

TM124MBK36B, TM124MBK36R 1048576 BY 36-BIT  
 TM248NBK36B, TM248NBK36R 2097152 BY 36-BIT  
 DYNAMIC RAM MODULE

SMMS137E – JANUARY 1991 – REVISED JUNE 1995

- **Organization**  
 TM124MBK36B . . . 1 048 576 × 36  
 TM248NBK36B . . . 2 097 152 × 36
- **Single 5-V Power Supply (±10% Tolerance)**
- **72-pin Leadless Single In-Line Memory Module (SIMM) for Use With Sockets**
- **TM124MBK36B—Utilizes Eight 4-Megabit DRAMs in Plastic Small-Outline J-Lead (SOJ) Packages and One 4-Megabit Quad-CAS DRAM in a Plastic Small-Outline J-Lead (SOJ) Package**
- **TM248NBK36B—Utilizes Sixteen 4-Megabit DRAMs in Plastic Small-Outline J-Lead (SOJ) Packages and Two 4-Megabit Quad-CAS DRAMs in Plastic Small-Outline J-Lead (SOJ) Packages**
- **Long Refresh Period**  
 16 ms (1024 Cycles)
- **All Inputs, Outputs, Clocks Fully TTL Compatible**
- **3-State Output**
- **Common  $\overline{\text{CAS}}$  Control for Nine Common Data-In and Data-Out Lines, in Four Blocks**
- **Enhanced Page Mode Operation with CAS-Before-RAS (CBR), RAS-Only, and Hidden Refresh**

- **Presence Detect**
- **Performance Ranges:**

	ACCESS TIME	ACCESS TIME	ACCESS TIME	READ OR WRITE CYCLE
	t <sub>RAC</sub>	t <sub>AA</sub>	t <sub>CAC</sub>	
	(MAX)	(MAX)	(MAX)	(MIN)
'124MBK36B-60	60 ns	30 ns	15 ns	110 ns
'124MBK36B-70	70 ns	35 ns	18 ns	130 ns
'124MBK36B-80	80 ns	40 ns	20 ns	150 ns
'248NBK36B-60	60 ns	30 ns	15 ns	110 ns
'248NBK36B-70	70 ns	35 ns	18 ns	130 ns
'248NBK36B-80	80 ns	40 ns	20 ns	150 ns

- **Low Power Dissipation**
- **Operating Free-Air Temperature Range**  
 0°C to 70°C
- **Gold-Tabbed Versions Available:†**
  - TM124MBK36B
  - TM248NBK36B
- **Tin-Lead (Solder) Tabbed Versions Available:**
  - TM124MBK36R
  - TM248NBK36R

## description

### TM124MBK36B

The TM124MBK36B is a dynamic random-access memory (DRAM) organized as four times 1 048 576 × 9 (bit 9 is generally used for parity) in a 72-pin leadless single in-line memory module (SIMM). The SIMM is composed of eight TMS44400DJ, 1 048 576 × 4-bit DRAMs, each in 20/26-lead plastic small-outline J-lead packages (SOJs), and one TMS44460DJ, 1 048 576 × 4-bit Quad-CAS DRAM in a 24/26-lead plastic small-outline J-lead package (SOJ), mounted on a substrate with decoupling capacitors. Each TMS44400DJ and TMS44460DJ is described in the TMS44400 or TMS44460 data sheet, respectively.

The TM124MBK36B is available in the single-sided BK leadless module for use with sockets.

The TM124MBK36B features  $\overline{\text{RAS}}$  access times of 60 ns, 70 ns, and 80 ns. This device is rated for operation from 0°C to 70°C.

### TM248NBK36B

The TM248NBK36B is a DRAM organized as four times 2 097 152 × 9 (bit 9 is generally used for parity) in a 72-pin leadless SIMM. The SIMM is composed of sixteen TMS44400DJ, 1 048 576 × 4-bit DRAMs, each in 20/26-lead plastic small-outline J-lead packages (SOJs), and two TMS44460DJ, 1 048 576 × 4-bit Quad-CAS DRAMs, each in a 24/26-lead plastic small-outline J-lead package (SOJ), mounted on a substrate with decoupling capacitors. Each TMS44400DJ and TMS44460DJ is described in the TMS44400 and TMS44460 data sheet, respectively.

† Part numbers in this data sheet are for the gold-tabbed version; the information applies to both gold-tabbed and solder-tabbed versions.

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**TM248NBK36B (continued)**

The TM124NBK36B is available in the double-sided BK leadless module for use with sockets.

The TM124NBK36B features  $\overline{\text{RAS}}$  access times of 60 ns, 70 ns, and 80 ns. This device is rated for operation from 0°C to 70°C

**operation**

**TM124MBK36B**

The TM124MBK36B operates as eight TMS44400DJs and one TMS44460DJ connected as shown in the functional block diagram and Table 1. The parity bits are provided by the TMS44460DJ and are controlled by  $\overline{\text{RAS2}}$ . To ensure proper parity bit operation all memory accesses should include a  $\overline{\text{RAS2}}$  pulse. Refer to the TMS44400 and TMS44460 data sheets for details of operation. The common I/O feature dictates the use of early write cycles to prevent contention on D and Q.

**TM248NBK36B**

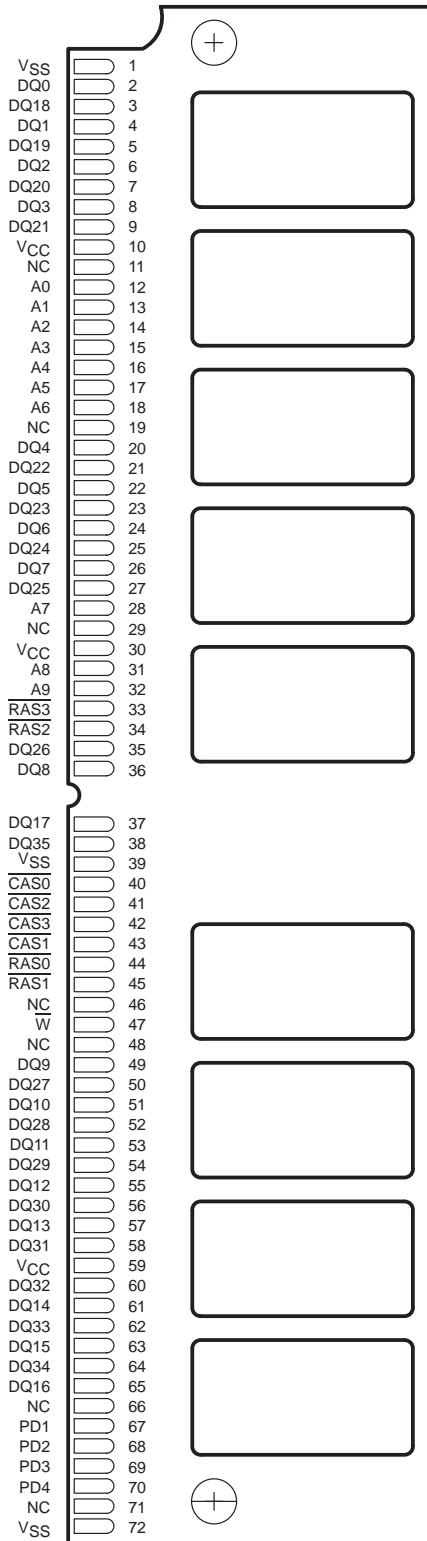
The TM248NBK36B operates as sixteen TMS44400DJs and two TMS44460DJs connected as shown in the functional block diagram and Table 1. The parity bits are provided by the TMS44460DJ and are controlled by  $\overline{\text{RAS2}}$  on side 1 and  $\overline{\text{RAS3}}$  on side 2. To ensure proper parity bit operation, all memory accesses should include a  $\overline{\text{RAS2}}$  or  $\overline{\text{RAS3}}$  pulse. Refer to the TMS44400 and TMS44460 data sheets for details of operation. The common I/O feature dictates the use of early write cycles to prevent contention on D and Q.



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**BK SINGLE IN-LINE MEMORY MODULE  
 (TOP VIEW)**



**TM124MBK36B  
 (SIDE VIEW)**



**TM248NBK36B  
 (SIDE VIEW)**



**PIN NOMENCLATURE**

A0–A9	Address Inputs
CAS0–CAS3	Column-Address Strobe
DQ0–DQ35	Data In/Data Out
NC	No Connection
PD1–PD4	Presence Detects
RAS0–RAS3	Row-Address Strobe
VCC	5-V Supply
VSS	Ground
W	Write Enable

**PRESENCE DETECT**

		PD1 (67)	PD2 (68)	PD3 (69)	PD4 (70)
<b>TM124MBK36B</b>	80 ns	VSS	VSS	NC	VSS
	70 ns	VSS	VSS	VSS	NC
	60 ns	VSS	VSS	NC	NC
<b>TM248NBK36B</b>	80 ns	NC	NC	NC	VSS
	70 ns	NC	NC	VSS	NC
	60 ns	NC	NC	NC	NC

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**Table 1. Connection Table**

DATA BLOCK	$\overline{\text{RASx}}$		$\overline{\text{CASx}}$
	SIDE 1	SIDE 2†	
DQ0–DQ7 DQ8	$\overline{\text{RAS0}}$ $\overline{\text{RAS2}}$	$\overline{\text{RAS1}}$ $\overline{\text{RAS3}}$	$\overline{\text{CAS0}}$ $\overline{\text{CAS0}}$
DQ9–DQ16 DQ17	$\overline{\text{RAS0}}$ $\overline{\text{RAS2}}$	$\overline{\text{RAS1}}$ $\overline{\text{RAS3}}$	$\overline{\text{CAS1}}$ $\overline{\text{CAS1}}$
DQ18–DQ25 DQ26	$\overline{\text{RAS2}}$ $\overline{\text{RAS2}}$	$\overline{\text{RAS3}}$ $\overline{\text{RAS3}}$	$\overline{\text{CAS2}}$ $\overline{\text{CAS2}}$
DQ27–DQ34 DQ35	$\overline{\text{RAS2}}$ $\overline{\text{RAS2}}$	$\overline{\text{RAS3}}$ $\overline{\text{RAS3}}$	$\overline{\text{CAS3}}$ $\overline{\text{CAS3}}$

† Side 2 applies to the TM248NBK36B only.

**single-in-line memory module and components**

PC substrate: 1,27 ± 0,1 mm (0.05 inch) nominal thickness; 0.005 inch/inch maximum warpage

Bypass capacitors: Multilayer ceramic

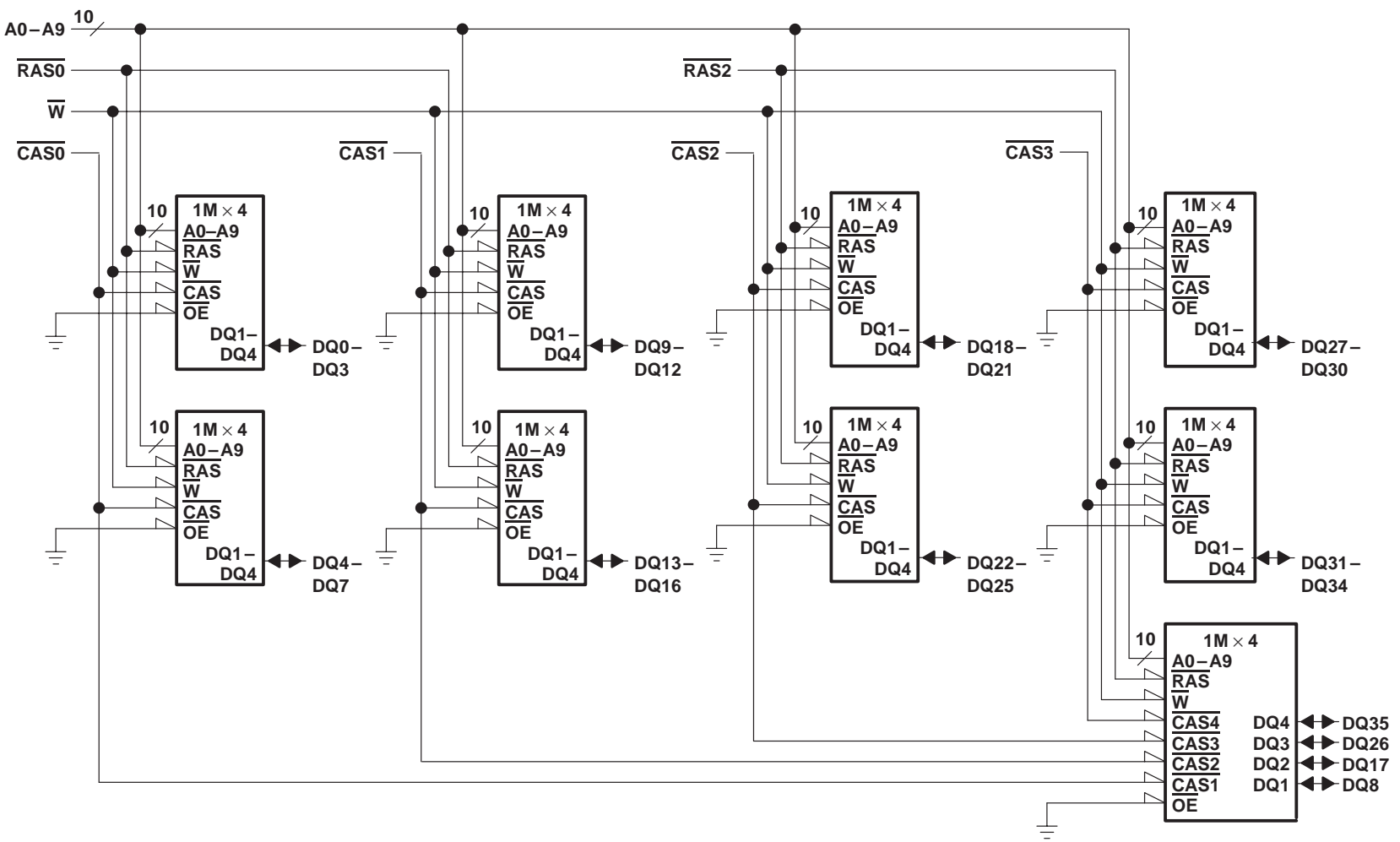
Contact area for TM124MBK36B and TM248NBK36B: Nickel plate and gold plate over copper

Contact area for TM124MBK36R and TM248NBK36R: Nickel plate and tin-lead over copper



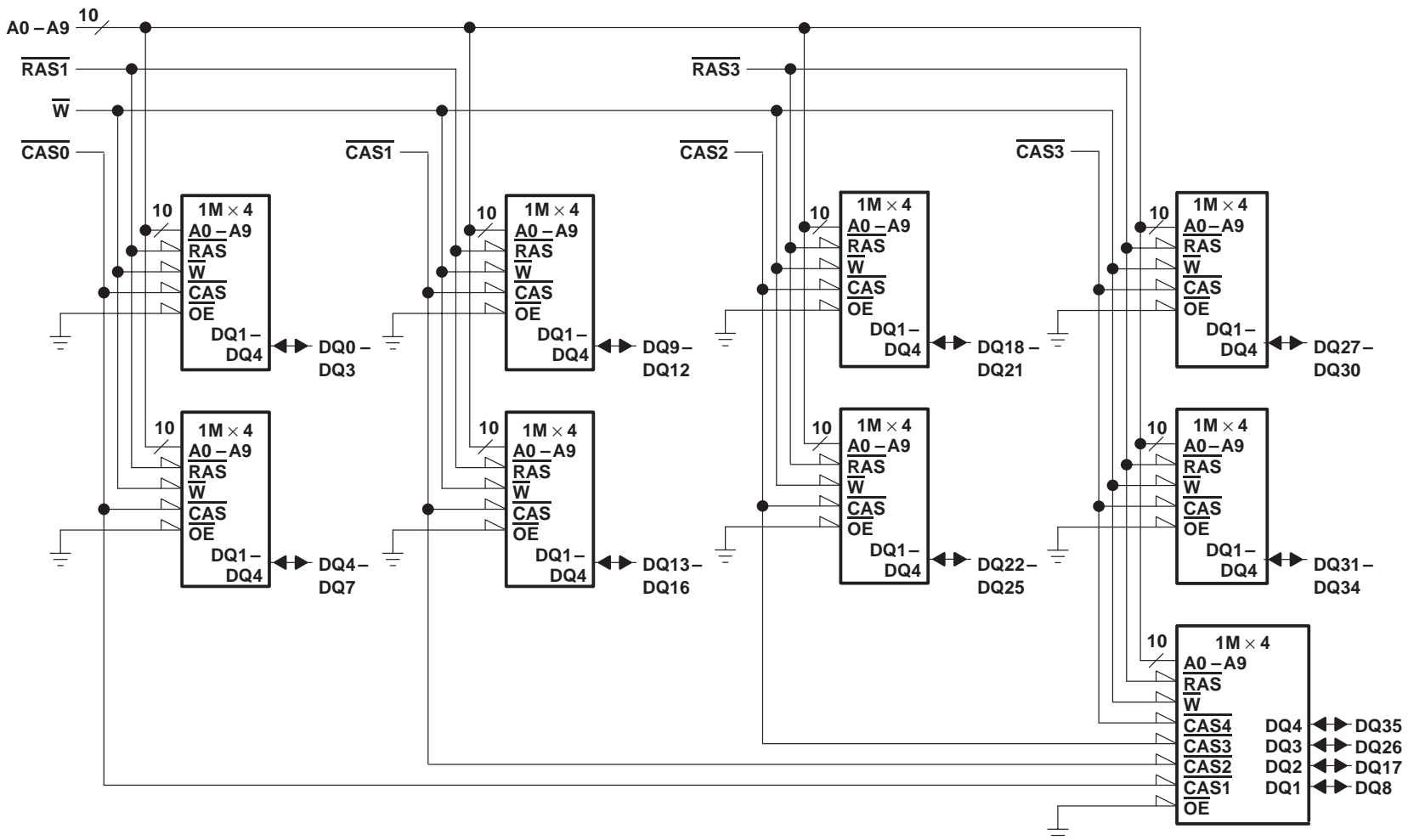
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functional block diagram (TM124MBK36B and TM248NBK36B, side 1)



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functional block diagram (TM248NBK36B, side 2)



**TM124MBK36B, TM124MBK36R 1048576 BY 36-BIT  
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**absolute maximum ratings over operating free-air temperature range (unless otherwise noted)†**

Voltage range on any pin (see Note 1) .....	– 1 V to 7 V
Voltage range on V <sub>CC</sub> (see Note 1) .....	– 1 V to 7 V
Short-circuit output current .....	50 mA
Power dissipation .....	9 W
Operating free-air temperature range, T <sub>A</sub> .....	0°C to 70°C
Storage temperature range, T <sub>stg</sub> .....	– 55°C to 125°C

† Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

NOTE 1: All voltage values are with respect to V<sub>SS</sub>.

**recommended operating conditions**

	MIN	NOM	MAX	UNIT
V <sub>CC</sub> Supply voltage	4.5	5	5.5	V
V <sub>IH</sub> High-level input voltage	2.4		6.5	V
V <sub>IL</sub> Low-level input voltage (see Note 2)	– 1		0.8	V
T <sub>A</sub> Operating free-air temperature	0		70	°C

NOTE 2: The algebraic convention, where the more negative (less positive) limit is designated as minimum, is used for logic-voltage levels only.

**electrical characteristics over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted)**

PARAMETER	TEST CONDITIONS	'124MBK36B-60		'124MBK36B-70		'124MBK36B-80		UNIT
		MIN	MAX	MIN	MAX	MIN	MAX	
V <sub>OH</sub> High-level output voltage	I <sub>OH</sub> = – 5 mA	2.4		2.4		2.4		V
V <sub>OL</sub> Low-level output voltage	I <sub>OL</sub> = 4.2 mA		0.4		0.4		0.4	V
I <sub>I</sub> Input current (leakage)	V <sub>CC</sub> = 5.5 V, V <sub>I</sub> = 0 V to 6.5 V, All other pins = 0 V to V <sub>CC</sub>		± 10		± 10		± 10	µA
I <sub>O</sub> Output current (leakage)	V <sub>CC</sub> = 5.5 V, V <sub>O</sub> = 0 V to V <sub>CC</sub> , CAS high		± 10		± 10		± 10	µA
I <sub>CC1</sub> Read or write cycle current (see Note 3)	V <sub>CC</sub> = 5.5 V, Minimum cycle		945		810		720	mA
I <sub>CC2</sub> Standby current	After 1 memory cycle, RAS and CAS high, V <sub>IH</sub> = 2.4 V (TTL)		18		18		18	mA
	After 1 memory cycle, RAS and CAS high, V <sub>IH</sub> = V <sub>CC</sub> – 0.2 V (CMOS)		9		9		9	mA
I <sub>CC3</sub> Average refresh current (RAS only or CBR) (see Note 3)	V <sub>CC</sub> = 5.5 V, Minimum cycle, RAS cycling, CAS high (RAS only), RAS low after CAS low (CBR)		945		810		720	mA
I <sub>CC4</sub> Average page current (see Note 4)	V <sub>CC</sub> = 5.5 V, t <sub>PC</sub> = minimum, RAS low, CAS cycling		810		720		630	mA

NOTES: 3. Measured with a maximum of one address change while RAS = V<sub>IL</sub>  
4. Measured with a maximum of one address change while CAS = V<sub>IH</sub>



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**electrical characteristics over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted)**

PARAMETER	TEST CONDITIONS	'248NBK36B-60		'248NBK36B-70		'248NBK36B-80		UNIT
		MIN	MAX	MIN	MAX	MIN	MAX	
V <sub>OH</sub>	High-level output voltage	I <sub>OH</sub> = -5 mA		2.4		2.4		V
V <sub>OL</sub>	Low-level output voltage	I <sub>OL</sub> = 4.2 mA		0.4		0.4		V
I <sub>I</sub>	Input current (leakage)	V <sub>CC</sub> = 5.5 V, V <sub>I</sub> = 0 V to 6.5 V, All other pins = 0 V to V <sub>CC</sub>		± 20		± 20		µA
I <sub>O</sub>	Output current (leakage)	V <sub>CC</sub> = 5.5 V, CAS high, V <sub>O</sub> = 0 V to V <sub>CC</sub>		± 20		± 20		µA
I <sub>CC1</sub>	Read or write cycle current (see Note 3)	V <sub>CC</sub> = 5.5 V, Minimum cycle		963		828		mA
I <sub>CC2</sub>	Standby current	After 1 memory cycle, RAS and CAS high, V <sub>IH</sub> = 2.4 V (TTL)		36		36		mA
		After 1 memory cycle, RAS and CAS high, V <sub>IH</sub> = V <sub>CC</sub> - 0.2 V (CMOS)		18		18		mA
I <sub>CC3</sub>	Average refresh current (RAS only or CBR) (see Note 3)	V <sub>CC</sub> = 5.5 V, Minimum cycle, RAS cycling, CAS high (RAS only), RAS low after CAS low (CBR)		1890		1620		mA
I <sub>CC4</sub>	Average page current (see Note 4)	V <sub>CC</sub> = 5.5 V, t <sub>PC</sub> = minimum, RAS low, CAS cycling		828		738		mA

NOTES: 3. Measured with a maximum of one address change while  $\overline{\text{RAS}} = V_{IL}$   
 4. Measured with a maximum of one address change while  $\overline{\text{CAS}} = V_{IH}$

**capacitance over recommended ranges of supply voltage and operating free-air temperature, f = 1 MHz (see Note 5)**

PARAMETER	'124MBK36B		'248NBK36B		UNIT	
	MIN	MAX	MIN	MAX		
C <sub>i(A)</sub>	Input capacitance, A0–A9		45		90	pF
C <sub>i(R)</sub>	Input capacitance, $\overline{\text{RAS}}$		35		35	pF
C <sub>i(C)</sub>	Input capacitance, $\overline{\text{CAS}}$		21		42	pF
C <sub>i(W)</sub>	Input capacitance, $\overline{\text{W}}$		63		126	pF
C <sub>o(DQ)</sub>	Output capacitance on DQ pins		7		14	pF

NOTE 5: V<sub>CC</sub> = 5 V ± 0.5 V and the bias on pins under test is 0 V.





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switching characteristics over recommended ranges of supply voltage and operating free-air temperature

PARAMETER	'124MBK36B-60 '248NBK36B-60		'124MBK36B-70 '248NBK36B-70		'124MBK36B-80 '248NBK36B-80		UNIT
	MIN	MAX	MIN	MAX	MIN	MAX	
t <sub>CAC</sub> Access time from $\overline{\text{CAS}}$ low	15		18		20		ns
t <sub>AA</sub> Access time from column address	30		35		40		ns
t <sub>RAC</sub> Access time from $\overline{\text{RAS}}$ low	60		70		80		ns
t <sub>CPA</sub> Access time from column precharge	35		40		45		ns
t <sub>CLZ</sub> $\overline{\text{CAS}}$ to output in low impedance	0		0		0		ns
t <sub>OFF</sub> Output disable time after $\overline{\text{CAS}}$ high (see Note 6)	0 15		0 18		0 20		ns

NOTE 6: t<sub>OFF</sub> is specified when the output is no longer driven.

timing requirements over recommended ranges of supply voltage and operating free-air temperature

	'124MBK36B-60 '248NBK36B-60		'124MBK36B-70 '248NBK36B-70		'124MBK36B-80 '248NBK36B-80		UNIT
	MIN	MAX	MIN	MAX	MIN	MAX	
t <sub>RC</sub> Cycle time, random read or write (see Note 7)	110		130		150		ns
t <sub>RWC</sub> Cycle time, read write	130		153		175		ns
t <sub>PC</sub> Cycle time, page-mode read or write (see Note 8)	40		45		50		ns
t <sub>RASP</sub> Pulse duration, page mode, $\overline{\text{RAS}}$ low	60	100 000	70	100 000	80	100 000	ns
t <sub>RAS</sub> Pulse duration, nonpage mode, $\overline{\text{RAS}}$ low	60	10 000	70	10 000	80	10 000	ns
t <sub>CAS</sub> Pulse duration, $\overline{\text{CAS}}$ low	15	10 000	18	10 000	20	10 000	ns
t <sub>CP</sub> Pulse duration, $\overline{\text{CAS}}$ high	10		10		10		ns
t <sub>RP</sub> Pulse duration, $\overline{\text{RAS}}$ high (precharge)	40		50		60		ns
t <sub>WP</sub> Pulse duration, write	15		15		15		ns
t <sub>ASC</sub> Setup time, column address before $\overline{\text{CAS}}$ low	0		0		0		ns
t <sub>ASR</sub> Setup time, row address before $\overline{\text{RAS}}$ low	0		0		0		ns
t <sub>DS</sub> Setup time, data	0		0		0		ns
t <sub>RCS</sub> Setup time, read before $\overline{\text{CAS}}$ low	0		0		0		ns
t <sub>CWL</sub> Setup time, $\overline{\text{W}}$ low before $\overline{\text{CAS}}$ high	15		18		20		ns
t <sub>RWL</sub> Setup time, $\overline{\text{W}}$ low before $\overline{\text{RAS}}$ high	15		18		20		ns
t <sub>WCS</sub> Setup time, $\overline{\text{W}}$ low before $\overline{\text{CAS}}$ low	0		0		0		ns
t <sub>WSR</sub> Setup time, $\overline{\text{W}}$ high (see Note 9)	10		10		10		ns

- NOTES: 7. All cycles assume t<sub>T</sub> = 5 ns.  
 8. To assure t<sub>PC</sub> min, t<sub>ASC</sub> should be ≥ 5 ns.  
 9. CBR refresh only



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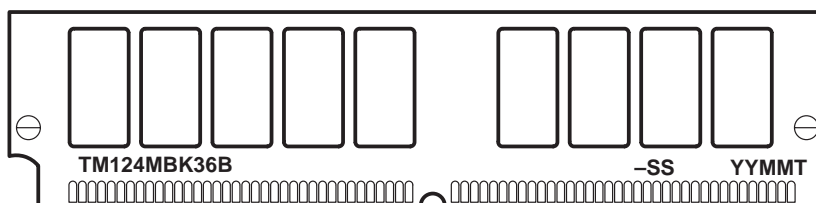
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**timing requirements over recommended ranges of supply voltage and operating free-air temperature (continued)**

		'124MBK36B-60 '248NBK36B-60		'124MBK36B-70 '248NBK36B-70		'124MBK36B-80 '248NBK36B-80		UNIT
		MIN	MAX	MIN	MAX	MIN	MAX	
t <sub>CAH</sub>	Hold time, column address after $\overline{\text{CAS}}$ low	10		15		15		ns
t <sub>DHR</sub>	Hold time, data after $\overline{\text{RAS}}$ low (see Note 10)	50		55		60		ns
t <sub>DH</sub>	Hold time, data	10		15		15		ns
t <sub>AR</sub>	Hold time, column address after $\overline{\text{RAS}}$ low (see Note 10)	50		55		60		ns
t <sub>CLCH</sub>	Hold time, $\overline{\text{CAS}}$ low to $\overline{\text{CAS}}$ high	5		5		5		ns
t <sub>RAH</sub>	Hold time, row address after $\overline{\text{RAS}}$ low	10		10		10		ns
t <sub>RCH</sub>	Hold time, read after $\overline{\text{CAS}}$ high (see Note 11)	0		0		0		ns
t <sub>RRH</sub>	Hold time, read after $\overline{\text{RAS}}$ high (see Note 11)	0		0		0		ns
t <sub>WCH</sub>	Hold time, write after $\overline{\text{CAS}}$ low	15		15		15		ns
t <sub>WCR</sub>	Hold time, write after $\overline{\text{RAS}}$ low (see Note 10)	50		55		60		ns
t <sub>WHR</sub>	Hold time, $\overline{\text{W}}$ high (see Note 9)	10		10		10		ns
t <sub>CHR</sub>	Delay time, $\overline{\text{RAS}}$ low to $\overline{\text{CAS}}$ high (see Note 9)	15		15		20		ns
t <sub>CRP</sub>	Delay time, $\overline{\text{CAS}}$ high to $\overline{\text{RAS}}$ low	0		0		0		ns
t <sub>CSH</sub>	Delay time, $\overline{\text{RAS}}$ low to $\overline{\text{CAS}}$ high	60		70		80		ns
t <sub>CSR</sub>	Delay time, $\overline{\text{CAS}}$ low to $\overline{\text{RAS}}$ low (see Note 9)	10		10		10		ns
t <sub>RAD</sub>	Delay time, $\overline{\text{RAS}}$ low to column address (see Note 12)	15	30	15	35	15	40	ns
t <sub>RAL</sub>	Delay time, column address to $\overline{\text{RAS}}$ high	30		35		40		ns
t <sub>CAL</sub>	Delay time, column address to $\overline{\text{CAS}}$ high	30		35		40		ns
t <sub>RCD</sub>	Delay time, $\overline{\text{RAS}}$ low to $\overline{\text{CAS}}$ low (see Note 12)	20	45	20	52	20	60	ns
t <sub>RPC</sub>	Delay time, $\overline{\text{RAS}}$ high to $\overline{\text{CAS}}$ low (see Note 9)	0		0		0		ns
t <sub>RSH</sub>	Delay time, $\overline{\text{CAS}}$ low to $\overline{\text{RAS}}$ high	15		18		20		ns
t <sub>REF</sub>	Refresh time interval		16		16		16	ms
t <sub>T</sub>	Transition time	2	50	2	50	2	50	ns

- NOTES: 9. CBR refresh only  
 10. The minimum value is measured when t<sub>RCD</sub> is set to t<sub>RCD</sub> min as a reference.  
 11. Either t<sub>RRH</sub> or t<sub>RCH</sub> must be satisfied for a read cycle.  
 12. The maximum value is specified only to assure access time.

**device symbolization (TM124MBK36B illustrated)**



- YY = Year Code  
 MM = Month Code  
 T = Assembly Site Code  
 -SS = Speed Code

NOTE: Location of symbolization may vary.



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