315ball FBGA Specification

64Gb LPDDR5X (x32)

PSL5M0D7S-064G

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LPDDR5X SDRAM

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/LPDDR5 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)
  - 16*n*-bit or 32*n*-bit prefetch architecture
  - Bank Architecture: 8-bank (8B) mode, 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
  - 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} = 1.70–1.95V; 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**
  - 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 0.45V[1]/0.30V
- **Array Configuration**
  - 1Gb x 16 (1Gb16 x 1 Die x 1Ch x 1R) — 1G16
  - 1Gb x 32 (1Gb16 x 1 Die x 2Ch x 1R) — 1G32
  - 2Gb x 32 (1Gb16 x 1 Die x 2Ch x 2R) — 2G32
  - 4Gb x 32 (2Gb8 x 2 Die x 2Ch x 2R) — 4G32
  - 1Gb x 64 (1Gb16 x 1 Die x 4Ch x 1R) — 1G64
  - 2Gb x 64 (1Gb16 x 1 Die x 4Ch x 2R) — 2G64
- **Device configuration**
  - 1 die in package (1Gb16 x 1 die) — D1
  - 2 die in package (1Gb16 x 2 die) — D2
  - 4 die in package (1Gb16 x 4 die) — D4
  - 8 die in package (2Gb8 x 8 die) — D8
  - 8 die in package (1Gb16 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)**
  - 6400 Mb/s — -031
- **Operating Temperature:**
  - –25°C ≤ T_C ≤ +85°C
- **Revision**

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

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Part Number Ordering Information

Figure 1: Part Number Chart

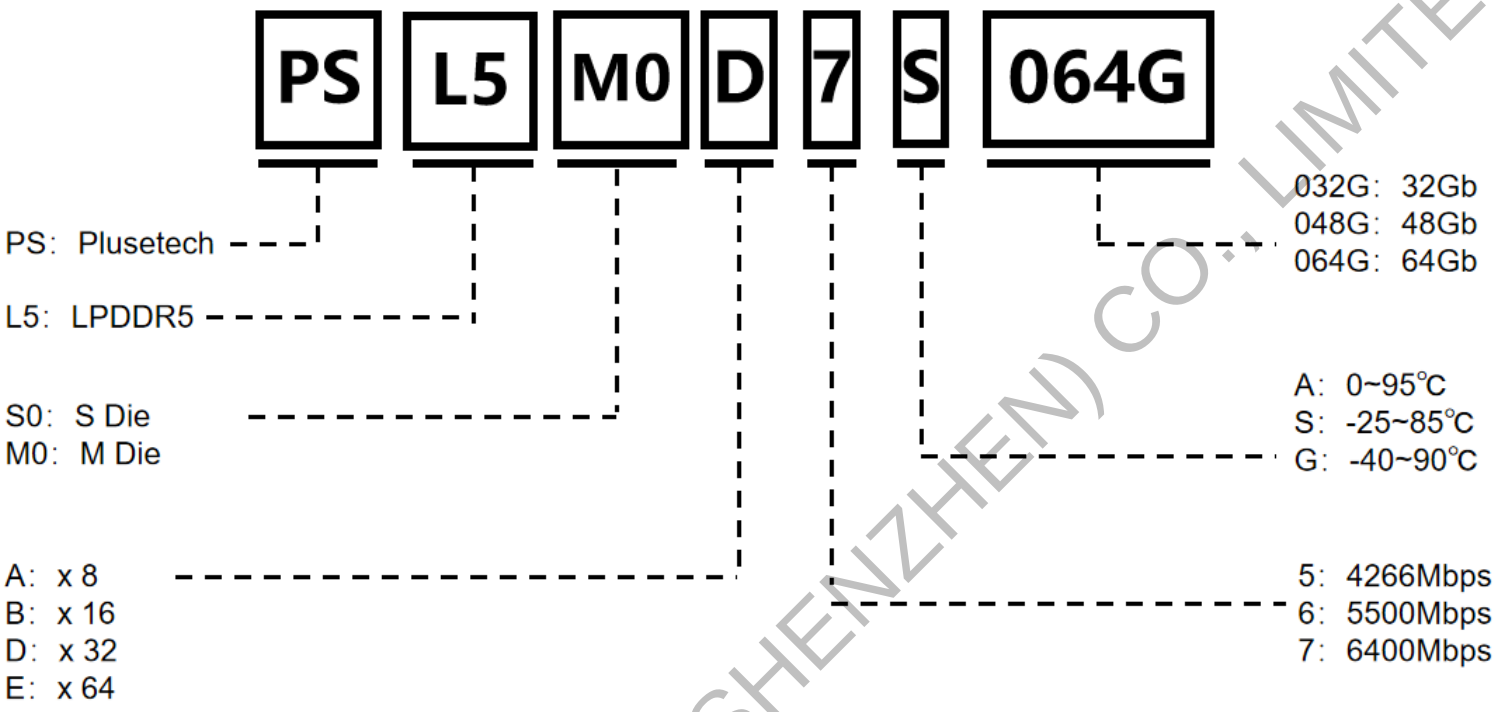


Table 1: Part Number List

Part Number	Total Density
PSL5M0D7S-064G	8GB (64Gb)

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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

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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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Device Configuration

Table 2: Die Organization in the Package (x16)

Die Organization	1G16 (16 Gb/package)
Channel A	x16 mode × 1 die

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

Table 3: Die Organization in the Package (x32)

Die Organization	1G32 (32 Gb/package)	2G32 (64 Gb/package)	4G32 (128 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 4: Die Organization in the Package (x64)

Die Organization	1G64 (64 Gb/package)	2G64 (128 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

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

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Table 5: Die Addressing

Description	1G16 (16 Gb/package), 1G32 (32 Gb/package), 2G32 (64 Gb/package), 1G64 (64 Gb/package), 2G64 (128 Gb/package)			4G32 (128 Gb/package)		
Density per die	16Gb			16Gb		
Bits	17,179,869,184			17,179,869,184		
Bank mode	BG mode	16B mode	8B mode	BG mode	16B mode	8B mode
Configuration	64Mb × 16 DQ × 4 Banks × 4BG	64Mb × 16 DQ × 16 Banks	128Mb × 16 DQ × 8 Banks	128Mb × 8 DQ × 4 Banks × 4BG	128Mb × 8 DQ × 16 Banks	256Mb × 8 DQ × 8 Banks
Number of banks	4	16	8	4	16	8
Number of bank groups	4	1	1	4	1	1
Array prefetch bits	256	256	512	128	128	256
Rows per bank	65,536			131,072		
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]			R[16:0]		
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		

Note: 1. Refer to the SDRAM Addressing section in General LPDDR5/LPDDR5X Specifications 3.

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Refresh Requirement Parameters

Table 6: Refresh Requirement Parameters

Parameter	Symbol	16Gb 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 7: 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. vCSIHL_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 8: 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 8: 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

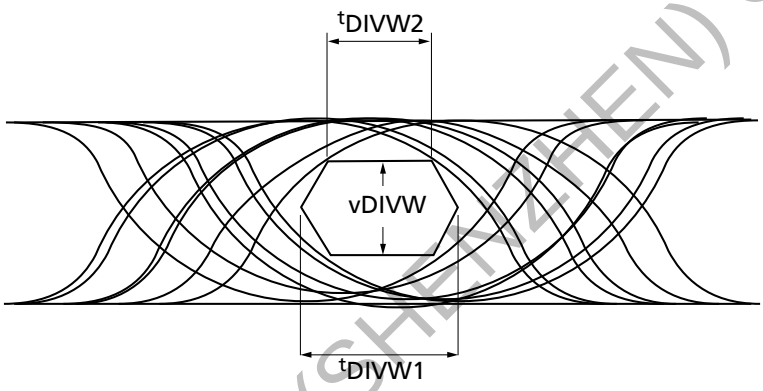
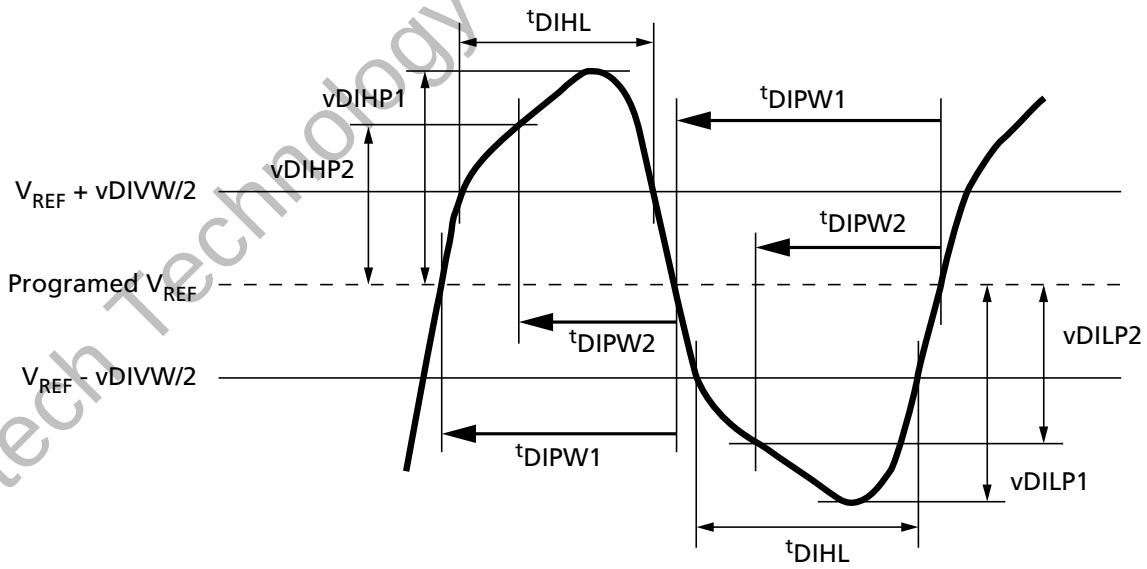


Figure 3: LPDDR5X DQ Single Pulse Definition



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 9: 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.

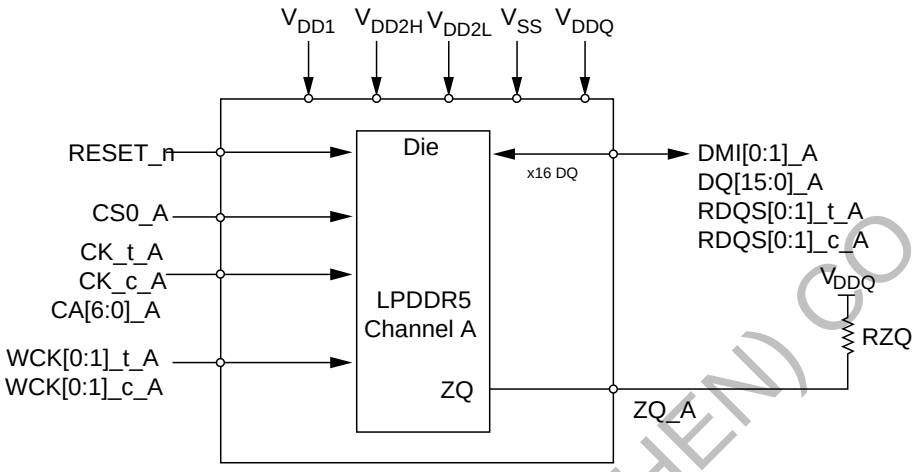
2. Rx mask voltage vDIVW must be centered around $V_{REF(DQ)}$.
3. Mask specifications (^{t}DIVW1, ^{t}DIVW2, and vDIVW) are the same regardless DFE enabled or disabled. DFE co-efficient can be included as part of input waveform amplitude when DFE is enabled.
4. UI = ^{t}WCK/2, programed V_{REF}, is defined as a percentage of MR14/15 code x V_{DDQ}.
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

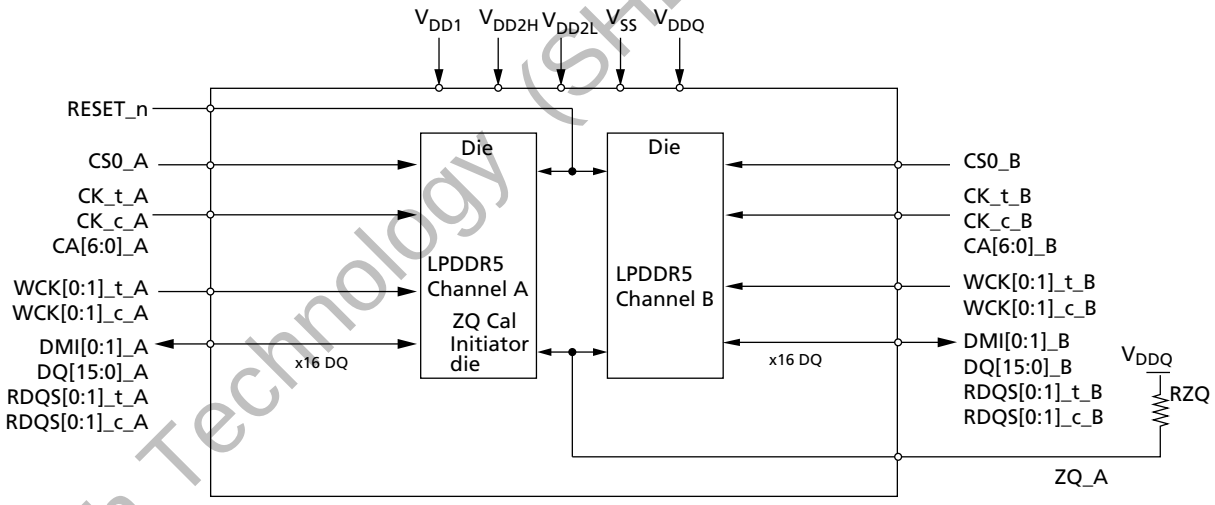
Single Die, Single Channel, Single Rank

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



Dual Die, Dual Channel, Single Rank

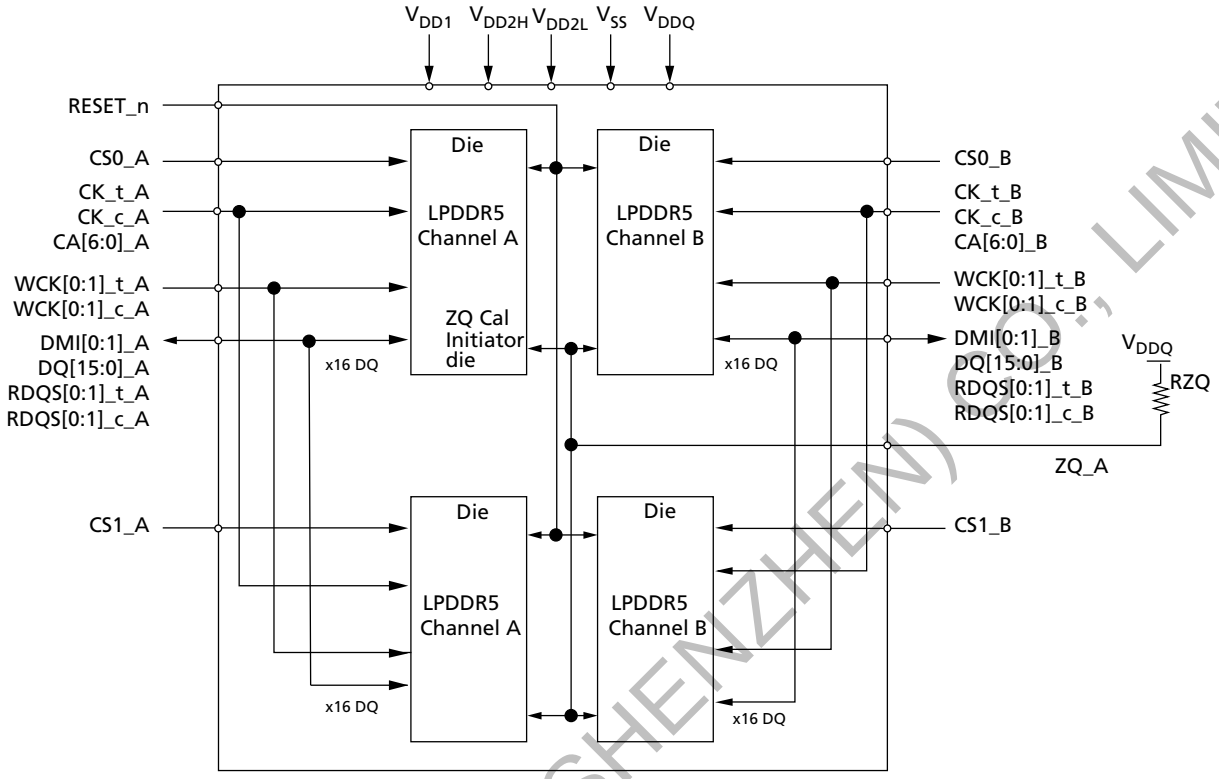
Figure 5: Dual-Die, Dual-Channel, Single-Rank Package Block Diagram



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Quad Die, Dual Channel, Dual Rank

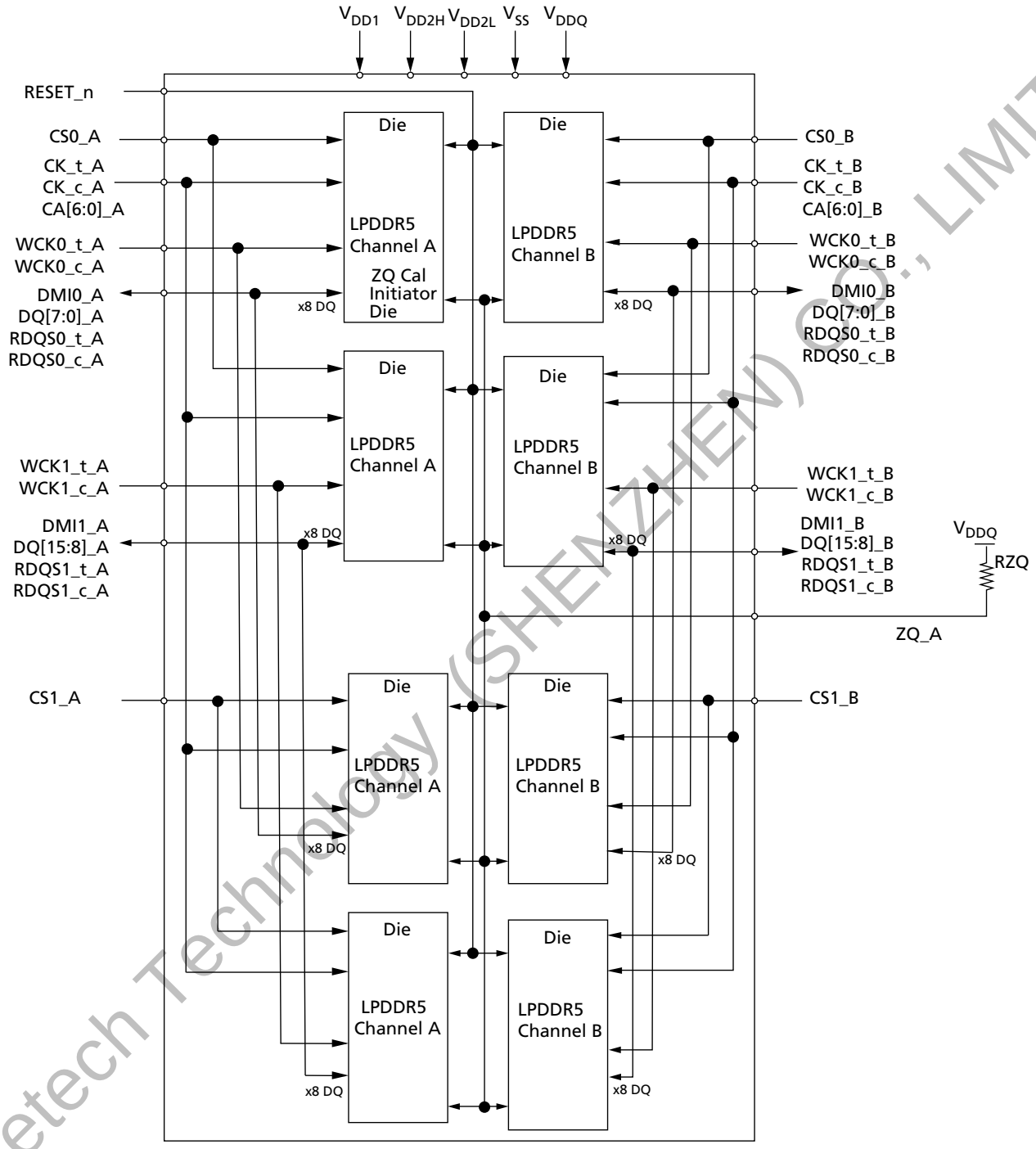
Figure 6: Quad-Die, Dual-Channel, Dual-Rank Package Block Diagram



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Eight Die, Dual Channel, Dual Rank

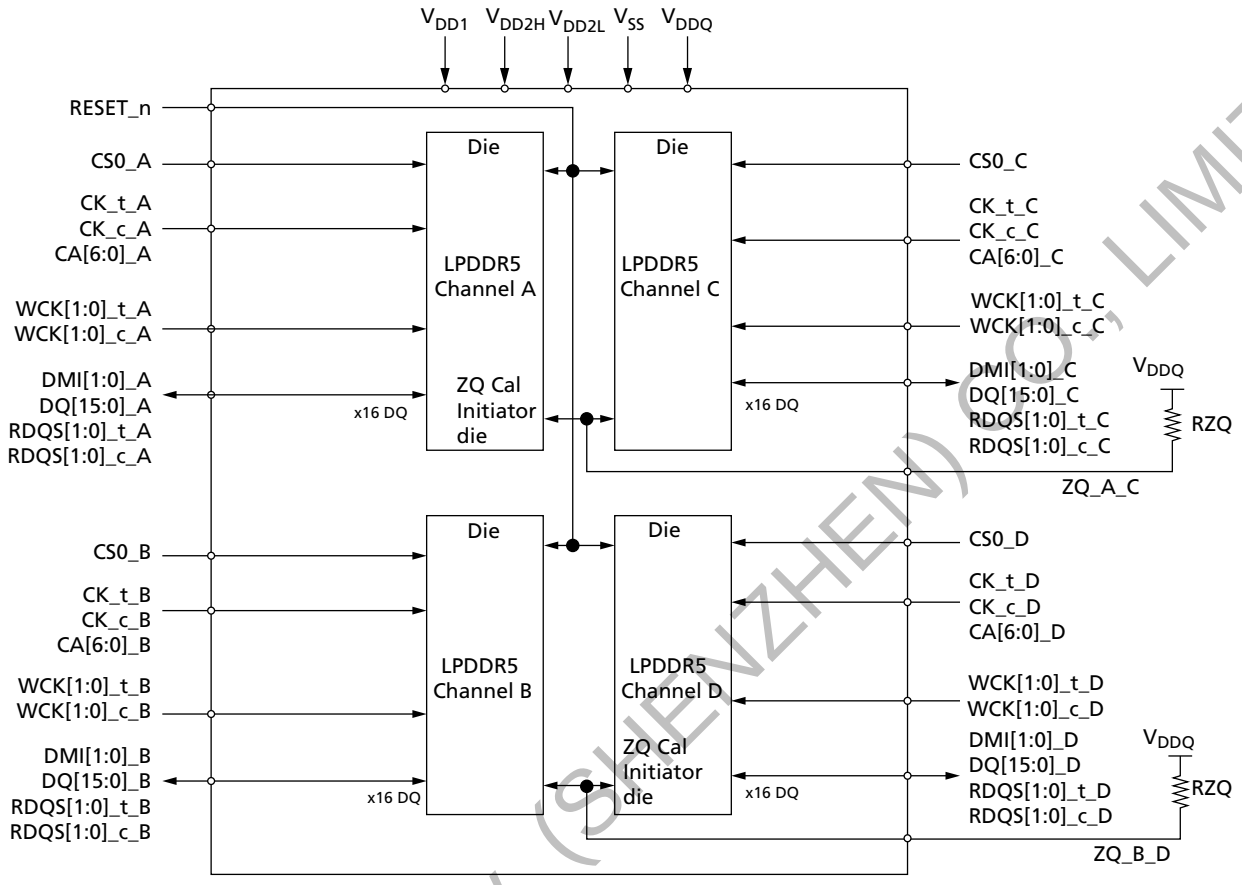
Figure 7: Eight-Die, Dual-Channel, Dual-Rank Package Block Diagram



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Quad-Die, Quad-Channel, Single-Rank

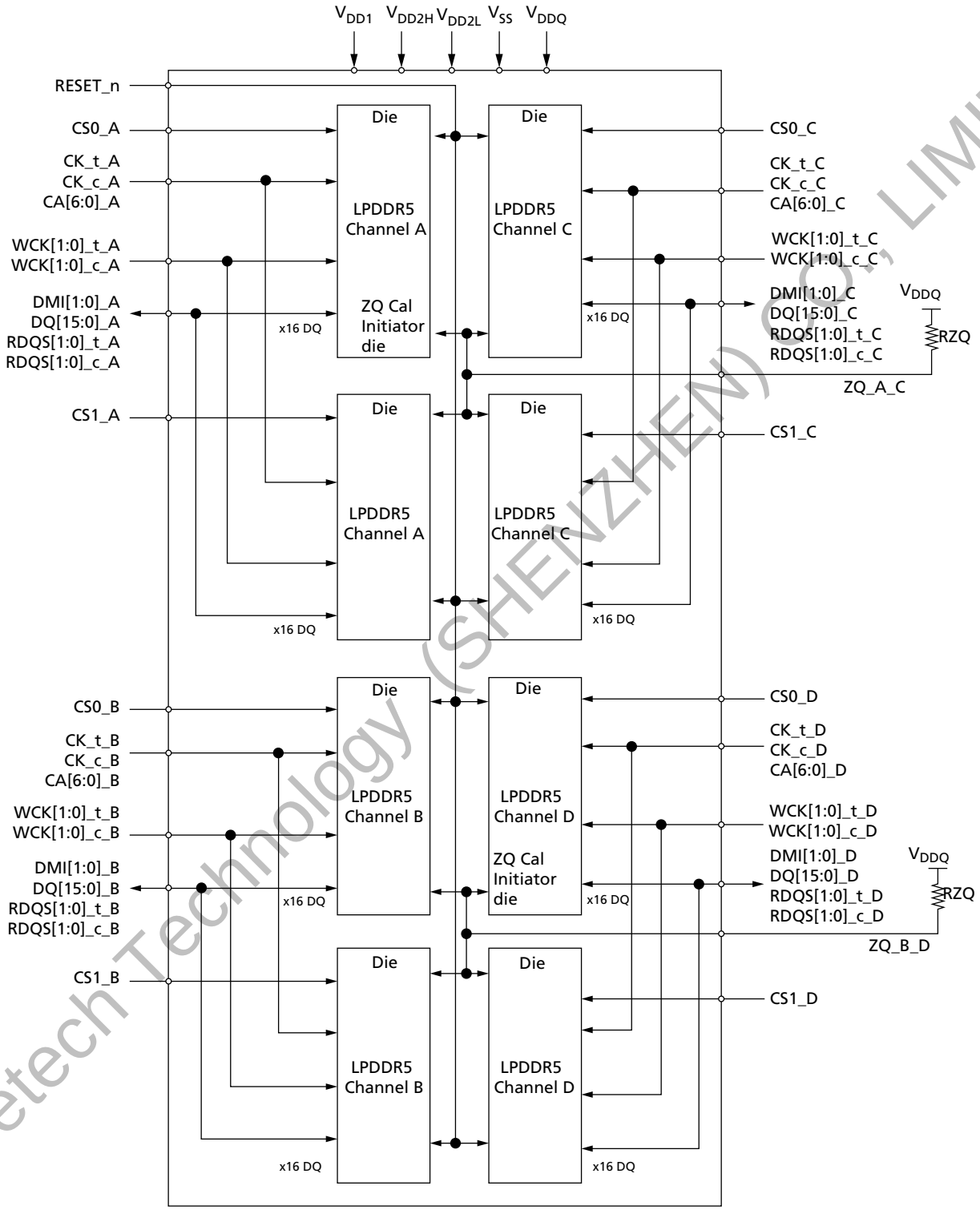
Figure 8: Quad-Die, Quad-Channel, Single-Rank Package Block Diagram



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Eight-Die, Quad-Channel, Dual-Rank

Figure 9: Eight-Die, Quad-Channel, Dual-Rank Package Block Diagram



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Ball Assignments and Descriptions

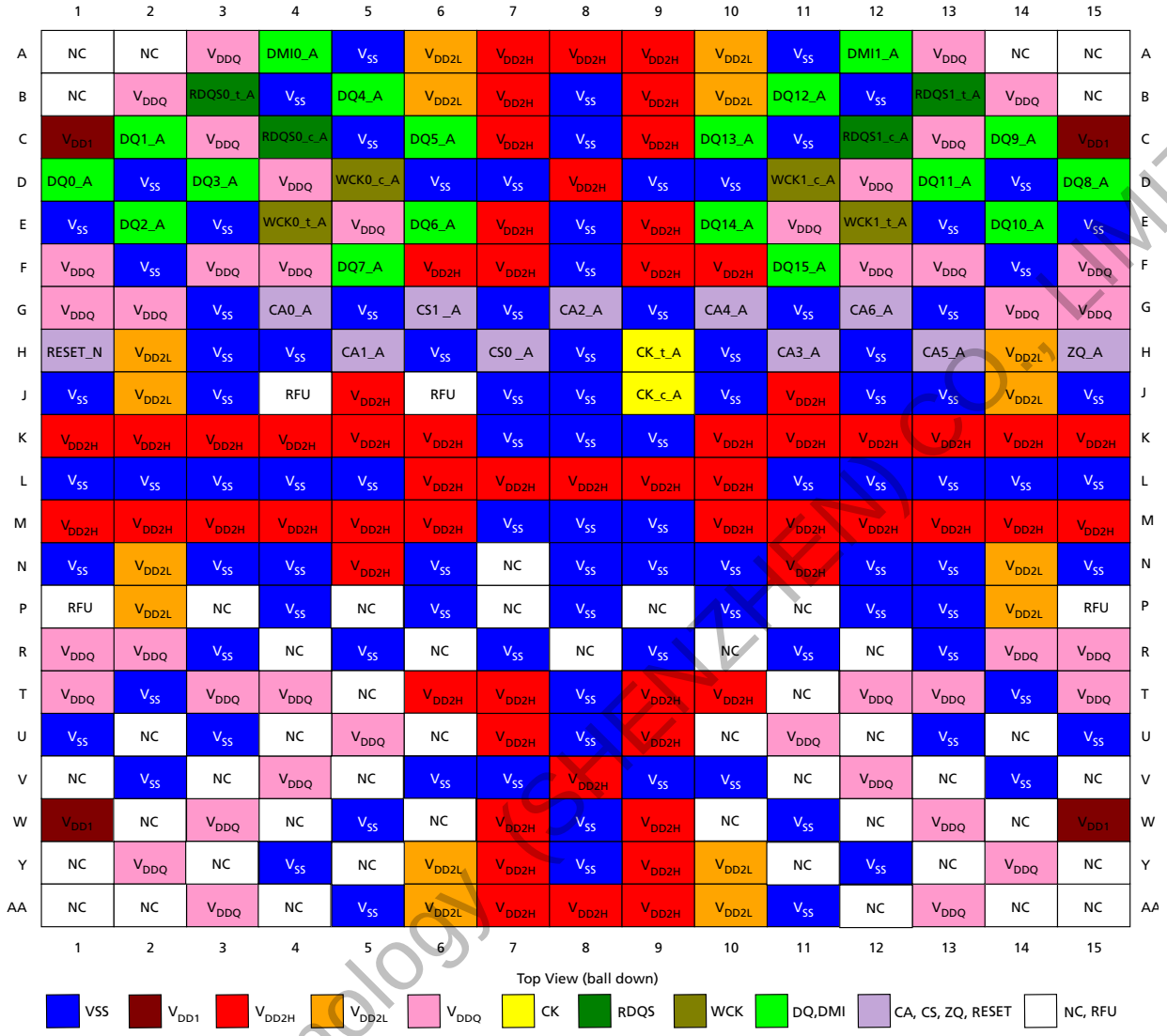
315b Single Die, Single Channel, 1 Rank, 2 Rank

Table 10: Single Channel 315-Ball/Pad Descriptions

Symbol	Type	Description
CK_t_[A], CK_c_[A]	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], CS1_[A]	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]	Input	**Command/address inputs:** Provide the command and address inputs according to the command truth table.
WCK[1:0]_t_[A], WCK[1:0]_c_[A]	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]	I/O	**Data input/output:** Bidirectional data bus.
RDQS[1:0]_t_[A], RDQS[1:0]_c_[A]	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]	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 240Ω±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 10: 315-Ball Single-Channel Discrete FBGA



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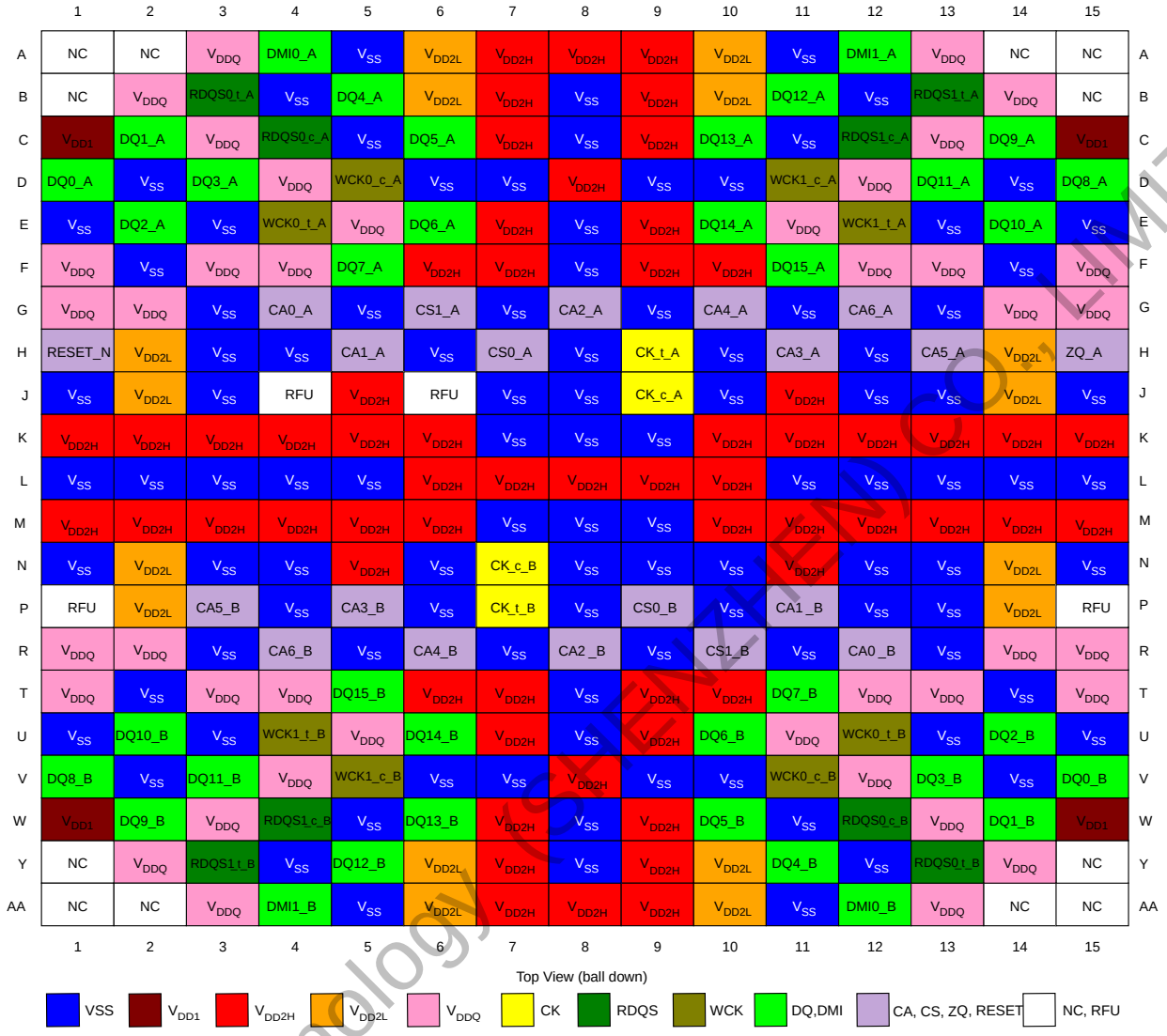
315b Dual Channel, 1 Rank, 2 Rank

Table 11: 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 240Ω±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 11: 315-Ball Dual-Channel Discrete FBGA



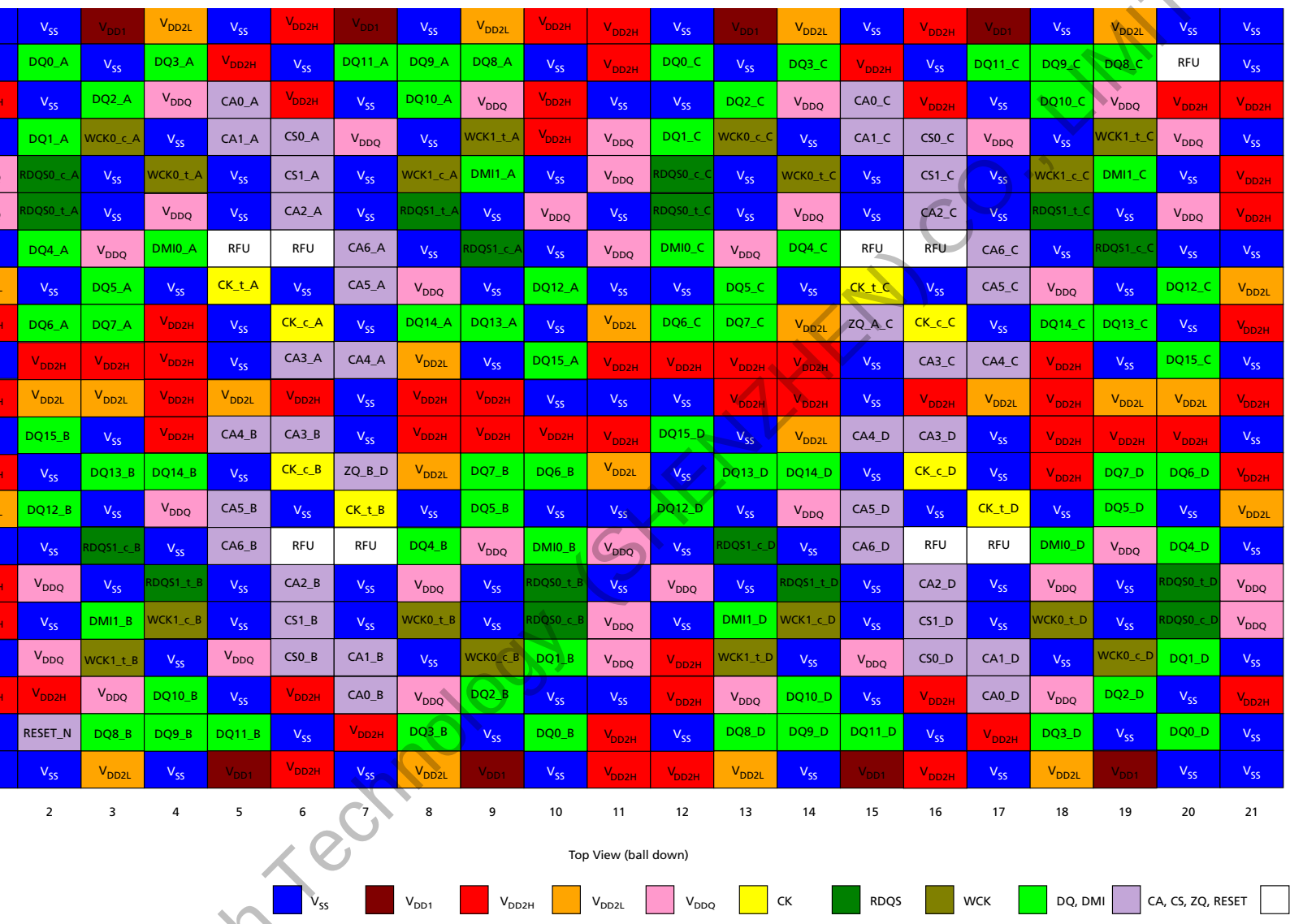
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441-Ball Quad-Channel, 1-Rank, 2-Rank

Table 12: 441-Ball/Pad Descriptions

Symbol	Type	Description
CK_t_[A:D], CK_c_[A:D]	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:D], CS1_[A:D]	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:D] become NC pins in a single-rank package.
CA[6:0]_[A:D]	Input	**Command/address inputs:** 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	**Data clock:** 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	**Data input/output:** Bidirectional data bus.
RDQS[1:0]_t_[A:D], RDQS[1:0]_c_[A:D]	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:D]	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_C, ZQ_B_D	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 240Ω±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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563b Quad Channel, 1 Rank, 2 Rank

Table 13: 563-Ball/Pad Descriptions

Symbol	Type	Description
CK_t_[A:D] CK_c_[A:D]	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:D], CS1_[A:D]	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:D] become NC pins in a single-rank package.
CA[6:0]_[A:D]	Input	**Command/address inputs:** 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	**Data clock:** 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	**Data input/output:** Bidirectional data bus.
RDQS[1:0]_t_[A:D] RDQS[1:0]_c_[A:D]	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:D]	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_C, ZQ_B_D	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 240Ω ±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.

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	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
A	NC	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	NC	NC
B	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{DD2H}	V_{DD2H}	V_{SS}	V_{DD2H}	V_{DD2H}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	NC
C	V_{SS}	DQ0_A	V_{DDQ}	V_{SS}	DMI0_A	DQ5_A	V_{SS}	CS0_A	CS1_A	CA3_A	V_{SS}	DQ13_A	DMI1_A	V_{SS}	V_{DDQ}	DQ8_A	V_{SS}	V_{SS}
D	V_{DD1}	V_{SS}	DQ3_A	WCK0_C_A	V_{DDQ}	V_{SS}	CA0_A	V_{SS}	V_{SS}	V_{SS}	CA6_A	V_{SS}	V_{DDQ}	WCK1_C_A	DQ11_A	V_{SS}	V_{DD1}	V_{SS}
E	V_{DD2H}	DQ1_A	V_{SS}	WCK0_T_A	V_{SS}	DQ6_A	V_{DDQ}	CA1_A	CK_T_A	CA4_A	V_{DDQ}	DQ14_A	V_{SS}	WCK1_T_A	V_{SS}	DQ9_A	V_{DD2H}	V_{SS}
F	V_{SS}	V_{DDQ}	RDQS0_T_A	V_{DD2H}	DQ4_A	V_{DDQ}	V_{SS}	V_{SS}	CK_C_A	V_{SS}	V_{SS}	V_{DDQ}	DQ12_A	V_{DD2H}	RDQS1_T_A	V_{DDQ}	V_{SS}	V_{SS}
G	V_{DD2L}	DQ2_A	RDQS0_C_A	V_{SS}	V_{DD2H}	DQ7_A	V_{DD2H}	CA2_A	V_{DD2L}	CA5_A	V_{DD2H}	DQ15_A	V_{DD2H}	V_{SS}	RDQS1_C_A	DQ10_A	ZQ_A_C	V_{SS}
H	V_{DD2H}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{DD2L}	V_{SS}
J	V_{DD2L}	DQ2_C	RDQS0_C_C	V_{SS}	V_{DD2H}	DQ7_C	V_{DD2H}	CA2_C	V_{DD2L}	CA5_C	V_{DD2H}	DQ15_C	V_{DD2H}	V_{SS}	RDQS1_C_C	DQ10_C	RESET_N	V_{SS}
K	V_{SS}	V_{DDQ}	RDQS0_T_C	V_{DD2H}	DQ4_C	V_{DDQ}	V_{SS}	V_{SS}	CK_C_C	V_{SS}	V_{SS}	V_{DDQ}	DQ12_C	V_{DD2H}	RDQS1_T_C	V_{DDQ}	V_{SS}	V_{SS}
L	V_{DD2H}	DQ1_C	V_{SS}	WCK0_T_C	V_{SS}	DQ6_C	V_{DDQ}	CA1_C	CK_T_C	CA4_C	V_{DDQ}	DQ14_C	V_{SS}	WCK1_T_C	V_{SS}	DQ9_C	V_{DD2H}	V_{SS}
M	V_{SS}	V_{SS}	DQ3_C	WCK0_C_C	V_{DDQ}	V_{SS}	CA0_C	V_{SS}	V_{SS}	V_{SS}	CA6_C	V_{SS}	V_{DDQ}	WCK1_C_C	DQ11_C	V_{SS}	VSS	V_{SS}
N	V_{DD1}	DQ0_C	V_{DDQ}	V_{SS}	DMI0_C	DQ5_C	V_{SS}	CS0_C	CS1_C	CA3_C	V_{SS}	DQ13_C	DMI1_C	V_{SS}	V_{DDQ}	DQ8_C	V_{DD1}	V_{SS}
P	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{DD2H}	V_{DD2H}	V_{SS}	V_{DD2H}	V_{DD2H}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}
R	V_{SS}				V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}
T	V_{SS}				V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}
U	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{DD2H}	V_{DD2H}	V_{SS}	V_{DD2H}	V_{DD2H}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}
V	V_{DD1}	DQ8_D	V_{DDQ}	V_{SS}	DMI1_D	DQ13_D	V_{SS}	CA3_D	CS1_D	CS0_D	V_{SS}	DQ5_D	DMI0_D	V_{SS}	V_{DDQ}	DQ0_D	V_{DD1}	V_{SS}
W	V_{SS}	V_{SS}	DQ11_D	WCK1_C_D	V_{DDQ}	V_{SS}	CA6_D	V_{SS}	V_{SS}	V_{SS}	CA0_D	V_{SS}	V_{DDQ}	WCK0_C_D	DQ3_D	V_{SS}	V_{SS}	V_{SS}
Y	V_{DD2H}	DQ9_D	V_{SS}	WCK1_T_D	V_{SS}	DQ14_D	V_{DDQ}	CA4_D	CK_T_D	CA1_D	V_{DDQ}	DQ6_D	V_{SS}	WCK0_T_D	V_{SS}	DQ1_D	V_{DD2H}	V_{SS}
AA	V_{SS}	V_{DDQ}	RDQS1_T_D	V_{DD2H}	DQ12_D	V_{DDQ}	V_{SS}	V_{SS}	CK_C_D	V_{SS}	V_{SS}	V_{DDQ}	DQ4_D	V_{DD2H}	RDQS0_T_D	V_{DDQ}	V_{SS}	V_{SS}
AB	V_{DD2L}	DQ10_D	RDQS1_C_D	V_{SS}	V_{DD2H}	DQ15_D	V_{DD2H}	CA5_D	V_{DD2L}	CA2_D	V_{DD2H}	DQ7_D	V_{DD2H}	V_{SS}	RDQS0_C_D	DQ2_D	V_{SS}	V_{SS}
AC	V_{DD2H}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{DD2L}	V_{SS}
AD	V_{DD2L}	DQ10_B	RDQS1_C_B	V_{SS}	V_{DD2H}	DQ15_B	V_{DD2H}	CA5_B	V_{DD2L}	CA2_B	V_{DD2H}	DQ7_B	V_{DD2H}	V_{SS}	RDQS0_C_B	DQ2_B	ZQ_B_D	V_{SS}
AE	V_{SS}	V_{DDQ}	RDQS1_T_B	V_{DD2H}	DQ12_B	V_{DDQ}	V_{SS}	V_{SS}	CK_C_B	V_{SS}	V_{SS}	V_{DDQ}	DQ4_B	V_{DD2H}	RDQS0_T_B	V_{DDQ}	V_{SS}	V_{SS}
AF	V_{DD2H}	DQ9_B	V_{SS}	WCK1_T_B	V_{SS}	DQ14_B	V_{DDQ}	CA4_B	CK_T_B	CA1_B	V_{DDQ}	DQ6_B	V_{SS}	WCK0_T_B	V_{SS}	DQ1_B	V_{DD2H}	V_{SS}
AG	V_{DD1}	V_{SS}	DQ11_B	WCK1_C_B	V_{DDQ}	V_{SS}	CA6_B	V_{SS}	V_{SS}	V_{SS}	CA0_B	V_{SS}	V_{DDQ}	WCK0_C_B	DQ3_B	V_{SS}	V_{DD1}	V_{SS}
AH	V_{SS}	DQ8_B	V_{DDQ}	V_{SS}	DMI1_B	DQ13_B	V_{SS}	CA3_B	CS1_B	CS0_B	V_{SS}	DQ5_B	DMI0_B	V_{SS}	V_{DDQ}	DQ0_B	V_{SS}	V_{SS}
AJ	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{DD2H}	V_{DD2H}	V_{SS}	V_{DD2H}	V_{DD2H}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	NC
AK	NC	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	V_{SS}	NC	NC

Top View (ball down)

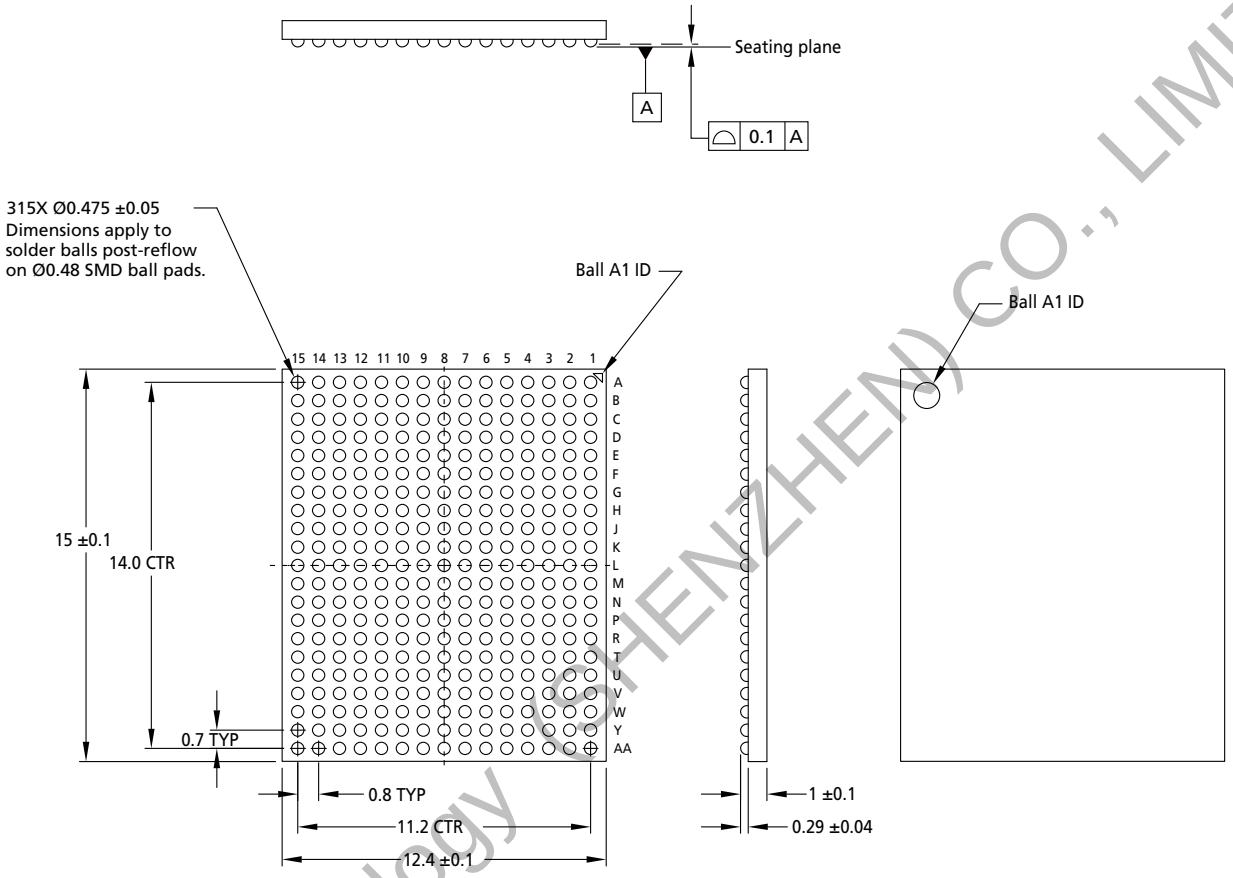
V_{SS} V_{DD1} V_{DD2H} V_{DD2HQ} V_{DD2L} V_{DDQ} CK DQS, RDQS DQ, DMI WCK CA, CS, ZQ, RESET NC, RFU, DNU

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Package Dimensions

315-Ball Package (Package Code: DS)

Figure 14: 315-Ball TFBGA – 12.4mm (TYP) × 15.0mm (TYP) × 1.1mm (MAX) (Package Code: DS)

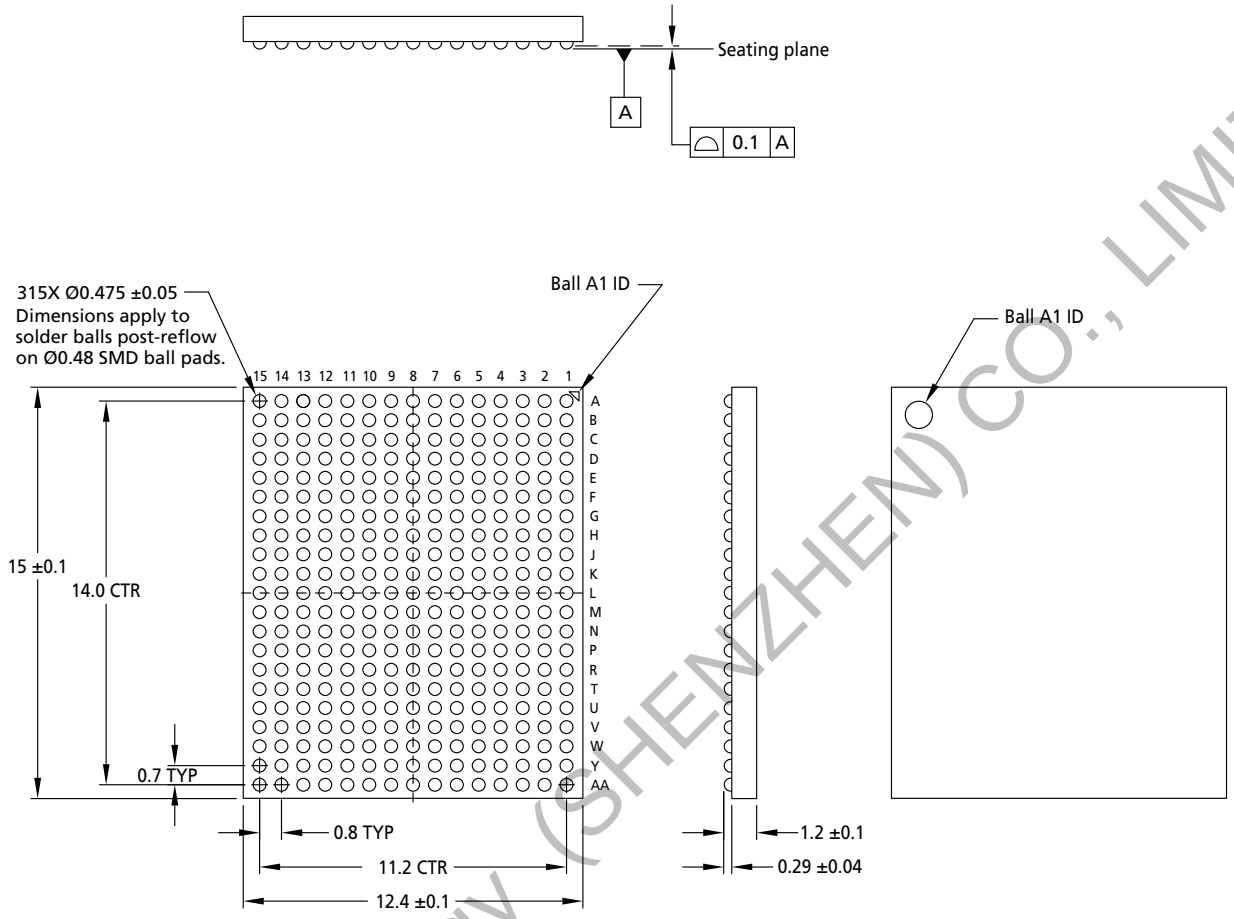


Notes: 1. All dimensions are in millimeters.
2. Solder ball composition: SACQ with CuOSP pads (Sn-4Ag-0.5Cu-3Bi-0.05Ni)

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315-Ball Package (Package Code: DV)

Figure 15: 315-Ball LFBGA – 12.4mm (TYP) × 15.0mm (TYP) × 1.3mm (MAX) (Package Code: DV)

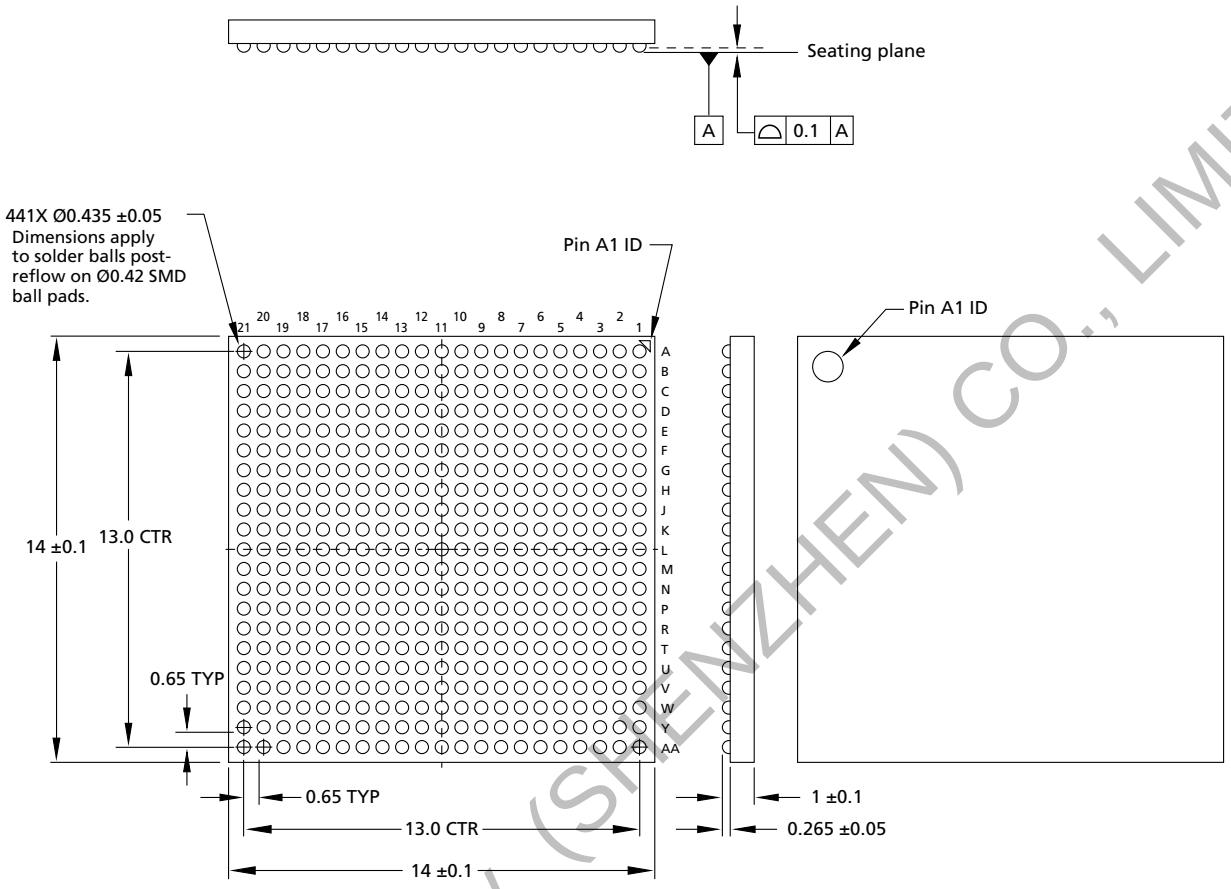


Notes: 1. All dimensions are in millimeters.
2. Solder ball composition: SACQ with CuOSP pads (Sn-4Ag-0.5Cu-3Bi-0.05Ni)

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441-Ball Package (Package Code: EK)

Figure 16: 441-Ball TFBGA – 14.0mm (TYP) x 14.0mm (TYP) x 1.1mm (MAX) (Package Code: EK)

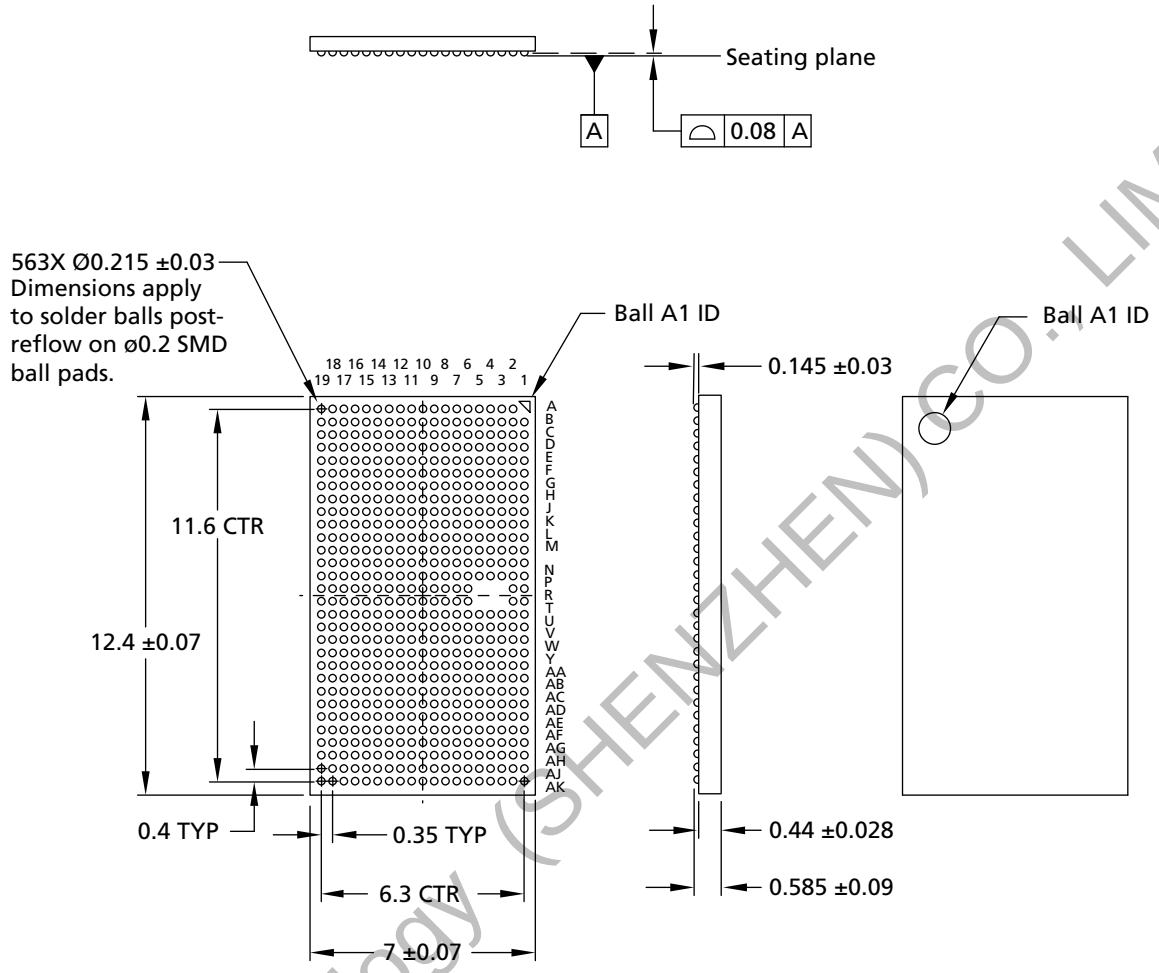


Notes: 1. All dimensions are in millimeters.
2. Solder ball composition: SACQ with CuOSP pads (Sn-4Ag-0.5Cu-3Bi-0.05Ni).

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563-Ball Package (Package Code: AH)

Figure 17: 563-Ball WFBGA – 7.0mm (TYP) x 12.4mm (TYP) x 0.675mm (MAX) (Package Code: AH)

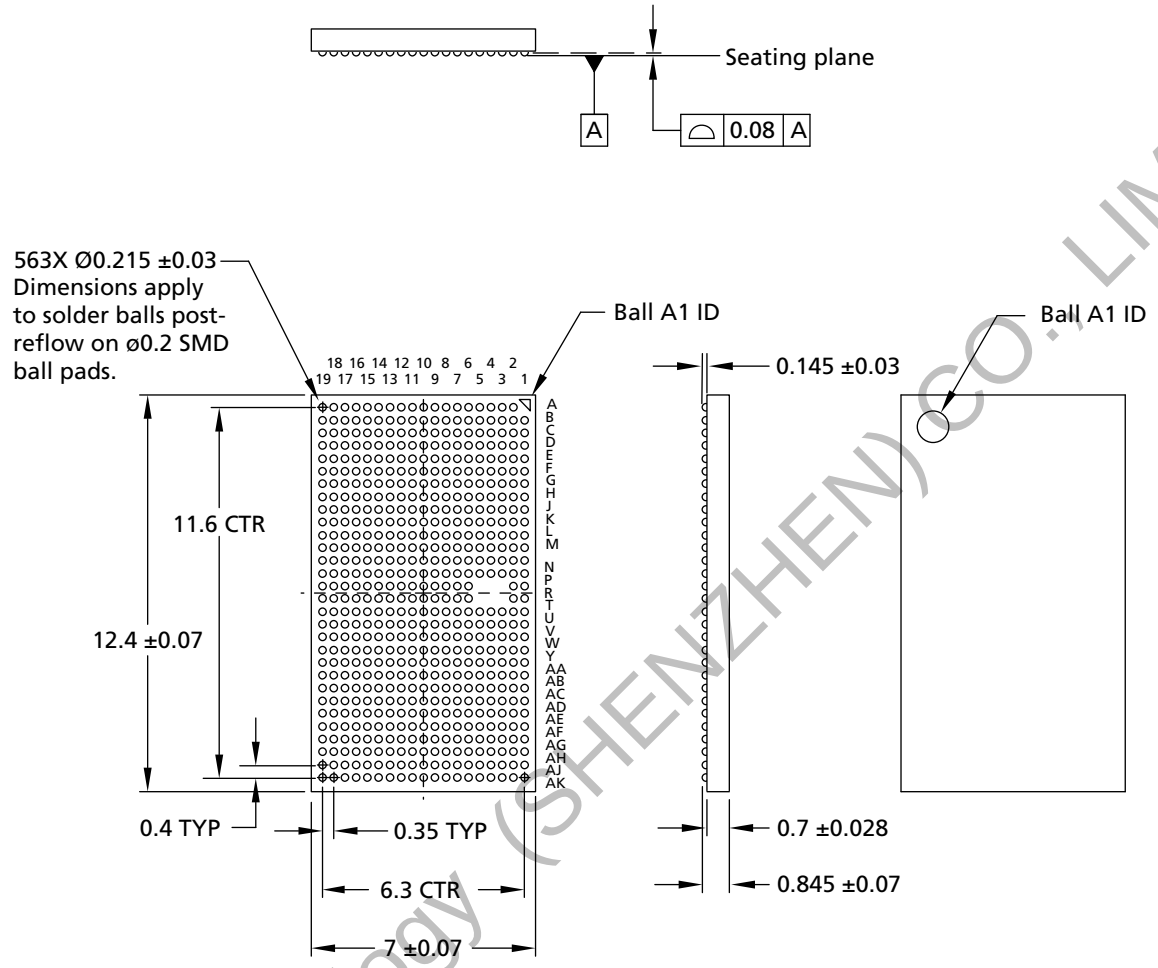


Notes: 1. All dimensions are in millimeters.
2. Solder ball composition: SAC302 with Ni/Au pads (Sn-3Ag-0.2Cu).

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563-Ball Package (Package Code: AJ)

Figure 18: 563-Ball VFBGA – 7.0mm (TYP) x 12.4mm (TYP) x 0.915mm (MAX) (Package Code: AJ)



Notes: 1. All dimensions are in millimeters.
2. Solder ball composition: SAC302 with Ni/Au pads (Sn-3Ag-0.2Cu).

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Package Thermal Impedance

Table 14: Package Thermal Impedance Characteristics

Die Revision	Package	Parameter	Symbol	Value	Unit
Rev B	315-ball, SDP, package code DS	Junction-to-case (TOP)	Θ_{JC}	3.5	°C/W
		Junction-to-board	Θ_{JB}	11.6	°C/W
	315-ball, DDP, package code DS	Junction-to-case (TOP)	Θ_{JC}	3.4	°C/W
		Junction-to-board	Θ_{JB}	11.1	°C/W
	315-ball, QDP, package code DS	Junction-to-case (TOP)	Θ_{JC}	2.7	°C/W
		Junction-to-board	Θ_{JB}	11.7	°C/W
	315-ball, 8DP, package code DV	Junction-to-case (TOP)	Θ_{JC}	2.3	°C/W
		Junction-to-board	Θ_{JB}	12.4	°C/W
	441-ball, QDP, package code EK	Junction-to-case (TOP)	Θ_{JC}	2.1	°C/W
		Junction-to-board	Θ_{JB}	7.8	°C/W
	441-ball, 8DP, package code EK	Junction-to-case (TOP)	Θ_{JC}	1.6	°C/W
		Junction-to-board	Θ_{JB}	7.5	°C/W
	563-ball, QDP, package code AH	Junction-to-case (TOP)	Θ_{JC}	3.3	°C/W
		Junction-to-board	Θ_{JB}	9.1	°C/W
	563-ball, 8DP, package code AJ	Junction-to-case (TOP)	Θ_{JC}	4.1	°C/W
		Junction-to-board	Θ_{JB}	10.1	°C/W

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Product-Specific Mode Register Definition

Table 15: 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 1G16, 1G32, 2G32, 1G64, 2G64 OP[1] = 1b: Device supports x8 mode latency for 4G32							
	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						**DRFM support[3]**	**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 supports DRFM							
MR3				**BK/BG Org**				
	OP[4:3] = 00b: BG, 01b: 8B, 10b: 16B Mode Supported							
MR4				**Refresh Multiplier** (Note 6)				
	OP[4:0]: Refer to General LPDDR5/LPDDR5X Specification 1 for mode register definitions.							
MR5	**Manufacturer ID**							
	1111 1111b: Micron							
MR6	**Revision ID1**							
	0000 0111b							
MR8	**I/O width**		**Density**				**Type**	
	OP[7:6] = 00b: x16 for 1G16, 1G32, 2G32, 1G64, 2G64 OP[7:6] = 01b: x8 for 4G32		OP[5:2] = 0110b: 16Gb				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 15: 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] = 01110b: 112							
	OP[7:6] = 01b: 4X							
MR41					**E-DVFSC ODT OP support**	**DVFSC/E-DVFSC Support**		
	OP[2:1] = 00b: Only Legacy DVFSC Mode supported							
	OP[3] = 0b: Enhanced DVFSC ODT OP not supported							
MR43		**SBEC rule**						
	OP[6] = 1b: Simultaneous SBE on each DQ byte and DMI are independently counted							
MR57	**ARFM[3]**				**RFMSB**		**RAADEC**	
	OP[1:0] = 10b: 2 × RAAIMT							
	OP[3:2] = 00b: 1 = Does not support single-bank mode							
	OP[7:6] = 00b: default (01110b: 112), 01b: Level A = 01101b: 104, Level B = 01100b: 96, Level C = 01011: 88							
MR63 - MR164	Reserved MR bits MR63 through MR164 are RFU by JEDEC standard and should not be accessed by user unless directed by supplier.							

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 3-step DFE.
6. 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

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operating temperature, places ownership and responsibility of the correct operating temperature on the system developer or end user.

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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 16: WT I_{DD} Parameters – Single Die

Symbol	Supply	Speed Grade				Unit	Note
		x8 Mode		x16 Mode			
		7500 Mb/s	8533 Mb/s	7500 Mb/s	8533 Mb/s		
I_{DD01}	V_{DD1}	3.20	3.20	3.20	3.20	mA	
I_{DD02H}	V_{DD2H}	28.50	28.50	29.00	29.00		
I_{DD02L}	V_{DD2L}	0.20	0.20	0.20	0.20		
I_{DD0Q}	V_{DDQ}	0.60	0.60	0.60	0.60		
I_{DD2P1}	V_{DD1}	1.50	1.50	1.50	1.50	mA	
I_{DD2P2H}	V_{DD2H}	2.50	2.50	2.50	2.50		
I_{DD2P2L}	V_{DD2L}	0.20	0.20	0.20	0.20		
I_{DD2PQ}	V_{DDQ}	0.60	0.60	0.60	0.60		
I_{DD2PS1}	V_{DD1}	1.50	1.50	1.50	1.50	mA	
$I_{DD2PS2H}$	V_{DD2H}	2.50	2.50	2.50	2.50		
$I_{DD2PS2L}$	V_{DD2L}	0.20	0.20	0.20	0.20		
I_{DD2PSQ}	V_{DDQ}	0.60	0.60	0.60	0.60		
I_{DD2N1}	V_{DD1}	1.50	1.50	1.50	1.50	mA	
I_{DD2N2H}	V_{DD2H}	16.50	16.50	17.00	17.00		
I_{DD2N2L}	V_{DD2L}	0.20	0.20	0.20	0.20		
I_{DD2NQ}	V_{DDQ}	0.60	0.60	0.60	0.60		
I_{DD2NS1}	V_{DD1}	1.50	1.50	1.50	1.50	mA	
$I_{DD2NS2H}$	V_{DD2H}	16.50	16.50	17.00	17.00		
$I_{DD2NS2L}$	V_{DD2L}	0.20	0.20	0.20	0.20		
I_{DD2NSQ}	V_{DDQ}	0.60	0.60	0.60	0.60		
I_{DD3P1}	V_{DD1}	1.50	1.50	1.50	1.50	mA	
I_{DD3P2H}	V_{DD2H}	6.50	6.50	6.50	6.50		
I_{DD3P2L}	V_{DD2L}	0.20	0.20	0.20	0.20		
I_{DD3PQ}	V_{DDQ}	0.60	0.60	0.60	0.60		
I_{DD3PS1}	V_{DD1}	1.50	1.50	1.50	1.50	mA	
$I_{DD3PS2H}$	V_{DD2H}	6.50	6.50	6.50	6.50		
$I_{DD3PS2L}$	V_{DD2L}	0.20	0.20	0.20	0.20		
I_{DD3PSQ}	V_{DDQ}	0.60	0.60	0.60	0.60		
I_{DD3N1}	V_{DD1}	1.80	1.80	1.80	1.80	mA	
I_{DD3N2H}	V_{DD2H}	20.50	20.50	21.00	21.00		
I_{DD3N2L}	V_{DD2L}	0.20	0.20	0.20	0.20		
I_{DD3NQ}	V_{DDQ}	0.60	0.60	0.60	0.60		

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Table 16: WT I_{DD} Parameters – Single Die (Continued)

Symbol	Supply	Speed Grade				Unit	Note
		x8 Mode		x16 Mode			
		7500 Mb/s	8533 Mb/s	7500 Mb/s	8533 Mb/s		
I_{DD4R1}	V_{DD1}	9.00	9.00	11.00	12.00	mA	3, 4
I_{DD4R2H}	V_{DD2H}	295.00	325.00	435.00	485.00		
I_{DD4R2L}	V_{DD2L}	0.20	0.20	0.20	0.20		
I_{DD4RQ}	V_{DDQ}	58.00	63.00	116.00	126.00		
I_{DD4W1}	V_{DD1}	8.00	9.00	10.00	11.00	mA	3
I_{DD4W2H}	V_{DD2H}	225.00	245.00	305.00	335.00		
I_{DD4W2L}	V_{DD2L}	0.20	0.20	0.20	0.20		
I_{DD4WQ}	V_{DDQ}	0.60	0.60	0.60	0.60		
I_{DD51}	V_{DD1}	23.00	23.00	23.00	23.00	mA	
I_{DD52H}	V_{DD2H}	165.00	165.00	165.00	165.00		
I_{DD52L}	V_{DD2L}	0.20	0.20	0.20	0.20		
I_{DD5Q}	V_{DDQ}	0.60	0.60	0.60	0.60		
I_{DD5AB1}	V_{DD1}	3.20	3.20	3.20	3.20	mA	
$I_{DD5AB2H}$	V_{DD2H}	26.50	26.50	27.00	27.00		
$I_{DD5AB2L}$	V_{DD2L}	0.20	0.20	0.20	0.20		
I_{DD5ABQ}	V_{DDQ}	0.60	0.60	0.60	0.60		
I_{DD5PB1}	V_{DD1}	3.20	3.20	3.20	3.20	mA	
$I_{DD5PB2H}$	V_{DD2H}	26.50	26.50	27.00	27.00		
$I_{DD5PB2L}$	V_{DD2L}	0.20	0.20	0.20	0.20		
I_{DD5PBQ}	V_{DDQ}	0.60	0.60	0.60	0.60		

Notes: 1. Applies to entire table: 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. 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); T_C = –25°C to +85°C
6. Notes 1, 2, and 5 apply to entire table.

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Table 17: WT I_{DD} Parameters – With DVFSC Enabled - Single Die

Symbol	Supply	Speed Grade		Unit	Note
		x8 Mode	x16 Mode		
		1600 Mb/s	1600 Mb/s		
$I_{DD4R-DVFSC1}$	V_{DD1}	–	–	mA	4
$I_{DD4R-DVFSC2H}$	V_{DD2H}	–	–		
$I_{DD4R-DVFSC2L}$	V_{DD2L}	–	–		
$I_{DD4R-DVFSCQ}$	V_{DDQ}	–	–		
$I_{DD4W-DVFSC1}$	V_{DD1}	–	–	mA	
$I_{DD4W-DVFSC2H}$	V_{DD2H}	–	–		
$I_{DD4W-DVFSC2L}$	V_{DD2L}	–	–		
$I_{DD4W-DVFSCQ}$	V_{DDQ}	–	–		

Notes: 1. Applies to entire table: Published I_{DD} values except I_{DD4RQ} are the maximum I_{DD} values considering the worst-case conditions of process, temperature, and voltage.
2. DVFSC enabled, DVFSQ enabled, 1600 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); T_C = –25°C to +85°C
6. Notes 1, 2, 3, and 5 apply to entire table.

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Table 18: WT Full-Array Power-Down Self Refresh Current – Single Die

Temperature	Symbol	Supply	Value	Unit	Notes
25°C	I_{DD61}	V_{DD1}	0.27	mA	
	I_{DD62H}	V_{DD2H}	0.60		
	I_{DD62L}	V_{DD2L}	2.00	uA	4
	I_{DD6Q}	V_{DDQ}	30.00		
	I_{DD6DS1}	V_{DD1}	0.27	mA	
	$I_{DD6DS2H}$	V_{DD2H}	0.60		
	$I_{DD6DS2L}$	V_{DD2L}	2.00	uA	4
	I_{DD6DSQ}	V_{DDQ}	30.00		
45°C	I_{DD61}	V_{DD1}	TBD	mA	
	I_{DD62H}	V_{DD2H}	TBD		
	I_{DD62L}	V_{DD2L}	TBD	uA	4
	I_{DD6Q}	V_{DDQ}	TBD		
	I_{DD6DS1}	V_{DD1}	TBD	mA	
	$I_{DD6DS2H}$	V_{DD2H}	TBD		
	$I_{DD6DS2L}$	V_{DD2L}	TBD	uA	4
	I_{DD6DSQ}	V_{DDQ}	TBD		
65°C	I_{DD61}	V_{DD1}	TBD	mA	
	I_{DD62H}	V_{DD2H}	TBD		
	I_{DD62L}	V_{DD2L}	TBD	uA	4
	I_{DD6Q}	V_{DDQ}	TBD		
	I_{DD6DS1}	V_{DD1}	TBD	mA	
	$I_{DD6DS2H}$	V_{DD2H}	TBD		
	$I_{DD6DS2L}$	V_{DD2L}	TBD	uA	4
	I_{DD6DSQ}	V_{DDQ}	TBD		
85°C	I_{DD61}	V_{DD1}	3.30	mA	
	I_{DD62H}	V_{DD2H}	13.00		
	I_{DD62L}	V_{DD2L}	0.20	mA	4
	I_{DD6Q}	V_{DDQ}	0.60		
	I_{DD6DS1}	V_{DD1}	3.30	mA	
	$I_{DD6DS2H}$	V_{DD2H}	13.00		
	$I_{DD6DS2L}$	V_{DD2L}	0.20	mA	4
	I_{DD6DSQ}	V_{DDQ}	0.60		

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; T_C = –25°C to +85°C
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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Table 19: IT I_{DD} Parameters – Single Die

Symbol	Supply	Speed Grade				Unit	Note
		x8 Mode		x16 Mode			
		7500 Mb/s	8533 Mb/s	7500 Mb/s	8533 Mb/s		
I_{DD01}	V_{DD1}	3.30	3.30	3.30	3.30	mA	
I_{DD02H}	V_{DD2H}	30.50	30.50	31.00	31.00		
I_{DD02L}	V_{DD2L}	0.20	0.20	0.20	0.20		
I_{DD0Q}	V_{DDQ}	0.60	0.60	0.60	0.60		
I_{DD2P1}	V_{DD1}	1.60	1.60	1.60	1.60	mA	
I_{DD2P2H}	V_{DD2H}	2.70	2.70	2.70	2.70		
I_{DD2P2L}	V_{DD2L}	0.20	0.20	0.20	0.20		
I_{DD2PQ}	V_{DDQ}	0.60	0.60	0.60	0.60		
I_{DD2PS1}	V_{DD1}	1.60	1.60	1.60	1.60	mA	
$I_{DD2PS2H}$	V_{DD2H}	2.70	2.70	2.70	2.70		
$I_{DD2PS2L}$	V_{DD2L}	0.20	0.20	0.20	0.20		
I_{DD2PSQ}	V_{DDQ}	0.60	0.60	0.60	0.60		
I_{DD2N1}	V_{DD1}	1.60	1.60	1.60	1.60	mA	
I_{DD2N2H}	V_{DD2H}	17.50	17.50	18.00	18.00		
I_{DD2N2L}	V_{DD2L}	0.20	0.20	0.20	0.20		
I_{DD2NQ}	V_{DDQ}	0.60	0.60	0.60	0.60		
I_{DD2NS1}	V_{DD1}	1.60	1.60	1.60	1.60	mA	
$I_{DD2NS2H}$	V_{DD2H}	17.50	17.50	18.00	18.00		
$I_{DD2NS2L}$	V_{DD2L}	0.20	0.20	0.20	0.20		
I_{DD2NSQ}	V_{DDQ}	0.60	0.60	0.60	0.60		
I_{DD3P1}	V_{DD1}	1.60	1.60	1.60	1.60	mA	
I_{DD3P2H}	V_{DD2H}	7.00	7.00	7.00	7.00		
I_{DD3P2L}	V_{DD2L}	0.20	0.20	0.20	0.20		
I_{DD3PQ}	V_{DDQ}	0.60	0.60	0.60	0.60		
I_{DD3PS1}	V_{DD1}	1.60	1.60	1.60	1.60	mA	
$I_{DD3PS2H}$	V_{DD2H}	7.00	7.00	7.00	7.00		
$I_{DD3PS2L}$	V_{DD2L}	0.20	0.20	0.20	0.20		
I_{DD3PSQ}	V_{DDQ}	0.60	0.60	0.60	0.60		
I_{DD3N1}	V_{DD1}	1.90	1.90	1.90	1.90	mA	
I_{DD3N2H}	V_{DD2H}	22.50	22.50	23.00	23.00		
I_{DD3N2L}	V_{DD2L}	0.20	0.20	0.20	0.20		
I_{DD3NQ}	V_{DDQ}	0.60	0.60	0.60	0.60		
I_{DD4R1}	V_{DD1}	9.00	10.00	11.00	12.00	mA	3, 4
I_{DD4R2H}	V_{DD2H}	300.00	330.00	440.00	490.00		
I_{DD4R2L}	V_{DD2L}	0.20	0.20	0.20	0.20		
I_{DD4RQ}	V_{DDQ}	58.00	63.00	116.00	126.00		

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Table 19: IT I_{DD} Parameters – Single Die (Continued)

Symbol	Supply	Speed Grade				Unit	Note
		x8 Mode		x16 Mode			
		7500 Mb/s	8533 Mb/s	7500 Mb/s	8533 Mb/s		
I_{DD4W1}	V_{DD1}	8.00	9.00	10.00	11.00	mA	3
I_{DD4W2H}	V_{DD2H}	230.00	250.00	310.00	340.00		
I_{DD4W2L}	V_{DD2L}	0.20	0.20	0.20	0.20		
I_{DD4WQ}	V_{DDQ}	0.60	0.60	0.60	0.60		
I_{DD51}	V_{DD1}	23.00	23.00	23.00	23.00	mA	
I_{DD52H}	V_{DD2H}	165.00	165.00	165.00	165.00		
I_{DD52L}	V_{DD2L}	0.20	0.20	0.20	0.20		
I_{DD5Q}	V_{DDQ}	0.60	0.60	0.60	0.60		
I_{DD5AB1}	V_{DD1}	3.20	3.20	3.20	3.20	mA	
$I_{DD5AB2H}$	V_{DD2H}	26.50	26.50	27.00	27.00		
$I_{DD5AB2L}$	V_{DD2L}	0.20	0.20	0.20	0.20		
I_{DD5ABQ}	V_{DDQ}	0.60	0.60	0.60	0.60		
I_{DD5PB1}	V_{DD1}	3.20	3.20	3.20	3.20	mA	
$I_{DD5PB2H}$	V_{DD2H}	26.50	26.50	27.00	27.00		
$I_{DD5PB2L}$	V_{DD2L}	0.20	0.20	0.20	0.20		
I_{DD5PBQ}	V_{DDQ}	0.60	0.60	0.60	0.60		

Notes: 1. Applies to entire table: 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. 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); T_C = –40°C to +95°C
6. Notes 1, 2, and 5 apply to entire table.

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Table 20: IT I_{DD} Parameters – With DVFSC Enable - Single Die

Symbol	Supply	Speed Grade		Unit	Note
		x8 Mode	x16 Mode		
		1600 Mb/s	1600 Mb/s		
$I_{DD4R-DVFSC1}$	V_{DD1}	–	–	mA	4
$I_{DD4R-DVFSC2H}$	V_{DD2H}	–	–		
$I_{DD4R-DVFSC2L}$	V_{DD2L}	–	–		
$I_{DD4R-DVFSCQ}$	V_{DDQ}	–	–		
$I_{DD4W-DVFSC1}$	V_{DD1}	–	–	mA	
$I_{DD4W-DVFSC2H}$	V_{DD2H}	–	–		
$I_{DD4W-DVFSC2L}$	V_{DD2L}	–	–		
$I_{DD4W-DVFSCQ}$	V_{DDQ}	–	–		

Notes: 1. Applies to entire table: Published I_{DD} values except I_{DD4RQ} are the maximum I_{DD} values considering the worst-case conditions of process, temperature, and voltage.
2. DVFSC enabled, DVFSQ enabled, 1600 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); T_C = –40°C to +95°C
6. Notes 1, 2, 3, and 5 apply to entire table.

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Table 21: IT Full-Array Power-Down Self Refresh Current – Single Die

Temperature	Symbol	Supply	Value	Unit	Notes
25°C	I_{DD61}	V_{DD1}	0.27	mA	
	I_{DD62H}	V_{DD2H}	0.60		
	I_{DD62L}	V_{DD2L}	2.00	uA	4
	I_{DD6Q}	V_{DDQ}	30.00		
	I_{DD6DS1}	V_{DD1}	0.27	mA	
	$I_{DD6DS2H}$	V_{DD2H}	0.60		
	$I_{DD6DS2L}$	V_{DD2L}	2.00	uA	4
	I_{DD6DSQ}	V_{DDQ}	30.00		
45°C	I_{DD61}	V_{DD1}	–	mA	
	I_{DD62H}	V_{DD2H}	–		
	I_{DD62L}	V_{DD2L}	–	uA	4
	I_{DD6Q}	V_{DDQ}	–		
	I_{DD6DS1}	V_{DD1}	–	mA	
	$I_{DD6DS2H}$	V_{DD2H}	–		
	$I_{DD6DS2L}$	V_{DD2L}	–	uA	4
	I_{DD6DSQ}	V_{DDQ}	–		
65°C	I_{DD61}	V_{DD1}	–	mA	
	I_{DD62H}	V_{DD2H}	–		
	I_{DD62L}	V_{DD2L}	–	uA	4
	I_{DD6Q}	V_{DDQ}	–		
	I_{DD6DS1}	V_{DD1}	–	mA	
	$I_{DD6DS2H}$	V_{DD2H}	–		
	$I_{DD6DS2L}$	V_{DD2L}	–	uA	4
	I_{DD6DSQ}	V_{DDQ}	–		
85°C	I_{DD61}	V_{DD1}	3.30	mA	
	I_{DD62H}	V_{DD2H}	13.00		
	I_{DD62L}	V_{DD2L}	0.20	mA	4
	I_{DD6Q}	V_{DDQ}	0.60		
	I_{DD6DS1}	V_{DD1}	3.30	mA	
	$I_{DD6DS2H}$	V_{DD2H}	13.00		
	$I_{DD6DS2L}$	V_{DD2L}	0.20	mA	4
	I_{DD6DSQ}	V_{DDQ}	0.60		

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; T_C = –40°C to +95°C
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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