Automotive LPDDR5X SDRAM

MT62F768M32D2, MT62F1536M32D4, MT62F3G32D8

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)
  - Differential read strobe (RDQS_t/RDQS_c)
  - 16*n*-bit or 32*n*-bit prefetch architecture
  - Bank Architecture: Bank Group (BG) mode, and 16-bank (16B) mode supported
  - Command-selectable burst lengths (BL = 16 or 32) in bank group or 16-bank modes
  - Background ZQ calibration/command-based ZQ calibration
  - Link protection (link ECC) support
  - Partial-array self refresh (PASR) and partial-array auto refresh (PARC) with segment mask
- **Ultra-low-voltage core and I/O power supplies**
  - V_{DD1} = 1.70–1.95V; 1.80V TYP
  - V_{DD2H} = 1.01–1.12V; 1.05V TYP
  - V_{DD2L} = V_{DD2H} or 0.87–0.97V; 0.90V TYP
  - V_{DDQ} = 0.50V or 0.45V[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**
  - Enhanced DVFSC: Enhanced Dynamic voltage frequency scaling core
  - Single-ended CK, single-ended WCK, and single-ended RDQS
  - Data copy
  - Write X

Options	Marking
Operating Voltage	F
– $V_{DD1}/V_{DD2H}/V_{DD2L}/V_{DDQ}/V_{DDQ}$ (ODT off only):1.80V/1.05V/V_{DD2H} or 0.90V/0.50V or 0.45V[1]/0.30V	
Array configuration	
– 768 Mb x 32 (768Mb16 x 1 Die x 2Ch x 1R)	768M32
– 1536 Mb x 32 (768Mb16 x 1 Die x 2Ch x 2R)	1536M32
– 3 Gb x 32 (1536Mb8 x 2 Die x 2Ch x 2R)	3G32
Device configuration	
– 2 die in package (768Mb16 x 2 die)	D2
– 4 die in package (768Mb16 x 4 die)	D4
– 8 die in package (1536Mb8 x 8 die)	D8
FBGA RoHS-compliant, "green" package	
– 315-ball TFBGA 12.4mm x 15.0mm (TYP), seated height 1.1mm (MAX)	DS
– 315-ball LFBGA 12.4mm x 15.0mm (TYP), seated height 1.3mm (MAX)	DV
Speed grade, cycle time (^{t}WCK)	
– 8533 Mb/s	-023
– 7500 Mb/s	-026
Functional Safety & DLEP	F[2]
– Micron safety features enabled	
– Suitable for meeting random HW metrics up to ASIL D	
– Dynamic Link ECC Protocol (DLEP)	
– FMEDA (ISO 26262-5:2018, cl. 8, 9)	
– Safety manual	
Automotive	A
– AEC-Q100	
– PPAP	
– ISO 26262 ASIL D compliant development	
Operating temperature	
– –40°C ≤ T_C ≤ +95°C	IT
– –40°C ≤ T_C ≤ +105°C	AT
– –40°C ≤ T_C ≤ +125°C	UT[3]
Revision	:C

Notes: 1. V_{DDQ} = 0.45V (TYP) support on all packages up to 7500 Mb/s.

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2. For functional safety documentation, contact Micron sales representative.
3. Based on automotive usage model. Contact Micron sales representative with questions.

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Part Number Ordering Information

Figure 1: Part Number Chart

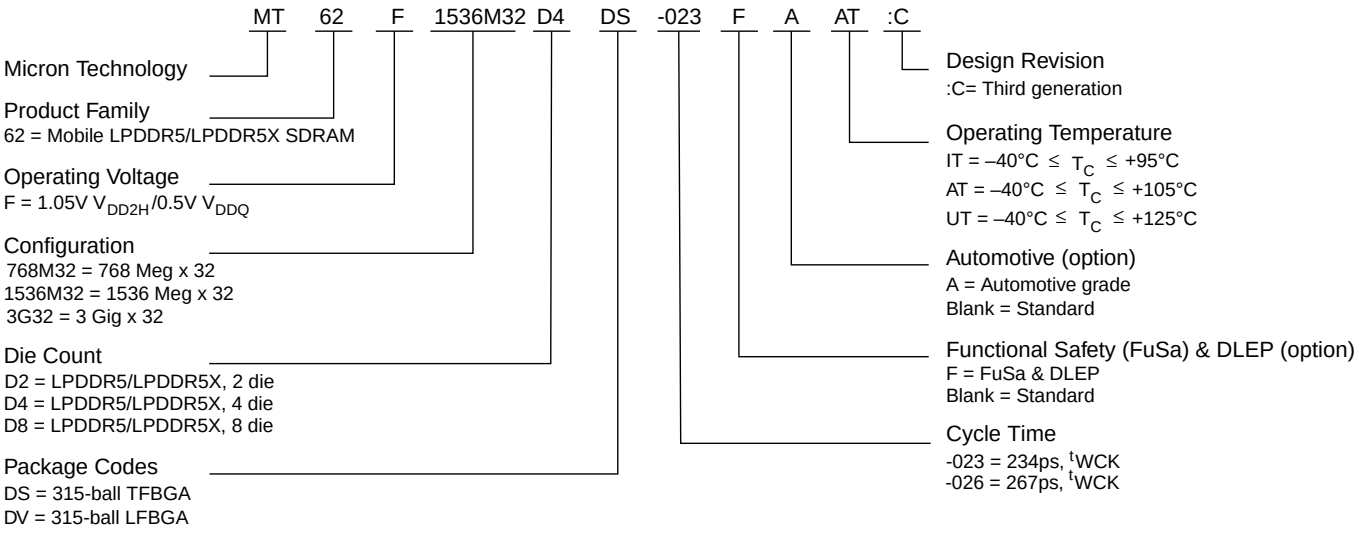

Table 1: Part Number List

Part Number	Total Density	Data Rate per Pin
MT62F768M32D2DS-023 AIT:C	3GB (24Gb)	8533 Mb/s
MT62F768M32D2DS-023 AAT:C		
MT62F768M32D2DS-023 AUT:C		
MT62F768M32D2DS-023 FAAT:C		
MT62F768M32D2DS-023 FAUT:C		
MT62F768M32D2DS-023 FAIT:C		
MT62F1536M32D4DS-023 AIT:C	6GB (48Gb)	
MT62F1536M32D4DS-023 AAT:C		
MT62F1536M32D4DS-023 AUT:C		
MT62F1536M32D4DS-023 FAAT:C		
MT62F1536M32D4DS-023 FAUT:C		
MT62F1536M32D4DS-023 FAIT:C		
MT62F3G32D8DV-023 AIT:C	12GB (96Gb)	
MT62F3G32D8DV-023 AAT:C		
MT62F3G32D8DV-023 AUT:C		
MT62F3G32D8DV-023 FAAT:C		
MT62F3G32D8DV-023 FAUT:C		
MT62F3G32D8DV-023 FAIT:C		
MT62F1536M32D4DS-026 AIT:C	6GB (48Gb)	7500 Mb/s
MT62F1536M32D4DS-026 AAT:C		
MT62F3G32D8DV-026 AIT:C	12GB (96Gb)	
MT62F3G32D8DV-026 AAT:C		

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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.

LPDDR5/LPDDR5X Data Sheet List

This data sheet only describes the product specifications that are unique to the Micron devices listed in Table 1. 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

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System Design and Implementation. This product has been developed for multiple applications based on assumed use cases and requirements (including assumed functional safety requirements and constraints). It is the customer's sole responsibility to evaluate and confirm the validity and suitability of Micron's product datasheet, assumed use cases and requirements, and evaluation results by verifying Micron's assumptions against actual use cases and requirements in the intended end system and application. The customer must ensure compliance with all applicable requirements and standards (including industry, product, security, privacy, safety, etc.) to its system and applications. The customer must protect against death, personal injury, and severe property and environmental damage by ensuring that adequate design and redundancy (as needed), manufacturing and operating safeguards are included into customer's applications to ensure that failure of the Micron component will not result in such harms.

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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_t, RDQS_c, CK_t, CK_c, and WCK_t, WCK_c 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_{REF} indicates $V_{REF(CA)}$ and $V_{REF(DQ)}$.

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 content defined in this device ID specific data sheet document takes precedence over similar content defined in the general core LPDDR5/LPDDR5X SDRAM data sheet document(s).

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

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Functional Safety Notes

This automotive LPDDR5/LPDDR5X DRAM product family has been developed according to ISO 26262:2018 requirements to provide a level of systematic fault coverage that allows its use in systems targeting up to ASIL D compliance.

This LPDDR5/LPDDR5X DRAM contains several new functional safety features that operate within the JEDEC LPDDR5/LPDDR5X protocols (commands, timings, and so forth) and are made available to the integrator on "F" parts (see Part Number Ordering Information). The specification addendum governing these functional safety features is available under NDA. This LPDDR5/LPDDR5X DRAM may operate as a standard JEDEC LPDDR5/LPDDR5X DRAM only, or as a standard JEDEC LPDDR5/LPDDR5X DRAM specifically designed to include functional safety features to communicate fault detection (only available on "F" parts). Additional support may be available to customers who need to integrate Micron's products in their functional safety-related applications. This support may include Safety Analysis Report, reporting FMEDA results and metrics, Safety Manual and Pin FMEA Report, providing guidelines and instructions for using Micron products in safety-related applications.

Contact a Micron sales representative to initiate the process required to obtain the functional safety documentation.

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Device Configuration

Table 2: Die Organization in the Package

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

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

Table 3: Die Addressing

Description	768M32 (24 Gb/package), 1536M32 (48 Gb/package)		3G32 (96 Gb/package)	
Density per die	12Gb		12Gb	
Bits	12,884,901,888		12,884,901,888	
Bank mode	BG mode	16B mode	BG mode	16B mode
Configuration	48Mb × 16 DQ × 4 banks × 4BG	48Mb × 16 DQ × 16 banks	96Mb × 8 DQ × 4 banks × 4BG	96Mb × 8 DQ × 16 banks
Number of banks	4	16	4	16
Number of bank groups	4	1	4	1
Array prefetch bits	256	256	128	128
Rows per bank	49,152		98,304	
Columns	64		64	
Page size (bytes)	2048	2048	1024	1024
Native burst length	16	16	16	16
Number of I/Os	16		8	
Bank address	BA[1:0]	BA[3:0]	BA[1:0]	BA[3:0]
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[3:0]	B[3:0]
Burst starting address boundary	128-bit		128-bit	

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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.

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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.

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CS Rx Relaxed Specification

Table 5: CS Rx Specifications

Item	Symbol	Min/ Max	CK Frequency (MHz)													Unit	Note
			67[6]	133	200	266	344	400	467	533	600	688	750	800	937.5	1066.5		
Rx mask																		
CS Rx mask height	vCSIVW	Min	155														mV	2, 7
CS Rx mask width at V_{REF} CS	^{t}CSIVW1	Min	0.3														UI	1
CS Rx mask width at vCSIVW	^{t}CSIVW2	Min	0.22														UI	1
Rx single pulse																		
CS Rx pulse amplitude	vCSIHL_AC	Min	240														mV	3
CS reference voltage	vREFCS		V_{DD2H}/3														mV	
CS Rx pulse width	^{t}CSIPW	Min	0.6														UI	
Power down																		
CS V_{IL} during power down/deep sleep	V_{ILPD}	Max	130														mV	4
CS V_{IH} during power down/deep sleep	V_{IHPD}	Min	550														mV	5
		Max	V_{DD2H} + 200															

Notes: 1. CS Rx mask voltage and timing parameters at the pin include temperature drift and voltage AC noise impact based on Z(f) specification at a fixed temperature on the package. The voltage supply noise must comply to the component min/max DC operating conditions.
2. CS single-pulse signal amplitude into the receiver must meet or exceed vCSIHL_AC at any point over the total UI; No timing requirement above a certain level. vCSIIHL_AC is the peak-to-peak voltage centered around V_{REF} CS such that vCSIHL_AC/2 min has to be met both above and below V_{REF} CS.
3. vCSIHL_AC does not have to be met when no transitions are occurring.
4. The input voltage presented to the CS Rx pin during power down should be 0V nominally to minimize leakage current.
5. V_{IHPD} is only applied for POWER DOWN and DEEP SLEEP EXIT operations.
6. The Rx voltage and absolute timing requirements apply for all CS operating frequencies at or below 67 for all speed bins. For example, ^{t}CSIVW1 (ns) = 4.477ns at or below 67 MHz CK frequency.
7. Measured at die pad.

DQ Rx Mask and Single Input Pulse Relaxed Specifications

Table 6: DQ Rx Mask and Single Input Pulse Specifications

Item	Symbol	Min/ Max	WCK Frequency (MHz)		Unit	Notes
			3750	4266		
DQ Rx mask height	vDIVW	Min	70		mV	1, 2, 3
DQ Rx mask width at $V_{REF(DQ)}$	^{t}DIVW1	Min	0.35		UI	1, 3
DQ Rx mask width at vDIVW	^{t}DIVW2	Min	0.18		UI	1, 3
DQ Rx pulse width at $V_{REF(DQ)}$	^{t}DIPW1	Min	0.51		UI	4
DQ Rx pulse reference	^{t}DIPW2	Min	0.26		UI	4
DQ Rx pulse width at $V_{REF(DQ)}$ ± vDIVW/2	^{t}DIHL	Min	0.24		UI	4
DQ Rx pulse amplitude from programmed $V_{REF(DQ)}$	vDIHP1	Min	70		mV	
	vDILP1	Max	–70		mV	

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Table 6: DQ Rx Mask and Single Input Pulse Specifications (Continued)

Item	Symbol	Min/ Max	WCK Frequency (MHz)		Unit	Notes
			3750	4266		
DQ Rx early pulse amplitude from programmed $V_{REF(DQ)}$	vDIHP2	Min	55		mV	
	vDILP2	Max	–55		mV	

Notes: 1. Data Rx mask voltage and timing parameters are applied per pin and include the DRAM DQ-to-DQS voltage AC noise impact for frequencies greater than TBD MHz and maximum voltage of TBD mV peak-to-peak from DC-TBD MHz at a fixed temperature on the package. The voltage supply noise must comply with the component min/max DC operating conditions.
2. Rx mask voltage vDIVW must be centered around $V_{REF(DQ)}$.
3. Mask specifications (^{t}DIVW1, ^{t}DIVW2, and vDIVW) are the same regardless DFE enabled or disabled. DFE co-efficient can be included as part of input waveform amplitude when DFE is enabled.
4. UI = ^{t}WCK/2, programed V_{REF}, is defined as a percentage of MR14/15 code x V_{DDQ}.

Figure 2: DQ Rx Mask Definition

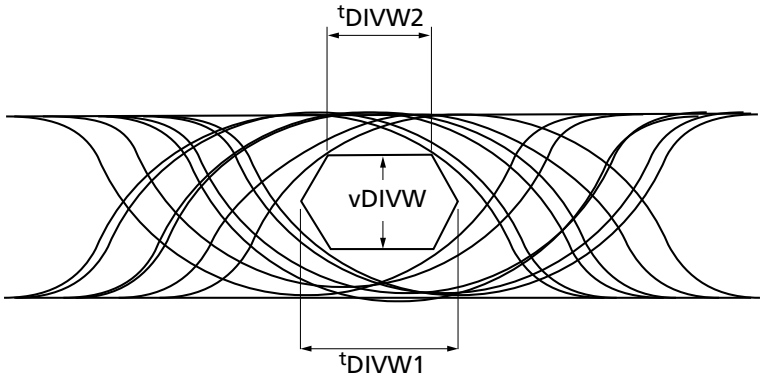
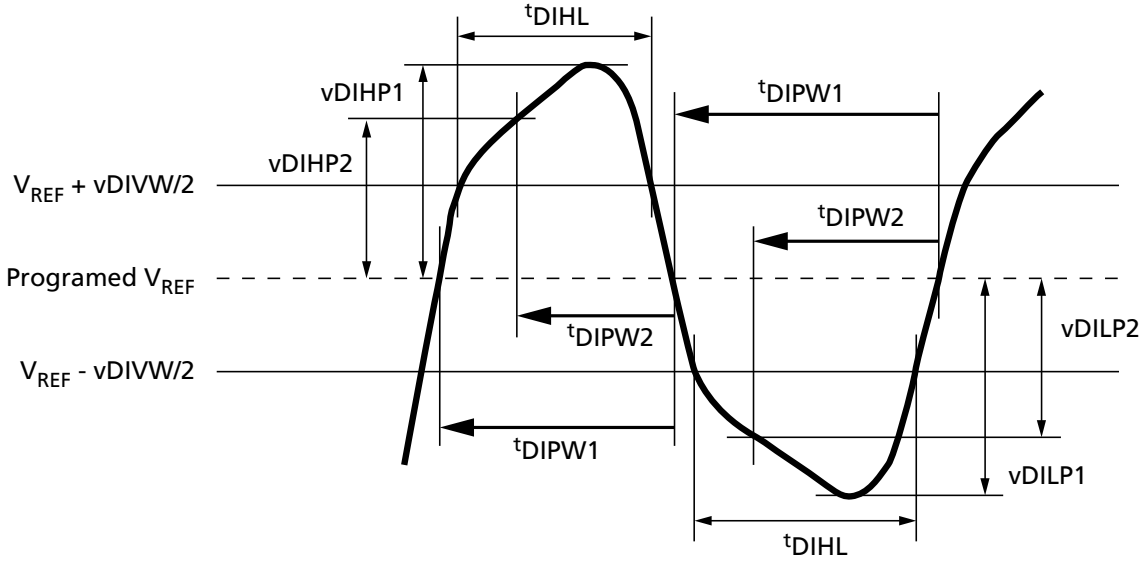


Figure 3: LPDDR5X DQ Single Pulse Definition



Note: 1. vDIHL_AC/2 = vDIHP1 = vDILP1. Programmed $V_{REF(DQ)}$ is defined as percentage of MR14/15 code * V_{DDQ}.

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DQ Rx Mask and Single Input Pulse Relaxed Specifications 3200 MHz

Table 7: DQ, DMI, Parity and DBI Rx Mask and Single Input Pulse Specifications

Item	Symbol	Min/Max	WCK Frequency (MHz)	Unit	Notes
			3200		
DQ Rx mask height	vDIVW	Min	70	mV	1, 2, 3, 6
DQ Rx mask width at $V_{REF(DQ)}$	^{t}DIVW1	Min	0.35	UI	1, 3
DQ Rx mask width at vDIVW	^{t}DIVW2	Min	0.18	UI	1, 3
DQ Rx pulse width at $V_{REF(DQ)}$	^{t}DIPW1	Min	0.51	UI	4, 6
DQ Rx pulse reference	^{t}DIPW2	Min	0.26	UI	4
DQ Rx pulse width at $V_{REF(DQ)}$ ± vDIVW/2	^{t}DIHL	Min	0.24	UI	4, 6
DQ Rx pulse amplitude from programmed $V_{REF(DQ)}$	vDIHP1	Min	70	mV	
	vDILP1	Max	–70	mV	
DQ Rx early pulse amplitude from programmed $V_{REF(DQ)}$	vDIHP2	Min	55	mV	
	vDILP2	Max	–55	mV	
DQ V_{REF}	VREF(DQ)	Min	75	mV	6
		Max	180	mV	6
DQ to DQ offset	^{t}DQ2DQ	Max	30	ps	5

Notes: 1. Data Rx mask voltage and timing parameters are applied per pin and include the DRAM DQ-to-DQS voltage AC noise impact for frequencies greater than TBD MHz and maximum voltage of TBD mV peak-to-peak from DC-TBD MHz at a fixed temperature on the package. The voltage supply noise must comply with the component min/max DC operating conditions.

2. Rx mask voltage vDIVW must be centered around $V_{REF(DQ)}$.
3. Mask specifications (^{t}DIVW1, ^{t}DIVW2, and vDIVW) are the same regardless DFE enabled or disabled. DFE coefficient can be included as part of input waveform amplitude when DFE is enabled.
4. UI = ^{t}WCK/2, programed V_{REF}, is defined as a percentage of MR14/15 code x V_{DDQ}.
5. DQ to DQ offset defined within byte from DRAM pin to DRAM internal latch for a given component.
6. When vDIVW is 70mV or more and less than 80mV.

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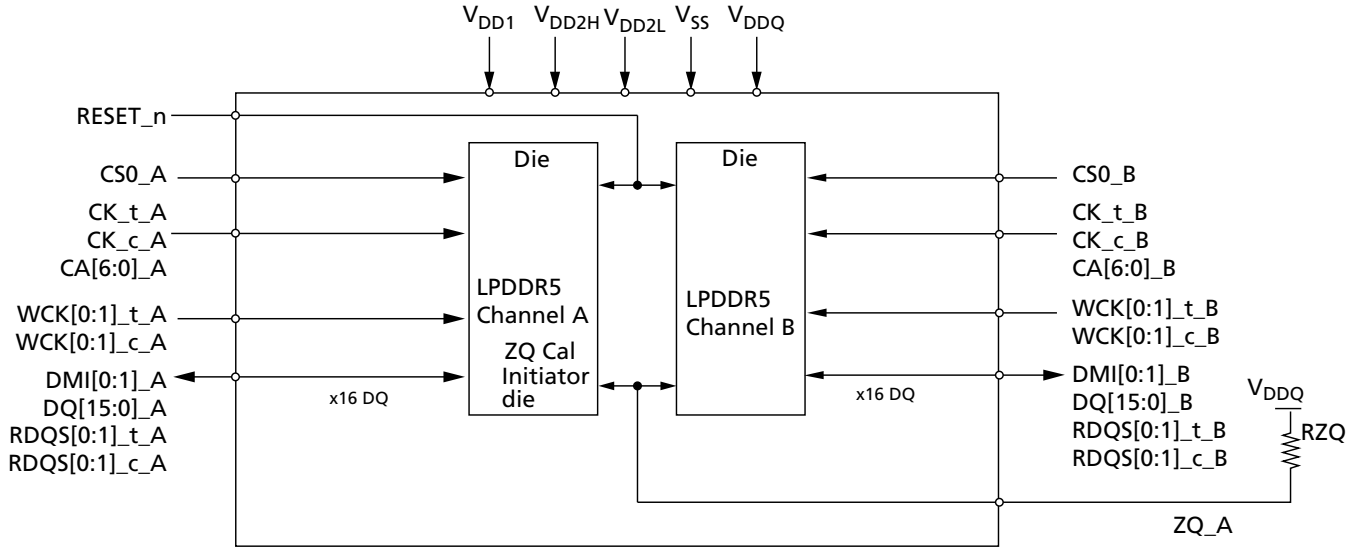
Package Block Diagrams

Dual Die, Dual Channel, Single Rank

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



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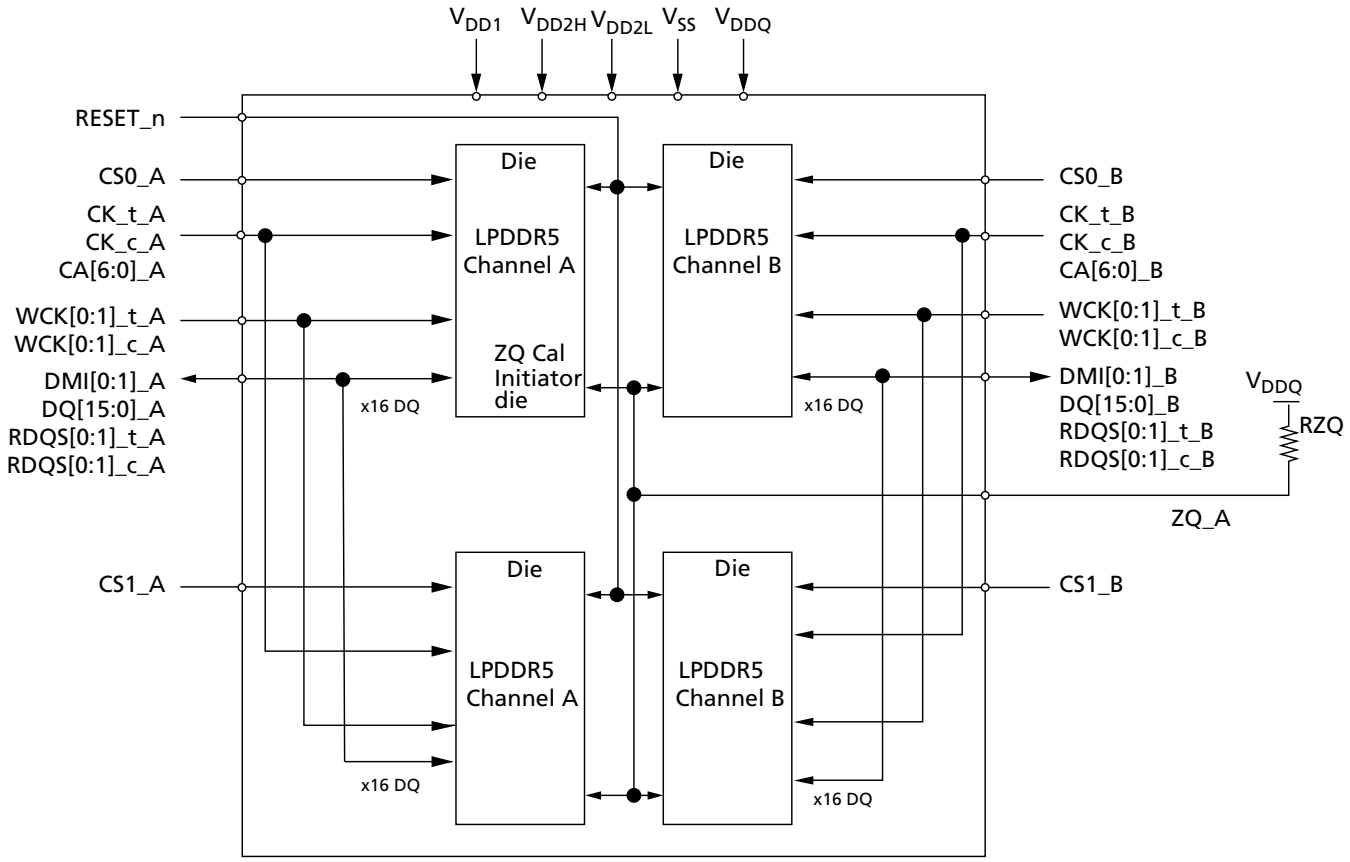
Quad Die, Dual Channel, Dual Rank

Figure 5: Quad-Die, Dual-Channel, Dual-Rank Package Block Diagram



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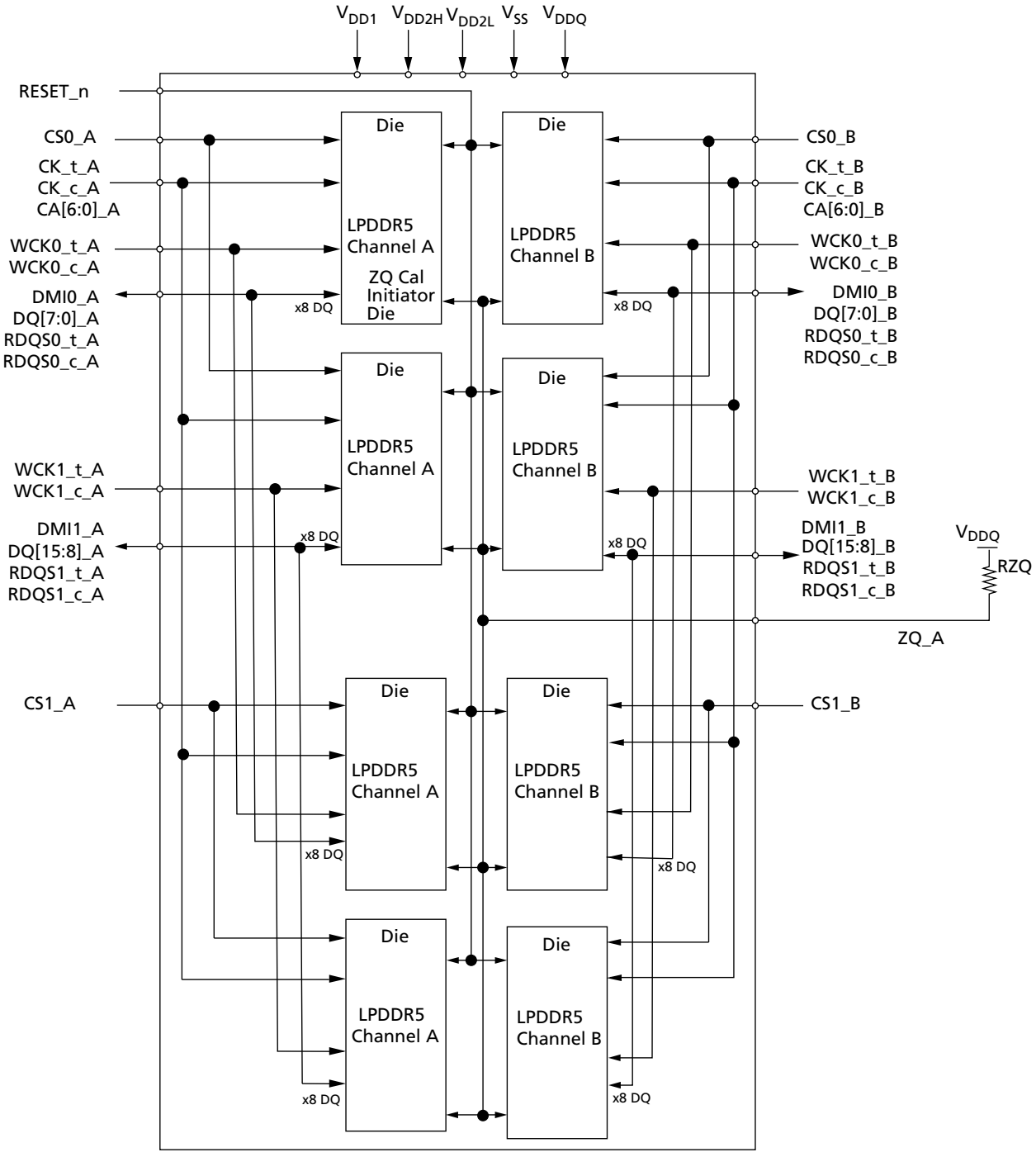
Eight Die, Dual Channel, Dual Rank

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



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315b Dual Channel, 1 Rank, 2 Rank

Table 8: 315-Ball/Pad Descriptions

Symbol	Type	Description
CK_t_[A:B], CK_c_[A:B]	Input	**Clock:** 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	**Chip select:** 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	**Command/address inputs:** 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	**Data clock:** 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	**Data input/output:** Bidirectional data bus.
RDQS[1:0]_t_[A:B], RDQS[1:0]_c_[A:B]	I/O Output	**Read data strobe:** 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	**Data mask inversion:** 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	**ZQ calibration reference:** Used to calibrate the output drive strength and the termination resistance. The ZQ pin should be connected to V_{DDQ} through a 240 ohm ±1% resistor.
V_{DDQ}, V_{DD1}, V_{DD2H}, V_{DD2L}	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 the die. Reset is an asynchronous signal.
NC	–	**No connect:** Not internally connected.
RFU	–	**Reserved Future Use:** Not internally connected.

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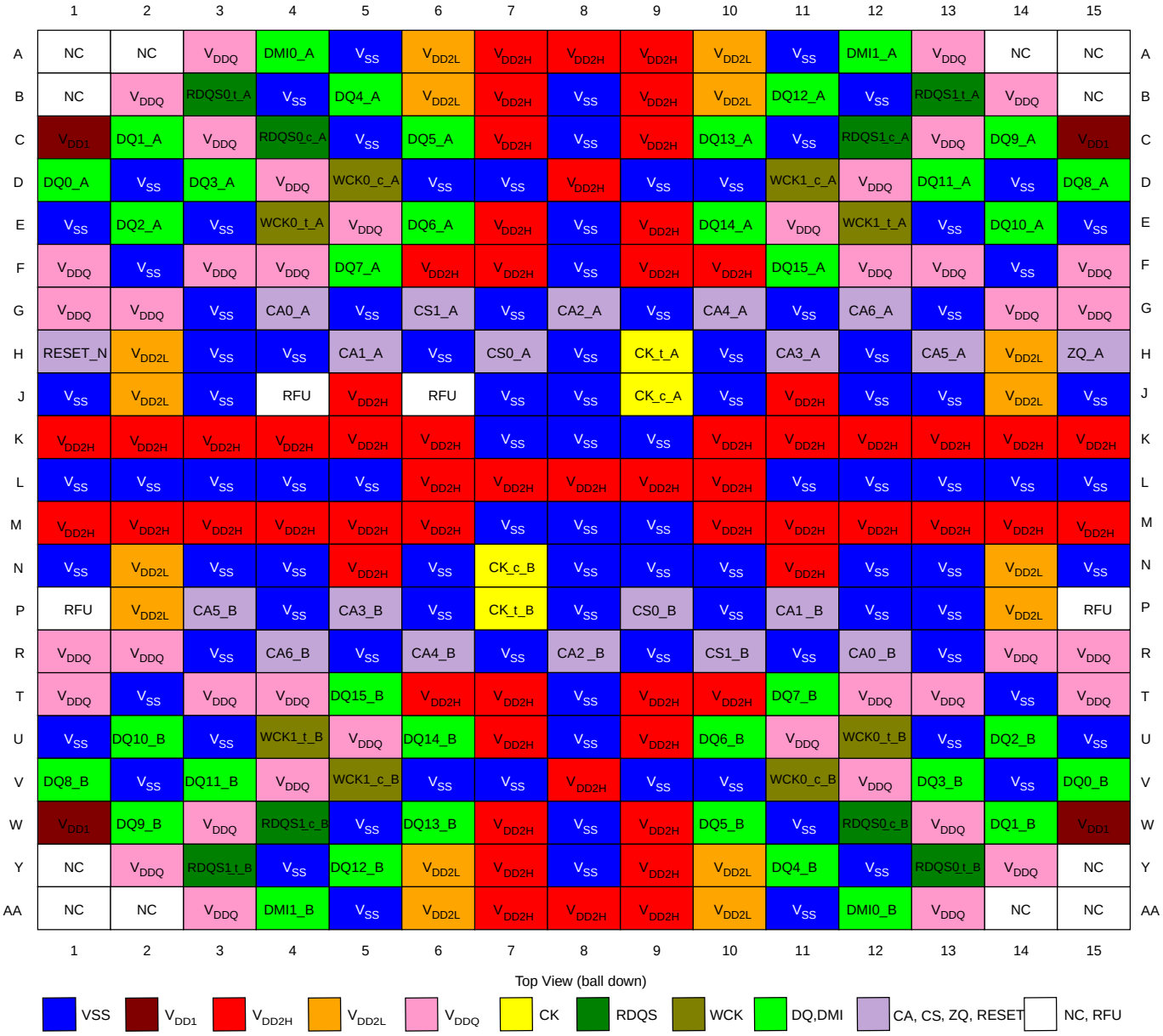
Figure 7: 315-Ball Dual-Channel Discrete FBGA



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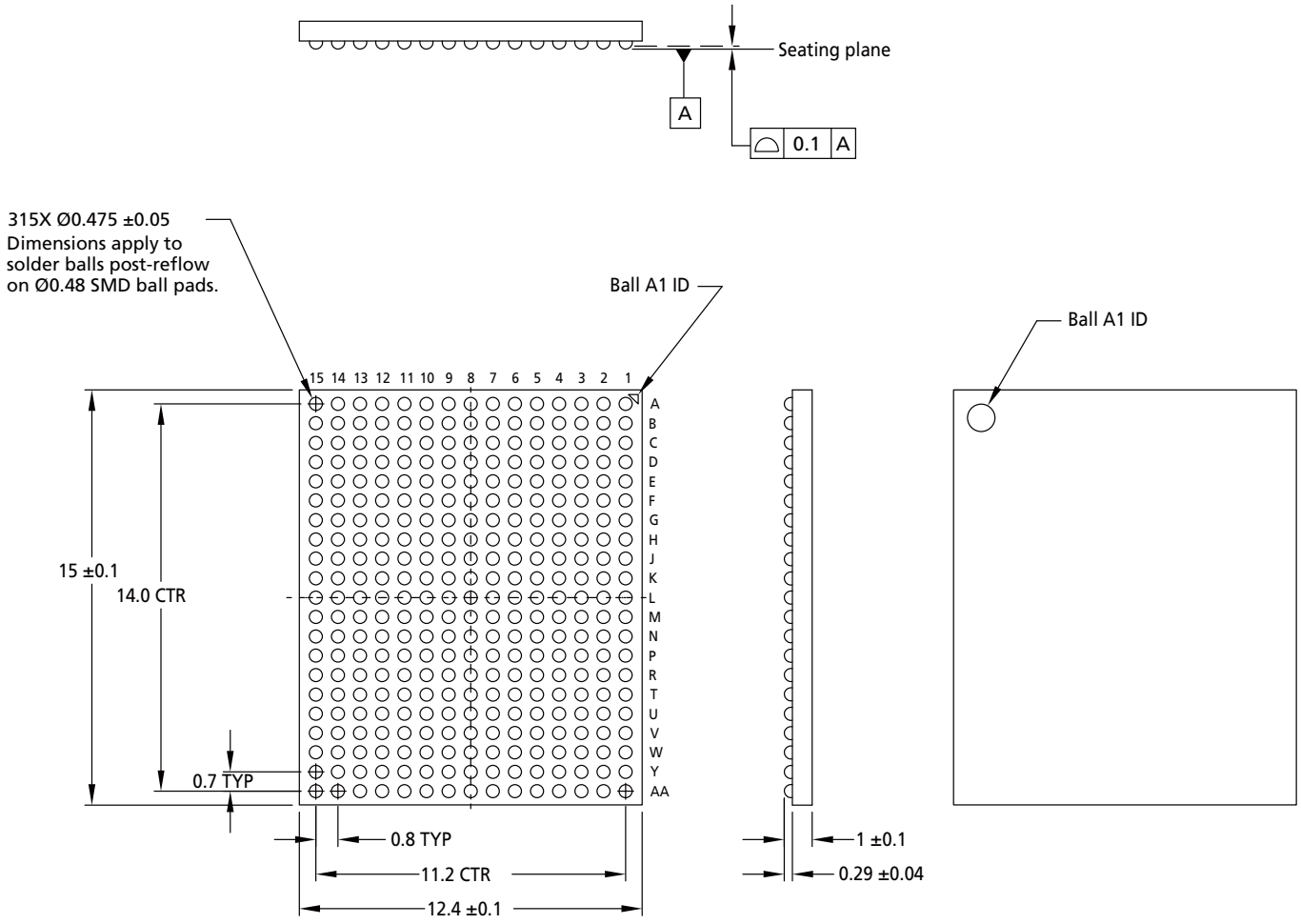
Package Dimensions

315-Ball Package (Package Code: DS)

Figure 8: 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)

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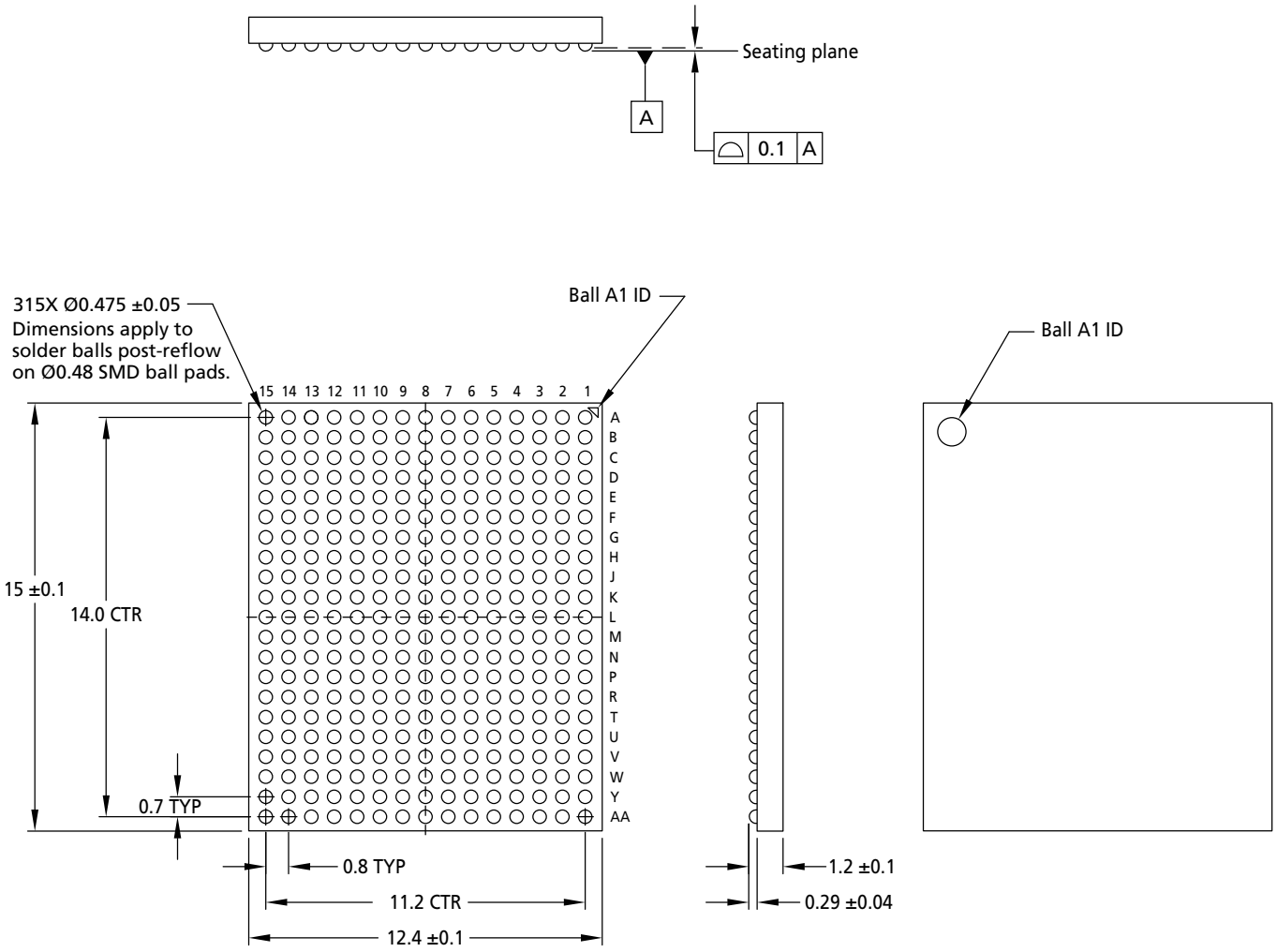
315-Ball Package (Package Code: DV)

Figure 9: 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)

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Package Thermal Impedance

Table 9: Package Thermal Impedance Characteristics

Die Revision	Package	Parameter	Symbol	Value	Unit
Rev C	315-ball, DDP, package code DS	Junction-to-case (TOP)	Θ_{JC}	2.7	°C/W
		Junction-to-board	Θ_{JB}	7.9	°C/W
	315-ball, QDP, package code DS	Junction-to-case (TOP)	Θ_{JC}	2.9	°C/W
		Junction-to-board	Θ_{JB}	9.2	°C/W
	315-ball, 8DP, package code DV	Junction-to-case (TOP)	Θ_{JC}	3.5	°C/W
		Junction-to-board	Θ_{JB}	9.6	°C/W

Note: 1. Thermal impedance values provided are for reference only. These values are based on a model and represent a maximum characteristic.

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Product-Specific Mode Register Definition

Table 10: Mode Register Contents

Mode Register	OP7	OP6	OP5	OP4	OP3	OP2	OP1	OP0
MR0	**Per-pin DFE**	**Pre Emphasis**	**Unified NT ODT behavior mode**	**DMI output behavior mode**	**Optimized refresh mode**	**Enhanced WCK always-on mode**	**Latency mode**	**NT ODT timing mode**
	OP[0] = 1b: Device supports different NT ODT latency for DQ and RDQS							
	OP[1] = 0b: Device supports x16 mode latency for 768M32, 1536M32 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] = 1b: Device supports Per Pin DFE							
MR1						**DRFM support[7]**	**ARFM support[3]**	**CS ODT OP support**
	OP[0] = 1b: Device supports CS ODT behavior OP							
	OP[1] = 1b: Device supports ARFM							
	OP[2] = 0b: Device does not support DRFM							
MR3				**BK/BG ORG**				
	OP[4:3] = 00b: BG mode supported							
	01b: 8B mode not supported							
	10b: 16B Mode supported							
	11b: RFU							
MR4				**Refresh Multiplier (Note 8, 9)**				
	OP[4:0]: Refer to General LPDDR5/LPDDR5X Specification 1 for mode register definitions.							
MR5	**Manufacturer ID**							
	1111 1111b: Micron							
MR6	**Revision ID1**							
	0000 1000b							
MR8	**I/O width**		**Density**					**Type**
	OP[7:6] = 00b: x16 for 768M32, 1536M32 OP[7:6] = 01b: x8 for 3G32		OP[5:2] = 0101b: 12Gb					OP[1:0] = 01b: LPDDR5X SDRAM
MR13						**VRO**		
	OP[2] = 0b: Normal operation (default) 1b: Output the $V_{REF(CA)}$ value on DQ7 and $V_{REF(DQ)}$ value on DQ6							
MR19			**WCK2DQ OSC FM**					
	OP[5] = 1b: WCK2DQ OSC FM supported							

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Table 10: Mode Register Contents (Continued)

Mode Register	OP7	OP6	OP5	OP4	OP3	OP2	OP1	OP0
MR21	**WXS**				**ODTD-CSFS**	**WXFS**	**RDCFS**	**WDCFS**
	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							
MR22	**RECC**			**WECC**				
	OP[5:4] = 00b: Write link ECC disabled (default) 01b: Write link ECC enabled (See Note 4)							
	OP[7:6] = 00b: Read link ECC disabled (default) 01b: Read link ECC enabled (See Note 4)							
MR24	**DFES**				**Read DCA**			
	OP[3] = 1b: Device supports Read DCA							
	OP[7] = 1b: Device supports DFE (See Note #5)							
MR26		**RDQSTFS**						
	OP[6] = 1b: Read/write-based RDQS_t TRAINING function supported							
MR27	**RAAMULT**			**RAAIMT**				**RFM**
	OP[0] = 1b: RFM is required							
	OP[5:1] = 00101b: 40							
	OP[7:6] = 01b: 4X							
MR41					**E-DVFSC ODT**	**DVFSC/E-DVFSC Support**		
	OP[2:1] = 10b: Both DVFSC and Enhanced DVFSC Mode supported							
	OP[3] = 1b: Enhanced DVFSC ODT option is supported							
MR43		**SBEC rule**						
	OP[6] = 1b: Simultaneous SBE on each DQ byte and DMI are independently counted							
MR57	**ARFM**[3]		**RFMSBC**		**RFMSB**		**RAADEC**	
	OP[1:0] = 10b: 2 × RAAIMT							
	OP[3:2] = 00b: Single Bank Mode not supported							
	OP[5:4] = 00b: One RAA counter per two banks (1 of 8)							
	OP[7:6] = 00b: default (00101b: 40), 01b: Level A, 10b: Level B, 11b: Level C							
MR75								**BRCS**
	OP[0] = 0b: BRC is not supported							
MR63-MR74, MR76-MR164	Reserved MR bits MR63 through MR74 and MR76 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. Refer to General LPDDR5/LPDDR5X Specification 3 for feature description not described here.
4. Write link ECC and read link ECC are supported.
5. Device supports 7-step DFE.

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6. Device type only supports Bank Group and 16B modes.
7. Refer to General LPDDR5/LPDDR5X Specification 3 for DRFM details not described here
8. MR4:OP[4:0] output from each die in a defined package shall be used to determine the required package level refresh rate. Any other method used to determine a valid refresh rate, places ownership and responsibility of the correct refresh rate on the system developer or end user. T_{OPER} (case surface temperature) shall be used to determine whether operating temperature requirements are being met. Any other method used to determine operating temperature, places ownership and responsibility of the correct operating temperature on the system developer or end user.
9. The intent of a MR4 OP[4:0] output of <01111> is to not to support a refresh rate of 0.125xd; rather a method to inform the host the die temperature is most likely being operated beyond its supported upper maximum limit and the host should immediately place the DRAM in to a refresh only state at 0.125xd refresh rate until the MR4 readout of <01111> no longer exists. No other operation other than refresh should be conducted.

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I_{DD} Parameters

Refer to I_{DD} Specification Parameters and Test Conditions section in General LPDDR5/LPDDR5X Specifications 2 for detailed conditions.

Table 11: I_{DD} Parameters at 7500 Mb/s – Single Die

Symbol	Supply	x8 7500 Mb/s			x16 7500 Mb/s			Unit	Note
		UT	AT	IT	UT	AT	IT		
I_{DD01}	V_{DD1}	4.3	3.9	3.9	4.3	3.9	3.9	mA	
I_{DD02H}	V_{DD2H}	76.7	55.3	55.3	79.0	57.0	57.0		
I_{DD02L}	V_{DD2L}	0.2	0.2	0.2	0.2	0.2	0.2		
I_{DD0Q}	V_{DDQ}	0.6	0.6	0.6	0.6	0.6	0.6		
I_{DD2P1}	V_{DD1}	2.2	1.8	1.8	2.2	1.8	1.8	mA	
I_{DD2P2H}	V_{DD2H}	7.5	4.5	4.5	7.5	4.5	4.5		
I_{DD2P2L}	V_{DD2L}	0.2	0.2	0.2	0.2	0.2	0.2		
I_{DD2PQ}	V_{DDQ}	0.6	0.6	0.6	0.6	0.6	0.6		
I_{DD2PS1}	V_{DD1}	2.2	1.8	1.8	2.2	1.8	1.8	mA	
$I_{DD2PS2H}$	V_{DD2H}	7.5	4.5	4.5	7.5	4.5	4.5		
$I_{DD2PS2L}$	V_{DD2L}	0.2	0.2	0.2	0.2	0.2	0.2		
I_{DD2PSQ}	V_{DDQ}	0.6	0.6	0.6	0.6	0.6	0.6		
I_{DD2N1}	V_{DD1}	2.2	1.7	1.7	2.2	1.7	1.7	mA	
I_{DD2N2H}	V_{DD2H}	54.0	36.3	36.3	58.0	39.0	39.0		
I_{DD2N2L}	V_{DD2L}	0.2	0.2	0.2	0.2	0.2	0.2		
I_{DD2NQ}	V_{DDQ}	0.6	0.6	0.6	0.6	0.6	0.6		
I_{DD2NS1}	V_{DD1}	2.2	1.7	1.7	2.2	1.7	1.7	mA	
$I_{DD2NS2H}$	V_{DD2H}	54.0	36.3	36.3	58.0	39.0	39.0		
$I_{DD2NS2L}$	V_{DD2L}	0.2	0.2	0.2	0.2	0.2	0.2		
I_{DD2NSQ}	V_{DDQ}	0.6	0.6	0.6	0.6	0.6	0.6		
I_{DD3P1}	V_{DD1}	3.3	2.8	2.8	3.4	2.9	2.9	mA	
I_{DD3P2H}	V_{DD2H}	25.0	16.0	16.0	25.0	16.0	16.0		
I_{DD3P2L}	V_{DD2L}	0.2	0.2	0.2	0.2	0.2	0.2		
I_{DD3PQ}	V_{DDQ}	0.6	0.6	0.6	0.6	0.6	0.6		
I_{DD3PS1}	V_{DD1}	3.3	2.8	2.8	3.4	2.9	2.9	mA	
$I_{DD3PS2H}$	V_{DD2H}	25.0	16.0	16.0	25.0	16.0	16.0		
$I_{DD3PS2L}$	V_{DD2L}	0.2	0.2	0.2	0.2	0.2	0.2		
I_{DD3PSQ}	V_{DDQ}	0.6	0.6	0.6	0.6	0.6	0.6		
I_{DD3N1}	V_{DD1}	3.6	3.1	3.1	3.6	3.1	3.1	mA	
I_{DD3N2H}	V_{DD2H}	66.5	45.6	45.6	70.0	48.0	48.0		
I_{DD3N2L}	V_{DD2L}	0.2	0.2	0.2	0.2	0.2	0.2		
I_{DD3NQ}	V_{DDQ}	0.6	0.6	0.6	0.6	0.6	0.6		

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Table 11: I_{DD} Parameters at 7500 Mb/s – Single Die (Continued)

Symbol	Supply	x8 7500 Mb/s			x16 7500 Mb/s			Unit	Note
		UT	AT	IT	UT	AT	IT		
I_{DD4R1}	V_{DD1}	16.2	15.6	15.6	18.0	17.0	17.0	mA	3, 4, 6
I_{DD4R2H}	V_{DD2H}	295.0	260.0	260.0	455.0	410.0	410.0		
I_{DD4R2L}	V_{DD2L}	0.2	0.2	0.2	0.2	0.2	0.2		
I_{DD4RQ}	V_{DDQ}	56.0	56.0	56.0	111.9	111.9	111.9		
I_{DD4W1}	V_{DD1}	14.7	14.1	14.1	16.0	15.0	15.0	mA	3, 6
I_{DD4W2H}	V_{DD2H}	220.0	185.0	185.0	320.0	280.0	280.0		
I_{DD4W2L}	V_{DD2L}	0.2	0.2	0.2	0.2	0.2	0.2		
I_{DD4WQ}	V_{DDQ}	0.6	0.6	0.6	0.6	0.6	0.6		
I_{DD51}	V_{DD1}	22.6	21.6	21.6	23.0	22.0	22.0	mA	
I_{DD52H}	V_{DD2H}	210.0	175.0	175.0	210.0	175.0	175.0		
I_{DD52L}	V_{DD2L}	0.2	0.2	0.2	0.2	0.2	0.2		
I_{DD5Q}	V_{DDQ}	0.6	0.6	0.6	0.6	0.6	0.6		
I_{DD5AB1}	V_{DD1}	4.0	3.6	3.6	4.0	3.6	3.6	mA	
$I_{DD5AB2H}$	V_{DD2H}	63.9	47.2	47.2	68.0	48.0	48.0		
$I_{DD5AB2L}$	V_{DD2L}	0.2	0.2	0.2	0.2	0.2	0.2		
I_{DD5ABQ}	V_{DDQ}	0.6	0.6	0.6	0.6	0.6	0.6		
I_{DD5PB1}	V_{DD1}	4.0	3.6	3.6	4.0	3.6	3.6	mA	
$I_{DD5PB2H}$	V_{DD2H}	63.9	47.2	47.2	68.0	48.0	48.0		
$I_{DD5PB2L}$	V_{DD2L}	0.2	0.2	0.2	0.2	0.2	0.2		
I_{DD5PBQ}	V_{DDQ}	0.6	0.6	0.6	0.6	0.6	0.6		

Notes: 1. Published I_{DD} values except I_{DD4RQ} are the maximum I_{DD} values considering the worst-case conditions of process, temperature, and voltage.
2. BG mode enabled. Enhanced DVFSC and DVFSQ disabled.
3. BL = 16, DBI disabled.
4. I_{DD4RQ} value is reference only. Typical value. Output load = 5pF; R_{ON} = 40 ohms; T_C = 25°C
5. V_{DD1} = 1.70–1.95V; V_{DD2H} = 1.01–1.12V; V_{DD2L} = 0.87–0.97V; V_{DDQ} = 0.47–0.57V (DVFSQ disabled)/0.27-0.37V (DVFSQ enabled)
6. IDD4R2 and IDD4W2 have implemented a more stringent pattern than required by JEDEC and therefore these IDD values are slightly higher than if the JEDEC pattern was used.
7. Notes 1, 2, and 5 apply to entire table.

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Table 12: I_{DD} Parameters at 8533 Mb/s – Single Die

Symbol	Supply	x8 8533 Mb/s			x16 8533 Mb/s			Unit	Note
		UT	AT	IT	UT	AT	IT		
I_{DD01}	V_{DD1}	4.3	3.9	3.9	4.3	3.9	3.9	mA	
I_{DD02H}	V_{DD2H}	76.7	55.3	55.3	79.0	57.0	57.0		
I_{DD02L}	V_{DD2L}	0.2	0.2	0.2	0.2	0.2	0.2		
I_{DD0Q}	V_{DDQ}	0.6	0.6	0.6	0.6	0.6	0.6		
I_{DD2P1}	V_{DD1}	2.2	1.8	1.8	2.2	1.8	1.8	mA	
I_{DD2P2H}	V_{DD2H}	7.5	4.5	4.5	7.5	4.5	4.5		
I_{DD2P2L}	V_{DD2L}	0.2	0.2	0.2	0.2	0.2	0.2		
I_{DD2PQ}	V_{DDQ}	0.6	0.6	0.6	0.6	0.6	0.6		
I_{DD2PS1}	V_{DD1}	2.2	1.8	1.8	2.2	1.8	1.8	mA	
$I_{DD2PS2H}$	V_{DD2H}	7.5	4.5	4.5	7.5	4.5	4.5		
$I_{DD2PS2L}$	V_{DD2L}	0.2	0.2	0.2	0.2	0.2	0.2		
I_{DD2PSQ}	V_{DDQ}	0.6	0.6	0.6	0.6	0.6	0.6		
I_{DD2N1}	V_{DD1}	2.2	1.7	1.7	2.2	1.7	1.7	mA	
I_{DD2N2H}	V_{DD2H}	54.0	36.3	36.3	58.0	39.0	39.0		
I_{DD2N2L}	V_{DD2L}	0.2	0.2	0.2	0.2	0.2	0.2		
I_{DD2NQ}	V_{DDQ}	0.6	0.6	0.6	0.6	0.6	0.6		
I_{DD2NS1}	V_{DD1}	2.2	1.7	1.7	2.2	1.7	1.7	mA	
$I_{DD2NS2H}$	V_{DD2H}	54.0	36.3	36.3	58.0	39.0	39.0		
$I_{DD2NS2L}$	V_{DD2L}	0.2	0.2	0.2	0.2	0.2	0.2		
I_{DD2NSQ}	V_{DDQ}	0.6	0.6	0.6	0.6	0.6	0.6		
I_{DD3P1}	V_{DD1}	3.3	2.8	2.8	3.4	2.9	2.9	mA	
I_{DD3P2H}	V_{DD2H}	25.0	16.0	16.0	25.0	16.0	16.0		
I_{DD3P2L}	V_{DD2L}	0.2	0.2	0.2	0.2	0.2	0.2		
I_{DD3PQ}	V_{DDQ}	0.6	0.6	0.6	0.6	0.6	0.6		
I_{DD3PS1}	V_{DD1}	3.3	2.8	2.8	3.4	2.9	2.9	mA	
$I_{DD3PS2H}$	V_{DD2H}	25.0	16.0	16.0	25.0	16.0	16.0		
$I_{DD3PS2L}$	V_{DD2L}	0.2	0.2	0.2	0.2	0.2	0.2		
I_{DD3PSQ}	V_{DDQ}	0.6	0.6	0.6	0.6	0.6	0.6		
I_{DD3N1}	V_{DD1}	3.6	3.1	3.1	3.6	3.1	3.1	mA	
I_{DD3N2H}	V_{DD2H}	66.5	45.6	45.6	70.0	48.0	48.0		
I_{DD3N2L}	V_{DD2L}	0.2	0.2	0.2	0.2	0.2	0.2		
I_{DD3NQ}	V_{DDQ}	0.6	0.6	0.6	0.6	0.6	0.6		
I_{DD4R1}	V_{DD1}	17.7	17.2	17.2	20.0	19.0	19.0	mA	3, 4, 6
I_{DD4R2H}	V_{DD2H}	315.0	280.0	280.0	495.0	450.0	450.0		
I_{DD4R2L}	V_{DD2L}	0.2	0.2	0.2	0.2	0.2	0.2		
I_{DD4RQ}	V_{DDQ}	60.5	60.5	60.5	121.0	121.0	121.0		

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Table 12: I_{DD} Parameters at 8533 Mb/s – Single Die (Continued)

Symbol	Supply	x8 8533 Mb/s			x16 8533 Mb/s			Unit	Note
		UT	AT	IT	UT	AT	IT		
I_{DD4W1}	V_{DD1}	16.7	16.1	16.1	18.0	17.0	17.0	mA	3, 6
I_{DD4W2H}	V_{DD2H}	230.0	195.0	195.0	335.0	295.0	295.0		
I_{DD4W2L}	V_{DD2L}	0.2	0.2	0.2	0.2	0.2	0.2		
I_{DD4WQ}	V_{DDQ}	0.6	0.6	0.6	0.6	0.6	0.6		
I_{DD51}	V_{DD1}	22.6	21.6	21.6	23.0	22.0	22.0	mA	
I_{DD52H}	V_{DD2H}	210.0	175.0	175.0	210.0	175.0	175.0		
I_{DD52L}	V_{DD2L}	0.2	0.2	0.2	0.2	0.2	0.2		
I_{DD5Q}	V_{DDQ}	0.6	0.6	0.6	0.6	0.6	0.6		
I_{DD5AB1}	V_{DD1}	4.0	3.6	3.6	4.0	3.6	3.6	mA	
$I_{DD5AB2H}$	V_{DD2H}	63.9	47.2	47.2	68.0	48.0	48.0		
$I_{DD5AB2L}$	V_{DD2L}	0.2	0.2	0.2	0.2	0.2	0.2		
I_{DD5ABQ}	V_{DDQ}	0.6	0.6	0.6	0.6	0.6	0.6		
I_{DD5PB1}	V_{DD1}	4.0	3.6	3.6	4.0	3.6	3.6	mA	
$I_{DD5PB2H}$	V_{DD2H}	63.9	47.2	47.2	68.0	48.0	48.0		
$I_{DD5PB2L}$	V_{DD2L}	0.2	0.2	0.2	0.2	0.2	0.2		
I_{DD5PBQ}	V_{DDQ}	0.6	0.6	0.6	0.6	0.6	0.6		

Notes: 1. Published I_{DD} values except I_{DD4RQ} are the maximum I_{DD} values considering the worst-case conditions of process, temperature, and voltage.
2. BG mode enabled. Enhanced DVFSC and DVFSQ disabled.
3. BL = 16, DBI disabled.
4. I_{DD4RQ} value is reference only. Typical value. Output load = 5pF; R_{ON} = 40 ohms; T_C = 25°C
5. V_{DD1} = 1.70–1.95V; V_{DD2H} = 1.01–1.12V; V_{DD2L} = 0.87–0.97V; V_{DDQ} = 0.47–0.57V (DVFSQ disabled)/0.27-0.37V (DVFSQ enabled)
6. IDD4R2 and IDD4W2 have implemented a more stringent pattern than required by JEDEC and therefore these IDD values are slightly higher than if the JEDEC pattern was used.
7. Notes 1, 2, and 5 apply to entire table.

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Table 13: I_{DD} Parameters at 3200 Mb/s – With Enhanced DVFSC Enabled - Single Die

Symbol	Supply	x8 3200 Mb/s			x16 3200 Mb/s			Unit	Note
		UT	AT	IT	UT	AT	IT		
$I_{DD4R-DVFSC1}$	V_{DD1}	9.1	8.1	8.1	10.0	9.0	9.0	mA	3, 4, 6
$I_{DD4R-DVFSC2H}$	V_{DD2H}	40.0	31.0	31.0	42.0	33.0	33.0		
$I_{DD4R-DVFSC2L}$	V_{DD2L}	79.9	70.0	70.0	130.0	115.0	115.0		
$I_{DD4R-DVFSCQ}$	V_{DDQ}	37.4	37.4	37.4	74.7	74.7	74.7		
$I_{DD4W-DVFSC1}$	V_{DD1}	8.6	8.1	8.1	9.0	8.5	8.5	mA	3, 6
$I_{DD4W-DVFSC2H}$	V_{DD2H}	37.0	28.0	28.0	40.0	30.0	30.0		
$I_{DD4W-DVFSC2L}$	V_{DD2L}	67.8	54.0	54.0	105.0	90.0	90.0		
$I_{DD4W-DVFSCQ}$	V_{DDQ}	0.6	0.6	0.6	0.6	0.6	0.6		
I_{DD5ED1}	V_{DD1}	19.6	18.6	18.6	20.0	19.0	19.0	mA	
$I_{DD5ED2H}$	V_{DD2H}	170.0	150.0	150.0	170.0	150.0	150.0		
$I_{DD5ED2L}$	V_{DD2L}	33.0	23.0	23.0	33.0	23.0	23.0		
I_{DD5EDQ}	V_{DDQ}	0.6	0.6	0.6	0.6	0.6	0.6		
$I_{DD5ABED1}$	V_{DD1}	3.8	3.6	3.6	3.8	3.4	3.4	mA	
$I_{DD5ABED2H}$	V_{DD2H}	29.2	23.0	23.0	30.0	23.0	23.0		
$I_{DD5ABED2L}$	V_{DD2L}	26.6	18.7	18.7	3.0.0	22.0	22.0		
$I_{DD5ABEDQ}$	V_{DDQ}	0.6	0.6	0.6	0.6	0.6	0.6		
$I_{DD5PBED1}$	V_{DD1}	3.8	3.6	3.6	3.8	3.4	3.4	mA	
$I_{DD5PBED2H}$	V_{DD2H}	29.2	23.0	23.0	30.0	23.0	23.0		
$I_{DD5PBED2L}$	V_{DD2L}	26.6	18.7	18.7	3.0.0	22.0	22.0		
$I_{DD5PBEDQ}$	V_{DDQ}	0.6	0.6	0.6	0.6	0.6	0.6		

Notes:
1. Published I_{DD} values except I_{DD4RQ} are the maximum I_{DD} values considering the worst-case conditions of process, temperature, and voltage.
2. Enhanced DVFSC enabled, DVFSQ enabled, 3200 Mb/s, 16B mode
3. BL = 16, DBI disabled.
4. I_{DD4RQ} value is reference only. Typical value. Output load = 5pF; R_{ON} = 40 ohms; T_C = 25°C
5. V_{DD1} = 1.70–1.95V; V_{DD2H} = 1.01–1.12V; V_{DD2L} = 0.87–0.97V; V_{DDQ} = 0.47–0.57V (DVFSQ disabled)/0.27-0.37V (DVFSQ enabled)
6. IDD4R2 and IDD4W2 have implemented a more stringent pattern than required by JEDEC and therefore these IDD values are slightly higher than if the JEDEC pattern was used.
7. Notes 1, 2, and 5 apply to entire table.

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Table 14: Full-Array Power-Down Self Refresh Current – Single Die

Temperature	Symbol	Supply	Value	Unit	Notes
25°C	I_{DD61}	V_{DD1}	0.21	mA	
	I_{DD62H}	V_{DD2H}	0.60		
	I_{DD62L}	V_{DD2L}	0.01	uA	4
	I_{DD6Q}	V_{DDQ}	0.03		
	I_{DD6DS1}	V_{DD1}	0.21	mA	
	$I_{DD6DS2H}$	V_{DD2H}	0.60		
	$I_{DD6DS2L}$	V_{DD2L}	0.01	uA	4
	I_{DD6DSQ}	V_{DDQ}	0.03		
45°C	I_{DD61}	V_{DD1}	0.3	mA	
	I_{DD62H}	V_{DD2H}	1.1		
	I_{DD62L}	V_{DD2L}	0.01	uA	4
	I_{DD6Q}	V_{DDQ}	0.03		
	I_{DD6DS1}	V_{DD1}	0.3	mA	
	$I_{DD6DS2H}$	V_{DD2H}	1.1		
	$I_{DD6DS2L}$	V_{DD2L}	0.01	uA	4
	I_{DD6DSQ}	V_{DDQ}	0.03		
65°C	I_{DD61}	V_{DD1}	0.52	mA	
	I_{DD62H}	V_{DD2H}	2.3		
	I_{DD62L}	V_{DD2L}	0.01	uA	4
	I_{DD6Q}	V_{DDQ}	0.03		
	I_{DD6DS1}	V_{DD1}	0.52	mA	
	$I_{DD6DS2H}$	V_{DD2H}	2.3		
	$I_{DD6DS2L}$	V_{DD2L}	0.01	uA	4
	I_{DD6DSQ}	V_{DDQ}	0.03		
85°C	I_{DD61}	V_{DD1}	3.0	mA	
	I_{DD62H}	V_{DD2H}	13.0		
	I_{DD62L}	V_{DD2L}	0.2	mA	4
	I_{DD6Q}	V_{DDQ}	0.6		
	I_{DD6DS1}	V_{DD1}	3.0	mA	
	$I_{DD6DS2H}$	V_{DD2H}	13.0		
	$I_{DD6DS2L}$	V_{DD2L}	0.2	mA	4
	I_{DD6DSQ}	V_{DDQ}	0.6		

Notes: 1. I_{DD6}25/45/65°C is the typical value in the distribution with nominal V_{DD} and a reference-only value. I_{DD6}85°C is the maximum I_{DD} guaranteed value considering the worst-case conditions of process, temperature, and voltage.
2. DVFSC and DVFSQ disabled.
3. V_{DD1} = 1.70–1.95V; V_{DD2H} = 1.01–1.12V; V_{DD2L} = 0.87–0.97V; V_{DDQ} = 0.47–0.57V
4. While entering and exiting self-refresh modes, all defined/used supply rails (V_{DD1}, V_{DD2H}, V_{DD2L}, V_{DDQ}) are required to be at valid levels. After the self-refresh with power down mode entrance commands are completed and ^{t}ESPD timing requirement has been satisfied, the V_{DDQ} power rail may be turned off by the controller.

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Revision History

Rev. G – 05/2025

- Updated package thermal impedance
- Updated Features Page - Automotive section
- Updated Mode Register Settings

Rev. F – 10/2024

- Added "F" MPNs to Part Number List table

Rev. E – 09/2024

- Updated legal status to Production
- Added IDD4W2 and IDD4R2 related note to the datasheet

Rev. D – 05/2024

- Updated Package Thermal Impedance: Changed Package Thermal Resistance to Package Thermal Impedance; Specified Package Thermal impedance values
- Specified preliminary I_{DD} values

Rev. C – 11/2023

- Corrected IDD6 labels which were missing the “DS” for Deep Sleep Mode
- Added clarification to IDD table notes
- Added adjustments to CS_Rx and DQ_Rx mask parameters
- Updated initial IDD limits
- Updated IDD6 Note #4 to align with Core DS description
- Added IDD6 table entries for 45’C and 65’C, and removed auto temp I_{DD6} limits
- Updated General notes to highlight precedence between Core DS and Specific DS
- Updated MR24 to show DFE support bit setting
- Updated MR41 to show DVFSC ODT OP support setting
- Added DRFM support bit definition in MR1
- Remove IDD3NS from IDD tables
- Removed 8B bank arch support tables
- Added details related to extended frequency support for 2:1 16B mode
- Added table for DQ Rx adjustments at 3200Mhz

Rev. B – 09/2023

- Added Package Thermal resistance characteristics table
- Updated the new important notes and warnings file for automotive products
- Updated Note #4 in the IDD6 section, Removing VDD2L as power supply able to be removed.
- Added MR4 to the register definition section along with Note 8 and Note 9, to highlight how refresh rate is defined

Rev. A – 07/2023

- Initial preliminary release

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