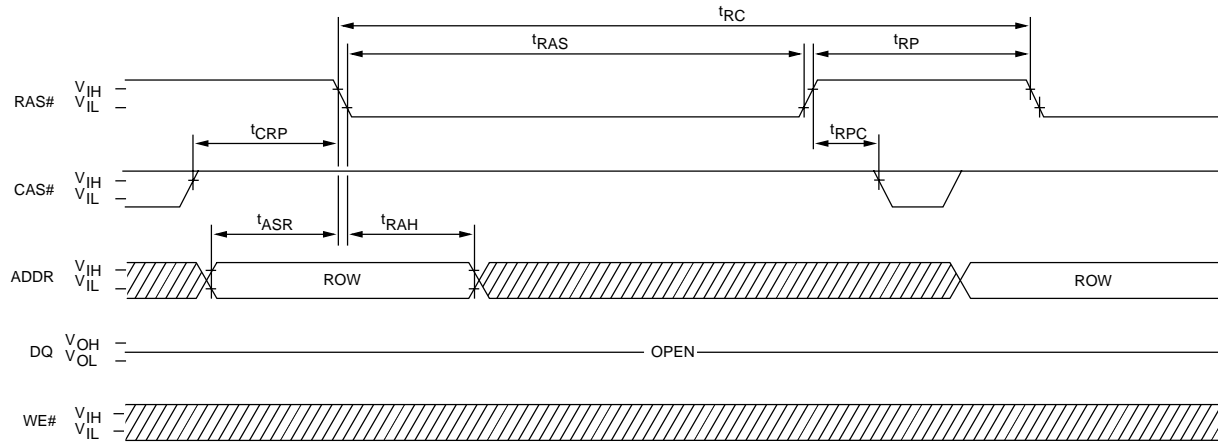
**EDO PAGE MODE  
TIMING PARAMETERS**



SYMBOL	-5		-6		UNITS
	MIN	MAX	MIN	MAX	
tAA		25		30	ns
tAR	38		45		ns
tASC	0		0		ns
tASR	0		0		ns
tCAC		13/15*		15	ns
tCAH	8		10		ns
tCAS	8	10,000	10	10,000	ns
tCLZ	0		0		ns
tCP	8		10		ns
tCRP	5		5		ns
tCSH	38		45		ns

SYMBOL	-5		-6		UNITS
	MIN	MAX	MIN	MAX	
tOD	0	12	0	15	ns
tOE		12		15	ns
tRAC		50		60	ns
tRAD	9		12		ns
tRAH	9		10		ns
tRCD	11		14		ns
tRCH	0		0		ns
tRCS	0		0		ns
tWHZ	0	12	0	15	ns
tWPZ	10		10		ns

\*8MB DIMM

**RAS#-ONLY REFRESH CYCLE <sup>25</sup>**



 DON'T CARE  
 UNDEFINED

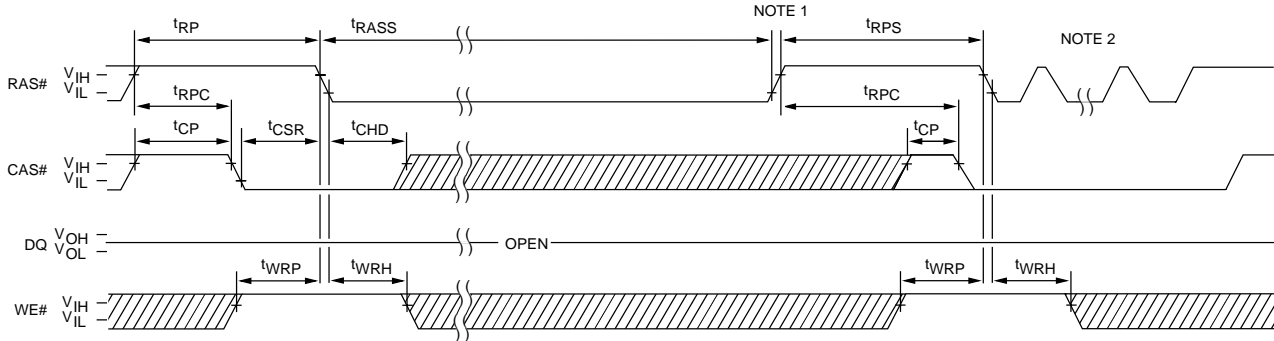
**FAST PAGE MODE AND EDO PAGE MODE  
TIMING PARAMETERS**

SYMBOL	-5*		-6		UNITS
	MIN	MAX	MIN	MAX	
t <sub>ASR</sub>	0		0		ns
t <sub>CRP</sub>	5		5		ns
t <sub>RAH</sub>	9		10		ns
t <sub>RAS</sub>	50	10,000	60	10,000	ns
t <sub>RC</sub> (FPM)	-		110		ns

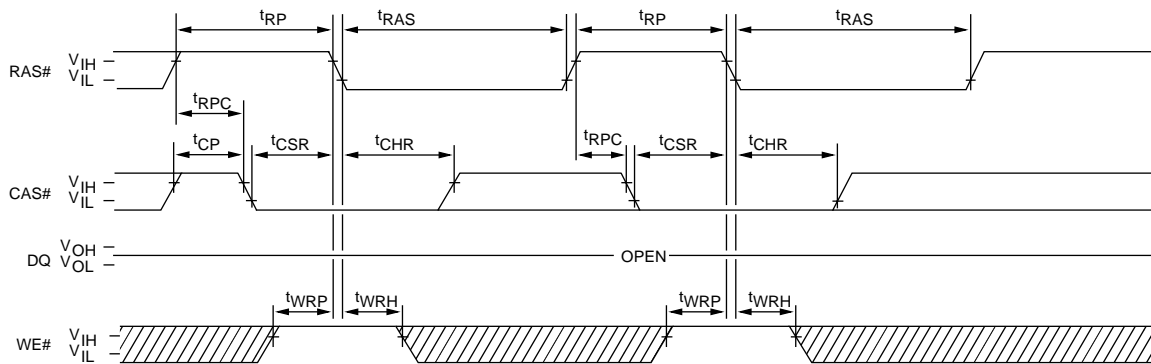
SYMBOL	-5*		-6		UNITS
	MIN	MAX	MIN	MAX	
t <sub>RC</sub> (EDO)	84		104		ns
t <sub>RP</sub>	30		40		ns
t <sub>RPC</sub> (FPM)	-		0		ns
t <sub>RPC</sub> (EDO)	5		5		ns

\*EDO version only

**SELF REFRESH CYCLE** <sup>25, 27</sup>  
(Addresses and OE# = DON'T CARE)



**CBR REFRESH CYCLE** <sup>25</sup>  
(Addresses = DON'T CARE)



DON'T CARE  
 UNDEFINED

**FAST PAGE MODE AND EDO PAGE MODE  
TIMING PARAMETERS**

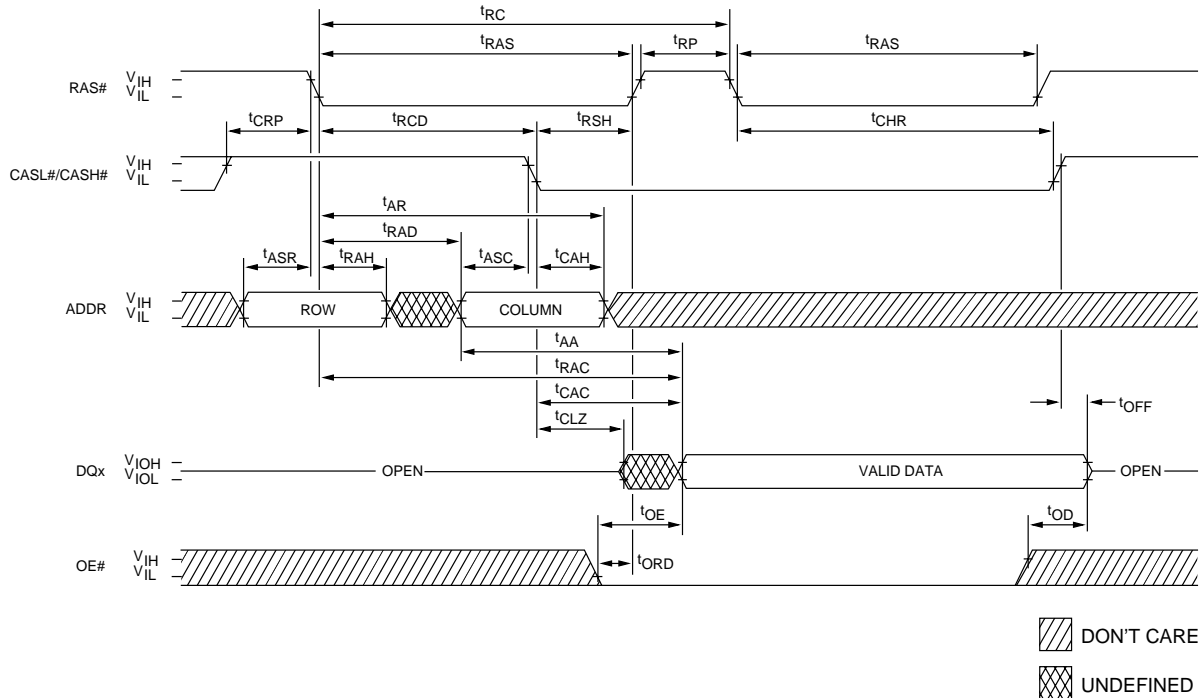
SYMBOL	-5*		-6		UNITS
	MIN	MAX	MIN	MAX	
$t_{CHD}$	15		15		ns
$t_{CHR}$	8		10		ns
$t_{CP}$	8		10		ns
$t_{CSR}$	5		5		ns
$t_{RAS}$	50	10,000	60	10,000	ns
$t_{RASS}$	100		100		$\mu$ s
$t_{RP}$	30		40		ns

SYMBOL	-5*		-6		UNITS
	MIN	MAX	MIN	MAX	
$t_{RPC}$ (FPM)	-		0		ns
$t_{RPC}$ (EDO)	5		5		ns
$t_{RPS}$ (EDO)	90		105		ns
$t_{RPS}$ (FPM)	-		110		ns
$t_{WRH}$	8		10		ns
$t_{WRP}$	8		10		ns

\*EDO version only

**NOTE:** 1. Once  $t_{RASS}$  (MIN) is met and RAS# remains LOW, the DRAM will enter self refresh mode.  
2. Once  $t_{RPS}$  is satisfied, a complete burst of all rows should be executed.

**HIDDEN REFRESH CYCLE** <sup>20, 25</sup>  
(WE# = HIGH)



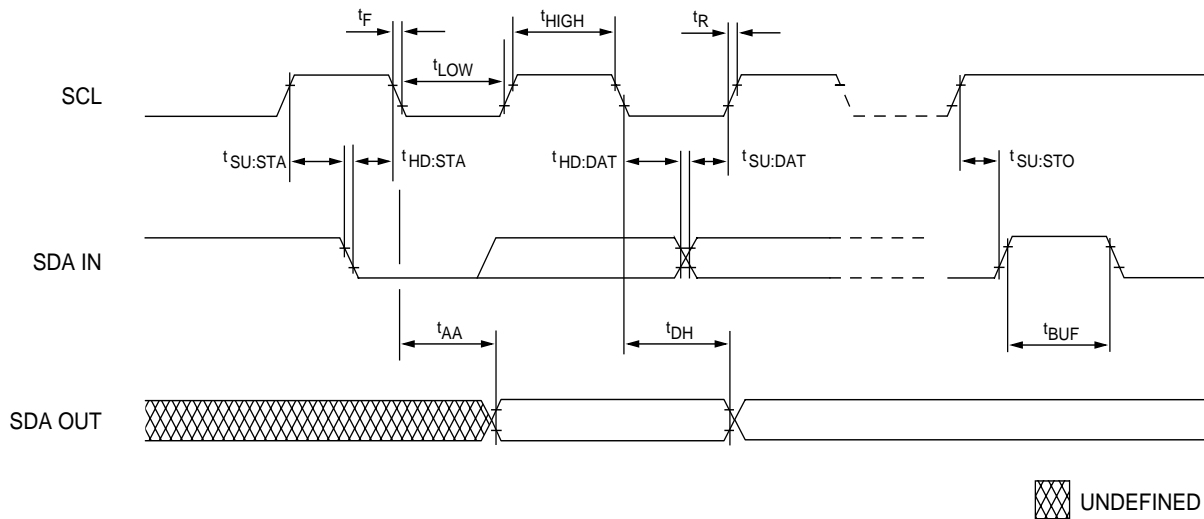
**FAST PAGE MODE AND EDO PAGE MODE  
TIMING PARAMETERS**

SYMBOL	-5*		-6		UNITS
	MIN	MAX	MIN	MAX	
t <sub>AA</sub>		25		30	ns
t <sub>AR</sub>	38		45		ns
t <sub>ASC</sub>	0		0		ns
t <sub>ASR</sub>	0		0		ns
t <sub>CAC</sub>		13/15**		15	ns
t <sub>CAH</sub>	8		10		ns
t <sub>CHR</sub>	8		10		ns
t <sub>CLZ</sub> (FPM)	-		3		ns
t <sub>CLZ</sub> (EDO)	0		0		ns
t <sub>CRP</sub>	5		5		ns
t <sub>OD</sub> (FPM)	-	-	3	15	ns
t <sub>OD</sub> (EDO)	0	12	0	15	ns
t <sub>OE</sub>		12		15	ns
t <sub>OFF</sub> (FPM)	-	-	3	15	ns

SYMBOL	-5*		-6		UNITS
	MIN	MAX	MIN	MAX	
t <sub>OFF</sub> (EDO)	0	12	0	15	ns
t <sub>ORD</sub>	0		0		ns
t <sub>RAC</sub>		50		60	ns
t <sub>RAD</sub> (FPM)	-		15		ns
t <sub>RAD</sub> (EDO)	9		12		ns
t <sub>RAH</sub>	9		10		ns
t <sub>RAS</sub>	50	10,000	60	10,000	ns
t <sub>RC</sub> (FPM)	-		110		ns
t <sub>RC</sub> (EDO)	84		104		ns
t <sub>RCD</sub> (FPM)	-		20		ns
t <sub>RCD</sub> (EDO)	11		14		ns
t <sub>RP</sub>	30		40		ns
t <sub>RSH</sub>	13		15		ns

\* EDO version only  
\*\* 8MB DIMM

**SPD EEPROM**



**SERIAL PRESENCE-DETECT EEPROM  
TIMING PARAMETERS**

SYMBOL	MIN	MAX	UNITS
$t_{AA}$	0.3	3.5	$\mu s$
$t_{BUF}$	4.7		$\mu s$
$t_{DH}$	300		ns
$t_F$		300	ns
$t_{HD:DAT}$	0		$\mu s$
$t_{HD:STA}$	4		$\mu s$

SYMBOL	MIN	MAX	UNITS
$t_{HIGH}$	4		$\mu s$
$t_{LOW}$	4.7		$\mu s$
$t_R$		1	$\mu s$
$t_{SU:DAT}$	250		ns
$t_{SU:STA}$	4.7		$\mu s$
$t_{SU:STO}$	4.7		$\mu s$

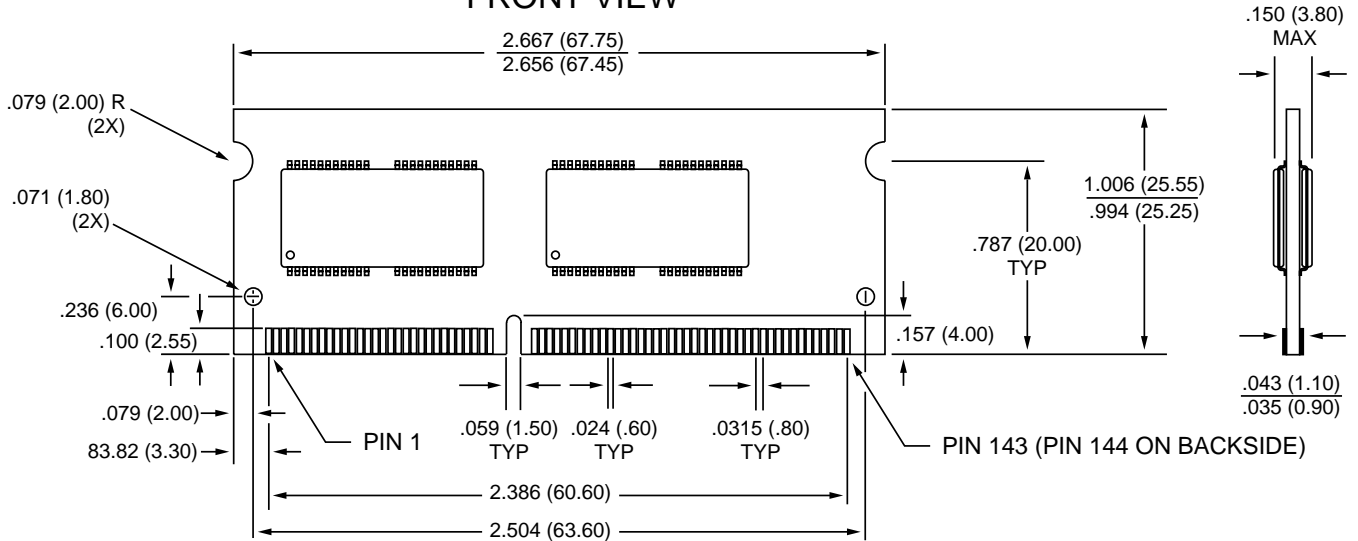
OBSOLETE



1, 2 MEG x 64  
DRAM SODIMMs

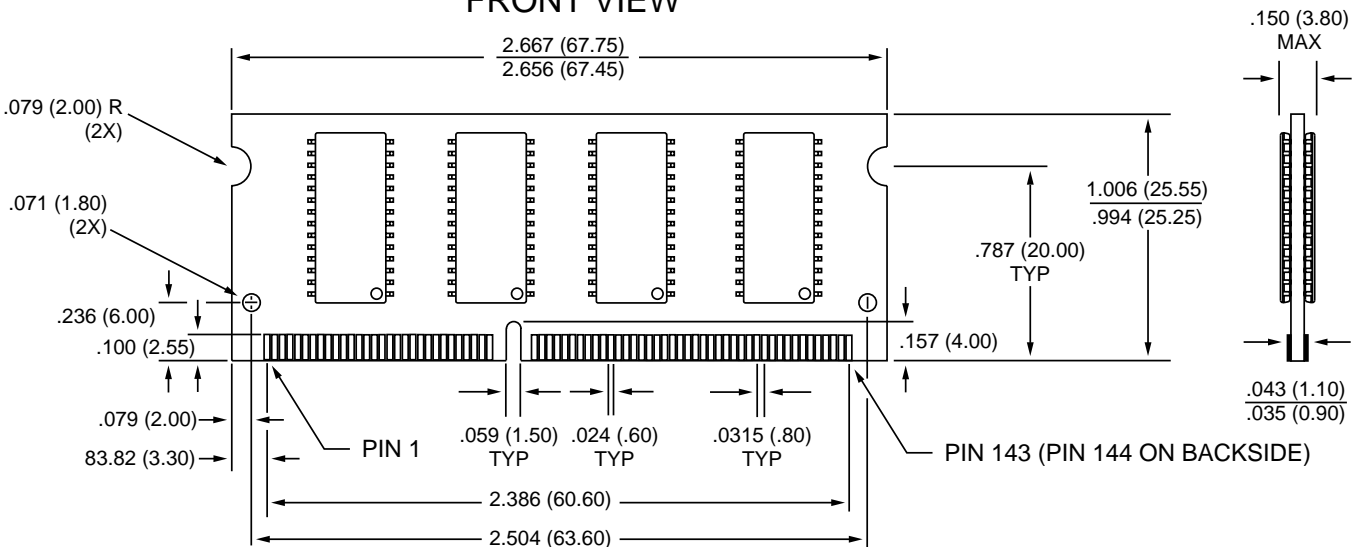
144-PIN SODIMM  
DG-5

FRONT VIEW



144-PIN SODIMM  
DG-6

FRONT VIEW



**NOTE:** 1. All dimensions in inches (millimeters)  $\frac{\text{MAX}}{\text{MIN}}$  or typical where noted.