

DATA SHEET

DDR3L SDRAM

240Pin Registered DIMM

Based on Elpida 4Gb F-die

78-ball FBGA With Lead-Free
(RoHS compliant)

Revision History

Revision No.	History	Draft Date	Remark
1.0	Initial Release	June, 2013	
1.1	Update IDD data	October,2013	

Features

- Package: 240-pin dual-in-line DDR3L memory module (RDIMM)
- Density: 16GB
- Organization: 2048Mb*72, 2 Rank
- Power supply: VDD = 1.35 V (1.283~1.45V)
Backward compatible to VDD = 1.5 V \pm 0.075V
- Data rates: 1600Mbps(max.)
Backward compatible to 1333Mbps/1066Mbps /800Mbps
- 8 independent internal banks
- Bi-directional Differential data strobe (DQS, DQS#)
- Differential clock inputs (CK,CK#)
- Commands entered on each rising CK edge
- Eight-bit pre-fetch architecture
- DQS edge-aligned with data for READs
- DQS center-aligned with data for WRITEs
- DLL to align DQ and DQS transitions with CK
- Data mask (DM) for masking write data
- Burst lengths(BL): 8 and 4 with Burst Chop(BC)
- ZQ calibration for DQ drive and ODT
- On-die termination (ODT)
- Serial Presence Detect (SPD) with EEPROM
- Operating case temperature range:
Tc = 0°C ~ 95°C
- Average refresh period:
7.8us at 0 ~ 85°C; 3.9us at 85 ~ 95°C
- Asynchronous reset
- Lead-free (RoHS compliant)
- For contact pads, electrolytic gold plating

Ordering Information

Part Number	Density	Organization	Component Composition	Number of Rank	Gold plating thickness(min.)
RMS6031EF74FBW-1600	16GB	2048M*72	1024Mx4(EDJ4204EFBG-GN-F) *36	2	0.76um

Detailed Information

For detailed electrical specifications and further information, please refer to the component DDR3L SDRAM datasheet EDJ4204EFBG-GN-F .

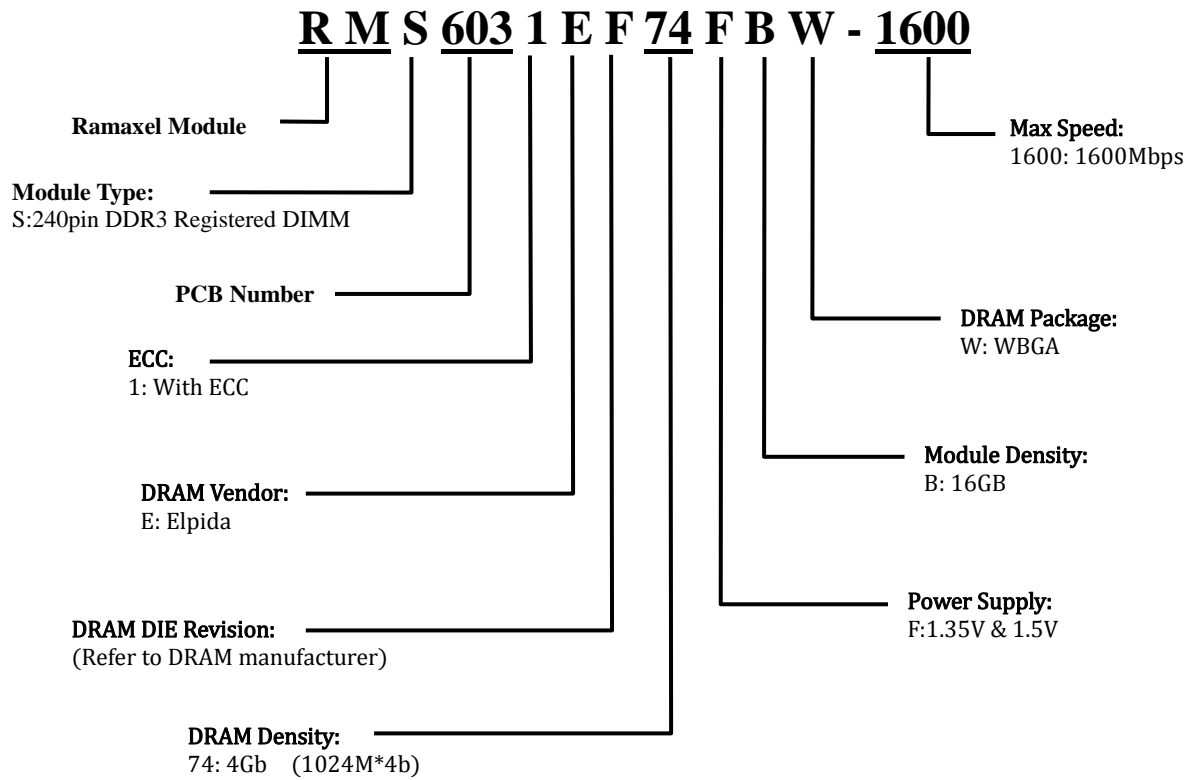
Key Parameters

Speed	DDR3L-800	DDR3L-1066	DDR3L-1333	DDR3L-1600	Unit
	6-6-6	7-7-7	9-9-9	11-11-11	
tCK(min)	2.5	1.875	1.5	1.25	ns
CAS Latency	5,6	5,6,7,8	5,6,7,8,9,10	5,6,7,8,9,10,11	tCK
tRCD(min)	15	13.125	13.5	13.75	ns
tRP(min)	15	13.125	13.5	13.75	ns
tRAS(min)	37.5	37.5	36	35	ns
tRC(min)	52.5	50.625	49.5	48.75	ns

Address Configuration

Organization	Row Address	Column Address	Bank Address	Auto Precharge
1024*4(4Gb) based module	A0-A15	A0-A9,A11	BA0-BA2	A10/AP

Part Number



Pin Assignments

Pin	Front	Pin	Back	Pin	Front	Pin	Back	Pin	Front	Pin	Back	Pin	Front	Pin	Back
1	VREFDQ	121	VSS	31	DQ25	151	VSS	61	A3	181	A1	91	DQ41	211	VSS
2	VSS	122	DQ4	32	VSS	152	DM3/ TDQS12 ²	62	VDD	182	VDD	92	VSS	212	DM5/ TDQS14
3	DQ0	123	DQ5	33	DQS3	153	NC/ TDQS2 ⁵	63	CK1/NC ³	183	VDD	93	DQS5	213	NC/ TDQS4
4	DQ1	124	VSS	34	DQS3	154	VSS	64	CK0/NC ³	184	CK0	94	DQS5	214	VSS
5	VSS	125	DM0/ TDQS9 ⁹	35	VSS	155	DQ30	65	VDD	185	CK0	95	VSS	215	DQ46
6	DQS0	126	NC/ TDQS5 ⁵	36	DQ26	156	DQ31	66	VDD	186	VDD	96	DQ42	216	DQ47
7	DQS0	127	VSS	37	DQ27	157	VSS	67	VREFCA	187	EVENT ¹	97	DQ43	217	VSS
8	VSS	128	DQ6	38	VSS	158	NC	68	NC	188	A0	98	VSS	218	DQ52
9	DQ2	129	DQ7	39	NC	159	NC	69	VDD	189	VDD	99	DQ48	219	DQ53
10	DQ3	130	VSS	40	NC	160	VSS	70	A10/AP	190	BA1	100	DQ49	220	VSS
11	VSS	131	DQ12	41	VSS	161	DM8/ TDQS17 ⁷	71	BA0	191	VDD	101	VSS	221	DM6/ TDQS15 ⁵
12	DQ8	132	DQ13	42	DQS8	162	NC/ TDQS7 ⁵	72	VDD	192	RAS	102	DQS6	222	NC/ TDQS5 ⁵
13	DQ9	133	VSS	43	DQS8	163	VSS	73	WE	193	SE	103	DQS6	223	VSS
14	VSS	134	DM1/ TDQS10 ⁶	44	VSS	164	NC	74	CAS	194	VDD	104	VSS	224	DQ54
15	DQS1	135	NC/ TDQS0 ⁵	45	NC	165	NC	75	VDD	195	ODT0	105	DQ50	225	DQ55
16	DQS1	136	VSS	46	NC	166	VSS	76	SA/NC ²	196	A13	106	DQ51	226	VSS
17	VSS	137	DQ14	47	VSS	167	NC, TEST ⁴	77	ODT1/NC ²	197	VDD	107	VSS	227	DQ60
18	DQ10	138	DQ15	48	NC	168	RESET ⁷	78	VDD	198	SE	108	DQ56	228	DQ61
19	DQ11	139	VSS	49	NC	169	CKE1/NC ²	79	NC	199	VSS	109	DQ57	229	VSS
20	VSS	140	DQ20	50	CKE0	170	VDD	80	VSS	200	DQ36	110	VSS	230	DM7/ TDQS16 ⁶
21	DQ16	141	DQ21	51	VDD	171	A15	81	DQ32	201	DQ37	111	DQS7	231	NC/ TDQS6 ⁶
22	DQ17	142	VSS	52	BA2	172	A14	82	DQ33	202	VSS	112	DQS7	232	VSS
23	VSS	143	DM2/ TDQS11 ⁵	53	NC	173	VDD	83	VSS	203	DM4/ TDQS13 ³	113	VSS	233	DQ62
24	DQS2	144	NC/ TDQS11 ⁵	54	VDD	174	A12	84	DQS4	204	NC TDQS3 ³	114	DQ58	234	DQ63
25	DQS2	145	VSS	55	A11	175	A9	85	DQS4	205	DQS5	115	DQ59	235	VSS
26	VSS	146	DQ22	56	A7	176	VDD	86	VSS	206	DQ38	116	VSS	236	VDDSPD
27	DQ18	147	DQ23	57	VDD	177	A8	87	DQ34	207	DQ39	117	SA0	237	SA1
28	DQ19	148	VSS	58	A5	178	A6	88	DQ35	208	VSS	118	SCL	238	SDA
29	VSS	149	DQ28	59	A4	179	VDD	89	VSS	209	DQ44	119	SA2	239	VSS
30	DQ24	150	DQ29	60	VDD	180	A3	90	DQ40	210	DQ45	120	VTT	240	VTT

Notes

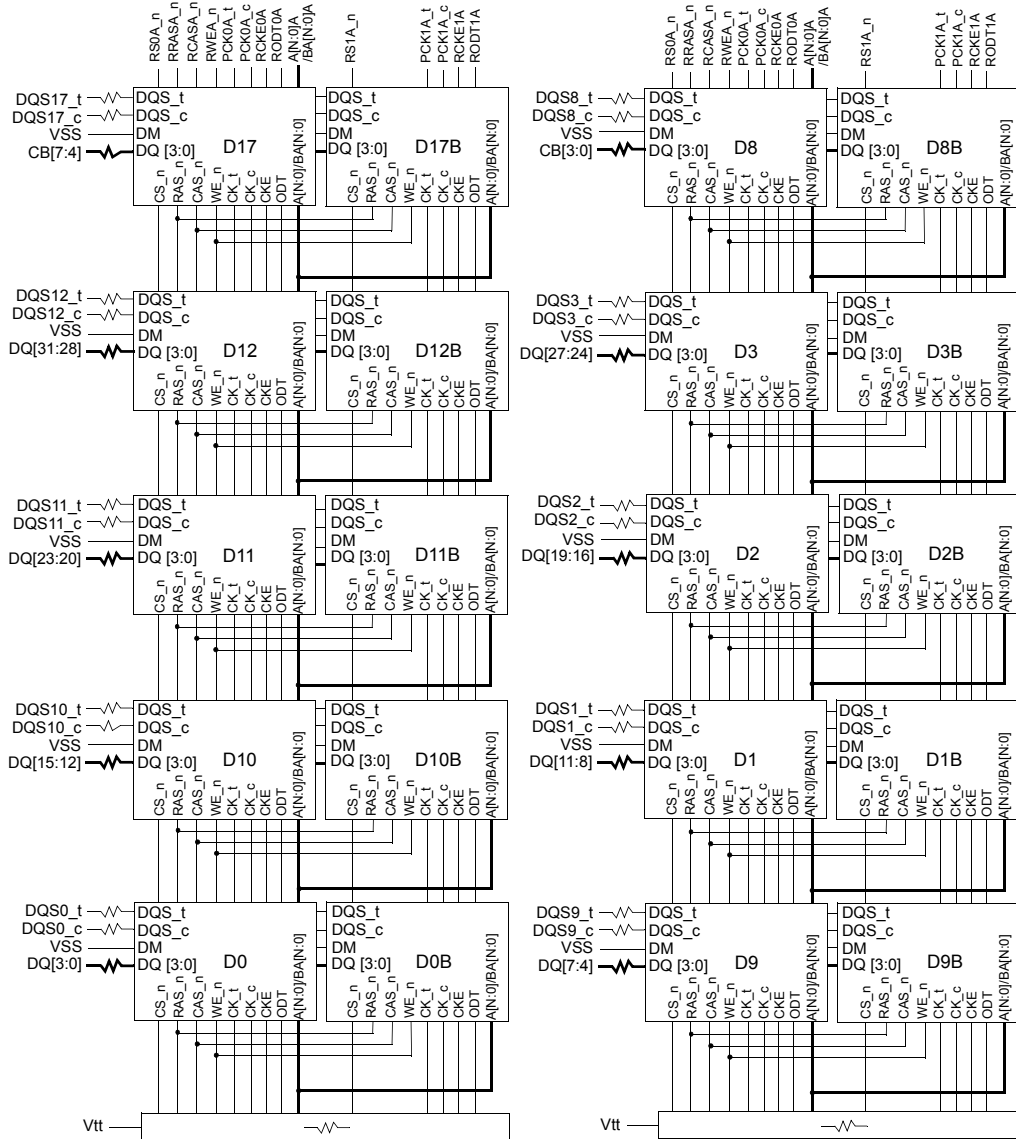
1. NC = No Connect, NU = Not Useable.
2. SA, ODT1,CKE1: Used for dualrank DIMMs; NC on single rank DIMMs
3. CK1,NC and CK0,NC : Used for dualrank UDIMMs, not used on single rank DIMMs, but terminated
4. TEST used by memory bus analysis tools (unused on memory DIMMs)
5. DM[0:8] used on UDIMMs, DM8 is not used on x64 UDIMMs, NC, TDQS[9:17] and TDQS[9:17] used on RDIMMs.

Pin Functional Description

Symbol	Type	Polarity	Function
CK0/ CK0 CK1/ CK1	Input	Cross point	CK and CK are differential clock inputs. All the DDR3 SDRAM add/ctrl inputs are sampled on the crossing of positive edge of CK and negative edge CK Output (read) data is referenced to the crossing of CK and CK (Both directions of crossing).
CKE[0:1]	Input	Active High	Activates the SDRAM CK signal when high and deactivates the CK signal when low. By deactivating the clocks, CKE low initiates the Power Down mode, or the Self Refresh mode.
CS[0:1]	Input	Active Low	Enables the associated SDRAM command decoder when low and disables the command decoder when high. When the command decoder is disabled, new addrs are ignored but previous operations continue. This signal provides for external rank selection on systems with multiple ranks.
RAS/CAS WE	Input	Active Low	RAS/CAS and WE (along with CS define the command being entered.
ODT[0:1]	Input	Active High	When high, termination resistance is enabled for all DQ, DQS_t, DQS_c and DM pins, assuming this function is enabled on the DRAM.
DM[0:8]	Input	Active High	DM is an input mask signal for write data. Input data is masked when DM is sampled Hi coincident 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 matches the DQ and DQS loading.
TDQS[9:17], TDQS[9:17]	Output		TDQS is enabled/disabled via the LOADMODE command to the extended mode register (EMR). When TDQS is enabled, DM is disabled and TDQS and TDQS# provide termination resistance otherwise, TDQS# also function.
DQS[0:8] DQS[0:8]	I/O	Cross point	Data strobe for input and output data. For raw cards using organized DRAMs, Pins DQ0-DQ7 are associated with the LDQS and UDQS pins and Pins DQ8-DQ15 are associated with UDQS and UDQS pins.
BA[0:2]	Input	-	Selects which SDRAM bank of eight is activated.
A0- A15	Input	-	During a Bank Activate command, Address input defines the row address (RA0-RA15). During a Read or Write command cycle, Address input defines the column address. In addition to the column address, AP is used to invoke autoprecharge operation at the end of the burst read or write cycle. If AP is high, autoprecharge is selected and BA0, BA1, BA2 defines the bank to be precharged. If AP is low, auto precharge is disabled. During a Precharge command cycle, AP is used in conjunction with BA0, BA1, BA2 to control which bank(s) to precharge. If AP is high, all banks will be precharged regardless of the state of BA0, BA1 or BA2. If AP is low, BA0, BA1 and BA2 are used to define which bank to precharge. BA2 sampled during READ and WRITE commands to determine if burst chop (if any) will be performed (HIGH, no burst chop; LOW, burst chopped).
DQ[0:63] CB0-CB7	I/O	-	Data and Check Bit Input/Output pins.
VDD, VSS	Supply	-	Power and ground for the DDR3 SDRAM input buffers, and core logic. VDD and VDDQ pins are tied to VDD/VDDQ planes on these modules.
VDDQ	Supply	-	Power supply for the DDR3 SDRAM output buffers to provide improved noise immunity. For all current DDR3 unbuffered DIMM designs, VDDQ shares the same power plane as VDD pins.
VDDSPD	Supply	-	Power supply for SPD EEPROM. This supply is separate from the VDD/VDDQ power plane. EEPROM supply is operable from 3.0V to 3.6V
VREFDQ	Supply	-	Reference voltage for I/O inputs.
VREFCA	Supply	-	Reference voltage for command/address inputs.
SDA	I/O	-	This bidirectional pin is used to transfer data into or out of the SPD EEPROM. An external resistor may be connected from the SDA bus line to VDDSPD to act as a pullup on the system board.
SCL	Input	-	This signal is used to clock data into and out of the SPD EEPROM. An external resistor may be connected from the SCL bus time to VDDSPD to act as a pullup on the system board.
SA[0:2]	Input	-	These signals are tied at the system planar to either VSS or VDDSPD to configure the serial SPD EEPROM address range.
EVENT	Output	Active Low	This signal indicates that a thermal event has been detected in the thermal sensing device. The system should guarantee the electrical level requirement is met for EVENT pin on the TS/SPD part.
RESET	Input	Active Low	The RESET pin is connected to the RESET pin on each DRAM. When low, all DRAMs are set to a known state.

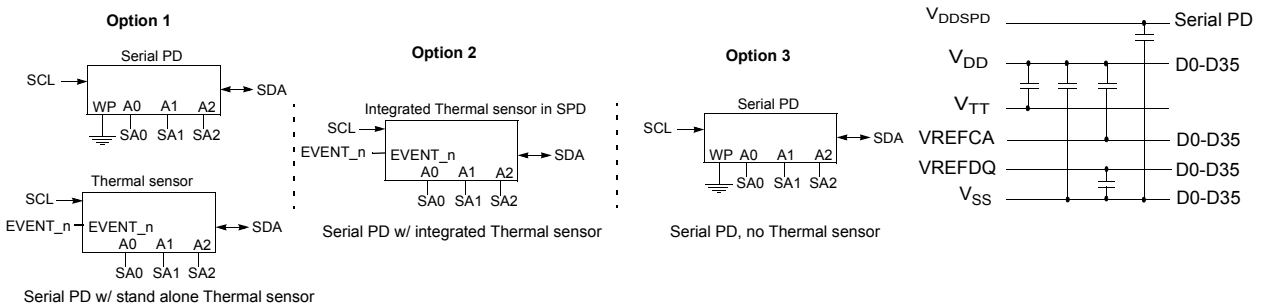
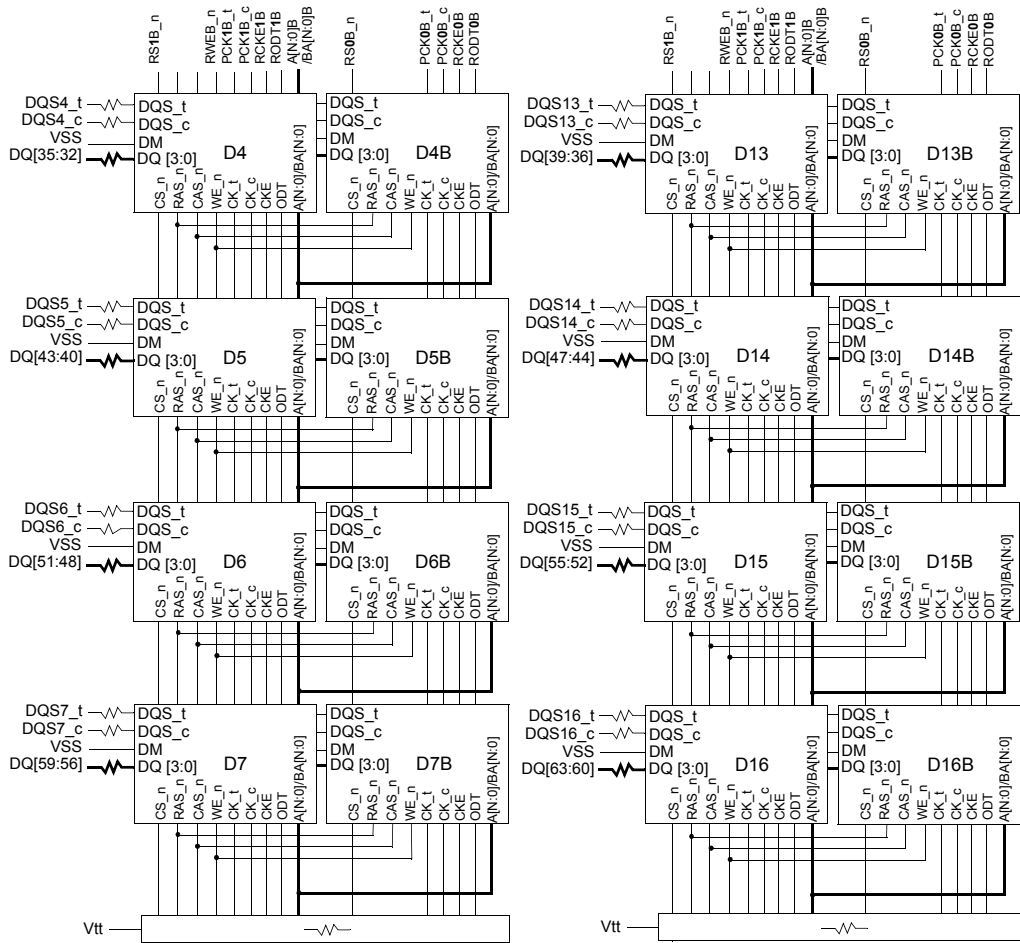
Block Diagram

Raw Card E (x72 DIMM, populated as two physical ranks of x4 DDR3 SDRAMs, part 1 of 2)



Block Diagram

Raw Card E (x72 DIMM, populated as two physical ranks of x4 DDR3 SDRAMs, part 2 of 2)



- NOTE 1 DQ-to-I/O wiring may be changed within a nibble.
- NOTE 2 See wiring diagrams for resistor values.
- NOTE 3 ZQ pins for each SDRAM are connected to ground through individual RZQ resistors (240 ohm +/-1%) ohms.

Electrical Specifications

All voltages are referenced to VSS (GND).

Absolute Maximum DC Rating

Symbol	Parameter	Rating	Units	Notes
VDD	Voltage on VDD pin relative to VSS	-0.4 ~ 1.975	V	1
VDDQ	Voltage on VDDQ pin relative to VSS	-0.4 ~ 1.975	V	1
VIN, VOUT	Voltage on any pin relative to VSS	-0.4 ~ 1.975	V	1
TSTG	Storage Temperature	-55 ~ +100	°C	1,2

Notes:

- Stresses greater than those listed under “Absolute Maximum Ratings” 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.
- Storage Temperature is the case surface temperature on the center/top side of the DRAM. For the measurement conditions, please refer to JESD51-2 standard.
- VDD and VDDQ must be within 300mV of each other at all times; and VREF must not be greater than 0.6 x VDDQ. When VDD and VDDQ are less than 500mV; VREF may be equal to or less than 300mV.

Module Temperature Condition

Operating Temperature Condition

Parameter	Symbol	Rating	Unit	Notes
Operating case temperature	Tc	0 to +95	°C	1,2,3

Notes:

- Operating temperature is the case surface temperature on the center/top side of the DRAM.
- The Normal Temperature Range specifies the temperatures where all DRAM specifications will be supported. During operation, the DRAM case temperature must be maintained between 0 to 85°C under all operating conditions.
- Some applications require operation of the DRAM in the Extended Temperature Range between 85°C and 95°C case temperature. Full specifications are guaranteed in this range, but the following additional conditions apply:
 - Refresh commands must be doubled in frequency, therefore reducing the refresh interval tREFI to 3.9µs. (This double refresh requirement may not apply for some devices.)
 - If Self-refresh operation is required in the Extended Temperature Range, then it is mandatory to either use the Manual Self-Refresh mode with Extended Temperature Range capability (MR2 bit [A6, A7] = [0, 1]) or enable the optional Auto Self-Refresh mode (MR2 bit [A6, A7] = [1, 0]).

DC/AC Operating Condition

Recommended DC Operating Conditions - DDR3L (1.35V) operation

Symbol	Parameter	Rating			Units	Notes
		Min.	Typ.	Max.		
VDD	Supply Voltage	1.283	1.35	1.45	V	1,2,3,4
VDDQ	Supply Voltage for Output	1.283	1.35	1.45	V	1,2,3,4
VrefCA(DC)	Input reference voltage for address, command inputs	0.49*VDD	-	0.51*VDD	V	5, 6
VrefDQ(DC)	Input reference voltage for DQ, DM inputs	0.49*VDD	-	0.51*VDD	V	5, 6

Notes:

1. Maximum DC value may not be greater than 1.425V. The DC value is the linear average of VDD/VDDQ(t) over a very long period of time (e.g., 1 sec).
2. If maximum limit is exceeded, input levels shall be governed by DDR3 specifications.
3. Under these supply voltages, the device operates to this DDR3L specification.
4. Once initialized for DDR3L operation, DDR3 operation may only be used if the device is in reset while VDD and VDDQ are changed for DDR3 operation.
5. The AC peak noise on Vref may not allow Vref to deviate from Vref(DC) by more than $\pm 1\%$ VDD (for reference: approx ± 13.5 mV).
6. For reference: approx. $VDD/2 \pm 13.5$ mV.

Recommended DC Operating Conditions - DDR3 (1.5V) operation

Symbol	Parameter	Rating			Units	Notes
		Min.	Typ.	Max.		
VDD	Supply Voltage	1.425	1.5	1.575	V	1,2,3
VDDQ	Supply Voltage for Output	1.425	1.5	1.575	V	1,2,3
VrefCA(DC)	Input reference voltage for address, command inputs	0.49*VDD	-	0.51*VDD	V	4,5,
VrefDQ(DC)	Input reference voltage for DQ, DM inputs	0.49*VDD	-	0.51*VDD	V	4,5,

Notes:

1. If minimum limit is exceeded, input levels shall be governed by DDR3L specifications.
2. Under 1.5V operation, this DDR3L device operates to the DDR3 specifications under the same speed timings as defined for this device.
3. Once initialized for DDR3 operation, DDR3L operation may only be used if the device is in reset while VDD and VDDQ are changed for DDR3L operation.
4. The AC peak noise on Vref may not allow Vref to deviate from Vref(DC) by more than $\pm 1\%$ VDD (for reference: approx ± 15 mV).
5. For reference: approx. $VDD/2 \pm 15$ mV.

IDD Specifications and Conditions

DC Characteristics 1 (TC = 0 °C to +85 °C, VDD = 1.283 to 1.45V, VSS = 0V)

Data rate (Mbps)		1600	1333		
Parameter	Symbol	max.	max.	Unit	Notes
Operating current (ACT-PRE) (Another rank in IDD2P1)	IDD0	1134	1026	mA	
Operating current (ACT-PRE) (Another rank in IDD3N)	IDD0	1350	1260	mA	
Operating current (ACT-READ-PRE) (Another rank in IDD2P1)	IDD1	2880	2610	mA	
Operating current (ACT-READ-PRE) (Another rank in IDD3N)	IDD1	2106	1530	mA	
Precharge power-down standby	IDD2P0	432	432	mA	Slow PD Exit
	IDD2P1	648	612	mA	Fast PD Exit
Precharge standby current	IDD2N	900	900	mA	
Precharge standby ODT current	IDD2NT	1080	1080	mA	
Precharge quiet standby current	IDD2Q	900	900	mA	
Active power-down current (Always fast exit)	IDD3P	720	720	mA	
Active standby current	IDD3N	1080	1080	mA	
Operating current (Burst read operating) (Another rank in IDD2P1)	IDD4R	2124	1926	mA	
Operating current (Burst read operating) (Another rank in IDD3N)	IDD4R	2340	2160	mA	
Operating current (Burst write operating) (Another rank in IDD2P1)	IDD4W	3420	3420	mA	
Operating current (Burst write operating) (Another rank in IDD3N)	IDD4W	3150	3060	mA	
Burst refresh current (Another rank in IDD2P1)	IDD5B	576	576	mA	
Burst refresh current (Another rank in IDD3N)	IDD5B	540	540	mA	
All bank interleave read current (Another rank in IDD2P1)	IDD7	2016	1836	mA	
All bank interleave read current (Another rank in IDD3N)	IDD7	2196	2016	mA	
RESET low current	IDD8	432	432	mA	

Self-Refresh Current (TC = 0 °C to +85 °C, VDD = 1.283 to 1.45V)

Parameter	Symbol	max.	Unit	Notes
Self-refresh current normal temperature range	IDD6	432	mA	
Self-refresh current extended temperature range	IDD6ET	612	mA	
Auto self-refresh current (optional)	IDD6TC	-	mA	

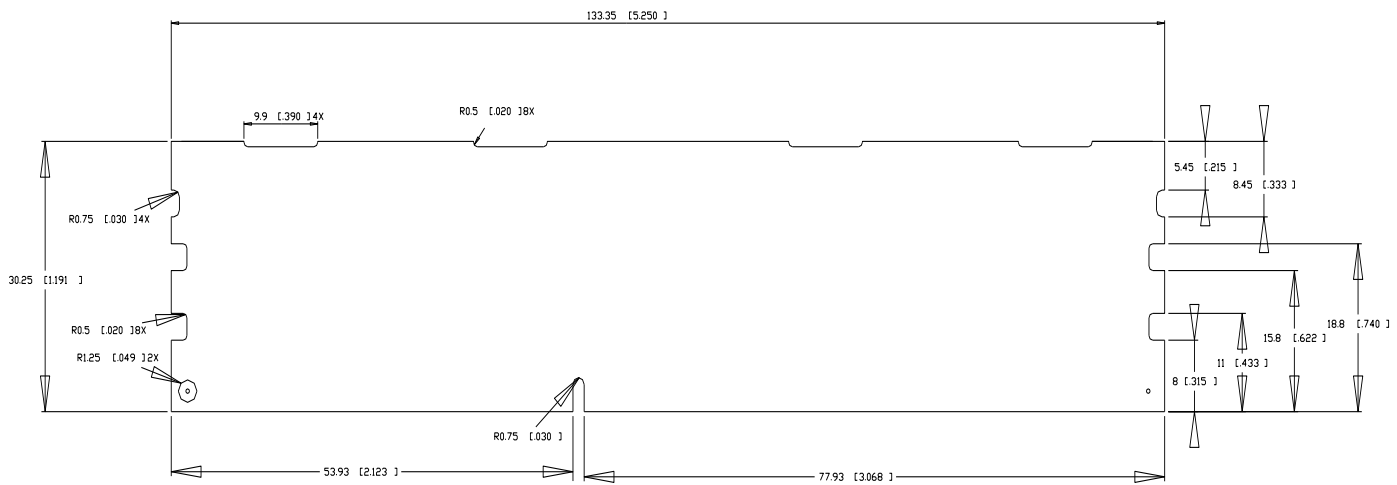
SPD Matrix

Byte No.	Function described	Function support	Hex
0	Number of Serial PD Bytes Written/ SPD Device Size / CRC Coverage	176/256/0-116	92
1	SPD Revision	Version 1.1	11
2	Key Byte / DRAM Device Type	DDR3 SDRAM	0B
3	Key Byte / Module Type	RDIMM	01
4	SDRAM Density and Banks	8 banks,4Gb	04
5	SDRAM Addressing	16 Row × 11 Col	22
6	Module Nominal Voltage, VDD	1.35V&1.5V	02
7	Module Organization	2Ranks x4	08
8	Module Memory Bus Width	72bits/ECC	0B
9	Fine Timebase (FTB) Dividend/Divisor	2.5ps	52
10	Medium Timebase (MTB) Dividend	0.125ns	01
11	Medium Timebase (MTB) Divisor	0.125ns	08
12	SDRAM Minimum Cycle Time (tCKmin)	DDR3 1600	0A
13	Reserved	Reserved	00
14	CAS Latencies Supported, LSB	11,10,9,8,7,6,5,	FE
15	CAS Latencies Supported, MSB	-	00
16	Minimum CAS Latency Time (tAAmin)	13.125ns	69
17	Minimum Write Recovery Time (tWRmin)	15ns	78
18	Minimum RAS# to CAS# Delay Time (tRCDmin)	13.125ns	69
19	Minimum Row Active to Row Active Delay Time (tRRDmin)	6ns	30
20	Minimum Row Precharge Delay Time (tRPmin)	13.125ns	69
21	Upper Nibbles for tRAS and tRC	Refer to Byte22,23	11
22	Minimum Active to Precharge Delay Time (tRASmin), LSB	35ns	18
23	Minimum Active to Active/Refresh Delay Time (tRCmin), LSB	48.125ns	81
24	Minimum Refresh Recovery Delay Time (tRFCmin), LSB	260ns	20
25	Minimum Refresh Recovery Delay Time (tRFCmin), MSB	260ns	08
26	Minimum Internal Write to Read Command Delay Time (tWTRmin)	7.5ns	3C
27	Minimum Internal Read to Precharge Command Delay Time (tRTPmin)	7.5ns	3C
28	Upper Nibble for tFAW	30ns	00
29	Minimum Four Activate Window Delay Time (tFAWmin)	30ns	F0
30	SDRAM Optional Features	Dll-off,RZQ/7,6	83
31	SDRAM Thermal and Refresh Options	PASR,2X at 85-95°C, 0-95°C	81
32	Module Thermal Sensor	Incorporated	80
33	SDRAM Device Type	Standard	00
34-59	Reserved	Reserved	00
60	Module Nominal Height	30.25mm	10
61	Module Maximun Thickness	F:1-2mm, B:1-2mm	11
62	Reference Raw Card Used	Raw Card: E	04
63	DIMM Module Attributes	2 rows,1 register	09
64	RDIMM Thermal Heat Spreader Solution	Not incorporated	00

65	Register Manufacturer ID Code, LSB	Montage	86
66	Register Manufacturer ID Code, MSB	Montage	32
67	Register Revision Number		10
68	Register Type		00
69	RC1 (MS Nibble) / RC0 (LS Nibble)		00
70	RC3 (MS Nibble) / RC2 (LS Nibble) - Drive Strength,Command/Address		50
71	RC5 (MS Nibble) / RC4 (LS Nibble) - Drive Strength,Control and Clock		55
72	RC7 (MS Nibble) / RC6 (LS Nibble) - Reserved for Register Vendor Specific Modes		00
73	RC9 (MS Nibble) / RC8 (LS Nibble) - Reserved		00
74	RC11 (MS Nibble) / RC10 (LS Nibble) - Reserved		00
75	RC13 (MS Nibble) / RC12 (LS Nibble) - Reserved		00
76	RC15 (MS Nibble) / RC14 (LS Nibble) - Reserved		00
77-116	Reserved	-	00
117	Module ID: Module Manufacturer's JEDEC ID Code	Ramaxel	04
118	Module ID: Module Manufacturer's JEDEC ID Code	Ramaxel	43
119	Module ID: Module Manufacturing Location	Shenzhen	01
120-121	Module ID: Module Manufacturing Date	-	00
122-125	Module ID: Module Serial Number	-	00
126	Cyclical Redundancy Code(CRC)		64
127	Cyclical Redundancy Code(CRC)		D6
128-145	Module Part Number	R	52
129		M	4D
130		S	53
131		6	36
132		0	30
133		3	33
134		1	31
135		E	45
136		F	46
137		7	37
138		4	34
139		F	46
140		B	42
141		W	57
142		1	31
143		6	36
144		0	30
145		0	30
146	Module Revision Code	A	41
147	Module Revision Code	-	00
148	DRAM Manufacturer's JEDEC ID Code, LSB	Elpida	02
149	DRAM Manufacturer's JEDEC ID Code, MSB	Elpida	FE
150-175	Manufacturer's Specific Data	-	00
176-255	Open for customer use	-	00

Dimensions

Unit: mm[inch]



*Note: Tolerances on all dimensions ± 0.15 unless otherwise specified.

CAUTION FOR HANDLING MEMORY MODULES

When handling or inserting memory modules, be sure not to touch any components on the modules, such as the memory ICs, chip capacitors and chip resistors. It is necessary to avoid undue mechanical stress on these components to prevent damaging them. In particular, do not push module cover or drop the modules in order to protect from mechanical defects, which would be electrical defects.

When re-packing memory modules, be sure the modules are not touching each other. Modules in contact with other modules may cause excessive mechanical stress, which may damage the modules.

NOTES FOR CMOS DEVICES

1) PRECAUTION AGAINST ESD FOR MOS DEVICES

Exposing the MOS devices to a strong electric field can cause destruction of the gate oxide and ultimately degrade the MOS devices operation. Steps must be taken to stop generation of static electricity as much as possible, and quickly dissipate it, when once it has occurred. Environmental control must be adequate. When it is dry, humidifier should be used. It is recommended to avoid using insulators that easily build static electricity. MOS devices must be stored and transported in an anti-static container, static shielding bag or conductive material. All test and measurement tools including work bench and floor should be grounded. The operator should be grounded using wrist strap. MOS devices must not be touched with bare hands. Similar precautions need to be taken for PW boards with semiconductor MOS devices on it.

2) HANDLING OF UNUSED INPUT PINS FOR CMOS DEVICES

No connection for CMOS devices input pins can be a cause of malfunction. If no connection is provided to the input pins, it is possible that an internal input level may be generated due to noise, etc., hence causing malfunction. CMOS devices behave differently than Bipolar or NMOS devices. Input levels of CMOS devices must be fixed high or low by using a pull-up or pull-down circuitry. Each unused pin should be connected to VDD or GND with a resistor, if it is considered to have a possibility of being an output pin. The unused pins must be handled in accordance with the related specifications.

3) STATUS BEFORE INITIALIZATION OF MOS DEVICES

Power-on does not necessarily define initial status of MOS devices. Production process of MOS does not define the initial operation status of the device. Immediately after the power source is turned ON, the MOS devices with reset function have not yet been initialized. Hence, power-on does not guarantee output pin levels, I/O settings or contents of registers. MOS devices are not initialized until the reset signal is received. Reset operation must be executed immediately after power-on for MOS devices having reset function.