DDR2 SDRAM Small-Outline DIMM

MT8HTF3264HD – 256MB

MT8HTF6464HD – 512MB

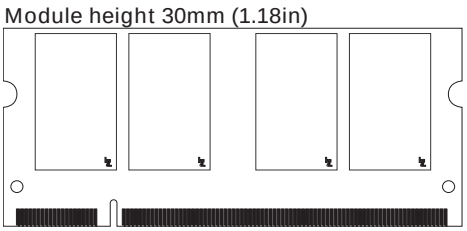
MT8HTF12864HD – 1GB

For component data sheets, refer to Micron's Web site: www.micron.com

Features

- 200-pin, small-outline, dual in-line memory module (SODIMM)
- Fast data transfer rates: PC2-3200, PC2-4200, PC2-5300, or PC2-6400
- 256MB (32 Meg x 64), 512MB (64 Meg x 64), 1GB (128 Meg x 64)
- V_{DD} = +1.8V
- V_{DDSPD} = +1.7V to +3.6V
- JEDEC-standard 1.8V I/O (SSTL_18-compatible)
- Differential data strobe (DQS, DQS#) option
- 4*n*-bit prefetch architecture
- Dual rank
- Multiple internal device banks for concurrent operation
- Programmable CAS# latency (CL)
- Posted CAS# additive latency (AL)
- WRITE latency = READ latency - 1 ^{t}CK
- Programmable burst lengths: 4 or 8
- Adjustable data-output drive strength
- 64ms, 8,192-cycle refresh
- On-die termination (ODT)
- Serial presence-detect (SPD) with EEPROM
- Gold edge contacts

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



Options — Marking

- Operating temperature[1]
  - Commercial (0°C ≤ T_A ≤ +70°C) — D
  - Industrial (–40°C ≤ T_A ≤ +85°C) — T
- Package
  - 200-pin DIMM (Pb-free) — Y
- Frequency/CAS latency
  - 2.5ns @ CL = 5 (DDR2-800) — -80E
  - 2.5ns @ CL = 6 (DDR2-800) — -800
  - 3.0ns @ CL = 5 (DDR2-667) — -667
  - 3.75ns @ CL = 4 (DDR2-533) — -53E
  - 5.0ns @ CL = 3 (DDR2-400) — -40E
- PCB height
  - 30mm (1.18in)

Notes: 1. Contact Micron for industrial temperature module offerings.

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	533	–	12.5	12.5	55
-800	PC2-6400	800	667	533	–	15	15	55
-667	PC2-5300	–	667	533	400	15	15	55
-53E	PC2-4200	–	–	533	400	15	15	55
-40E	PC2-3200	–	–	400	400	15	15	55

Table 2: Addressing

	256MB	512MB	1GB
Refresh count	8K	8K	8K
Row address	8K (A0–A12)	8K (A0–A12)	8K (A0–A12)
Device bank address	4 (BA0, BA1)	4 (BA0, BA1)	8 (BA0, BA1, BA2)
Device page size per bank	1KB	1KB	1KB
Device configuration	256Mb (16 Meg x 16)	512Mb (32 Meg x 16)	1Gb (64 Meg x 16)
Column address	512 (A0–A8)	1K (A0–A9)	1K (A0–A9)
Module rank address	2 (S0#, S1#)	2 (S0#, S1#)	2 (S0#, S1#)

Table 3: Part Numbers and Timing Parameters – 256MB Modules

Base device: MT47H16M16,[1] 256Mb DDR2 SDRAM

Part Number[2]	Module Density	Configuration	Module Bandwidth	Memory Clock/ Data Rate	Latency (CL-^{t}RCD-^{t}RP)
MT8HTF3264HD-667__	256MB	32 Meg x 64	5.3 GB/s	3.0ns/667 MT/s	5-5-5
MT8HTF3264HD-53E__	256MB	32 Meg x 64	4.3 GB/s	3.75ns/533 MT/s	4-4-4
MT8HTF3264HD-40E__	256MB	32 Meg x 64	3.2 GB/s	5.0ns/400 MT/s	3-3-3

Table 4: Part Numbers and Timing Parameters – 512MB Modules

Base device: MT47H32M16,[1] 512Mb DDR2 SDRAM

Part Number[2]	Module Density	Configuration	Module Bandwidth	Memory Clock/ Data Rate	Latency (CL-^{t}RCD-^{t}RP)
MT8HTF6464HD-80E__	512MB	64 Meg x 64	6.4 GB/s	2.5ns/800 MT/s	5-5-5
MT8HTF6464HD-800__	512MB	64 Meg x 64	6.4 GB/s	2.5ns/800 MT/s	6-6-6
MT8HTF6464HD-667__	512MB	64 Meg x 64	5.3 GB/s	3.0ns/667 MT/s	5-5-5
MT8HTF6464HD-53E__	512MB	64 Meg x 64	4.3 GB/s	3.75ns/533 MT/s	4-4-4
MT8HTF6464HD-40E__	512MB	64 Meg x 64	3.2 GB/s	5.0ns/400 MT/s	3-3-3

Table 5: Part Numbers and Timing Parameters – 1GB Modules

Base device: MT47H64M16,[1] 1Gb DDR2 SDRAM

Part Number[2]	Module Density	Configuration	Module Bandwidth	Memory Clock/ Data Rate	Latency (CL-^{t}RCD-^{t}RP)
MT8HTF12864HD-80E__	1GB	128 Meg x 64	6.4 GB/s	2.5ns/800 MT/s	5-5-5
MT8HTF12864HD-800__	1GB	128 Meg x 64	6.4 GB/s	2.5ns/800 MT/s	6-6-6
MT8HTF12864HD-667__	1GB	128 Meg x 64	5.3 GB/s	3.0ns/667 MT/s	5-5-5
MT8HTF12864HD-53E__	1GB	128 Meg x 64	4.3 GB/s	3.75ns/533 MT/s	4-4-4
MT8HTF12864HD-40E__	1GB	128 Meg x 64	3.2 GB/s	5.0ns/400 MT/s	3-3-3

Notes: 1. Data sheets for the base devices can be found on Micron's Web site.
2. All part numbers end with a two-place code (not shown), designating component and PCB revisions. Consult factory for current revision codes. Example: MT8HTF6464HDY-40ED3.

Pin Assignments and Descriptions

Table 6: Pin Assignments

200-Pin SODIMM Front							
Pin	Symbol	Pin	Symbol	Pin	Symbol	Pin	Symbol
1	VREF	51	DQS2	101	A1	151	DQ42
3	VSS	53	VSS	103	VDD	153	DQ43
5	DQ0	55	DQ18	105	A10	155	VSS
7	DQ1	57	DQ19	107	BA0	157	DQ48
9	VSS	59	VSS	109	WE#	159	DQ49
11	DQS0#	61	DQ24	111	VDD	161	VSS
13	DQS0	63	DQ25	113	CAS#	163	NC
15	VSS	65	VSS	115	S1#	165	VSS
17	DQ2	67	DM3	117	VDD	167	DQS6#
19	DQ3	69	NC	119	ODT1	169	DQS6
21	VSS	71	VSS	121	VSS	171	VSS
23	DQ8	73	DQ26	123	DQ32	173	DQ50
25	DQ9	75	DQ27	125	DQ33	175	DQ51
27	VSS	77	VSS	127	VSS	177	VSS
29	DQS1#	79	CKE0	129	DQS4#	179	DQ56
31	DQS1	81	VDD	131	DQS4	181	DQ57
33	VSS	83	NC	133	VSS	183	VSS
35	DQ10	85[1]	NC/BA2	135	DQ34	185	DM7
37	DQ11	87	VDD	137	DQ35	187	VSS
39	VSS	89	A12	139	VSS	189	DQ58
41	VSS	91	A9	141	DQ40	191	DQ59
43	DQ16	93	A8	143	DQ41	193	VSS
45	DQ17	95	VDD	145	VSS	195	SDA
47	VSS	97	A5	147	DM5	197	SCL
49	DQS2#	99	A3	149	VSS	199	VDDSPD

200-Pin SODIMM Back							
Pin	Symbol	Pin	Symbol	Pin	Symbol	Pin	Symbol
2	VSS	52	DM2	102	A0	152	DQ46
4	DQ4	54	VSS	104	VDD	154	DQ47
6	DQ5	56	DQ22	106	BA1	156	VSS
8	VSS	58	DQ23	108	RAS#	158	DQ52
10	DM0	60	VSS	110	S0#	160	DQ53
12	VSS	62	DQ28	112	VDD	162	VSS
14	DQ6	64	DQ29	114	ODT0	164	CK1
16	DQ7	66	VSS	116	NC	166	CK1#
18	VSS	68	DQS3#	118	VDD	168	VSS
20	DQ12	70	DQS3	120	NC	170	DM6
22	DQ13	72	VSS	122	VSS	172	VSS
24	VSS	74	DQ30	124	DQ36	174	DQ54
26	DM1	76	DQ31	126	DQ37	176	DQ55
28	VSS	78	VSS	128	VSS	178	VSS
30	CK0	80	CKE1	130	DM4	180	DQ60
32	CK0#	82	VDD	132	VSS	182	DQ61
34	VSS	84	NC	134	DQ38	184	VSS
36	DQ14	86	NC	136	DQ39	186	DQS7#
38	DQ15	88	VDD	138	VSS	188	DQS7
40	VSS	90	A11	140	DQ44	190	VSS
42	VSS	92	A7	142	DQ45	192	DQ62
44	DQ20	94	A6	144	VSS	194	DQ63
46	DQ21	96	VDD	146	DQS5#	196	VSS
48	VSS	98	A4	148	DQS5	198	SA0
50	NC	100	A2	150	VSS	200	SA1

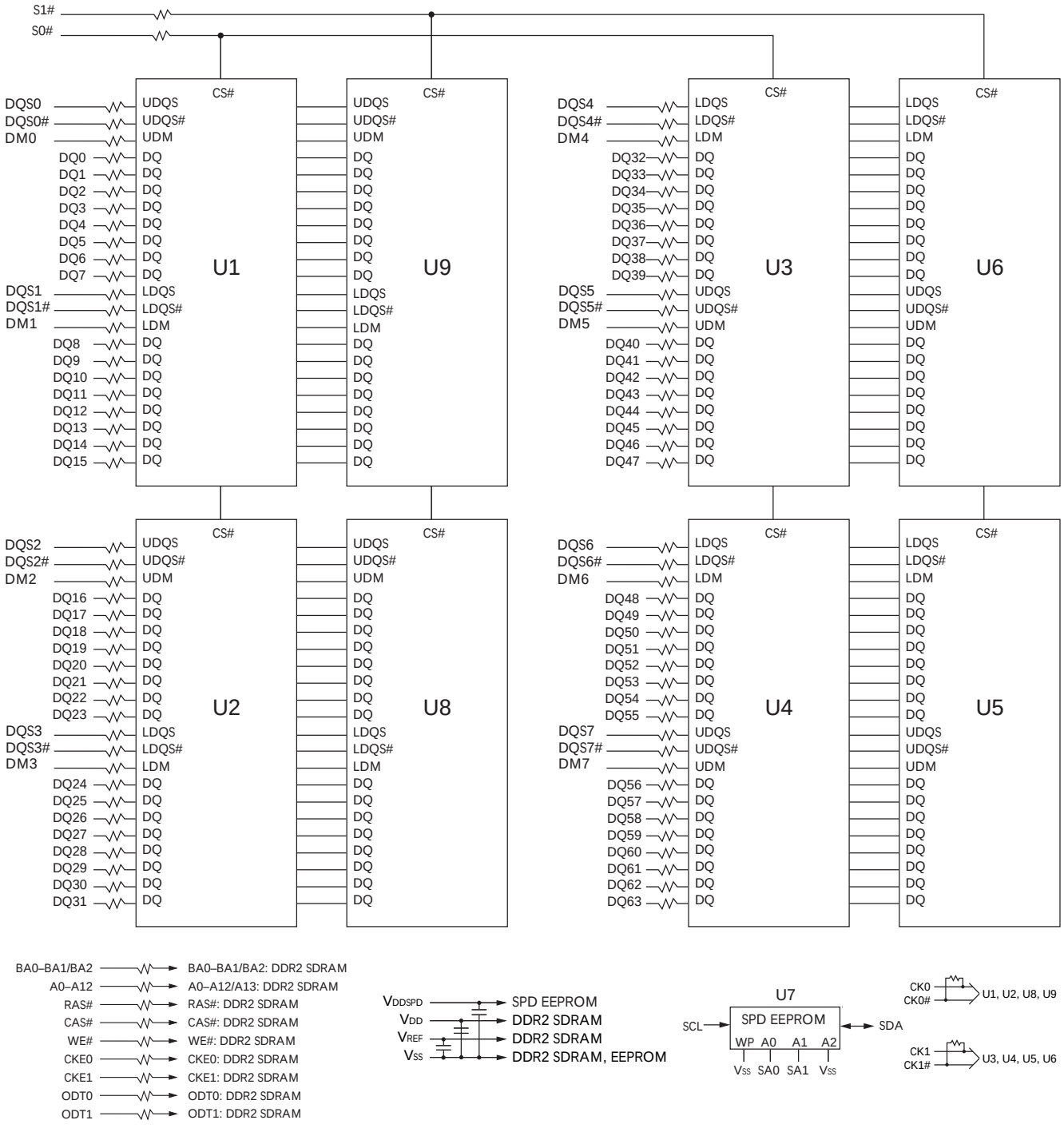
Notes: 1. Pin 85 is NC for 256MB and 512MB, BA2 for 1GB.

Table 7: Pin Descriptions

Symbol	Type	Description
ODT0, ODT1	Input (SSTL_18)	**On-die termination:** ODT (registered HIGH) enables termination resistance internal to the DDR2 SDRAM. When enabled, ODT is only applied to each of the following pins: DQ, DQS, DQS#, and DM. The ODT input will be ignored if disabled via the LOAD MODE command.
CK0, CK0#, CK1, CK1#	Input (SSTL_18)	**Clock:** CK and CK# are differential clock inputs. All address and control input signals are sampled on the crossing of the positive edge of CK and negative edge of CK#. Output data (DQs and DQS/DQS#) is referenced to the crossings of CK and CK#.
CKE0, CKE1	Input (SSTL_18)	**Clock enable:** CKE (registered HIGH) activates and CKE (registered LOW) deactivates clocking circuitry on the DDR2 SDRAM.
S0#, S1#	Input (SSTL_18)	**Chip select:** S# enables (registered LOW) and disables (registered HIGH) the command decoder. All commands are masked when S# is registered HIGH. S# provides for external rank selection on systems with multiple ranks. S# is considered part of the command code.
RAS#, CAS#, WE#	Input (SSTL_18)	**Command inputs:** RAS#, CAS#, and WE# (along with S#) define the command being entered.
BA0, BA1, BA2 (1GB)	Input (SSTL_18)	**Bank address inputs:** BA0–BA1/BA2 define to which device bank an ACTIVE, READ, WRITE, or PRECHARGE command is being applied. BA0–BA1/BA2 define which mode register, including MR, EMR, EMR(2), and EMR(3), is loaded during the LOAD MODE command.
A0–A12	Input (SSTL_18)	**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 device bank (A10 LOW, device bank selected by BA0–BA1/BA2) or all device banks (A10 HIGH). The address inputs also provide the op-code during a LOAD MODE command.
DM0–DM7	Input (SSTL_18)	**Input data mask:** 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. DM is sampled on both edges of DQS. Although DM pins are input-only, the DM loading is designed to match that of DQ and DQS pins.
SCL	Input (SSTL_18)	**Serial clock for presence-detect:** SCL is used to synchronize the presence-detect data transfer to and from the module.
SA0–SA1	Input (SSTL_18)	**Presence-detect address inputs:** These pins are used to configure the presence-detect device.
DQ0–DQ63	I/O (SSTL_18)	**Data input/output:** Bidirectional data bus.
DQS0–DQS7, DQS0#–DQS7#	I/O (SSTL_18)	**Data strobe:** Output with read data, input with write data for source synchronous operation. Edge-aligned with read data, center-aligned with write data. DQS# is only used when differential data strobe mode is enabled via the LOAD MODE command.
SDA	I/O (SSTL_18)	**Serial presence-detect data:** SDA is a bidirectional pin used to transfer addresses and data into and out of the presence-detect portion of the module.
V_{DD}	Supply (SSTL_18)	**Power supply:** +1.8V ±0.1V.
V_{REF}	Supply (SSTL_18)	SSTL_18 reference voltage.
V_{SS}	Supply (SSTL_18)	Ground.
V_{DDSPD}	Supply (SSTL_18)	**Serial EEPROM positive power supply:** +1.7V to +3.6V.
NC	–	**No connect:** These pins should be left unconnected.

Functional Block Diagram

Figure 2: Functional Block Diagram



General Description

The MT8HTF3264HD, MT8HTF6464HD, and MT8HTF12864HD DDR2 SDRAM modules are high-speed, CMOS, dynamic random-access 256MB, 512MB, and 1GB memory modules organized in a x64 configuration. DDR2 SDRAM modules use internally configured 4-bank (256Mb, 512Mb) or 8-bank (1Gb) DDR2 SDRAM devices.

DDR2 SDRAM modules use double data rate architecture to achieve high-speed operation. The double data rate architecture is essentially a 4*n*-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 4*n*-bit-wide, one-clock-cycle data transfer at the internal DRAM core and four corresponding *n*-bit-wide, one-half-clock-cycle data transfers at the I/O pins.

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 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 Operation

DDR2 SDRAM modules incorporate serial presence-detect (SPD). The SPD function is implemented using a 2,048-bit EEPROM. This nonvolatile storage device contains 256 bytes. The first 128 bytes can be programmed by Micron to identify the module type and various 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 I^2C bus using the DIMM's SCL (clock) and SDA (data) signals, together with SA (1:0), which provide four unique DIMM/EEPROM addresses. Write protect (WP) is pulled from V_{SS} on the module, permanently disabling hardware write protect.

Electrical Specifications

Stresses greater than those listed in Table 8, 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 above those indicated in each device's data sheet is not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.

Table 8: Absolute Maximum Ratings

Symbol	Parameter		Min	Max	Units
V_{DD}	V_{DD} 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 ≤ V_{IN} ≤ V_{DD}; V_{REF} input 0V ≤ V_{IN} ≤ 0.95V (All other pins not under test = 0V)	Command/address RAS#, CAS#, WE#, S#, CKE, ODT, BA	–40	40	µA
		CK, CK#	–20	20	
		DM	–10	10	
Ioz	Output leakage current; 0V ≤ V_{OUT} ≤ V_{DD}; DQs and ODT are disabled	DQ, DQS, DQS#	–10	10	µA
I_{VREF}	V_{REF} leakage current; V_{REF} = valid V_{REF} level		–16	16	µA
T_A	Module ambient operating temperature	Commercial	0	+70	°C
		Industrial	–40	+85	°C
T_C[1]	DDR2 SDRAM component case operating temperature[2]	Commercial	0	+85	°C
		Industrial	–40	+95	°C

Notes:
1. Refresh rate is required to double when 85°C < TC ≤ 95°C.
2. For further information, refer to technical note TN-00-08: Thermal Applications, available on Micron's Web site.

Input Capacitance

Micron encourages designers to simulate the performance of the module to achieve optimum values. Simulations are significantly more accurate and realistic than a gross estimation of module capacitance when inductance and delay parameters associated with trace lengths are used in simulations. JEDEC modules are currently designed using simulations to close timing budgets.

Component AC Timing and 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, as shown in Table 9.

Table 9: Module and Component Speed Grades

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

Table 10: DDR2 IDD Specifications and Conditions – 256MB

Values shown for MT47H16M16 DDR2 SDRAM only and are computed from values specified in the 256Mb (16 Meg x 16) component data sheet

Parameter/Condition		Symbol	-667	-53E	-40E	Units
Operating one bank active-precharge current: $^{t}CK = {}^{t}CK$ (IDD), $^{t}RC = {}^{t}RC$ (IDD), $^{t}RAS = {}^{t}RAS$ MIN (IDD); CKE is HIGH, S# is HIGH between valid commands; Address bus inputs are switching; Data bus inputs are switching		IDD0[1]	380	340	320	mA
Operating one bank active-read-precharge current: IOUT = 0mA; BL = 4, CL = CL (IDD), AL = 0; $^{t}CK = {}^{t}CK$ (IDD), $^{t}RC = {}^{t}RC$ (IDD), $^{t}RAS = {}^{t}RAS$ MIN (IDD), $^{t}RCD = {}^{t}RCD$ (IDD); CKE is HIGH, S# is HIGH between valid commands; Address bus inputs are switching; Data pattern is same as IDD4W		IDD1[1]	420	380	360	mA
Precharge power-down current: All device banks idle; $^{t}CK = {}^{t}CK$ (IDD); CKE is LOW; Other control and address bus inputs are stable; Data bus inputs are floating		IDD2P[2]	40	40	40	mA
Precharge quiet standby current: All device banks idle; $^{t}CK = {}^{t}CK$ (IDD); CKE is HIGH, S# is HIGH; Other control and address bus inputs are stable; Data bus inputs are floating		IDD2Q[2]	400	280	200	mA
Precharge standby current: All device banks idle; $^{t}CK = {}^{t}CK$ (IDD); CKE is HIGH, S# is HIGH; Other control and address bus inputs are switching; Data bus inputs are switching		IDD2N[2]	320	280	240	mA
Active power-down current: All device banks open; $^{t}CK = {}^{t}CK$ (IDD); CKE is LOW; Other control and address bus inputs are stable; Data bus inputs are floating	Fast PDN exit MR[12] = 0	IDD3P[2]	240	200	160	mA
	Slow PDN exit MR[12] = 1		48	48	48	mA
Active standby current: All device banks open; $^{t}CK = {}^{t}CK$ (IDD), $^{t}RAS = {}^{t}RAS$ MAX (IDD), $^{t}RP = {}^{t}RP$ (IDD); CKE is HIGH, S# is HIGH between valid commands; Other control and address bus inputs are switching; Data bus inputs are switching		IDD3N[2]	400	320	240	mA
Operating burst write current: All device banks open; Continuous burst writes; BL = 4, CL = CL (IDD), AL = 0; $^{t}CK = {}^{t}CK$ (IDD), $^{t}RAS = {}^{t}RAS$ MAX (IDD), $^{t}RP = {}^{t}RP$ (IDD); CKE is HIGH, S# is HIGH between valid commands; Address bus inputs are switching; Data bus inputs are switching		IDD4W[1]	880	740	580	mA
Operating burst read current: All device banks open; Continuous burst reads; IOUT = 0mA; BL = 4, CL = CL (IDD), AL = 0; $^{t}CK = {}^{t}CK$ (IDD), $^{t}RAS = {}^{t}RAS$ MAX (IDD), $^{t}RP = {}^{t}RP$ (IDD); CKE is HIGH, S# is HIGH between valid commands; Address bus inputs are switching; Data bus inputs are switching		IDD4R[1]	780	660	500	mA
Burst refresh current: $^{t}CK = {}^{t}CK$ (IDD); REFRESH command at every ^{t}RFC (IDD) interval; CKE is HIGH, S# is HIGH between valid commands; Other control and address bus inputs are switching; Data bus inputs are switching		IDD5[2]	1,440	1,360	1,320	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		IDD6[2]	40	40	40	mA
Operating bank interleave read current: All device banks interleaving reads; IOUT = 0mA; BL = 4, CL = CL (IDD), AL = ^{t}RCD (IDD) - 1 × ^{t}CK (IDD); $^{t}CK = {}^{t}CK$ (IDD), $^{t}RC = {}^{t}RC$ (IDD), $^{t}RRD = {}^{t}RRD$ (IDD), $^{t}RCD = {}^{t}RCD$ (IDD); CKE is HIGH, S# is HIGH between valid commands; Address bus inputs are stable during deselects; Data bus inputs are switching		IDD7[1]	1,020	980	940	mA

Notes:
1. Value calculated as one module rank in this operating condition; all other module ranks in IDD2P (CKE LOW) mode.
2. Value calculated reflects all module ranks in this operating condition.

Table 11: DDR2 IDD Specifications and Conditions – 512MB

Values shown for MT47H32M16 DDR2 SDRAM only and are computed from values specified in the 512Mb (32 Meg x 16) component data sheet

Parameter/Condition		Symbol	-80E/ -800	-667	-53E	-40E	Units
Operating one bank active-precharge current: ^{t}CK = ^{t}CK (IDD), ^{t}RC = ^{t}RC (IDD), ^{t}RAS = ^{t}RAS MIN (IDD); CKE is HIGH, S# is HIGH between valid commands; Address bus inputs are switching; Data bus inputs are switching		IDD0[1]	560	500	460	440	mA
Operating one bank active-read-precharge current: IOUT = 0mA; BL = 4, CL = CL (IDD), AL = 0; ^{t}CK = ^{t}CK (IDD), ^{t}RC = ^{t}RC (IDD), ^{t}RAS = ^{t}RAS MIN (IDD), ^{t}RCD = ^{t}RCD (IDD); CKE is HIGH, S# is HIGH between valid commands; Address bus inputs are switching; Data pattern is same as IDD4W		IDD1[1]	680	620	560	520	mA
Precharge power-down current: All device banks idle; ^{t}CK = ^{t}CK (IDD); CKE is LOW; Other control and address bus inputs are stable; Data bus inputs are floating		IDD2P[2]	56	56	56	56	mA
Precharge quiet standby current: All device banks idle; ^{t}CK = ^{t}CK (IDD); CKE is HIGH, S# is HIGH; Other control and address bus inputs are stable; Data bus inputs are floating		IDD2Q[2]	520	440	360	320	mA
Precharge standby current: All device banks idle; ^{t}CK = ^{t}CK (IDD); CKE is HIGH, S# is HIGH; Other control and address bus inputs are switching; Data bus inputs are switching		IDD2N[2]	560	480	400	360	mA
Active power-down current: All device banks open; ^{t}CK = ^{t}CK (IDD); CKE is LOW; Other control and address bus inputs are stable; Data bus inputs are floating	Fast PDN exit MR[12] = 0	IDD3P[2]	320	280	240	200	mA
	Slow PDN exit MR[12] = 1		96	96	96	96	mA
Active standby current: All device banks open; ^{t}CK = ^{t}CK (IDD), ^{t}RAS = ^{t}RAS MAX (IDD), ^{t}RP = ^{t}RP (IDD); CKE is HIGH, S# is HIGH between valid commands; Other control and address bus inputs are switching; Data bus inputs are switching		IDD3N[2]	600	560	480	400	mA
Operating burst write current: All device banks open; Continuous burst writes; BL = 4, CL = CL (IDD), AL = 0; ^{t}CK = ^{t}CK (IDD), ^{t}RAS = ^{t}RAS MAX (IDD), ^{t}RP = ^{t}RP (IDD); CKE is HIGH, S# is HIGH between valid commands; Address bus inputs are switching; Data bus inputs are switching		IDD4W[1]	1,200	1,020	840	640	mA
Operating burst read current: All device banks open; Continuous burst reads; IOUT = 0mA; BL = 4, CL = CL (IDD), AL = 0; ^{t}CK = ^{t}CK (IDD), ^{t}RAS = ^{t}RAS MAX (IDD), ^{t}RP = ^{t}RP (IDD); CKE is HIGH, S# is HIGH between valid commands; Address bus inputs are switching; Data bus inputs are switching		IDD4R[1]	1,120	960	800	620	mA
Burst refresh current: ^{t}CK = ^{t}CK (IDD); REFRESH command at every ^{t}RFC (IDD) interval; CKE is HIGH, S# is HIGH between valid commands; Other control and address bus inputs are switching; Data bus inputs are switching		IDD5[2]	1,840	1,480	1,400	1,360	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		IDD6[2]	56	56	56	56	mA
Operating bank interleave read current: All device banks interleaving reads; IOUT = 0mA; BL = 4, CL = CL (IDD), AL = ^{t}RCD (IDD) - 1 × ^{t}CK (IDD); ^{t}CK = ^{t}CK (IDD), ^{t}RC = ^{t}RC (IDD), ^{t}RRD ^{t}RRD (IDD), ^{t}RCD = ^{t}RCD (IDD); CKE is HIGH, S# is HIGH between valid commands; Address bus inputs are stable during deselects; Data bus inputs are switching		IDD7[1]	1,500	1,420	1,380	1,360	mA

Notes:
1. Value calculated as one module rank in this operating condition; all other module ranks in IDD2P (CKE LOW) mode.
2. Value calculated reflects all module ranks in this operating condition.

Table 12: DDR2 IDD Specifications and Conditions (Die Revision A) – 1GB

Values shown for MT47H64M16 DDR2 SDRAM only and are computed from values specified in the 1GB (64 Meg x 16) component data sheet

Parameter/Condition		Symbol	-667	-53E	-40E	Units
Operating one bank active-precharge current: tCK = tCK (IDD), tRC = tRC (IDD), tRAS = tRAS MIN (IDD); CKE is HIGH, S# is HIGH between valid commands; Address bus inputs are switching; Data bus inputs are switching		IDD0[1]	560	460	440	mA
Operating one bank active-read-precharge current: IOUT = 0mA; BL = 4, CL = CL (IDD), AL = 0; tCK = tCK (IDD), tRC = tRC (IDD), tRAS = tRAS MIN (IDD), tRCD = tRCD (IDD); CKE is HIGH, S# is HIGH between valid commands; Address bus inputs are switching; Data pattern is same as IDD4W		IDD1[1]	540	500	460	mA
Precharge power-down current: All device banks idle; tCK = tCK (IDD); CKE is LOW; Other control and address bus inputs are stable; Data bus inputs are floating		IDD2P[2]	56	56	56	mA
Precharge quiet standby current: All device banks idle; tCK = tCK (IDD); CKE is HIGH, S# is HIGH; Other control and address bus inputs are stable; Data bus inputs are floating		IDD2Q[2]	520	360	320	mA
Precharge standby current: All device banks idle; tCK = tCK (IDD); CKE is HIGH, S# is HIGH; Other control and address bus inputs are switching; Data bus inputs are switching		IDD2N[2]	560	400	320	mA
Active power-down current: All device banks open; tCK = tCK (IDD); CKE is LOW; Other control and address bus inputs are stable; Data bus inputs are floating	Fast PDN exit MR[12] = 0	IDD3P[2]	320	280	280	mA
	Slow PDN exit MR[12] = 1		112	112	112	mA
Active standby current: All device banks open; tCK = tCK (IDD), tRAS = tRAS MAX (IDD), tRP = tRP (IDD); CKE is HIGH, S# is HIGH between valid commands; Other control and address bus inputs are switching; Data bus inputs are switching		IDD3N[2]	600	480	440	mA
Operating burst write current: All device banks open; Continuous burst writes; BL = 4, CL = CL (IDD), AL = 0; tCK = tCK (IDD), tRAS = tRAS MAX (IDD), tRP = tRP (IDD); CKE is HIGH, S# is HIGH between valid commands; Address bus inputs are switching; Data bus inputs are switching		IDD4W[1]	820	740	640	mA
Operating burst read current: All device banks open; Continuous burst reads; IOUT = 0mA; BL = 4, CL = CL (IDD), AL = 0; tCK = tCK (IDD), tRAS = tRAS MAX (IDD), tRP = tRP (IDD); CKE is HIGH, S# is HIGH between valid commands; Address bus inputs are switching; Data bus inputs are switching		IDD4R[1]	900	740	640	mA
Burst refresh current: tCK = tCK (IDD); REFRESH command at every tRFC (IDD) interval; CKE is HIGH, S# is HIGH between valid commands; Other control and address bus inputs are switching; Data bus inputs are switching		IDD5[2]	2,160	2,000	1,920	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		IDD6[2]	24	24	24	mA
Operating bank interleave read current: All device banks interleaving reads; IOUT = 0mA; BL = 4, CL = CL (IDD), AL = tRCD (IDD) - 1 × tCK (IDD); tCK = tCK (IDD), tRC = tRC (IDD), tRRD = tRRD (IDD), tRCD = tRCD (IDD); CKE is HIGH, S# is HIGH between valid commands; Address bus inputs are stable during deselects; Data bus inputs are switching		IDD7[1]	1,420	1,380	1,320	mA

Notes:
1. Value calculated as one module rank in this operating condition; all other module ranks in IDD2P (CKE LOW) mode.
2. Value calculated reflects all module ranks in this operating condition.

Table 13: DDR2 IDD Specifications and Conditions (Die Revision E) – 1GB

Values shown for MT47H64M16 DDR2 SDRAM only and are computed from values specified in the 1Gb (64 Meg x 16) component data sheet

Parameter/Condition		Symbol	-80E/ -800	-667	-53E	-40E	Units
Operating one bank active-precharge current: tCK = tCK (IDD), tRC = tRC (IDD), tRAS = tRAS MIN (IDD); CKE is HIGH, S# is HIGH between valid commands; Address bus inputs are switching; Data bus inputs are switching		IDD0[1]	628	568	468	468	mA
Operating one bank active-read-precharge current: IOUT = 0mA; BL = 4, CL = CL (IDD), AL = 0; tCK = tCK (IDD), tRC = tRC (IDD), tRAS = tRAS MIN (IDD), tRCD = tRCD (IDD); CKE is HIGH, S# is HIGH between valid commands; Address bus inputs are switching; Data pattern is same as IDD4W		IDD1[1]	728	548	508	488	mA
Precharge power-down current: All device banks idle; tCK = tCK (IDD); CKE is LOW; Other control and address bus inputs are stable; Data bus inputs are floating		IDD2P[2]	56	56	56	56	mA
Precharge quiet standby current: All device banks idle; tCK = tCK (IDD); CKE is HIGH, S# is HIGH; Other control and address bus inputs are stable; Data bus inputs are floating		IDD2Q[2]	600	520	360	320	mA
Precharge standby current: All device banks idle; tCK = tCK (IDD); CKE is HIGH, S# is HIGH; Other control and address bus inputs are switching; Data bus inputs are switching		IDD2N[2]	640	560	400	320	mA
Active power-down current: All device banks open; tCK = tCK (IDD); CKE is LOW; Other control and address bus inputs are stable; Data bus inputs are floating	Fast PDN exit MR[12] = 0	IDD3P[2]	320	240	240	240	mA
	Slow PDN exit MR[12] = 1		80	80	80	80	mA
Active standby current: All device banks open; tCK = tCK (IDD), tRAS = tRAS MAX (IDD), tRP = tRP (IDD); CKE is HIGH, S# is HIGH between valid commands; Other control and address bus inputs are switching; Data bus inputs are switching		IDD3N[2]	680	600	480	440	mA
Operating burst write current: All device banks open; Continuous burst writes; BL = 4, CL = CL (IDD), AL = 0; tCK = tCK (IDD), tRAS = tRAS MAX (IDD), tRP = tRP (IDD); CKE is HIGH, S# is HIGH between valid commands; Address bus inputs are switching; Data bus inputs are switching		IDD4W[1]	1,288	828	748	668	mA
Operating burst read current: All device banks open; Continuous burst reads; IOUT = 0mA; BL = 4, CL = CL (IDD), AL = 0; tCK = tCK (IDD), tRAS = tRAS MAX (IDD), tRP = tRP (IDD); CKE is HIGH, S# is HIGH between valid commands; Address bus inputs are switching; Data bus inputs are switching		IDD4R[1]	1,308	908	748	668	mA
Burst refresh current: tCK = tCK (IDD); REFRESH command at every tRFC (IDD) interval; CKE is HIGH, S# is HIGH between valid commands; Other control and address bus inputs are switching; Data bus inputs are switching		IDD5[2]	2,240	2,160	2,000	1,920	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		IDD6[2]	56	56	56	56	mA
Operating bank interleave read current: All device banks interleaving reads; IOUT = 0mA; BL = 4, CL = CL (IDD), AL = tRCD (IDD) - 1 × tCK (IDD); tCK = tCK (IDD), tRC = tRC (IDD), tRRD = tRRD (IDD), tRCD = tRCD (IDD); CKE is HIGH, S# is HIGH between valid commands; Address bus inputs are stable during deselects; Data bus inputs are switching		IDD7[1]	1,788	1,428	1,348	1,228	mA

Notes:
1. Value calculated as one module rank in this operating condition; all other module ranks in IDD2P (CKE LOW) mode.
2. Value calculated reflects all module ranks in this operating condition.

Serial Presence-Detect

Table 14: Serial Presence-Detect EEPROM DC Operating Conditions
All voltages referenced to V_{SS}; V_{DDSPD} = +1.7V to +3.6V

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} x 0.7	V_{DDSPD} + 0.5	V
Input low voltage: Logic 0; All inputs	V_{IL}	–0.6	V_{DDSPD} x 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}	0.10	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	ICC_R	0.4	1	mA
Power supply current, WRITE: SCL clock frequency = 100 kHz	ICC_W	2	3	mA

Table 15: Serial Presence-Detect EEPROM AC Operating Conditions
All voltages referenced to V_{SS}; V_{DDSPD} = +1.7V to +3.6V

Parameter/Condition	Symbol	Min	Max	Units	Notes
SCL LOW to SDA data-out valid	^tAA	0.2	0.9	µs	1
Time the bus must be free before a new transition can start	^tBUF	1.3	–	µs	
Data-out hold time	^tDH	200	–	ns	
SDA and SCL fall time	^tF	–	300	ns	2
Data-in hold time	$^tHD:DAT$	0	–	µs	
Start condition hold time	$^tHD:STA$	0.6	–	µs	
Clock HIGH period	^tHIGH	0.6	–	µs	
Noise suppression time constant at SCL, SDA inputs	^tI	–	50	ns	
Clock LOW period	^tLOW	1.3	–	µs	
SDA and SCL rise time	^tR	–	0.3	µs	2
SCL clock frequency	^fSCL	–	400	kHz	
Data-in setup time	$^tSU:DAT$	100	–	ns	
Start condition setup time	$^tSU:STA$	0.6	–	µs	3
Stop condition setup time	$^tSU:STO$	0.6	–	µs	
WRITE cycle time	^tWRC	–	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 (^tWRC) 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.

Table 16: Serial Presence-Detect Matrix

Byte	Description	Entry (Version)	256MB[1]	512MB	1GB
0	Number of SPD bytes used by Micron	128	80	80	80
1	Total number of bytes in SPD device	256	08	08	08
2	Fundamental memory type	DDR2 SDRAM	08	08	08
3	Number of row addresses on assembly	13	0D	0D	0D
4	Number of column addresses on assembly	9, 10	09	0A	0A
5	DIMM height and module ranks	30mm, dual rank	61	61	61
6	Module data width	64	40	40	40
7	Reserved	0	00	00	00
8	Module voltage interface levels	SSTL 1.8V	05	05	05
9	SDRAM cycle time, ^{t}CK (CL = MAX value, see byte 18)	-80E/800 -667 -53E -40E	– 30 3D 50	25 30 3D 50	25 30 3D 50
10	SDRAM access from clock, ^{t}AC (CL = MAX value, see byte 18)	-80E/800 -667 -53E -40E	– 45 50 60	40 45 50 60	40 45 50 60
11	Module configuration type	Non-ECC	00	00	00
12	Refresh rate/type	7.81µs/SELF	82	82	82
13	SDRAM device width (primary SDRAM)	16	10	10	10
14	Error-checking SDRAM data width	n/a	00	00	00
15	Reserved	0	00	00	00
16	Burst lengths supported	4, 8	0C	0C	0C
17	Number of banks on SDRAM device	4 or 8	04	04	08
18	CAS latencies supported	-80E -800 -667 (5, 4, 3) -53E/-40E (4, 3)	– – 38 18	30 70 38 18	30 70 38 18
19	Module thickness		01	01	01
20	DDR2 DIMM type	SODIMM	04	04	04
21	SDRAM module attributes	Unbuffered	00	00	00
22	SDRAM device attributes: weak driver (01) and 50Ω ODT (03)	-80E/-800/-667 -53E/-40E	–/–/03 01	03 01	03 01
23	SDRAM cycle time, ^{t}CK, MAX CL - 1	-80E -800 -667 -53E/-40E	– – 3D 50	3D 30 3D 50	3D 30 3D 50
24	SDRAM access from CK, ^{t}AC, MAX CL - 1	-80E/-800 -667 -53E -40E	– 45 50 60	40 45 50 60	40 45 50 60
25	SDRAM cycle time, ^{t}CK, MAX CL - 2	-80E -800 -667 -53E/-40E	– – 50 00	00 3D 50 00	00 3D 50 00
26	SDRAM access from CK, ^{t}AC, MAX CL - 2	-80E -800 -667 -53E/-40E	– – 45 00	00 40 45 00	00 40 45 00

Table 16: Serial Presence-Detect Matrix (continued)

Byte	Description	Entry (Version)	256MB[1]	512MB	1GB
27	MIN row precharge time, ^{t}RP		3C	3C	3C
28	MIN row active-to-row active, ^{t}RRD		28	28	28
29	MIN RAS#-to-CAS# delay, ^{t}RCD		3C	3C	3C
30	MIN active-to-precharge time, ^{t}RAS	-80E/-800 -667/-53E -40E	– 2D 28	2D 2D 28	2D 2D 28
31	Module rank density	256MB, 512MB, 1GB	20	40	80
32	Address and command setup time, $^{t}IS_{b}$	-80E/-800 -667 -53E -40E	– 20 25 35	17 20 25 35	17 20 25 35
33	Address and command hold time, $^{t}IH_{b}$	-80E/-800 -667 -53E -40E	– 27 37 47	25 27 37 47	25 27 37 47
34	Data/data mask input setup time, $^{t}DS_{b}$	-80E/-800 -667/-53E -40E	– 10 15	05 10 15	05 10 15
35	Data/data mask input hold time, $^{t}DH_{b}$	-80E/-800 -667 -53E -40E	– 17 22 27	12 17 22 27	12 17 22 27
36	Write recovery time, ^{t}WR		3C	3C	3C
37	WRITE-to-READ command delay, ^{t}WTR	-80E/-667/-53E -800/-40E	–/1E/1E –/28	1E 28	1E 28
38	READ-to-PRECHARGE command delay, ^{t}RTP	-80E/-800 -667/-53E/-40E	– 1E	1E 1E	1E 1E
39	Memory analysis probe		00	00	00
40	Extension for bytes 41 and 42	-80E -800 -667/-53E/-40E	– – 00	30 00 00	36 06 06
41	MIN active-to-active/refresh time, ^{t}RC[2]	-80E -800/-667/-53E -40E	– –/3C 37	39 3C 37	39 3C 37
42	MIN AUTO REFRESH-to-ACTIVE/ AUTO REFRESH command period, ^{t}RFC		4B	69	7F
43	SDRAM device MAX cycle time, ^{t}CK (MAX)		80	80	80
44	SDRAM device MAX DQS-DQ skew time, $^{t}DQSQ$	-80E/-800 -667 -53E -40E	– 18 1E 23	14 18 1E 23	14 18 1E 23
45	SDRAM device MAX read data hold skew factor, ^{t}QHS	-80E/-800 -667 -53E -40E	– 22 28 2D	1E 22 28 2D	1E 22 28 2D
46	PLL relock time		00	00	00
47–61	Optional features, not supported		00	00	00
62	SPD revision	Release 1.2	12	12	12

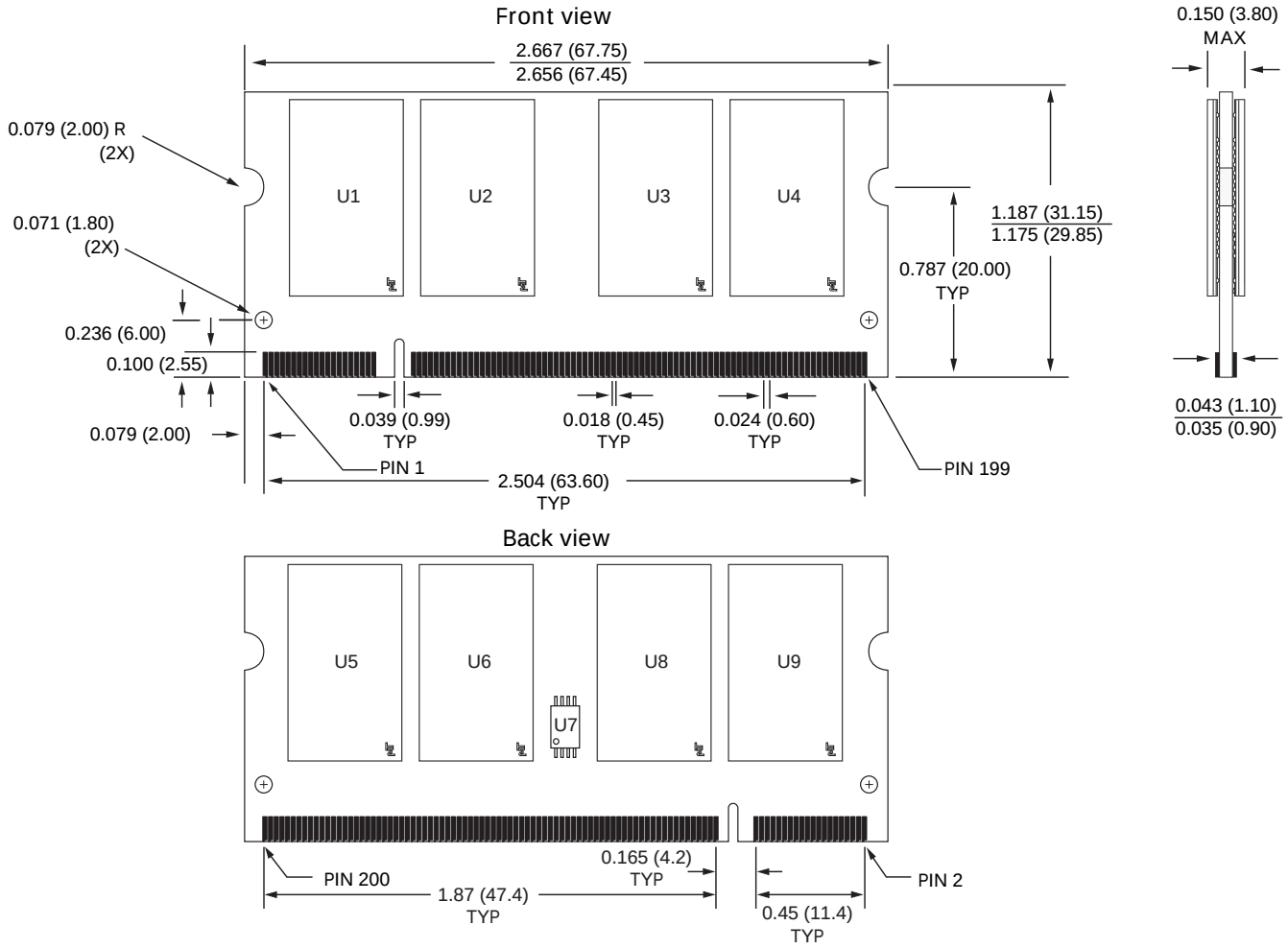
Table 16: Serial Presence-Detect Matrix (continued)

Byte	Description	Entry (Version)	256MB[1]	512MB	1GB
63	Checksum for bytes 0–62	-80E -800 -667 -53E -40E	– – E0 8B F2	63 04 1F CA 31	C3 64 7F 2A 91
64	Manufacturer's JEDEC ID code	MICRON	2C	2C	2C
65–71	Manufacturer's JEDEC ID code	(continued)	FF	FF	FF
72	Manufacturing location	1–12	01–0C	01–0C	01–0C
73–90	Module part number (ASCII)	–	Variable data	Variable data	Variable data
91	PCB identification code	1–9	01–09	01–09	01–09
92	Identification code (continued)	0	00	00	00
93	Year of manufacture in BCD	–	Variable data	Variable data	Variable data
94	Week of manufacture in BCD	–	Variable data	Variable data	Variable data
95–98	Module serial number	–	Variable data	Variable data	Variable data
99–127	Reserved for manufacturer-specific data		00	00	00
128–255	Reserved for customer-specific data		FF	FF	FF

Notes:
1. The 256MB module is not available in -80E and -800 speed grades.
2. The ^{t}RC SPD values shown are JEDEC DDR2 device specification values. The actual Micron DDR2 device specification is ^{t}RC = 55ns for all speed grades.

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 complete design dimensions.

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