

DDR2 SDRAM SODIMM

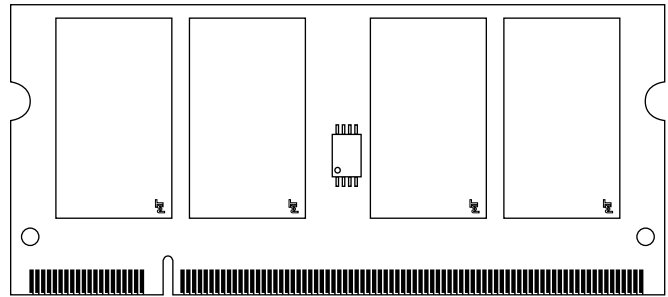
MT4HTF6464HZ – 512MB

Features

- 200-pin, small-outline dual in-line memory module (SODIMM)
- Fast data transfer rates: PC2-3200, PC2-4200, PC2-5300, or PC2-6400
- 512MB (64 Meg x 64)
- $V_{DD} = V_{DDQ} 1.8V$
- $V_{DDSPD} = 1.7-3.6V$
- JEDEC-standard 1.8V I/O (SSTL_18-compatible)
- Differential data strobe (DQS, DQS#) option
- 4n-bit prefetch architecture
- Multiple internal device banks for concurrent operation
- Programmable CAS latency (CL)
- Posted CAS additive latency (AL)
- WRITE latency = READ latency - 1 tCK
- Programmable burst lengths (BL): 4 or 8
- Adjustable data-output drive strength
- 64ms, 8192-cycle refresh
- On-die termination (ODT)
- Halogen-free
- Serial presence detect (SPD) with EEPROM
- Gold edge contacts
- Single rank

Figure 1: 200-Pin SODIMM (MO-224 R/C C)

Module height: 30mm (1.18in)



Options

- Operating temperature
 - Commercial ($0^{\circ}C \leq T_A \leq +70^{\circ}C$)
 - Industrial ($-40^{\circ}C \leq T_A \leq +85^{\circ}C$)¹
- Package
 - 200-pin DIMM (halogen-free)
- Frequency/CL²
 - 1.875ns @ CL = 7 (DDR2-1066)³
 - 2.5ns @ CL = 5 (DDR2-800)
 - 2.5ns @ CL = 6 (DDR2-800)
 - 3.0ns @ CL = 5 (DDR2-667)

Marking

None
I
Z
-1GA
-80E
-800
-667

- Notes:
1. Contact Micron for industrial temperature module offerings.
 2. CL = CAS (READ) latency.
 3. Not recommended for new designs.

Table 1: Key Timing Parameters

Speed Grade	Industry Nomenclature	Data Rate (MT/s)				t _{RCD} (ns)	t _{RP} (ns)	t _{RC} (ns)
		CL = 6	CL = 5	CL = 4	CL = 3			
-80E	PC2-6400	800	800	533	400	12.5	12.5	55
-800	PC2-6400	800	667	533	400	15	15	55
-667	PC2-5300	–	667	553	400	15	15	55
-53E	PC2-4200	–	–	553	400	15	15	55
-40E	PC2-3200	–	–	400	400	15	15	55

Table 2: Addressing

Parameter	512MB
Refresh count	8K
Row address	8K A[12:0]
Device bank address	8 BA[2:0]
Device configuration	1Gb (64 Meg x 16)
Column address	1K A[9:0]
Module rank address	1 S0#

Table 3: Part Numbers and Timing Parameters – 512MB Modules

 Base device: MT47H64M16,¹ 1Gb DDR2 SDRAM

Part Number ²	Module Density	Configuration	Module Bandwidth	Memory Clock/ Data Rate	Clock Cycles (CL- ^t RCD- ^t RP)
MT4HTF6464H(I)Z-1GA__	512MB	64 Meg x 64	8.5 GB/s	1.875ns/1066 MT/s	7-7-7
MT4HTF6464H(I)Z-80E__	512MB	64 Meg x 64	6.4 GB/s	2.5ns/800 MT/s	5-5-5
MT4HTF6464H(I)Z-800__	512MB	64 Meg x 64	6.4 GB/s	2.5ns/800 MT/s	6-6-6
MT4HTF6464H(I)Z-667__	512MB	64 Meg x 64	5.3 GB/s	3.0ns/667 MT/s	5-5-5

- Notes:
1. The data sheet for the base device can be found on Micron's Web site.
 2. All part numbers end with a two-place code (not shown) that designates component and PCB revisions. Consult factory for current revision codes. Example: MT4HTF6464HY-1GAH1.

Pin Assignments

Table 4: Pin Assignments

200-Pin DDR2 SODIMM Front								200-Pin DDR2 SODIMM Back							
Pin	Symbol	Pin	Symbol	Pin	Symbol	Pin	Symbol	Pin	Symbol	Pin	Symbol	Pin	Symbol	Pin	Symbol
1	V _{REF}	51	DQS2	101	A1	151	DQ42	2	V _{SS}	52	DM2	102	A0	152	DQ46
3	V _{SS}	53	V _{SS}	103	V _{DD}	153	DQ43	4	DQ4	54	V _{SS}	104	V _{DD}	154	DQ47
5	DQ0	55	DQ18	105	A10	155	V _{SS}	6	DQ5	56	DQ22	106	BA1	156	V _{SS}
7	DQ1	57	DQ19	107	BA0	157	DQ48	8	V _{SS}	58	DQ23	108	RAS#	158	DQ52
9	V _{SS}	59	V _{SS}	109	WE#	159	DQ49	10	DM0	60	V _{SS}	110	S0#	160	DQ53
11	DQS0#	61	DQ24	111	V _{DD}	161	V _{SS}	12	V _{SS}	62	DQ28	112	V _{DD}	162	V _{SS}
13	DQS0	63	DQ25	113	CAS#	163	NC	14	DQ6	64	DQ29	114	ODT0	164	CK1
15	V _{SS}	65	V _{SS}	115	NC	165	V _{SS}	16	DQ7	66	V _{SS}	116	NC	166	CK1#
17	DQ2	67	DM3	117	V _{DD}	167	DQS6#	18	V _{SS}	68	DQS3#	118	V _{DD}	168	V _{SS}
19	DQ3	69	NC	119	NC	169	DQS6	20	DQ12	70	DQS3	120	NC	170	DM6
21	V _{SS}	71	V _{SS}	121	V _{SS}	171	V _{SS}	22	DQ13	72	V _{SS}	122	V _{SS}	172	V _{SS}
23	DQ8	73	DQ26	123	DQ32	173	DQ50	24	V _{SS}	74	DQ30	124	DQ36	174	DQ54
25	DQ9	75	DQ27	125	DQ33	175	DQ51	26	DM1	76	DQ31	126	DQ37	176	DQ55
27	V _{SS}	77	V _{SS}	127	V _{SS}	177	V _{SS}	28	V _{SS}	78	V _{SS}	128	V _{SS}	178	V _{SS}
29	DQS1#	79	CKE0	129	DQS4#	179	DQ56	30	CK0	80	NC	130	DM4	180	DQ60
31	DQS1	81	V _{DD}	131	DQS4	181	DQ57	32	CK0#	82	V _{DD}	132	V _{SS}	182	DQ61
33	V _{SS}	83	NC	133	V _{SS}	183	V _{SS}	34	V _{SS}	84	NC	134	DQ38	184	V _{SS}
35	DQ10	85	BA2	135	DQ34	185	DM7	36	DQ14	86	NC	136	DQ39	186	DQS7#
37	DQ11	87	V _{DD}	137	DQ35	187	V _{SS}	38	DQ15	88	V _{DD}	138	V _{SS}	188	DQS7
39	V _{SS}	89	A12	139	V _{SS}	189	DQ58	40	V _{SS}	90	A11	140	DQ44	190	V _{SS}
41	V _{SS}	91	A9	141	DQ40	191	DQ59	42	V _{SS}	92	A7	142	DQ45	192	DQ62
43	DQ16	93	A8	143	DQ41	193	V _{SS}	44	DQ20	94	A6	144	V _{SS}	194	DQ63
45	DQ17	95	V _{DD}	145	V _{SS}	195	SDA	46	DQ21	96	V _{DD}	146	DQS5#	196	V _{SS}
47	V _{SS}	97	A5	147	DM5	197	SCL	48	V _{SS}	98	A4	148	DQS5	198	SA0
49	DQS2#	99	A3	149	V _{SS}	199	V _{DDSPD}	50	NC	100	A2	150	V _{SS}	200	SA1

Pin Descriptions

The pin description table below is a comprehensive list of all possible pins for all DDR2 modules. All pins listed may not be supported on this module. See Pin Assignments for information specific to this module.

Table 5: Pin Descriptions

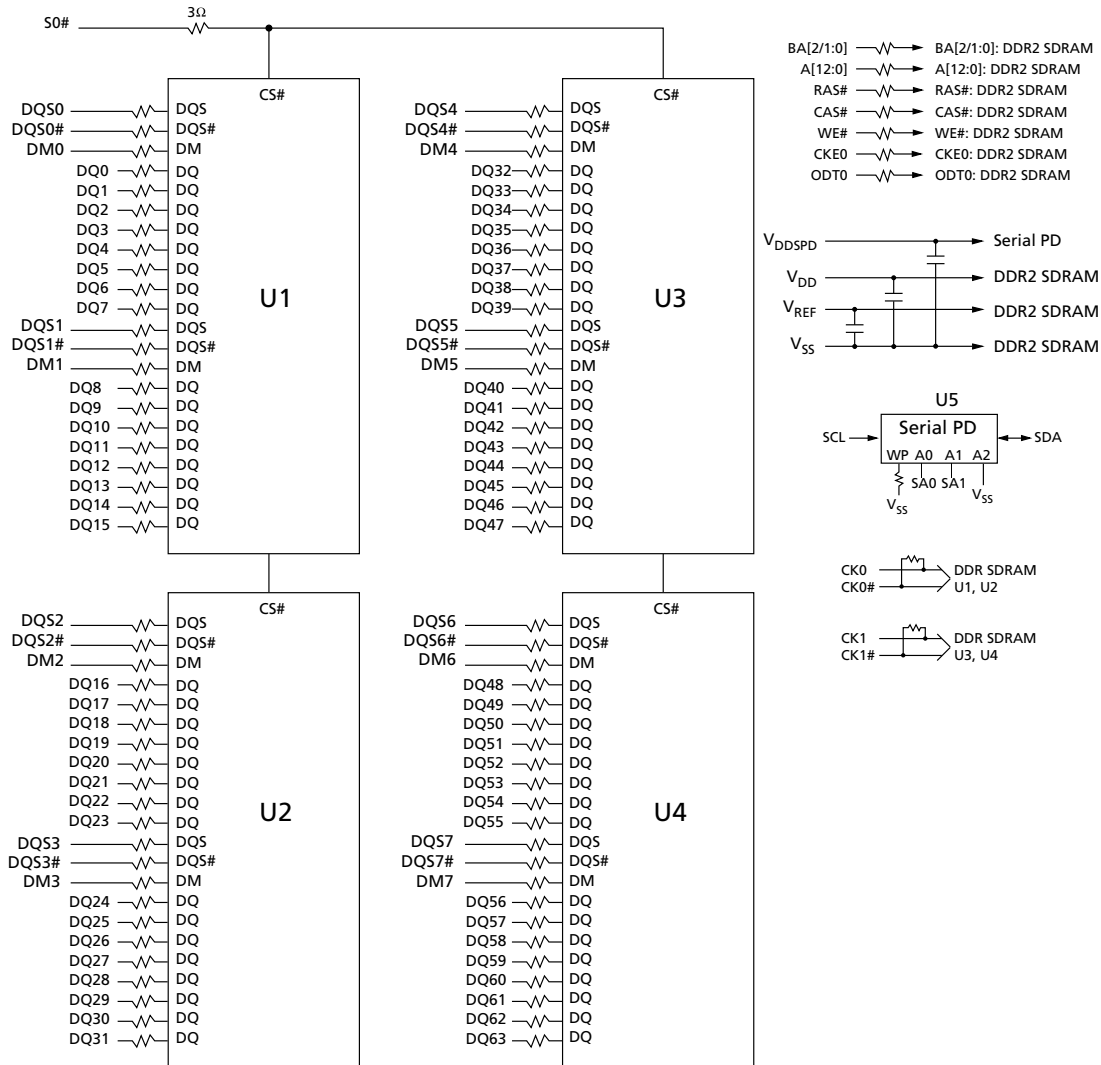
Symbol	Type	Description
Ax	Input	Address inputs: Provide the row address for ACTIVE commands, and the column address and auto precharge bit (A10) for READ/WRITE commands, to select one location out of the memory array in the respective bank. A10 sampled during a PRECHARGE command determines whether the PRECHARGE applies to one bank (A10 LOW, bank selected by BAx) or all banks (A10 HIGH). The address inputs also provide the op-code during a LOAD MODE command. See the Pin Assignments Table for density-specific addressing information.
BAx	Input	Bank address inputs: Define the device bank to which an ACTIVE, READ, WRITE, or PRECHARGE command is being applied. BA define which mode register (MR0, MR1, MR2, and MR3) is loaded during the LOAD MODE command.
CKx, CK#x	Input	Clock: Differential clock inputs. All control, command, and address input signals are sampled on the crossing of the positive edge of CK and the negative edge of CK#.
CKEx	Input	Clock enable: Enables (registered HIGH) and disables (registered LOW) internal circuitry and clocks on the DDR2 SDRAM.
DMx,	Input	Data mask (x8 devices only): DM is an input mask signal for write data. Input data is masked when DM is sampled HIGH, along with that input data, during a write access. Although DM pins are input-only, DM loading is designed to match that of the DQ and DQS pins.
ODTx	Input	On-die termination: Enables (registered HIGH) and disables (registered LOW) termination resistance internal to the DDR2 SDRAM. When enabled in normal operation, ODT is only applied to the following pins: DQ, DQS, DQS#, DM, and CB. The ODT input will be ignored if disabled via the LOAD MODE command.
Par_In	Input	Parity input: Parity bit for Ax, RAS#, CAS#, and WE#.
RAS#, CAS#, WE#	Input	Command inputs: RAS#, CAS#, and WE# (along with S#) define the command being entered.
RESET#	Input	Reset: Asynchronously forces all registered outputs LOW when RESET# is LOW. This signal can be used during power-up to ensure that CKE is LOW and DQ are High-Z.
S#x	Input	Chip select: Enables (registered LOW) and disables (registered HIGH) the command decoder.
SAx	Input	Serial address inputs: Used to configure the SPD EEPROM address range on the I ² C bus.
SCL	Input	Serial clock for SPD EEPROM: Used to synchronize communication to and from the SPD EEPROM on the I ² C bus.
CBx	I/O	Check bits. Used for system error detection and correction.
DQx	I/O	Data input/output: Bidirectional data bus.
DQSx, DQS#x	I/O	Data strobe: Travels with the DQ and is used to capture DQ at the DRAM or the controller. Output with read data; input with write data for source synchronous operation. DQS# is only used when differential data strobe mode is enabled via the LOAD MODE command.

Table 5: Pin Descriptions (Continued)

Symbol	Type	Description
SDA	I/O	Serial data: Used to transfer addresses and data into and out of the SPD EEPROM on the I ² C bus.
RDQSx, RDQS#x	Output	Redundant data strobe (x8 devices only): RDQS is enabled/disabled via the LOAD MODE command to the extended mode register (EMR). When RDQS is enabled, RDQS is output with read data only and is ignored during write data. When RDQS is disabled, RDQS becomes data mask (see DMx). RDQS# is only used when RDQS is enabled and differential data strobe mode is enabled.
Err_Out#	Output (open drain)	Parity error output: Parity error found on the command and address bus.
V _{DD} /V _{DDQ}	Supply	Power supply: 1.8V ±0.1V. The component V _{DD} and V _{DDQ} are connected to the module V _{DD} .
V _{DDSPD}	Supply	SPD EEPROM power supply: 1.7–3.6V.
V _{REF}	Supply	Reference voltage: V _{DD} /2.
V _{SS}	Supply	Ground.
NC	–	No connect: These pins are not connected on the module.
NF	–	No function: These pins are connected within the module, but provide no functionality.
NU	–	Not used: These pins are not used in specific module configurations/operations.
RFU	–	Reserved for future use.

Functional Block Diagram

Figure 2: Functional Block Diagram



General Description

DDR2 SDRAM modules are high-speed, CMOS dynamic random access memory modules that use internally configured 4 or 8-bank DDR2 SDRAM devices. DDR2 SDRAM modules use DDR architecture to achieve high-speed operation. DDR2 architecture is essentially a $4n$ -prefetch architecture with an interface designed to transfer two data words per clock cycle at the I/O pins. A single read or write access for the DDR2 SDRAM module effectively consists of a single $4n$ -bit-wide, one-clock-cycle data transfer at the internal DRAM core and eight corresponding n -bit-wide, one-half-clock-cycle data transfers at the I/O pins.

DDR2 modules use two sets of differential signals: DQS, DQS# to capture data and CK and CK# to capture commands, addresses, and control signals. Differential clocks and data strobes ensure exceptional noise immunity for these signals and provide precise crossing points to capture input signals. A bidirectional data strobe (DQS, DQS#) is transmitted externally, along with data, for use in data capture at the receiver. DQS is a strobe transmitted by the DDR2 SDRAM device during READs and by the memory controller during WRITEs. DQS is edge-aligned with data for READs and center-aligned with data for WRITEs.

DDR2 SDRAM modules operate from a differential clock (CK and CK#); the crossing of CK going HIGH and CK# going LOW will be referred to as the positive edge of CK. Commands (address and control signals) are registered at every positive edge of CK. Input data is registered on both edges of DQS, and output data is referenced to both edges of DQS, as well as to both edges of CK.

Serial Presence-Detect EEPROM Operation

DDR2 SDRAM modules incorporate serial presence-detect. The SPD data is stored in a 256-byte EEPROM. The first 128 bytes are programmed by Micron to identify the module type and various SDRAM 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 occur via a standard I²C bus using the DIMM's SCL (clock) SDA (data), and SA (address) pins. Write protect (WP) is connected to V_{SS}, permanently disabling hardware write protection.

Electrical Specifications

Stresses greater than those listed may cause permanent damage to the module. This is a stress rating only, and functional operation of the module at these or any other conditions outside those indicated in the device data sheet are not implied. Exposure to absolute maximum rating conditions for extended periods may adversely affect reliability.

Table 6: Absolute Maximum Ratings

Symbol	Parameter	Min	Max	Units	
V_{DD}/V_{DDQ}	V_{DD}/V_{DDQ} supply voltage relative to V_{SS}	-0.5	2.3	V	
V_{IN}, V_{OUT}	Voltage on any pin relative to V_{SS}	-0.5	2.3	V	
I_I	Input leakage current; Any input $0V \leq V_{IN} \leq V_{DD}$; V_{REF} input $0V \leq V_{IN} \leq 0.95V$; (All other pins not under test = $0V$)	Address inputs, RAS#, CAS#, WE#, S#, CKE, ODT, BA	-20	20	μA
		CK, CK#	-10	10	
		DM	-5	5	
I_{OZ}	Output leakage current; $0V \leq V_{OUT} \leq V_{DDQ}$; DQ and ODT are disabled	-5	5	μA	
I_{VREF}	V_{REF} leakage current; V_{REF} = valid V_{REF} level	-8	8	μA	
T_A	Module ambient operating temperature	Commercial	0	70	$^{\circ}C$
		Industrial	-40	85	$^{\circ}C$
T_C^1	DDR2 SDRAM component operating temperature ²	Commercial	0	85	$^{\circ}C$
		Industrial	-40	95	$^{\circ}C$

- Notes:
1. The refresh rate is required to double when T_C exceeds $85^{\circ}C$.
 2. For further information, refer to technical note TN-00-08: "Thermal Applications," available on Micron's Web site.

DRAM Operating Conditions

Recommended AC operating conditions are given in the DDR2 component data sheets. Component specifications are available on Micron's Web site. Module speed grades correlate with component speed grades.

Table 7: Module and Component Speed Grades

DDR2 components may exceed the listed module speed grades; module may not be available in all listed speed grades

Module Speed Grade	Component Speed Grade
-1GA	-187E
-80E	-25E
-800	-25
-667	-3
-53E	-37E
-40E	-5E

Design Considerations

Simulations

Micron memory modules are designed to optimize signal integrity through carefully designed terminations, controlled board impedances, routing topologies, trace length matching, and decoupling. However, good signal integrity starts at the system level. Micron encourages designers to simulate the signal characteristics of the system's memory bus to ensure adequate signal integrity of the entire memory system.

Power

Operating voltages are specified at the DRAM, not at the edge connector of the module. Designers must account for any system voltage drops at anticipated power levels to ensure the required supply voltage is maintained.

I_{DD} Specifications

Table 8: DDR2 I_{DD} Specifications and Conditions – 1GB

Values shown for MT47H32M16 DDR2 SDRAM only and are computed from values specified in the 1Gb (64 Meg x 16) component data sheet

Parameter	Symbol	-1GA	-80E/ -800	-667	Units	
Operating one bank active-precharge current: $t^{CK} = t^{CK} (I_{DD})$, $t^{RC} = t^{RC} (I_{DD})$, $t^{RAS} = t^{RAS} \text{ MIN} (I_{DD})$; CKE is HIGH, S# is HIGH between valid commands; Address bus inputs are switching; Data bus inputs are switching	I _{DD0}	720	600	540	mA	
Operating one bank active-read-precharge current: I _{OUT} = 0mA; BL = 4, CL = CL (I _{DD}), AL = 0; $t^{CK} = t^{CK} (I_{DD})$, $t^{RC} = t^{RC} (I_{DD})$, $t^{RAS} = t^{RAS} \text{ MIN} (I_{DD})$, $t^{RCD} = t^{RCD} (I_{DD})$; CKE is HIGH, S# is HIGH between valid commands; Address bus inputs are switching; Data pattern is same as I _{DD4W}	I _{DD1}	840	700	520	mA	
Precharge power-down current: All device banks idle; $t^{CK} = t^{CK} (I_{DD})$; CKE is LOW; Other control and address bus inputs are stable; Data bus inputs are floating	I _{DD2P}	28	28	28	mA	
Precharge quiet standby current: All device banks idle; $t^{CK} = t^{CK} (I_{DD})$; CKE is HIGH, S# is HIGH; Other control and address bus inputs are stable; Data bus inputs are floating	I _{DD2Q}	360	300	260	mA	
Precharge standby current: All device banks idle; $t^{CK} = t^{CK} (I_{DD})$; CKE is HIGH, S# is HIGH; Other control and address bus inputs are switching; Data bus inputs are switching	I _{DD2N}	380	320	280	mA	
Active power-down current: All device banks open; $t^{CK} = t^{CK} (I_{DD})$; CKE is LOW; Other control and address bus inputs are stable; Data bus inputs are floating	I _{DD3P}	Fast PDN exit MR[12] = 0	200	160	120	mA
		Slow PDN exit MR[12] = 1	40	40	40	
Active standby current: All device banks open; $t^{CK} = t^{CK} (I_{DD})$, $t^{RAS} = t^{RAS} \text{ MAX} (I_{DD})$, $t^{RP} = t^{RP} (I_{DD})$; CKE is HIGH, S# is HIGH between valid commands; Other control and address bus inputs are switching; Data bus inputs are switching	I _{DD3N}	380	340	300	mA	
Operating burst write current: All device banks open; Continuous burst writes; BL = 4, CL = CL (I _{DD}), AL = 0; $t^{CK} = t^{CK} (I_{DD})$, $t^{RAS} = t^{RAS} \text{ MAX} (I_{DD})$, $t^{RP} = t^{RP} (I_{DD})$; CKE is HIGH, S# is HIGH between valid commands; Address bus inputs are switching; Data bus inputs are switching	I _{DD4W}	1620	1260	800	mA	
Operating burst read current: All device banks open; Continuous burst read, I _{OUT} = 0mA; BL = 4, CL = CL (I _{DD}), AL = 0; $t^{CK} = t^{CK} (I_{DD})$, $t^{RAS} = t^{RAS} \text{ MAX} (I_{DD})$, $t^{RP} = t^{RP} (I_{DD})$; CKE is HIGH, S# is HIGH between valid commands; Address bus inputs are switching; Data bus inputs are switching	I _{DD4R}	1680	1280	880	mA	
Burst refresh current: $t^{CK} = t^{CK} (I_{DD})$; REFRESH command at every $t^{RFC} (I_{DD})$ interval; CKE is HIGH, S# is HIGH between valid commands; Other control and address bus inputs are switching; Data bus inputs are switching	I _{DD5}	1200	1200	1080	mA	
Self refresh current: CK and CK# at 0V; CKE ≤ 0.2V; Other control and address bus inputs are floating; Data bus inputs are floating	I _{DD6}	28	28	28	mA	

Table 8: DDR2 I_{DD} Specifications and Conditions – 1GB (Continued)

Values shown for MT47H32M16 DDR2 SDRAM only and are computed from values specified in the 1Gb (64 Meg x 16) component data sheet

Parameter	Symbol	-1GA	-80E/ -800	-667	Units
Operating bank interleave read current: All device banks interleaving reads; I _{OUT} = 0mA; BL = 4, CL = CL (I _{DD}), AL = ^t RCD (I _{DD}) - 1 × ^t CK (I _{DD}); ^t CK = ^t CK (I _{DD}), ^t RC = ^t RC (I _{DD}), ^t RRD = ^t RRD (I _{DD}), ^t RCD = ^t RCD (I _{DD}); CKE is HIGH, S# is HIGH between valid commands; Address bus inputs are stable during deselects; Data bus inputs are switching	I _{DD7}	2080	1760	1400	mA

Serial Presence-Detect

For the latest SPD data, refer to Micron's SPD page: www.micron.com/SPD.

Table 9: SPD EEPROM Operating Conditions

Parameter/Condition	Symbol	Min	Max	Units
Supply voltage	V_{DDSPD}	1.7	3.6	V
Input high voltage: logic 1; All inputs	V_{IH}	$V_{DDSPD} \times 0.7$	$V_{DDSPD} + 0.5$	V
Input low voltage: logic 0; All inputs	V_{IL}	-0.6	$V_{DDSPD} \times 0.3$	V
Output low voltage: $I_{OUT} = 3mA$	V_{OL}	-	0.4	V
Input leakage current: $V_{IN} = GND$ to V_{DD}	I_{LI}	0.1	3	μA
Output leakage current: $V_{OUT} = GND$ to V_{DD}	I_{LO}	0.05	3	μA
Standby current	I_{SB}	1.6	4	μA
Power supply current, READ: SCL clock frequency = 100 kHz	I_{CCR}	0.4	1	mA
Power supply current, WRITE: SCL clock frequency = 100 kHz	I_{CCW}	2	3	mA

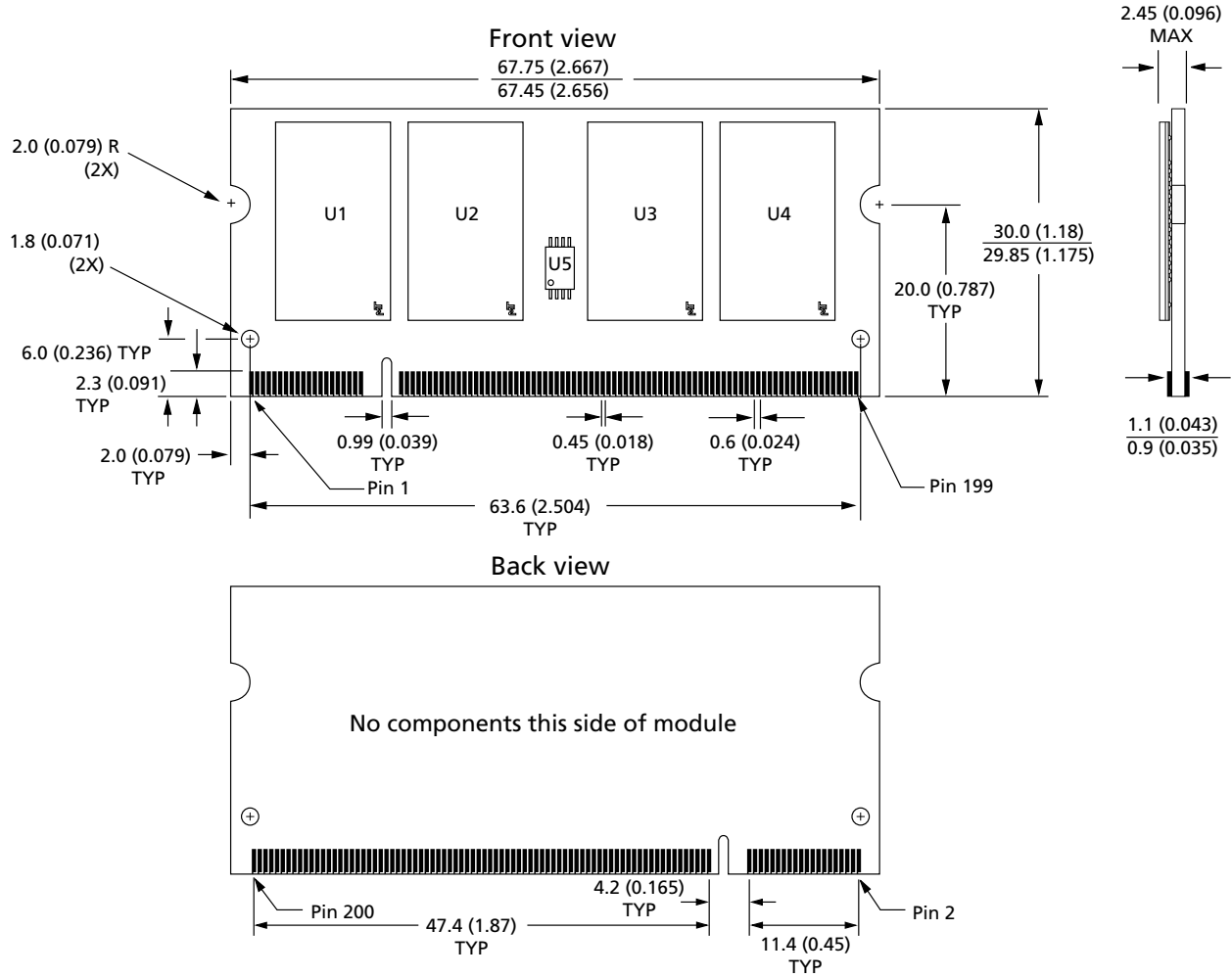
Table 10: SPD EEPROM AC Operating Conditions

Parameter/Condition	Symbol	Min	Max	Units	Notes
SCL LOW to SDA data-out valid	t_{AA}	0.2	0.9	μs	1
Time bus must be free before a new transition can start	t_{BUF}	1.3	-	μs	
Data-out hold time	t_{DH}	200	-	ns	
SDA and SCL fall time	t_F	-	300	ns	2
SDA and SCL rise time	t_R	-	300	ns	2
Data-in hold time	$t_{HD:DAT}$	0	-	μs	
Start condition hold time	$t_{HD:STA}$	0.6	-	μs	
Clock HIGH period	t_{HIGH}	0.6	-	μs	
Noise suppression time constant at SCL, SDA inputs	t_I	-	50	μs	
Clock LOW period	t_{LOW}	1.3	-	μs	
SCL clock frequency	t_{SCL}	-	400	kHz	
Data-in setup time	$t_{SU:DAT}$	100	-	ns	
Start condition setup time	$t_{SU:STA}$	0.6	-	μs	3
Stop condition setup time	$t_{SU:STO}$	0.6	-	μs	
WRITE cycle time	t_{WRC}	-	10	ms	4

- Notes:
1. To avoid spurious start and stop conditions, a minimum delay is placed between SCL = 1 and the falling or rising edge of SDA.
 2. This parameter is sampled.
 3. For a restart condition or following a WRITE cycle.
 4. The SPD EEPROM WRITE cycle time (t_{WRC}) 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 resistance, and the EEPROM does not respond to its slave address.

Module Dimensions

Figure 3: 200-Pin DDR2 SODIMM



- Notes:
1. All dimensions are in millimeters (inches); MAX/MIN or typical (TYP) where noted.
 2. The dimensional diagram is for reference only. Refer to the JEDEC MO document for additional design dimensions.

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This data sheet contains minimum and maximum limits specified over the power supply and temperature range set forth herein. Although considered final, these specifications are subject to change, as further product development and data characterization sometimes occur.