ELPIDA

DATA SHEET

2GB Unbuffered DDR3 SDRAM DIMM

EBJ20EF8BCFA (256M words × 72 bits, 1 Rank)

Specifications

- Density: 2GB
- Organization
  - 256M words × 72 bits, 1 rank
- Mounting 9 pieces of 2G bits DDR3 SDRAM sealed in FBGA
- Package: 240-pin socket type dual in line memory module (DIMM)
  - PCB height: 30.0mm
  - Lead pitch: 1.0mm
  - Lead-free (RoHS compliant) and Halogen-free
- Power supply: VDD = 1.5V ± 0.075V
- Data rate: 1600Mbps/1333Mbps (max.)
- Eight internal banks for concurrent operation (components)
- Interface: SSTL_15
- Burst lengths (BL): 8 and 4 with Burst Chop (BC)
- /CAS Latency (CL): 6, 7, 8, 9, 10, 11
- /CAS write latency (CWL): 5, 6, 7, 8
- Precharge: auto precharge option for each burst access
- Refresh: auto-refresh, self-refresh
- Refresh cycles
  - Average refresh period
    7.8μs at 0°C ≤ TC ≤ +85°C
    3.9μs at +85°C < TC ≤ +95°C
- Operating case temperature range
  - TC = 0°C to +95°C

Features

- Double-data-rate architecture: two data transfers per clock cycle
- The high-speed data transfer is realized by the 8 bits prefetch pipelined architecture
- Bi-directional differential data strobe (DQS and /DQS) is transmitted/received with data for capturing data at the receiver
- DQS is edge-aligned with data for READs; center-aligned with data for WRITEs
- Differential clock inputs (CK and /CK)
- DLL aligns DQ and DQS transitions with CK transitions
- Commands entered on each positive CK edge; data and data mask referenced to both edges of DQS
- Data mask (DM) for write data
- Posted /CAS by programmable additive latency for better command and data bus efficiency
- On-Die-Termination (ODT) for better signal quality
  - Synchronous ODT
  - Dynamic ODT
  - Asynchronous ODT
- Multi Purpose Register (MPR) for pre-defined pattern read out
- ZQ calibration for DQ drive and ODT
- Programmable Partial Array Self-Refresh (PASR)
- /RESET pin for Power-up sequence and reset function
- SRT range:
  - Normal/extended
- Programmable Output driver impedance control
- Class B temperature sensor functionality with EEPROM

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Ordering Information

Part number	Data rate Mbps (max.)	Component JEDEC speed bin (CL-tRCD-tRP)	Package	Contact pad	Mounted devices
EBJ20EF8BCFA-GN-F	1600	DDR3-1600K (11-11-11)	240-pin DIMM (lead-free and halogen-free)	Gold	EDJ2108BCSE-GN-F
EBJ20EF8BCFA-DJ-F	1333	DDR3-1333H (9-9-9)			EDJ2108BCSE-GN-F EDJ2108BCSE-DJ-F

Detailed Information

For detailed electrical specifications and further information, please refer to the component DDR3 SDRAM datasheet EDJ2104BCSE, EDJ2108BCSE (E1677E).

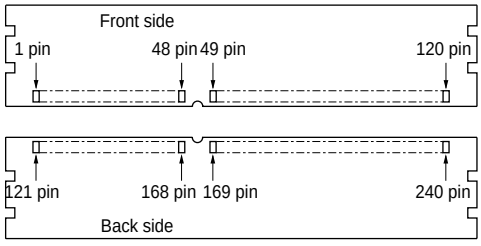
Pin Configurations

Front side		Back side		Front side		Back side		Front side		Back side	
Pin No.	Pin name	Pin No.	Pin name	Pin No.	Pin name	Pin No.	Pin name	Pin No.	Pin name	Pin No.	Pin name
1	VREFDQ	121	VSS	42	/DQS8	162	NC	82	DQ33	202	VSS
2	VSS	122	DQ4	43	DQS8	163	VSS	83	VSS	203	DM4
3	DQ0	123	DQ5	44	VSS	164	CB6	84	/DQS4	204	NC
4	DQ1	124	VSS	45	CB2	165	CB7	85	DQS4	205	VSS
5	VSS	125	DM0	46	CB3	166	VSS	86	VSS	206	DQ38
6	/DQS0	126	NC	47	VSS	167	NC	87	DQ34	207	DQ39
7	DQS0	127	VSS	48	NC	168	/RESET	88	DQ35	208	VSS
8	VSS	128	DQ6			KEY		89	VSS	209	DQ44
9	DQ2	129	DQ7	49	NC	169	NC	90	DQ40	210	DQ45
10	DQ3	130	VSS	50	CKE0	170	VDD	91	DQ41	211	VSS
11	VSS	131	DQ12	51	VDD	171	NC	92	VSS	212	DM5
12	DQ8	132	DQ13	52	BA2	172	A14	93	/DQS5	213	NC
13	DQ9	133	VSS	53	NC	173	VDD	94	DQS5	214	VSS
14	VSS	134	DM1	54	VDD	174	A12	95	VSS	215	DQ46
15	/DQS1	135	NC	55	A11	175	A9	96	DQ42	216	DQ47
16	DQS1	136	VSS	56	A7	176	VDD	97	DQ43	217	VSS
17	VSS	137	DQ14	57	VDD	177	A8	98	VSS	218	DQ52
18	DQ10	138	DQ15	58	A5	178	A6	99	DQ48	219	DQ53
19	DQ11	139	VSS	59	A4	179	VDD	100	DQ49	220	VSS
20	VSS	140	DQ20	60	VDD	180	A3	101	VSS	221	DM6
21	DQ16	141	DQ21	61	A2	181	A1	102	/DQS6	222	NC
22	DQ17	142	VSS	62	VDD	182	VDD	103	DQS6	223	VSS
23	VSS	143	DM2	63	NC	183	VDD	104	VSS	224	DQ54
24	/DQS2	144	NC	64	NC	184	CK0	105	DQ50	225	DQ55
25	DQS2	145	VSS	65	VDD	185	/CK0	106	DQ51	226	VSS
26	VSS	146	DQ22	66	VDD	186	VDD	107	VSS	227	DQ60
27	DQ18	147	DQ23	67	VREFCA	187	/EVENT	108	DQ56	228	DQ61
28	DQ19	148	VSS	68	NC	188	A0	109	DQ57	229	VSS
29	VSS	149	DQ28	69	VDD	189	VDD	110	VSS	230	DM7
30	DQ24	150	DQ29	70	A10(AP)	190	BA1	111	/DQS7	231	NC
31	DQ25	151	VSS	71	BA0	191	VDD	112	DQS7	232	VSS
32	VSS	152	DM3	72	VDD	192	/RAS	113	VSS	233	DQ62
33	/DQS3	153	NC	73	/WE	193	/CS0	114	DQ58	234	DQ63
34	DQS3	154	VSS	74	/CAS	194	VDD	115	DQ59	235	VSS
35	VSS	155	DQ30	75	VDD	195	ODT0	116	VSS	236	VDDSPD
36	DQ26	156	DQ31	76	NC	196	A13	117	SA0	237	SA1
37	DQ27	157	VSS	77	NC	197	VDD	118	SCL	238	SDA
38	VSS	158	CB4	78	VDD	198	NC	119	SA2	239	VSS
39	CB0	159	CB5	79	NC	199	VSS	120	VTT	240	VTT
40	CB1	160	VSS	80	VSS	200	DQ36				
41	VSS	161	DM8	81	DQ32	201	DQ37				

Pin Description

Pin name	Function	
A0 to A14	Address input Row address Column address	 A0 to A14 A0 to A9
A10 (AP)	Auto precharge	
A12 (/BC)	Burst chop	
BA0, BA1, BA2	Bank select address	
/RAS	Row address strobe	
/CAS	Column address strobe	
/WE	Write enable	
/CS0	Chip select	
CKE0	Clock enable	
CK0	Clock input	
/CK0	Differential clock input	
ODT0	ODT control	
DQ0 to DQ63	Data input/output	
CB0 to CB7	Check bit (Data input/output)	
DQS0 to DQS8, /DQS0 to /DQS8	Input and output data strobe	
DM0 to DM8	Input mask	
SCL	Clock input for serial PD	
SDA	Data input/output for serial PD	
SA0, SA1, SA2	Address input for serial PD	
VDD*[1]	Power for internal circuit	
VDDSPD	Power for serial PD	
VREFCA	Reference voltage for CA	
VREFDQ	Reference voltage for DQ	
VSS	Ground	
VTT	I/O termination supply for SDRAM	
/RESET	Set DRAM to a known state	
/EVENT	Temperature event pin	
NC	No connection	

Note: 1. The VDD and VDDQ pins are tied common to a single power-plane on these designs.

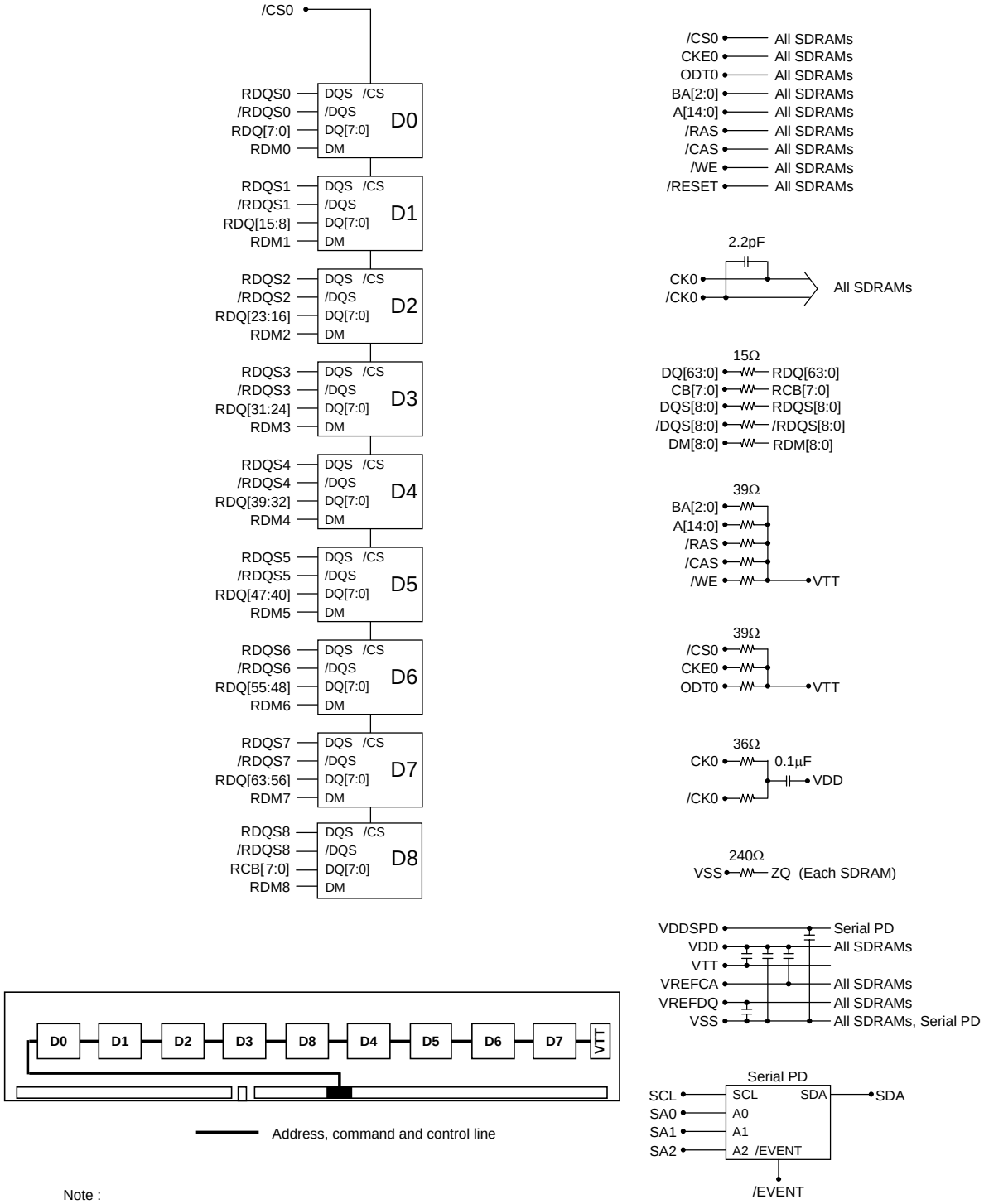


Serial PD Matrix

		-DJ		-GN	
Byte No.	Function described	Hex	Comments	Hex	Comments
0	Number of serial PD bytes written/SPD device size/CRC coverage	92h	176/256/0-116	92h	176/256/0-116
1	SPD revision	10h	Rev.1.0	10h	Rev.1.0
2	Key byte/DRAM device type	0Bh	DDR3 SDRAM	0Bh	DDR3 SDRAM
3	Key byte/module type	02h	UDIMM	02h	UDIMM
4	SDRAM density and banks	03h	2G bits, 8 banks	03h	2G bits, 8 banks
5	SDRAM addressing	19h	15 rows, 10 columns	19h	15 rows, 10 columns
6	Module nominal voltage, VDD	00h	1.5V	00h	1.5V
7	Module organization	01h	1 rank/× 8 bits	01h	1 rank/×8 bits
8	Module memory bus width	0Bh	72 bits/ECC	0Bh	72 bits/ECC
9	Fine timebase (FTB) dividend/divisor	52h	5/2	52h	5/2
10	Medium timebase (MTB) dividend	01h	1	01h	1
11	Medium timebase (MTB) divisor	08h	8	08h	8
12	SDRAM minimum cycle time (tCK (min.))	0Ch	1.5ns	0Ah	1.25ns
13	Reserved	00h	—	00h	—
14	SDRAM CAS latencies supported, LSB	7Ch	6, 7, 8, 9, 10	FCh	6, 7, 8, 9, 10, 11
15	SDRAM CAS latencies supported, MSB	00h	—	00h	—
16	SDRAM minimum CAS latencies time (tAA (min.))	69h	13.125ns	69h	13.125ns
17	SDRAM minimum write recovery time (tWR (min.))	78h	15ns	78h	15ns
18	SDRAM minimum /RAS to /CAS delay (tRCD (min.))	69h	13.125ns	69h	13.125ns
19	SDRAM minimum row active to row active delay (tRRD (min.))	30h	6ns	30h	6ns
20	SDRAM minimum row precharge time (tRP (min.))	69h	13.125ns	69h	13.125ns
21	SDRAM upper nibbles for tRAS and tRC	11h	—	11h	—
22	SDRAM minimum active to precharge time (tRAS (min.)), LSB	20h	36ns	18h	35ns
23	SDRAM minimum active to active /auto-refresh time (tRC (min.)), LSB	89h	49.125ns	81h	48.125ns
24	SDRAM minimum refresh recovery time delay (tRFC (min.)), LSB	00h	160ns	00h	160ns
25	SDRAM minimum refresh recovery time delay (tRFC (min.)), MSB	05h	160ns	05h	160ns
26	SDRAM minimum internal write to read command delay (tWTR (min.))	3Ch	7.5ns	3Ch	7.5ns
27	SDRAM minimum internal read to precharge command delay (tRTP (min.))	3Ch	7.5ns	3Ch	7.5ns
28	Upper nibble for tFAW	00h	30ns	00h	30ns
29	Minimum four activate window delay time (tFAW (min.))	F0h	30ns	F0h	30ns
30	SDRAM optional features	83h	DLL-off, RZQ/6, 7	83h	DLL-off, RZQ/6, 7
31	SDRAM thermal and refresh options	81h	PASR/2X refresh at +85°C to +95°C	81h	PASR/2X refresh at +85°C to +95°C
32	Module thermal sensor	80h	Incorporated	80h	Incorporated
33	SDRAM device type	00h	Standard	00h	Standard
34 to 59	Reserved	00h	—	00h	—

		-DJ		-GN	
Byte No.	Function described	Hex	Comments	Hex	Comments
60	Module nominal height	0Fh	29 < height ≤ 30mm	0Fh	29 < height ≤ 30mm
61	Module maximum thickness	01h	Single side	01h	Single side
62	Reference raw card used	23h	Raw Card D1	23h	Raw Card D1
63	Address mapping from edge connector to DRAM	00h	Standard	00h	Standard
64 to 116	Reserved	00h	—	00h	—
117	Module ID: manufacturer's JEDEC ID code, LSB	02h	Elpida Memory	02h	Elpida Memory
118	Module ID: manufacturer's JEDEC ID code, MSB	FEh	Elpida Memory	FEh	Elpida Memory
119	Module ID: manufacturing location	××	—	××	—
120	Module ID: manufacturing date	yy	Year code (BCD)	yy	Year code (BCD)
121	Module ID: manufacturing date	ww	Week code (BCD)	ww	Week code (BCD)
122 to 125	Module ID: module serial number	××	—	××	—
126	Cyclical redundancy code (CRC)	1Eh	—	CBh	—
127	Cyclical redundancy code (CRC)	67h	—	B9h	—
128	Module part number	45h	E	45h	E
129	Module part number	42h	B	42h	B
130	Module part number	4Ah	J	4Ah	J
131	Module part number	32h	2	32h	2
132	Module part number	30h	0	30h	0
133	Module part number	45h	E	45h	E
134	Module part number	46h	F	46h	F
135	Module part number	38h	8	38h	8
136	Module part number	42h	B	42h	B
137	Module part number	43h	C	43h	C
138	Module part number	46h	F	46h	F
139	Module part number	41h	A	41h	A
140	Module part number	2Dh	—	2Dh	—
141	Module part number	44h	D	47h	G
142	Module part number	4Ah	J	4Eh	N
143	Module part number	2Dh	—	2Dh	—
144	Module part number	46h	F	46h	F
145	Module part number	20h	(Space)	20h	(Space)
146	Module revision code	30h	Initial	30h	Initial
147	Module revision code	20h	(Space)	20h	(Space)
148	SDRAM manufacturer's JEDEC ID code, LSB	02h	Elpida Memory	02h	Elpida Memory
149	SDRAM manufacturer's JEDEC ID code, MSB	FEh	Elpida Memory	FEh	Elpida Memory
150 to 175	Manufacturer's specific data				
176 to 255	Open for customer use	00h	—	00h	—

Block Diagram



Note :
1. DQ wiring may be changed within a byte.

Electrical Specifications

- All voltages are referenced to VSS (GND).

Absolute Maximum Ratings

Parameter	Symbol	Value	Unit	Notes
Power supply voltage	VDD	–0.4 to +1.975	V	1, 3, 4
Input voltage	VIN	–0.4 to +1.975	V	1, 4
Output voltage	VOUT	–0.4 to +1.975	V	1, 4
Reference voltage	VREFCA	–0.4 to 0.6 × VDD	V	3, 4
Reference voltage for DQ	VREFDQ	–0.4 to 0.6 × VDDQ	V	3, 4
Storage temperature	Tstg	–55 to +100	°C	1, 2, 4
Power dissipation	PD	9	W	
Short circuit output current	IOUT	50	mA	1, 4

Notes: 1. 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.

2. Storage temperature is the case surface temperature on the center/top side of the DRAM.
3. VDD and VDDQ must be within 300mV of each other at all times; and VREF must be not greater than 0.6 × VDDQ, When VDD and VDDQ are less than 500mV; VREF may be equal to or less than 300mV.
4. DDR3 SDRAM component specification.

Caution Exposing the device to stress above those listed in Absolute Maximum Ratings could cause permanent damage. The device is not meant to be operated under conditions outside the limits described in the operational section of this specification Exposure to Absolute Maximum Rating conditions for extended periods may affect device reliability.

Operating Temperature Condition

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

Notes: 1. Operating temperature is the case surface temperature on the center/top side of the DRAM.

2. 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°C to +85°C under all operating conditions.
3. 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:
   a) 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.)
   b) 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]).

Recommended DC Operating Conditions (TC = 0°C to +85°C)

Parameter	Symbol	min.	typ.	max.	Unit	Notes
Supply voltage	VDD, VDDQ	1.425	1.5	1.575	V	1, 2, 3
	VSS	0	0	0	V	1
	VDDSPD	3.0	3.3	3.6	V	
Input reference voltage for address, command inputs	VREFCA (DC)	0.49 × VDD	—	0.51 × VDD	V	1, 4, 5
Input reference voltage for DQ, DM inputs	VREFDQ (DC)	0.49 × VDD	—	0.51 × VDD	V	1, 4, 5

Notes: 1. DDR3 SDRAM component specification.

2. Under all conditions VDDQ must be less than or equal to VDD.
3. VDDQ tracks with VDD. AC parameters are measured with VDD and VDDQ tied together.
4. The AC peak noise on VREF may not allow VREF to deviate from VREF(DC) by more than ±1% VDD (for reference: approx ±15 mV).
5. For reference: approx. VDD/2 ± 15 mV.

DC Characteristics 1 (TC = 0°C to +85°C, VDD = 1.5V ± 0.075V, VSS = 0V)

Data rate (Mbps)		1600	1333		
Parameter	Symbol	max.	max.	Unit	Notes
Operating current (ACT-PRE)	IDD0	630	585	mA	
Operating current (ACT-READ-PRE)	IDD1	765	720	mA	
Precharge power-down standby current	IDD2P1	333	315	mA	Fast PD Exit
	IDD2P0	135	135	mA	Slow PD Exit
Precharge standby current	IDD2N	450	405	mA	
Precharge standby ODT current	IDD2NT	450	405	mA	
Precharge quiet standby current	IDD2Q	450	405	mA	
Active power-down current (Always fast exit)	IDD3P	351	333	mA	
Active standby current	IDD3N	585	540	mA	
Operating current (Burst read operating)	IDD4R	1440	1260	mA	
Operating current (Burst write operating)	IDD4W	1485	1305	mA	
Burst refresh current	IDD5B	2250	2160	mA	
All bank interleave read current	IDD7	2340	2250	mA	
RESET low current	IDD8	153	153	mA	

Self-Refresh Current (TC = 0°C to +85°C, VDD = 1.5V ± 0.075V)

Parameter	Symbol	max.	Unit	Notes
Self-refresh current normal temperature range	IDD6	153	mA	
Self-refresh current extended temperature range	IDD6ET	198	mA	
Auto self-refresh current (optional)	IDD6TC	—	mA	

Timings used for IDD and IDDQ Measurement-Loop Patterns

	DDR3-1600	DDR3-1333	
Parameter	11-11-11	9-9-9	Unit
CL	11	9	nCK
tCK min.	1.25	1.5	ns
nRCD min.	11	9	nCK
nRC min.	39	33	nCK
nRAS min.	28	24	nCK
nRP min.	11	9	nCK
nFAW	24	20	nCK
nRRD	5	4	nCK
nRFC	128	107	nCK

Pin Functions

CK, /CK (input pin)

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 (read) data is referenced to the crossings of CK and /CK (both directions of crossing).

/CS (input pin)

All commands are masked when /CS is registered high. /CS provides for external rank selection on systems with multiple ranks. /CS is considered part of the command code.

/RAS, /CAS, and /WE (input pins)

/RAS, /CAS and /WE (along with /CS) define the command being entered.

A0 to A14 (input pins)

Provided the row address for active commands and the column address for read/write commands to select one location out of the memory array in the respective bank. (A10(AP) and A12(/BC) have additional functions, see below) The address inputs also provide the op-code during mode register set commands.

[Address Pins Table]

Address (A0 to A14)		
Row address (RA)	Column address (CA)	Notes
AX0 to AX14	AY0 to AY9	

A10 (AP) (input pin)

A10 is sampled during read/write commands to determine whether auto-precharge should be performed to the accessed bank after the read/write operation. (high: auto-precharge; low: no auto-precharge)

A10 is sampled during a precharge command to determine whether the precharge applies to one bank (A10 = low) or all banks (A10 = high). If only one bank is to be precharged, the bank is selected by bank addresses (BA).

A12 (/BC) (input pin)

A12 is sampled during read and write commands to determine if burst chop (on-the-fly) will be performed.

(A12 = high: no burst chop, A12 = low: burst chopped.)

BA0 to BA2 (input pins)

BA0, BA1 and BA2 define to which bank an active, read, write or precharge command is being applied. BA0 and BA1 also determine if a mode register is to be accessed during a MRS cycle.

[Bank Select Signal Table]

	BA0	BA1	BA2
Bank 0	L	L	L
Bank 1	H	L	L
Bank 2	L	H	L
Bank 3	H	H	L
Bank 4	L	L	H
Bank 5	H	L	H
Bank 6	L	H	H
Bank 7	H	H	H

Remark: H: VIH. L: VIL.

CKE (input pin)

CKE high activates, and CKE low deactivates, internal clock signals and device input buffers and output drivers. Taking CKE low provides precharge power-down and self-refresh operation (all banks idle), or active power-down (row active in any bank). CKE is asynchronous for self-refresh exit. After VREF has become stable during the power-on and initialization sequence, it must be maintained for proper operation of the CKE receiver. For proper self-refresh entry and exit, VREF must be maintained to this input. CKE must be maintained high throughout read and write accesses. Input buffers, excluding CK, /CK, ODT and CKE are disabled during power-down. Input buffers, excluding CKE, are disabled during self-refresh.

DQ and CB (input and output pins)

Bi-directional data bus.

DQS and /DQS (input and output pins)

Output with read data, input with write data. Edge-aligned with read data, centered in write data.
The data strobe DQS is paired with differential signals /DQS to provide differential pair signaling to the system during READs and WRITEs.

ODT (input pin)

ODT (registered high) enables termination resistance internal to the DDR3 SDRAM. When enabled, ODT is only applied to each DQ, DQS, /DQS, DM. The ODT pin will be ignored if the mode register (MR1) is programmed to disable ODT.

DM (input pins)

DM is the reference signal of the data input mask function. DMs are sampled at the cross point of DQS and /DQS.

VDD (power supply pins)

1.5V is applied. (VDD is for the internal circuit.)

VDDSPD (power supply pin)

3.3V is applied (For serial EEPROM).

VSS (power supply pins)

Ground is connected.

VTT (power supply pins)

I/O termination supply for SDRAM.

VREFDQ (power supply pin)

Reference voltage for DQ.

VREFCA (power supply pin)

Reference voltage for CA.

/RESET (input pin)

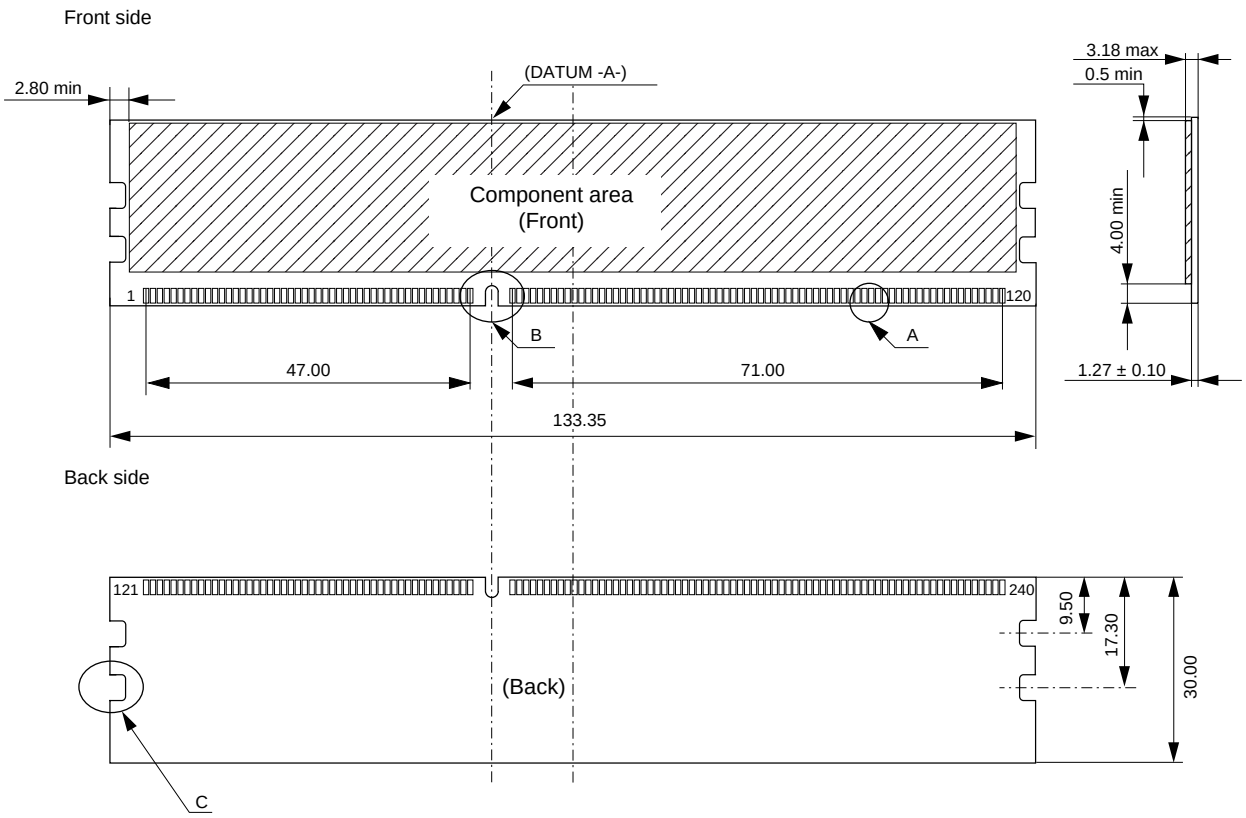
/RESET is negative active signal (active low) and is referred to VSS.

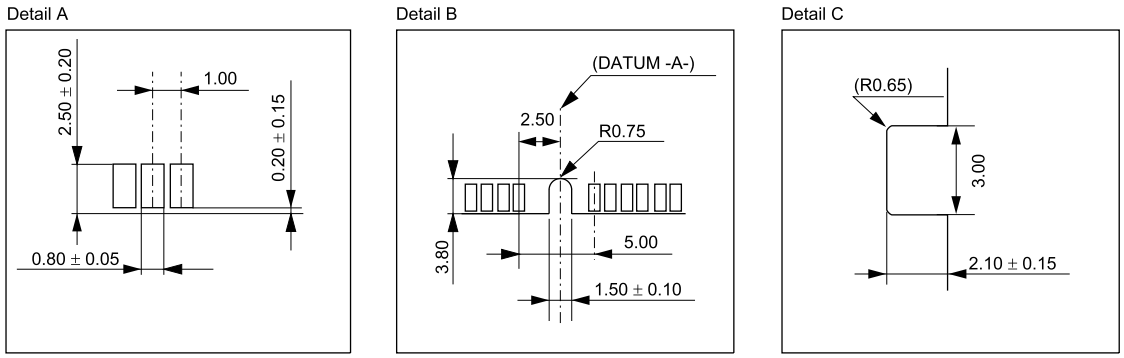
/EVENT (output pin)

Temperature alert output.

Physical Outline

Unit: mm





ECA-TS2-0193-03

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.

MDE0202

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 V_{DD} 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.

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[Usage environment]
Usage in environments with special characteristics as listed below was not considered in the design.
Accordingly, our company assumes no responsibility for loss of a customer or a third party when used in environments with the special characteristics listed below.

Example:
1) Usage in liquids, including water, oils, chemicals and organic solvents.
2) Usage in exposure to direct sunlight or the outdoors, or in dusty places.
3) Usage involving exposure to significant amounts of corrosive gas, including sea air, CL_2, H_2S, NH_3, SO_2, and NO_X.
4) Usage in environments with static electricity, or strong electromagnetic waves or radiation.
5) Usage in places where dew forms.
6) Usage in environments with mechanical vibration, impact, or stress.
7) Usage near heating elements, igniters, or flammable items.

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