

DRAM

4M x 4 DRAM EDO PAGE MODE

FEATURES

- X4 organization
- EDO (Extended Data-Out) access mode
- Single power supply :
5V ± 10% Vcc for 5V product
3.3V ± 10% Vcc for 3.3V product
- Interface for inputs and outputs
TTL-compatible for 5V products
LVTTTL-compatible for 3.3V products
- 2048-cycle refresh in 32ms
- Refresh modes : $\overline{\text{RAS}}$ only, $\overline{\text{CAS}}$ BEFORE $\overline{\text{RAS}}$ (CBR) and HIDDEN capabilities,
- Optional self-Refresh capabilities(S-ver. Only)
- JEDEC standard pinout
- Key AC Parameter

	t _{RAC}	t _{CAC}	t _{RC}	t _{PC}
-45	45	11	77	16
-50	50	13	84	20
-60	60	15	104	25

ORDERING INFORMATION - PACKAGE

24 / 26-pin 300mil SOJ
24 / 26-pin 300mil TSOP (Typell)

PRODUCT NO.	Refresh	Vcc	PACKING TYPE
M11B1644A-45J/50J/60J	Normal	5V	SOJ
M11B1644SA-45J/50J/60J	*Self-Refresh		
M11L1644A-45J/50J/60J	Normal	3.3V	
M11L1644SA-45J/50J/60J	Self-Refresh		
M11B1644A-45T/50T/60T	Normal	5V	TSOPII
M11B1644SA-45T/50T/60T	*Self-Refresh		
M11L1644A-45T/50T/60T	Normal	3.3V	
M11L1644SA-45T/50T/60T	Self-Refresh		

* Ordered by special request

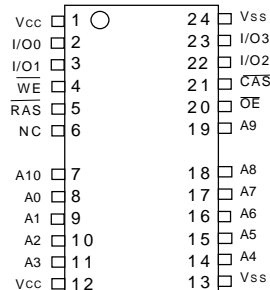
GENERAL DESCRIPTION

The M11B1644/M11L1644 series is a randomly accessed solid state memory, organized as 4,194,304 x 4 bits device. It offers Extended Data-Output access mode. Single power supply (5V ± 10%, 3.3V ± 10%), access time (-45,-50,-60), self-refresh function and package type (SOJ, TSOP II) are optional features of this family. All these family have $\overline{\text{CAS}}$ - before - $\overline{\text{RAS}}$, $\overline{\text{RAS}}$ -only refresh and Hidden refresh.

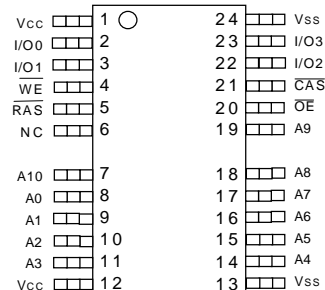
The primary advantage of EDO is the availability of data-out even after $\overline{\text{CAS}}$ returns high. EDO allows $\overline{\text{CAS}}$ precharge time (t_{PC}) to occur without the output data going invalid. This elimination of $\overline{\text{CAS}}$ output control allows pipeline Read.

PIN ASSIGNMENT

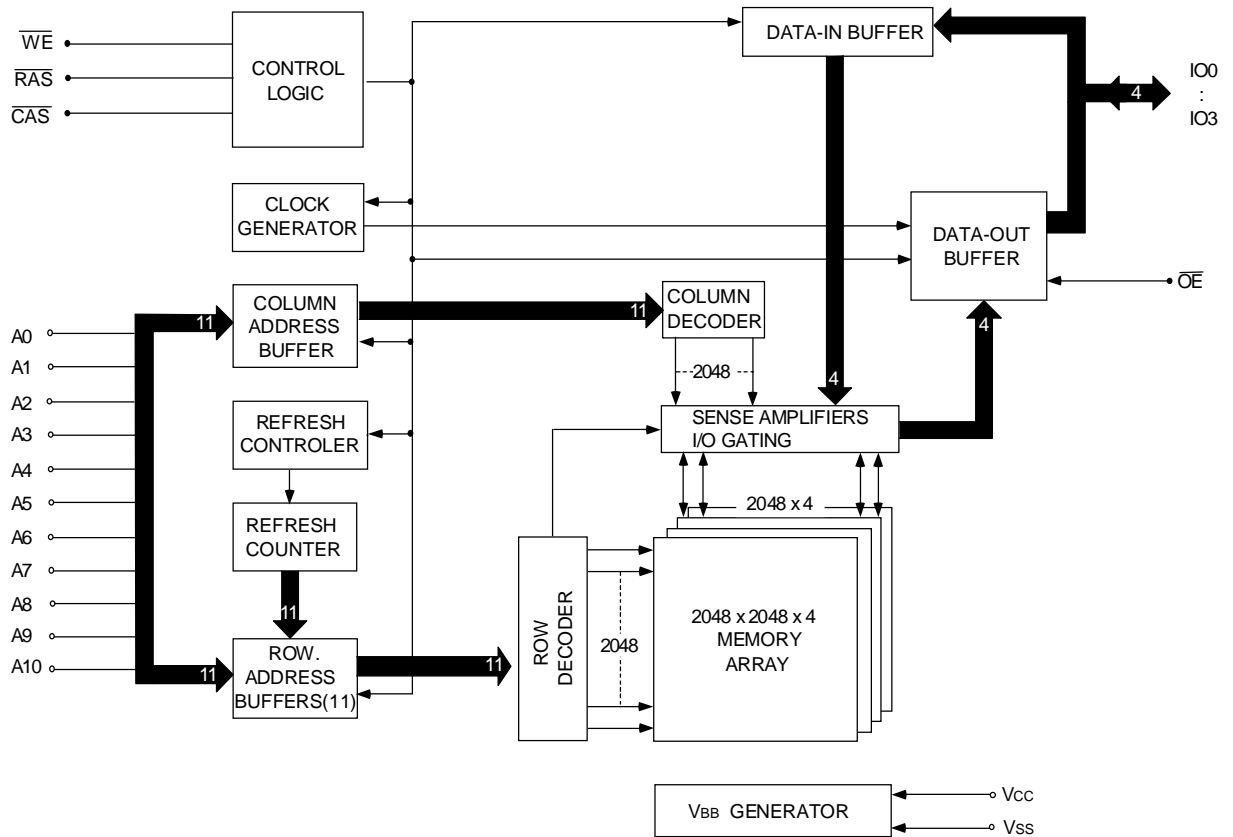
SOJ Top View



TSOP (Typell) Top View



FUNCTIONAL BLOCK DIAGRAM



PIN DESCRIPTIONS

PIN NO.	PIN NAME	TYPE	DESCRIPTION
8~11,14~19,7	A0~A10	Input	Address Input Row Address : A0~A10 Column Address : A0~A10
5	\overline{RAS}	Input	Row Address Strobe
21	\overline{CAS}	Input	Column Address Strobe
4	\overline{WE}	Input	Write Enable
20	\overline{OE}	Input	Output Enable
2,3,22,23	I/O0 ~ I/O3	Input / Output	Data Input / Output
1,12	V _{cc}	Supply	Power, (5V or 3.3V)
13,24	V _{ss}	Ground	Ground
6	NC	-	No Connect

ABSOLUTE MAXIMUM RATINGS

Voltage on Any pin Relative to Vss
 5V Product ... -1V to +7V
 3.3V Product ... -0.5V to +4.6V
 Operating Temperature, T_A (ambient) ... 0 °C to +70 °C
 Storage Temperature (plastic) ... -55 °C to +150 °C
 Power Dissipation 1.0W
 Short Circuit Output Current 50mA

Permanent device damage may occur if "Absolute Maximum Ratings" are exceeded. This is a stress rating only, and functional operation of the device above those conditions 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 RECOMMENDED

OPERATING CONDITIONS (0 °C ≤ T_A ≤ 70 °C)

PARAMETER	CONDITIONS	SYMBOL	3.3V		5V		UNITS	NOTES
			MIN	MAX	MIN	MAX		
Supply Voltage		V _{CC}	3.0	3.6	4.5	5.5	V	1
Supply Voltage		V _{SS}	0	0	0	0	V	
Input High Voltage		V _{IH}	2.0	V _{CC} +0.3	2.4	V _{CC} +0.3	V	1
Input Low Voltage		V _{IL}	-0.3	0.8	-0.3	0.8	V	1
Input Leakage Current	0V ≤ V _{IN} ≤ V _{IH(max)}	I _{LI}	-10	10	-10	10	μA	
Output Leakage Current	0V ≤ V _{OUT} ≤ V _{CC} Output(s) disable	I _{LO}	-10	10	-10	10	μA	
Output High Voltage	5V I _{OH} = -5 mA	V _{OH}	2.4	-	2.4	-	V	
	3.3V I _{OH} = -2 mA							
Output Low Voltage	5V I _{OL} = 4.2 mA	V _{OL}	-	0.4	-	0.4	V	
	3.3V I _{OL} = 2 mA							

Note : 1.All Voltages referenced to V_{SS}

PARAMETER	CONDITIONS	SYMBOL	MAX			UNITS	NOTES
			-45	-50	-60		
Operating Current	\overline{RAS} , \overline{CAS} cycling, t _{RC} = min	I _{CC1}	150	140	130	mA	1,2
Standby Current	TTL interface, \overline{RAS} , \overline{CAS} = V _{IH} , D _{OUT} = High-Z	I _{CC2}	4	4	4	mA	
	CMOS interface, \overline{RAS} , \overline{CAS} ≥ V _{CC} -0.2V		2	2	2	mA	
\overline{RAS} only refresh Current	t _{RC} = min	I _{CC3}	150	140	130	mA	2
EDO Page Mode Current	t _{PC} = min	I _{CC4}	150	140	130	mA	1,3
\overline{CAS} Before \overline{RAS} Refresh Current	t _{RC} = min	I _{CC6}	150	140	130	mA	
Battery Backup Current (S-ver. Only)	Standby with CBR refresh, t _{RC} = 31.2us t _{RAS} ≤ 300ns, D _{OUT} = Hi-Z, CMOS interface	I _{CC7}	2	2	2	mA	
Self Refresh Current	\overline{RAS} , \overline{CAS} ≤ 0.2V, D _{OUT} = Hi-Z, CMOS interface	I _{CC8}	2	2	2	mA	

- Note : 1. I_{CC} max is specified at the output open condition.
 2. Address can be changed twice or less while \overline{RAS} = V_{IL}.
 3. Address can be changed once or less while \overline{CAS} = V_{IH}.

CAPACITANCE ($T_a = 25^\circ\text{C}$, $V_{CC} = 5V \pm 10\%$ or $3.3V \pm 10\%$)

PARAMETER	SYMBOL	TYP	MAX	UNIT
Input Capacitance (address)	C_{i1}	-	5	pF
Input Capacitance ($\overline{\text{RAS}}$, $\overline{\text{CAS}}$, $\overline{\text{WE}}$, $\overline{\text{OE}}$)	C_{i2}	-	7	pF
Output capacitance (I/O0~I/O3)	$C_{i/o}$	-	10	pF

AC ELECTRICAL CHARACTERISTICS ($T_a = 0$ to 70°C , $V_{CC} = 5V \pm 10\%$ or $3.3V \pm 10\%$, $V_{SS} = 0V$) (note 14)

Test Conditions

Input timing reference levels : 0.8V, 2.4V (for 5V power supply), 0.8V, 2.0V (for 3.3V power supply)

Output reference level : $V_{OL} = 0.8V$, $V_{OH} = 2.0V$

Output Load : 2TTL gate + CL (50pF)

Assumed $t_r = 2ns$

PARAMETER	SYMBOL	-45		-50		-60		UNIT	Notes
		MIN	MAX	MIN	MAX	MIN	MAX		
Read or Write Cycle Time	t_{RC}	77		84		104		ns	
Read Write Cycle Time	t_{RWC}	97		110		135		ns	
EDO-Page-Mode Read or Write Cycle Time	t_{PC}	16		20		25		ns	
EDO-Page-Mode Read-Write Cycle Time	t_{PCM}	53		58		68		ns	
Access Time From $\overline{\text{RAS}}$	t_{RAC}		45		50		60	ns	4
Access Time From $\overline{\text{CAS}}$	t_{CAC}		11		13		15	ns	5
Access Time From $\overline{\text{OE}}$	t_{OAC}		11		13		15	ns	13
Access Time From Column Address	t_{AA}		22		25		30	ns	
Access Time From $\overline{\text{CAS}}$ Precharge	t_{ACP}		25		28		33	ns	
$\overline{\text{RAS}}$ Pulse Width	t_{RAS}	45	10,000	50	10,000	60	10,000	ns	
$\overline{\text{RAS}}$ Pulse Width (EDO Page Mode)	t_{RASC}	45	100,000	50	100,000	60	100,000	ns	
$\overline{\text{RAS}}$ Hold Time	t_{RSH}	6		7		10		ns	
$\overline{\text{RAS}}$ Precharge Time	t_{RP}	28		30		40		ns	
$\overline{\text{CAS}}$ Pulse Width	t_{CAS}	6	10,000	7	10,000	10	10,000	ns	18
$\overline{\text{CAS}}$ Hold Time	t_{CSH}	35		37		40		ns	
$\overline{\text{CAS}}$ Precharge Time	t_{CP}	6		7		10		ns	6
$\overline{\text{RAS}}$ to $\overline{\text{CAS}}$ Delay Time	t_{RCD}	10	34	11	37	14	45	ns	7
$\overline{\text{CAS}}$ to $\overline{\text{RAS}}$ Precharge Time	t_{CRP}	5		5		5		ns	
Row Address Setup Time	t_{ASR}	0		0		0		ns	
Row Address Hold Time	t_{RAH}	6		7		10		ns	
$\overline{\text{RAS}}$ to Column Address Delay Time	t_{RAD}	8	23	9	25	12	30	ns	8
Column Address Setup Time	t_{ASC}	0		0		0		ns	
Column Address Hold Time	t_{CAH}	6		7		10		ns	
Column Address Hold Time (Reference to $\overline{\text{RAS}}$)	t_{AR}	40		44		55		ns	
Column Address to $\overline{\text{RAS}}$ Lead Time	t_{RAL}	23		25		30		ns	
Column Address setup to $\overline{\text{CAS}}$ precharge	t_{ACH}	10		11		13		ns	

(Continued)

PARAMETER	SYMBOL	-45		-50		-60		UNIT	Notes
		MIN	MAX	MIN	MAX	MIN	MAX		
Read Command Setup Time	tRCS	0		0		0		ns	15
Read Command Hold Time Reference to $\overline{\text{CAS}}$	tRCH	0		0		0		ns	9,15
Read Command Hold Time Reference to $\overline{\text{RAS}}$	tRRH	0		0		0		ns	9
$\overline{\text{CAS}}$ to Output in Low-Z	tCLZ	0		0		0		ns	
Output Buffer Turn-off Delay From $\overline{\text{CAS}}$ or $\overline{\text{RAS}}$	tOFF1	0	11	0	13	0	15	ns	10,17
Output Buffer Turn-off to $\overline{\text{OE}}$	tOFF2	0	11	0	13	0	15	ns	17,19
Write Command Setup Time	tWCS	0		0		0		ns	11,15
Write Command Hold Time	tWCH	6		7		10		ns	15
Write Command Hold Time(Reference to $\overline{\text{RAS}}$)	tWCR	40		44		55		ns	15
Write Command Pulse Width	tWP	6		7		10		ns	15
Write Command to $\overline{\text{RAS}}$ Lead Time	tRWL	11		13		15		ns	15
Write Command to $\overline{\text{CAS}}$ Lead Time	tCWL	6		7		10		ns	15
Data-in Setup Time	tDS	0		0		0		ns	12
Data-in Hold Time	tDH	6		7		10		ns	12
Data-in Hold Time (Reference to $\overline{\text{RAS}}$)	tDHR	40		44		55		ns	
$\overline{\text{RAS}}$ to $\overline{\text{WE}}$ Delay Time	tRWD	57		67		79		ns	11
Column Address to $\overline{\text{WE}}$ Delay Time	tAWD	34		42		49		ns	11
$\overline{\text{CAS}}$ to $\overline{\text{WE}}$ Delay Time	tCWD	23		30		34		ns	11
Transition Time (rise or fall)	tT	1	50	1	50	1	50	ns	2,3
Refresh Period (2048 cycles)	tREF		32		32		32	ms	
$\overline{\text{RAS}}$ to $\overline{\text{CAS}}$ Precharge Time	tRPC	5		5		5		ns	
$\overline{\text{CAS}}$ Setup Time(CBR REFRESH)	tCSR	5		5		5		ns	1
$\overline{\text{CAS}}$ Hold Time(CBR REFRESH)	tCHR	10		10		10		ns	1
$\overline{\text{OE}}$ Hold Time From $\overline{\text{WE}}$ During Read-Mode-Write Cycle	tOEH	6		7		10		ns	16
$\overline{\text{OE}}$ Low to $\overline{\text{CAS}}$ High Setup Time	tOES	5		5		5		ns	
$\overline{\text{OE}}$ High Hold Time From $\overline{\text{CAS}}$ High	tOEHC	2		2		2		ns	
$\overline{\text{OE}}$ precharge time	tOEP	2		2		2		ns	
$\overline{\text{OE}}$ Setup Prior to $\overline{\text{RAS}}$ During Hidden Refresh Cycle	tORD	0		0		0		ns	
Data Output Hold After $\overline{\text{CAS}}$ Returning Low	tCOH	3		3		3		ns	
Output Disable Delay From $\overline{\text{WE}}$	tWHZ	0	11	0	13	0	15	ns	
Self Refresh $\overline{\text{RAS}}$ Low Pulse width	tRASS	100		100		100		us	20,21
Self Refresh $\overline{\text{RAS}}$ High Precharge Time	tRPS	77		84		104		ns	20,21
Self Refresh $\overline{\text{CAS}}$ Hold Time	tCHS	-50		-50		-50		ns	20,21
$\overline{\text{WE}}$ Setup Time Reference to $\overline{\text{RAS}}$ in CBR/SR	tRSR	0		0		0		ns	20,21
$\overline{\text{WE}}$ Hold Time Reference to $\overline{\text{RAS}}$ in CBR/SR	tRHR	6		7		10		ns	20,21

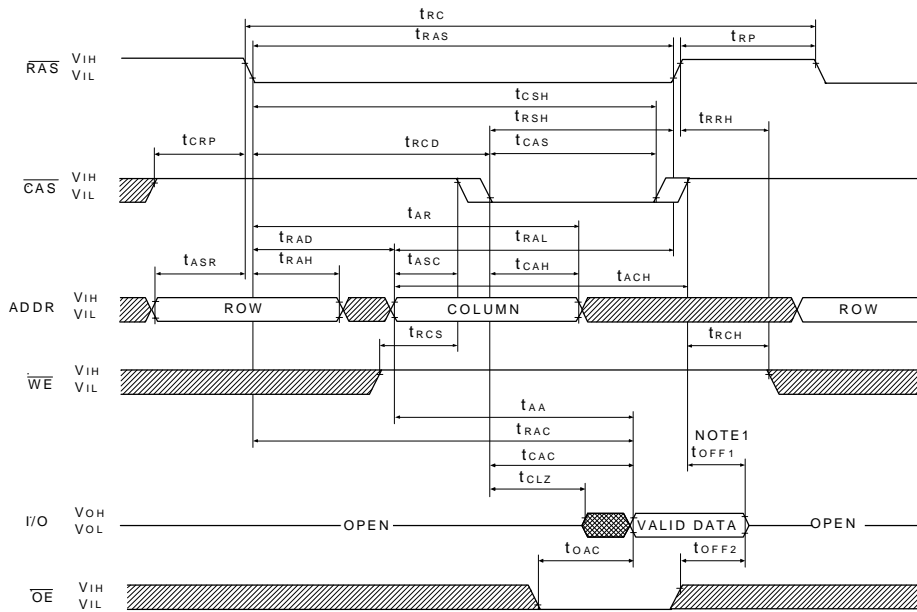
Notes :

1. Enables on-chip refresh and address counters.
2. $V_{IH}(\min)$ and $V_{IL}(\max)$ are reference levels for measuring timing of input signals. Transition times are measured between V_{IH} and V_{IL} .
3. In addition to meet the transition rate specification, all input signals must transit between V_{IH} and V_{IL} in a monotonic manner.
4. Assume that $t_{RCD} < t_{RCD}(\max)$. If t_{RCD} is greater than the maximum recommended value shown in this table, t_{RAC} will increase by the amount that t_{RCD} exceeds the value shown.
5. Assume that $t_{RCD} \geq t_{RCD}(\max)$
6. If \overline{CAS} is low at the falling edge of \overline{RAS} , data-out will be maintained from the previous cycle. To initiate a new cycle and clear the data-out buffer, \overline{CAS} and \overline{RAS} must be pulsed high.
7. Operation within the t_{RCD} limit ensures that $t_{RCD}(\max)$ can be met, $t_{RCD}(\max)$ is specified as a reference point only ; if t_{RCD} is greater than the specified $t_{RCD}(\max)$ limit, access time is controlled by t_{CAC} .
8. Operation within the t_{RAD} limit ensures that $t_{RAD}(\max)$ can be met. $t_{RAD}(\max)$ is specified as a reference point only ; if t_{RAD} is greater than the specified $t_{RAD}(\max)$ limit, access time is controlled by t_{AA} .
9. Either t_{RCH} or t_{RRH} must be satisfied for a READ cycle.
10. $t_{OFF1}(\max)$ defines the time at which the output achieves the open circuit condition ; it is not a reference to V_{OH} or V_{OL} .
11. t_{WCS} , t_{RWD} , t_{AWD} and t_{CWD} are restrictive operating parameters in LATE WRITE and READ-MODIFY-WRITE cycle only. 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 $t_{RWD} \geq t_{RWD}(\min)$, $t_{AWD} \geq t_{AWD}(\min)$ and $t_{CWD} \geq t_{CWD}(\min)$, the cycle is READ-WRITE and the data output will contain data read from the selected cell. If neither of the above conditions is met, the state of I/O (at access time and until \overline{CAS} and \overline{RAS} or \overline{OE} go back to V_{IH}) is indeterminate. \overline{OE} held high and \overline{WE} taken low after \overline{CAS} goes low result in a LATE WRITE (\overline{OE} - controlled) cycle.
12. Those parameters are referenced to \overline{CAS} leading edge in EARLY WRITE cycles and \overline{WE} leading edge in LATE WRITE or READ-MODIFY-WRITE cycles.
13. During a READ cycle, if \overline{OE} is low then taken HIGH before \overline{CAS} goes high, I/O goes open, if \overline{OE} is tied permanently low, a LATE WRITE or READ-MODIFY-WRITE operation is not possible.
14. An initial pause of 200 μ s is required after power-up followed by eight \overline{RAS} refresh cycles (\overline{RAS} only or CBR) before proper device operation is assured. The eight \overline{RAS} cycle wake-ups should be repeated any time the t_{REF} refresh requirement is exceeded.
15. WRITE command is defined as \overline{WE} going low.
16. LATE WRITE and READ-MODIFY-WRITE cycles must have both t_{OFF2} and t_{OEH} met (\overline{OE} high during WRITE cycle) in order to ensure that the output buffers will be open during the WRITE cycles.
17. The I/Os open during READ cycles once t_{OFF1} or t_{OFF2} occur.
18. Each \overline{CAS} must meet minimum pulse width.
19. All IOs controlled by \overline{OE} , regardless \overline{CAS} .
20. Self refresh mode is initiated by performing a CBR refresh cycle and holding \overline{RAS} low for the specified t_{RASS} . Self refresh mode is terminated by rising \overline{RAS} high for a minimum time of t_{RPS} .
21. For all of the refresh mode except the distributed CBR refresh mode, all rows must be refreshed within the refresh rate before and after self refresh.

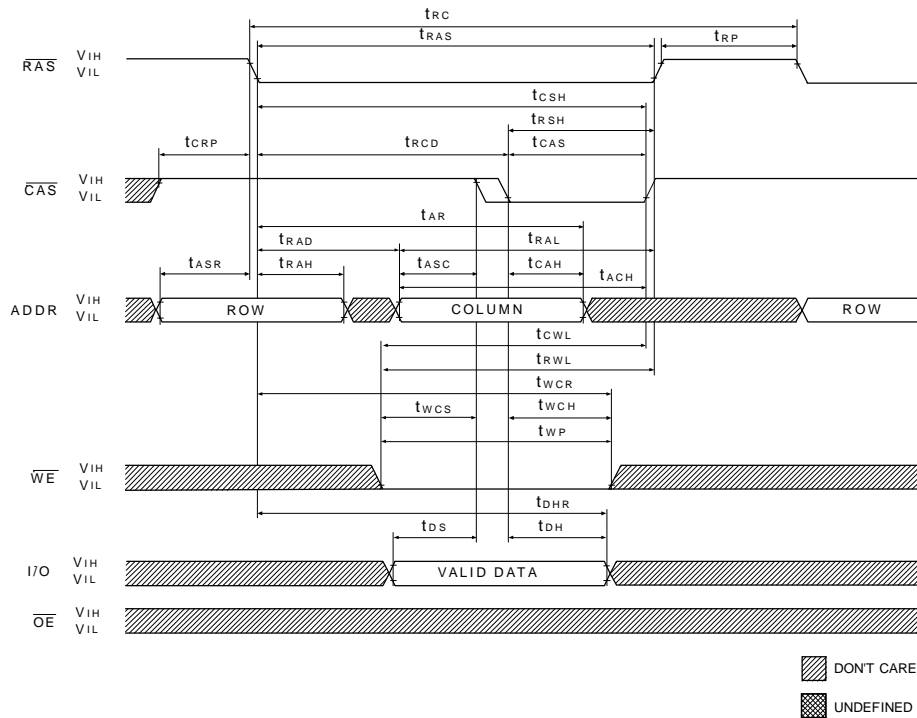
TRUTH TABLE

FUNCTION		RAS	CAS	WE	OE	ADDRESSES		DQs
						ROW	COL	
Standby		H	H→X	X	X	X	X	High-Z
Read		L	L	H	L	ROW	COL	Data-Out
Write (Early Write)		L	L	L	X	ROW	COL	Data-In
Read-Write		L	L	H→L	L→H	ROW	COL	Data-Out, Data-In
EDO-Page-Mode Read	1st Cycle	L	H→L	H	L	ROW	COL	Data-Out
	2nd Cycle	L	H→L	H	L	X	COL	Data-Out
	Any Cycle	L	L→H	H	L	X	X	Data-Out
EDO-Page-Mode Write (Early)	1st Cycle	L	H→L	L	X	ROW	COL	Data-In
	2nd Cycle	L	H→L	L	X	X	COL	Data-In
EDO-Page-Mode Read-Write	1st Cycle	L	H→L	H→L	L→H	ROW	COL	Data-Out, Data-In
	2nd Cycle	L	H→L	H→L	L→H	X	COL	Data-Out, Data-In
Hidden Refresh		L→H→L	L	H	L	ROW	COL	Data-Out
RAS -Only Refresh		L	H	X	X	ROW	X	High-Z
CBR Refresh		H→L	L	H	X	X	X	High-Z
Self Refresh		H→L	L	H	X	X	X	High-Z

READ CYCLE



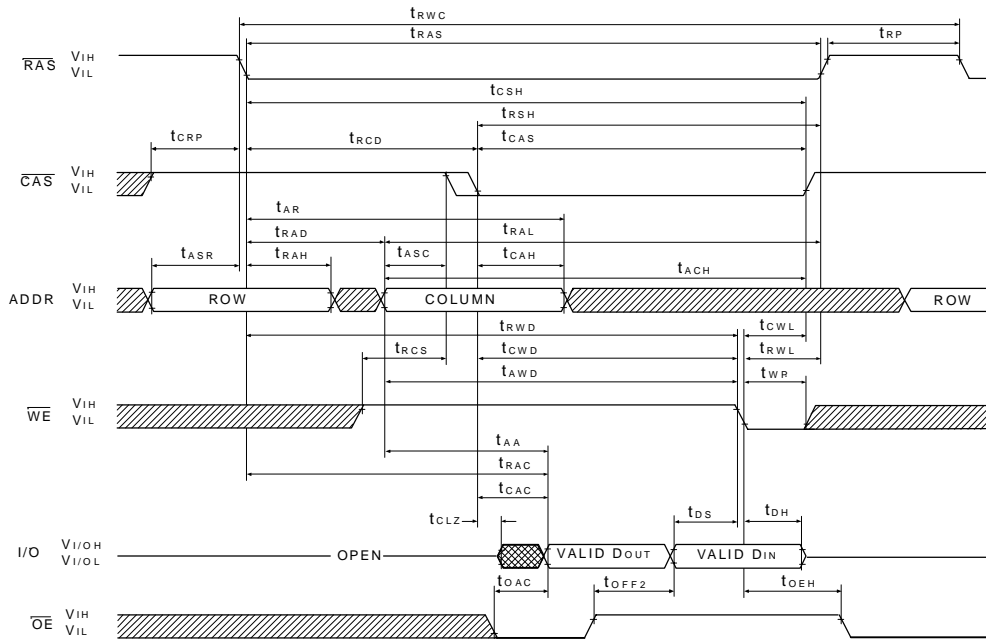
EARLY WRITE CYCLE



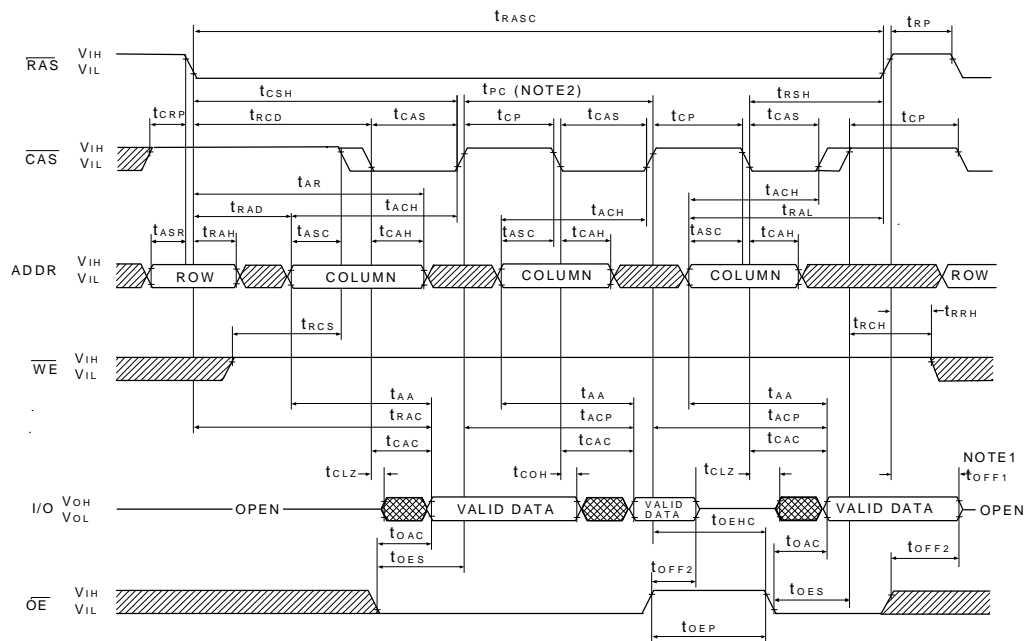
 DONT CARE
 UNDEFINED

Note: 1. t_{OFF1} is referenced from the rising edge of \overline{RAS} or \overline{CAS} , whichever occurs last.

**READ WRITE CYCLE
(LATE WRITE and READ-MODIFY-WRITE CYCLES)**



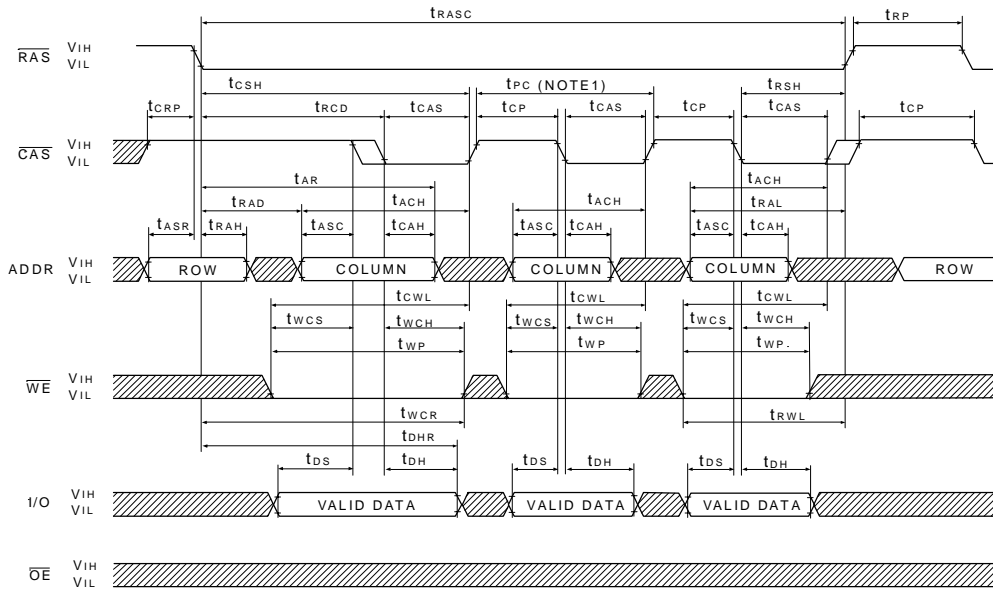
EDO-PAGE-MODE READ CYCLE



▨ DONT CARE
▣ UNDEFINED

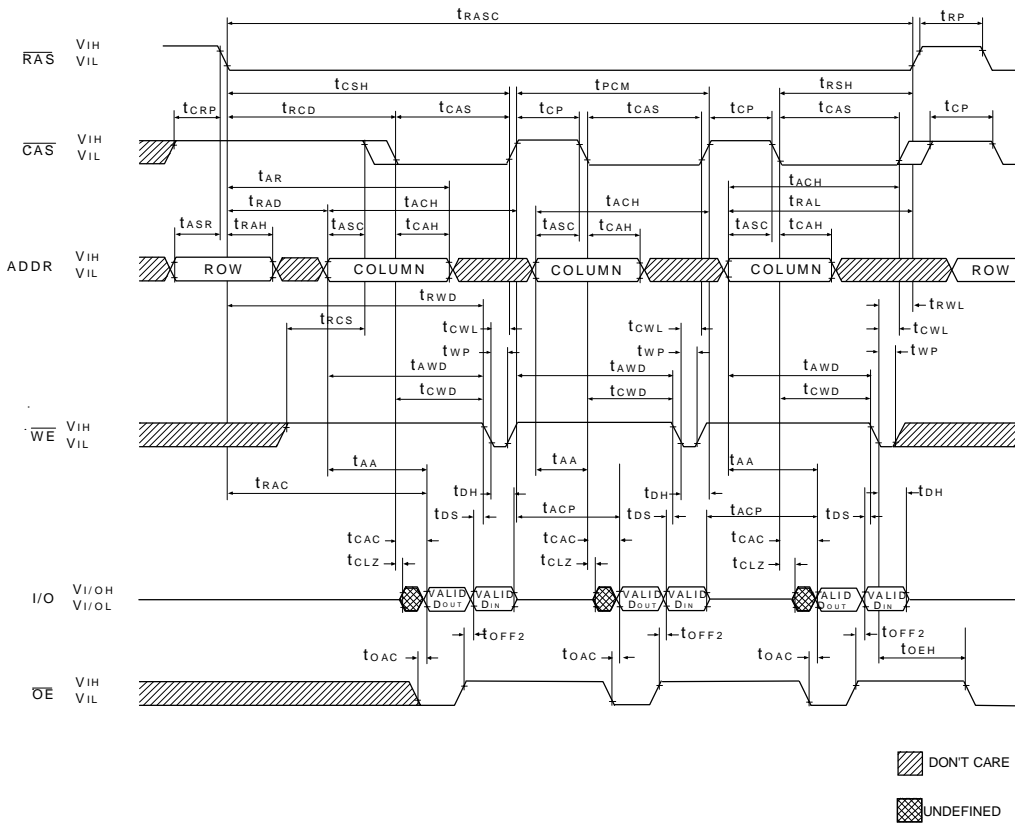
- *NOTE : 1. t_{OFF1} is referenced from the rising edge of \overline{RAS} or \overline{CAS} , whichever occurs last.
- 2. t_{PC} can be measured from falling edge of \overline{CAS} to falling edge of \overline{CAS} , or from rising edge of \overline{CAS} to rising edge of \overline{CAS} . Both measurements must meet the t_{PC} specification.

EDO-PAGE-MODE EARLY-WRITE CYCLE



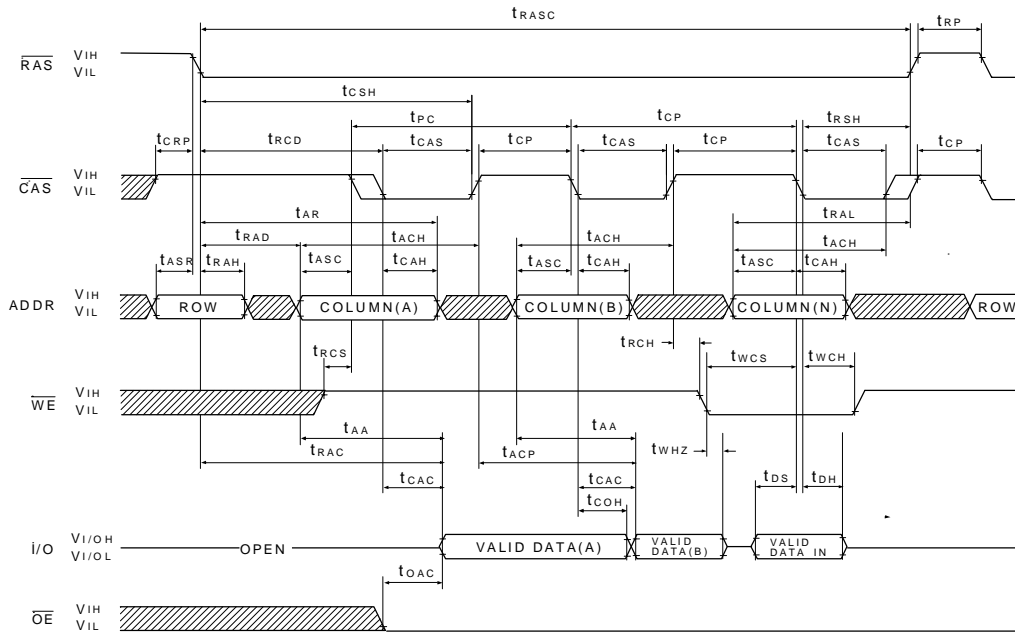
EDO-PAGE-MODE READ-WRITE CYCLE

(LATE WRITE and READ-MODIFY-WRITE CYCLES)

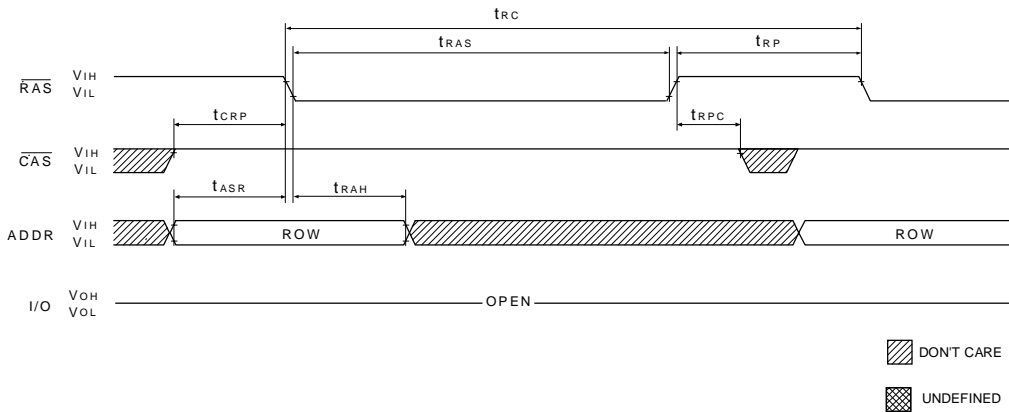


Note : 1. t_{PC} can be measured from falling edge to falling edge of $\overline{\text{CAS}}$, or from rising edge to rising edge of $\overline{\text{CAS}}$. Both measurements must meet the t_{PC} specification.

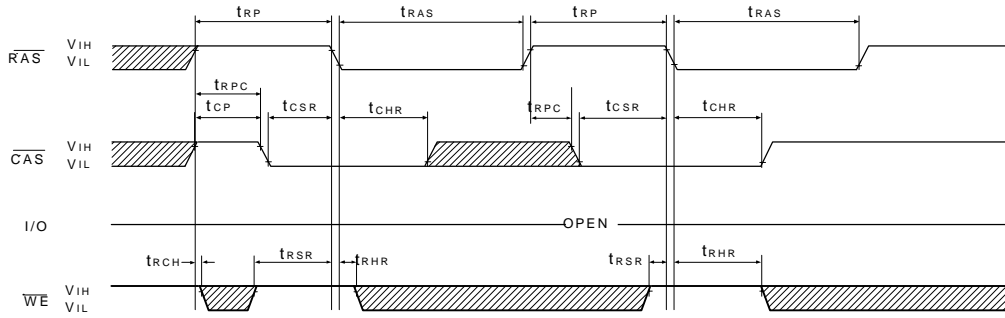
**EDO-PAGE-MODE READ-EARLY-WRITE CYCLE
(Psuedo READ-MODIFY-WRITE)**



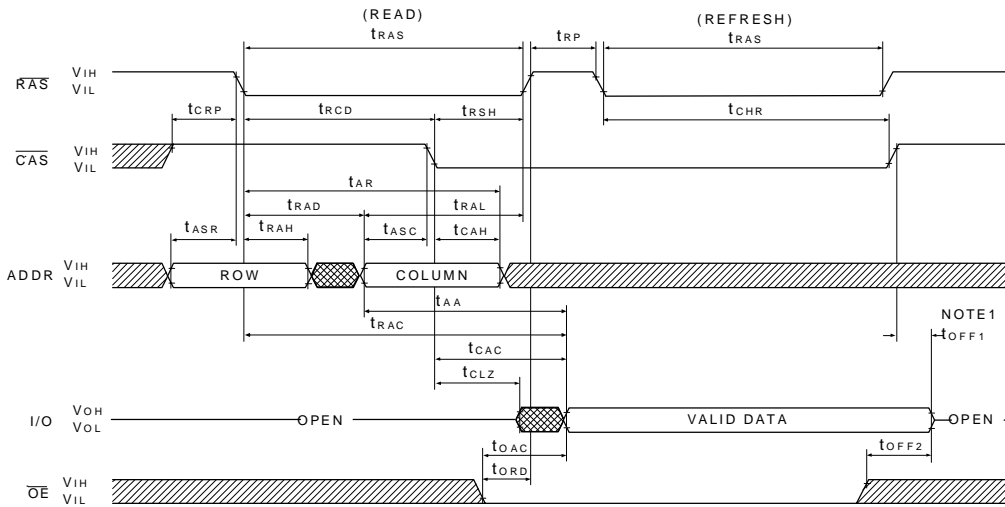
**RAS ONLY REFRESH CYCLE
(ADDR = A0~A10 ; OE , WE = DON'T CARE)**



**CBR REFRESH CYCLE
(A0~A10 ; \overline{OE} = DON'T CARE)**



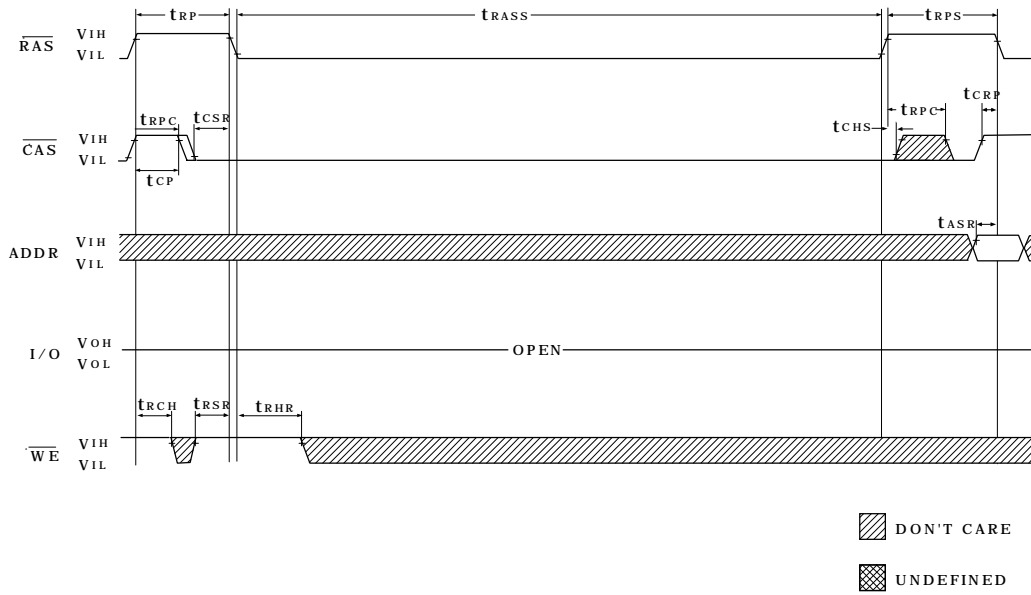
**HIDDEN REFRESH CYCLE
(\overline{WE} = HIGH ; \overline{OE} = LOW)**



DON'T CARE
 UNDEFINED

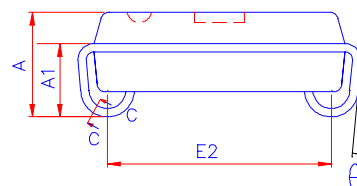
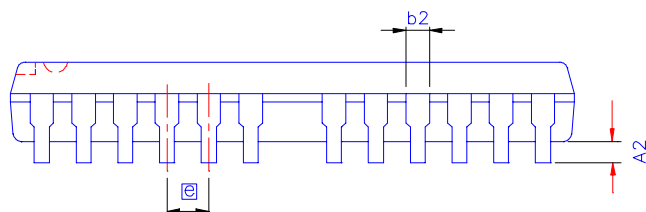
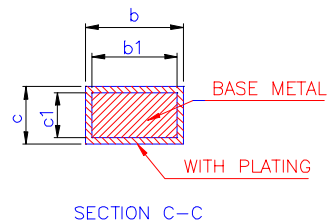
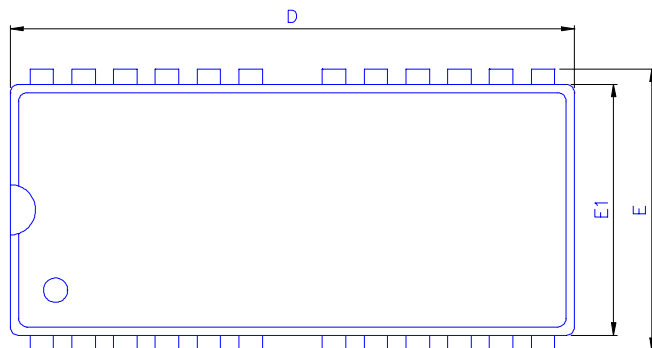
Note : 1. t_{OFF1} is reference from the rising edge of \overline{RAS} or \overline{CAS} , whichever occurs last.

**SELF REFRESH CYCLE
(\overline{OE} = DON'T CARE)**



PACKING DIMENSIONS

24 / 26-LEAD SOJ(300mil)



Symbol	Dimension mm			Dimension inch		
	Min	Nom	Max	Min	Nom	Max
A	3.25	3.51	3.76	0.128	0.138	0.148
A1	2.08	-	-	0.082	-	-
A2	0.635	-	-	0.025	-	-
B	0.41		0.51	0.016		0.020
B1	0.41	0.46	0.48	0.016	0.018	0.019
B2	0.66	0.71	0.81	0.026	0.028	0.032
C	0.18	0.20	0.28	0.007	0.008	0.012
C1	0.18		0.28	0.007		0.011
D	17.02	17.15	17.27	0.670	0.675	0.680
E		8.51			0.335	
E1	7.49	7.62	7.75	0.295	0.300	0.305
θ	0°		10°	0°		10°
e	1.27 BASIC			0.050 BASIC		

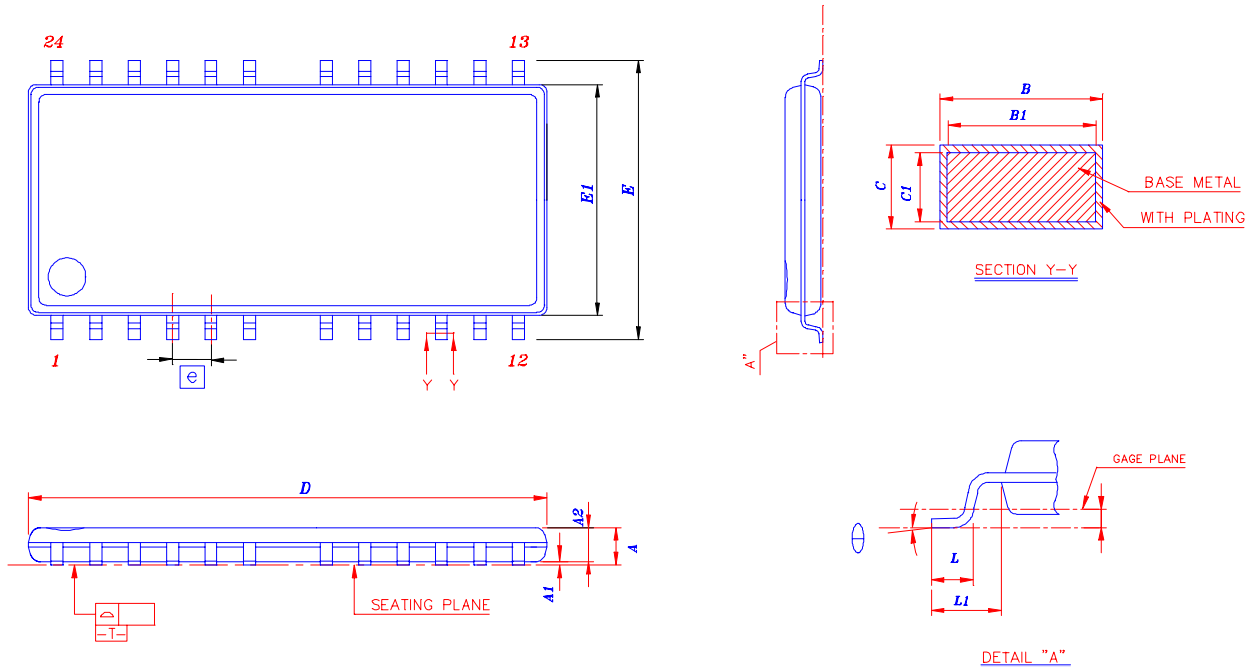
PACKING

DIMENSIONS

24 / 26-LEAD

TSOP(II)

DRAM(300mil)



Symbol	Dimension in mm			Dimension in inch		
	Min	Nom	Max	Min	Nom	Max
A	-	-	1.20	-	-	0.047
A1	0.05	-	0.15	0.002	-	0.006
A2	0.95	1.00	1.05	0.037	0.039	0.041
B	0.30	-	0.52	0.012	-	0.02
B1	0.30	0.40	0.45	0.012	0.016	0.018
C	0.12	-	0.21	0.005	-	0.008
C1	0.12	0.15	0.16	0.005	0.006	0.0063
D	17.01	17.14	17.27	0.67	0.675	0.68
ZD	0.95 REF			0.374 REF		
E	9.02	9.22	9.42	0.355	0.363	0.371
E1	7.49	7.62	7.75	0.295	0.3	0.305
L	0.40	0.50	0.60	0.016	0.020	0.024
L1	0.031 REF			0.080 REF		
e	1.27 BSC			0.05 BSC		
R	0.12	-	0.25	0.005	-	0.01
R1	0.12	-	-	0.005	-	-
θ	0°	-	5°	0°	-	5°
y	-	-	0.10	-	-	0.004

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