

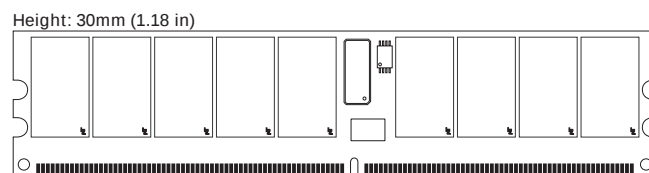
DDR2 SDRAM Registered DIMM (RDIMM)

MT9HTF3272(P) – 256MB
MT9HTF6472(P) – 512MB
MT9HTF12872(P) – 1GB

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

Features

- Supports 95°C with double refresh
- 240-pin, registered dual in-line memory module
- Fast data transfer rates: PC2-3200, PC2-4200, PC2-5300, or PC2-6400
- Supports ECC error detection and correction
- $V_{DD} = V_{DDQ} = +1.8V$
- $V_{DDSPD} = +1.7V$ to $+3.6V$
- JEDEC-standard 1.8V I/O (SSTL_18-compatible)
- Differential data strobe (DQS, DQS#) option
- 4-bit prefetch architecture
- DLL to align DQ and DQS transitions with CK
- 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 (BL): 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 DIMM (MO-237 R/C "A")


Options

- Parity
- Package
 - 240-pin DIMM (lead-free)
- Frequency/CAS latency¹
 - 2.5ns @ CL = 5 (DDR2-800)²
 - 2.5ns @ CL = 6 (DDR2-800)²
 - 3.0ns @ CL = 5 (DDR2-667)³
 - 3.75ns @ CL = 4 (DDR2-533)
 - 5.0ns @ CL = 3 (DDR2-400)
- PCB height
 - 30mm (1.18 in)

Marking

P
Y
-80E
-800
-667
-53E
-40E

- Notes: 1. CL = CAS (READ) latency; registered mode will add one clock cycle to CL.
 2. Not available in 256MB module density.
 3. Contact Micron for product availability.

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	800	533	–	12.5	12.5	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)	16K (A0–A13)	16K (A0–A13)
Device bank address	4 (BA0, BA1)	4 (BA0, BA1)	8 (BA0, BA1, BA2)



256MB, 512MB, 1GB (x72, ECC, SR): 240-Pin DDR2 SDRAM RDIMM Features

Table 2: Addressing (continued)

	256MB	512MB	1GB
Device page size per bank	1KB	1KB	1KB
Device configuration	256Mb (32 Meg x 8)	512Mb (64 Meg x 8)	1Gb (128 Meg x 8)
Column address	1K (A0–A9)	1K (A0–A9)	1K (A0–A9)
Module rank address	1 (S0#)	1 (S0#)	1 (S0#)

Notes: 1. All part numbers end with a two-place code (not shown), designating component and PCB revisions. Consult factory for current revision codes. Example: MT9HTF6472Y-667C2.

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

Base device: MT47H32M8, 256Mb DDR2 SDRAM – www.micron.com

Part Number ¹	Module Density	Configuration	Module Bandwidth	Memory Clock/ Data Rate	Latency (CL - ^t RCD - ^t RP)
MT9HTF3272(P)Y-667__	256MB	32 Meg x 72	5.3 GB/s	3.0ns/667MT/s	5-5-5
MT9HTF3272(P)Y-53E__	256MB	32 Meg x 72	4.3 GB/s	3.75ns/533 MT/s	4-4-4
MT9HTF3272(P)Y-40E__	256MB	32 Meg x 72	3.2 GB/s	5.0ns/400MT/s	3-3-3

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

Base device: MT47H64M8, 512Mb DDR2 SDRAM – www.micron.com

Part Number ¹	Module Density	Configuration	Module Bandwidth	Memory Clock/ Data Rate	Latency (CL - ^t RCD - ^t RP)
MT9HTF6472(P)Y-80E__	512MB	64 Meg x 72	6.2 GB/s	2.5ns/800 MT/s	5-5-5
MT9HTF6472(P)Y-800__	512MB	64 Meg x 72	6.2 GB/s	2.5ns/800 MT/s	6-6-6
MT9HTF6472(P)Y-667__	512MB	64 Meg x 72	5.3 GB/s	3.0ns/667MT/s	5-5-5
MT9HTF6472(P)Y-53E__	512MB	64 Meg x 72	4.3 GB/s	3.75ns/533 MT/s	4-4-4
MT9HTF6472(P)Y-40E__	512MB	64 Meg x 72	3.2 GB/s	5.0ns/400MT/s	3-3-3

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

Base device: MT47H128M8, 1Gb DDR2 SDRAM – www.micron.com

Part Number ¹	Module Density	Configuration	Module Bandwidth	Memory Clock/ Data Rate	Latency (CL - ^t RCD - ^t RP)
MT9HTF12872(P)Y-80E__	1GB	128 Meg x 72	6.2 GB/s	2.5ns/800 MT/s	5-5-5
MT9HTF12872(P)Y-800__	1GB	128 Meg x 72	6.2 GB/s	2.5ns/800 MT/s	6-6-6
MT9HTF12872(P)Y-667__	1GB	128 Meg x 72	5.3 GB/s	3.0ns/667MT/s	5-5-5
MT9HTF12872(P)Y-53E__	1GB	128 Meg x 72	4.3 GB/s	3.75ns/533 MT/s	4-4-4
MT9HTF12872(P)Y-40E__	1GB	128 Meg x 72	3.2 GB/s	5.0ns/400MT/s	3-3-3



Pin Assignments and Descriptions

Table 6: Pin Assignments

240-Pin RDIMM Front								240-Pin RDIMM Back							
Pin	Symbol	Pin	Symbol	Pin	Symbol	Pin	Symbol	Pin	Symbol	Pin	Symbol	Pin	Symbol	Pin	Symbol
1	VREF	31	DQ19	61	A4	91	Vss	121	Vss	151	Vss	181	VDDQ	211	DM5/ DQS14
2	Vss	32	Vss	62	VDDQ	92	DQS5#	122	DQ4	152	DQ28	182	A3	212	NC/ DQS14#
3	DQ0	33	DQ24	63	A2	93	DQS5	123	DQ5	153	DQ29	183	A1	213	Vss
4	DQ1	34	DQ25	64	VDD	94	Vss	124	Vss	154	Vss	184	VDD	214	DQ46
5	Vss	35	Vss	65	Vss	95	DQ42	125	DM0/ DQS9	155	DM3/ DQS12	185	CK0	215	DQ47
6	DQS0#	36	DQS3#	66	Vss	96	DQ43	126	NC/ DQS9#	156	NC/ DQS12#	186	CK0#	216	Vss
7	DQS0	37	DQS3	67	VDD	97	Vss	127	Vss	157	Vss	187	VDD	217	DQ52
8	Vss	38	Vss	68	PAR_IN	98	DQ48	128	DQ6	158	DQ30	188	A0	218	DQ53
9	DQ2	39	DQ26	69	VDD	99	DQ49	129	DQ7	159	DQ31	189	VDD	219	Vss
10	DQ3	40	DQ27	70	A10/AP	100	Vss	130	Vss	160	Vss	190	BA1	220	RFU
11	Vss	41	Vss	71	BA0	101	SA2	131	DQ12	161	CB4	191	VDDQ	221	RFU
12	DQ8	42	CB0	72	VDDQ	102	NC	132	DQ13	162	CB5	192	RAS#	222	Vss
13	DQ9	43	CB1	73	WE#	103	Vss	133	Vss	163	Vss	193	SO#	223	DM6/ DQS15
14	Vss	44	Vss	74	CAS#	104	DQS6#	134	DM1/ DQS10	164	DM8/ DQS17	194	VDDQ	224	NC/ DQS15#
15	DQS1#	45	DQS8#	75	VDDQ	105	DQS6	135	NC/ DQS10#	165	NC/ DQS17#	195	ODT0	225	Vss
16	DQS1	46	DQS8	76	S1#	106	Vss	136	Vss	166	Vss	196	NC/A13	226	DQ54
17	Vss	47	Vss	77	ODT1	107	DQ50	137	RFU	167	CB6	197	VDD	227	DQ55
18	RESET#	48	CB2	78	VDDQ	108	DQ51	138	RFU	168	CB7	198	Vss	228	Vss
19	NC	49	CB3	79	Vss	109	Vss	139	Vss	169	Vss	199	DQ36	229	DQ60
20	Vss	50	Vss	80	DQ32	110	DQ56	140	DQ14	170	VDDQ	200	DQ37	230	DQ61
21	DQ10	51	VDDQ	81	DQ33	111	DQ57	141	DQ15	171	CKE1	201	Vss	231	Vss
22	DQ11	52	CKE0	82	Vss	112	Vss	142	Vss	172	VDD	202	DM4/ DQS13	232	DM7/ DQS16
23	Vss	53	VDD	83	DQS4#	113	DQS7#	143	DQ20	173	NC	203	NC/ DQS13#	233	NC/ DQS16#
24	DQ16	54	NC/BA2	84	DQS4	114	DQS7	144	DQ21	174	NC	204	Vss	234	Vss
25	DQ17	55	ERR_OUT	85	Vss	115	Vss	145	Vss	175	VDDQ	205	DQ38	235	DQ62
26	Vss	56	VDDQ	86	DQ34	116	DQ58	146	DM2/ DQS11	176	A12	206	DQ39	236	DQ63
27	DQS2#	57	A11	87	DQ35	117	DQ59	147	NC/ DQS11#	177	A9	207	Vss	237	Vss
28	DQS2	58	A7	88	Vss	118	Vss	148	Vss	178	VDD	208	DQ44	238	VDDSPD
29	Vss	59	VDD	89	DQ40	119	SDA	149	DQ22	179	A8	209	DQ45	239	SA0
30	DQ18	60	A5	90	DQ41	120	SCL	150	DQ23	180	A6	210	Vss	240	SA1

Note: Pin 196 is NC for 256MB or A13 for 512MB and 1GB. Pin 54 is NC for 256MB or BA2 for 1GB.

Table 7: Pin Descriptions

Pin numbers may not correlate with symbols; refer to Table 6 on page 3 for more information

Symbol	Type	Description
ODT0	Input (SSTL18)	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#	Input (SSTL18)	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 (SSTL18)	Clock enable: CKE (registered HIGH) activates and CKE (registered LOW) deactivates clocking circuitry on the DDR2 SDRAM.
S0#	Input (SSTL18)	Chip select: S# enables (registered LOW) and disables (registered HIGH) the command decoder.
RAS#, CAS#, WE#	Input (SSTL18)	Command inputs: RAS#, CAS#, and WE# (along with S#) define the command being entered.
BA0, BA1 (256MB, 512MB) BA0, BA1, BA2 (1GB)	Input (SSTL18)	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 (256MB) A0–A13 (512MB, 1GB)	Input (SSTL18)	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.
PAR_IN	Input (SSTL18)	Parity bit for the address and control bus.
SCL	Input	Serial clock for presence-detect: SCL is used to synchronize the presence-detect data transfer to and from the module.
SA0–SA2	Input	Presence-detect address inputs: These pins are used to configure the presence-detect device.
RESET#	Input (LVCMOS)	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 DQs are High-Z.
DQS0–DQS8, DQS0#–DQS17# DM0–DM8 (DQS9–DQS17)	I/O (SSTL18)	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. 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. If RDQS is disabled, DQS0–DQS17 become DM0–DM8 and DQS9#–DQS17# are not used.
DQ0–DQ63	I/O (SSTL18)	Data input/output: Bidirectional data bus.
CB0–CB7	I/O (SSTL18)	Check bits.
SDA	I/O	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.
ERR_OUT	Output (open drain)	Parity error found on the address and control bus.
VDD	Supply	Power supply: 1.8V ±0.1V.
VDDQ	Supply	DQ power supply: 1.8V ±0.1V.
VREF	Supply	SSTL_18 reference voltage.



256MB, 512MB, 1GB (x72, ECC, SR): 240-Pin DDR2 SDRAM RDIMM Pin Assignments and Descriptions

Table 7: Pin Descriptions (continued)

Pin numbers may not correlate with symbols; refer to Table 6 on page 3 for more information

Symbol	Type	Description
Vss	Supply	Ground.
VDDSPD	Supply	Serial EEPROM positive power supply: +1.7V to +3.6V.
NC	–	No connect: These pins should be left unconnected.
RFU	–	Reserved for future use.

Figure 2: Functional Block Diagram



General Description

The MT9HTF3272, MT9HTF6472, and MT9HTF12872 DDR2 SDRAM modules are high-speed, CMOS, dynamic random-access 256MB, 512MB, and 1GB memory modules organized in x72 configuration. These DDR2 SDRAM modules use internally configured quad-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 $4n$ -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 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 (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.

PLL and Register Operation

DDR2 SDRAM modules operate in registered mode, where the command/address input signals are latched in the registers on the rising clock edge and sent to the DDR2 SDRAM devices on the following rising clock edge (data access is delayed by one clock cycle). A phase-lock loop (PLL) on the module receives and redrives the differential clock signals (CK, CK#) to the DDR2 SDRAM devices. The registers and PLL minimize system and clock loading. PLL clock timing is defined by JEDEC specifications and ensured by use of the JEDEC clock reference board. Registered mode will add one clock cycle to CL.

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 I²C 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 ground on the module, permanently disabling hardware write protect.

Electrical Specifications

Stresses greater than those listed in Table 8 may cause permanent damage to the device. This is a stress rating only, and functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.

Table 8: Absolute Maximum DC Ratings

Symbol	Parameter		Min	Max	Units
VDD	VDD supply voltage relative to Vss		−1.0	2.3	V
VDDQ	VDDQ supply voltage relative to Vss		−0.5	2.3	V
VDDL	VDDL supply voltage relative to Vss		−0.5	2.3	V
VIN, VOUT	Voltage on any pin relative to Vss		−0.5	2.3	V
T _{STG}	Storage temperature		−55	100	°C
T _{CASE}	DDR2 SDRAM device operating temperature (ambient)		0	85	°C
T _{OPR}	Operating temperature (ambient)		0	65	°C
I _I	Input leakage current; Any input $0V \leq V_{IN} \leq V_{DD}$; VREF input $0V \leq V_{IN} \leq 0.95V$; (All other pins not under test = 0V)	Command/Address, RAS#, CAS#, WE# S#, CKE	−5	5	μA
		CK, CK#	−10	10	
		DM	−5	5	
I _{OZ}	Output Leakage Current; $0V \leq V_{OUT} \leq V_{DDQ}$; DQs and ODT are disabled	DQ, DQS, DQS#	−5	5	μA
I _{VREF}	VREF Leakage Current; VREF = Valid VREF level		−18	18	μA

Capacitance

At DDR2 data rates, Micron encourages designers to simulate the performance of the module to achieve optimum values. When inductance and delay parameters associated with trace lengths are used in simulations, they are significantly more accurate and realistic than a gross estimation of module capacitance. Simulations can then render a considerably more accurate result. JEDEC modules are now designed by using simulations to close timing budgets.

IDD Specifications

Table 9: DDR2 IDD Specifications and Conditions – 256MB

Values shown for MT47H32M8 DDR2 SDRAM only and are computed from values specified in the 256Mb (32 Meg x 8) component data sheet

Parameter/Condition	Symbol	-667	-53E	-40E	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	IDD0	810	720	675	mA
Operating one bank active-read-precharge current: $I_{OUT} = 0\text{mA}$; BL = 4, CL = CL (IDD), 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 IDD4W	IDD1	900	810	765	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	IDD2P	45	45	45	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	IDD2Q	360	315	225	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	IDD2N	360	315	270	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	IDD3P	270	225	180	mA
		54	54	54	mA
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	IDD3N	450	360	270	mA
Operating burst write current: All device banks open; Continuous burst writes; BL = 4, CL = CL (IDD), 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	IDD4W	1,710	1,440	1,125	mA
Operating burst read current: All device banks open; Continuous burst reads, $I_{OUT} = 0\text{mA}$; BL = 4, CL = CL (IDD), 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	IDD4R	1,620	1,350	1,035	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	IDD5	1,620	1,530	1,485	mA
Self refresh current: CK and CK# at 0V; CKE $\leq 0.2\text{V}$; Other control and address bus inputs are floating; Data bus inputs are floating	IDD6	45	45	45	mA
Operating bank interleave read current: All device banks interleaving reads, $I_{OUT} = 0\text{mA}$; BL = 4, CL = CL (IDD), AL = $t_{RCD} (I_{DD}) - 1 \times t_{CK} (I_{DD})$; $t_{CK} = t_{CK} (I_{DD})$, $t_{RC} = t_{RC} (I_{DD})$, $t_{RRD} = t_{RRD} (I_{DD})$, $t_{RCD} = t_{RCD} (I_{DD})$; CKE is HIGH, S# is HIGH between valid commands; Address bus inputs are stable during deselects; Data bus inputs are switching	IDD7	2,250	2,160	2,070	mA

Table 10: DDR2 I_{DD} Specifications and Conditions – 512MB

Values shown for MT47H64M8 DDR2 SDRAM only and are computed from values specified in the 512Mb (64 Meg x 8) component data sheet

Parameter/Condition	Symbol	-80E	-800	-667	-53E	-40E
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	IDD0	900	900	810	720	720
Operating one bank active-read-precharge current: $I_{OUT} = 0\text{mA}$; BL = 4, CL = CL (IDD), 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 IDD4W	IDD1	1,035	1,035	945	855	810
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	IDD2P	63	63	63	63	63
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	IDD2Q	450	450	405	360	315
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	IDD2N	495	495	450	405	360
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	IDD3P	360	360	315	270	225
		108	108	108	108	108
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	IDD3N	630	630	585	495	405
Operating burst write current: All device banks open; Continuous burst writes; BL = 4, CL = CL (IDD), 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	IDD4W	1,755	1,755	1,530	1,260	1,035
Operating burst read current: All device banks open; Continuous burst reads, $I_{OUT} = 0\text{mA}$; BL = 4, CL = CL (IDD), 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	IDD4R	1,845	1,845	1,620	1,305	1,035
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	IDD5	2,070	2,070	1,620	1,530	1,485
Self refresh current: CK and CK# at 0V; CKE $\leq 0.2\text{V}$; Other control and address bus inputs are floating; Data bus inputs are floating	IDD6	63	63	63	63	63
Operating bank interleave read current: All device banks interleaving reads, $I_{OUT} = 0\text{mA}$; BL = 4, CL = CL (IDD), AL = $t_{RCD} (I_{DD}) - 1 \times t_{CK} (I_{DD})$; $t_{CK} = t_{CK} (I_{DD})$, $t_{RC} = t_{RC} (I_{DD})$, $t_{RRD} = t_{RRD} (I_{DD})$, $t_{RCD} = t_{RCD} (I_{DD})$; CKE is HIGH, S# is HIGH between valid commands; Address bus inputs are stable during deselections; Data bus inputs are switching	IDD7	2,700	2,700	2,160	2,025	1,980

Table 11: DDR2 I_{DD} Specifications and Conditions – 1GB

Values shown for MT47H128M8 DDR2 SDRAM only and are computed from values specified in the 1Gb (128 Meg x 8) component data sheet

Parameter/Condition	Symbol	-80E	-800	-667	-53E	-40E
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	IDD0	900	900	810	720	630
Operating one bank active-read-precharge current: $I_{OUT} = 0\text{mA}$; BL = 4, CL = CL (IDD), 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 IDD4W	IDD1	990	990	900	855	720
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	IDD2P	63	63	63	63	63
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	IDD2Q	585	585	495	369	315
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	IDD2N	630	630	540	405	360
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	IDD3P	405	405	360	315	315
		126	126	126	126	126
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	IDD3N	675	675	630	495	405
Operating burst write current: All device banks open; Continuous burst writes; BL = 4, CL = CL (IDD), 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	IDD4W	1,665	1,665	1,440	1,170	990
Operating burst read current: All device banks open; Continuous burst reads, $I_{OUT} = 0\text{mA}$; BL = 4, CL = CL (IDD), 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	IDD4R	1,710	1,710	1,440	1,305	990
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	IDD5	2,520	2,520	2,340	2,250	1,980
Self refresh current: CK and CK# at 0V; CKE $\leq 0.2\text{V}$; Other control and address bus inputs are floating; Data bus inputs are floating	IDD6	63	63	63	63	63
Operating bank interleave read current: All device banks interleaving reads, $I_{OUT} = 0\text{mA}$; BL = 4, CL = CL (IDD), AL = $t_{RCD} (I_{DD}) - 1 \times t_{CK} (I_{DD})$; $t_{CK} = t_{CK} (I_{DD})$, $t_{RC} = t_{RC} (I_{DD})$, $t_{RRD} = t_{RRD} (I_{DD})$, $t_{RCD} = t_{RCD} (I_{DD})$; CKE is HIGH, S# is HIGH between valid commands; Address bus inputs are stable during deselects; Data bus inputs are switching	IDD7	3,015	3,015	2,700	2,610	2,340



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: www.micron.com. Module speed grades correlate with component speed grades as shown in Table 12.

Table 12: Module and Component Speed Grade Table

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

Register and PLL Specifications

Table 13: Register (SSTU32866 devices or equivalent JESD82-16)

Parameter	Symbol	Pins	Condition	Min	Max	Units
DC high-level input voltage	V _{IH} (DC)	Address, control, command	SSTL_18	V _{REF} (DC) + 125	V _{DDQ} + 250	mV
DC low-level input voltage	V _{IL} (DC)	Address, control, command	SSTL_18	0	V _{REF} (DC) - 125	mV
AC high-level input voltage	V _{IH} (AC)	Address, control, command	SSTL_18	V _{REF} (DC) + 250	V _{DD}	mV
AC low-level input voltage	V _{IL} (AC)	Address, control, command	SSTL_18	0	V _{REF} (DC) - 250	mV
Output high voltage	V _{OH}	Parity output	LVC MOS	1.2	–	mV
Output low voltage	V _{OL}	Parity output	LVC MOS	–	0.5	mV
Input current	I _I	All pins	V _I = V _{DDQ} or V _{SSQ}	–5	5	μA
Static standby	I _{DD}	All pins	RESET# = V _{SSQ} (I/O = 0)	–	100	μA
Static operating	I _{DD}	All pins	RESET# = V _{SSQ} ; V _I = V _{IH} (AC) or V _{IL} (DC) I/O = 0	–	40mA	μA
Dynamic operating – clock tree	I _{DDD}	n/a	RESET# = V _{DD} , V _I = V _{IH} (AC) or V _{IL} (AC), I/O = 0; CK and CK# switching 50% duty cycle	–	Varies by manufacturer	μA
Dynamic operating (per each input)	I _{DDD}	n/a	RESET# = V _{DD} , V _I = V _{IH} (AC) or V _{IL} (AC), I/O = 0; CK and CK# switching 50% duty cycle; One data input switching at t _{CK/2} , 50% duty cycle	–	Varies by manufacturer	μA
Input capacitance (per device, per pin)	C _I	All inputs except RESET#	V _I = V _{REF} ±250mV; V _{DDQ} = 1.8V	2.5	3.5	pF
		RESET#	V _I = V _{DDQ} or V _{SSQ}	–	Varies by manufacturer	pF

Notes: 1. Specifications for the register listed above are critical for proper operation of DDR2 SDRAM registered DIMMs. These are meant to be a subset of the parameters for the specific device used on the module. Detailed information for this register is available in JEDEC Standard JESD82.

PLL

Table 14: PLL (CU877 device or equivalent JESD82-8.01)

Parameter	Symbol	Pins	Condition	Min	Max	Units
DC high-level input voltage	V _{IH}	RESET#	LVC MOS	$0.65 \times V_{DD}$	–	mV
DC low-level input voltage	V _{IL}	RESET#	LVC MOS	–	$0.35 \times V_{DD}$	mV
Input voltage (limits)	V _{IN}	RESET#, CK, CK#		–0.3	V _{DDQ} + 0.3	mV
DC high-level input voltage	V _{IH}	CK, CK#	Differential input	$0.65 \times V_{DD}$	–	mV
DC low-level input voltage	V _{IL}	CK, CK#	Differential input	–	$0.35 \times V_{DD}$	mV
Input differential-pair cross voltage	V _{IX}	CK, CK#	Differential input	$(V_{DDQ}/2) - 0.15$	$(V_{DDQ}/2) + 0.15$	V
Input differential voltage	V _{ID} (DC)	CK, CK#	Differential input	0.3	V _{DDQ} + 0.4	V
Input differential voltage	V _{ID} (AC)	CK, CK#	Differential input	0.6	V _{DDQ} + 0.4	V
Input current	I _I	RESET#	V _I = V _{DDQ} or V _{SSQ}	–10	10	μA
		CK, CK#	V _I = V _{DDQ} or V _{SSQ}	–250	250	μA
Output disabled current	I _{ODL}		RESET# = V _{SSQ} ; V _I = V _{IH} (AC) or V _{IL} (DC)	100	–	μA
Static supply current	I _{DDL}		CK = CK# = LOW	–	500	μA
Dynamic supply	I _{DD}	N/A	CK, CK# = 270 MHz, all outputs open (not connected to PCB)	–	300	mA
Input capacitance	C _{IN}	Each input	V _I = V _{DDQ} or V _{SSQ}	2	3	pF

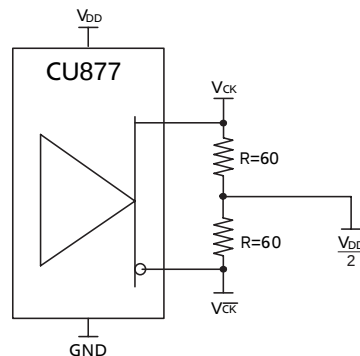
- Notes: 1. Specifications for the PLL listed above are critical for proper operation of DDR2 SDRAM registered DIMMs. These are meant to be a subset of the parameters for the specific device used on the module. Detailed information for this PLL is available in JEDEC Standard JESD82.

Table 15: PLL Clock Driver Timing Requirements and Switching Characteristics

Note: 1

Parameter	Symbol	0°C ≤ T _{OPR} ≤ +55°C V _{DD} = +1.8V ±0.1V		Units
		Min	Max	
Stabilization time	t _L	–	15	μs
Input clock slew rate	t _{LS_I}	1.0	4	V/ns
SSC modulation frequency		30	33	kHZ
SSC clock input frequency deviation		0.0	–0.50	%
PLL loop bandwidth (-3dB from unity gain)		2.0	–	MHz

- Notes:
1. PLL specifications are critical for proper operation of the DDR2 DIMM. This is a subset of parameters for the specific PLL used. Detailed PLL information is available in JEDEC Standard JESD82.
 2. Static phase offset does not include jitter.
 3. Period jitter and half-period jitter specifications are separate specifications that must be met independently of each other.
 4. Design target is 60ps, unless it is not achievable.
 5. Vox specified at the DRAM clock input, or the test load.
 6. The output slew rate is determined from the IBIS model:



Serial Presence-Detect

Table 16: 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} × 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	I _{CCR}	0.4	1	mA
Power supply current, WRITE: SCL clock frequency = 100 KHz	I _{CCW}	2	3	mA

Table 17: 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	t_{AA}	0.2	0.9	μs	1
Time the 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
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	ns	
Clock LOW period	t_{LOW}	1.3	–	μs	
SDA and SCL rise time	t_R	–	0.3	μs	2
SCL clock frequency	f_{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 resistor, and the EEPROM does not respond to its slave address.



Table 18: Serial Presence-Detect Matrix

"1"/"0": serial data, "driven to HIGH"/"driven to LOW"

Byte	Description	Entry (Version)	MT9HTF3272(P)	MT9HTF6472(P)	MT9HTF12872(P)
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, 14	0D	0E	0E
4	Number of column addresses on SDRAM	10	0A	0A	0A
5	DIMM height and module ranks	30mm, single rank	60	60	60
6	Module data width	72	48	48	48
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	ECC ECC and parity	02 06	02 06	02 06
12	Refresh rate/type	7.81 μ s/SELF	82	82	82
13	SDRAM device width (primary SDRAM)	8	08	08	08
14	Error-checking SDRAM data width	8	08	08	08
15	Reserved		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 60 38 18	30 60 38 18
19	Module thickness		01	01	01
20	DDR2 DIMM type	Registered DIMM	01	01	01
21	SDRAM module attributes	1 PLL, 1 Reg	04	04	04
22	SDRAM device attributes: weak driver (01) or, weak driver and 50 Ω 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(N/S)	– 50 00	00 50 00	00 50 00



Table 18: Serial Presence-Detect Matrix (continued)
 "1"/"0": serial data, "driven to HIGH"/"driven to LOW"

Byte	Description	Entry (Version)	MT9HTF3272(P)	MT9HTF6472(P)	MT9HTF12872(P)
26	SDRAM access from CK, t_{AC} , MAX CL - 2	-80E -667 -53E/-40E(N/S)	– 45 00	00 45 00	00 45 00
27	MIN row precharge time, t_{RP}	-80E -800/-667/-53E/ -40E	– 3C	32 3C	32 3C
28	MIN row active to row active, t_{RRD}		1E	1E	1E
29	MIN RAS# to CAS# delay, t_{RCD}	-80E -800/-667/-53E/ -40E	– 3C	32 3C	32 3C
30	MIN RAS# pulse width, t_{RAS} (see note 1)	-80E/-800/-667/ -53E -40E	– /2D 28	2D 28	2D 28
31	Module rank density	256MB, 512MB, 1GB	40	80	01
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 CMD delay, t_{WTR}	-80E/-667/-53E -800/-40E	– /1E/1E –/28	1E 28	1E 28
38	Read to precharge CMD 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	– –/00/00/00	30 00	36 06
41	MIN active auto refresh time, t_{RC}	-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_{CKMAX}		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



Table 18: Serial Presence-Detect Matrix (continued)
 "1"/"0": serial data, "driven to HIGH"/"driven to LOW"

Byte	Description	Entry (Version)	MT9HTF3272(P)	MT9HTF6472(P)	MT9HTF12872(P)
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	15μs	0F	0F	0F
47–61	Optional features, not supported		00	00	00
62	SPD revision	Release 1.2	12	12	12
63	Checksum for bytes 0–62 ECC / ECC and Parity	-80E -800 -667 -53E -40E	– – 10/14 BB/BF 22/26	B3/B7 C7/CB 6F/73 1A/1E 81/85	54/58 68/6C 10/14 BB/BF 22/26
64	Manufacturer's JEDEC ID code	MICRON	2C	2C	2C
65–71	Manufacturer's JEDEC ID code	(continued)	FF	FF	FF
72	Manufacturing location	01–12	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	Manufacturer-specific data (RSVD)		FF	FF	FF

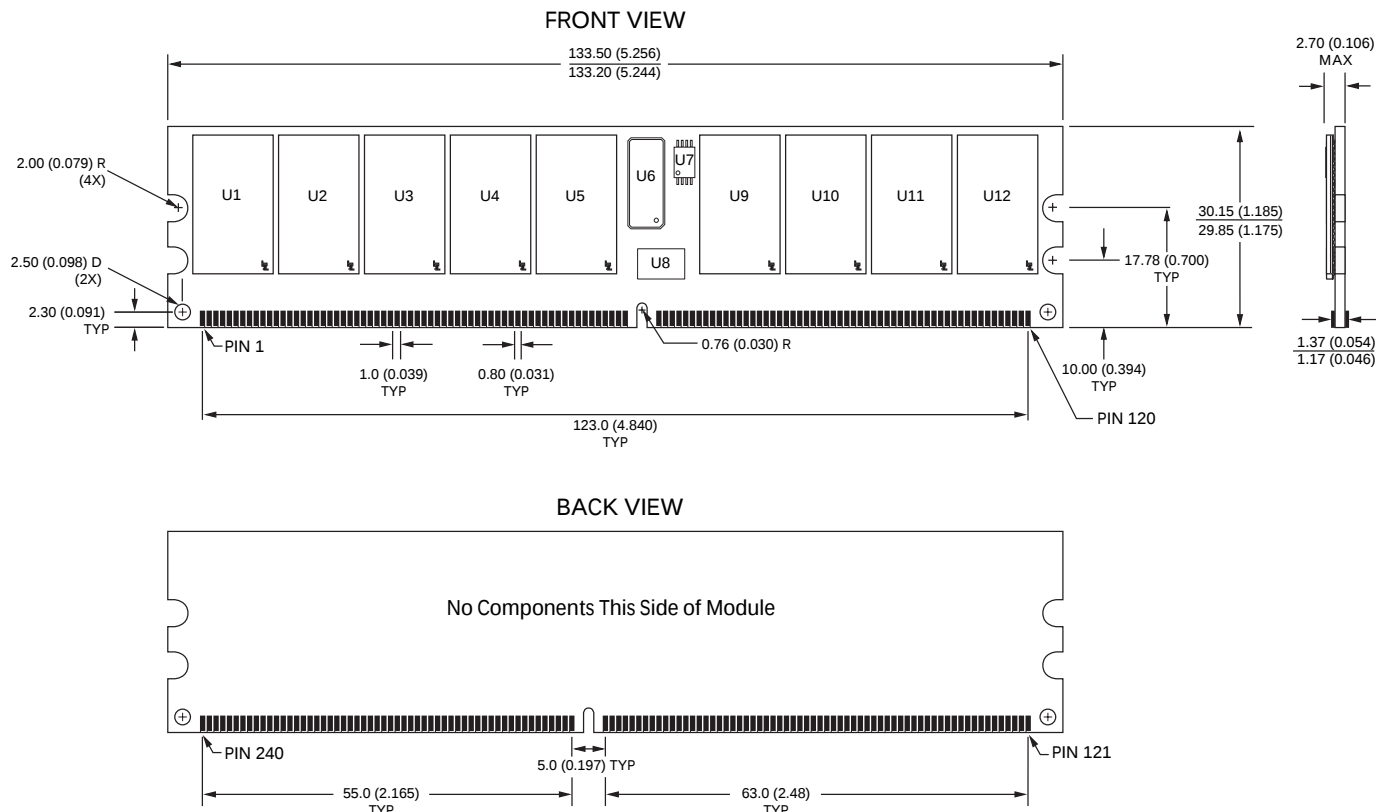
Notes: 1. The ^tRC SPD values shown are JEDEC DDR2 device specification values. The actual Micron device specification is ^tRC = 55ns for all speed grades.



256MB, 512MB, 1GB (x72, ECC, SR): 240-Pin DDR2 SDRAM RDIMM Module Dimensions

Module Dimensions

Figure 3: 240-Pin DDR2 DIMM



- Notes:
1. All dimensions are in millimeters (inches).
 2. The dimensional diagram is for reference only. Refer to the MO document for complete design dimensions.



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