LPDDR4/4X Datasheet

RS512M32LX4D2BNR-53BT

200-Ball

Revision 1.0

Apr. 27. 2023

Revision History

Version	Date	Editor
V1.0	2023-4-27	Basic spec and architecture

Notes： *This data sheet contains minimum and maximum limits specified over the power supply and temperature range set forth herein. Although considered final, these specifications are subject to change at any time without notice, as further product development and data characterization sometimes occur.*

Contents

1. Product Overview

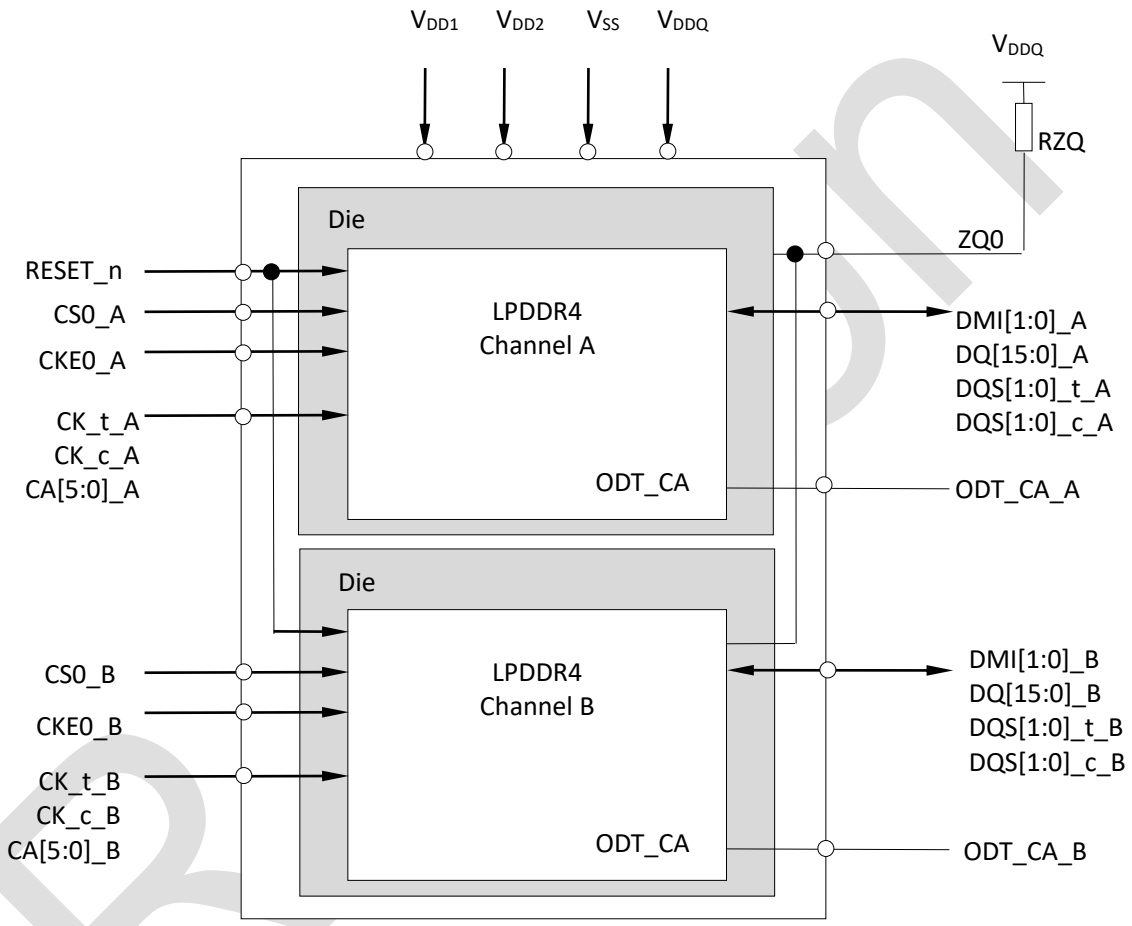
1.1. Feature Overview

- Ultra-low-voltage core and I/O power supplies
  - V_{DD1} = 1.70-1.95V; 1.80V nominal
  - V_{DD2} = 1.06-1.17V; 1.10V nominal
  - V_{DDQ} = 0.57-0.65V; 0.60V nominal Or V_{DDQ} = 1.06-1.17V; 1.10V nominal
- Frequency range
  - 1866-10 MHz (data rate range per pin:3733-20Mbp/s)
- 16n prefetch DDR architecture
- 8 internal banks per channel for concurrent operation
- Single-data-rate CMD / ADR entry
- Bidirectional / differential data strobe per byte lane
- Programmable READ and WRITE latencies (RL / WL)
- Programmable and on-the-fly burst lengths (BL = 16, 32)
- Directed per-bank refresh for concurrent bank operation and ease of command scheduling
- Up to 8.53 GB / s per die x16 channel
- On-chip temperature sensor to control self refresh rate
- Partial-array self refresh (PASR)
- Selectable output drive strength (DS)
- Clock-stop capability
- RoHS-compliant, “green” packaging
- V_{DD1}/V_{DD2}/V_{DDQ}: 1.80V/1.10V/0.60V or 1.10V
- Array configuration
  - 512Meg x 32 (2 channels x 16 I/O)
  - 512M16 x 2 die in package
- FBGA “green” package
  - 200-ball FBGA (10mm x15mm x0.85±0.1mm)
- Speed grade,cycle time
  - 535ps@ RL = 32/36
- Operating temperature range

- -25°C to + 85°C

2. Physical Specifications

2.1. Function Block Diagram



Dual-Die, Dual-Channel Package,Single-Rank Block Diagram

2.2. Package ballout & Addressing

200-Ball Dual-Channel, Single-Rank Discrete FBGA

	1	2	3	4	5	6	7	8	9	10	11	12
A	DNU	DNU	V_{SS}	V_{DD2}	ZQ0			NC	V_{DD2}	V_{SS}	DNU	DNU
B	DNU	DQ0_A	V_{DDQ}	DQ7_A	V_{DDQ}			V_{DDQ}	DQ15_A	V_{DDQ}	DQ8_A	DNU
C	V_{SS}	DQ1_A	DMI0_A	DQ6_A	V_{SS}			V_{SS}	DQ14_A	DMI1_A	DQ9_A	V_{SS}
D	V_{DDQ}	V_{SS}	DQS0_t_A	V_{SS}	V_{DDQ}			V_{DDQ}	V_{SS}	DQS1_t_A	V_{SS}	V_{DDQ}
E	V_{SS}	DQ2_A	DQS0_c_A	DQ5_A	V_{SS}			V_{SS}	DQ13_A	DQS1_c_A	DQ10_A	V_{SS}
F	V_{DD1}	DQ3_A	V_{DDQ}	DQ4_A	V_{DD2}			V_{DD2}	DQ12_A	V_{DDQ}	DQ11_A	V_{DD1}
G	V_{SS}	ODT_CA_A	V_{SS}	V_{DD1}	V_{SS}			V_{SS}	V_{DD1}	V_{SS}	NC	V_{SS}
H	V_{DD2}	CA0_A	NC	CS0_A	V_{DD2}			V_{DD2}	CA2_A	CA3_A	CA4_A	V_{DD2}
J	V_{SS}	CA1_A	V_{SS}	CKE0_A	NC			CK_t_A	CK_c_A	V_{SS}	CA5_A	V_{SS}
K	V_{DD2}	V_{SS}	V_{DD2}	V_{SS}	NC			NC	V_{SS}	V_{DD2}	V_{SS}	V_{DD2}
L												
M												
N	V_{DD2}	V_{SS}	V_{DD2}	V_{SS}	NC			NC	V_{SS}	V_{DD2}	V_{SS}	V_{DD2}
P	V_{SS}	CA1_B	V_{SS}	CKE0_B	NC			CK_t_B	CK_c_B	V_{SS}	CA5_B	V_{SS}
R	V_{DD2}	CA0_B	NC	CS0_B	V_{DD2}			V_{DD2}	CA2_B	CA3_B	CA4_B	V_{DD2}
T	V_{SS}	ODT_CA_B	V_{SS}	V_{DD1}	V_{SS}			V_{SS}	V_{DD1}	V_{SS}	RESET_n	V_{SS}
U	V_{DD1}	DQ3_B	V_{DDQ}	DQ4_B	V_{DD2}			V_{DD2}	DQ12_B	V_{DDQ}	DQ11_B	V_{DD1}
V	V_{SS}	DQ2_B	DQS0_c_B	DQ5_B	V_{SS}			V_{SS}	DQ13_B	DQS1_c_B	DQ10_B	V_{SS}
W	V_{DDQ}	V_{SS}	DQS0_t_B	V_{SS}	V_{DDQ}			V_{DDQ}	V_{SS}	DQS1_t_B	V_{SS}	V_{DDQ}
Y	V_{SS}	DQ1_B	DMI0_B	DQ6_B	V_{SS}			V_{SS}	DQ14_B	DMI1_B	DQ9_B	V_{SS}
AA	DNU	DQ0_B	V_{DDQ}	DQ7_B	V_{DDQ}			V_{DDQ}	DQ15_B	V_{DDQ}	DQ8_B	DNU
AB	DNU	DNU	V_{SS}	V_{DD2}	V_{SS}			V_{SS}	V_{DD2}	V_{SS}	DNU	DNU

Top View

LPDDR4_A(Channel A） LPDDR4_B(Channel B） ZQ,ODT_CA,RESET Supply Ground

2.3. Pad Definition

"_A" and "_B" indicate DRAM channels. "_A" pads are present in all devices while "_B" pads are present in dual channel SDRAM devices only.

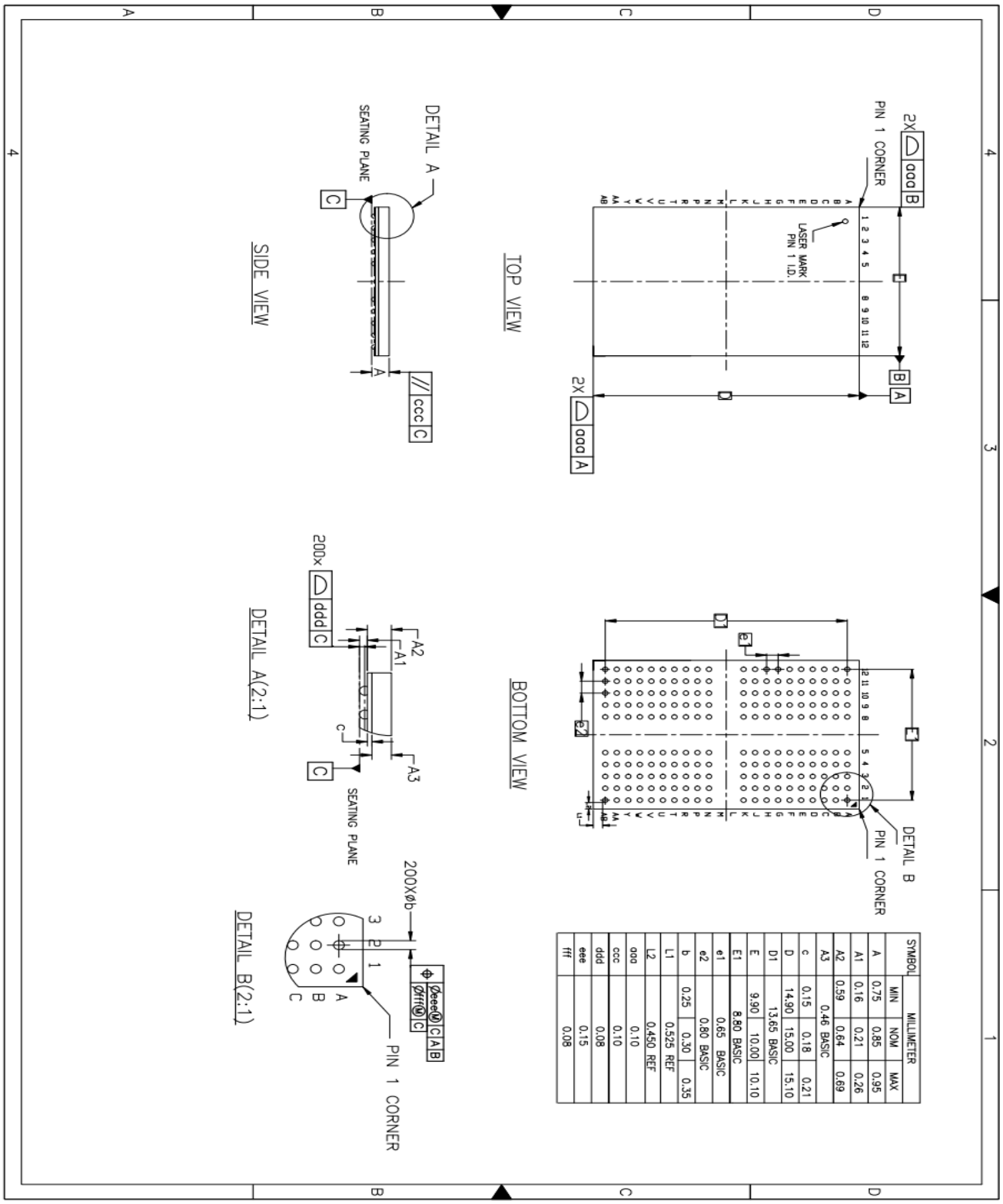
LPDDR4X pad definitions are the same as LPDDR4, except ODT_CA pins as described in the following Table

Symbol	Type	Description
CK_t_A, CK_c_A CK_t_B, CK_c_B	Input	**Clock:** CK_t and CK_c are differential clock inputs. All address, command and control input signals are sampled on positive edge of CK_t and the negative edge of CK_c.AC timings for CA parameters are referenced to clock. Each channel (A, B) has its own clock pair.
CKE0_A,CKE1_A CKE0_B,CKE1_B	Input	**Clock enable:** CKE HIGH activates and CKE LOW deactivates the internal clock signals, input buffers, and output drivers. Power-saving modes are entered and exited via CKE transitions. CKE is sampled at the rising edge of CK.
CS0_A CS0_B	Input	**Chip select:** Each channel (A, B) has its own CS signals.
CA[5:0]_A CA[5:0]_B	Input	**Command/address inputs:** Provide the command and address inputs according to the command truth table. Each channel (A, B) has its own CA signals.
ODT_CA_A ODT_CA_B	Input	**LPDDR4X CA ODT Control:** The ODT_CA pin is ignored by LPDDR4X devices. CA ODT is fully controlled through MR11 and MR22. The ODT_CA pin shall be connected to a valid logic level.
DQ[15:0]_A DQ[15:0]_B	I/O	**Data input/output:** Bidirectional data bus.
DQS[1:0]_t_A DQS[1:0]_c_A DQS[1:0]_t_B DQS[1:0]_c_B	I/O	**Data strobe:** DQS_t and DQS_c are bidirectional differential output clock signals used to strobe data during a READ or WRITE. The data strobe is generated by the DRAM for a READ and is edge-aligned with data. The data strobe is generated by the SoC memory controller for a WRITE and is trained to precede data. Each byte of data has a data strobe signal pair. Each channel (A, B) has its own DQS_t and DQS_c strobes.
DMI[1:0]_A DMI[1:0]_B	I/O	**Data mask/Data bus inversion:** DMI is a dual use bidirectional signal used to indicate data to be masked, and data which is inverted on the bus. For data bus inversion(DBI), the DMI signal is driven HIGH when the data on the data bus is inverted, or driven LOW when the data is in its normal state. DBI can be disabled via a mode register setting. For data mask, the DMI signal is used in combination with the data lines to indicate data to be masked in a MASK WRITE command (see the Data Mask (DM) and Data Bus Inversion (DBI) sections for details). The data mask function can be disabled via a mode register setting. Each byte of data has a DMI signal. Each channel has its own DMI signals.

Symbol	Type	Description
ZQ0, ZQ1	Reference	**ZQ calibration reference:** Used to calibrate the output drive strength and the termination resistance. The ZQ pin shall be connected to V_{DDQ} through a 240Ω ±1% resistor.
V_{DDQ}, V_{DD1}, V_{DD2}	Supply	**Power supplies:** Isolated on the die for improved noise immunity.
V_{SS}	Supply	**Ground reference:** Power supply ground reference.
RESET_n	Input	**RESET:** When asserted LOW, the RESET pin resets all channels of the die.
DNU	–	**Do not use:** Must be grounded or left floating.
NC	–	**No connect:** Not internally connected.

2.4. Discrete Package Dimension

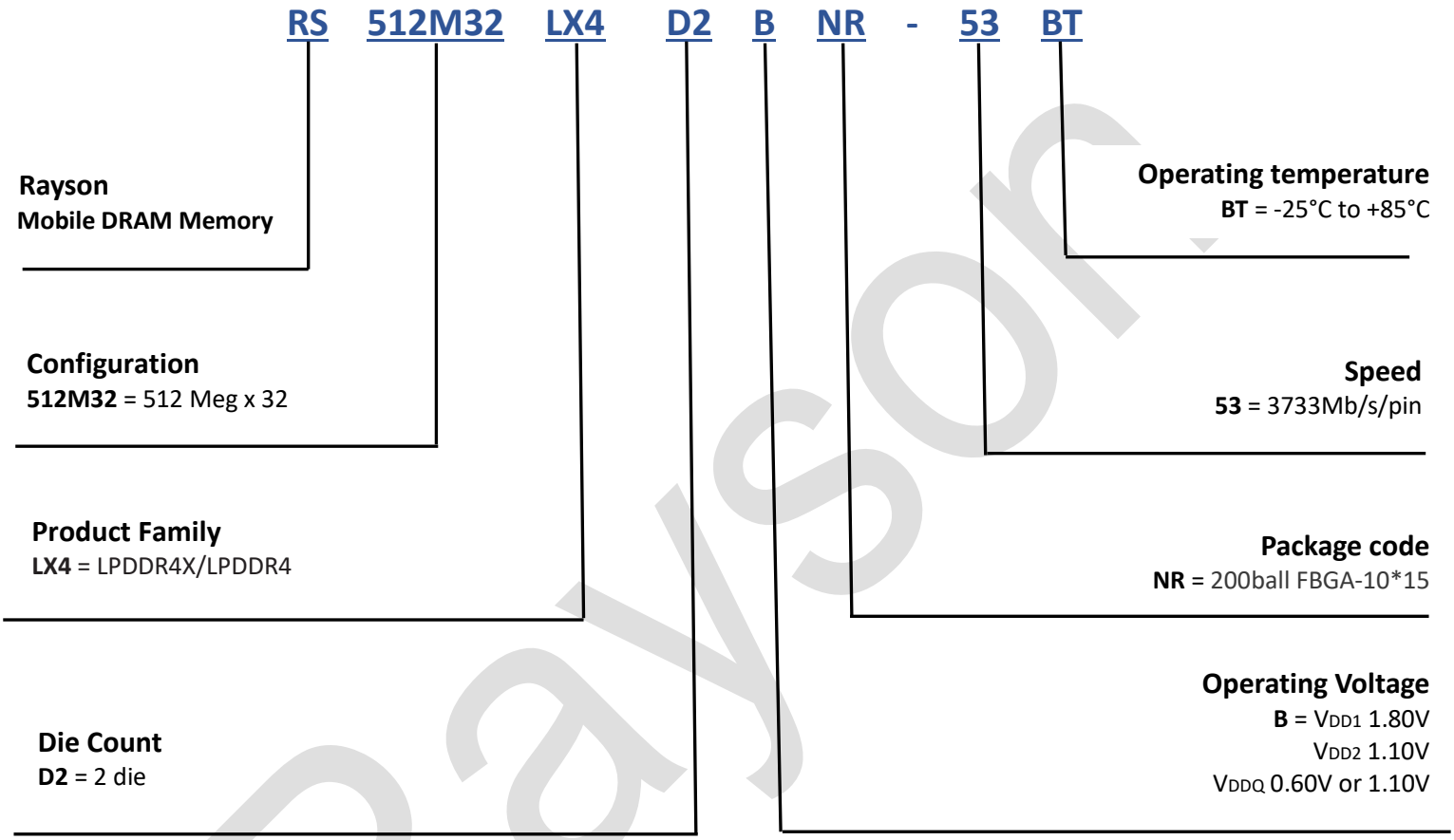
10mm X15mm (Package Code: NR)



SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	0.75	0.85	0.95
A1	0.16	0.21	0.26
A2	0.59	0.64	0.69
A3		0.46 BASIC	
c	0.15	0.18	0.21
D	14.90	15.00	15.10
D1		13.65 BASIC	
E	9.90	10.00	10.10
E1		8.80 BASIC	
e1		0.65 BASIC	
e2		0.80 BASIC	
b	0.25	0.30	0.35
L1		0.525 REF	
L2		0.450 REF	
aaa		0.10	
ccc		0.10	
ddd		0.08	
eee		0.15	
fff		0.08	

3. Core Specifications

3.1. Part Number Decoding



3.2. Ordering Options

Table 1: Key Timing Parameters

Speed Grade	Clock Rate (MHz)	Data Rate (Mb/s/pin)	WRITE Latency		READ Latency	
			Set A	Set B	DBI Disabled	DBI Enabled
-53	1866	3733	16	30	32	36

Table 2: Part Number List

Part Number	Total Density	Data Rate	Operating temperature
RS512M32LX4D2BNR-53BT	2GB(16Gb)	3733 Mb/s/pin	-25°C to + 85°C

Table 3: Refresh Requirement Parameters

Parameter	Symbol	8Gb Per Channel	unit
REFRESH cycle time (all banks)	^{t}RFCab	280	ns
REFRESH cycle time (per bank)	^{t}RFCpb	140	ns
Per bank refresh to per bank refresh time (different bank)	^{t}PBR2PBR	90	ns

3.3. Die Addressing Table

Configuration		512M32 (16Gb/package)
Die Configuration	Channel A, rank 0	x16 mode × 1 die
	Channel B, rank 0	x16 mode × 1 die
	Channel A, rank 1	-
	Channel B, rank 1	
Die Addressing	Memory density (per die)	8Gb
	Memory density (per channel)	8Gb
	Configuration	64Mb × 16 DQ × 8 banks x 2 channels x1 rank
	Number of channels (per die)	1
	Number of banks per channel	8
	Array prefetch(bits,per channel)	256
	Number of rows (per channel)	65,536
	Number of columns (fetch boundaries)	64
	Page size (bytes)	2048
	Channel density (bits per channel)	8,589,934,592
	Total density (bits per die)	8,589,934,592
	Bank address	BA[2:0]
	Row address	R[15:0]
	Column address	C[9:0]
	Burst starting address boundary	64-bit

Notes： *Note: 1.Refer to Package Block Diagram section and Monolithic Device Addressing section*

3.4. Mode Register Contens

MR0		
OP7		**OP[0] = 0b:** Both legacy and modified refresh mode supported **OP[1] = 0b:** Device supports normal latency **1b:** Device supports byte more latency
OP6		
OP5		
OP4		
OP3		
OP2		
OP1	Latency Mode	
OP0	REF	

MR5		
OP7	Manufacturer ID	**0001 0011b :** CX
OP6		
OP5		
OP4		
OP3		
OP2		
OP1		
OP0		

MR6		
OP7	Revision ID1	0000 0000b
OP6		
OP5		
OP4		
OP3		
OP2		
OP1		
OP0		

MR8		
OP7	I/O width	**OP[7:6] =** **00b:** x16/channel
OP6		
OP5	Density	**OP[5:2]** = **0100b:** 8Gb single-channel die
OP4		
OP3		
OP2		
OP1		
OP0		

MR13		
OP7		**OP[2] = 0b:** Normal operation (default) **1b:** Output the $V_{REF(CA)}$ value on DQ7 and $V_{REF(DQ)}$ value on DQ6
OP6		
OP5		
OP4		
OP3		
OP2	VRO	
OP1		
OP0		

MR24		
OP7	TRR Mode	**OP[3:0]** = **1000b:** Unlimited MAC **OP[7]** = **0b:** Disable (default) **1b:** Reserved
OP6		
OP5		
OP4		
OP3	Unlimited MAC	
OP2	MAC Value	
OP1		
OP0		

Notes：*1、The contents of MR0, MR[6:5], MR8, MR13 and MR24 will reflect information specific to each in these package*

2、Other bits not defined above and other mode registers are referred to in Mode Register Assignments and Definitions section.