DDR2 SDRAM UDIMM

MT4HTF1664A – 128MB[1]

MT4HTF3264A – 256MB

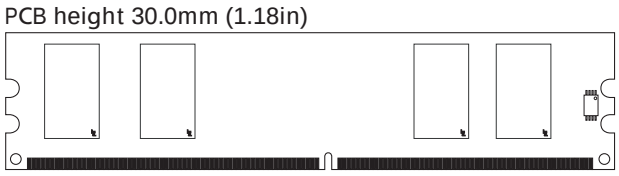
MT4HTF6464A – 512MB

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

Features

- 240-pin, unbuffered dual in-line memory module (UDIMM)
- Fast data transfer rates: PC2-3200, PC2-4200, PC2-5300 or PC2-6400
- 128MB (16 Meg x 64), 256MB (32 Meg x 64), 512MB (64 Meg x 64)
- $V_{DD} = V_{DD}Q = +1.8V$
- $V_{DDSPD} = +1.7V$ to $+3.6V$
- JEDEC-standard 1.8V I/O (SSTL_18-compatible)
- Differential data strobe (DQS, DQS#) option
- 4*n*-bit prefetch architecture
- Single 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: 240-Pin UDIMM (MO-237 R/C C)



Options — Marking

- Operating temperature
  - Commercial ($0°C \le T_C \le +85°C$) — None
  - Industrial ($–40°C \le T_C \le +95°C$)[2, 3, 4] — I
- Package
  - 240-pin DIMM (Pb-free) — Y
- Frequency/CAS latency
  - 2.5ns @ CL = 5 (DDR2-800)[4] — -80E
  - 2.5ns @ CL = 6 (DDR2-800)[4] — -800
  - 3.0ns @ CL = 5 (DDR2-667) — -667
  - 3.75ns @ CL = 4 (DDR2-533)[3] — -53E
  - 5.0ns @ CL = 3 (DDR2-400)[3] — -40E
- PCB height
  - 30mm (1.18in)

Notes: 1. End of life.
2. Contact Micron for industrial temperature module offerings.
3. Contact Micron for product availability.
4. Not available in 128MB module density.

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

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Table 2: Addressing

Parameter	128MB	256MB	512MB
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–BA2)
Device page size per bank	1KB	2KB	2KB
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	1 (S0#)	1 (S0#)	1 (S0#)

Table 3: Part Numbers and Timing Parameters – 128MB 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)
MT4HTF1664AY-667__	128MB	16 Meg x 64	5.3 GB/s	3.0ns/667 MT/s	5-5-5
MT4HTF1664AY-53E__	128MB	16 Meg x 64	4.3 GB/s	3.75ns/533 MT/s	4-4-4
MT4HTF1664AY-40E__	128MB	16 Meg x 64	3.2 GB/s	5.0ns/400 MT/s	3-3-3

Table 4: Part Numbers and Timing Parameters – 256MB 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)
MT4HTF3264A(I)Y-80E__	256MB	32 Meg x 64	6.4 GB/s	2.5ns/800 MT/s	5-5-5
MT4HTF3264A(I)Y-800__	256MB	32 Meg x 64	6.4 GB/s	2.5ns/800 MT/s	6-6-6
MT4HTF3264A(I)Y-667__	256MB	32 Meg x 64	5.3 GB/s	3.0ns/667 MT/s	5-5-5
MT4HTF3264A(I)Y-53E__	256MB	32 Meg x 64	4.3 GB/s	3.75ns/533 MT/s	4-4-4
MT4HTF3264A(I)Y-40E__	256MB	32 Meg x 64	3.2 GB/s	5.0ns/400 MT/s	3-3-3

Table 5: 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	Latency (CL-^{t}RCD-^{t}RP)
MT4HTF6464A(I)Y-80E__	512MB	64 Meg x 64	6.4 GB/s	2.5ns/800 MT/s	5-5-5
MT4HTF6464A(I)Y-800__	512MB	64 Meg x 64	6.4 GB/s	2.5ns/800 MT/s	6-6-6
MT4HTF6464A(I)Y-667__	512MB	64 Meg x 64	5.3 GB/s	3.0ns/667 MT/s	5-5-5
MT4HTF6464A(I)Y-53E__	512MB	64 Meg x 64	4.3 GB/s	3.75ns/533 MT/s	4-4-4
MT4HTF6464A(I)Y-40E__	512MB	64 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: MT4HTF3264AY-667E1.

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Pin Assignments and Descriptions

Table 6: Pin Assignments

240-Pin UDIMM Front							
Pin	Symbol	Pin	Symbol	Pin	Symbol	Pin	Symbol
1	VREF	31	DQ19	61	A4	91	VSS
2	VSS	32	VSS	62	VDDQ	92	DQS5#
3	DQ0	33	DQ24	63	A2	93	DQS5
4	DQ1	34	DQ25	64	VDD	94	VSS
5	VSS	35	VSS	65	VSS	95	DQ42
6	DQS0#	36	DQS3#	66	VSS	96	DQ43
7	DQS0	37	DQS3	67	VDD	97	VSS
8	VSS	38	VSS	68	NC	98	DQ48
9	DQ2	39	DQ26	69	VDD	99	DQ49
10	DQ3	40	DQ27	70	A10	100	VSS
11	VSS	41	VSS	71	BA0	101	SA2
12	DQ8	42	NC	72	VDDQ	102	NC
13	DQ9	43	NC	73	WE#	103	VSS
14	VSS	44	VSS	74	CAS#	104	DQS6#
15	DQS1#	45	NC	75	VDDQ	105	DQS6
16	DQS1	46	NC	76	NC	106	VSS
17	VSS	47	VSS	77	NC	107	DQ50
18	NC	48	NC	78	VDDQ	108	DQ51
19	NC	49	NC	79	VSS	109	VSS
20	VSS	50	VSS	80	DQ32	110	DQ56
21	DQ10	51	VDDQ	81	DQ33	111	DQ57
22	DQ11	52	CKE0	82	VSS	112	VSS
23	VSS	53	VDD	83	DQS4#	113	DQS7#
24	DQ16	54	NC/BA2[1]	84	DQS4	114	DQS7
25	DQ17	55	NC	85	VSS	115	VSS
26	VSS	56	VDDQ	86	DQ34	116	DQ58
27	DQS2#	57	A11	87	DQ35	117	DQ59
28	DQS2	58	A7	88	VSS	118	VSS
29	VSS	59	VDD	89	DQ40	119	SDA
30	DQ18	60	A5	90	DQ41	120	SCL

240-Pin UDIMM Back							
Pin	Symbol	Pin	Symbol	Pin	Symbol	Pin	Symbol
121	VSS	151	VSS	181	VDDQ	211	DM5
122	DQ4	152	DQ28	182	A3	212	NC
123	DQ5	153	DQ29	183	A1	213	VSS
124	VSS	154	VSS	184	VDD	214	DQ46
125	DM0	155	DM3	185	CK0	215	DQ47
126	NC	156	NC	186	CK0#	216	VSS
127	VSS	157	VSS	187	VDD	217	DQ52
128	DQ6	158	DQ30	188	A0	218	DQ53
129	DQ7	159	DQ31	189	VDD	219	VSS
130	VSS	160	VSS	190	BA1	220	CK2
131	DQ12	161	NC	191	VDDQ	221	CK2#
132	DQ13	162	NC	192	RAS#	222	VSS
133	VSS	163	VSS	193	S0#	223	DM6
134	DM1	164	NC	194	VDDQ	224	NC
135	NC	165	NC	195	ODT0	225	VSS
136	VSS	166	VSS	196	NC	226	DQ54
137	CK1	167	NC	197	VDD	227	DQ55
138	CK1#	168	NC	198	VSS	228	VSS
139	VSS	169	VSS	199	DQ36	229	DQ60
140	DQ14	170	VDDQ	200	DQ37	230	DQ61
141	DQ15	171	NC	201	VSS	231	VSS
142	VSS	172	VDD	202	DM4	232	DM7
143	DQ20	173	NC	203	NC	233	NC
144	DQ21	174	NC	204	VSS	234	VSS
145	VSS	175	VDDQ	205	DQ38	235	DQ62
146	DM2	176	A12	206	DQ39	236	DQ63
147	NC	177	A9	207	VSS	237	VSS
148	VSS	178	VDD	208	DQ44	238	VDDSPD
149	DQ22	179	A8	209	DQ45	239	SA0
150	DQ23	180	A6	210	VSS	240	SA1

Notes: 1. Pin 54 is NC for 128MB and 256MB or BA2 for 512MB.

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Table 7: Pin Descriptions

Symbol	Type	Description
ODT0	Input (SSTL_18)	**On-die termination:** ODT (registered HIGH) enables termination resistance internal to the DDR2 SDRAM. When enabled, ODT is only applied to the following pins: DQ, DQS, DQS#, and CB. The ODT input will be ignored if disabled via the LOAD MODE command.
CK0, CK0#, CK1, CK1#, CK2, CK2#	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	Input (SSTL_18)	**Clock enable:** CKE (registered HIGH) activates and CKE (registered LOW) deactivates clocking circuitry on the DDR2 SDRAM.
S0#	Input (SSTL_18)	**Chip select:** S# enables (registered LOW) and disables (registered HIGH) the command decoder.
RAS#, CAS#, WE#	Input (SSTL_18)	**Command inputs:** RAS#, CAS#, and WE# (along with S#) define the command being entered.
BA0, BA1 (128MB, 256MB) BA0–BA2 (512MB)	Input (SSTL_18)	**Bank address inputs:** BA0–BA2 define to which device bank an ACTIVE, READ, WRITE, or PRECHARGE command is being applied. BA0–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–BA2) or all device banks (A10 HIGH). The address inputs also provide the op-code during a LOAD MODE command.
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–SA2	Input (SSTL_18)	**Presence-detect address inputs:** These pins are used to configure the presence-detect device.
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.
DM0–DM7	I/O (SSTL_18)	**Data input 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.
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}/V_{DD}Q	Supply	**Power supply:** 1.8V ±0.1V.
V_{REF}	Supply	SSTL_18 reference voltage.
V_{SS}	Supply	Ground.
V_{DDSPD}	Supply	**Serial EEPROM positive power supply:** +1.7V to +3.6V.
NC	–	**No connect:** These pins should be left unconnected.

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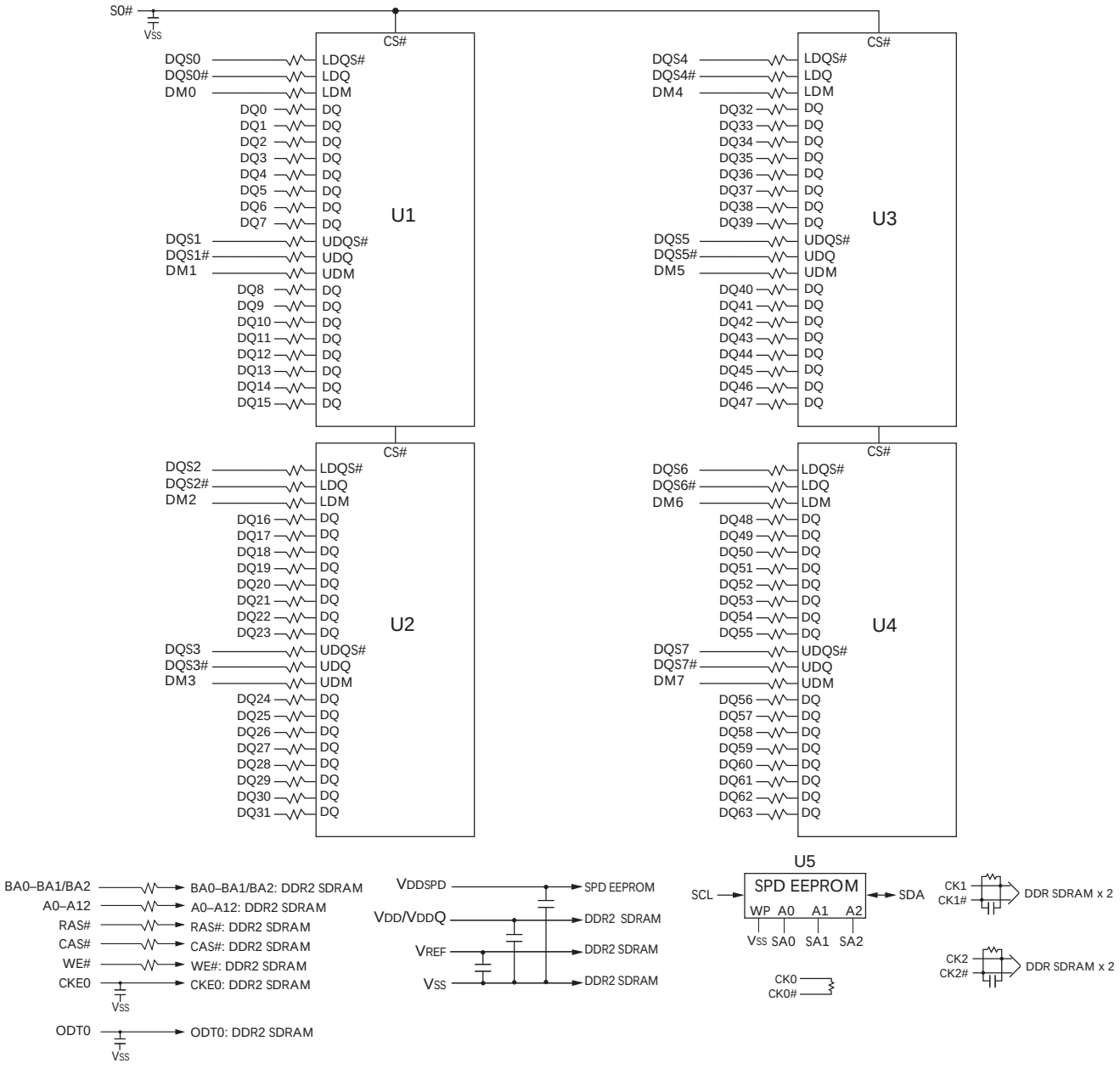
Functional Block Diagram

Figure 2: Functional Block Diagram



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General Description

The MT4HTF1664A, MT4HTF3264A, and MT4HTF6464A DDR2 SDRAM modules are high-speed, CMOS, dynamic random-access 128MB, 256MB, and 512MB memory modules organized in a x64 configuration. These 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 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 I^2C bus using the DIMM's SCL (clock) and SDA (data) signals, together with SA (2:0), which provide eight unique DIMM/EEPROM addresses. Write protect (WP) is tied to V_{SS} on the module, permanently disabling hardware write protect.

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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_{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 $0V \le V_{IN} \le V_{DD}$; V_{REF} input $0V \le V_{IN} \le 0.95V$ (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; $0V \le V_{OUT} \le V_{DDQ}$; DQs and ODT are disabled	DQ, DQS, DQS#	–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	°C
		Industrial	–40	+85	°C
T_C[1]	DDR2 SDRAM device case operating temperature[2]	Commercial	0	+85	°C
		Industrial	–40	+95	°C

Notes:
1. The refresh rate is required to double when $85°C < T_C \le 95°C$.
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	-3
-53E	-37E
-40E	-5E

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IDD Specifications

Table 10: DDR2 IDD Specifications and Conditions – 128MB

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	360	320	300	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	400	360	340	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	20	20	20	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	200	140	100	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	160	140	120	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	120	100	80	mA
	Slow PDN exit MR[12] = 1		24	24	24	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	220	160	120	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	860	720	560	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	760	640	480	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	720	680	660	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	20	20	20	mA
Operating bank interleave read current: All device banks interleaving reads; IOUT = 0mA; BL = 4, C = 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	1,000	960	920	mA

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Table 11: DDR2 IDD Specifications and Conditions – 256MB

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: 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	540	480	440	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	660	600	540	520	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	28	28	28	28	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	260	220	180	160	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	280	240	200	180	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	160	140	120	100	mA
	Slow PDN exit MR[12] = 1		48	48	48	48	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	300	280	240	200	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	1,180	1,000	820	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	1,100	940	780	620	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	920	740	700	680	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	28	28	28	28	mA
Operating bank interleave read current: All device banks interleaving reads; IOUT = 0mA; BL = 4, C = 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	1,480	1,400	1,360	1,360	mA

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Table 12: DDR2 IDD Specifications and Conditions (Die Revision A) – 512MB
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	600	540	440	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	700	520	480	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	28	28	28	28	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	300	260	180	160	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	320	280	200	160	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	180	160	140	140	mA
	Slow PDN exit MR[12] = 1		56	56	56	56	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	340	300	240	220	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	1,260	800	720	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	1,280	880	720	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	1,120	1,080	1,000	960	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	28	28	28	28	mA
Operating bank interleave read current: All device banks interleaving reads; IOUT = 0mA; BL = 4, C = 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	1,760	1,400	1,360	1,320	mA

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Table 13: DDR2 IDD Specifications and Conditions (Die Revision E) – 512MB
Values shown for MT47H64M16 DDR2 SDRAM only and are computed from values specified in the 1Gb (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	600	540	440	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	700	520	480	460	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	28	28	28	28	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	300	260	180	160	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	320	280	200	160	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	160	120	120	120	mA
	Slow PDN exit MR[12] = 1		40	40	40	40	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	340	300	240	220	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	1,260	800	720	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	1,280	880	720	640	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	1,120	1,080	1,000	960	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	28	28	28	28	mA
Operating bank interleave read current: All device banks interleaving reads; IOUT = 0mA; BL = 4, C = 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	1,760	1,400	1,320	1,200	mA

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Serial Presence-Detect

Table 14: Serial Presence-Detect EEPROM DC Operating Conditions
All voltages referenced to V_{SS}

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} × 0.7	V_{DDSPD} + 0.5	V
Input low voltage: Logic 0; All inputs	V_{IL}	–0.6	V_{DDSPD} × 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}

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 the pull-up resistance, and the EEPROM does not respond to its slave address.

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Table 16: Serial Presence-Detect Matrix

Byte	Description	Entry (Version)	128MB[1]	256MB	512MB
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 SDRAM	13	0D	0D	0D
4	Number of column addresses on SDRAM	09 or 10	09	0A	0A
5	DIMM height and module ranks	30mm, single rank	60	60	60
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 25 30 3D 50	25 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	0	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 (5, 4) -800 (6, 5, 4) -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	Unbuffered DIMM	02	02	02
21	SDRAM module attributes	No PLL or Reg	00	00	00
22	SDRAM device attributes: weak driver (01) or, weak driver 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/-667 -800 -53E/-40E	–/3D – 50	3D 30 50	3D 30 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

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Table 16: Serial Presence-Detect Matrix (continued)

Byte	Description	Entry (Version)	128MB[1]	256MB	512MB
27	MIN row precharge time, ^{t}RP	-80E -800/-667 -53E/-40E	– –/3C 3C	32 3C 3C	32 3C 3C
28	MIN row active-to-row active, ^{t}RRD	–	28	28	28
29	MIN RAS#-to-CAS# delay, ^{t}RCD	-80E -800/-667 -53E/-40E	– –/3C 3C	32 3C 3C	32 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	128MB, 256MB, 512MB	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	–	1E	1E	1E
39	Memory analysis probe	–	00	00	00
40	Extension for bytes 41 and 42	-80E -800/-667 -53E/-40E	– –/00 00	30 00 00	36 06 06
41	MIN active-to-active/refresh time, ^{t}RC[2]	-80E -800/-667/-53E -40E	– –/3C/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

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Table 16: Serial Presence-Detect Matrix (continued)

Byte	Description	Entry (Version)	128MB[1]	256MB	512MB
46	PLL relock time	n/a	00	00	00
47–61	Optional features, not supported	–	00	00	00
62	SPD revision	Release 1.2	12	12	12
63	Checksum for bytes 0–62	-80E -800 -667 -53E -40E	– – DD 88 EF	60 01 1C C7 2E	C0 61 7C 27 8E
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 128MB module is not available in -80E or -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.

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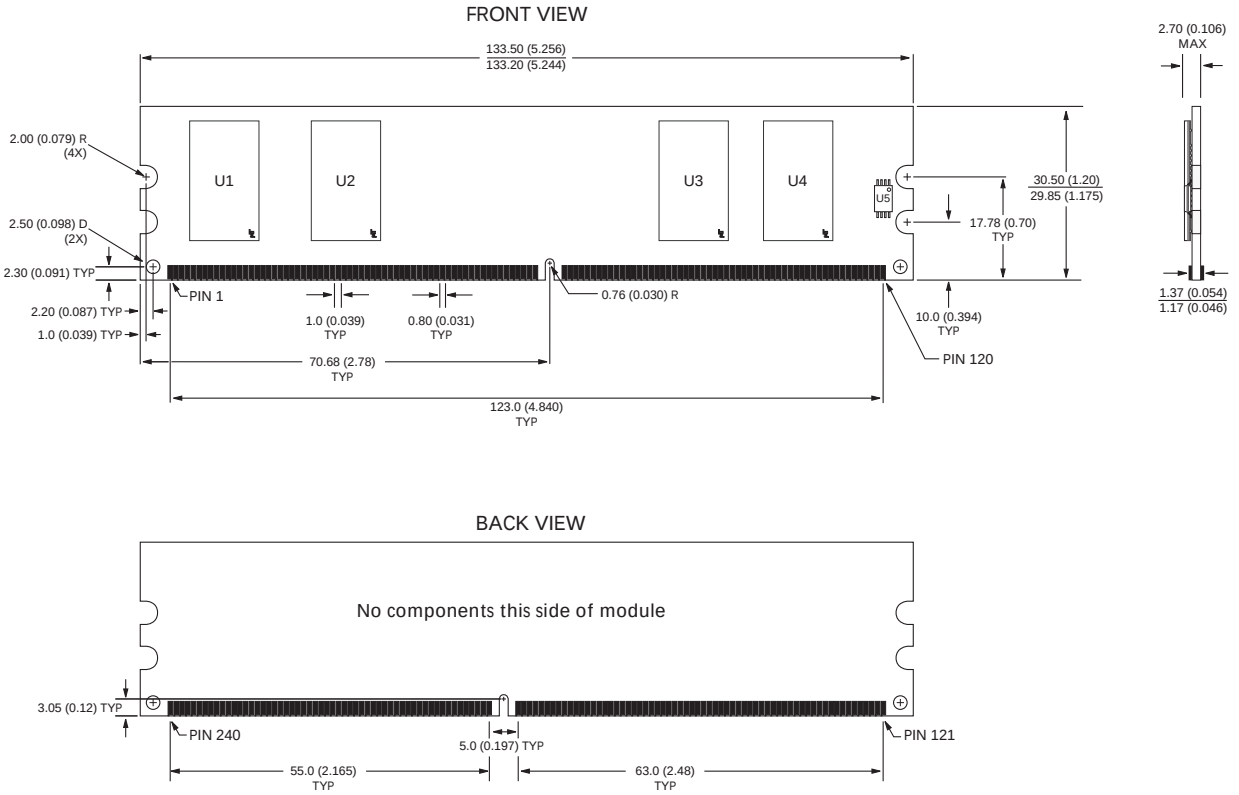
Module Dimensions

Figure 3: 240-Pin DDR2 UDIMM



Notes:
1. All dimensions are in millimeters (inches), MAX/MIN or 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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This data sheet contains minimum and maximum limits specified over the complete power supply and temperature range for production devices. Although considered final, these specifications are subject to change, as further product development and data characterization sometimes occur.

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