

## 16M × 72-Bit Dynamic RAM Module (ECC - Module )

**HYM 72V1600GS-50/-60**  
**HYM 72V1610GS-50/-60**

### Preliminary Information

- 16 777 216 words by 72-bit ECC - mode organization
- Fast access and cycle time
  - 50 ns access time
  - 90 ns cycle time (-50 version)
  - 60 ns access time
  - 110 ns cycle time (-60 version)
- Fast page mode capability with
  - 35 ns cycle time (-50 version)
  - 40 ns cycle time (-60 version)
- Single + 3.3V (± 0.3V) supply
- Low power dissipation
  - max. 6480 mW active (-50 version)
  - max. 5832 mW active (-60 version)

CMOS – 108 mW standby  
LVTTL – 180 mW standby
- $\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$  refresh,  $\overline{\text{RAS}}$ -only-refresh
- 18 decoupling capacitors mounted on substrate
- All inputs, outputs and clock fully LVTTL & LVCMOS compatible
- 4 Byte interleave enabled, Dual Address inputs (A0/B0)
- Buffered inputs excepts  $\overline{\text{RAS}}$  and DQ
- 168 pin, dual read-out, Single in-Line Memory Module
- Utilizes eighteen 16M × 4 -DRAMs and four BiCMOS 8-bit buffers/line drivers VT244A
- Two versions : HYM 72V1600GS with TSOPII-components (4 mm thickness)  
HYM 72V1610GS with SOJ-components (9 mm thickness)
- 8192 refresh cycles / 128 ms with 13 / 11 addressing
- Gold contact pad
- double sided module with 38.1 mm (1500 mil) height

## 16M × 72-Bit Dynamic RAM Module (ECC - Module )

**HYM 72V1600GS-50/-60**  
**HYM 72V1610GS-50/-60**

### Preliminary Information

- 16 777 216 words by 72-bit ECC - mode organization
- Fast access and cycle time
  - 50 ns access time
  - 90 ns cycle time (-50 version)
  - 60 ns access time
  - 110 ns cycle time (-60 version)
- Fast page mode capability with
  - 35 ns cycle time (-50 version)
  - 40 ns cycle time (-60 version)
- Single + 3.3V (± 0.3V) supply
- Low power dissipation
  - max. 6480 mW active (-50 version)
  - max. 5832 mW active (-60 version)

CMOS – 108 mW standby  
LVTTL – 180 mW standby
- $\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$  refresh,  $\overline{\text{RAS}}$ -only-refresh
- 18 decoupling capacitors mounted on substrate
- All inputs, outputs and clock fully LVTTL & LVCMOS compatible
- 4 Byte interleave enabled, Dual Address inputs (A0/B0)
- Buffered inputs excepts  $\overline{\text{RAS}}$  and DQ
- 168 pin, dual read-out, Single in-Line Memory Module
- Utilizes eighteen 16M × 4 -DRAMs and four BiCMOS 8-bit buffers/line drivers VT244A
- Two versions : HYM 72V1600GS with TSOPII-components (4 mm thickness)  
HYM 72V1610GS with SOJ-components (9 mm thickness)
- 8192 refresh cycles / 128 ms with 13 / 11 addressing
- Gold contact pad
- double sided module with 38.1 mm (1500 mil) height

The HYM 72V1600/10GS-50/-60 is a 128 MByte DRAM module organized as 16 777 216 words by 72-bit in a 168-pin, dual read-out, single-in-line package comprising eighteen HYB 3164400BT/BJ 16M × 4 DRAMs in 500 mil wide TSOPII or SOJ- packages mounted together with eighteen 0.2 μF ceramic decoupling capacitors on a PC board. All inputs except RAS and DQ are buffered by using four BiCMOS 8-bit buffers/line drivers.

Each HYB 3164400BT/BJ is described in the data sheet and is fully electrically tested and processed according to Siemens standard quality procedure prior to module assembly. After assembly onto the board, a further set of electrical tests is performed.

The density and speed of the module can be detected by the use of presence detect pins.

### Ordering Information

Type	Ordering Code	Package	Descriptions
HYM 72V1600GS-50		L-DIM-168-7	3.3V 50ns DRAM module
HYM 72V1600GS-60	Q67100-Q2079	L-DIM-168-7	3.3V 60ns DRAM module
HYM 72V1610GS-50		L-DIM-168-7	3.3V 50ns DRAM module
HYM 72V1610GS-60	Q67100-Q2080	L-DIM-168-7	3.3V 60ns DRAM module

### Pin Names

A0-A12,B0	Address Input
DQ0 - DQ71	Data Input/Output
RAS0, RAS2	Row Address Strobe
CAS0 , CAS2	Column Address Strobe
WE0, WE2	Read / Write Input
OE0, OE2	Output Enable
Vcc	Power (+3.3 Volt)
Vss	Ground
PD1 - PD8	Presence Detect Pins
PDE	Presence Detect Enable
ID0 , ID1	ID identification bit
N.C.	No Connection

### Presence-Detect and ID-pin Truth Table:

Module	ID0	ID1	PD1	PD2	PD3	PD4	PD5	PD6	PD7	PD8
HYM 72V1600GS-50	Vss	Vss	1	1	1	1	0	0	0	0
HYM 72V1600GS-60	Vss	Vss	1	1	1	1	0	1	1	0

**Note:** 1 = High Level ( Driver Output) , 0 = Low Level (Driver Output) for  $\overline{PDE}$  active ( ground) . For  $\overline{PDE}$  at a high level all PD terminal are in tri-state.

The HYM 72V1600/10GS-50/-60 is a 128 MByte DRAM module organized as 16 777 216 words by 72-bit in a 168-pin, dual read-out, single-in-line package comprising eighteen HYB 3164400BT/BJ 16M × 4 DRAMs in 500 mil wide TSOPII or SOJ- packages mounted together with eighteen 0.2 μF ceramic decoupling capacitors on a PC board. All inputs except RAS and DQ are buffered by using four BiCMOS 8-bit buffers/line drivers.

Each HYB 3164400BT/BJ is described in the data sheet and is fully electrically tested and processed according to Siemens standard quality procedure prior to module assembly. After assembly onto the board, a further set of electrical tests is performed.

The density and speed of the module can be detected by the use of presence detect pins.

### Ordering Information

Type	Ordering Code	Package	Descriptions
HYM 72V1600GS-50		L-DIM-168-7	3.3V 50ns DRAM module
HYM 72V1600GS-60	Q67100-Q2079	L-DIM-168-7	3.3V 60ns DRAM module
HYM 72V1610GS-50		L-DIM-168-7	3.3V 50ns DRAM module
HYM 72V1610GS-60	Q67100-Q2080	L-DIM-168-7	3.3V 60ns DRAM module

### Pin Names

A0-A12,B0	Address Input
DQ0 - DQ71	Data Input/Output
RAS0, RAS2	Row Address Strobe
CAS0 , CAS2	Column Address Strobe
WE0, WE2	Read / Write Input
OE0, OE2	Output Enable
Vcc	Power (+3.3 Volt)
Vss	Ground
PD1 - PD8	Presence Detect Pins
PDE	Presence Detect Enable
ID0 , ID1	ID identification bit
N.C.	No Connection

### Presence-Detect and ID-pin Truth Table:

Module	ID0	ID1	PD1	PD2	PD3	PD4	PD5	PD6	PD7	PD8
HYM 72V1600GS-50	Vss	Vss	1	1	1	1	0	0	0	0
HYM 72V1600GS-60	Vss	Vss	1	1	1	1	0	1	1	0

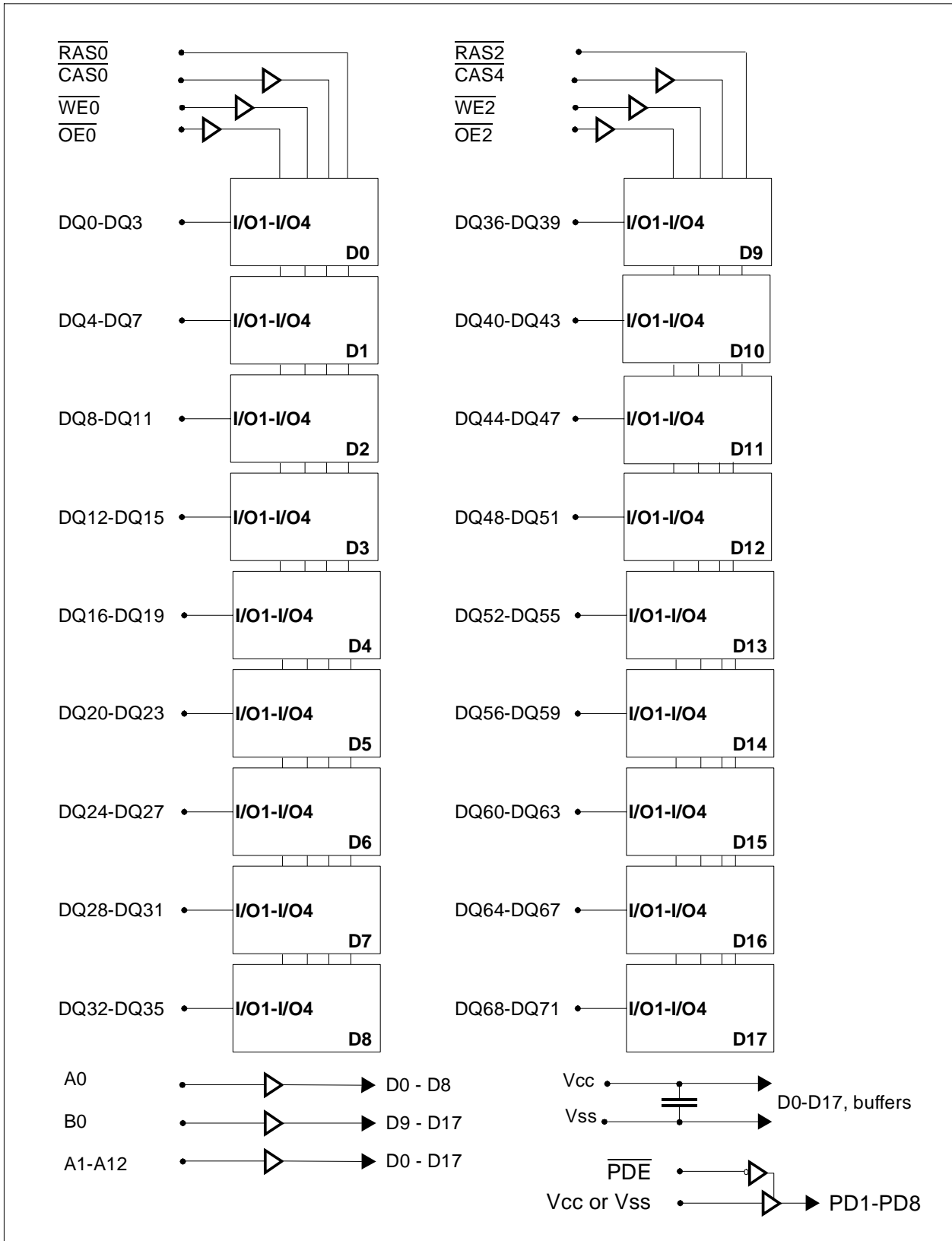
**Note:** 1 = High Level ( Driver Output) , 0 = Low Level (Driver Output) for  $\overline{PDE}$  active ( ground) . For  $\overline{PDE}$  at a high level all PD terminal are in tri-state.

### Pin Configuration

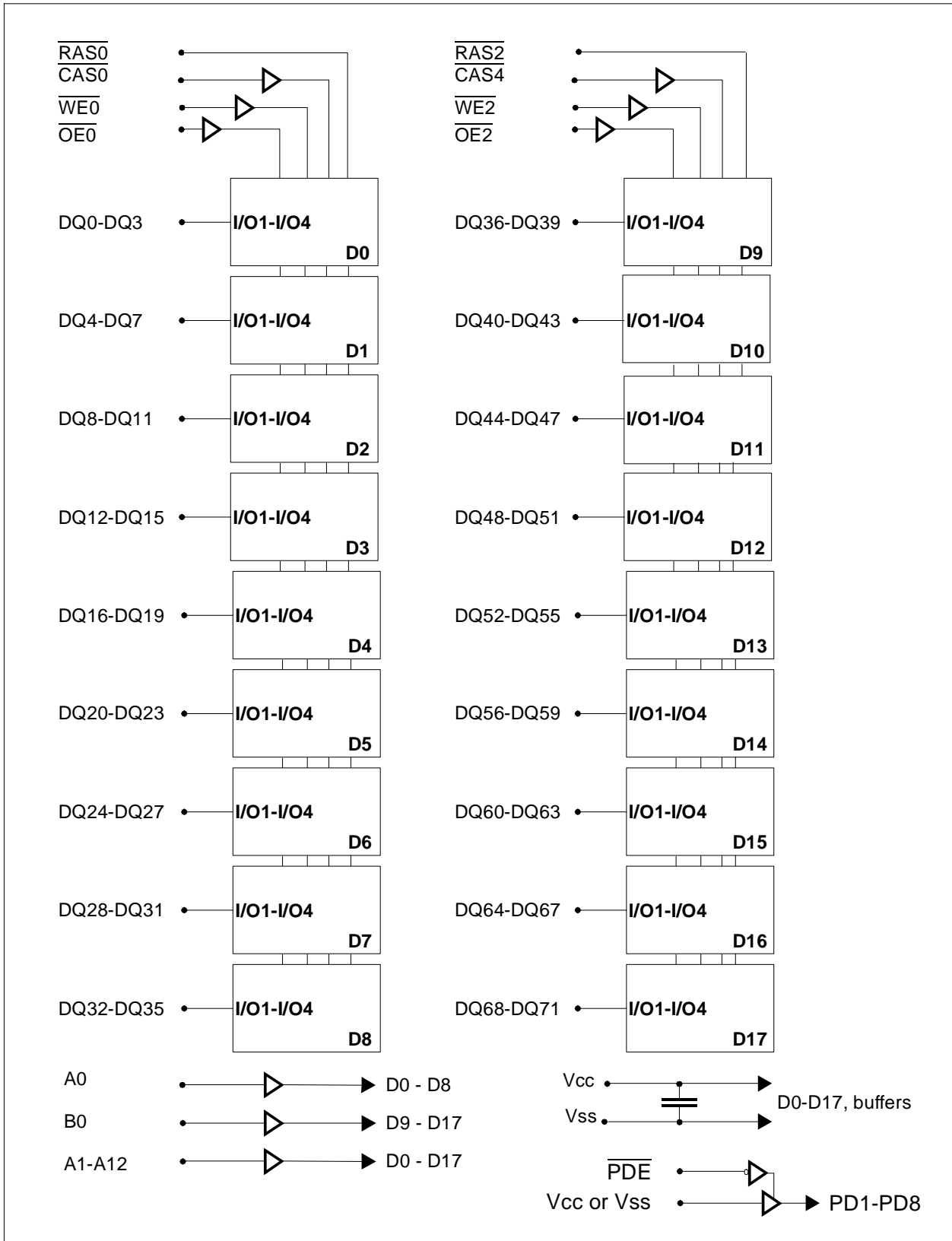
PIN #	Symbol	PIN #	Symbol	PIN #	Symbol	PIN #	Symbol
1	VSS	43	VSS	85	VSS	127	VSS
2	DQ0	44	OE2	86	DQ36	128	NC
3	DQ1	45	RAS2	87	DQ37	129	NC
4	DQ2	46	CAS4	88	DQ38	130	NC
5	DQ3	47	NC	89	DQ39	131	NC
6	VCC	48	WE2	90	VCC	132	PDE
7	DQ4	49	VCC	91	DQ40	133	VCC
8	DQ5	50	NC	92	DQ41	134	NC
9	DQ6	51	NC	93	DQ42	135	NC
10	DQ7	52	DQ18	94	DQ43	136	DQ54
11	DQ8	53	DQ19	95	DQ44	137	DQ55
12	VSS	54	VSS	96	VSS	138	VSS
13	DQ9	55	DQ20	97	DQ45	139	DQ56
14	DQ10	56	DQ21	98	DQ46	140	DQ57
15	DQ11	57	DQ22	99	DQ47	141	DQ58
16	DQ12	58	DQ23	100	DQ48	142	DQ59
17	DQ13	59	VCC	101	DQ49	143	VCC
18	VCC	60	DQ24	102	VCC	144	DQ60
19	DQ14	61	NC	103	DQ50	145	NC
20	DQ15	62	NC	104	DQ51	146	NC
21	DQ16	63	NC	105	DQ52	147	NC
22	DQ17	64	NC	106	DQ53	148	NC
23	VSS	65	DQ25	107	VSS	149	DQ61
24	NC	66	DQ26	108	NC	150	DQ62
25	NC	67	DQ27	109	NC	151	DQ63
26	VCC	68	VSS	110	VCC	152	VSS
27	WE0	69	DQ28	111	NC	153	DQ64
28	CAS0	70	DQ29	112	NC	154	DQ65
29	NC	71	DQ30	113	NC	155	DQ66
30	RAS0	72	DQ31	114	NC	156	DQ67
31	OE0	73	VCC	115	NC	157	VCC
32	VSS	74	DQ32	116	VSS	158	DQ68
33	A0	75	DQ33	117	A1	159	DQ69
34	A2	76	DQ34	118	A3	160	DQ70
35	A4	77	DQ35	119	A5	161	DQ71
36	A6	78	VSS	120	A7	162	VSS
37	A8	79	PD1	121	A9	163	PD2
38	A10	80	PD3	122	A11	164	PD4
39	A12	81	PD5	123	NC	165	PD6
40	VCC	82	PD7	124	VCC	166	PD8
41	NC	83	ID0 (VSS)	125	NC	167	ID1 (VSS)
42	NC	84	VCC	126	B0	168	VCC

### Pin Configuration

PIN #	Symbol	PIN #	Symbol	PIN #	Symbol	PIN #	Symbol
1	VSS	43	VSS	85	VSS	127	VSS
2	DQ0	44	OE2	86	DQ36	128	NC
3	DQ1	45	RAS2	87	DQ37	129	NC
4	DQ2	46	CAS4	88	DQ38	130	NC
5	DQ3	47	NC	89	DQ39	131	NC
6	VCC	48	WE2	90	VCC	132	PDE
7	DQ4	49	VCC	91	DQ40	133	VCC
8	DQ5	50	NC	92	DQ41	134	NC
9	DQ6	51	NC	93	DQ42	135	NC
10	DQ7	52	DQ18	94	DQ43	136	DQ54
11	DQ8	53	DQ19	95	DQ44	137	DQ55
12	VSS	54	VSS	96	VSS	138	VSS
13	DQ9	55	DQ20	97	DQ45	139	DQ56
14	DQ10	56	DQ21	98	DQ46	140	DQ57
15	DQ11	57	DQ22	99	DQ47	141	DQ58
16	DQ12	58	DQ23	100	DQ48	142	DQ59
17	DQ13	59	VCC	101	DQ49	143	VCC
18	VCC	60	DQ24	102	VCC	144	DQ60
19	DQ14	61	NC	103	DQ50	145	NC
20	DQ15	62	NC	104	DQ51	146	NC
21	DQ16	63	NC	105	DQ52	147	NC
22	DQ17	64	NC	106	DQ53	148	NC
23	VSS	65	DQ25	107	VSS	149	DQ61
24	NC	66	DQ26	108	NC	150	DQ62
25	NC	67	DQ27	109	NC	151	DQ63
26	VCC	68	VSS	110	VCC	152	VSS
27	WE0	69	DQ28	111	NC	153	DQ64
28	CAS0	70	DQ29	112	NC	154	DQ65
29	NC	71	DQ30	113	NC	155	DQ66
30	RAS0	72	DQ31	114	NC	156	DQ67
31	OE0	73	VCC	115	NC	157	VCC
32	VSS	74	DQ32	116	VSS	158	DQ68
33	A0	75	DQ33	117	A1	159	DQ69
34	A2	76	DQ34	118	A3	160	DQ70
35	A4	77	DQ35	119	A5	161	DQ71
36	A6	78	VSS	120	A7	162	VSS
37	A8	79	PD1	121	A9	163	PD2
38	A10	80	PD3	122	A11	164	PD4
39	A12	81	PD5	123	NC	165	PD6
40	VCC	82	PD7	124	VCC	166	PD8
41	NC	83	ID0 (VSS)	125	NC	167	ID1 (VSS)
42	NC	84	VCC	126	B0	168	VCC



Block Diagram



**Block Diagram**



### Absolute Maximum Ratings

Operating temperature range ..... 0 to + 70 °C  
 Storage temperature range..... – 55 to + 125 °C  
 Input/output voltage ..... -0.5 to min (V<sub>CC</sub>+0.5, 4.6) V  
 Power supply voltage..... – 1.0 V to + 4.6 V  
 Power dissipation..... 8.3 W  
 Data out current (short circuit) ..... 50 mA

**Note:** Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

### DC Characteristics

T<sub>A</sub> = 0 to 70 °C; V<sub>CC</sub> = 3.3 V ± 0.3 V

Parameter	Symbol	Limit Values		Unit	Test Condition
		min.	max.		
Input high voltage	V <sub>IH</sub>	2.0	V <sub>CC</sub> +0.5	V	1)
Input low voltage	V <sub>IL</sub>	– 1.0	0.8	V	1)
Output high voltage (LVTTTL) Output „H“ voltage level (I <sub>OUT</sub> = – 2 mA)	V <sub>OH</sub>	2.4	–	V	1)
Output low voltage (LVTTTL) Output „L“ voltage level (I <sub>OUT</sub> = 2 mA)	V <sub>OL</sub>	–	0.4	V	1)
Output high voltage (LVCMOS) Output „H“ voltage level (I <sub>OUT</sub> = – 100 μA)	V <sub>OH</sub>	V <sub>CC</sub> -0.2	–	V	1)
Output low voltage (LVCMOS) Output „L“ voltage level (I <sub>OUT</sub> = 100 μA)	V <sub>OL</sub>	–	0.2	V	1)
Input leakage current (0 V < V <sub>IN</sub> < V <sub>CC</sub> , all other pins = 0 V)	I <sub>I(L)</sub>	– 20	20	μA	1)
Output leakage current (DO is disabled, 0 V < V <sub>OUT</sub> < V <sub>CC</sub> )	I <sub>O(L)</sub>	– 20	20	μA	1)
Average V <sub>CC</sub> supply current: -50 version -60 version  ( $\overline{\text{RAS}}$ , $\overline{\text{CAS}}$ , address cycling, t <sub>RC</sub> = t <sub>RC</sub> min.)	I <sub>CC1</sub>	– –	2000 1800	mA mA	2) 3) 4)
Standby V <sub>CC</sub> supply current ( $\overline{\text{RAS}} = \overline{\text{CAS}} = V_{IH}$ , one address change)	I <sub>CC2</sub>	–	50	mA	–

### Absolute Maximum Ratings

Operating temperature range ..... 0 to + 70 °C  
 Storage temperature range..... – 55 to + 125 °C  
 Input/output voltage ..... -0.5 to min (V<sub>CC</sub>+0.5, 4.6) V  
 Power supply voltage..... – 1.0 V to + 4.6 V  
 Power dissipation..... 8.3 W  
 Data out current (short circuit) ..... 50 mA

**Note:** Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

### DC Characteristics

T<sub>A</sub> = 0 to 70 °C; V<sub>CC</sub> = 3.3 V ± 0.3 V

Parameter	Symbol	Limit Values		Unit	Test Condition
		min.	max.		
Input high voltage	V <sub>IH</sub>	2.0	V <sub>CC</sub> +0.5	V	1)
Input low voltage	V <sub>IL</sub>	– 1.0	0.8	V	1)
Output high voltage (LVTTTL) Output „H“ voltage level (I <sub>OUT</sub> = – 2 mA)	V <sub>OH</sub>	2.4	–	V	1)
Output low voltage (LVTTTL) Output „L“ voltage level (I <sub>OUT</sub> = 2 mA)	V <sub>OL</sub>	–	0.4	V	1)
Output high voltage (LVCMOS) Output „H“ voltage level (I <sub>OUT</sub> = – 100 μA)	V <sub>OH</sub>	V <sub>CC</sub> -0.2	–	V	1)
Output low voltage (LVCMOS) Output „L“ voltage level (I <sub>OUT</sub> = 100 μA)	V <sub>OL</sub>	–	0.2	V	1)
Input leakage current (0 V < V <sub>IN</sub> < V <sub>CC</sub> , all other pins = 0 V)	I <sub>I(L)</sub>	– 20	20	μA	1)
Output leakage current (DO is disabled, 0 V < V <sub>OUT</sub> < V <sub>CC</sub> )	I <sub>O(L)</sub>	– 20	20	μA	1)
Average V <sub>CC</sub> supply current: -50 version -60 version  ( $\overline{\text{RAS}}$ , $\overline{\text{CAS}}$ , address cycling, t <sub>RC</sub> = t <sub>RC</sub> min.)	I <sub>CC1</sub>	– –	2000 1800	mA mA	2) 3) 4)
Standby V <sub>CC</sub> supply current ( $\overline{\text{RAS}} = \overline{\text{CAS}} = V_{IH}$ , one address change)	I <sub>CC2</sub>	–	50	mA	–

Parameter	Symbol	Limit Values		Unit	Test Condition
		min.	max.		
Average $V_{CC}$ supply current during $\overline{RAS}$ only refresh cycles: -50 version -60 version  ( $\overline{RAS}$ cycling, $\overline{CAS} = V_{IH}$ , $t_{RC} = t_{RC \text{ min.}}$ )	$I_{CC3}$	–	2000 1800	mA mA	2) 4)
Average $V_{CC}$ supply current during fast page mode: -50 version -60 version  ( $\overline{RAS} = V_{IL}$ , $\overline{CAS}$ , address cycling $t_{PC} = t_{PC \text{ min.}}$ )	$I_{CC4}$	–	1550 1400	mA mA	2) 3) 4)
Standby $V_{CC}$ supply current ( $\overline{RAS} = \overline{CAS} = V_{CC} - 0.2 \text{ V}$ , V16one address change)	$I_{CC5}$	–	30	mA	–
Average $V_{CC}$ supply current during $\overline{CAS}$ -before- $\overline{RAS}$ refresh mode: -50 version -60 version  ( $\overline{RAS}$ , $\overline{CAS}$ cycling, $t_{RC} = t_{RC \text{ min.}}$ )	$I_{CC6}$	–	2000 1800	mA mA	2) 4)

Parameter	Symbol	Limit Values		Unit	Test Condition
		min.	max.		
Average $V_{CC}$ supply current during $\overline{RAS}$ only refresh cycles: -50 version -60 version  ( $\overline{RAS}$ cycling, $\overline{CAS} = V_{IH}$ , $t_{RC} = t_{RC \text{ min.}}$ )	$I_{CC3}$	–	2000 1800	mA mA	2) 4)
Average $V_{CC}$ supply current during fast page mode: -50 version -60 version  ( $\overline{RAS} = V_{IL}$ , $\overline{CAS}$ , address cycling $t_{PC} = t_{PC \text{ min.}}$ )	$I_{CC4}$	–	1550 1400	mA mA	2) 3) 4)
Standby $V_{CC}$ supply current ( $\overline{RAS} = \overline{CAS} = V_{CC} - 0.2 \text{ V}$ , V16one address change)	$I_{CC5}$	–	30	mA	–
Average $V_{CC}$ supply current during $\overline{CAS}$ -before- $\overline{RAS}$ refresh mode: -50 version -60 version  ( $\overline{RAS}$ , $\overline{CAS}$ cycling, $t_{RC} = t_{RC \text{ min.}}$ )	$I_{CC6}$	–	2000 1800	mA mA	2) 4)

### AC Characteristics (note: 5,6,7,8)

$T_A = 0$  to  $70$  °C,  $V_{CC} = 3.3 \pm 0.3$  V

Parameter	Symbol	-50		-60		Unit	Note
		min.	max.	min.	max.		

#### *common parameters*

Random read or write cycle time	$t_{RC}$	90	–	110	–	ns	
RAS precharge time	$t_{RP}$	30	–	40	–	ns	
RAS pulse width	$t_{RAS}$	50	100k	60	100k	ns	
$\overline{CAS}$ pulse width	$t_{CAS}$	13	100k	15	100k	ns	
Row address setup time	$t_{ASR}$	5	–	5	–	ns	9
Row address hold time	$t_{RAH}$	8	–	8	–	ns	10
Column address setup time	$t_{ASC}$	2	–	2	–	ns	11
Column address hold time	$t_{CAH}$	15	–	15	–	ns	9
RAS to $\overline{CAS}$ delay time	$t_{RCD}$	16	32	18	40		12
RAS to column address delay time	$t_{RAD}$	11	20	13	25	ns	12
RAS hold time	$t_{RSH}$	18	–	20	–	ns	9
$\overline{CAS}$ hold time	$t_{CSH}$	48	–	58	–	ns	10
$\overline{CAS}$ to RAS precharge time	$t_{CRP}$	10	–	10	–	ns	9
Transition time (rise and fall)	$t_T$	3	30	3	30	ns	7
Refresh period	$t_{REF}$	–	128	–	128	ms	

#### *Read Cycle*

Access time from $\overline{RAS}$	$t_{RAC}$	–	50	–	60	ns	13,14
Access time from $\overline{CAS}$	$t_{CAC}$	–	18	–	20	ns	9,13,14
Access time from column address	$t_{AA}$	–	30	–	35	ns	9,13, 15
$\overline{OE}$ access time	$t_{OEA}$	–	18	–	20	ns	9,13
Column address to $\overline{RAS}$ lead time	$t_{RAL}$	30	–	35	–	ns	9
Read command setup time	$t_{RCS}$	2	–	2	–	ns	11
Read command hold time	$t_{RCH}$	2	–	2	–	ns	11,16
Read command hold time referenced to $\overline{RAS}$	$t_{RRH}$	0	–	0	–	ns	16
$\overline{CAS}$ to output in low-Z	$t_{CLZ}$	2	–	2	–	ns	11,13
Output buffer turn-off delay	$t_{OFF}$	–	18	–	20	ns	9,17

### AC Characteristics (note: 5,6,7,8)

$T_A = 0$  to  $70$  °C,  $V_{CC} = 3.3 \pm 0.3$  V

Parameter	Symbol	-50		-60		Unit	Note
		min.	max.	min.	max.		

#### *common parameters*

Random read or write cycle time	$t_{RC}$	90	–	110	–	ns	
RAS precharge time	$t_{RP}$	30	–	40	–	ns	
RAS pulse width	$t_{RAS}$	50	100k	60	100k	ns	
$\overline{CAS}$ pulse width	$t_{CAS}$	13	100k	15	100k	ns	
Row address setup time	$t_{ASR}$	5	–	5	–	ns	9
Row address hold time	$t_{RAH}$	8	–	8	–	ns	10
Column address setup time	$t_{ASC}$	2	–	2	–	ns	11
Column address hold time	$t_{CAH}$	15	–	15	–	ns	9
RAS to $\overline{CAS}$ delay time	$t_{RCD}$	16	32	18	40		12
RAS to column address delay time	$t_{RAD}$	11	20	13	25	ns	12
RAS hold time	$t_{RSH}$	18	–	20	–	ns	9
$\overline{CAS}$ hold time	$t_{CSH}$	48	–	58	–	ns	10
$\overline{CAS}$ to RAS precharge time	$t_{CRP}$	10	–	10	–	ns	9
Transition time (rise and fall)	$t_T$	3	30	3	30	ns	7
Refresh period	$t_{REF}$	–	128	–	128	ms	

#### *Read Cycle*

Access time from $\overline{RAS}$	$t_{RAC}$	–	50	–	60	ns	13,14
Access time from $\overline{CAS}$	$t_{CAC}$	–	18	–	20	ns	9,13,14
Access time from column address	$t_{AA}$	–	30	–	35	ns	9,13, 15
$\overline{OE}$ access time	$t_{OEA}$	–	18	–	20	ns	9,13
Column address to $\overline{RAS}$ lead time	$t_{RAL}$	30	–	35	–	ns	9
Read command setup time	$t_{RCS}$	2	–	2	–	ns	11
Read command hold time	$t_{RCH}$	2	–	2	–	ns	11,16
Read command hold time referenced to $\overline{RAS}$	$t_{RRH}$	0	–	0	–	ns	16
$\overline{CAS}$ to output in low-Z	$t_{CLZ}$	2	–	2	–	ns	11,13
Output buffer turn-off delay	$t_{OFF}$	–	18	–	20	ns	9,17

**AC Characteristics** (cont'd)(note: 5,6,7,8)

$T_A = 0$  to  $70$  °C,  $V_{CC} = 3.3 \pm 0.3$  V

Parameter	Symbol	-50		-60		Unit	Note
		min.	max.	min.	max.		
Output buffer turn-off delay from $\overline{OE}$	$t_{OEZ}$	–	18	–	20	ns	9,17
$\overline{CAS}$ delay time from Din	$t_{DZC}$	0	–	0	–	ns	18
Data to $\overline{OE}$ low delay	$t_{DZO}$	0	–	0	–	ns	18
$\overline{CAS}$ high to data delay	$t_{CDD}$	18	–	20	–	ns	9,19
$\overline{OE}$ high to data delay	$t_{ODD}$	18	–	20	–	ns	9,19

**Write Cycle**

Write command hold time	$t_{WCH}$	13	–	15	–	ns	9
Write command pulse width	$t_{WP}$	8	–	10	–	ns	
Write command setup time	$t_{WCS}$	2	–	2	–	ns	11,20
Write command to $\overline{RAS}$ lead time	$t_{RWL}$	18	–	20	–	ns	9
Write command to $\overline{CAS}$ lead time	$t_{CWL}$	13	–	15	–	ns	
Data setup time	$t_{DS}$	-2	–	-2	–	ns	10,21
Data hold time	$t_{DH}$	15	–	15	–	ns	9,21

**Read-Modify-Write Cycle**

Read-write cycle time	$t_{RWC}$	131	–	155	–	ns	9
$\overline{RAS}$ to $\overline{WE}$ delay time	$t_{RWD}$	70	–	82	–	ns	11,21
$\overline{CAS}$ to $\overline{WE}$ delay time	$t_{CWD}$	33	–	37	–	ns	11,21
Column address to $\overline{WE}$ delay time	$t_{AWD}$	45	–	52	–	ns	11,21
$\overline{OE}$ command hold time	$t_{OEH}$	11	–	13	–	ns	10

**Fast Page Mode Cycle**

Fast page mode cycle time	$t_{PC}$	35	–	40	–	ns	
$\overline{CAS}$ precharge time	$t_{CP}$	10	–	10	–	ns	
Access time from $\overline{CAS}$ precharge	$t_{CPA}$	–	35	–	40	ns	9,13
$\overline{RAS}$ pulse width	$t_{RAS}$	50	200k	60	200k	ns	
$\overline{CAS}$ precharge to $\overline{RAS}$ Delay	$t_{RHCP}$	35	–	40	–	ns	9

### AC Characteristics (cont'd)(note: 5,6,7,8)

$T_A = 0$  to  $70$  °C,  $V_{CC} = 3.3 \pm 0.3$  V

Parameter	Symbol	-50		-60		Unit	Note
		min.	max.	min.	max.		
Output buffer turn-off delay from $\overline{OE}$	$t_{OEZ}$	–	18	–	20	ns	9,17
$\overline{CAS}$ delay time from Din	$t_{DZC}$	0	–	0	–	ns	18
Data to $\overline{OE}$ low delay	$t_{DZO}$	0	–	0	–	ns	18
$\overline{CAS}$ high to data delay	$t_{CDD}$	18	–	20	–	ns	9,19
$\overline{OE}$ high to data delay	$t_{ODD}$	18	–	20	–	ns	9,19

### Write Cycle

Write command hold time	$t_{WCH}$	13	–	15	–	ns	9
Write command pulse width	$t_{WP}$	8	–	10	–	ns	
Write command setup time	$t_{WCS}$	2	–	2	–	ns	11,20
Write command to $\overline{RAS}$ lead time	$t_{RWL}$	18	–	20	–	ns	9
Write command to $\overline{CAS}$ lead time	$t_{CWL}$	13	–	15	–	ns	
Data setup time	$t_{DS}$	-2	–	-2	–	ns	10,21
Data hold time	$t_{DH}$	15	–	15	–	ns	9,21

### Read-Modify-Write Cycle

Read-write cycle time	$t_{RWC}$	131	–	155	–	ns	9
$\overline{RAS}$ to $\overline{WE}$ delay time	$t_{RWD}$	70	–	82	–	ns	11,21
$\overline{CAS}$ to $\overline{WE}$ delay time	$t_{CWD}$	33	–	37	–	ns	11,21
Column address to $\overline{WE}$ delay time	$t_{AWD}$	45	–	52	–	ns	11,21
$\overline{OE}$ command hold time	$t_{OEH}$	11	–	13	–	ns	10

### Fast Page Mode Cycle

Fast page mode cycle time	$t_{PC}$	35	–	40	–	ns	
$\overline{CAS}$ precharge time	$t_{CP}$	10	–	10	–	ns	
Access time from $\overline{CAS}$ precharge	$t_{CPA}$	–	35	–	40	ns	9,13
$\overline{RAS}$ pulse width	$t_{RAS}$	50	200k	60	200k	ns	
$\overline{CAS}$ precharge to $\overline{RAS}$ Delay	$t_{RHCP}$	35	–	40	–	ns	9



### AC Characteristics (cont'd)(note: 5,6,7,8)

$T_A = 0$  to  $70$  °C,  $V_{CC} = 3.3 \pm 0.3$  V

Parameter	Symbol	-50		-60		Unit	Note
		min.	max.	min.	max.		

### ***Fast Page Mode Read-Modify-Write Cycle***

Fast page mode read-write cycle time	$t_{PRWC}$	73	–	82	–	ns	11
$\overline{CAS}$ precharge to $\overline{WE}$	$t_{CPWD}$	50	–	57	–	ns	11,21

### ***$\overline{CAS}$ -before- $\overline{RAS}$ Refresh Cycle***

$\overline{CAS}$ setup time	$t_{CSR}$	7	–	7	–	ns	11
$\overline{CAS}$ hold time	$t_{CHR}$	8	–	8	–	ns	10
$\overline{RAS}$ to $\overline{CAS}$ precharge time	$t_{RPC}$	5	–	5	–	ns	
Write to $\overline{RAS}$ precharge time	$t_{WRP}$	12	–	12	–	ns	11
Write hold time referenced to $\overline{RAS}$	$t_{WRH}$	8	–	8	–	ns	10

### ***Presence Detect Read Cycle***

$\overline{PDE}$ to valid presence detect data	$t_{PD}$	–	10	–	10	ns	
$\overline{PDE}$ inactive to presence detects inactive	$t_{PDOFF}$	0	10	0	10	ns	

### AC Characteristics (cont'd)(note: 5,6,7,8)

$T_A = 0 \text{ to } 70 \text{ }^\circ\text{C}$ ,  $V_{CC} = 3.3 \pm 0.3 \text{ V}$

Parameter	Symbol	-50		-60		Unit	Note
		min.	max.	min.	max.		

### ***Fast Page Mode Read-Modify-Write Cycle***

Fast page mode read-write cycle time	$t_{PRWC}$	73	–	82	–	ns	11
$\overline{\text{CAS}}$ precharge to $\overline{\text{WE}}$	$t_{CPWD}$	50	–	57	–	ns	11,21

### ***$\overline{\text{CAS}}$ -before- $\overline{\text{RAS}}$ Refresh Cycle***

$\overline{\text{CAS}}$ setup time	$t_{CSR}$	7	–	7	–	ns	11
$\overline{\text{CAS}}$ hold time	$t_{CHR}$	8	–	8	–	ns	10
$\overline{\text{RAS}}$ to $\overline{\text{CAS}}$ precharge time	$t_{RPC}$	5	–	5	–	ns	
Write to $\overline{\text{RAS}}$ precharge time	$t_{WRP}$	12	–	12	–	ns	11
Write hold time referenced to $\overline{\text{RAS}}$	$t_{WRH}$	8	–	8	–	ns	10

### ***Presence Detect Read Cycle***

$\overline{\text{PDE}}$ to valid presence detect data	$t_{PD}$	–	10	–	10	ns	
$\overline{\text{PDE}}$ inactive to presence detects inactive	$t_{PDOFF}$	0	10	0	10	ns	

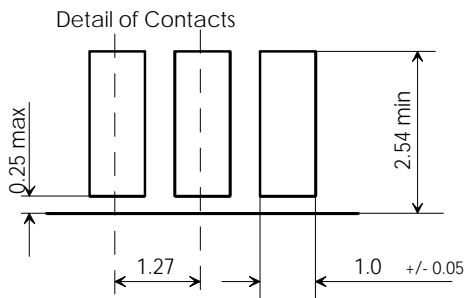
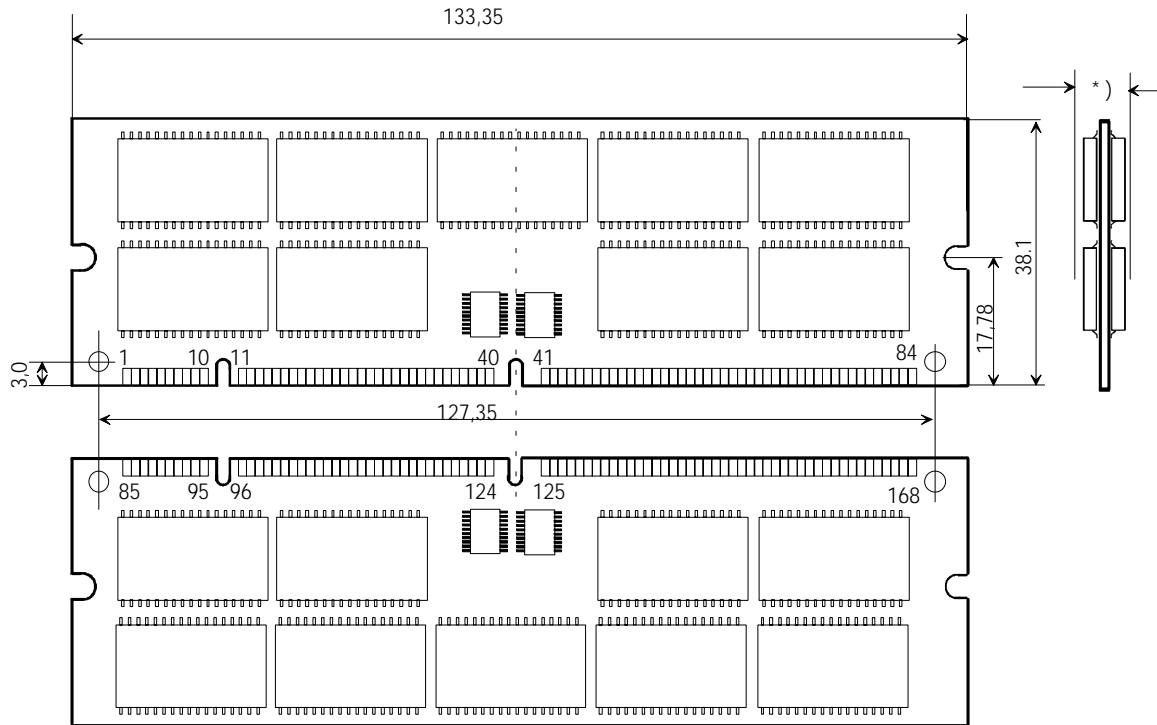
**Notes:**

- 1) All voltages are referenced to VSS.
- 2) ICC1, ICC3, ICC4 and ICC6 and ICC7 depend on cycle rate.
- 3) ICC1 and ICC4 depend on output loading. Specified values are measured with the output open.
- 4) Address can be changed once or less while  $\overline{\text{RAS}} = \text{Vil}$ . In the case of ICC4 it can be changed once or less during a fast page mode cycle ( tpc).
- 5) An initial pause of 100  $\mu\text{s}$  is required after power-up followed by 8 RAS-only-refresh cycles, before proper device operation is achieved. In case of using internal refresh counter, a minimum of 8  $\overline{\text{CAS}}$ -before-RAS initialization cycles instead of 8  $\overline{\text{RAS}}$  cycles are required.
- 6) AC measurements assume  $t_T = 5 \text{ ns}$ .
- 7)  $\text{VIH}$  (min.) and  $\text{VIL}$  (max.) are reference levels for measuring timing of input signals. Also, transition times are measured between  $\text{VIH}$  and  $\text{VIL}$ .
- 8) The specified timings include buffer, loading and skew delay adders: 2ns minimum, 5ns ( $\overline{\text{CAS}}$ ,  $\overline{\text{WE}}$ ,  $\overline{\text{OE}}$ , addresses) maximum delay, no pulse shrinkage to the DRAM device timings. The data and RAS signals are not buffered, which preserves the DRAMs access specification of 50ns and 60ns.
- 9) A +5ns timing skew from the DRAM to the module resulted from the addition of line drivers.
- 10) A -2ns timing skew from the DRAM to the module resulted from the addition of line drivers.
- 11) A +2ns timing skew from the DRAM to the module resulted from the addition of line drivers.
- 12) A -2ns (min.) and a -5ns (max.) timing skew from the DRAM to the module resulted from the addition of line drivers.
- 13) Measured with the specified current load and 100 pF at  $\text{Voh} = 2.0 \text{ V}$  and  $\text{Vol} = 0.8 \text{ V}$ .
- 14) Operation within the  $t_{\text{RCD}}$  (max.) limit ensures that  $t_{\text{RAC}}$  (max.) can be met.  $t_{\text{RCD}}$  (max.) is specified as a reference point only: If  $t_{\text{RCD}}$  is greater than the specified  $t_{\text{RCD}}$  (max.) limit, then access time is controlled by  $t_{\text{CAC}}$ .
- 15) Operation within the  $t_{\text{RAD}}$  (max.) limit ensures that  $t_{\text{RAC}}$  (max.) can be met.  $t_{\text{RAD}}$  (max.) is specified as a reference point only: If  $t_{\text{RAD}}$  is greater than the specified  $t_{\text{RAD}}$  (max.) limit, then access time is controlled by  $t_{\text{AA}}$ .
- 16) Either  $t_{\text{RCH}}$  or  $t_{\text{RRH}}$  must be satisfied for a read cycle.
- 17)  $t_{\text{OFF}}$  (max.) and  $t_{\text{OEZ}}$  (max.) define the time at which the outputs achieve the open-circuit condition and are not referenced to output voltage levels.
- 18) Either  $t_{\text{DZC}}$  or  $t_{\text{DZO}}$  must be satisfied.
- 19) Either  $t_{\text{CDD}}$  or  $t_{\text{ODD}}$  must be satisfied.
- 20)  $t_{\text{WCS}}$ ,  $t_{\text{RWD}}$ ,  $t_{\text{CWD}}$ ,  $t_{\text{AWD}}$  and  $t_{\text{CPWD}}$  are not restrictive operating parameters. They are included in the data sheet as electrical characteristics only. If  $t_{\text{WCS}} > t_{\text{WCS}} (\text{min.})$ , the cycle is an early write cycle and the I/O pin will remain open-circuit (high impedance) through the entire cycle; if  $t_{\text{RWD}} > t_{\text{RWD}} (\text{min.})$ ,  $t_{\text{CWD}} > t_{\text{CWD}} (\text{min.})$ ,  $t_{\text{AWD}} > t_{\text{AWD}} (\text{min.})$  and  $t_{\text{CPWD}} > t_{\text{CPWD}} (\text{min.})$ , the cycle is a read-write cycle and I/O pins will contain data read from the selected cells. If neither of the above sets of conditions is satisfied, the condition of the I/O pins (at access time) is indeterminate.
- 21) These parameters are referenced to  $\overline{\text{CAS}}$  leading edge in early write cycles and to  $\overline{\text{WE}}$  leading edge in Read-Modify-Write cycles.

**Notes:**

- 1) All voltages are referenced to VSS.
- 2) ICC1, ICC3, ICC4 and ICC6 and ICC7 depend on cycle rate.
- 3) ICC1 and ICC4 depend on output loading. Specified values are measured with the output open.
- 4) Address can be changed once or less while  $\overline{\text{RAS}} = \text{Vil}$ . In the case of ICC4 it can be changed once or less during a fast page mode cycle ( tpc).
- 5) An initial pause of 100  $\mu\text{s}$  is required after power-up followed by 8 RAS-only-refresh cycles, before proper device operation is achieved. In case of using internal refresh counter, a minimum of 8  $\overline{\text{CAS}}$ -before-RAS initialization cycles instead of 8  $\overline{\text{RAS}}$  cycles are required.
- 6) AC measurements assume  $t_T = 5 \text{ ns}$ .
- 7) VIH (min.) and VIL (max.) are reference levels for measuring timing of input signals. Also, transition times are measured between VIH and VIL.
- 8) The specified timings include buffer, loading and skew delay adders: 2ns minimum, 5ns ( $\overline{\text{CAS}}$ ,  $\overline{\text{WE}}$ ,  $\overline{\text{OE}}$ , addresses) maximum delay, no pulse shrinkage to the DRAM device timings. The data and RAS signals are not buffered, which preserves the DRAMs access specification of 50ns and 60ns.
- 9) A +5ns timing skew from the DRAM to the module resulted from the addition of line drivers.
- 10) A -2ns timing skew from the DRAM to the module resulted from the addition of line drivers.
- 11) A +2ns timing skew from the DRAM to the module resulted from the addition of line drivers.
- 12) A -2ns (min.) and a -5ns (max.) timing skew from the DRAM to the module resulted from the addition of line drivers.
- 13) Measured with the specified current load and 100 pF at  $V_{oh} = 2.0 \text{ V}$  and  $V_{ol} = 0.8 \text{ V}$ .
- 14) Operation within the tRCD (max.) limit ensures that tRAC (max.) can be met. tRCD (max.) is specified as a reference point only: If tRCD is greater than the specified tRCD (max.) limit, then access time is controlled by tCAC.
- 15) Operation within the tRAD (max.) limit ensures that tRAC (max.) can be met. tRAD (max.) is specified as a reference point only: If tRAD is greater than the specified tRAD (max.) limit, then access time is controlled by tAA.
- 16) Either tRCH or tRRH must be satisfied for a read cycle.
- 17) tOFF (max.) and tOEZ (max.) define the time at which the outputs achieve the open-circuit condition and are not referenced to output voltage levels.
- 18) Either tDZC or tDZO must be satisfied.
- 19) Either tCDD or tODD must be satisfied.
- 20) tWCS, tRWD, tCWD, tAWD and tCPWD are not restrictive operating parameters. They are included in the data sheet as electrical characteristics only. If  $tWCS > tWCS (\text{min.})$ , the cycle is an early write cycle and the I/O pin will remain open-circuit (high impedance) through the entire cycle; if  $tRWD > tRWD (\text{min.})$ ,  $tCWD > tCWD (\text{min.})$ ,  $tAWD > tAWD (\text{min.})$  and  $tCPWD > tCPWD (\text{min.})$ , the cycle is a read-write cycle and I/O pins will contain data read from the selected cells. If neither of the above sets of conditions is satisfied, the condition of the I/O pins (at access time) is indeterminate.
- 21) These parameters are referenced to  $\overline{\text{CAS}}$  leading edge in early write cycles and to  $\overline{\text{WE}}$  leading edge in Read-Modify-Write cycles.

**L-DIM-168-7  
Module package  
(dual read-out, single in-line memory module)**

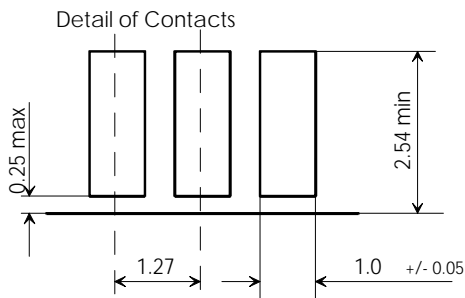
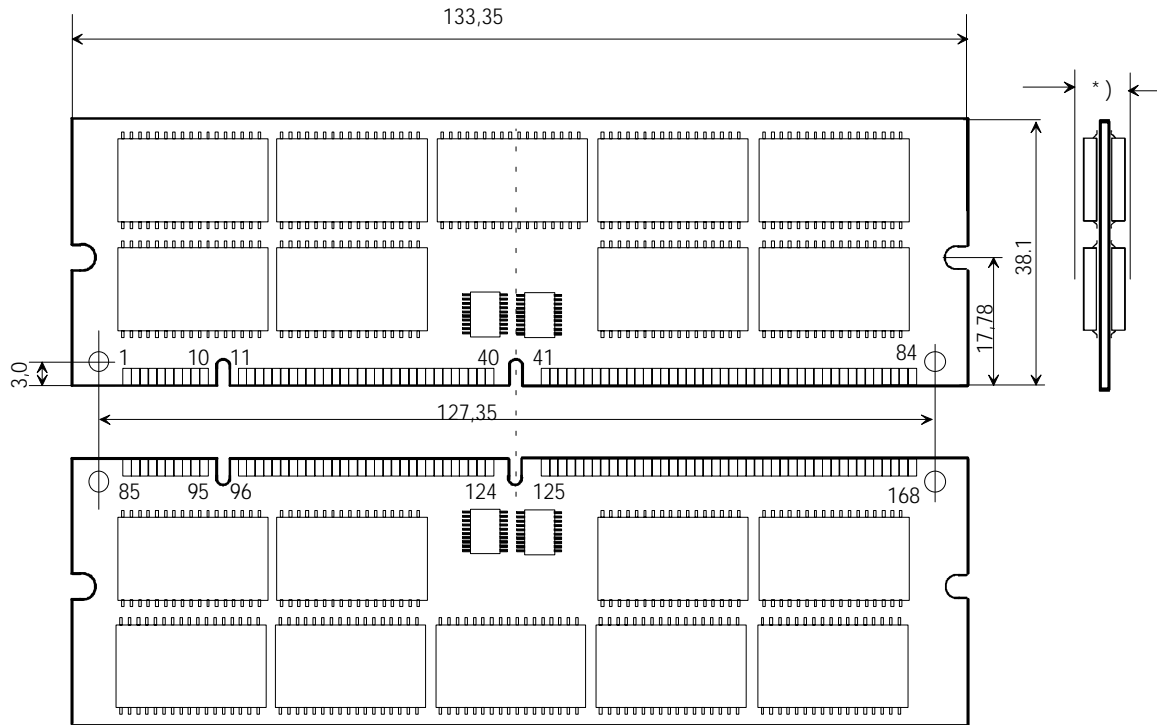


16Mx72 3.3V  
DM168-7.WMF

preliminary drawing

\*) 9 mm max for modules assembled with SOJ-devices  
4 mm max. for modules assembled with TSOPII-devices

**L-DIM-168-7  
Module package  
(dual read-out, single in-line memory module)**



16Mx72 3.3V  
DM168-7.WMF

preliminary drawing

\*) 9 mm max for modules assembled with SOJ-devices  
4 mm max. for modules assembled with TSOPII-devices