

DDR2 SDRAM Dual-Rank VLP RDIMM

MT18HVF12872(P)D – 1GB

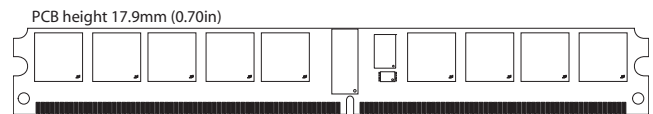
MT18HVF25672(P)D – 2GB

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

Features

- Fits with ATCA form factor
- 240-pin, very low profile registered dual in-line memory module (VLP RDIMM)
- Fast data transfer rates: PC2-3200, PC2-4200, PC2-5300, or PC2-6400
- 1GB (128 Meg x 72) or 2GB (256 Meg x 72)
- 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
- 4n-bit prefetch architecture
- Multiple internal device banks for concurrent operation
- Programmable CAS# latency (CL)
- Posted CAS# additive latency (AL)
- WRITE latency = READ latency - 1 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
- Dual rank

Figure 1: 240-Pin VLP RDIMM (ATCA Form Factor)



Options

- Parity
- Operating temperature¹
 - Commercial ($0^{\circ}C \leq T_A \leq +70^{\circ}C$)
 - Industrial ($-40^{\circ}C \leq T_A \leq +85^{\circ}C$)
- Package
 - 240-pin DIMM (Pb-free)
- Frequency/CAS latency²
 - 2.5ns @ CL = 5 (DDR2-800)
 - 2.5ns @ CL = 6 (DDR2-800)
 - 3.0ns @ CL = 5 (DDR2-667)
 - 3.75ns @ CL = 4 (DDR2-533)
 - 5.0ns @ CL = 3 (DDR2-400)
- PCB height
 - 17.9mm (0.70in)

Marking

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

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

2. CL = CAS (READ) latency; registered mode will add one clock cycle to CL.

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



1GB, 2GB (x72, ECC, DR) 240-Pin DDR2 SDRAM VLP RDIMM Features

Table 2: Addressing

Parameter	1GB	2GB
Refresh count	8K	8K
Row address	16K (A0–A13)	16K (A0–A13)
Device bank address	4 (BA0, BA1)	8 (BA0–BA2)
Device page size per bank	1KB	1KB
Device configuration	512Mb (64 Meg x 8)	1Gb (128 Meg x 8)
Column address	1K (A0–A9)	1K (A0–A9)
Module rank address	2 (S0#, S1#)	2 (S0#, S1#)

Table 3: Part Numbers and Timing Parameters – 1GB Modules

Base device: MT47H64M8¹, 512Mb DDR2 SDRAM

Part Number ²	Module Density	Configuration	Module Bandwidth	Memory Clock/ Data Rate	Latency (CL ¹ -RCD ¹ -RP)
MT18HVF12872(P)D-80E__	1GB	128 Meg x 72	6.4 GB/s	2.5ns/800 MT/s	5-5-5
MT18HVF12872(P)D-800__	1GB	128 Meg x 72	6.4 GB/s	2.5ns/800 MT/s	6-6-6
MT18HVF12872(P)D-667__	1GB	128 Meg x 72	5.3 GB/s	3.0ns/667 MT/s	5-5-5
MT18HVF12872(P)D-53E__	1GB	128 Meg x 72	4.3 GB/s	3.75ns/533 MT/s	4-4-4
MT18HVF12872(P)D-40E__	1GB	128 Meg x 72	3.2 GB/s	5.0ns/400 MT/s	3-3-3

Table 4: Part Numbers and Timing Parameters – 2GB Modules

Base device: MT47H128M8¹, 1Gb DDR2 SDRAM

Part Number ²	Module Density	Configuration	Module Bandwidth	Memory Clock/ Data Rate	Latency (CL ¹ -RCD ¹ -RP)
MT18HVF25672(P)D-80E__	2GB	256 Meg x 72	6.4 GB/s	2.5ns/800 MT/s	5-5-5
MT18HVF25672(P)D-800__	2GB	256 Meg x 72	6.4 GB/s	2.5ns/800 MT/s	6-6-6
MT18HVF25672(P)D-667__	2GB	256 Meg x 72	5.3 GB/s	3.0ns/667 MT/s	5-5-5
MT18HVF25672(P)D-53E__	2GB	256 Meg x 72	4.3 GB/s	3.75ns/533 MT/s	4-4-4
MT18HVF25672(P)D-40E__	2GB	256 Meg x 72	3.2 GB/s	5.0ns/400 MT/s	3-3-3

- Notes:
1. Data sheets for the base device parts 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: MT18HVF12872(P)DY-667E1.



1GB, 2GB (x72, ECC, DR) 240-Pin DDR2 SDRAM VLP RDIMM Pin Assignments and Descriptions

Pin Assignments and Descriptions

Table 5: Pin Assignments

240-Pin VLP RDIMM Front								240-Pin VLP 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	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	S0#	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	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	A15	203	NC/ DQS13#	233	NC/ DQS16#
24	DQ16	54	BA2	84	DQS4	114	DQS7	144	DQ21	174	A14	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



1GB, 2GB (x72, ECC, DR) 240-Pin DDR2 SDRAM VLP RDIMM Pin Assignments and Descriptions

Table 6: Pin Descriptions

Symbol	Type	Description
ODT0, ODT1	Input (SSTL_18)	On-die termination: ODT1 (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 (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.
RAS#, CAS#, WE#	Input (SSTL_18)	Command inputs: RAS#, CAS#, and WE# (along with S#) define the command being entered.
BA0–BA2	Input (SSTL_18)	Bank address inputs: BA0–BA2 define the device bank to which 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. BA0–BA1 (1GB), BA0–BA2 (2GB).
A0–A15	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. A14, A15 connected for parity.
PAR_IN	Input (SSTL_18)	Parity bit for the address and control bus.
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 devices.
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#	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–DM8 (DQS9–DQS17)	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. If RDQS is disabled, DQS9–DQS17 become DM0–DM8 and DQS9#–DQS17# are not used.
DQ0–DQ63	I/O (SSTL_18)	Data input/output: Bidirectional data bus.
CB0–CB7	I/O (SSTL_18)	Check bits.
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.
ERR_OUT	Output (open drain)	Parity error found on the address and control bus.
VDD/VDDQ	Supply	Power supply: 1.8V ±0.1V.
VREF	Supply	SSTL_18 reference voltage.
VSS	Supply	Ground.
VDDSPD	Supply	Serial EEPROM positive power supply: +1.7V to +3.6V.



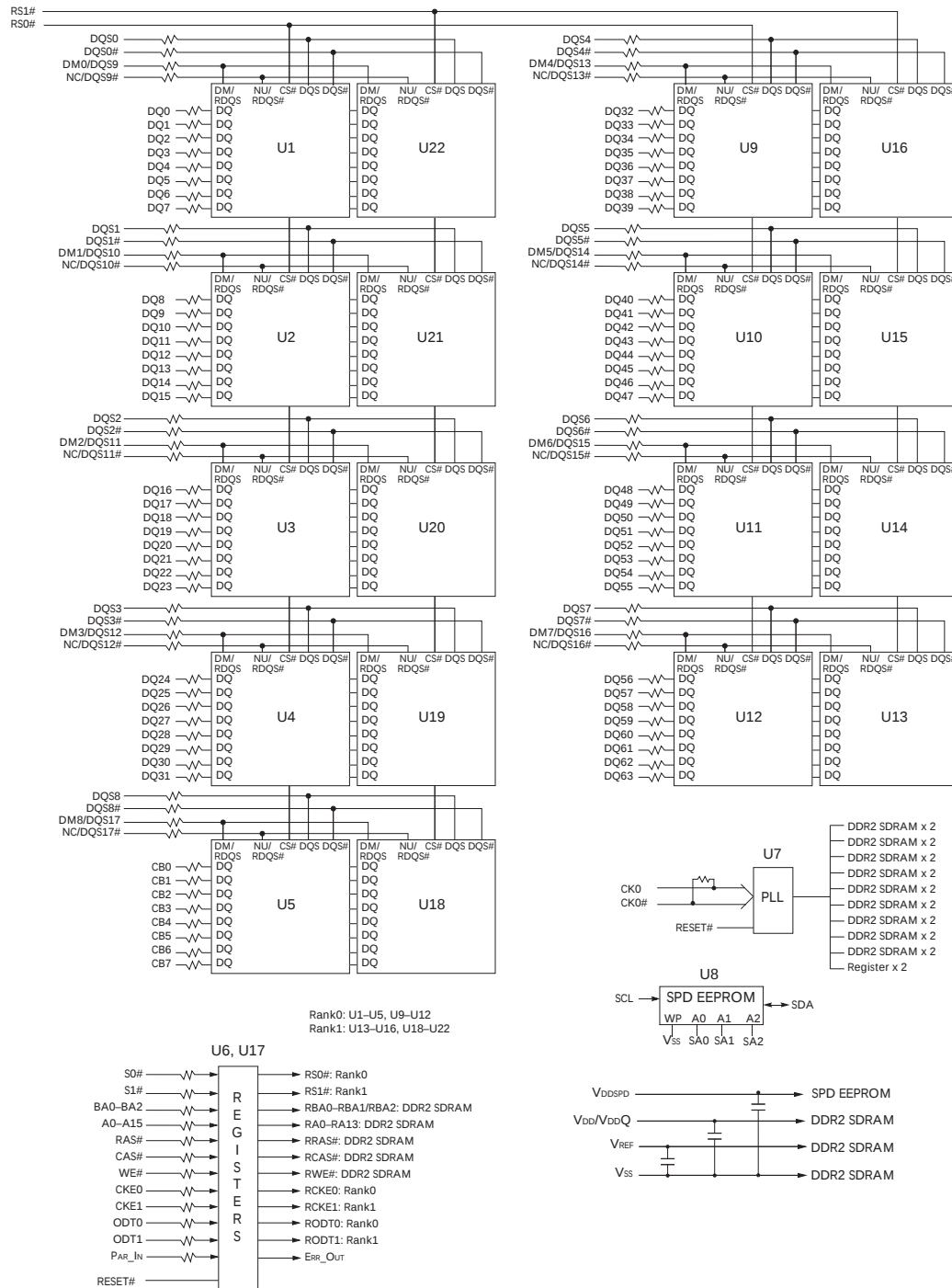
1GB, 2GB (x72, ECC, DR) 240-Pin DDR2 SDRAM VLP RDIMM Pin Assignments and Descriptions

Table 6: Pin Descriptions (continued)

Symbol	Type	Description
NC	–	No connect: These pins should be left unconnected.
RFU	–	Reserved for future use.

Functional Block Diagram

Figure 2: Functional Block Diagram



General Description

The MT18HVF12872(P)D and MT18HVF25672(P)D DDR2 SDRAM modules are high-speed, CMOS, dynamic random-access 1GB and 2GB memory modules organized in a x72 configuration. These DDR2 SDRAM modules use internally configured 4-bank (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 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.

Register and PLL 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 re-drives the differential clock signals (CK, CK#) to the DDR2 SDRAM devices. The register(s) and PLL reduce address, command, control, and clock signal loading by isolating DRAM from the system controller. 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 are programmed by Micron to identify the module type and various SDRAM organizations and timing parameters. The remaining 128 bytes of storage are available for use by the customer. System READ/WRITE operations between the master (system logic) and the slave EEPROM device occur via a standard I²C bus using the DIMM's SCL (clock) and SDA (data) signals, together with SA (2:0), which provide eight unique DIMM/EEPROM addresses. Write protect (WP) is tied to VSS on the module, permanently disabling hardware write protect.

Electrical Specifications

Stresses greater than those listed in Table 7 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 7: Absolute Maximum Ratings

Symbol	Parameter		Min	Max	Units
VDD/VDDQ	VDD/VDDQ supply voltage relative to Vss		−0.5	+2.3	V
VIN, VOUT	Voltage on any pin relative to Vss		−0.5	+2.3	V
II	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)	Address inputs RAS#, CAS#, WE#, S#, CKE, ODT, BA	−5	+5	μA
		CK, CK#	−250	+250	
		DM	−10	+10	
IOZ	Output leakage current; $0V \leq V_{OUT} \leq V_{DDQ}$; DQs and ODT are disabled	DQ, DQS, DQS#	−10	+10	μA
IVREF	VREF leakage current; VREF = valid VREF level		−36	+36	μA
TA	Module ambient operating temperature	Commercial	0	+70	°C
		Industrial	−40	+85	°C
TC 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 $85^{\circ}C < T_C \leq 95^{\circ}C$.
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 8.

Table 8: Module and Component Speed Grades

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

IDD Specifications

Table 9: DDR2 IDD Specifications and Conditions – 1GB

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	Units
Operating one bank active-precharge current: $t_{CK} = t_{CK} (IDD)$, $t_{RC} = t_{RC} (IDD)$, $t_{RAS} = t_{RAS} \text{ MIN} (IDD)$; CKE is HIGH, S# is HIGH between valid commands; Address bus inputs are switching; Data bus inputs are switching	IDD0 ¹	963	873	783	783	mA
Operating one bank active-read-precharge current: IOUT = 0mA; BL = 4, CL = CL (IDD), AL = 0; $t_{CK} = t_{CK} (IDD)$, $t_{RC} = t_{RC} (IDD)$, $t_{RAS} = t_{RAS} \text{ MIN} (IDD)$, $t_{RCD} = t_{RCD} (IDD)$; CKE is HIGH, S# is HIGH between valid commands; Address bus inputs are switching; Data pattern is same as IDD4W	IDD1 ¹	1,098	1,008	918	873	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	126	126	126	126	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	900	810	720	630	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	990	900	810	720	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	720	630	540	450	mA
	Slow PDN exit MR[12] = 1	216	216	216	216	mA
Active standby current: All device banks open; $t_{CK} = t_{CK} (IDD)$, $t_{RAS} = t_{RAS} \text{ MAX} (IDD)$, $t_{RP} = t_{RP} (IDD)$; CKE is HIGH, S# is HIGH between valid commands; Other control and address bus inputs are switching; Data bus inputs are switching	IDD3N ²	1,260	1,170	990	810	mA
Operating burst write current: All device banks open; Continuous burst writes; BL = 4, CL = CL (IDD), AL = 0; $t_{CK} = t_{CK} (IDD)$, $t_{RAS} = t_{RAS} \text{ MAX} (IDD)$, $t_{RP} = t_{RP} (IDD)$; CKE is HIGH, S# is HIGH between valid commands; Address bus inputs are switching; Data bus inputs are switching	IDD4W ¹	1,818	1,593	1,323	1,098	mA
Operating burst read current: All device banks open; Continuous burst reads; IOUT = 0mA; BL = 4, CL = CL (IDD), AL = 0; $t_{CK} = t_{CK} (IDD)$, $t_{RAS} = t_{RAS} \text{ MAX} (IDD)$, $t_{RP} = t_{RP} (IDD)$; CKE is HIGH, S# is HIGH between valid commands; Address bus inputs are switching; Data bus inputs are switching	IDD4R ¹	1,908	1,683	1,368	1,098	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	4,140	3,240	3,060	2,970	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	126	126	126	126	mA
Operating bank interleave read current: All device banks interleaving reads; IOUT = 0mA; BL = 4, CL = CL (IDD), AL = $t_{RCD} (IDD) - 1 \times t_{CK} (IDD)$; $t_{CK} = t_{CK} (IDD)$, $t_{RC} = t_{RC} (IDD)$, $t_{RRD} = t_{RRD} (IDD)$, $t_{RCD} = t_{RCD} (IDD)$; CKE is HIGH, S# is HIGH between valid commands; Address bus inputs are stable during deselections; Data bus inputs are switching	IDD7 ¹	2,763	2,223	2,088	2,043	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 10: DDR2 I_{DD} Specifications and Conditions – 2GB

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	Units
Operating one bank active-precharge current: $t_{CK} = t_{CK} (I_{DD})$, $t_{RC} = t_{RC} (I_{DD})$, $t_{RAS} = t_{RAS} \text{ MIN} (I_{DD})$; CKE is HIGH, S# is HIGH between valid commands; Address bus inputs are switching; Data bus inputs are switching	I_{DD0}^1	873	828	693	693	mA
Operating one bank active-read-precharge current: $I_{OUT} = 0\text{mA}$; BL = 4, CL = CL (I _{DD}), AL = 0; $t_{CK} = t_{CK} (I_{DD})$, $t_{RC} = t_{RC} (I_{DD})$, $t_{RAS} = t_{RAS} \text{ MIN} (I_{DD})$, $t_{RCD} = t_{RCD} (I_{DD})$; CKE is HIGH, S# is HIGH between valid commands; Address bus inputs are switching; Data pattern is same as I _{DD4W}	I_{DD1}^1	1,053	963	918	873	mA
Precharge power-down current: All device banks idle; $t_{CK} = t_{CK} (I_{DD})$; CKE is LOW; Other control and address bus inputs are stable; Data bus inputs are floating	I_{DD2P}^2	126	126	126	126	mA
Precharge quiet standby current: All device banks idle; $t_{CK} = t_{CK} (I_{DD})$; CKE is HIGH, S# is HIGH; Other control and address bus inputs are stable; Data bus inputs are floating	I_{DD2Q}^2	900	720	720	630	mA
Precharge standby current: All device banks idle; $t_{CK} = t_{CK} (I_{DD})$; CKE is HIGH, S# is HIGH; Other control and address bus inputs are switching; Data bus inputs are switching	I_{DD2N}^2	900	720	720	630	mA
Active power-down current: All device banks open; $t_{CK} = t_{CK} (I_{DD})$; CKE is LOW; Other control and address bus inputs are stable; Data bus inputs are floating	I_{DD3P}^2	720	540	540	540	mA
		180	180	180	180	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	I_{DD3N}^2	1,080	990	810	720	mA
Operating burst write current: All device banks open; Continuous burst writes; BL = 4, CL = CL (I _{DD}), AL = 0; $t_{CK} = t_{CK} (I_{DD})$, $t_{RAS} = t_{RAS} \text{ MAX} (I_{DD})$, $t_{RP} = t_{RP} (I_{DD})$; CKE is HIGH, S# is HIGH between valid commands; Address bus inputs are switching; Data bus inputs are switching	I_{DD4W}^1	1,503	1,278	1,188	1,008	mA
Operating burst read current: All device banks open; Continuous burst reads; $I_{OUT} = 0\text{mA}$; BL = 4, CL = CL (I _{DD}), AL = 0; $t_{CK} = t_{CK} (I_{DD})$, $t_{RAS} = t_{RAS} \text{ MAX} (I_{DD})$, $t_{RP} = t_{RP} (I_{DD})$; CKE is HIGH, S# is HIGH between valid commands; Address bus inputs are switching; Data bus inputs are switching	I_{DD4R}^1	1,503	1,278	1,188	1,008	mA
Burst refresh current: $t_{CK} = t_{CK} (I_{DD})$; REFRESH command at every $t_{RFC} (I_{DD})$ interval; CKE is HIGH, S# is HIGH between valid commands; Other control and address bus inputs are switching; Data bus inputs are switching	I_{DD5}^2	4,230	3,870	3,780	3,690	mA
Self refresh current: CK and CK# at 0V; CKE ≤ 0.2V; Other control and address bus inputs are floating; Data bus inputs are floating	I_{DD6}^2	126	126	126	126	mA
Operating bank interleave read current: All device banks interleaving reads; $I_{OUT} = 0\text{mA}$; BL = 4, CL = CL (I _{DD}), 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	I_{DD7}^1	3,078	2,583	2,493	2,403	mA

- Notes:
- Value calculated as one module rank in this operating condition; all other module ranks in I_{DD2P} (CKE LOW) mode.
 - Value calculated reflects all module ranks in this operating condition.

Register and PLL Specifications

Table 11: Register Specifications
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	–	V
Output low voltage	V _{OL}	Parity output	LVC MOS	–	0.5	V
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	–	40	mA
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	Data	V _I = V _{REF} ±250mV; V _{DDQ} = 1.8V	2.5	3.5	pF
Input capacitance (per device, per pin)	C _I	RESET#	V _I = V _{DDQ} or V _{SSQ}	–	Varies by manufacturer	pF

Notes: 1. Timing and switching specifications for the register listed above are critical for proper operation of the 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.

Table 12: PLL Specifications
CU877 device or equivalent JESD82-8.18

Parameter	Symbol	Pins	Condition	Min	Max	Units
DC high-level input voltage	V _{IH}	RESET#	LVC MOS	0.65 × V _{DD}	–	V
DC low-level input voltage	V _{IL}	RESET#	LVC MOS	–	0.35 × V _{DD}	V
Input voltage (limits)	V _{IN}	RESET#, CK, CK#		–0.3	V _{DDQ} + 0.3	V
DC high-level input voltage	V _{IH}	CK, CK#	Differential input	0.65 × V _{DD}	–	V
DC low-level input voltage	V _{IL}	CK, CK#	Differential input	–	0.35 × V _{DD}	V
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# = 410 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

Table 13: PLL Clock Driver Timing Requirements and Switching Characteristics

Parameter	Symbol	Min	Max	Units
Stabilization time	t _L	–	15	μs
Input clock slew rate	slr(i) _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 timing and switching 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 JESD82-8.01.

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	I _{CCR}	0.4	1	mA
Power supply current, WRITE: SCL clock frequency = 100 kHz	I _{CCW}	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	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 resistance, and the EEPROM does not respond to its slave address.



Table 16: Serial Presence-Detect Matrix

Byte	Description	Entry (Version)	1GB	2GB
0	Number of SPD bytes used by Micron	128	80	80
1	Total number of bytes in SPD device	256	08	08
2	Fundamental memory type	DDR2 SDRAM	08	08
3	Number of row addresses on SDRAM	14	0E	0E
4	Number of column addresses on SDRAM	10	0A	0A
5	DIMM height and module ranks	17.9mm, dual rank	11	11
6	Module data width	72	48	48
7	Reserved	0	00	00
8	Module voltage interface levels	SSTL 1.8V	05	05
9	SDRAM cycle time, t_{CK} (CL = MAX value, see byte 18)	-80E/-800 -667 -53E -40E	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	40 45 50 60	40 45 50 60
11	Module configuration type	ECC ECC and parity	02 06	02 06
12	Refresh rate/type	7.81μs/SELF	82	82
13	SDRAM device width (primary SDRAM)	8	08	08
14	Error-checking SDRAM data width	8	08	08
15	Reserved	0	00	00
16	Burst lengths supported	4, 8	0C	0C
17	Number of banks on SDRAM device	4 or 8	04	08
18	CAS latencies supported	-80E (5, 4) -800 (6, 5, 4) -667 (5, 4, 3) -53E/-40E (4, 3)	30 70 38 18	30 70 38 18
19	Module thickness		01	01
20	DDR2 DIMM type	Registered DIMM	01	01
21	SDRAM module attributes	1 PLL, 2 Reg	05	05
22	SDRAM device attributes: weak driver (01), or weak driver and 50Ω ODT (03)	-80E/-800/-667 -53E/-40E	03 01	03 01
23	SDRAM cycle time, t_{CK} , MAX CL - 1	-80E/-667 -800 -53E/-40E	3D 30 50	3D 30 50
24	SDRAM access from CK, t_{AC} , MAX CL - 1	-80E/-800 -667 -53E -40E	40 45 50 60	40 45 50 60
25	SDRAM cycle time, t_{CK} , MAX CL - 2	-80E/-800 -667 -53E/-40E	00/3D 50 00	00/3D 50 00
26	SDRAM access from CK, t_{AC} , MAX CL - 2	-80E/-800 -667 -53E/-40E	00/40 45 00	00/40 45 00
27	MIN row precharge time, t_{RP}	-80E -800/-667/-53E/-40E	32 3C	32 3C
28	MIN row active-to-row active, t_{RRD}		1E	1E

Table 16: Serial Presence-Detect Matrix (continued)

Byte	Description	Entry (Version)	1GB	2GB
29	MIN RAS#-to-CAS# delay, t_{RCD}	-80E -800/-667/-53E/-40E	32 3C	32 3C
30	MIN active-to-precharge time, t_{RAS}	-80E/-800/-667/-53E -40E	2D 28	2D 28
31	Module rank density	512MB, 1GB	80	01
32	Address and command setup time, t_{IS_b}	-80E/-800 -667 -53E -40E	17 20 25 35	17 20 25 35
33	Address and command hold time, t_{IH_b}	-80E/-800 -667 -53E -40E	25 27 37 47	25 27 37 47
34	Data/data mask input setup time, t_{DS_b}	-80E/-800 -667/-53E -40E	05 10 15	05 10 15
35	Data/data mask input hold time, t_{DH_b}	-80E/-800 -667 -53E -40E	12 17 22 27	12 17 22 27
36	Write recovery time, t_{WR}		3C	3C
37	WRITE-to-READ command delay, t_{WTR}	-80E/-667/-53E -800/-40E	1E 28	1E 28
38	READ-to-PRECHARGE command delay, t_{RTP}		1E	1E
39	Memory analysis probe		00	00
40	Extension for bytes 41 and 42	-80E -800/-667/-53E/-40E	30 00	36 06
41	MIN active-to-active/refresh time, t_{RC}^1	-80E -800/-667/-53E -40E	39 3C 37	39 3C 37
42	MIN AUTO REFRESH-to-ACTIVE/AUTO REFRESH command period, t_{RFC}		69	7F
43	SDRAM device MAX cycle time, $t_{CK} (MAX)$		80	80
44	SDRAM device MAX DQS-DQ skew time, t_{DQSQ}	-80E/-800 -667 -53E -40E	14 18 1E 23	14 18 1E 23
45	SDRAM device MAX read data hold skew factor, t_{QHS}	-80E/-800 -667 -53E -40E	1E 22 28 2D	1E 22 28 2D
46	PLL relock time	15 μ s	0F	0F
47-61	Optional features, not supported		00	00
62	SPD revision	Release 1.2	12	12
63	Checksum for bytes 0-62 ECC/ECC and parity	-80E -800 -667 -53E -40E	65/69 06/0A 21/25 CC/D0 33/37	06/0A A7/AB C2/C6 6D/71 D4/D8
64	Manufacturer's JEDEC ID code	MICRON	2C	2C
65-71	Manufacturer's JEDEC ID code	(continued)	FF	FF



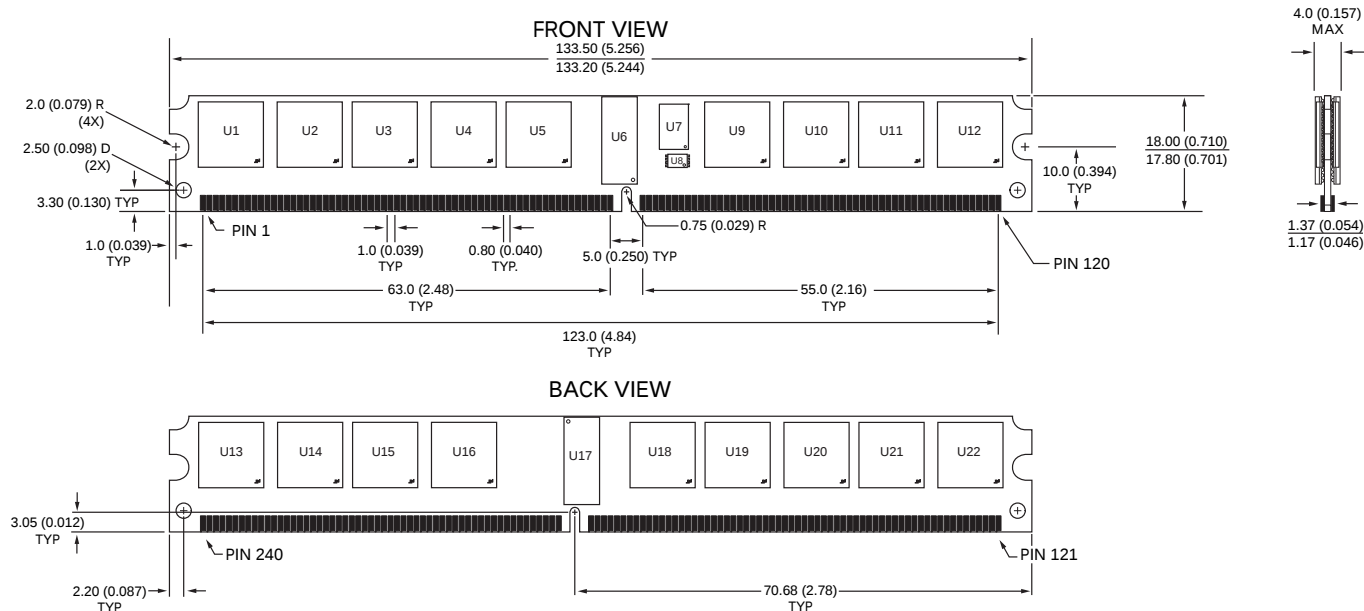
Table 16: Serial Presence-Detect Matrix (continued)

Byte	Description	Entry (Version)	1GB	2GB
72	Manufacturing location	1–12	01–0C	01–0C
73–90	Module part number (ASCII)	–	Variable data	Variable data
91	PCB identification code	1–9	01–09	01–09
92	Identification code (continued)	0	00	00
93	Year of manufacture in BCD	–	Variable data	Variable data
94	Week of manufacture in BCD	–	Variable data	Variable data
95–98	Module serial number	–	Variable data	Variable data
99–127	Reserved for manufacturer-specific data		00	00
128–255	Reserved for customer-specific data		FF	FF

Notes: 1. The t_{RC} SPD values shown are JEDEC DDR2 device specification values. The actual Micron DDR2 device specification is $t_{RC} = 55\text{ns}$ for all speed grades.

Module Dimensions

Figure 3: 240-Pin DDR2 VLP RDIMM



- 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.



8000 S. Federal Way, P.O. Box 6, Boise, ID 83707-0006, Tel: 208-368-3900

prodmtg@micron.com www.micron.com Customer Comment Line: 800-932-4992

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