

# LPDDR5/LPDDR5X SDRAM

**MT62F1536M32D4, MT62F3G32D8, MT62F768M32D2,  
MT62F768M64D4, MT62F1536M64D8**

## Features

- **Architecture**
  - 17.1 GB/s maximum bandwidth per channel
  - Frequency range: 1067–5 MHz (data rate range per pin: 8533–40 Mb/s with WCK:CK = 4:1)
  - Selectable CKR (WCK:CK = 2:1 or 4:1)
- **LPDDR5X data interface**
  - Single x16 channel/die
  - Double-data-rate command/address entry
  - Differential command clocks (CK\_t/CK\_c) for high-speed operation
  - Differential data clocks (WCK\_t/WCK\_c)
  - Optional differential read strobe (RDQS\_t/RDQS\_c)
  - 16n-bit or 32n-bit prefetch architecture
  - Command-selectable burst lengths (BL = 16 or 32) in bank group or 16-bank modes
  - Background ZQ calibration/command-based ZQ calibration
  - Optional link protection (link ECC)
  - Partial-array self refresh (PASR) and partial-array auto refresh (PAAR) with segment mask
- **Ultra-low-voltage core and I/O power supplies**
  - $V_{DD1} = 1.70\text{--}1.95\text{V}$ ; 1.80V TYP
  - $V_{DD2H} = 1.01\text{--}1.12\text{V}$ ; 1.05V TYP
  - $V_{DD2L} = V_{DD2H}$  or  $0.87\text{--}0.97\text{V}$ ; 0.90V TYP
  - $V_{DDQ} = 0.50\text{V}$  or  $0.45\text{V}^1$  TYP; 0.30V TYP (ODT off only)
- **I/O characteristics**
  - Interface-LVSTL 0.5/0.3
  - I/O type: Low-swing single-ended,  $V_{SS}$  terminated
  - $V_{OH}$ -compensated output drive
  - Programmable  $V_{SS}$  on-die termination (ODT)
  - Non target ODT support
  - DVFSQ support
- **Low power features**
  - DVFSC: Dynamic voltage frequency scaling core
  - Single-ended CK, single-ended WCK and single-ended RDQS
  - Data copy
  - Write X

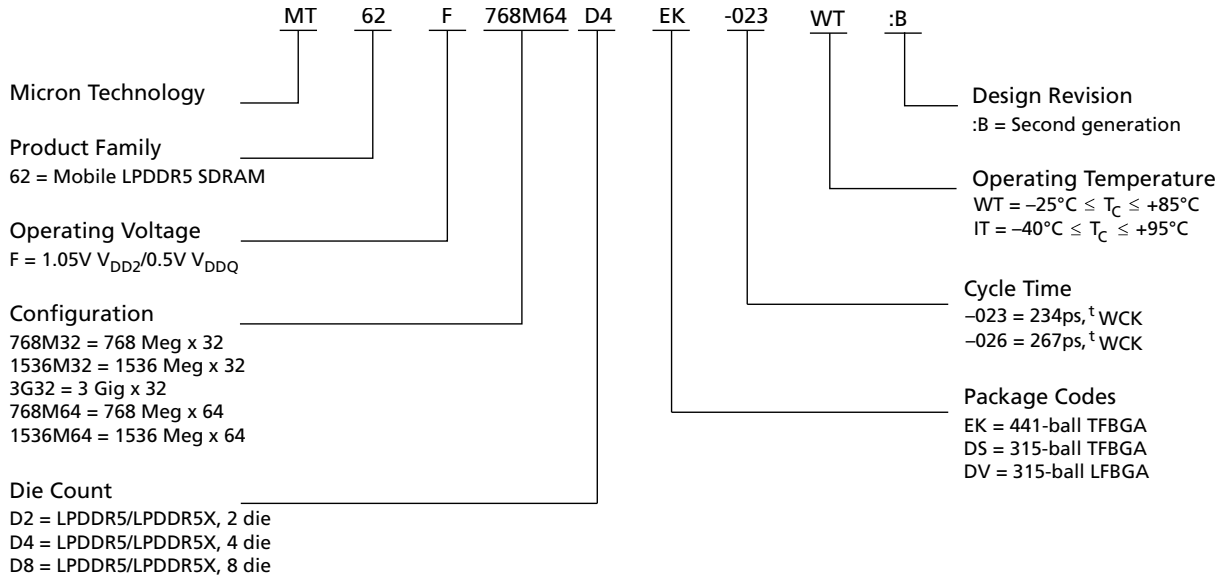
## Options

- **Operating Voltage**
  - $V_{DD1}/V_{DD2H}/V_{DD2L}/V_{DDQ}/V_{DDQ}$  (ODT off only): 1.80V/1.05V/ $V_{DD2H}$  or 0.90V/0.50V or  $0.45\text{V}^1/0.30\text{V}$
- **Array configuration**
  - 768 Meg x 32 (768M16 x 2Ch x 1R) 768M32
  - 1536 Meg x 32 (768M16 x 2Ch x 2R) 1536M32
  - 3 Gig x 32 (1536M16 x 2Ch x 2R) 3G32
  - 768Meg x 64 (768M16 x 4Ch x 1R) 768M64
  - 1536Meg x 64 (768M16 x 4Ch x 2R) 1536M64
- **Device configuration**
  - 2 die in package (768M16 x 2 die) D2
  - 4 die in package (768M16 x 4 die) D4
  - 8 die in package (768M16 x 8 die) D8
  - 8 die in package (1536M8 x 8 die) D8
- **FBGA RoHS-compliant, "green" package**
  - 315-ball TFBGA DS  
12.4mm x 15.0mm (TYP)  
Seated height 1.1mm (MAX)
  - 315-ball LFBGA DV  
12.4mm x 15.0mm (TYP)  
Seated height 1.3mm (MAX)
  - 441-ball TFBGA EK  
14.0mm x 14.0mm (TYP)  
Seated height 1.1mm (MAX)
- **Speed grade, cycle time (<sup>t</sup>WCK)**
  - 8533 Mb/s -023
  - 7500 Mb/s -026
- **Operating temperature**
  - $-25^{\circ}\text{C} \leq T_C \leq +85^{\circ}\text{C}$  WT
  - $-40^{\circ}\text{C} \leq T_C \leq +95^{\circ}\text{C}$  IT
- **Revision** :B

**Note:** 1.  $V_{DDQ} = 0.45\text{V}$  (TYP) only supported in 441-ball package up to 6400 Mb/s.

## Part Number Ordering Information

**Figure 1: Part Number Chart**



### FBGA Part Marking Decoder

Due to space limitations, FBGA-packaged components have an abbreviated part marking that is different from the part number. Micron’s FBGA part marking decoder is available at [www.micron.com/decoder](http://www.micron.com/decoder).

### LPDDR5/LPDDR5X Data Sheet List

For general LPDDR5/LPDDR5X specifications, please refer to the data sheets below.

- General LPDDR5/LPDDR5X Specifications 1: Mode Registers
- General LPDDR5/LPDDR5X Specifications 2: AC/DC and Interface Specifications
- General LPDDR5/LPDDR5X Specifications 3: Features and Functionalities



## Contents

- Part Number Ordering Information ..... 2
  - FBGA Part Marking Decoder ..... 2
  - LPDDR5/LPDDR5X Data Sheet List ..... 2
- Important Notes and Warnings ..... 6
- General Notes ..... 7
- Device Configuration ..... 8
- Refresh Requirement Parameters ..... 9
- Package Block Diagrams ..... 10
  - Dual Die, Dual Channel, Single Rank ..... 10
  - Quad Die, Dual Channel, Dual Rank ..... 11
  - Eight Die, Dual Channel, Dual Rank ..... 12
  - Quad Die, Quad Channel, Single Rank ..... 13
  - Eight Die, Quad Channel, Dual Rank ..... 14
- Ball Assignments and Descriptions ..... 15
- Package Dimensions ..... 19
  - 315-Ball Package (Package Code: DS) ..... 19
  - 315-Ball Package (Package Code: DV) ..... 20
  - 441-Ball Package (Package Code: EK) ..... 21
- Product-Specific Mode Register Definition ..... 22
- I<sub>DD</sub> Parameters ..... 24
- Revision History ..... 29
  - Rev. D – 08/2022 ..... 29
  - Rev. C – 04/2022 ..... 29
  - Rev. B – 12/2021 ..... 29
  - Rev. A – 10/2021 ..... 29

## List of Figures

Figure 1: Part Number Chart ..... 2

Figure 2: Dual Die, Dual Channel, Single Rank Package Block Diagram ..... 10

Figure 3: Quad-Die, Dual-Channel, Dual-Rank Package Block Diagram ..... 11

Figure 4: Eight-Die, Dual-Channel, Dual-Rank Package Block Diagram ..... 12

Figure 5: Quad Die, Quad Channel, Single Rank Package Block Diagram ..... 13

Figure 6: Eight Die, Quad Channel, Dual Rank Package Block Diagram ..... 14

Figure 7: 315-Ball Dual-Channel Discrete FBGA ..... 16

Figure 8: 441-Ball Quad-Channel FBGA ..... 18

Figure 9: 315-Ball TFBGA – 12.4mm (TYP) × 15.0mm (TYP) × 1.1mm (MAX) (Package Code: DS) ..... 19

Figure 10: 315-Ball LFBGA – 12.4mm (TYP) × 15.0mm (TYP) × 1.3mm (MAX) (Package Code: DV) ..... 20

Figure 11: 441-Ball TFBGA – 14.0mm (TYP) × 14.0mm (TYP) × 1.1mm (MAX) (Package Code: EK) ..... 21



## List of Tables

Table 1: Die Organization in the Package (x32) ..... 8  
Table 2: Die Organization in the Package (x64) ..... 8  
Table 3: Die Addressing ..... 8  
Table 4: Refresh Requirement Parameters ..... 9  
Table 5: 315-Ball/Pad Descriptions..... 15  
Table 6: ..... 17  
Table 7: Mode Register Contents..... 22  
Table 8: WT I<sub>DD</sub> Parameters – Single Die ..... 24  
Table 9: WT Full-Array Power-Down Self Refresh Current – Single Die ..... 26  
Table 10: IT I<sub>DD</sub> Parameters – Single Die ..... 26  
Table 11: IT Full-Array Power-Down Self Refresh Current – Single Die ..... 28



## Important Notes and Warnings

Micron Technology, Inc. ("Micron") reserves the right to make changes to information published in this document, including without limitation specifications and product descriptions. This document supersedes and replaces all information supplied prior to the publication hereof. You may not rely on any information set forth in this document if you obtain the product described herein from any unauthorized distributor or other source not authorized by Micron.

**Automotive Applications.** Products are not designed or intended for use in automotive applications unless specifically designated by Micron as automotive-grade by their respective data sheets. Distributor and customer/distributor shall assume the sole risk and liability for and shall indemnify and hold Micron harmless against all claims, costs, damages, and expenses and reasonable attorneys' fees arising out of, directly or indirectly, any claim of product liability, personal injury, death, or property damage resulting directly or indirectly from any use of non-automotive-grade products in automotive applications. Customer/distributor shall ensure that the terms and conditions of sale between customer/distributor and any customer of distributor/customer (1) state that Micron products are not designed or intended for use in automotive applications unless specifically designated by Micron as automotive-grade by their respective data sheets and (2) require such customer of distributor/customer to indemnify and hold Micron harmless against all claims, costs, damages, and expenses and reasonable attorneys' fees arising out of, directly or indirectly, any claim of product liability, personal injury, death, or property damage resulting from any use of non-automotive-grade products in automotive applications.

**Critical Applications.** Products are not authorized for use in applications in which failure of the Micron component could result, directly or indirectly in death, personal injury, or severe property or environmental damage ("Critical Applications"). Customer must protect against death, personal injury, and severe property and environmental damage by incorporating safety design measures into customer's applications to ensure that failure of the Micron component will not result in such harms. Should customer or distributor purchase, use, or sell any Micron component for any critical application, customer and distributor shall indemnify and hold harmless Micron and its subsidiaries, subcontractors, and affiliates and the directors, officers, and employees of each against all claims, costs, damages, and expenses and reasonable attorneys' fees arising out of, directly or indirectly, any claim of product liability, personal injury, or death arising in any way out of such critical application, whether or not Micron or its subsidiaries, subcontractors, or affiliates were negligent in the design, manufacture, or warning of the Micron product.

**Customer Responsibility.** Customers are responsible for the design, manufacture, and operation of their systems, applications, and products using Micron products. ALL SEMICONDUCTOR PRODUCTS HAVE INHERENT FAILURE RATES AND LIMITED USEFUL LIVES. IT IS THE CUSTOMER'S SOLE RESPONSIBILITY TO DETERMINE WHETHER THE MICRON PRODUCT IS SUITABLE AND FIT FOR THE CUSTOMER'S SYSTEM, APPLICATION, OR PRODUCT. Customers must ensure that adequate design, manufacturing, and operating safeguards are included in customer's applications and products to eliminate the risk that personal injury, death, or severe property or environmental damages will result from failure of any semiconductor component.

**Limited Warranty.** In no event shall Micron be liable for any indirect, incidental, punitive, special or consequential damages (including without limitation lost profits, lost savings, business interruption, costs related to the removal or replacement of any products or rework charges) whether or not such damages are based on tort, warranty, breach of contract or other legal theory, unless explicitly stated in a written agreement executed by Micron's duly authorized representative.

## General Notes

Throughout the data sheet, figures and text refer to DQs as DQ. DQ should be interpreted as any or all DQs collectively, unless specifically stated otherwise.

RDQS, CK, and WCK should be interpreted as RDQS<sub>t</sub>, RDQS<sub>c</sub>, CK<sub>t</sub>, CK<sub>c</sub>, and WCK<sub>t</sub>, WCK<sub>c</sub> respectively unless specifically stated otherwise. CA includes all CA pins used for a given density.

In timing diagrams, CMD is used as an indicator only. Actual signals occur on CA[6:0].

V<sub>REF</sub> indicates V<sub>REF(CA)</sub> and V<sub>REF(DQ)</sub>.

Complete functionality is described throughout the entire document. Any page or diagram may have been simplified to convey a topic and may not be inclusive of all requirements.

Any specific requirement takes precedence over a general statement.

Any functionality not specifically stated herein is considered undefined, illegal, is not supported, and will result in unknown operation.



## Device Configuration

**Table 1: Die Organization in the Package (x32)**

Die Organization	768M32 (24 Gb/package)	1536M32 (48 Gb/package)	3G32 (96 Gb/package)
Channel A	x16 mode × 1 die	–	–
Channel B	x16 mode × 1 die	–	–
Channel A, rank 0	–	x16 mode × 1 die	–
Channel B, rank 0	–	x16 mode × 1 die	–
Channel A, rank 1	–	x16 mode × 1 die	–
Channel B, rank 1	–	x16 mode × 1 die	–
Channel A, rank 0 DQ[7:0]	–	–	x8 mode × 1 die
Channel A, rank 1 DQ[7:0]	–	–	x8 mode × 1 die
Channel B, rank 0 DQ[7:0]	–	–	x8 mode × 1 die
Channel B, rank 1 DQ[7:0]	–	–	x8 mode × 1 die
Channel A, rank 0 DQ[15:8]	–	–	x8 mode × 1 die
Channel A, rank 1 DQ[15:8]	–	–	x8 mode × 1 die
Channel B, rank 0 DQ[15:8]	–	–	x8 mode × 1 die
Channel B, rank 1 DQ[15:8]	–	–	x8 mode × 1 die

Notes: 1. Refer to the Package Block Diagram section in this data sheet.

**Table 2: Die Organization in the Package (x64)**

Die Organization	768M64 (48 Gb/package)	1536M64 (96 Gb/package)
Channel A, rank 0	x16 mode × 1 die	x16 mode × 1 die
Channel B, rank 0	x16 mode × 1 die	x16 mode × 1 die
Channel C, rank 0	x16 mode × 1 die	x16 mode × 1 die
Channel D, rank 0	x16 mode × 1 die	x16 mode × 1 die
Channel A, rank 1	–	x16 mode × 1 die
Channel B, rank 1	–	x16 mode × 1 die
Channel C, rank 1	–	x16 mode × 1 die
Channel D, rank 1	–	x16 mode × 1 die

Notes: 1. Refer to the Package Block Diagram section in this data sheet.

**Table 3: Die Addressing**

Description	768M32 (24 Gb/pkg), 1536M32 (48 Gb/pkg), 768M64 (48 Gb/pkg), 1536M64 (96 Gb/pkg)			3G32 (96 Gb/package)		
	Density per die	12Gb			12Gb	
Bits	12,884,901,888			12,884,901,888		
Bank mode	BG mode	16B mode	8B mode	BG mode	16B mode	8B mode
Configuration	48Mb × 16 DQ × 4 banks × 4BG	48Mb × 16 DQ × 16 banks	96Mb × 16 DQ × 8 banks	96Mb × 8 DQ × 4 banks × 4BG	96Mb × 8 DQ × 16 banks	192Mb × 8 DQ × 8 banks





## Y4BM LPDDR5/LPDDR5X SDRAM Refresh Requirement Parameters

**Table 3: Die Addressing (Continued)**

Description	768M32 (24 Gb/pkg), 1536M32 (48 Gb/pkg), 768M64 (48 Gb/pkg), 1536M64 (96 Gb/pkg)			3G32 (96 Gb/package)		
	Number of banks	4	16	8	4	16
Number of bank groups	4	1	1	4	1	1
Array prefetch bits	256	256	512	128	128	256
Rows per bank	49,152			98,304		
Columns	64			64		
Page size (bytes)	2048	2048	4096	1024	1024	2048
Native burst length	16	16	32	16	16	32
Number of I/Os	16			8		
Bank address	BA[1:0]	BA[3:0]	BA[2:0]	BA[1:0]	BA[3:0]	BA[2:0]
Bank group address	BG[1:0]	–	–	BG[1:0]	–	–
Row address	R[15:0] (R14 = 0 when R15 = 1)			R[16:0] (R15 = 0 when R16 = 1)		
Column address	C[5:0]			C[5:0]		
Burst address	B[3:0]	B[3:0]	B[4:0]	B[3:0]	B[3:0]	B[4:0]
Burst starting address boundary	128-bit			128-bit		

- Notes: 1. Refer to the SDRAM Addressing section in General LPDDR5/LPDDR5X Specifications 3.  
2. Refer to the Speed Grades and Effective Burst Length in General LPDDR5/LPDDR5X Specifications 3.

## Refresh Requirement Parameters

**Table 4: Refresh Requirement Parameters**

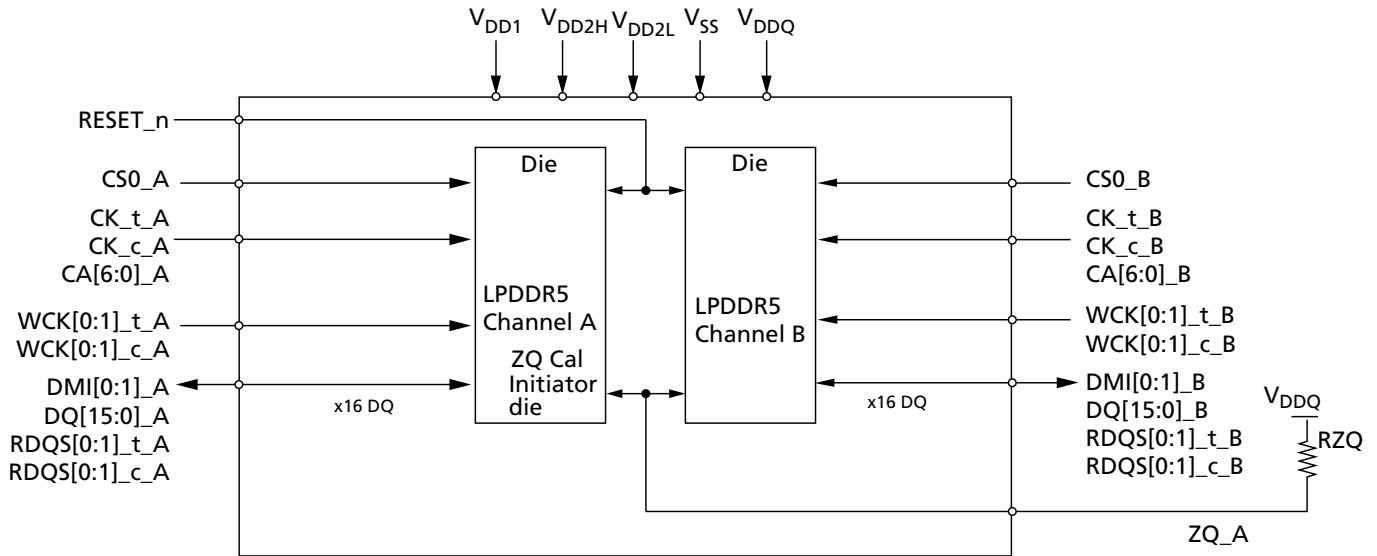
Parameter	Symbol	12Gb Die		Unit
		BG and 16B Mode	8B Mode	
REFRESH cycle time (all banks)	$t_{RFCab}$	280	280	ns
REFRESH cycle time (per bank)	$t_{RFCpb}$	140	140	ns
Per bank refresh to per bank refresh time (different bank)	$t_{PBR2PBR}$	90	90	ns
Per bank refresh to ACTIVATE command time (different bank)	$t_{PBR2ACT}$	7.5	10	ns

- Note: 1. This table only describes refresh parameters that are density dependent. Refer to Refresh Requirement section in General LPDDR5/LPDDR5X Specifications 3 for all refresh parameters.

## Package Block Diagrams

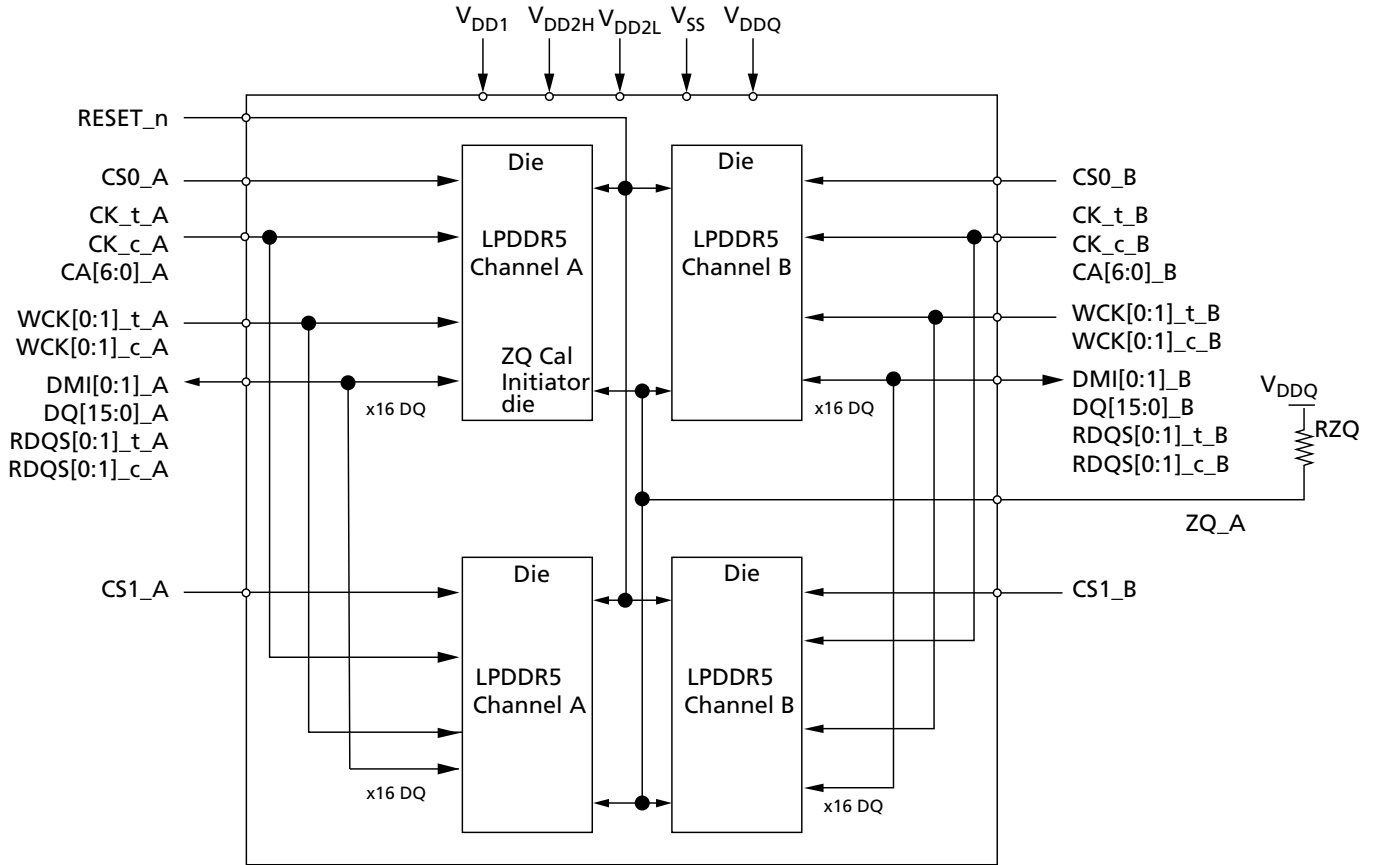
### Dual Die, Dual Channel, Single Rank

**Figure 2: Dual Die, Dual Channel, Single Rank Package Block Diagram**



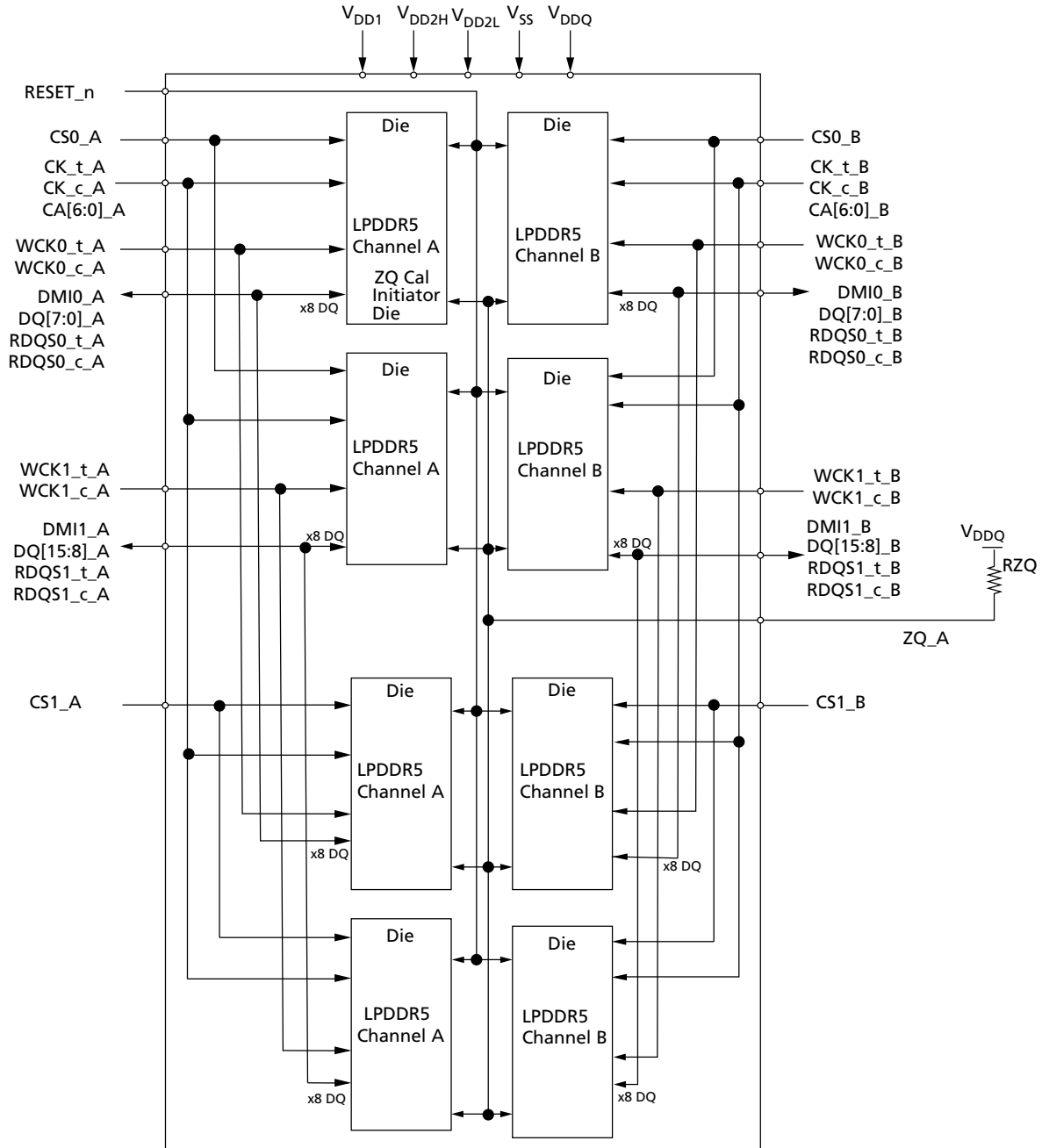
**Quad Die, Dual Channel, Dual Rank**

**Figure 3: Quad-Die, Dual-Channel, Dual-Rank Package Block Diagram**



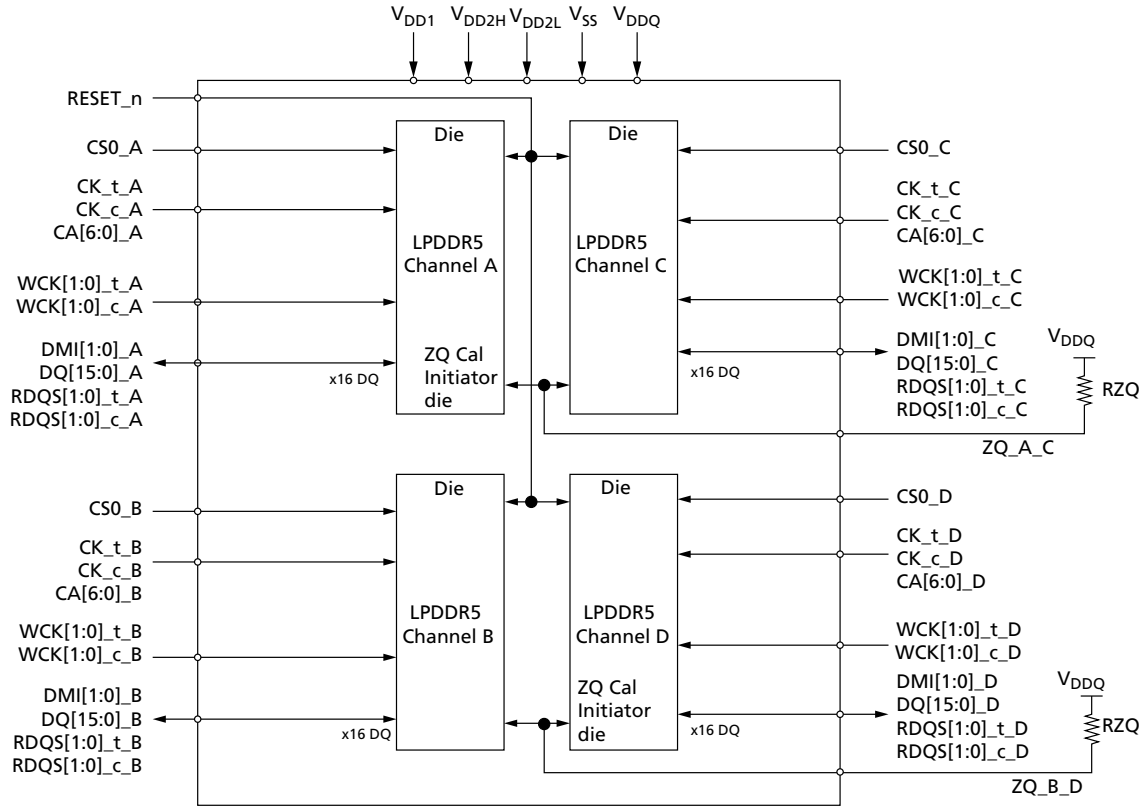
**Eight Die, Dual Channel, Dual Rank**

**Figure 4: Eight-Die, Dual-Channel, Dual-Rank Package Block Diagram**



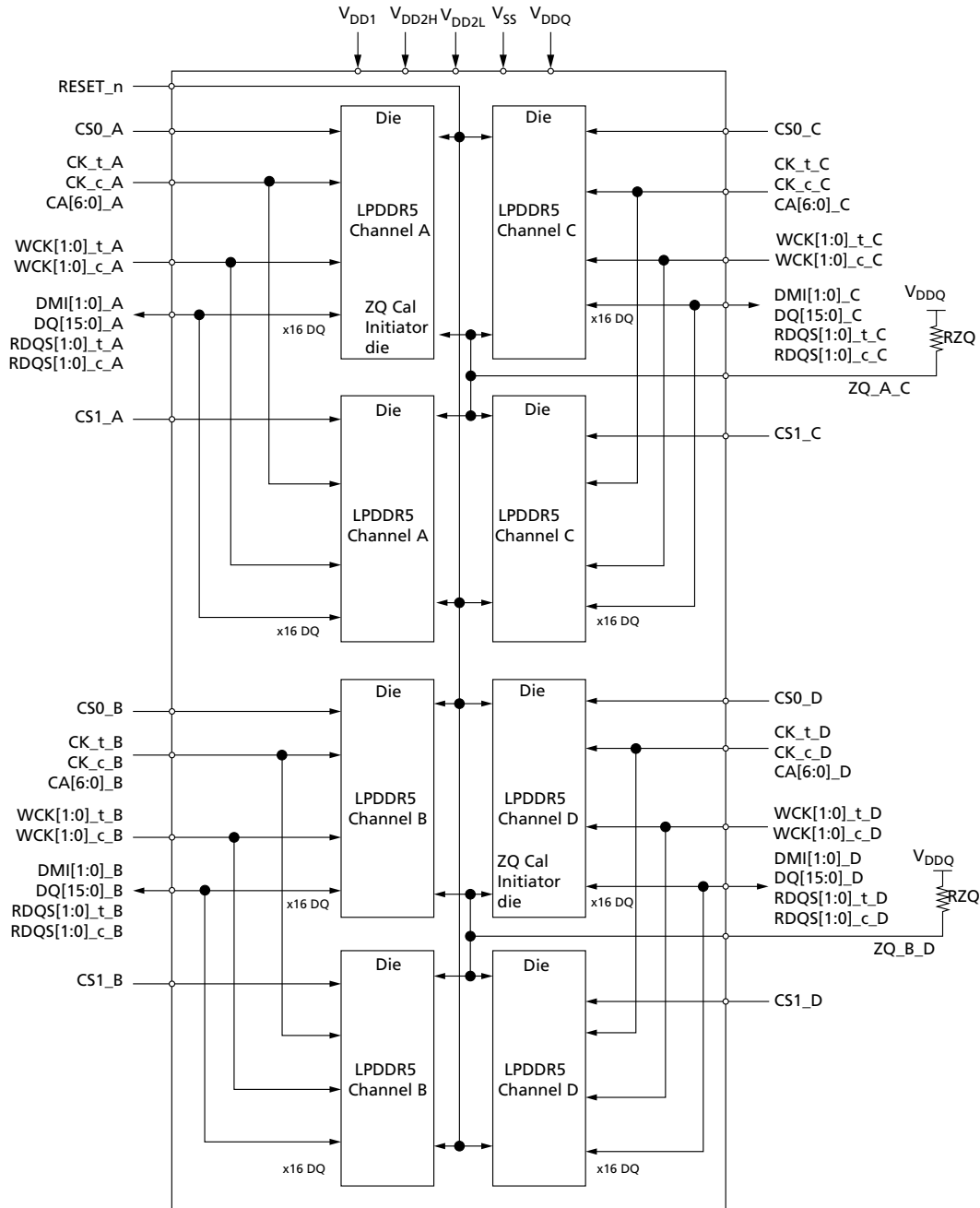
**Quad Die, Quad Channel, Single Rank**

**Figure 5: Quad Die, Quad Channel, Single Rank Package Block Diagram**



**Eight Die, Quad Channel, Dual Rank**

**Figure 6: Eight Die, Quad Channel, Dual Rank Package Block Diagram**





## Ball Assignments and Descriptions

**Table 5: 315-Ball/Pad Descriptions**

Symbol	Type	Description
CK_t_[A:B] CK_c_[A:B]	Input	<b>Clock:</b> CK_t and CK_c are differential clock inputs. All double data rate (DDR) command/address inputs are sampled on both crossing points of CK_t and CK_c. The first crossing point is the rising (falling) edge of CK_t (CK_c) and second crossing point is falling (rising) edge of CK_t (CK_c). Single data rate (SDR) inputs, CS is sampled on the crossing point that is the rising (falling) edge of CK_t (CK_c).
CS0_[A:B], CS1_[A:B]	Input	<b>Chip select:</b> CS is part of the command code, and is sampled on the rising (falling) edge of CK_t (CK_c) unless the device is in power-down or deep sleep mode where it becomes an asynchronous signal. Each rank (0, 1) has its own CS signals. CS1_[A:B] become NC pins in a single-rank package.
CA[6:0]_[A:B]	Input	<b>Command/address inputs:</b> Provide the command and address inputs according to the command truth table.
WCK[1:0]_t_[A:B] WCK[1:0]_c_[A:B]	Input	<b>Data clock:</b> WCK_t and WCK_c are differential clock inputs used for write data capture and read data output.
DQ[15:0]_[A:B]	I/O	<b>Data input/output:</b> Bidirectional data bus.
RDQS[1:0]_t_[A:B] RDQS[1:0]_c_[A:B]	I/O Output	<b>Read data strobe:</b> RDQS_t and RDQS_c are differential output clock signals used to strobe data during a READ operation. RDQS_t is also used as a parity pin during write link protection enabled. Each byte of data has RDQS_t and RDQS_c signals.
DMI[1:0]_[A:B]	I/O	<b>Data mask inversion:</b> DMI serves multiple functions such as data mask (DM), data bus inversion (DBI), and parity at READ with ECC operation by setting the mode register. DMI is a bidirectional signal and each byte of data has a DMI signal.
ZQ_A	Reference	<b>ZQ calibration reference:</b> Used to calibrate the output drive strength and the termination resistance. The ZQ pin should be connected to V <sub>DDQ</sub> through a 240Ω ±1% resistor.
V <sub>DDQ</sub> , V <sub>DD1</sub> , V <sub>DD2H</sub> , V <sub>DD2L</sub>	Supply	<b>Power supplies:</b> Isolated on the die for improved noise immunity.
V <sub>SS</sub>	Supply	<b>Ground reference:</b> Power supply ground reference.
RESET_n	Input	<b>Reset:</b> When asserted LOW, the RESET pin resets the die. Reset is an asynchronous signal.
NC	–	<b>No connect:</b> Not internally connected.



# Y4BM LPDDR5/LPDDR5X SDRAM Ball Assignments and Descriptions

**Figure 7: 315-Ball Dual-Channel Discrete FBGA**

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
A	NC	NC	V <sub>DDQ</sub>	DMI0_A	V <sub>SS</sub>	V <sub>DD2L</sub>	V <sub>DD2H</sub>	V <sub>DD2H</sub>	V <sub>DD2H</sub>	V <sub>DD2L</sub>	V <sub>SS</sub>	DMI1_A	V <sub>DDQ</sub>	NC	NC	A
B	NC	V <sub>DDQ</sub>	RDQS0_t_A	V <sub>SS</sub>	DQ4_A	V <sub>DD2L</sub>	V <sub>DD2H</sub>	V <sub>SS</sub>	V <sub>DD2H</sub>	V <sub>DD2L</sub>	DQ12_A	V <sub>SS</sub>	RDQS1_t_A	V <sub>DDQ</sub>	NC	B
C	V <sub>DD1</sub>	DQ1_A	V <sub>DDQ</sub>	RDQS0_c_A	V <sub>SS</sub>	DQ5_A	V <sub>DD2H</sub>	V <sub>SS</sub>	V <sub>DD2H</sub>	DQ13_A	V <sub>SS</sub>	RDQS1_c_A	V <sub>DDQ</sub>	DQ9_A	V <sub>DD1</sub>	C
D	DQ0_A	V <sub>SS</sub>	DQ3_A	V <sub>DDQ</sub>	WCK0_c_A	V <sub>SS</sub>	V <sub>SS</sub>	V <sub>DD2H</sub>	V <sub>SS</sub>	V <sub>SS</sub>	WCK1_c_A	V <sub>DDQ</sub>	DQ11_A	V <sub>SS</sub>	DQ8_A	D
E	V <sub>SS</sub>	DQ2_A	V <sub>SS</sub>	WCK0_t_A	V <sub>DDQ</sub>	DQ6_A	V <sub>DD2H</sub>	V <sub>SS</sub>	V <sub>DD2H</sub>	DQ14_A	V <sub>DDQ</sub>	WCK1_t_A	V <sub>SS</sub>	DQ10_A	V <sub>SS</sub>	E
F	V <sub>DDQ</sub>	V <sub>SS</sub>	V <sub>DDQ</sub>	V <sub>DDQ</sub>	DQ7_A	V <sub>DD2H</sub>	V <sub>DD2H</sub>	V <sub>SS</sub>	V <sub>DD2H</sub>	V <sub>DD2H</sub>	DQ15_A	V <sub>DDQ</sub>	V <sub>DDQ</sub>	V <sub>SS</sub>	V <sub>DDQ</sub>	F
G	V <sub>DDQ</sub>	V <sub>DDQ</sub>	V <sub>SS</sub>	CA0_A	V <sub>SS</sub>	CS1_A	V <sub>SS</sub>	CA2_A	V <sub>SS</sub>	CA4_A	V <sub>SS</sub>	CA6_A	V <sub>SS</sub>	V <sub>DDQ</sub>	V <sub>DDQ</sub>	G
H	RESET_N	V <sub>DD2L</sub>	V <sub>SS</sub>	V <sub>SS</sub>	CA1_A	V <sub>SS</sub>	CS0_A	V <sub>SS</sub>	CK_t_A	V <sub>SS</sub>	CA3_A	V <sub>SS</sub>	CA5_A	V <sub>DD2L</sub>	ZQ_A	H
J	V <sub>SS</sub>	V <sub>DD2L</sub>	V <sub>SS</sub>	RFU	V <sub>DD2H</sub>	RFU	V <sub>SS</sub>	V <sub>SS</sub>	CK_c_A	V <sub>SS</sub>	V <sub>DD2H</sub>	V <sub>SS</sub>	V <sub>SS</sub>	V <sub>DD2L</sub>	V <sub>SS</sub>	J
K	V <sub>DD2H</sub>	V <sub>DD2H</sub>	V <sub>DD2H</sub>	V <sub>DD2H</sub>	V <sub>DD2H</sub>	V <sub>DD2H</sub>	V <sub>SS</sub>	V <sub>SS</sub>	V <sub>SS</sub>	V <sub>DD2H</sub>	V <sub>DD2H</sub>	V <sub>DD2H</sub>	V <sub>DD2H</sub>	V <sub>DD2H</sub>	V <sub>DD2H</sub>	K
L	V <sub>SS</sub>	V <sub>SS</sub>	V <sub>SS</sub>	V <sub>SS</sub>	V <sub>SS</sub>	V <sub>DD2H</sub>	V <sub>DD2H</sub>	V <sub>DD2H</sub>	V <sub>DD2H</sub>	V <sub>DD2H</sub>	V <sub>SS</sub>	V <sub>SS</sub>	V <sub>SS</sub>	V <sub>SS</sub>	V <sub>SS</sub>	L
M	V <sub>DD2H</sub>	V <sub>DD2H</sub>	V <sub>DD2H</sub>	V <sub>DD2H</sub>	V <sub>DD2H</sub>	V <sub>DD2H</sub>	V <sub>SS</sub>	V <sub>SS</sub>	V <sub>SS</sub>	V <sub>DD2H</sub>	V <sub>DD2H</sub>	V <sub>DD2H</sub>	V <sub>DD2H</sub>	V <sub>DD2H</sub>	V <sub>DD2H</sub>	M
N	V <sub>SS</sub>	V <sub>DD2L</sub>	V <sub>SS</sub>	V <sub>SS</sub>	V <sub>DD2H</sub>	V <sub>SS</sub>	CK_c_B	V <sub>SS</sub>	V <sub>SS</sub>	V <sub>SS</sub>	V <sub>DD2H</sub>	V <sub>SS</sub>	V <sub>SS</sub>	V <sub>DD2L</sub>	V <sub>SS</sub>	N
P	RFU	V <sub>DD2L</sub>	CA5_B	V <sub>SS</sub>	CA3_B	V <sub>SS</sub>	CK_t_B	V <sub>SS</sub>	CS0_B	V <sub>SS</sub>	CA1_B	V <sub>SS</sub>	V <sub>SS</sub>	V <sub>DD2L</sub>	RFU	P
R	V <sub>DDQ</sub>	V <sub>DDQ</sub>	V <sub>SS</sub>	CA6_B	V <sub>SS</sub>	CA4_B	V <sub>SS</sub>	CA2_B	V <sub>SS</sub>	CS1_B	V <sub>SS</sub>	CA0_B	V <sub>SS</sub>	V <sub>DDQ</sub>	V <sub>DDQ</sub>	R
T	V <sub>DDQ</sub>	V <sub>SS</sub>	V <sub>DDQ</sub>	V <sub>DDQ</sub>	DQ15_B	V <sub>DD2H</sub>	V <sub>DD2H</sub>	V <sub>SS</sub>	V <sub>DD2H</sub>	V <sub>DD2H</sub>	DQ7_B	V <sub>DDQ</sub>	V <sub>DDQ</sub>	V <sub>SS</sub>	V <sub>DDQ</sub>	T
U	V <sub>SS</sub>	DQ10_B	V <sub>SS</sub>	WCK1_t_B	V <sub>DDQ</sub>	DQ14_B	V <sub>DD2H</sub>	V <sub>SS</sub>	V <sub>DD2H</sub>	DQ6_B	V <sub>DDQ</sub>	WCK0_t_B	V <sub>SS</sub>	DQ2_B	V <sub>SS</sub>	U
V	DQ8_B	V <sub>SS</sub>	DQ11_B	V <sub>DDQ</sub>	WCK1_c_B	V <sub>SS</sub>	V <sub>SS</sub>	V <sub>DD2H</sub>	V <sub>SS</sub>	V <sub>SS</sub>	WCK0_c_B	V <sub>DDQ</sub>	DQ3_B	V <sub>SS</sub>	DQ0_B	V
W	V <sub>DD1</sub>	DQ9_B	V <sub>DDQ</sub>	RDQS1_c_B	V <sub>SS</sub>	DQ13_B	V <sub>DD2H</sub>	V <sub>SS</sub>	V <sub>DD2H</sub>	DQ5_B	V <sub>SS</sub>	RDQS0_c_B	V <sub>DDQ</sub>	DQ1_B	V <sub>DD1</sub>	W
Y	NC	V <sub>DDQ</sub>	RDQS1_t_B	V <sub>SS</sub>	DQ12_B	V <sub>DD2L</sub>	V <sub>DD2H</sub>	V <sub>SS</sub>	V <sub>DD2H</sub>	V <sub>DD2L</sub>	DQ4_B	V <sub>SS</sub>	RDQS0_t_B	V <sub>DDQ</sub>	NC	Y
AA	NC	NC	V <sub>DDQ</sub>	DMI1_B	V <sub>SS</sub>	V <sub>DD2L</sub>	V <sub>DD2H</sub>	V <sub>DD2H</sub>	V <sub>DD2H</sub>	V <sub>DD2L</sub>	V <sub>SS</sub>	DMI0_B	V <sub>DDQ</sub>	NC	NC	AA

Top View (ball down)

<span style="display: inline-block; width: 15px; height: 15px; background-color: blue; border: 1px solid black;"></span> V <sub>SS</sub>	<span style="display: inline-block; width: 15px; height: 15px; background-color: darkred; border: 1px solid black;"></span> V <sub>DD1</sub>	<span style="display: inline-block; width: 15px; height: 15px; background-color: red; border: 1px solid black;"></span> V <sub>DD2H</sub>	<span style="display: inline-block; width: 15px; height: 15px; background-color: orange; border: 1px solid black;"></span> V <sub>DD2L</sub>	<span style="display: inline-block; width: 15px; height: 15px; background-color: pink; border: 1px solid black;"></span> V <sub>DDQ</sub>	<span style="display: inline-block; width: 15px; height: 15px; background-color: yellow; border: 1px solid black;"></span> CK	<span style="display: inline-block; width: 15px; height: 15px; background-color: green; border: 1px solid black;"></span> RDQS	<span style="display: inline-block; width: 15px; height: 15px; background-color: olive; border: 1px solid black;"></span> WCK	<span style="display: inline-block; width: 15px; height: 15px; background-color: lightgreen; border: 1px solid black;"></span> DQ,DMI	<span style="display: inline-block; width: 15px; height: 15px; background-color: lightpurple; border: 1px solid black;"></span> CA, CS, ZQ, RESET	<span style="display: inline-block; width: 15px; height: 15px; background-color: white; border: 1px solid black;"></span> NC, RFU
--	--	---	--	---	---	--	---	---	---	---



**Table 6:**

Symbol	Type	Description
CK_t_[A:D] CK_c_[A:D]	Input	<b>Clock:</b> CK_t and CK_c are differential clock inputs. All double data rate (DDR) command/address inputs are sampled on both crossing points of CK_t and CK_c. The first crossing point is the rising (falling) edge of CK_t (CK_c) and second crossing point is falling (rising) edge of CK_t (CK_c). Single data rate (SDR) inputs, CS is sampled on the crossing point that is the rising (falling) edge of CK_t (CK_c).
CS0_[A:D], CS1_[A:D]	Input	<b>Chip select:</b> CS is part of the command code, and is sampled on the rising (falling) edge of CK_t (CK_c) unless the device is in power-down or deep sleep mode where it becomes an asynchronous signal. Each rank (0, 1) has its own CS signals. CS1_[A:D] become NC pins in a single-rank package.
CA[6:0]_[A:D]	Input	<b>Command/address inputs:</b> Provide the command and address inputs according to the command truth table.
WCK[1:0]_t_[A:D] WCK[1:0]_c_[A:D]	Input	<b>Data clock:</b> WCK_t and WCK_c are differential clock inputs used for WRITE data capture and READ data output.
DQ[15:0]_[A:D]	I/O	<b>Data input/output:</b> Bidirectional data bus.
RDQS[1:0]_t_[A:D] RDQS[1:0]_c_[A:D]	I/O Output	<b>Read data strobe:</b> RDQS_t and RDQS_c are differential output clock signals used to strobe data during a READ operation. RDQS_t is also used as a parity pin during write link protection enabled. Each byte of data has RDQS_t and RDQS_c signals.
DMI[1:0]_[A:D]	I/O	<b>Data mask inversion:</b> DMI serves multiple functions such as data mask (DM), data bus inversion (DBI), and parity at READ with ECC operation by setting the mode register. DMI is a bidirectional signal and each byte of data has a DMI signal.
ZQ_A_C, ZQ_B_D	Reference	<b>ZQ calibration reference:</b> Used to calibrate the output drive strength and the termination resistance. The ZQ pin should be connected to V <sub>DDQ</sub> through a 240Ω ±1% resistor.
V <sub>DDQ</sub> , V <sub>DD1</sub> , V <sub>DD2H</sub> , V <sub>DD2L</sub>	Supply	<b>Power supplies:</b> Isolated on the die for improved noise immunity.
V <sub>SS</sub>	Supply	<b>Ground reference:</b> Power supply ground reference.
RESET_n	Input	<b>Reset:</b> When asserted LOW, the RESET pin resets the die. Reset is an asynchronous signal.
NC	–	<b>No connect:</b> Not internally connected.
RFU	–	<b>Reserved Future Use:</b> Not internally connected.



**Figure 8: 441-Ball Quad-Channel FBGA**

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	
A	V <sub>SS</sub>	V <sub>SS</sub>	V <sub>DD1</sub>	V <sub>DD2L</sub>	V <sub>SS</sub>	V <sub>DD2H</sub>	V <sub>DD1</sub>	V <sub>SS</sub>	V <sub>DD2L</sub>	V <sub>DD2H</sub>	V <sub>DD2H</sub>	V <sub>SS</sub>	V <sub>DD1</sub>	V <sub>DD2L</sub>	V <sub>SS</sub>	V <sub>DD2H</sub>	V <sub>DD1</sub>	V <sub>SS</sub>	V <sub>DD2L</sub>	V <sub>SS</sub>	V <sub>SS</sub>	A
B	V <sub>SS</sub>	DQ0_A	V <sub>SS</sub>	DQ3_A	V <sub>DD2H</sub>	V <sub>SS</sub>	DQ11_A	DQ9_A	DQ8_A	V <sub>SS</sub>	V <sub>DD2H</sub>	DQ0_C	V <sub>SS</sub>	DQ3_C	V <sub>DD2H</sub>	V <sub>SS</sub>	DQ11_C	DQ9_C	DQ8_C	RFU	V <sub>SS</sub>	B
C	V <sub>DD2H</sub>	V <sub>SS</sub>	DQ2_A	V <sub>DDQ</sub>	CA0_A	V <sub>DD2H</sub>	V <sub>SS</sub>	DQ10_A	V <sub>DDQ</sub>	V <sub>DD2H</sub>	V <sub>SS</sub>	V <sub>SS</sub>	DQ2_C	V <sub>DDQ</sub>	CA0_C	V <sub>DD2H</sub>	V <sub>SS</sub>	DQ10_C	V <sub>DDQ</sub>	V <sub>DD2H</sub>	V <sub>DD2H</sub>	C
D	V <sub>SS</sub>	DQ1_A	WCK0_c_A	V <sub>SS</sub>	CA1_A	CS0_A	V <sub>DDQ</sub>	V <sub>SS</sub>	WCK1_t_A	V <sub>DD2H</sub>	V <sub>DDQ</sub>	DQ1_C	WCK0_c_C	V <sub>SS</sub>	CA1_C	CS0_C	V <sub>DDQ</sub>	V <sub>SS</sub>	WCK1_t_C	V <sub>DDQ</sub>	V <sub>SS</sub>	D
E	V <sub>DDQ</sub>	RDQ50_c_A	V <sub>SS</sub>	WCK0_t_A	V <sub>SS</sub>	CS1_A	V <sub>SS</sub>	WCK1_c_A	DMI1_A	V <sub>SS</sub>	V <sub>DDQ</sub>	RDQ50_c_C	V <sub>SS</sub>	WCK0_t_C	V <sub>SS</sub>	CS1_C	V <sub>SS</sub>	WCK1_c_C	DMI1_C	V <sub>SS</sub>	V <sub>DD2H</sub>	E
F	V <sub>DDQ</sub>	RDQ50_t_A	V <sub>SS</sub>	V <sub>DDQ</sub>	V <sub>SS</sub>	CA2_A	V <sub>SS</sub>	RDQ51_t_A	V <sub>SS</sub>	V <sub>DDQ</sub>	V <sub>SS</sub>	RDQ50_t_C	V <sub>SS</sub>	V <sub>DDQ</sub>	V <sub>SS</sub>	CA2_C	V <sub>SS</sub>	RDQ51_t_C	V <sub>SS</sub>	V <sub>DDQ</sub>	V <sub>DD2H</sub>	F
G	V <sub>SS</sub>	DQ4_A	V <sub>DDQ</sub>	DMI0_A	RFU	RFU	CA6_A	V <sub>SS</sub>	RDQ51_c_A	V <sub>SS</sub>	V <sub>DDQ</sub>	DMI0_C	V <sub>DDQ</sub>	DQ4_C	RFU	RFU	CA6_C	V <sub>SS</sub>	RDQ51_c_C	V <sub>SS</sub>	V <sub>SS</sub>	G
H	V <sub>DD2L</sub>	V <sub>SS</sub>	DQ5_A	V <sub>SS</sub>	CK_t_A	V <sub>SS</sub>	CA5_A	V <sub>DDQ</sub>	V <sub>SS</sub>	DQ12_A	V <sub>SS</sub>	V <sub>SS</sub>	DQ5_C	V <sub>SS</sub>	CK_t_C	V <sub>SS</sub>	CA5_C	V <sub>DDQ</sub>	V <sub>SS</sub>	DQ12_C	V <sub>DD2L</sub>	H
J	V <sub>DD2H</sub>	DQ6_A	DQ7_A	V <sub>DD2H</sub>	V <sub>SS</sub>	CK_c_A	V <sub>SS</sub>	DQ14_A	DQ13_A	V <sub>SS</sub>	V <sub>DD2L</sub>	DQ6_C	DQ7_C	V <sub>DD2L</sub>	ZQ_A_C	CK_c_C	V <sub>SS</sub>	DQ14_C	DQ13_C	V <sub>SS</sub>	V <sub>DD2H</sub>	J
K	V <sub>SS</sub>	V <sub>DD2H</sub>	V <sub>DD2H</sub>	V <sub>DD2H</sub>	V <sub>SS</sub>	CA3_A	CA4_A	V <sub>DD2L</sub>	V <sub>SS</sub>	DQ15_A	V <sub>DD2H</sub>	V <sub>DD2H</sub>	V <sub>DD2H</sub>	V <sub>DD2H</sub>	V <sub>SS</sub>	CA3_C	CA4_C	V <sub>DD2H</sub>	V <sub>SS</sub>	DQ15_C	V <sub>SS</sub>	K
L	V <sub>DD2H</sub>	V <sub>DD2L</sub>	V <sub>DD2L</sub>	V <sub>DD2H</sub>	V <sub>DD2L</sub>	V <sub>DD2H</sub>	V <sub>SS</sub>	V <sub>DD2H</sub>	V <sub>DD2H</sub>	V <sub>SS</sub>	V <sub>SS</sub>	V <sub>SS</sub>	V <sub>DD2H</sub>	V <sub>DD2H</sub>	V <sub>SS</sub>	V <sub>DD2H</sub>	V <sub>DD2L</sub>	V <sub>DD2H</sub>	V <sub>DD2L</sub>	V <sub>DD2L</sub>	V <sub>DD2H</sub>	L
M	V <sub>SS</sub>	DQ15_B	V <sub>SS</sub>	V <sub>DD2H</sub>	CA4_B	CA3_B	V <sub>SS</sub>	V <sub>DD2H</sub>	V <sub>DD2H</sub>	V <sub>DD2H</sub>	V <sub>DD2H</sub>	DQ15_D	V <sub>SS</sub>	V <sub>DD2L</sub>	CA4_D	CA3_D	V <sub>SS</sub>	V <sub>DD2H</sub>	V <sub>DD2H</sub>	V <sub>DD2H</sub>	V <sub>SS</sub>	M
N	V <sub>DD2H</sub>	V <sub>SS</sub>	DQ13_B	DQ14_B	V <sub>SS</sub>	CK_c_B	ZQ_B_D	V <sub>DD2L</sub>	DQ7_B	DQ6_B	V <sub>DD2L</sub>	V <sub>SS</sub>	DQ13_D	DQ14_D	V <sub>SS</sub>	CK_c_D	V <sub>SS</sub>	V <sub>DD2H</sub>	DQ7_D	DQ6_D	V <sub>DD2H</sub>	N
P	V <sub>DD2L</sub>	DQ12_B	V <sub>SS</sub>	V <sub>DDQ</sub>	CA5_B	V <sub>SS</sub>	CK_t_B	V <sub>SS</sub>	DQ5_B	V <sub>SS</sub>	V <sub>SS</sub>	DQ12_D	V <sub>SS</sub>	V <sub>DDQ</sub>	CA5_D	V <sub>SS</sub>	CK_t_D	V <sub>SS</sub>	DQ5_D	V <sub>SS</sub>	V <sub>DD2L</sub>	P
R	V <sub>SS</sub>	V <sub>SS</sub>	RDQ51_c_B	V <sub>SS</sub>	CA6_B	RFU	RFU	DQ4_B	V <sub>DDQ</sub>	DMI0_B	V <sub>DDQ</sub>	V <sub>SS</sub>	RDQ51_c_D	V <sub>SS</sub>	CA6_D	RFU	RFU	DMI0_D	V <sub>DDQ</sub>	DQ4_D	V <sub>SS</sub>	R
T	V <sub>DD2H</sub>	V <sub>DDQ</sub>	V <sub>SS</sub>	RDQ51_t_B	V <sub>SS</sub>	CA2_B	V <sub>SS</sub>	V <sub>DDQ</sub>	V <sub>SS</sub>	RDQ50_t_B	V <sub>SS</sub>	V <sub>DDQ</sub>	V <sub>SS</sub>	RDQ51_t_D	V <sub>SS</sub>	CA2_D	V <sub>SS</sub>	V <sub>DDQ</sub>	V <sub>SS</sub>	RDQ50_t_D	V <sub>DDQ</sub>	T
U	V <sub>DD2H</sub>	V <sub>SS</sub>	DMI1_B	WCK1_c_B	V <sub>SS</sub>	CS1_B	V <sub>SS</sub>	WCK0_t_B	V <sub>SS</sub>	RDQ50_c_B	V <sub>DDQ</sub>	V <sub>SS</sub>	DMI1_D	WCK1_c_D	V <sub>SS</sub>	CS1_D	V <sub>SS</sub>	WCK0_t_D	V <sub>SS</sub>	RDQ50_c_D	V <sub>DDQ</sub>	U
V	V <sub>SS</sub>	V <sub>DDQ</sub>	WCK1_t_B	V <sub>SS</sub>	V <sub>DDQ</sub>	CS0_B	CA1_B	V <sub>SS</sub>	WCK0_c_B	DQ1_B	V <sub>DDQ</sub>	V <sub>DD2H</sub>	WCK1_t_D	V <sub>SS</sub>	V <sub>DDQ</sub>	CS0_D	CA1_D	V <sub>SS</sub>	WCK0_c_D	DQ1_D	V <sub>SS</sub>	V
W	V <sub>DD2H</sub>	V <sub>DD2H</sub>	V <sub>DDQ</sub>	DQ10_B	V <sub>SS</sub>	V <sub>DD2H</sub>	CA0_B	V <sub>DDQ</sub>	DQ2_B	V <sub>SS</sub>	V <sub>SS</sub>	V <sub>DD2H</sub>	V <sub>DDQ</sub>	DQ10_D	V <sub>SS</sub>	V <sub>DD2H</sub>	CA0_D	V <sub>DDQ</sub>	DQ2_D	V <sub>SS</sub>	V <sub>DD2H</sub>	W
Y	V <sub>SS</sub>	RESET_N	DQ8_B	DQ9_B	DQ11_B	V <sub>SS</sub>	V <sub>DD2H</sub>	DQ3_B	V <sub>SS</sub>	DQ0_B	V <sub>DD2H</sub>	V <sub>SS</sub>	DQ8_D	DQ9_D	DQ11_D	V <sub>SS</sub>	V <sub>DD2H</sub>	DQ3_D	V <sub>SS</sub>	DQ0_D	V <sub>SS</sub>	Y
AA	V <sub>SS</sub>	V <sub>SS</sub>	V <sub>DD2L</sub>	V <sub>SS</sub>	V <sub>DD1</sub>	V <sub>DD2H</sub>	V <sub>SS</sub>	V <sub>DD2L</sub>	V <sub>DD1</sub>	V <sub>SS</sub>	V <sub>DD2H</sub>	V <sub>DD2H</sub>	V <sub>DD2L</sub>	V <sub>SS</sub>	V <sub>DD1</sub>	V <sub>DD2H</sub>	V <sub>SS</sub>	V <sub>DD2L</sub>	V <sub>DD1</sub>	V <sub>SS</sub>	V <sub>SS</sub>	AA

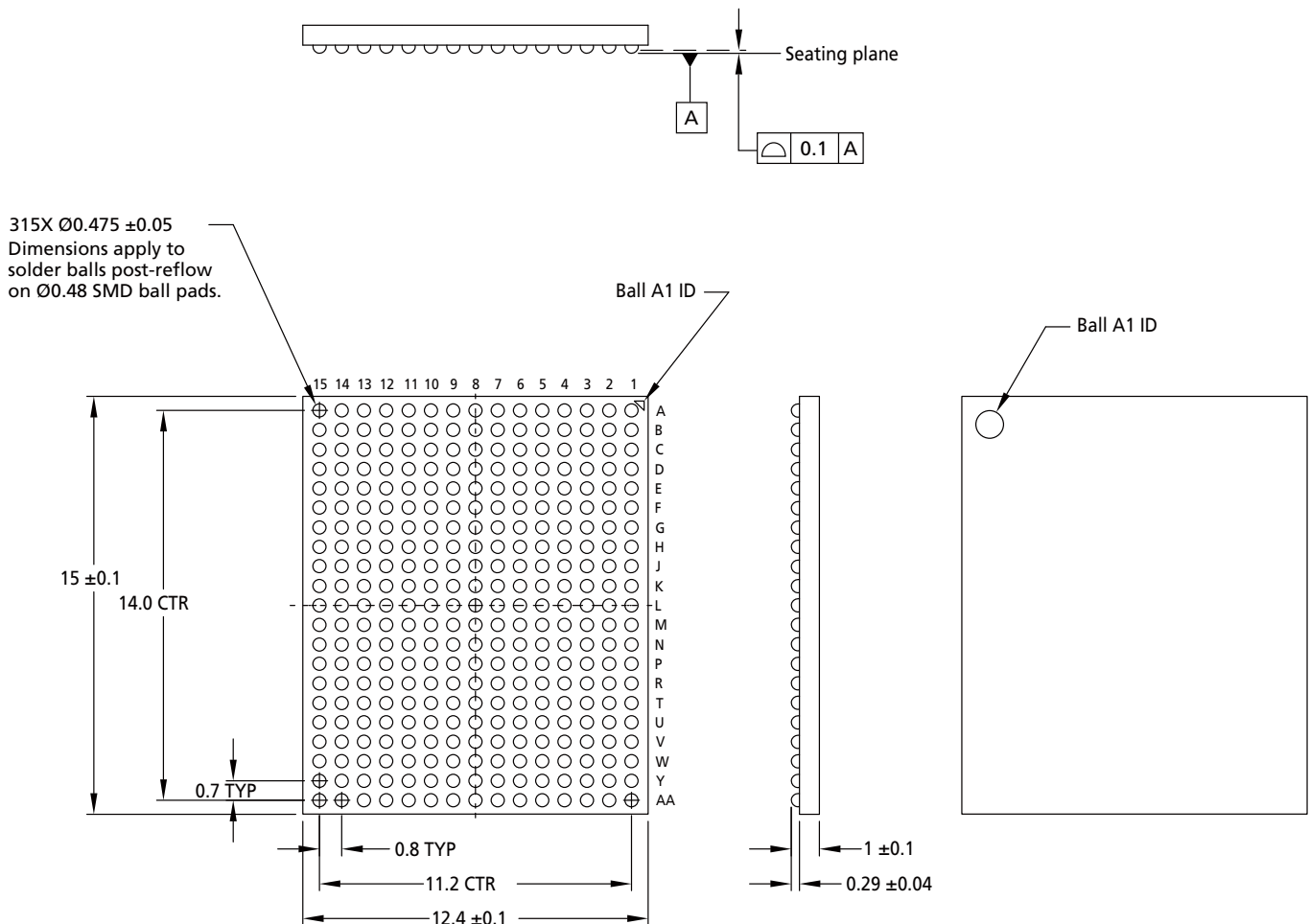
Top View (ball down)



## Package Dimensions

### 315-Ball Package (Package Code: DS)

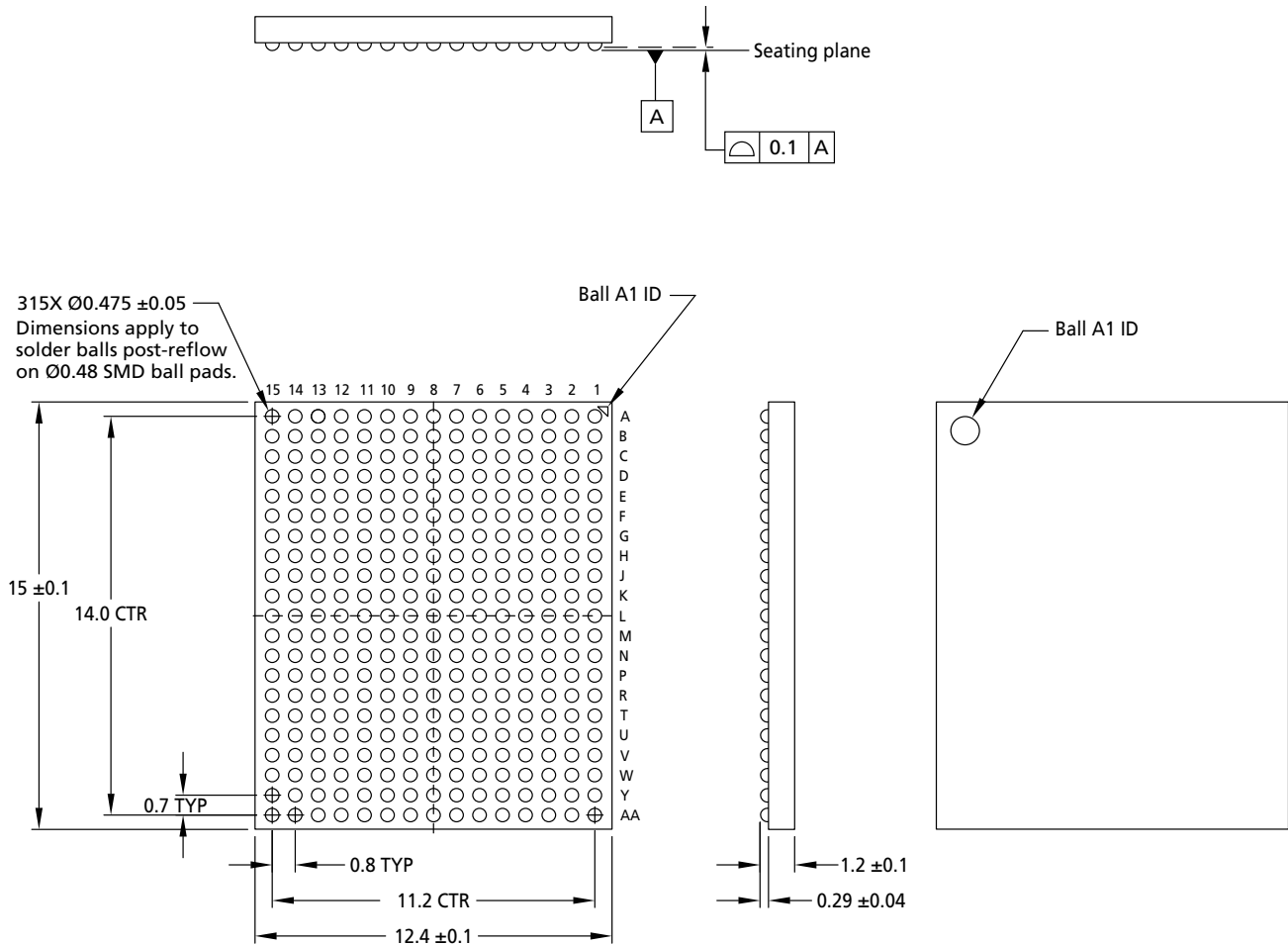
**Figure 9: 315-Ball TFBGA – 12.4mm (TYP) × 15.0mm (TYP) × 1.1mm (MAX) (Package Code: DS)**



- Notes: 1. All dimensions are in millimeters.  
2. Solder ball composition: SACQ with CuOSP pads (Sn-4Ag-0.5Cu-3Bi-0.05Ni)

**315-Ball Package (Package Code: DV)**

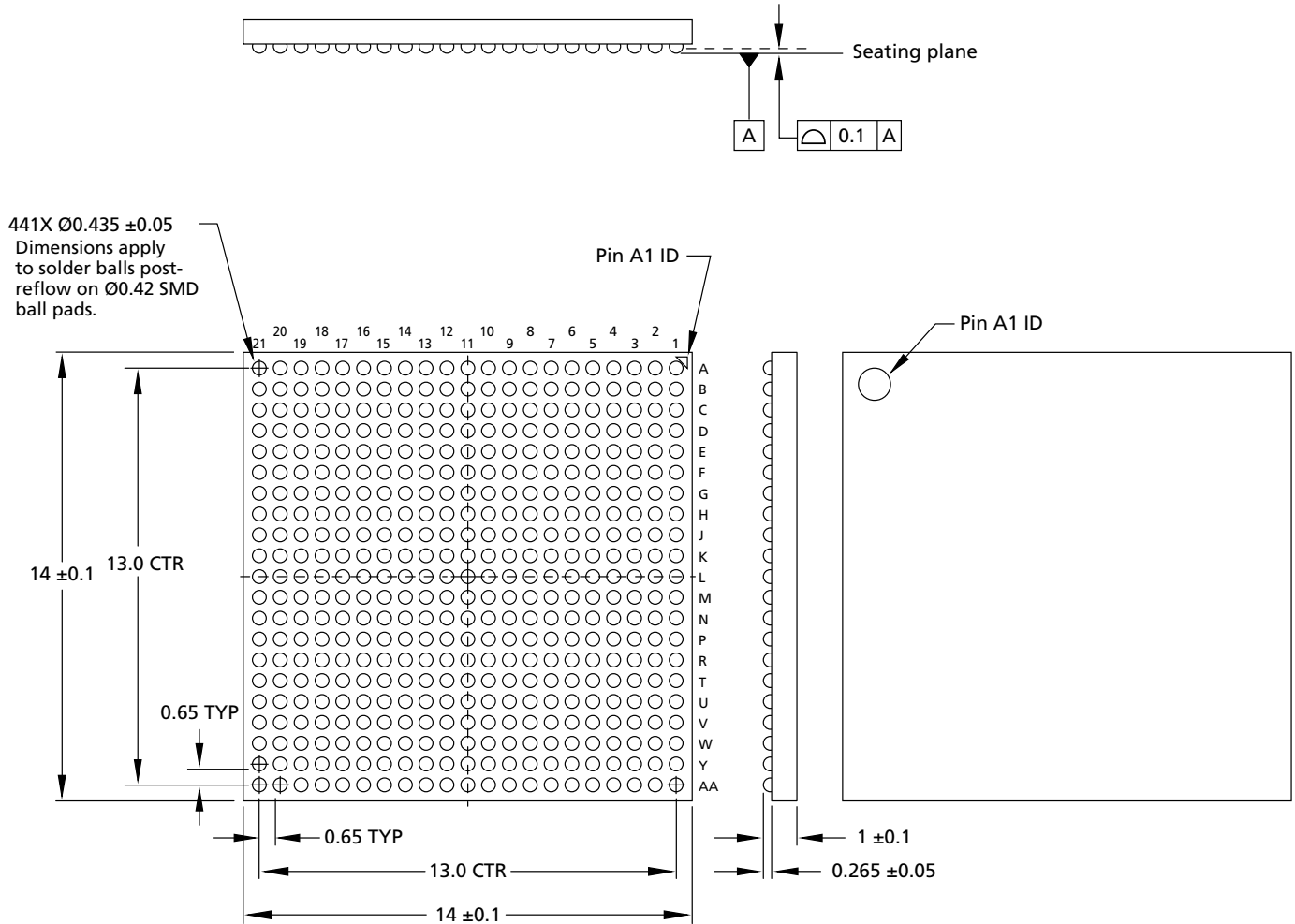
**Figure 10: 315-Ball LFBGA – 12.4mm (TYP) × 15.0mm (TYP) × 1.3mm (MAX) (Package Code: DV)**



- Notes: 1. All dimensions are in millimeters.  
 2. Solder ball composition: SACQ with CuOSP pads (Sn-4Ag-0.5Cu-3Bi-0.05Ni)

**441-Ball Package (Package Code: EK)**

**Figure 11: 441-Ball TFBGA – 14.0mm (TYP) × 14.0mm (TYP) × 1.1mm (MAX) (Package Code: EK)**



- Notes: 1. All dimensions are in millimeters.  
 2. Solder ball composition: SACQ with CuOSP pads (Sn- 4Ag-0.5Cu-3Bi-0.05Ni)



## Product-Specific Mode Register Definition

**Table 7: Mode Register Contents**

Mode Register	OP7	OP6	OP5	OP4	OP3	OP2	OP1	OP0
MR0	<b>Per-pin DFE</b>	<b>Pre-emphasis</b>	<b>Unified NT ODT behavior mode</b>	<b>DMI output behavior mode</b>	<b>Optimized refresh mode</b>	<b>Enhanced WCK always-on mode</b>	<b>Latency mode</b>	<b>NT ODT timing mode</b>
	OP[0] = 1b: Device supports different NT ODT latency for DQ and RDQS							
	OP[1] = 0b: Device supports x16 mode latency for 768M32, 1536M32, 768M64, 1536M64 OP[1] = 1b: Device supports x8 mode latency for 3G32							
	OP[2] = 1b: Device supports enhanced WCK always-on mode							
	OP[3] = 1b: Device supports optimized refresh mode							
	OP[4] = 1b: Device supports both DMI behavior mode 1 and 2 and mode selection							
	OP[5] = 1b: The NT ODT behavior follows the unified NT ODT behavior							
	OP[6] = 1b: Device supports pre-emphasis mode							
	OP[7] = 0b: Device does not support per-pin DFE							
MR1							<b>ARFM sup- port</b>	<b>CS ODT OP support</b>
	OP[0] = 0b: Device does not support CS ODT behavior OP							
	OP[1] = 0b: Device does not support ARFM							
MR5	<b>Manufacturer ID</b>							
	1111 1111b: Micron							
MR6	<b>Revision ID1</b>							
	0000 0111b							
MR8	<b>I/O width</b>	<b>Density</b>				<b>Type</b>		
	OP[7:6] = 00b: x16 for 768M32, 1536M32, 768M64, 1536M64 OP[7:6] = 01b: x8 for 3G32	OP[5:2] = 0101b: 12Gb				OP[1:0] = 01b: LPDDR5X SDRAM		
MR13						<b>VRO</b>		
	OP[2] = 0b: Normal operation (default) 1b: Output the $V_{REF(CA)}$ value on DQ7 and $V_{REF(DQ)}$ value on DQ6							
MR19			<b>WCK2DQ OSC FM</b>					
	OP[5] = 1b: WCK2DQ OSC FM supported							
MR21	<b>WXS</b>				<b>ODTD-CSFS</b>	<b>WXFS</b>	<b>RDCFS</b>	<b>WDCFS</b>
	OP[0] = 1b: WRITE DATA COPY function supported							
	OP[1] = 1b: READ DATA COPY function supported							
	OP[2] = 1b: WRITE X function supported							
	OP[3] = 1b: Device ODTD-CS is supported							
	OP[7] = 1b: Data to be written can be selected with 0 and 1							



**Table 7: Mode Register Contents (Continued)**

Mode Register	OP7	OP6	OP5	OP4	OP3	OP2	OP1	OP0
MR22	<b>RECC</b>		<b>WECC</b>					
	OP[5:4] = 00b: Write link ECC disabled (default) 01b: Write link ECC enabled (See Note 3)							
	OP[7:6] = 00b: Read link ECC disabled (default) 01b: Read link ECC enabled (See Note 3)							
MR24	<b>DFES</b>				<b>Read DCA</b>			
	OP[3] = 0b: Device does not support Read DCA							
	OP[7] = 0b: Device supports DFE							
MR26		<b>RDQSTFS</b>						
	OP[6] = 1b: Read/write-based RDQS_t TRAINING function supported							
MR27	<b>RAAMULT</b>		<b>RAAIMT</b>				<b>RFM</b>	
	OP[0] = 1b: RFM is required							
	OP[5:1] = 01110b: 112							
	OP[7:6] = 01b: 4X							
MR43		<b>SBEC rule</b>						
	OP[6] = 1b: Simultaneous SBE on each DQ byte and DMI are independently counted							
MR57					<b>RFMSB</b>	<b>RAADEC</b>		
	OP[1:0] = 10b: 2 × RAAIMT							
	OP[3:2] = 00b: 1 = Does not support single-bank mode							
MR63-R164	Reserved MR bits MR63 through MR164 are RFU by JEDEC standard and should not be accessed by user.							

- Notes: 1. The contents of mode registers described here reflect information specific to each die in these packages.  
 2. Refer to General LPDDR5/LPDDR5X Specification 1 for mode registers not described here.  
 3. Write link ECC and read link ECC are supported.



## I<sub>DD</sub> Parameters

Refer to the I<sub>DD</sub> Specification Parameters and Test Conditions section in General LPDDR5 Specifications 2 for detailed conditions.

**Table 8: WT I<sub>DD</sub> Parameters – Single Die**

Symbol	Supply	x8 Mode Speed Grade		x16 Mode Speed Grade		Unit	Note
		7500 Mb/s	8533 Mb/s	7500 Mb/s	8533 Mb/s		
I <sub>DD01</sub>	V <sub>DD1</sub>	3.0	3.0	4.5	4.5	mA	
I <sub>DD02H</sub>	V <sub>DD2H</sub>	27.5	27.5	28.0	28.0		
I <sub>DD02L</sub>	V <sub>DD2L</sub>	0.2	0.2	0.2	0.2		
I <sub>DD0Q</sub>	V <sub>DDQ</sub>	0.6	0.6	0.6	0.6		
I <sub>DD2P1</sub>	V <sub>DD1</sub>	1.5	1.5	1.5	1.5	mA	
I <sub>DD2P2H</sub>	V <sub>DD2H</sub>	2.0	2.0	2.0	2.0		
I <sub>DD2P2L</sub>	V <sub>DD2L</sub>	0.2	0.2	0.2	0.2		
I <sub>DD2PQ</sub>	V <sub>DDQ</sub>	0.6	0.6	0.6	0.6		
I <sub>DD2PS1</sub>	V <sub>DD1</sub>	1.5	1.5	1.5	1.5	mA	
I <sub>DD2PS2H</sub>	V <sub>DD2H</sub>	2.0	2.0	2.0	2.0		
I <sub>DD2PS2L</sub>	V <sub>DD2L</sub>	0.2	0.2	0.2	0.2		
I <sub>DD2PSQ</sub>	V <sub>DDQ</sub>	0.6	0.6	0.6	0.6		
I <sub>DD2N1</sub>	V <sub>DD1</sub>	1.5	1.5	1.5	1.5	mA	
I <sub>DD2N2H</sub>	V <sub>DD2H</sub>	15.5	15.5	16.0	16.0		
I <sub>DD2N2L</sub>	V <sub>DD2L</sub>	0.2	0.2	0.2	0.2		
I <sub>DD2NQ</sub>	V <sub>DDQ</sub>	0.6	0.6	0.6	0.6		
I <sub>DD2NS1</sub>	V <sub>DD1</sub>	1.5	1.5	1.5	1.5	mA	
I <sub>DD2NS2H</sub>	V <sub>DD2H</sub>	15.5	15.5	16.0	16.0		
I <sub>DD2NS2L</sub>	V <sub>DD2L</sub>	0.2	0.2	0.2	0.2		
I <sub>DD2NSQ</sub>	V <sub>DDQ</sub>	0.6	0.6	0.6	0.6		
I <sub>DD3P1</sub>	V <sub>DD1</sub>	1.5	1.5	1.5	1.5	mA	
I <sub>DD3P2H</sub>	V <sub>DD2H</sub>	5.5	5.5	5.5	5.5		
I <sub>DD3P2L</sub>	V <sub>DD2L</sub>	0.2	0.2	0.2	0.2		
I <sub>DD3PQ</sub>	V <sub>DDQ</sub>	0.6	0.6	0.6	0.6		
I <sub>DD3PS1</sub>	V <sub>DD1</sub>	1.5	1.5	1.5	1.5	mA	
I <sub>DD3PS2H</sub>	V <sub>DD2H</sub>	5.5	5.5	5.5	5.5		
I <sub>DD3PS2L</sub>	V <sub>DD2L</sub>	0.2	0.2	0.2	0.2		
I <sub>DD3PSQ</sub>	V <sub>DDQ</sub>	0.6	0.6	0.6	0.6		





**Table 8: WT I<sub>DD</sub> Parameters – Single Die**

Symbol	Supply	x8 Mode Speed Grade		x16 Mode Speed Grade		Unit	Note
		7500 Mb/s	8533 Mb/s	7500 Mb/s	8533 Mb/s		
I <sub>DD3N1</sub>	V <sub>DD1</sub>	1.7	1.7	1.7	1.7	mA	
I <sub>DD3N2H</sub>	V <sub>DD2H</sub>	20.5	20.5	21.0	21.0		
I <sub>DD3N2L</sub>	V <sub>DD2L</sub>	0.2	0.2	0.2	0.2		
I <sub>DD3NQ</sub>	V <sub>DDQ</sub>	0.6	0.6	0.6	0.6		
I <sub>DD3NS1</sub>	V <sub>DD1</sub>	1.7	1.7	1.7	1.7	mA	
I <sub>DD3NS2H</sub>	V <sub>DD2H</sub>	20.5	20.5	21.0	21.0		
I <sub>DD3NS2L</sub>	V <sub>DD2L</sub>	0.2	0.2	0.2	0.2		
I <sub>DD3NSQ</sub>	V <sub>DDQ</sub>	0.6	0.6	0.6	0.6		
I <sub>DD4R1</sub>	V <sub>DD1</sub>	9.0	10.0	11.0	12.0	mA	3, 4
I <sub>DD4R2H</sub>	V <sub>DD2H</sub>	285.0	315.0	425.0	475.0		
I <sub>DD4R2L</sub>	V <sub>DD2L</sub>	0.2	0.2	0.2	0.2		
I <sub>DD4RQ</sub>	V <sub>DDQ</sub>	58.0	63.0	116.0	126.0		
I <sub>DD4W1</sub>	V <sub>DD1</sub>	8.0	9.0	10.0	11.0	mA	3
I <sub>DD4W2H</sub>	V <sub>DD2H</sub>	200.0	220.0	280.0	310.0		
I <sub>DD4W2L</sub>	V <sub>DD2L</sub>	0.2	0.2	0.2	0.2		
I <sub>DD4WQ</sub>	V <sub>DDQ</sub>	0.6	0.6	0.6	0.6		
I <sub>DD51</sub>	V <sub>DD1</sub>	17.0	17.0	17.0	17.0	mA	
I <sub>DD52H</sub>	V <sub>DD2H</sub>	115.0	115.0	115.0	115.0		
I <sub>DD52L</sub>	V <sub>DD2L</sub>	0.2	0.2	0.2	0.2		
I <sub>DD5Q</sub>	V <sub>DDQ</sub>	0.6	0.6	0.6	0.6		
I <sub>DD5AB1</sub>	V <sub>DD1</sub>	2.5	2.5	2.5	2.5	mA	
I <sub>DD5AB2H</sub>	V <sub>DD2H</sub>	23.5	23.5	24.0	24.0		
I <sub>DD5AB2L</sub>	V <sub>DD2L</sub>	0.2	0.2	0.2	0.2		
I <sub>DD5ABQ</sub>	V <sub>DDQ</sub>	0.6	0.6	0.6	0.6		
I <sub>DD5PB1</sub>	V <sub>DD1</sub>	2.5	2.5	2.5	2.5	mA	
I <sub>DD5PB2H</sub>	V <sub>DD2H</sub>	23.5	23.5	24.0	24.0		
I <sub>DD5PB2L</sub>	V <sub>DD2L</sub>	0.2	0.2	0.2	0.2		
I <sub>DD5PBQ</sub>	V <sub>DDQ</sub>	0.6	0.6	0.6	0.6		

- Notes: 1. Published I<sub>DD</sub> values except I<sub>DD4RQ</sub> are the maximum I<sub>DD</sub> values speed grade considering the worst-case conditions of process, temperature, and voltage.  
 2. BG mode. DVFS and DVFSQ disabled.  
 3. BL = 16, DBI disabled.  
 4. I<sub>DD4RQ</sub> value is reference only. Typical value. Output load = 5pF; R<sub>ON</sub> = 40 ohms; T<sub>C</sub> = 25°C  
 5. V<sub>DD1</sub> = 1.70–1.95V; V<sub>DD2H</sub> = 1.01–1.12V; V<sub>DD2L</sub> = 0.87–0.97V; V<sub>DDQ</sub> = 0.47–0.57V; T<sub>C</sub> = –25°C to +85°C

6. Notes 1 and 2 apply to entire table.

**Table 9: WT Full-Array Power-Down Self Refresh Current – Single Die**

Temperature	Symbol	Supply	Value	Unit
25°C	I <sub>DD61</sub>	V <sub>DD1</sub>	0.25	mA
	I <sub>DD62H</sub>	V <sub>DD2H</sub>	0.45	
	I <sub>DD62L</sub>	V <sub>DD2L</sub>	- (See note 4)	
	I <sub>DD6Q</sub>	V <sub>DDQ</sub>	- (See note 4)	
85°C	I <sub>DD61</sub>	V <sub>DD1</sub>	3.00	
	I <sub>DD62H</sub>	V <sub>DD2H</sub>	9.00	
	I <sub>DD62L</sub>	V <sub>DD2L</sub>	0.20	
	I <sub>DD6Q</sub>	V <sub>DDQ</sub>	0.60	

- Notes: 1. I<sub>DD6</sub>25°C is the typical value in the distribution with nominal V<sub>DD</sub> and a reference-only value. I<sub>DD6</sub>85°C is the maximum I<sub>DD</sub> guaranteed value considering the worst-case conditions of process, temperature, and voltage.  
 2. DVFS and DVFSQ disabled.  
 3. V<sub>DD1</sub> = 1.70–1.95V; V<sub>DD2H</sub> = 1.01–1.12V; V<sub>DD2L</sub> = 0.87–0.97V; V<sub>DDQ</sub> = 0.47–0.57V; T<sub>C</sub> = –25°C to +85°C  
 4. V<sub>DD2L</sub> and V<sub>DDQ</sub> power rails are not used during power-down self refresh

**Table 10: IT I<sub>DD</sub> Parameters – Single Die**

Symbol	Supply	x8 Mode Speed Grade		x16 Mode Speed Grade		Unit	Note
		7500 Mb/s	8533 Mb/s	7500 Mb/s	8533 Mb/s		
I <sub>DD01</sub>	V <sub>DD1</sub>	3.3	3.3	3.3	3.3	mA	
I <sub>DD02H</sub>	V <sub>DD2H</sub>	29.5	29.5	30.0	30.0		
I <sub>DD02L</sub>	V <sub>DD2L</sub>	0.2	0.2	0.2	0.2		
I <sub>DD0Q</sub>	V <sub>DDQ</sub>	0.6	0.6	0.6	0.6		
I <sub>DD2P1</sub>	V <sub>DD1</sub>	1.5	1.5	1.5	1.5	mA	
I <sub>DD2P2H</sub>	V <sub>DD2H</sub>	2.2	2.2	2.2	2.2		
I <sub>DD2P2L</sub>	V <sub>DD2L</sub>	0.2	0.2	0.2	0.2		
I <sub>DD2PQ</sub>	V <sub>DDQ</sub>	0.6	0.6	0.6	0.6		
I <sub>DD2PS1</sub>	V <sub>DD1</sub>	1.5	1.5	1.5	1.5	mA	
I <sub>DD2PS2H</sub>	V <sub>DD2H</sub>	2.2	2.2	2.2	2.2		
I <sub>DD2PS2L</sub>	V <sub>DD2L</sub>	0.2	0.2	0.2	0.2		
I <sub>DD2PSQ</sub>	V <sub>DDQ</sub>	0.6	0.6	0.6	0.6		
I <sub>DD2N1</sub>	V <sub>DD1</sub>	1.5	1.5	1.5	1.5	mA	
I <sub>DD2N2H</sub>	V <sub>DD2H</sub>	16.5	16.5	17.0	17.0		
I <sub>DD2N2L</sub>	V <sub>DD2L</sub>	0.2	0.2	0.2	0.2		
I <sub>DD2NQ</sub>	V <sub>DDQ</sub>	0.6	0.6	0.6	0.6		



**Table 10: IT I<sub>DD</sub> Parameters – Single Die**

Symbol	Supply	x8 Mode Speed Grade		x16 Mode Speed Grade		Unit	Note
		7500 Mb/s	8533 Mb/s	7500 Mb/s	8533 Mb/s		
I <sub>DD2NS1</sub>	V <sub>DD1</sub>	1.5	1.5	1.5	1.5	mA	
I <sub>DD2NS2H</sub>	V <sub>DD2H</sub>	16.5	16.5	17.0	17.0		
I <sub>DD2NS2L</sub>	V <sub>DD2L</sub>	0.2	0.2	0.2	0.2		
I <sub>DD2NSQ</sub>	V <sub>DDQ</sub>	0.6	0.6	0.6	0.6		
I <sub>DD3P1</sub>	V <sub>DD1</sub>	1.5	1.5	1.5	1.5	mA	
I <sub>DD3P2H</sub>	V <sub>DD2H</sub>	6.0	6.0	6.0	6.0		
I <sub>DD3P2L</sub>	V <sub>DD2L</sub>	0.2	0.2	0.2	0.2		
I <sub>DD3PQ</sub>	V <sub>DDQ</sub>	0.6	0.6	0.6	0.6		
I <sub>DD3PS1</sub>	V <sub>DD1</sub>	1.5	1.5	1.5	1.5	mA	
I <sub>DD3PS2H</sub>	V <sub>DD2H</sub>	6.0	6.0	6.0	6.0		
I <sub>DD3PS2L</sub>	V <sub>DD2L</sub>	0.2	0.2	0.2	0.2		
I <sub>DD3PSQ</sub>	V <sub>DDQ</sub>	0.6	0.6	0.6	0.6		
I <sub>DD3N1</sub>	V <sub>DD1</sub>	1.7	1.7	1.7	1.7	mA	
I <sub>DD3N2H</sub>	V <sub>DD2H</sub>	21.5	21.5	22.0	22.0		
I <sub>DD3N2L</sub>	V <sub>DD2L</sub>	0.2	0.2	0.2	0.2		
I <sub>DD3NQ</sub>	V <sub>DDQ</sub>	0.6	0.6	0.6	0.6		
I <sub>DD3NS1</sub>	V <sub>DD1</sub>	1.7	1.7	1.7	1.7	mA	
I <sub>DD3NS2H</sub>	V <sub>DD2H</sub>	21.5	21.5	22.0	22.0		
I <sub>DD3NS2L</sub>	V <sub>DD2L</sub>	0.2	0.2	0.2	0.2		
I <sub>DD3NSQ</sub>	V <sub>DDQ</sub>	0.6	0.6	0.6	0.6		
I <sub>DD4R1</sub>	V <sub>DD1</sub>	9.0	10.0	11.0	12.0	mA	3, 4
I <sub>DD4R2H</sub>	V <sub>DD2H</sub>	290.0	320.0	430.0	480.0		
I <sub>DD4R2L</sub>	V <sub>DD2L</sub>	0.2	0.2	0.2	0.2		
I <sub>DD4RQ</sub>	V <sub>DDQ</sub>	58.0	63.0	116.0	126.0		
I <sub>DD4W1</sub>	V <sub>DD1</sub>	8.0	9.0	10.0	11.0	mA	3
I <sub>DD4W2H</sub>	V <sub>DD2H</sub>	205.0	225.0	285.0	315.0		
I <sub>DD4W2L</sub>	V <sub>DD2L</sub>	0.2	0.2	0.2	0.2		
I <sub>DD4WQ</sub>	V <sub>DDQ</sub>	0.6	0.6	0.6	0.6		
I <sub>DD51</sub>	V <sub>DD1</sub>	17.0	17.0	17.0	17.0	mA	
I <sub>DD52H</sub>	V <sub>DD2H</sub>	115.0	115.0	115.0	115.0		
I <sub>DD52L</sub>	V <sub>DD2L</sub>	0.2	0.2	0.2	0.2		
I <sub>DD5Q</sub>	V <sub>DDQ</sub>	0.6	0.6	0.6	0.6		

**Table 10: IT I<sub>DD</sub> Parameters – Single Die**

Symbol	Supply	x8 Mode Speed Grade		x16 Mode Speed Grade		Unit	Note
		7500 Mb/s	8533 Mb/s	7500 Mb/s	8533 Mb/s		
I <sub>DD5AB1</sub>	V <sub>DD1</sub>	2.5	2.5	2.5	2.5	mA	
I <sub>DD5AB2H</sub>	V <sub>DD2H</sub>	23.5	23.5	24.0	24.0		
I <sub>DD5AB2L</sub>	V <sub>DD2L</sub>	0.2	0.2	0.2	0.2		
I <sub>DD5ABQ</sub>	V <sub>DDQ</sub>	0.6	0.6	0.6	0.6		
I <sub>DD5PB1</sub>	V <sub>DD1</sub>	2.5	2.5	2.5	2.5	mA	
I <sub>DD5PB2H</sub>	V <sub>DD2H</sub>	23.5	23.5	24.0	24.0		
I <sub>DD5PB2L</sub>	V <sub>DD2L</sub>	0.2	0.2	0.2	0.2		
I <sub>DD5PBQ</sub>	V <sub>DDQ</sub>	0.6	0.6	0.6	0.6		

- Notes: 1. Published I<sub>DD</sub> values except I<sub>DD4RQ</sub> are the maximum I<sub>DD</sub> values considering the worst-case conditions of process, temperature, and voltage.  
2. BG mode. DVFS and DVFSQ disabled.  
3. BL = 16, DBI disabled.  
4. I<sub>DD4RQ</sub> value is reference only. Typical value. Output load = 5pF; R<sub>ON</sub> = 40 ohms; T<sub>C</sub> = 25°C  
5. V<sub>DD1</sub> = 1.70–1.95V; V<sub>DD2H</sub> = 1.01–1.12V; V<sub>DD2L</sub> = 0.87–0.97V; V<sub>DDQ</sub> = 0.47–0.57V; T<sub>C</sub> = –40°C to +95°C  
6. Notes 1 and 2 apply to entire table.

**Table 11: IT Full-Array Power-Down Self Refresh Current – Single Die**

Temperature	Symbol	Supply	Value	Unit
25°C	I <sub>DD61</sub>	V <sub>DD1</sub>	0.25	mA
	I <sub>DD62H</sub>	V <sub>DD2H</sub>	0.45	
	I <sub>DD62L</sub>	V <sub>DD2L</sub>	- (See note 4)	
	I <sub>DD6Q</sub>	V <sub>DDQ</sub>	- (See note 4)	
95°C	I <sub>DD61</sub>	V <sub>DD1</sub>	3.70	
	I <sub>DD62H</sub>	V <sub>DD2H</sub>	12.00	
	I <sub>DD62L</sub>	V <sub>DD2L</sub>	- (See note 4)	
	I <sub>DD6Q</sub>	V <sub>DDQ</sub>	- (See note 4)	

- Notes: 1. I<sub>DD6</sub>25°C is the typical value in the distribution with nominal V<sub>DD</sub> and a reference-only value. I<sub>DD6</sub>95°C is the maximum I<sub>DD</sub> guaranteed value considering the worst-case conditions of process, temperature, and voltage.  
2. DVFS and DVFSQ disabled.  
3. V<sub>DD1</sub> = 1.70–1.95V; V<sub>DD2H</sub> = 1.01–1.12V; V<sub>DD2L</sub> = 0.87–0.97V; V<sub>DDQ</sub> = 0.47–0.57V; T<sub>C</sub> = –40°C to +95°C  
4. V<sub>DD2L</sub> and V<sub>DDQ</sub> power rails are not used during power-down self refresh.