



R1QBA3636CBG / R1QBA3618CBG R1QEA3636CBG / R1QEA3618CBG

36-Mbit DDRII+ SRAM 2-word Burst

R10DS0159EJ0009

Rev. 0.09a
2011.09.14

Description

The R1Q#A3636 is a 1,048,576-word by 36-bit and the R1Q#A3618 is a 2,097,152-word by 18-bit synchronous double data rate static RAM fabricated with advanced CMOS technology using full CMOS six-transistor memory cell. It integrates unique synchronous peripheral circuitry and a burst counter. All input registers are controlled by an input clock pair (K and /K) and are latched on the positive edge of K and /K. These products are suitable for applications which require synchronous operation, high speed, low voltage, high density and wide bit configuration. These products are packaged in 165-pin plastic FBGA package.

= B: Latency =2.5, w/o ODT

= E: Latency =2.5, w/ ODT

Features

■ Power Supply

- 1.8 V for core (V_{DD}), 1.4 V to V_{DD} for I/O (V_{DDQ})

■ Clock

- Fast clock cycle time for high bandwidth
- Two input clocks (K and /K) for precise DDR timing at clock rising edges only
- Two output echo clocks (CQ and /CQ) simplify data capture in high-speed systems
- Clock-stop capability with μ s restart

■ I/O

- Common data input/output bus
- Pipelined double data rate operation
- HSTL I/O
- User programmable output impedance
- DLL/PLL circuitry for wide output data valid window and future frequency scaling
- Data valid pin (QVLD) to indicate valid data on the output

■ Function

- Two-tick burst for low DDR transaction size
- Internally self-timed write control
- Simple control logic for easy depth expansion
- JTAG 1149.1 compatible test access port

■ Package

- 165 FBGA package (15 x 17 x 1.4 mm)

- Notes:
1. QDR RAMs and Quad Data Rate RAMs comprise a new family of products developed by Cypress Semiconductor, IDT, Samsung, and Renesas Electronics Corp. (QDR Co-Development Team)
 2. The specifications of this device are subject to change without notice. Please contact your nearest Renesas Electronics Sales Office regarding specifications.
 3. Refer to "http://www.renesas.com/products/memory/fast_sram/qdr_sram/qdr_sram_root.jsp" for the latest and detailed information.
 4. Descriptions about x9 parts in this datasheet are just for reference.

Part Number Definition

| No. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | - | 12 | 13 | 14 | 15 | 16 |
|---------|---|---|---|---|---|---|---|---|---|---|----|----|---|----|----|----|----|----|
| Example | R | 1 | Q | A | A | 4 | 4 | 3 | 6 | R | B | G | - | 2 | 0 | R | B | 0 |

| No. | - | Comments | No. | - | Comments | No. | - | Comments |
|-----|----------------------|---|-----|-------------------|-----------------------|---------------------|----------------------|---|
| 0-1 | R1 | Renesas Memory Prefix | 4 | A | Vdd = 1.8 V | | | |
| 2-3 | Q2 | QDR II B2 ^[*1] (L15) ^[*2] | 5-6 | 36 | Density = 36Mb | 12-13 | 60 | Frequency = 167MHz |
| | Q3 | QDR II B4 (L15) | | 72 | Density = 72Mb | | 50 | Frequency = 200MHz |
| | Q4 | DDR II B2 (L15) | | 44 | Density = 144Mb | | 40 | Frequency = 250MHz |
| | Q5 | DDR II B4 (L15) | | 88 | Density = 288Mb | | 36 | Frequency = 275MHz |
| | Q6 | DDR II B2 SIO ^[*3] (L15) | 7-8 | 09 | Data width = 9bit | | 33 | Frequency = 300MHz |
| | QA | QDR II+ B4 L25 ^[*2] | | 18 | Data width = 18bit | | 30 | Frequency = 333MHz |
| | QB | DDR II+ B2 L25 | 9 | 36 | Data width = 36bit | | 27 | Frequency = 375MHz |
| | QC | DDR II+ B4 L25 | | R | 1st Generation | | 25 | Frequency = 400MHz |
| | QD | QDR II+ B4 L25 w/ODT ^[*4] | | A | 2nd Generation | | 22 | Frequency = 450MHz |
| | QE | DDR II+ B2 L25 w/ODT | | B | 3rd Generation | | 20 | Frequency = 500MHz |
| | QF | DDR II+ B4 L25 w/ODT | | C | 4th Generation | | 19 | Frequency = 533MHz |
| | QG | QDR II+ B4 L20 | | D | 5th Generation | | 14 | R |
| | QH | DDR II+ B2 L20 | | E | 6th Generation | I | | Industrial temp. Ta range = -40°C~85°C |
| | QJ | DDR II+ B4 L20 | | F | 7th Generation | 15 | | A |
| | QK | QDR II+ B4 L20 w/ODT | BG | PKG= BGA 15x17 mm | B | | | Pb-free and Tray |
| | QL | DDR II+ B2 L20 w/ODT | BA | PKG= BGA 13x15 mm | T | | Pb and Tape&Reel | |
| QM | DDR II+ B4 L20 w/ODT | | | S | Pb-free and Tape&Reel | | | |
| QN | QDR II+ B2 L20 | 10-11 | | | 16 | 0~9, A~Z or None | Renesas internal use | |
| QP | QDR II+ B2 L20 w/ODT | | | | | | | |

Note1: [*1] B=Burst length (B2: Burst length=2, B4: Burst length=4)
 [*2] L=Read Latency (L15: Read Latency = 1.5 cycle, L20: 2.0 cycle, L25: 2.5 cycle)
 [*3] SIO=Separate I/O
 [*4] ODT=On die termination

Note2: Package Marking Name
 Pb parts: Marking Name = Part Number (0-14)
 Pb-free parts: Marking Name = Part Number (0-14) + "PB-F"
 (Example) R1QAA4436RBG-20R ----- Pb parts
 R1QAA4436RBG-20R PB-F ----- Pb-free parts

Note3: Pb : RoHS Compliance Level = 5/6
 Pb-free: RoHS Compliance Level = 6/6

36M QDR II+ / DDR II+ SRAM Lineup

- Renesas supports or plans to support the parts listed below.

| No | Product Type | Burst Length | Latency (Cycle) | ODT | Organi- zation | Frequency (max) (MHz) | QDR II+ / DDR II+ | | | | | | QDR II / DDR II | | | | |
|--------------------|--------------|--------------|-----------------|-----|----------------|-----------------------|-----------------------|-----|-----|-----|-----|-----|-----------------|------|------|------|------|
| | | | | | | | 533 | 500 | 450 | 400 | 375 | 333 | 333 | 300 | 250 | 200 | |
| | | | | | | | Cycle Time (min) (ns) | | | | | | 1.875 | 2.00 | 2.22 | 2.50 | 2.66 |
| Part Number ↓ yy → | | | | | | -19 | -20 | -22 | -25 | -27 | -30 | -30 | -33 | -40 | -50 | | |
| 17 | QDRII+ | B4 | 2.5 | No | x18 | R1Q A A36 18 CBv-yy | -19 | -20 | -22 | | | | | | | | |
| 18 | | | | | x36 | R1Q A A36 36 CBv-yy | | | | | | | | | | | |
| 20 | DDRII+ | B2 | 2.5 | No | x18 | R1Q B A36 18 CBv-yy | -19 | -20 | -22 | | | | | | | | |
| 21 | | | | | x36 | R1Q B A36 36 CBv-yy | | | | | | | | | | | |
| 23 | | B4 | | | x18 | R1Q C A36 18 CBv-yy | -19 | -20 | -22 | | | | | | | | |
| 24 | | | | | x36 | R1Q C A36 36 CBv-yy | | | | | | | | | | | |
| 26 | QDRII+ | B4 | 2.5 | Yes | x18 | R1Q D A36 18 CBv-yy | -19 | -20 | -22 | | | | | | | | |
| 27 | | | | | x36 | R1Q D A36 36 CBv-yy | | | | | | | | | | | |
| 29 | DDRII+ | B2 | 2.5 | Yes | x18 | R1Q E A36 18 CBv-yy | -19 | -20 | -22 | | | | | | | | |
| 30 | | | | | x36 | R1Q E A36 36 CBv-yy | | | | | | | | | | | |
| 32 | | B4 | | | x18 | R1Q F A36 18 CBv-yy | -19 | -20 | -22 | | | | | | | | |
| 33 | | | | | x36 | R1Q F A36 36 CBv-yy | | | | | | | | | | | |
| 35 | QDRII+ | B4 | 2.0 | No | x18 | R1Q GA36 18 CBv-yy | | | | -25 | | | | | | | |
| 36 | | | | | x36 | R1Q GA36 36 CBv-yy | | | | | | | | | | | |
| 38 | DDRII+ | B2 | 2.0 | No | x18 | R1Q HA36 18 CBv-yy | | | | -25 | | | | | | | |
| 39 | | | | | x36 | R1Q HA36 36 CBv-yy | | | | | | | | | | | |
| 41 | | B4 | | | x18 | R1Q JA36 18 CBv-yy | | | | | | | -25 | | | | |
| 42 | | | | | x36 | R1Q JA36 36 CBv-yy | | | | | | | | | | | |
| 44 | QDRII+ | B4 | 2.0 | Yes | x18 | R1Q KA36 18 CBv-yy | | | | -25 | | | | | | | |
| 45 | | | | | x36 | R1Q KA36 36 CBv-yy | | | | | | | | | | | |
| 47 | DDRII+ | B2 | 2.0 | Yes | x18 | R1Q LA36 18 CBv-yy | | | | -25 | | | | | | | |
| 48 | | | | | x36 | R1Q LA36 36 CBv-yy | | | | | | | | | | | |
| 50 | | B4 | | | x18 | R1Q MA36 18 CBv-yy | | | | | | | -25 | | | | |
| 51 | | | | | x36 | R1Q MA36 36 CBv-yy | | | | | | | | | | | |

Notes:

- "yy" represents the speed bin. "R1QAA3636CBG-20" can operate at 500 MHz(max) of frequency, for example.
- "v" represents the package size. If "v" = "G" then size is 15 x 17 mm, and if "v" = "A" then 13 x 15 mm.
- The part which is not listed above is not supported, as of the day when this datasheet was issued, in spite of the existence of the part number or datasheet.

Pin Arrangement

R1Q4A3636 (Top) / R1QB(H)A3636 (Mid) / R1QE(L)A3636 (Bottom)

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|-------|------------------|------------------|------------------|-----------------|-------------------|-----------------|------------------|------------------|------------------|------|
| A | /CQ | NC | SA | R-/W | /BW2 | /K | /BW1 | /LD | SA | NC | CQ |
| B | NC | DQ27 | DQ18 | SA | /BW3 | K | /BW0 | SA | NC | NC | DQ8 |
| C | NC | NC | DQ28 | V _{SS} | SA | SA0 NC NC | SA | V _{SS} | NC | DQ17 | DQ7 |
| D | NC | DQ29 | DQ19 | V _{SS} | V _{SS} | V _{SS} | V _{SS} | V _{SS} | NC | NC | DQ16 |
| E | NC | NC | DQ20 | V _{DDQ} | V _{SS} | V _{SS} | V _{SS} | V _{DDQ} | NC | DQ15 | DQ6 |
| F | NC | DQ30 | DQ21 | V _{DDQ} | V _{DD} | V _{SS} | V _{DD} | V _{DDQ} | NC | NC | DQ5 |
| G | NC | DQ31 | DQ22 | V _{DDQ} | V _{DD} | V _{SS} | V _{DD} | V _{DDQ} | NC | NC | DQ14 |
| H | /DOFF | V _{REF} | V _{DDQ} | V _{DDQ} | V _{DD} | V _{SS} | V _{DD} | V _{DDQ} | V _{DDQ} | V _{REF} | ZQ |
| J | NC | NC | DQ32 | V _{DDQ} | V _{DD} | V _{SS} | V _{DD} | V _{DDQ} | NC | DQ13 | DQ4 |
| K | NC | NC | DQ23 | V _{DDQ} | V _{DD} | V _{SS} | V _{DD} | V _{DDQ} | NC | DQ12 | DQ3 |
| L | NC | DQ33 | DQ24 | V _{DDQ} | V _{SS} | V _{SS} | V _{SS} | V _{DDQ} | NC | NC | DQ2 |
| M | NC | NC | DQ34 | V _{SS} | V _{SS} | V _{SS} | V _{SS} | V _{SS} | NC | DQ11 | DQ1 |
| N | NC | DQ35 | DQ25 | V _{SS} | SA | SA | SA | V _{SS} | NC | NC | DQ10 |
| P | NC | NC | DQ26 | SA | SA | C QVLD QVLD | SA | SA | NC | DQ9 | DQ0 |
| R | TDO | TCK | SA | SA | SA | /C NC ODT | SA | SA | SA | TMS | TDI |

(Top View)

Top ←R1Q4A3636
 Mid ←R1QB(H)A3636
 Bottom ←R1QE(L)A3636

- Notes: 1. Address expansion order for future higher density SRAMs: 10A → 2A → 7A → 5B.
 2. NC pins can be left floating or connected to 0V ~ V_{DDQ}.

R1Q4A3618 (Top) / R1QB(H)A3618 (Mid) / R1QE(L)A3618 (Bottom)

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|-------|------------------|------------------|------------------|-----------------|-------------------|-----------------|------------------|------------------|------------------|-----|
| A | /CQ | NC | SA | R-/W | /BW1 | /K | NC | /LD | SA | SA | CQ |
| B | NC | DQ9 | NC | SA | NC | K | /BW0 | SA | NC | NC | DQ8 |
| C | NC | NC | NC | V _{SS} | SA | SA0 NC NC | SA | V _{SS} | NC | DQ7 | NC |
| D | NC | NC | DQ10 | V _{SS} | V _{SS} | V _{SS} | V _{SS} | V _{SS} | NC | NC | NC |
| E | NC | NC | DQ11 | V _{DDQ} | V _{SS} | V _{SS} | V _{SS} | V _{DDQ} | NC | NC | DQ6 |
| F | NC | DQ12 | NC | V _{DDQ} | V _{DD} | V _{SS} | V _{DD} | V _{DDQ} | NC | NC | DQ5 |
| G | NC | NC | DQ13 | V _{DDQ} | V _{DD} | V _{SS} | V _{DD} | V _{DDQ} | NC | NC | NC |
| H | /DOFF | V _{REF} | V _{DDQ} | V _{DDQ} | V _{DD} | V _{SS} | V _{DD} | V _{DDQ} | V _{DDQ} | V _{REF} | ZQ |
| J | NC | NC | NC | V _{DDQ} | V _{DD} | V _{SS} | V _{DD} | V _{DDQ} | NC | DQ4 | NC |
| K | NC | NC | DQ14 | V _{DDQ} | V _{DD} | V _{SS} | V _{DD} | V _{DDQ} | NC | NC | DQ3 |
| L | NC | DQ15 | NC | V _{DDQ} | V _{SS} | V _{SS} | V _{SS} | V _{DDQ} | NC | NC | DQ2 |
| M | NC | NC | NC | V _{SS} | V _{SS} | V _{SS} | V _{SS} | V _{SS} | NC | DQ1 | NC |
| N | NC | NC | DQ16 | V _{SS} | SA | SA | SA | V _{SS} | NC | NC | NC |
| P | NC | NC | DQ17 | SA | SA | C QVLD QVLD | SA | SA | NC | NC | DQ0 |
| R | TDO | TCK | SA | SA | SA | /C NC ODT | SA | SA | SA | TMS | TDI |

(Top View)

- Notes: 1. Address expansion order for future higher density SRAMs: 10A → 2A → 7A → 5B.
 2. NC pins can be left floating or connected to 0V ~ V_{DDQ}.

Pin Arrangement

Just Reference

R1Q4A3609 (Top) / R1QB(H)A3609 (Mid) / R1QE(L)A3609 (Bottom)

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|-------|------------------|------------------|------------------|-----------------|------------------------------|-----------------|------------------|------------------|------------------|-----|
| A | /CQ | NC | SA | R-/W | NC | /K | NC | /LD | SA | SA | CQ |
| B | NC | NC | NC | SA | NC | K | /BW | SA | NC | NC | DQ4 |
| C | NC | NC | NC | V _{SS} | SA | SA | SA | V _{SS} | NC | NC | NC |
| D | NC | NC | NC | V _{SS} | V _{SS} | V _{SS} | V _{SS} | V _{SS} | NC | NC | NC |
| E | NC | NC | DQ5 | V _{DDQ} | V _{SS} | V _{SS} | V _{SS} | V _{DDQ} | NC | NC | DQ3 |
| F | NC | NC | NC | V _{DDQ} | V _{DD} | V _{SS} | V _{DD} | V _{DDQ} | NC | NC | NC |
| G | NC | NC | DQ6 | V _{DDQ} | V _{DD} | V _{SS} | V _{DD} | V _{DDQ} | NC | NC | NC |
| H | /DOFF | V _{REF} | V _{DDQ} | V _{DDQ} | V _{DD} | V _{SS} | V _{DD} | V _{DDQ} | V _{DDQ} | V _{REF} | ZQ |
| J | NC | NC | NC | V _{DDQ} | V _{DD} | V _{SS} | V _{DD} | V _{DDQ} | NC | DQ2 | NC |
| K | NC | NC | NC | V _{DDQ} | V _{DD} | V _{SS} | V _{DD} | V _{DDQ} | NC | NC | NC |
| L | NC | DQ7 | NC | V _{DDQ} | V _{SS} | V _{SS} | V _{SS} | V _{DDQ} | NC | NC | DQ1 |
| M | NC | NC | NC | V _{SS} | V _{SS} | V _{SS} | V _{SS} | V _{SS} | NC | NC | NC |
| N | NC | NC | NC | V _{SS} | SA | SA | SA | V _{SS} | NC | NC | NC |
| P | NC | NC | DQ8 | SA | SA | ^C QVLD QVLD | SA | SA | NC | NC | DQ0 |
| R | TDO | TCK | SA | SA | SA | ^C NC ODT | SA | SA | SA | TMS | TDI |

(Top View)

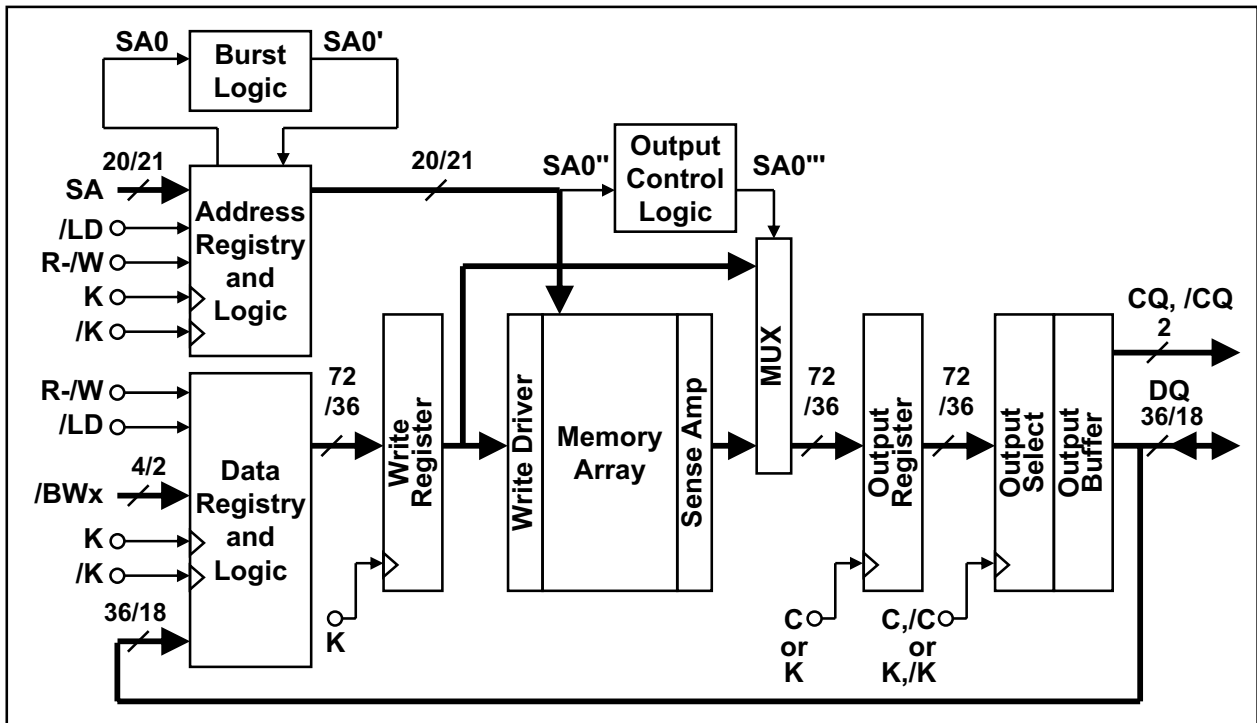
- Notes: 1. Address expansion order for future higher density SRAMs: 10A → 2A → 7A → 5B.
 2. NC pins can be left floating or connected to 0V ~ V_{DDQ}.
 3. Note that 6C is not SA0 and 7C is not SA1 in x9 product. Thus x9 product does not permit random start address on the two least significant address bits. SA0, SA1 = 0 at the start of each address.

Pin Descriptions

| Name | I/O type | Descriptions | Notes |
|--|----------|--|-------|
| SA _x | Input | Synchronous address inputs: These inputs are registered and must meet the setup and hold times around the rising edge of K. All transactions operate on a burst-of-four words (two clock periods of bus activity). SA0 and SA1 are used as the lowest two address bits for burst READ and burst WRITE operations permitting a random burst start address on ×18 and ×36 of DDR II (not II+) devices. These inputs are ignored when device is deselected or once burst operation is in progress. | |
| /LD | Input | Synchronous load: This input is brought low when a bus cycle sequence is to be defined. This definition includes address and READ / WRITE direction. All transactions operate on a burst-of-four data (two clock periods of bus activity). | |
| R-/W | Input | Synchronous read / write Input: When /LD is low, this input designates the access type (READ when R-/W is high, WRITE when R-/W is low) for the loaded address. R-/W must meet the setup and hold times around the rising edge of K. | |
| /BW _x | Input | Synchronous byte writes: When low, these inputs cause their respective byte to be registered and written during WRITE cycles. These signals are sampled on the same edge as the corresponding data and must meet setup and hold times around the rising edges of K and /K for each of the two rising edges comprising the WRITE cycle. See Byte Write Truth Table for signal to data relationship. | |
| K, /K | Input | Input clock: This input clock pair registers address and control inputs on the rising edge of K, and registers data on the rising edge of K and the rising edge of /K. /K is ideally 180 degrees out of phase with K. All synchronous inputs must meet setup and hold times around the clock rising edges. These balls cannot remain V _{REF} level. | |
| C, /C (II only) | Input | Output clock: This clock pair provides a user-controlled means of tuning device output data. The rising edge of /C is used as the output timing reference for the first and third output data. The rising edge of C is used as the output timing reference for second and fourth output data. Ideally, /C is 180 degrees out of phase with C. C and /C may be tied high to force the use of K and /K as the output reference clocks instead of having to provide C and /C clocks. If tied high, C and /C must remain high and not to be toggled during device operation. These balls cannot remain V _{REF} level. | 1 |
| /DOFF | Input | DLL/PLL disable: When low, this input causes the DLL/PLL to be bypassed for stable, low frequency operation. | |
| TMS TDI | Input | IEEE1149.1 test inputs: 1.8 V I/O levels. These balls may be left not connected if the JTAG function is not used in the circuit. | |
| TCK | Input | IEEE1149.1 clock input: 1.8 V I/O levels. This ball must be tied to V _{SS} if the JTAG function is not used in the circuit. | |
| <p>Notes:</p> <p>1. R1Q2, R1Q3, R1Q4, R1Q5, R1Q6 series have C and /C pins. R1QA, R1QB, R1QC, R1QD, R1QE, R1QF, R1QG, R1QH, R1QJ, R1QK, R1QL, R1QM, R1QN, R1QP series do not have C, /C pins. In the series, K and /K are used as the output reference clocks instead of C and /C. Therefore, hereafter, C and /C represent K and /K in this document.</p> | | | |

| Name | I/O type | Descriptions | Notes |
|---|----------------------|--|-------|
| ZQ | Input | Output impedance matching input: This input is used to tune the device outputs to the system data bus impedance. DQ and CQ output impedance are set to $0.2 \times RQ$, where RQ is a resistor from this ball to ground. This ball can be connected directly to V_{DDQ} , which enables the minimum impedance mode. This ball cannot be connected directly to V_{SS} or left unconnected. In ODT (On Die Termination) enable devices, the ODT termination values tracks the value of RQ. The ODT range is selected by ODT control input. | |
| ODT (II+ only) | Input | ODT control: When low ; [Option 1] Low range mode is selected. The impedance range is between 52Ω and 105Ω (Thevenin equivalent), which follows $0.3 \times RQ$ for $175 \Omega \leq RQ \leq 350 \Omega$. [Option 2] ODT is disabled. When high ; High range mode is selected. The impedance range is between 105Ω and 150Ω (Thevenin equivalent), which follows $0.6 \times RQ$ for $175 \Omega \leq RQ \leq 250 \Omega$. When floating ; [Option 1] High range mode is selected. [Option 2] ODT is disabled. | 1 |
| DQ ₀ to DQ _n | Input / output | Synchronous data I/Os: Input data must meet setup and hold times around the rising edges of K and /K. Output data is synchronized to the respective C and /C, or to the respective K and /K if C and /C are tied high. The ×9 device uses DQ0~DQ8. DQ9~DQ35 should be treated as NC pin. The ×18 device uses DQ0~DQ17. DQ18~DQ35 should be treated as NC pin. The ×36 device uses DQ0~DQ35. | |
| CQ, /CQ | Output | Synchronous echo clock outputs: The edges of these outputs are tightly matched to the synchronous data outputs and can be used as a data valid indication. These signals run freely and do not stop when DQ tri-states. | |
| TDO | Output | IEEE 1149.1 test output: 1.8 V I/O level. | |
| QVLD (II+ only) | Output | Valid output indicator: The Q Valid indicates valid output data. QVLD is edge aligned with CQ and /CQ. | |
| V _{DD} | Supply | Power supply: 1.8 V nominal. See DC Characteristics and Operating Conditions for range. | 2 |
| V _{DDQ} | Supply | Power supply: Isolated output buffer supply. Nominally 1.5 V. See DC Characteristics and Operating Conditions for range. | 2 |
| V _{SS} | Supply | Power supply: Ground. | 2 |
| V _{REF} | — | HSTL input reference voltage: Nominally $V_{DDQ}/2$, but may be adjusted to improve system noise margin. Provides a reference voltage for the HSTL input buffers. | |
| NC | — | No connect: These pins can be left floating or connected to $0V \sim V_{DDQ}$. | |
| Notes: 1. Renesas status: Option 1 = Available, Option 2 = Possible. 2. All power supply and ground balls must be connected for proper operation of the device. | | | |

Block Diagram (R1QxA3636 / R1QxA3618 series, x=4)

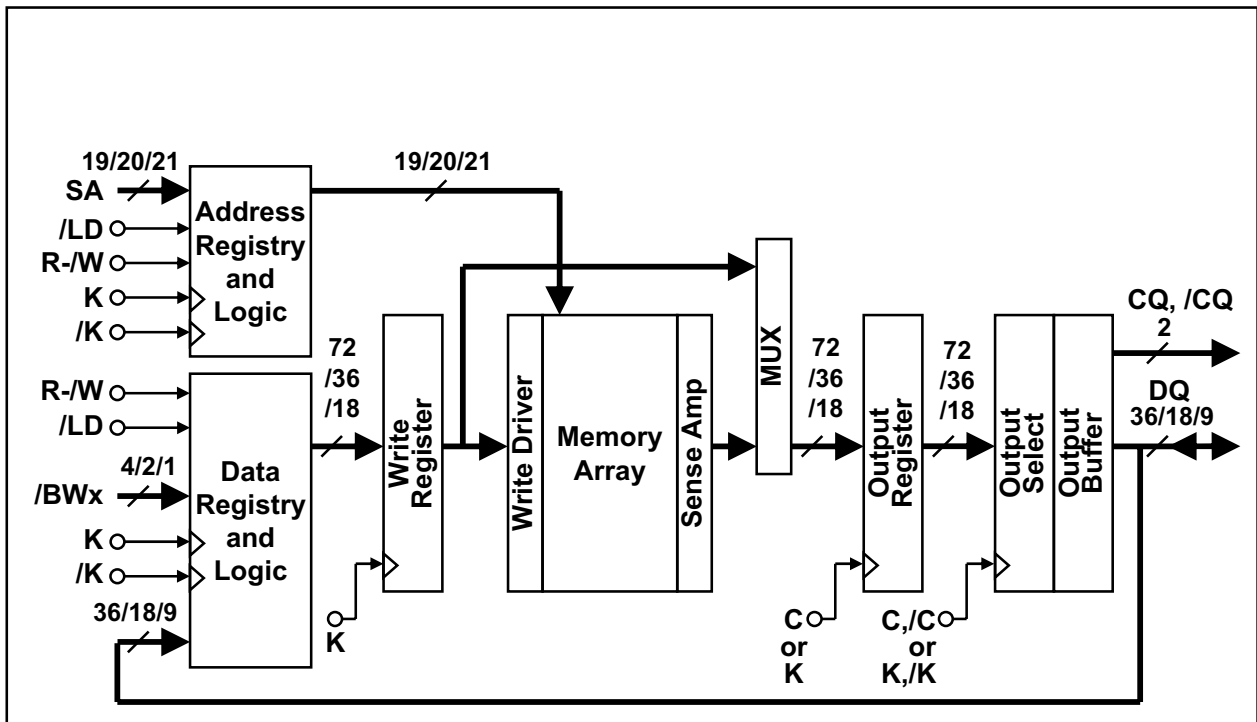


Notes

1. C and /C pins do not exist in II+ series parts.

Block Diagram

(R1QxA3636 / R1QxA3618 / R1QyA3609 series, x=B,E,H,L, y=4,B,E,H,L)



Notes

1. C and /C pins do not exist in II+ series parts.

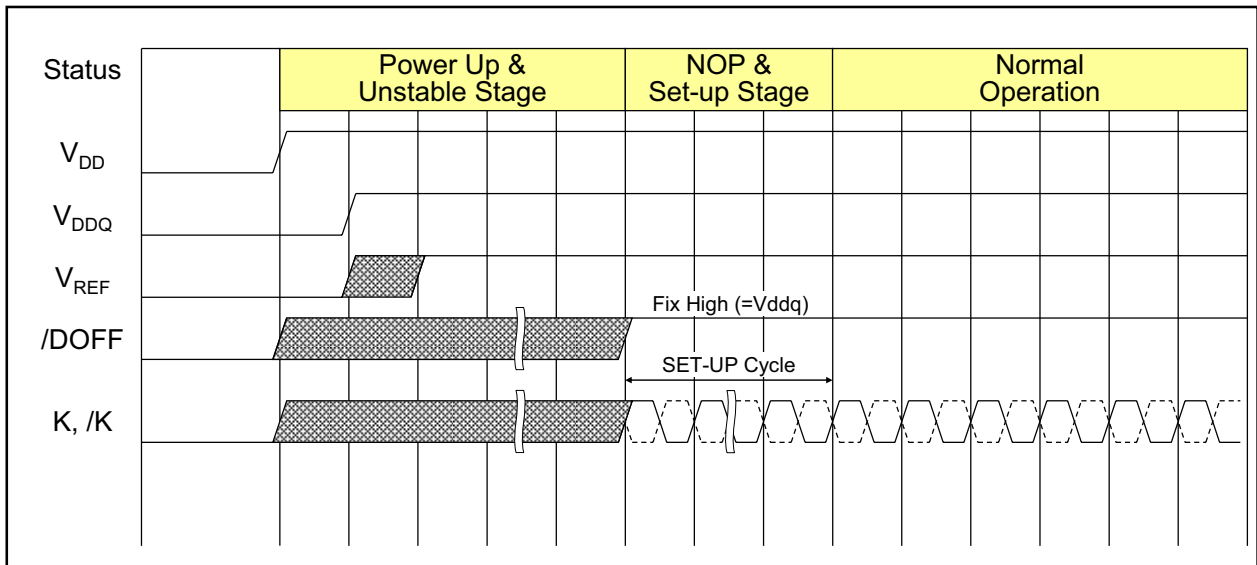
General Description

Power-up and Initialization Sequence

- V_{DD} must be stable before K, /K clocks are applied.
- Recommended voltage application sequence : $V_{SS} \rightarrow V_{DD} \rightarrow V_{DDQ} \& V_{REF} \rightarrow V_{IN}$. (0 V to V_{DD} , $V_{DDQ} < 200$ ms)
- Apply V_{REF} after V_{DDQ} or at the same time as V_{DDQ} .
- Then execute either one of the following three sequences.

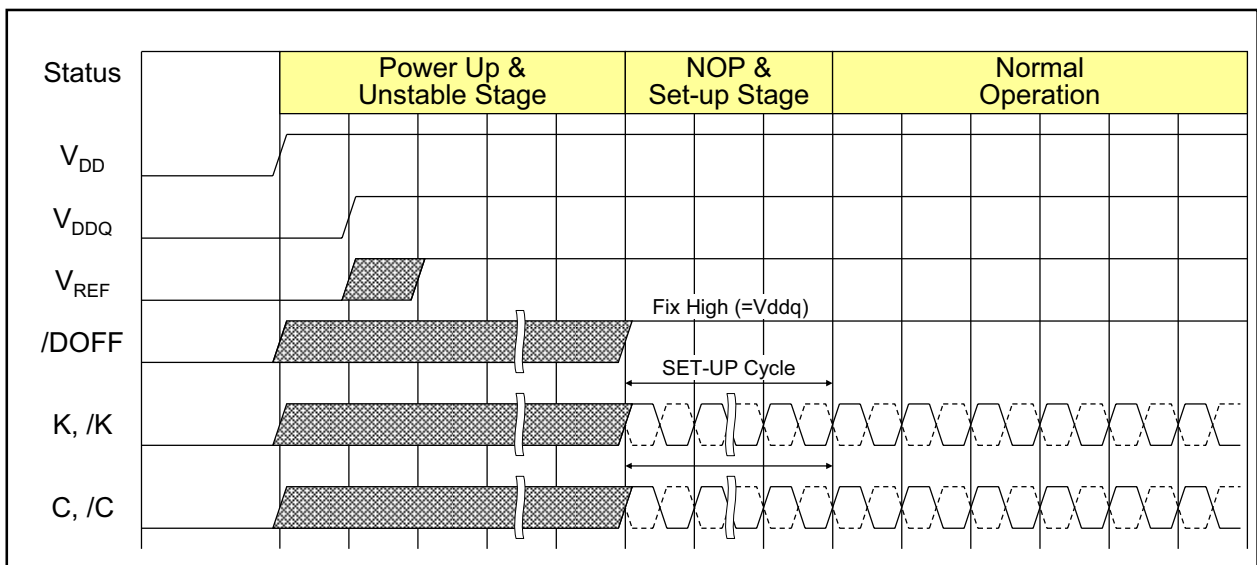
1. Single Clock Mode (C and /C tied high)

- Drive /DOFF high (/DOFF can be tied high from the start).
- Then provide stable clocks (K, /K) for at least 1024 cycles (II series) or 20 us (II+ series).
These meet the QDR common specification of 20 us.
- When the operating frequency is less than 180 MHz, 2048 cycles are required (II series).



2. Double Clock Mode (C and /C control outputs) (II series only)

- Drive /DOFF high (/DOFF can be tied high from the start)
- Then provide stable clocks (K, /K, C, /C) for at least 1024 cycles (II series).
This meets the QDR common specification of 20 us.
- When the operating frequency is less than 180 MHz, 2048 cycles are required (II series).



3. DLL/PLL Off Mode (/DOFF tied low)

- In the "NOP and setup stage", provide stable clocks (K, /K) for at least 1024 cycles (II series) or 20 us (II+ series). These meet the QDR common specification of 20 us.

DLL/PLL Constraints

1. DLL/PLL uses K clock as its synchronizing input. The input should have low phase jitter which is specified as tKC var.
2. The lower end of the frequency at which the DLL/PLL can operate is 120 MHz.
(Please refer to AC Characteristics table for detail.)
3. When the operating frequency is changed or /DOFF level is changed, setup cycles are required again.

Programmable Output Impedance

1. Output buffer impedance can be programmed by terminating the ZQ ball to V_{SS} through a precision resistor (RQ). The value of RQ is five times the output impedance desired. The allowable range of RQ to guarantee impedance matching with a tolerance of 15% is 250 Ω typical. The total external capacitance of ZQ ball must be less than 7.5 pF.

QVLD (Valid data indicator)

(R1QA, R1QB, R1QC, R1QD, R1QE, R1QF, R1QG, R1QH, R1QJ, R1QK, R1QL, R1QM, R1QN, R1QP series)

1. QVLD is provided on the QDR-II+ and DDR-II+ to simplify data capture on high speed systems. The Q Valid indicates valid output data. QVLD is activated half cycle before the read data for the receiver to be ready for capturing the data. QVLD is inactivated half cycle before the read finish for the receiver to stop capturing the data. QVLD is edge aligned with CQ and /CQ.

ODT (On Die Termination)

(R1QD, R1QE, R1QF, R1QK, R1QL, R1QM, R1QP series)

1. To reduce reflection which produces noise and lowers signal quality, the signals should be terminated, especially at high frequency. Renesas offers ODT on the input signals to QDR-II+ and DDR-II+ family of devices. (See the ODT pin table)
2. In ODT enable devices, the ODT termination values tracks the value of RQ. The ODT range is selected by ODT control input. (See the ODT range table)
3. In DDR-II+ devices having common I/O bus, ODT is automatically enabled when the device inputs data and disabled when the device outputs data.
4. There is no difference in AC timing characteristics between the SRAMs with ODT and SRAMs without ODT.
5. There is no increase in the I_{DD} of SRAMs with ODT, however, there is an increase in the I_{DDQ} (current consumption from the I/O voltage supply) with ODT.

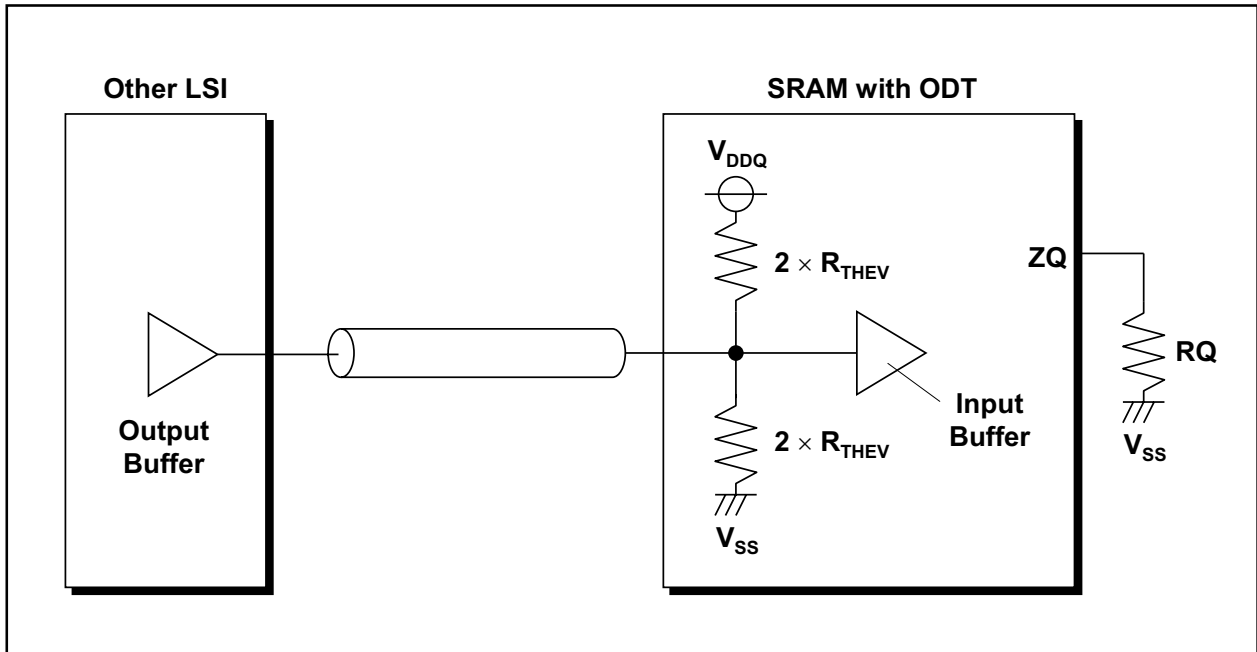
ODT range

| ODT control pin | Thevenin equivalent resistance (R _{THEV}) | | Unit | Notes |
|-----------------|---|---------------|------|-------|
| | Option 1 | Option 2 | | |
| Low | 0.3 × RQ | (ODT disable) | Ω | 1, 4 |
| High | 0.6 × RQ | 0.6 × RQ | Ω | 2, 5 |
| Floating | 0.6 × RQ | (ODT disable) | Ω | 3 |

Notes:

1. Allowable range of RQ for Option 1 to guarantee impedance matching a tolerance of ± 20 % is 175 Ω ≤ RQ ≤ 350 Ω.
2. Allowable range of RQ to guarantee impedance matching a tolerance of ± 20 % is 175 Ω ≤ RQ ≤ 250 Ω.
3. Allowable range of RQ for Option 1 to guarantee impedance matching a tolerance of ± 20 % is 175 Ω ≤ RQ ≤ 250 Ω.
4. At option 1, ODT control pin is connected to V_{DDQ} through 3.5 kΩ. Therefore it is recommended to connect it to V_{SS} through less than 100 Ω to make it low.
5. At option 2, ODT control pin is connected to V_{SS} through 3.5 kΩ. Therefore it is recommended to connect it to V_{DDQ} through less than 100 Ω to make it high.
6. Renesas status: Option 1 = Available, Option 2 = Possible. If you need devices with option 2, please contact Renesas sales office.

Thevenin termination

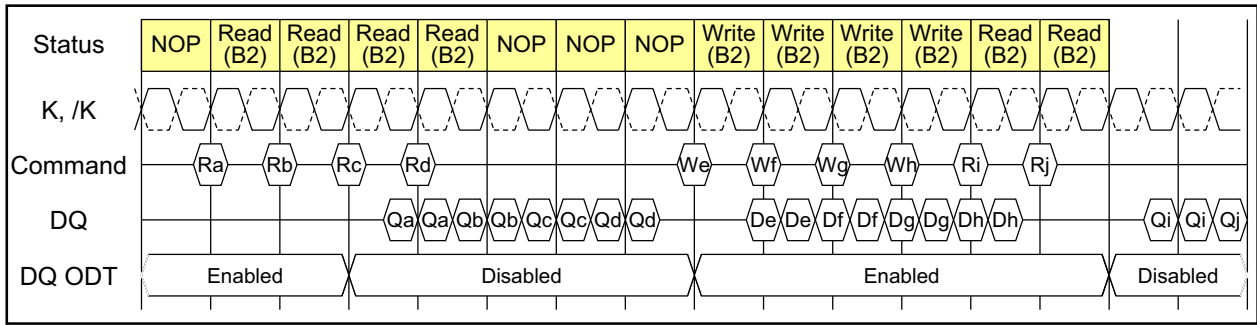


ODT pin (R1QD, R1QE, R1QF, R1QK, R1QL, R1QM, R1QP series)

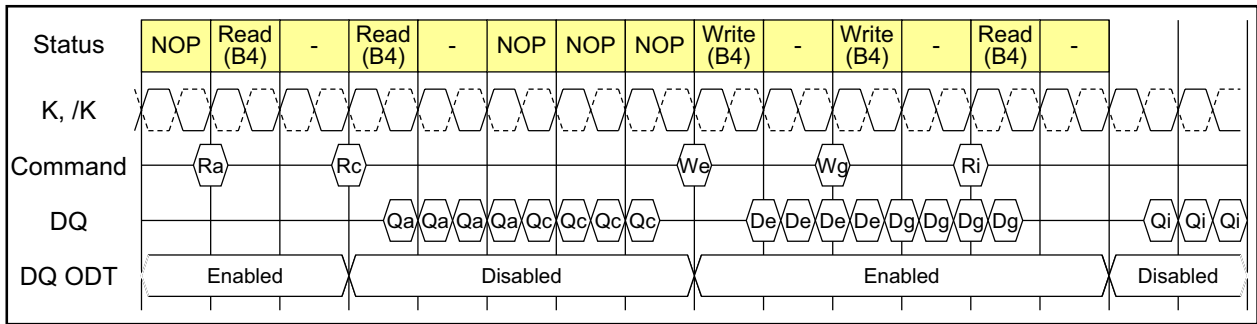
| Pin name | ODT On/Off timing | | Notes |
|--|--|----------------|-------|
| | Option 1 | Option 2 | |
| | | ODT pin = High | |
| $D_0 \sim D_n$ in separate I/O devices | Always On | Always Off | 1 |
| $DQ_0 \sim DQ_n$ in common I/O devices | Off: First Read Command + Read Latency - 0.5 cycle On: Last Read Command + Read Latency + BL/2 cycle + 0.5 cycle (See below timing chart) | Always Off | 2 |
| $/BW_x$ | Always On | Always Off | |
| K, /K | Always On | Always Off | |

Notes: 1. Separate I/O devices are R1QD, R1QK, R1QP series.
 2. Common I/O devices are R1QE, R1QF, R1QL, R1QM series.
 3. Renesas status: Option 1 = Available, Option 2 = Possible. If you need devices with option 2, please contact Renesas sales office.

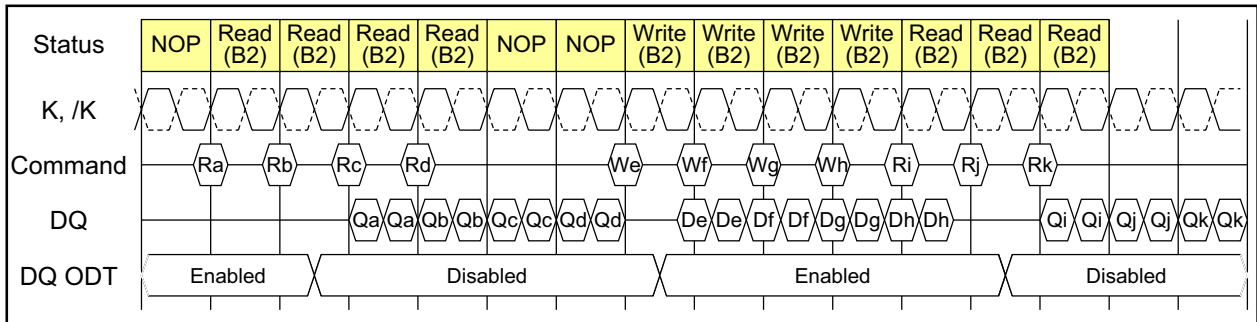
ODT on/off Timing Chart for R1QE series (DDR II+, Burst Length=2, Read Latency=2.5 cycle)



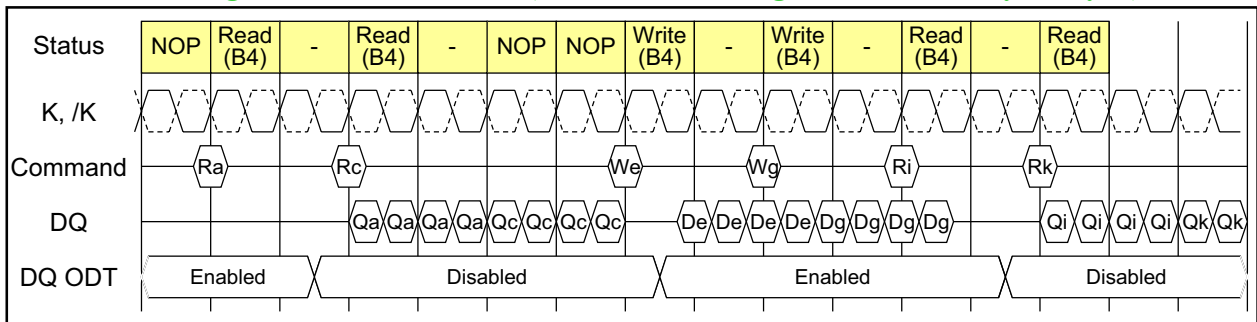
ODT on/off Timing Chart for R1QF series (DDR II+, Burst Length=4, Read Latency=2.5 cycle)



ODT on/off Timing Chart for R1QL series (DDR II+, Burst Length=2, Read Latency=2.0 cycle)



ODT on/off Timing Chart for R1QM series (DDR II+, Burst Length=4, Read Latency=2.0 cycle)



Notes

1. ODT on/off switching timings are edge aligned with CQ or /CQ.

K Truth Table

| Operation | K | /LD | R-/W | DQ | | | |
|---|---------|----------|---------|-------------------|----------|----------|----------|
| Write Cycle: Load address, input write data on consecutive K and /K rising edges | ↑ | L | L | Data in | | | |
| | | | | Input data | D(A1) | D(A2) | |
| | | | | Input clock | K(t+1)↑ | /K(t+1)↑ | |
| Read Cycle: Load address, output read data on consecutive C and /C rising edges | ↑ | L | H | Data out | | | |
| | | | | Output data | Q(A1) | Q(A2) | |
| | | | | Input clock for Q | RL*8=1.5 | /C(t+1)↑ | C(t+2)↑ |
| | | | | | RL=2.0 | C(t+2)↑ | /C(t+2)↑ |
| | RL=2.5 | /C(t+2)↑ | C(t+3)↑ | | | | |
| NOP (No operation) | ↑ | H | × | High-Z | | | |
| Standby (Clock stopped) | Stopped | × | × | Previous state | | | |

Notes:

1. H: high level, L: low level, ×: don't care, ↑: rising edge.
2. Data inputs are registered at K and /K rising edges. Data outputs are delivered at C and /C rising edges, except if C and /C are high, then data outputs are delivered at K and /K rising edges.
3. /LD and R-/W must meet setup/hold times around the rising edges (low to high) of K and are registered at the rising edge of K.
4. This device contains circuitry that will ensure the outputs will be in high-Z during power-up.
5. Refer to state diagram and timing diagrams for clarification.
6. When clocks are stopped, the following cases are recommended; the case of K = low, /K = high, C = low and /C = high, or the case of K = high, /K = low, C = high and /C = low. This condition is not essential, but permits most rapid restart by overcoming transmission line charging symmetrically.
7. A1 refers to the address input during a WRITE or READ cycle. A2 refers to the next internal burst address in accordance with the linear burst sequence.
8. RL = Read Latency (unit = cycle).

Burst Sequence

Linear Burst Sequence Table (R1Q4Aww36 / R1Q4Aww18 series)

| | SA0 | SA0 | Notes |
|----------------------------|-----|-----|-------|
| External address | 0 | 1 | |
| 1st internal burst address | 1 | 0 | |

Byte Write Truth Table (x 36)

| Operation | K | /K | /BW0 | /BW1 | /BW2 | /BW3 |
|------------------|---|----|------|------|------|------|
| Write D0 to D35 | ↑ | - | L | L | L | L |
| | - | ↑ | L | L | L | L |
| Write D0 to D8 | ↑ | - | L | H | H | H |
| | - | ↑ | L | H | H | H |
| Write D9 to D17 | ↑ | - | H | L | H | H |
| | - | ↑ | H | L | H | H |
| Write D18 to D26 | ↑ | - | H | H | L | H |
| | - | ↑ | H | H | L | H |
| Write D27 to D35 | ↑ | - | H | H | H | L |
| | - | ↑ | H | H | H | L |
| Write nothing | ↑ | - | H | H | H | H |
| | - | ↑ | H | H | H | H |

Notes:
 1. H: high level, L: low level, ↑: rising edge.
 2. Assumes a WRITE cycle was initiated. /BWx can be altered for any portion of the BURST WRITE operation provided that the setup and hold requirements are satisfied.

Byte Write Truth Table (x 18)

| Operation | K | /K | /BW0 | /BW1 |
|-----------------|---|----|------|------|
| Write D0 to D17 | ↑ | - | L | L |
| | - | ↑ | L | L |
| Write D0 to D8 | ↑ | - | L | H |
| | - | ↑ | L | H |
| Write D9 to D17 | ↑ | - | H | L |
| | - | ↑ | H | L |
| Write nothing | ↑ | - | H | H |
| | - | ↑ | H | H |

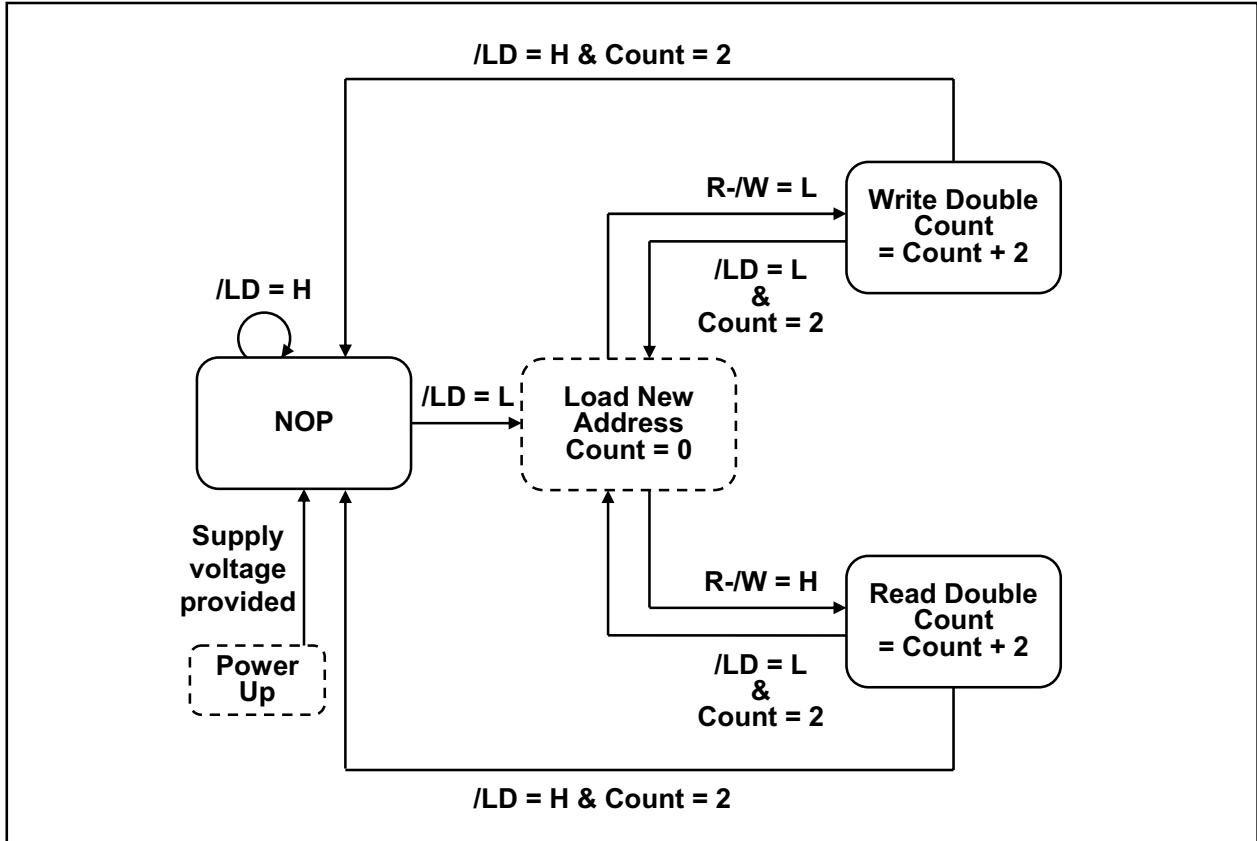
Notes:
 1. H: high level, L: low level, ↑: rising edge.
 2. Assumes a WRITE cycle was initiated. /BWx can be altered for any portion of the BURST WRITE operation provided that the setup and hold requirements are satisfied.

Byte Write Truth Table (x 9) Just Reference except R1Q2A7209 series

| Operation | K | /K | /BW |
|----------------|---|----|-----|
| Write D0 to D8 | ↑ | - | L |
| | - | ↑ | L |
| Write nothing | ↑ | - | H |
| | - | ↑ | H |

Notes:
 1. H: high level, L: low level, ↑: rising edge.
 2. Assumes a WRITE cycle was initiated. /BWx can be altered for any portion of the BURST WRITE operation provided that the setup and hold requirements are satisfied.

Bus Cycle State Diagram



Notes:

1. SA0 is internally advanced in accordance with the burst order table. Bus cycle is terminated at the end of this sequence (burst count = 2).
2. State machine control timing sequence is controlled by K.

Absolute Maximum Ratings

| Parameter | Symbol | Rating | Unit | Notes |
|---------------------------|-----------|---|------|-------|
| Input voltage on any ball | V_{IN} | -0.5 to $V_{DD} + 0.5$ (2.5 V max.) | V | 1, 4 |
| Input/output voltage | $V_{I/O}$ | -0.5 to $V_{DDQ} + 0.5$ (2.5 V max.) | V | 1, 4 |
| Core supply voltage | V_{DD} | -0.5 to 2.5 | V | 1, 4 |
| Output supply voltage | V_{DDQ} | -0.5 to V_{DD} | V | 1, 4 |
| Junction temperature | T_j | +125 (max) | °C | 5 |
| Storage temperature | T_{STG} | -55 to +125 | °C | |

Notes:

- All voltage is referenced to V_{SS} .
- Permanent device damage may occur if Absolute Maximum Ratings are exceeded. Functional operation should be restricted the Operation Conditions. Exposure to higher than recommended voltages for extended periods of time could affect device reliability.
- These CMOS memory circuits have been designed to meet the DC and AC specifications shown in the tables after thermal equilibrium has been established.
- The following supply voltage application sequence is recommended: V_{SS} , V_{DD} , V_{DDQ} , V_{REF} then V_{IN} . Remember, according to the Absolute Maximum Ratings table, V_{DDQ} is not to exceed 2.5 V, whatever the instantaneous value of V_{DDQ} .
- Some method of cooling or airflow should be considered in the system. (Especially for high frequency or ODT parts)

Recommended DC Operating Conditions

| Parameter | Symbol | Min | Typ | Max | Unit | Notes |
|--------------------------------|--------------|-----------------|------|-----------------|------|---------|
| Power supply voltage -- core | V_{DD} | 1.7 | 1.8 | 1.9 | V | 1 |
| Power supply voltage -- I/O | V_{DDQ} | 1.4 | 1.5 | V_{DD} | V | 1, 2 |
| Input reference voltage -- I/O | V_{REF} | 0.68 | 0.75 | 0.95 | V | 3 |
| Input high voltage | $V_{IH(DC)}$ | $V_{REF} + 0.1$ | — | $V_{DDQ} + 0.3$ | V | 1, 4, 5 |
| Input low voltage | $V_{IL(DC)}$ | -0.3 | — | $V_{REF} - 0.1$ | V | 1, 4, 5 |

Notes:

- At power-up, V_{DD} and V_{DDQ} are assumed to be a linear ramp from 0V to V_{DD} (min.) or V_{DDQ} (min.) within 200ms. During this time $V_{DDQ} < V_{DD}$ and $V_{IH} < V_{DDQ}$. During normal operation, V_{DDQ} must not exceed V_{DD} .
- Please pay attention to T_j not to exceed the temperature shown in the absolute maximum ratings table due to current from V_{DDQ} .
- Peak to peak AC component superimposed on V_{REF} may not exceed 5% of V_{REF} .
- These are DC test criteria. The AC V_{IH} / V_{IL} levels are defined separately to measure timing parameters.
- Overshoot: $V_{IH(AC)} \leq V_{DDQ} + 0.5 \text{ V}$ for $t \leq t_{KHKH}/2$
Undershoot: $V_{IL(AC)} \geq -0.5 \text{ V}$ for $t \leq t_{KHKH}/2$
During normal operation, $V_{IH(DC)}$ must not exceed V_{DDQ} and $V_{IL(DC)}$ must not be lower than V_{SS} .

R1QBA36CB* / R1QEA36**CB* Series**

DC Characteristics

(Ta = 0 ~ +70°C @ R1Q*A*****BG-**R** series, Ta = -40 ~ +85°C @ R1Q*A*****BG-**I** series)
 (V_{DD} = 1.8V ±0.1V, V_{DDQ} = 1.5V, V_{REF} = 0.75V)

Operating Supply Current (Write / Read)

Symbol = I_{DD}. Unit = mA. See Notes 1, 2 and 3 in the page after next.

| No | Product Type | Burst Length | Latency (Cycle) | ODT | Organi- zation | QDR II+ / DDR II+ | | | | | | QDR II / DDR II | | | | | |
|---------------|--------------|--------------|-----------------|-----|---------------------|-----------------------|---------------------|---------------------|------|------|------|-----------------|------|------|------|------|------|
| | | | | | | Frequency (max) (MHz) | | 533 | 500 | 450 | 400 | 375 | 333 | 333 | 300 | 250 | 200 |
| | | | | | | Cycle Time (min) (ns) | | 1.875 | 2.00 | 2.22 | 2.50 | 2.66 | 3.00 | 3.00 | 3.30 | 4.00 | 5.00 |
| Part Number ↓ | | yy → | -19 | -20 | -22 | -25 | -27 | -30 | -30 | -33 | -40 | -50 | | | | | |
| 17 | QDRII+ | B4 | 2.5 | No | x18 | R1Q A A36 18 CBv-yy | 1220 | 1160 | 1070 | | | | | | | | |
| 18 | | | | | x36 | R1Q A A36 36 CBv-yy | 1280 | 1220 | 1130 | | | | | | | | |
| 20 | DDRII+ | B2 | | | x18 | R1Q B A36 18 CBv-yy | 1030 | 990 | 920 | | | | | | | | |
| 21 | | x36 | | | R1Q B A36 36 CBv-yy | 1110 | 1060 | 990 | | | | | | | | | |
| 23 | B4 | x18 | | | R1Q C A36 18 CBv-yy | 820 | 790 | 750 | | | | | | | | | |
| 24 | | x36 | | | R1Q C A36 36 CBv-yy | 880 | 850 | 800 | | | | | | | | | |
| 26 | QDRII+ | B4 | 2.5 | Yes | x18 | R1Q D A36 18 CBv-yy | 1220 | 1160 | 1070 | | | | | | | | |
| 27 | | | | | x36 | R1Q D A36 36 CBv-yy | 1280 | 1220 | 1130 | | | | | | | | |
| 29 | DDRII+ | B2 | | | x18 | R1Q E A36 18 CBv-yy | 1030 | 990 | 920 | | | | | | | | |
| 30 | | x36 | | | R1Q E A36 36 CBv-yy | 1110 | 1060 | 990 | | | | | | | | | |
| 32 | B4 | x18 | | | R1Q F A36 18 CBv-yy | 820 | 790 | 750 | | | | | | | | | |
| 33 | | x36 | | | R1Q F A36 36 CBv-yy | 880 | 850 | 800 | | | | | | | | | |
| 35 | QDRII+ | B4 | | | 2.0 | No | x18 | R1Q G A36 18 CBv-yy | | | | | 980 | | | | |
| 36 | | | | | | | x36 | R1Q G A36 36 CBv-yy | | | | | 1060 | | | | |
| 38 | DDRII+ | B2 | | | | | x18 | R1Q H A36 18 CBv-yy | | | | | 850 | | | | |
| 39 | | x36 | | | | | R1Q H A36 36 CBv-yy | | | | | 910 | | | | | |
| 41 | B4 | x18 | | | | | R1Q J A36 18 CBv-yy | | | | | 710 | | | | | |
| 42 | | x36 | | | | | R1Q J A36 36 CBv-yy | | | | | 760 | | | | | |
| 44 | QDRII+ | B4 | 2.0 | Yes | | | x18 | R1Q K A36 18 CBv-yy | | | | | 980 | | | | |
| 45 | | | | | | | x36 | R1Q K A36 36 CBv-yy | | | | | 1060 | | | | |
| 47 | DDRII+ | B2 | | | | | x18 | R1Q L A36 18 CBv-yy | | | | | 850 | | | | |
| 48 | | x36 | | | | | R1Q L A36 36 CBv-yy | | | | | 910 | | | | | |
| 50 | B4 | x18 | | | R1Q M A36 18 CBv-yy | | | | | 710 | | | | | | | |
| 51 | | x36 | | | R1Q M A36 36 CBv-yy | | | | | 760 | | | | | | | |

Notes:

- "yy" represents the speed bin. "R1QAA3636CBG-20" can operate at 500 MHz(max) of frequency, for example.
- "v" represents the package size. If "v" = "G" then size is 15 x 17 mm, and if "v" = "A" then 13 x 15 mm.

Standby Supply Current (NOP)

Symbol = I_{SB1}. Unit = mA. See Notes 2, 4 and 5 in the next page.

| No | Product Type | Burst Length | Latency (Cycle) | ODT | Organi- zation | QDR II+ / DDR II+ | | | | | | QDR II / DDR II | | | | |
|---------------|--------------|--------------|-----------------|-----|----------------|-----------------------|-------|------|------|------|------|-----------------|------|------|------|------|
| | | | | | | Frequency (max) (MHz) | 533 | 500 | 450 | 400 | 375 | 333 | 333 | 300 | 250 | 200 |
| | | | | | | Cycle Time (min) (ns) | 1.875 | 2.00 | 2.22 | 2.50 | 2.66 | 3.00 | 3.00 | 3.30 | 4.00 | 5.00 |
| Part Number ↓ | | yy → | | -19 | -20 | -22 | -25 | -27 | -30 | -30 | -33 | -40 | -50 | | | |
| 17 | QDRII+ | B4 | 2.5 | No | x18 | R1Q A A36 18 CBv-yy | 870 | 830 | 780 | | | | | | | |
| 18 | | | | | x36 | R1Q A A36 36 CBv-yy | 910 | 870 | 810 | | | | | | | |
| 20 | DDRII+ | B2 | | | x18 | R1Q B A36 18 CBv-yy | 870 | 840 | 780 | | | | | | | |
| 21 | | | | | x36 | R1Q B A36 36 CBv-yy | 960 | 920 | 860 | | | | | | | |
| 23 | | B4 | | | x18 | R1Q C A36 18 CBv-yy | 690 | 660 | 630 | | | | | | | |
| 24 | | | | | x36 | R1Q C A36 36 CBv-yy | 730 | 710 | 670 | | | | | | | |
| 26 | QDRII+ | B4 | 2.5 | Yes | x18 | R1Q D A36 18 CBv-yy | 870 | 830 | 780 | | | | | | | |
| 27 | | | | | x36 | R1Q D A36 36 CBv-yy | 910 | 870 | 810 | | | | | | | |
| 29 | DDRII+ | B2 | | | x18 | R1Q E A36 18 CBv-yy | 870 | 840 | 780 | | | | | | | |
| 30 | | | | | x36 | R1Q E A36 36 CBv-yy | 960 | 920 | 860 | | | | | | | |
| 32 | | B4 | | | x18 | R1Q F A36 18 CBv-yy | 690 | 660 | 630 | | | | | | | |
| 33 | | | | | x36 | R1Q F A36 36 CBv-yy | 730 | 710 | 670 | | | | | | | |
| 35 | QDRII+ | B4 | 2.0 | No | x18 | R1Q GA36 18 CBv-yy | | | | 720 | | | | | | |
| 36 | | | | | x36 | R1Q GA36 36 CBv-yy | | | | 770 | | | | | | |
| 38 | DDRII+ | B2 | | | x18 | R1Q HA36 18 CBv-yy | | | | 720 | | | | | | |
| 39 | | | | | x36 | R1Q HA36 36 CBv-yy | | | | 790 | | | | | | |
| 41 | | B4 | | | x18 | R1Q JA36 18 CBv-yy | | | | 590 | | | | | | |
| 42 | | | | | x36 | R1Q JA36 36 CBv-yy | | | | 630 | | | | | | |
| 44 | QDRII+ | B4 | 2.0 | Yes | x18 | R1Q KA36 18 CBv-yy | | | | 720 | | | | | | |
| 45 | | | | | x36 | R1Q KA36 36 CBv-yy | | | | 770 | | | | | | |
| 47 | DDRII+ | B2 | | | x18 | R1Q LA36 18 CBv-yy | | | | 720 | | | | | | |
| 48 | | | | | x36 | R1Q LA36 36 CBv-yy | | | | 790 | | | | | | |
| 50 | | B4 | | | x18 | R1Q MA36 18 CBv-yy | | | | 590 | | | | | | |
| 51 | | | | | x36 | R1Q MA36 36 CBv-yy | | | | 630 | | | | | | |

Notes:

- "yy" represents the speed bin. "R1QAA3636CBG-20" can operate at 500 MHz(max) of frequency, for example.
- "v" represents the package size. If "v" = "G" then size is 15 x 17 mm, and if "v" = "A" then 13 x 15 mm.

Leakage Currents & Output Voltage

| Parameter | Symbol | Min | Max | Unit | Test condition | Notes |
|------------------------|-------------------|--------------------|--------------------|---------------|--------------------------------|-------|
| Input leakage current | I_{LI} | -2 | 2 | μA | | 10 |
| Output leakage current | I_{LO} | -5 | 5 | μA | | 11 |
| Output high voltage | V_{OH} (Low) | $V_{DDQ} - 0.2$ | V_{DDQ} | V | $ I_{OH} \leq 0.1 \text{ mA}$ | 8, 9 |
| | V_{OH} | $V_{DDQ}/2 - 0.12$ | $V_{DDQ}/2 + 0.12$ | V | Note 6 | 8, 9 |
| Output low voltage | V_{OL} (Low) | V_{SS} | 0.2 | V | $I_{OL} \leq 0.1 \text{ mA}$ | 8, 9 |
| | V_{OL} | $V_{DDQ}/2 - 0.12$ | $V_{DDQ}/2 + 0.12$ | V | Note 7 | 8, 9 |

Notes:

- All inputs (except ZQ, V_{REF}) are held at either V_{IH} or V_{IL} .
- $I_{OUT} = 0 \text{ mA}$. $V_{DD} = V_{DD} \text{ max}$, $t_{KHKH} = t_{KHKH} \text{ min}$.
- Operating supply currents (I_{DD}) are measured at 100% bus utilization. I_{DD} of QDR family is current of device with 100% write and 100% read cycle. I_{DD} of DDR family is current of device with 100% write cycle (if $I_{DD}(\text{Write}) > I_{DD}(\text{Read})$) or 100% read cycle (if $I_{DD}(\text{Write}) < I_{DD}(\text{Read})$).
- All address / data inputs are static at either $V_{IN} > V_{IH}$ or $V_{IN} < V_{IL}$.
- Reference value. (Condition = NOP currents are valid when entering NOP after all pending READ and WRITE cycles are completed.)
- Outputs are impedance-controlled. $|I_{OH}| = (V_{DDQ}/2)/(RQ/5)$ for values of $175 \Omega \leq RQ \leq 350 \Omega$.
- Outputs are impedance-controlled. $I_{OL} = (V_{DDQ}/2)/(RQ/5)$ for values of $175 \Omega \leq RQ \leq 350 \Omega$.
- AC load current is higher than the shown DC values. AC I/O curves are available upon request.
- HSTL outputs meet JEDEC HSTL Class I and Class II standards.
- $0 \leq V_{IN} \leq V_{DDQ}$ for all input balls (except V_{REF} , ZQ, TCK, TMS, TDI ball).
If R1QD, R1QE, R1QF, R1QK, R1QL, R1QM, R1QP series, balls with ODT do not follow this spec.
- $0 \leq V_{OUT} \leq V_{DDQ}$ (except TDO ball), output disabled.

Thermal Resistance

| Parameter | Symbol | Airflow | Typ | Unit | Test condition | Notes |
|---------------------|---------------|---------|------|------|------------------|-------|
| Junction to Ambient | θ_{JA} | 1 m/s | 11.0 | °C/W | EIA/JEDEC JESD51 | 1 |
| Junction to Case | θ_{JC} | - | 4.4 | | | |

Notes:

- These parameters are calculated under the condition. These are reference values.
- $T_j = T_a + \theta_{JA} \times P_d$
 $T_j = T_c + \theta_{JC} \times P_d$
 where
 T_j : junction temperature when the device has achieved a steady-state after application of P_d (°C)
 T_a : ambient temperature (°C)
 T_c : temperature of external surface of the package or case (°C)
 θ_{JA} : thermal resistance from junction-to-ambient (°C/W)
 θ_{JC} : thermal resistance from junction-to-case (package) (°C/W)
 P_d : power dissipation that produced change in junction temperature (W) (cf.JESD51-2A)

Capacitance

($T_a = +25^\circ\text{C}$, Frequency = 1.0MHz, $V_{DD} = 1.8\text{V}$, $V_{DDQ} = 1.5\text{V}$)

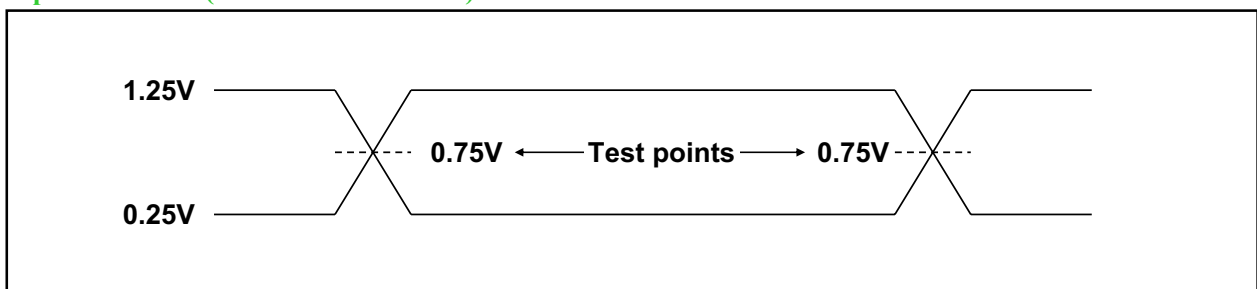
| Parameter | Symbol | Min | Typ | Max | Unit | Test condition | Notes |
|--|-----------|-----|-----|-----|------|-----------------------|-------|
| Input capacitance (SA, /R, /W, /BW, D(separate)) | C_{IN} | — | 4 | 5 | pF | $V_{IN} = 0\text{V}$ | 1, 2 |
| Clock input capacitance (K, /K, C, /C) | C_{CLK} | — | 4 | 5 | pF | $V_{CLK} = 0\text{V}$ | 1, 2 |
| Output capacitance (Q(separate), DQ(common), CQ, /CQ) | $C_{I/O}$ | — | 5 | 6 | pF | $V_{I/O} = 0\text{V}$ | 1, 2 |

Notes:

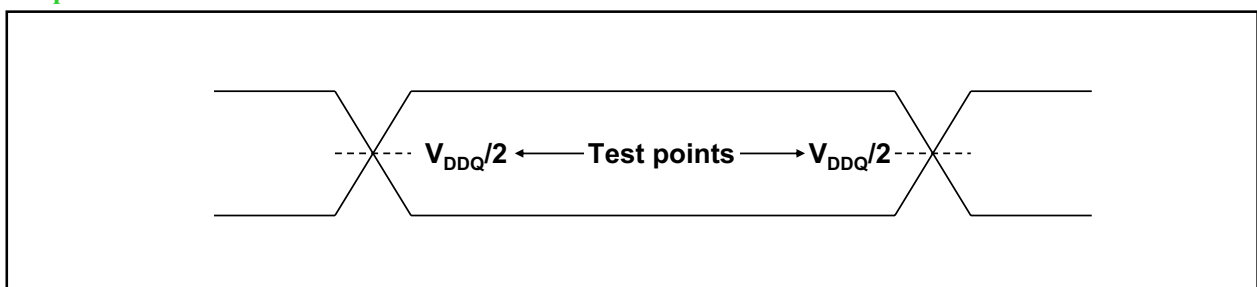
- These parameters are sampled and not 100% tested.
- Except JTAG (TCK, TMS, TDI, TDO) pins.

AC Test Conditions

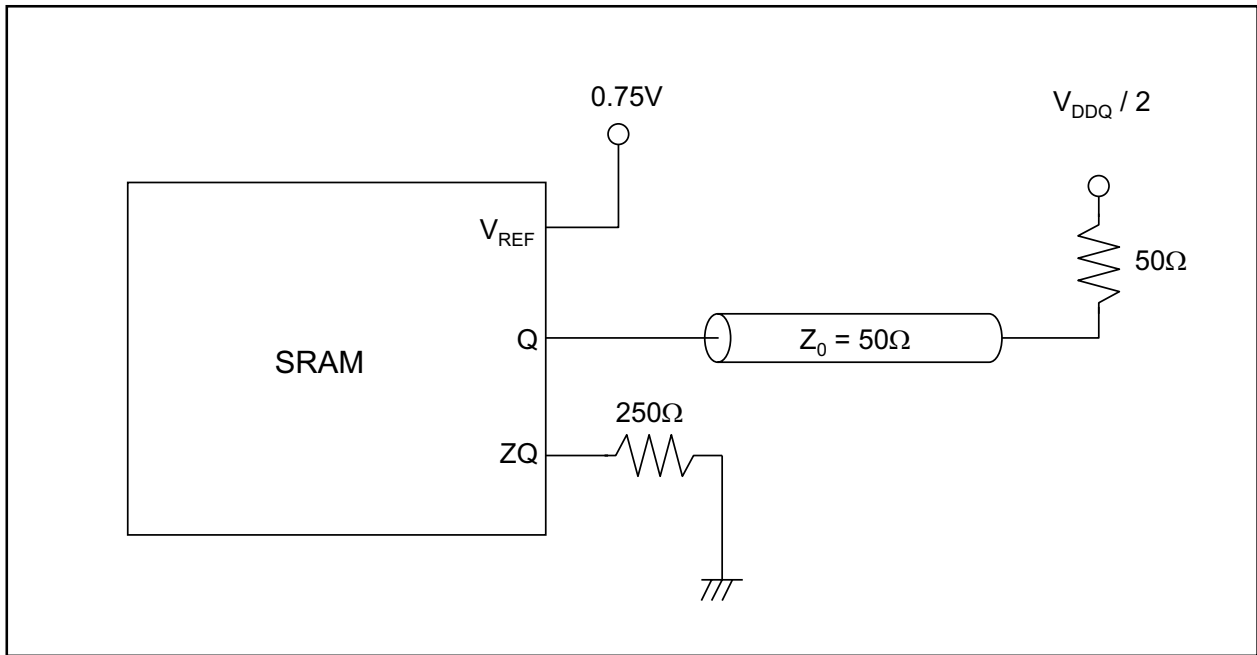
Input waveform (Rise/fall time $\leq 0.3\text{ ns}$)



Output waveform



Output load conditions



AC Operating Conditions

| Parameter | Symbol | Min | Typ | Max | Unit | Notes |
|--------------------|--------------|-----------------|-----|-----------------|------|------------|
| Input high voltage | $V_{IH(AC)}$ | $V_{REF} + 0.2$ | — | — | V | 1, 2, 3, 4 |
| Input low voltage | $V_{IL(AC)}$ | — | — | $V_{REF} - 0.2$ | V | 1, 2, 3, 4 |

Notes:

1. All voltages referenced to V_{SS} (GND).
During normal operation, V_{DDQ} must not exceed V_{DD} .
2. These conditions are for AC functions only, not for AC parameter test.
3. Overshoot: $V_{IH(AC)} \leq V_{DDQ} + 0.5\text{ V}$ for $t \leq t_{KHKH}/2$
Undershoot: $V_{IL(AC)} \geq -0.5\text{ V}$ for $t \leq t_{KHKH}/2$
Control input signals may not have pulse widths less than t_{KHKL} (min) or operate at cycle rates less than t_{KHKH} (min).
4. To maintain a valid level, the transitioning edge of the input must:
 - a. Sustain a constant slew rate from the current AC level through the target AC level, $V_{IL(AC)}$ or $V_{IH(AC)}$.
 - b. Reach at least the target AC level.
 - c. After the AC target level is reached, continue to maintain at least the target DC level, $V_{IL(DC)}$ or $V_{IH(DC)}$.

AC Characteristics (Read Latency = 2.5 cycle)

(Ta = 0 ~ +70°C @ R1Q*A*****BG-**R** series)

(Ta = -40 ~ +85°C @ R1Q*A*****BG-**I** series)

(V_{DD} = 1.8V ±0.1V, V_{DDQ} = 1.5V, V_{REF} = 0.75V)

| Parameter | Symbol | -19 | | -20 | | -22 | | -25 | | -27 | | -30 | | Unit | Notes |
|----------------------------------|-----------------------|-------|------|-------|------|-------|------|-------|------|-------|------|-------|------|-------|-------|
| | | Min | Max | Min | Max | Min | Max | Min | Max | Min | Max | Min | Max | | |
| Clock | | | | | | | | | | | | | | | |
| Average clock cycle time (K, /K) | t _{KHKH} | 1.875 | 4.00 | 2.00 | 4.00 | 2.22 | 4.00 | 2.50 | 4.00 | 2.66 | 4.00 | 3.00 | 4.00 | ns | |
| Clock high time (K, /K) | t _{KHKL} | 0.40 | — | 0.40 | — | 0.40 | — | 0.40 | — | 0.40 | — | 0.40 | — | Cycle | |
| Clock low time (K, /K) | t _{KLKH} | 0.40 | — | 0.40 | — | 0.40 | — | 0.40 | — | 0.40 | — | 0.40 | — | Cycle | |
| Clock to /clock (K to /K) | t _{KH/KH} | 0.425 | — | 0.425 | — | 0.425 | — | 0.425 | — | 0.425 | — | 0.425 | — | Cycle | |
| /Clock to clock (/K to K) | t _{/KHKH} | 0.425 | — | 0.425 | — | 0.425 | — | 0.425 | — | 0.425 | — | 0.425 | — | Cycle | |
| — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| DLL/PLL Timing | | | | | | | | | | | | | | | |
| Clock phase jitter (K, /K) | t _{KC var} | — | 0.15 | — | 0.15 | — | 0.15 | — | 0.20 | — | 0.20 | — | 0.20 | ns | 3 |
| Lock time (K) | t _{KC lock} | 20 | — | 20 | — | 20 | — | 20 | — | 20 | — | 20 | — | us | 2 |
| K static to DLL/PLL reset | t _{KC reset} | 30 | — | 30 | — | 30 | — | 30 | — | 30 | — | 30 | — | ns | 7 |
| Output Times | | | | | | | | | | | | | | | |
| K, /K high to output valid | t _{CHQV} | — | 0.45 | — | 0.45 | — | 0.45 | — | 0.45 | — | 0.45 | — | 0.45 | ns | |
| K, /K high to output hold | t _{CHQX} | -0.45 | — | -0.45 | — | -0.45 | — | -0.45 | — | -0.45 | — | -0.45 | — | ns | |
| K, /K high to echo clock valid | t _{CHCQV} | — | 0.45 | — | 0.45 | — | 0.45 | — | 0.45 | — | 0.45 | — | 0.45 | ns | |
| K, /K high to echo clock hold | t _{CHCQX} | -0.45 | — | -0.45 | — | -0.45 | — | -0.45 | — | -0.45 | — | -0.45 | — | ns | |
| CQ, /CQ high to output valid | t _{CQHqV} | — | 0.15 | — | 0.15 | — | 0.15 | — | 0.20 | — | 0.20 | — | 0.20 | ns | 4, 7 |
| CQ, /CQ high to output hold | t _{CQHqX} | -0.15 | — | -0.15 | — | -0.15 | — | -0.20 | — | -0.20 | — | -0.20 | — | ns | 4, 7 |
| K, /K high to output high-Z | t _{CHqZ} | — | 0.45 | — | 0.45 | — | 0.45 | — | 0.45 | — | 0.45 | — | 0.45 | ns | 5, 6 |
| K, /K high to output low-Z | t _{CHqX1} | -0.45 | — | -0.45 | — | -0.45 | — | -0.45 | — | -0.45 | — | -0.45 | — | ns | 5 |
| CQ high to QVLD valid | t _{QVLD} | -0.15 | 0.15 | -0.15 | 0.15 | -0.15 | 0.15 | -0.20 | 0.20 | -0.20 | 0.20 | -0.20 | 0.20 | ns | 7 |

R1QBA36CB* / R1QE36**CB* Series**

| Parameter | Symbol | -19 | | -20 | | -22 | | -25 | | -27 | | -30 | | Unit | Notes |
|---------------------------------------|------------------------------------|------|-----|------|-----|------|-----|------|-----|------|-----|------|-----|------|-------|
| | | Min | Max | Min | Max | Min | Max | Min | Max | Min | Max | Min | Max | | |
| Setup Times | | | | | | | | | | | | | | | |
| Address valid to K rising edge | t_{AVKH} (QDRII+ B2) | — | — | — | — | — | — | — | — | — | — | — | — | ns | 1, 8 |
| | t_{AVKH} (QDRII+ B4 & DDRII+) | 0.30 | — | 0.33 | — | 0.40 | — | 0.40 | — | 0.40 | — | 0.40 | — | | |
| Control inputs valid to K rising edge | t_{IVKH} (QDRII+ B2) | — | — | — | — | — | — | — | — | — | — | — | ns | 1, 8 | |
| | t_{IVKH} (QDRII+ B4 & DDRII+) | 0.30 | — | 0.33 | — | 0.40 | — | 0.40 | — | 0.40 | — | 0.40 | | | — |
| Data-in valid to K, /K rising edge | t_{DVKH} | 0.20 | — | 0.22 | — | 0.25 | — | 0.28 | — | 0.28 | — | 0.28 | — | ns | 1, 9 |
| Hold Times | | | | | | | | | | | | | | | |
| K rising edge to address hold | t_{KHAX} (QDRII+ B2) | — | — | — | — | — | — | — | — | — | — | — | — | ns | 1, 8 |
| | t_{KHAX} (QDRII+ B4 & DDRII+) | 0.30 | — | 0.33 | — | 0.40 | — | 0.40 | — | 0.40 | — | 0.40 | — | | |
| K rising edge to control inputs hold | t_{KHIX} (QDRII+ B2) | — | — | — | — | — | — | — | — | — | — | — | ns | 1, 8 | |
| | t_{KHIX} (QDRII+ B4 & DDRII+) | 0.30 | — | 0.33 | — | 0.40 | — | 0.40 | — | 0.40 | — | 0.40 | | | — |
| K, /K rising edge to data-in hold | t_{KHDx} | 0.20 | — | 0.22 | — | 0.25 | — | 0.28 | — | 0.28 | — | 0.28 | — | ns | 1, 9 |

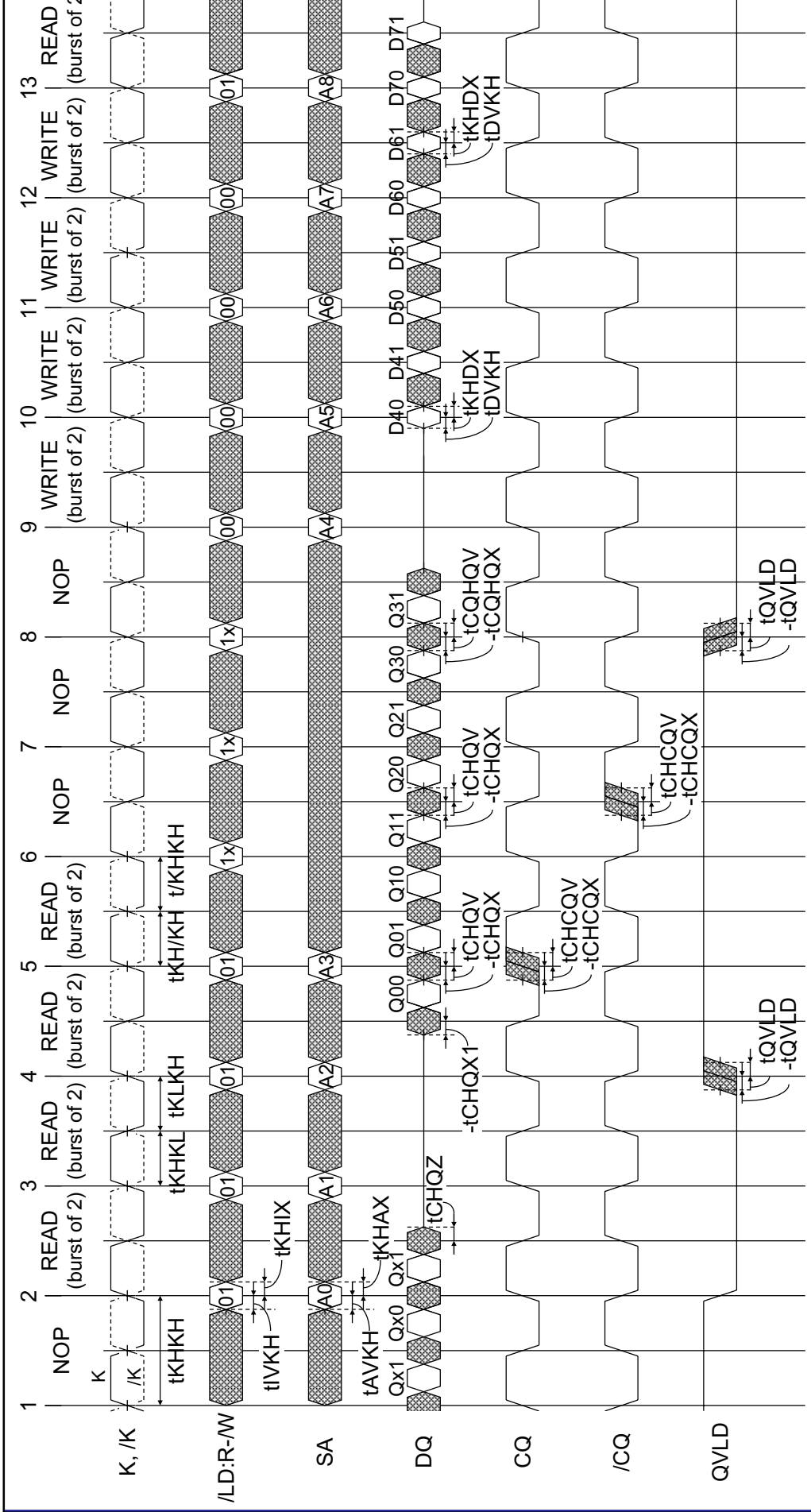
Notes:

1. This is a synchronous device. All addresses, data and control lines must meet the specified setup and hold times for all latching clock edges.
2. V_{DD} and V_{DDQ} slew rate must be less than 0.1 V DC per 50 ns for DLL/PLL lock retention. DLL/PLL lock time begins once V_{DD} , V_{DDQ} and input clock are stable.
It is recommended that the device is kept inactive during these cycles.
This specification meets the QDR common spec. of 20 us.
3. Clock phase jitter is the variance from clock rising edge to the next expected clock rising edge.
4. Echo clock is very tightly controlled to data valid / data hold. By design, there is a ± 0.1 ns variation from echo clock to data. The datasheet parameters reflect tester guardbands and test setup variations.
5. Transitions are measured ± 100 mV from steady-state voltage.
6. At any given voltage and temperature t_{CHQZ} is less than t_{CHQX1} and t_{CHQV} .
7. These parameters are sampled.
8. t_{AVKH} , t_{IVKH} , t_{KHAX} , t_{KHIX} spec is determined by the actual frequency regardless of Part Number (Marking Name). The following is the spec for the actual frequency.
0.30 ns for ≤ 533 MHz & > 500 MHz
0.33 ns for ≤ 500 MHz & > 450 MHz
0.40 ns for ≤ 450 MHz & ≥ 250 MHz
9. t_{DVKH} , t_{KHDx} spec is determined by the actual frequency regardless of Part Number (Marking Name). The following is the spec for the actual frequency.
0.20 ns for ≤ 533 MHz & > 500 MHz
0.22 ns for ≤ 500 MHz & > 450 MHz
0.25 ns for ≤ 450 MHz & > 400 MHz
0.28 ns for ≤ 400 MHz & ≥ 250 MHz

Remarks:

1. Test conditions as specified with the output loading as shown in AC Test Conditions unless otherwise noted.
2. Control input signals may not be operated with pulse widths less than t_{KHKL} (min).
3. V_{DDQ} is +1.5 V DC. V_{REF} is +0.75 V DC.
4. Control signals are /R, /W (QDR series), /LD, R-/W (DDR series), /BW, /BW0, /BW1, /BW2 and /BW3. Setup and hold times of /BWx signals must be the same as those of Data-in signals.

Timing Waveforms (DDRII+, B2, Read Latency = 2.5 cycle)



- Notes:
1. Q00 refers to output from address A0. Q01 refers to output from the next internal burst address following A0, etc.
 2. Outputs are disabled (high-Z) N clock cycle after the last read cycle. Here, N = Read Latency + Burst Length × 0.5.
 3. In this example, if address A8 = A7, then data Q80 = D70, Q81 = D71, etc. Write data is forwarded immediately as read results.
 4. To control read and write operations, /BW signals must operate at the same timing as Data-in signals.
 5. The third NOP cycle is not necessary for correct device operation; however, at high clock frequencies it may be required to prevent bus contention.

JTAG Specification

These products support a limited set of JTAG functions as in IEEE standard 1149.1.

Disabling the Test Access Port

It is possible to use this device without utilizing the TAP. To disable the TAP controller without interfering with normal operation of the device, TCK must be tied to V_{SS} to preclude mid level inputs.

TDI and TMS are internally pulled up and may be unconnected, or may be connected to VDD through a pull up resistor.

TDO should be left unconnected.

Test Access Port (TAP) Pins

| Symbol I/O | Pin assignments | Description | Notes |
|------------|-----------------|---|-------|
| TCK | 2R | Test clock input. All inputs are captured on the rising edge of TCK and all outputs propagate from the falling edge of TCK. | |
| TMS | 10R | Test mode select. This is the command input for the TAP controller state machine. | |
| TDI | 11R | Test data input. This is the input side of the serial registers placed between TDI and TDO. The register placed between TDI and TDO is determined by the state of the TAP controller state machine and the instruction that is currently loaded in the TAP instruction. | |
| TDO | 1R | Test data output. Output changes in response to the falling edge of TCK. This is the output side of the serial registers placed between TDI and TDO. | |

Notes:

The device does not have TRST (TAP reset). The Test-Logic Reset state is entered while TMS is held high for five rising edges of TCK. The TAP controller state is also reset on SRAM POWER-UP.

TAP DC Operating Characteristics

(Ta = 0 ~ +70°C @ R1Q*A*****BG-**R** series)

(Ta = -40 ~ +85°C @ R1Q*A*****BG-**I** series)

(V_{DD} = 1.8V ±0.1V)

| Parameter | Symbol | Min | Typ | Max | Unit | Notes |
|------------------------|------------------|------|-----|-----------------------|------|--|
| Input high voltage | V _{IH} | +1.3 | — | V _{DD} + 0.3 | V | |
| Input low voltage | V _{IL} | -0.3 | — | +0.5 | V | |
| Input leakage current | I _{LI} | -5.0 | — | +5.0 | μA | 0 V ≤ V _{IN} ≤ V _{DD} |
| Output leakage current | I _{LO} | -5.0 | — | +5.0 | μA | 0 V ≤ V _{IN} ≤ V _{DD} , output disabled |
| Output low voltage | V _{OL1} | — | — | 0.2 | V | I _{OLC} = 100 μA |
| | V _{OL2} | — | — | 0.4 | V | I _{OLT} = 2 mA |
| Output high voltage | V _{OH1} | 1.6 | — | — | V | I _{OHC} = 100 μA |
| | V _{OH2} | 1.4 | — | — | V | I _{OHT} = 2 mA |

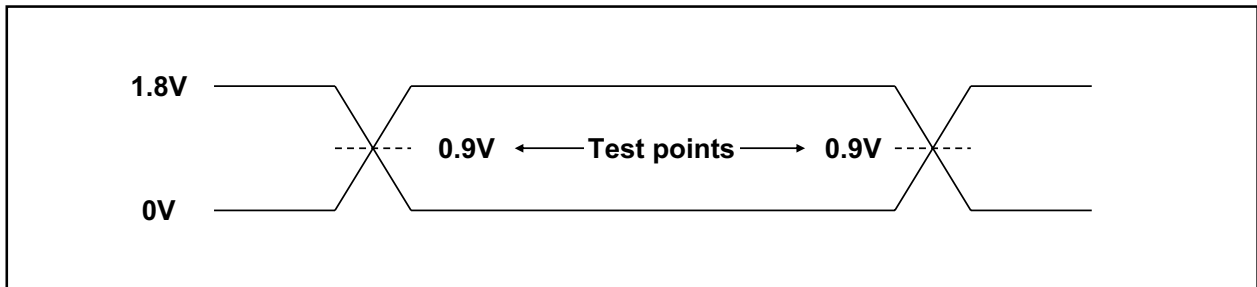
Notes:

- All voltages referenced to V_{SS} (GND).
- At power-up, V_{DD} and V_{DDQ} are assumed to be a linear ramp from 0V to V_{DD}(min.) or V_{DDQ}(min.) within 200ms. During this time V_{DDQ} < V_{DD} and V_{IH} < V_{DDQ}.
During normal operation, V_{DDQ} must not exceed V_{DD}.

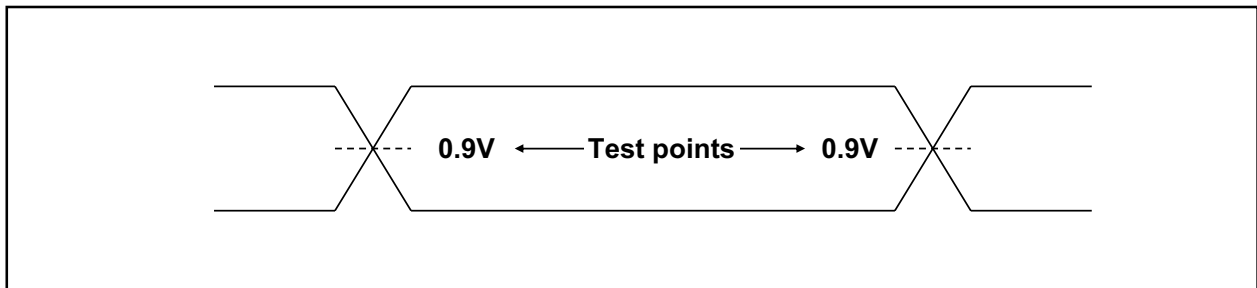
TAP AC Test Conditions

| Parameter | Symbol | Conditions | Unit | Notes |
|---|------------------|-------------|------|-------|
| Input timing measurement reference levels | V_{REF} | 0.9 | V | |
| Input pulse levels | V_{IL}, V_{IH} | 0 to 1.8 | V | |
| Input rise/fall time | t_r, t_f | ≤ 1.0 | ns | |
| Output timing measurement reference levels | | 0.9 | V | |
| Test load termination supply voltage (V_{TT}) | | 0.9 | V | |
| Output load | | See figures | | |

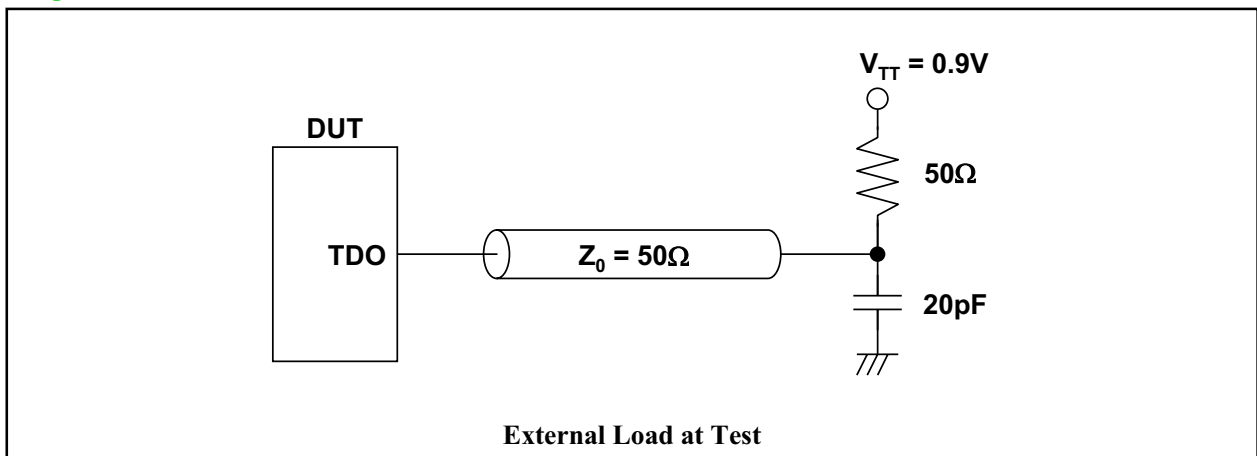
Input waveform



Output waveform



Output load condition



TAP AC Operating Characteristics

(Ta = 0 ~ +70°C @ R1Q*A*****BG-**R** series)

(Ta = -40 ~ +85°C @ R1Q*A*****BG-**I** series)

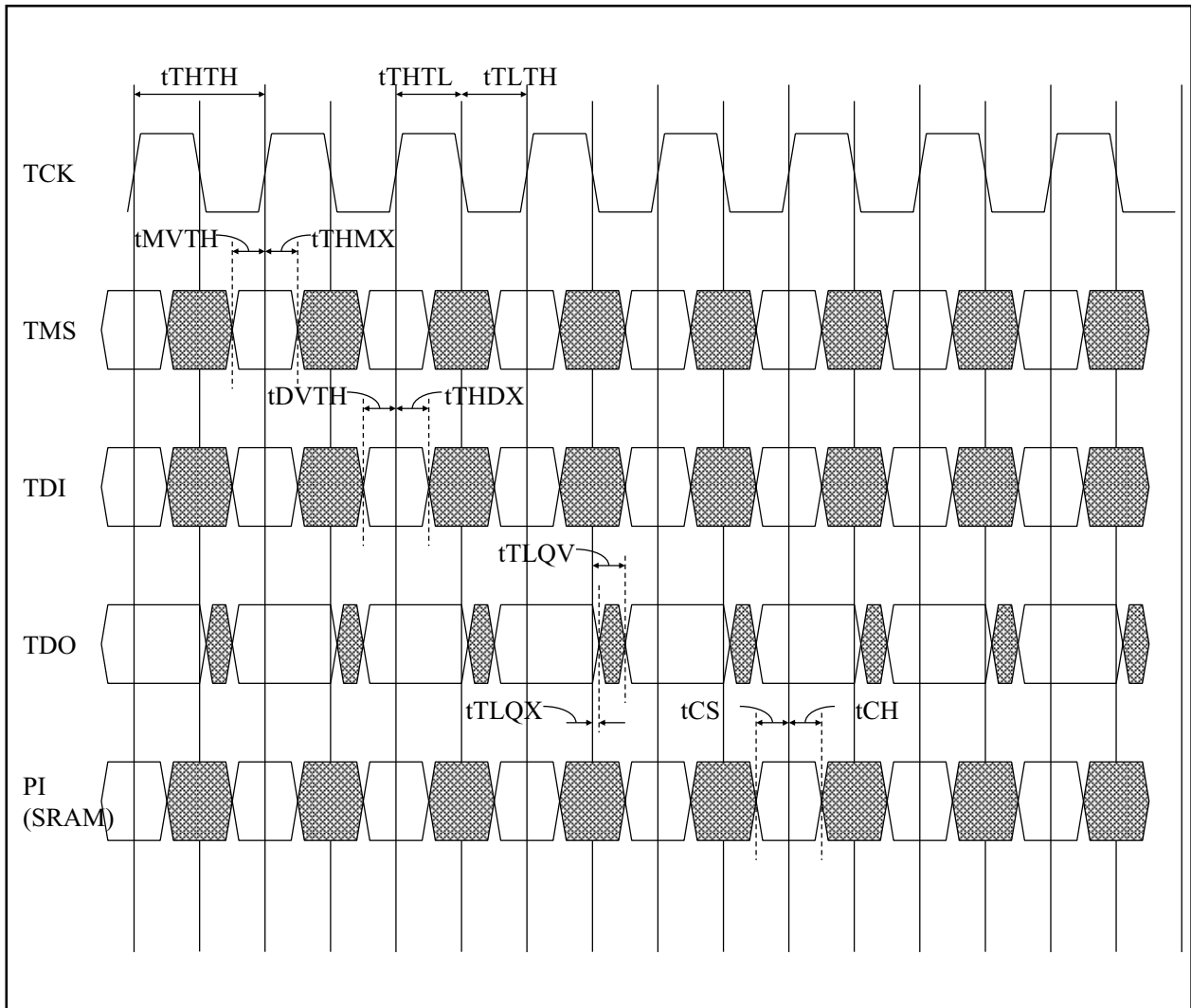
(V_{DD} = 1.8V ±0.1V)

| Parameter | Symbol | Min | Typ | Max | Unit | Notes |
|------------------------------|-------------------|-----|-----|-----|------|-------|
| Test clock (TCK) cycle time | t _{THTH} | 50 | — | — | ns | |
| TCK high pulse width | t _{THTL} | 20 | — | — | ns | |
| TCK low pulse width | t _{TLTH} | 20 | — | — | ns | |
| Test mode select (TMS) setup | t _{MVTH} | 5 | — | — | ns | |
| TMS hold | t _{THMX} | 5 | — | — | ns | |
| Capture setup | t _{CS} | 5 | — | — | ns | 1 |
| Capture hold | t _{CH} | 5 | — | — | ns | 1 |
| TDI valid to TCK high | t _{DVTH} | 5 | — | — | ns | |
| TCK high to TDI invalid | t _{THDX} | 5 | — | — | ns | |
| TCK low to TDO unknown | t _{TLQX} | 0 | — | — | ns | |
| TCK low to TDO valid | t _{TLQV} | — | — | 10 | ns | |

Notes:

- t_{CS} + t_{CH} defines the minimum pause in RAM I/O pad transitions to assure pad data capture.

TAP Controller Timing Diagram



Test Access Port Registers

| Register name | Length | Symbol | Notes |
|------------------------|----------|------------|-------|
| Instruction register | 3 bits | IR [2:0] | |
| Bypass register | 1 bit | BP | |
| ID register | 32 bits | ID [31:0] | |
| Boundary scan register | 109 bits | BS [109:1] | |

TAP Controller Instruction Set

| IR2 | IR1 | IR0 | Instruction | Description | Notes |
|-----|-----|-----|-------------------|--|------------|
| 0 | 0 | 0 | EXTEST | The EXTEST instruction allows circuitry external to the component package to be tested. Boundary scan register cells at output balls are used to apply test vectors, while those at input balls capture test results. Typically, the first test vector to be applied using the EXTEST instruction will be shifted into the boundary scan register using the PRELOAD instruction. Thus, during the Update-IR state of EXTEST, the output driver is turned on and the PRELOAD data is driven onto the output balls. | 1, 2, 3, 5 |
| 0 | 0 | 1 | IDCODE | The IDCODE instruction causes the ID ROM to be loaded into the ID register when the controller is in capture-DR mode and places the ID register between the TDI and TDO balls in shift-DR mode. The IDCODE instruction is the default instruction loaded in at power up and any time the controller is placed in the Test-Logic-Reset state. | |
| 0 | 1 | 0 | SAMPLE-Z | If the SAMPLE-Z instruction is loaded in the instruction register, all RAM outputs are forced to an inactive drive state (high-Z), moving the TAP controller into the capture-DR state loads the data in the RAMs input into the boundary scan register, and the boundary scan register is connected between TDI and TDO when the TAP controller is moved to the shift-DR state. | 3, 4, 5 |
| 0 | 1 | 1 | RESERVED | The RESERVED instructions are not implemented but are reserved for future use. Do not use these instructions. | |
| 1 | 0 | 0 | SAMPLE (/PRELOAD) | When the SAMPLE instruction is loaded in the instruction register, moving the TAP controller into the capture-DR state loads the data in the RAMs input and I/O buffers into the boundary scan register. Because the RAM clock(s) are independent from the TAP clock (TCK) it is possible for the TAP to attempt to capture the I/O ring contents while the input buffers are in transition (i.e., in a metastable state). Although allowing the TAP to SAMPLE metastable input will not harm the device, repeatable results cannot be expected. Moving the controller to shift-DR state then places the boundary scan register between the TDI and TDO balls. | 3, 5 |
| 1 | 0 | 1 | RESERVED | - | |
| 1 | 1 | 0 | RESERVED | - | |
| 1 | 1 | 1 | BYPASS | The BYPASS instruction is loaded in the instruction register when the bypass register is placed between TDI and TDO. This occurs when the TAP controller is moved to the shift-DR state. This allows the board level scan path to be shortened to facilitate testing of other devices in the scan path. | |

Notes:

1. Data in output register is not guaranteed if EXTEST instruction is loaded.
2. After performing EXTEST, power-up conditions are required in order to return part to normal operation.
3. RAM input signals must be stabilized for long enough to meet the TAPs input data capture setup plus hold time (t_{CS} plus t_{CH}). The RAMs clock inputs need not be paused for any other TAP operation except capturing the I/O ring contents into the boundary scan register.
4. Clock recovery initialization cycles are required after boundary scan.
5. For R1QD, R1QE, R1QF, R1QK, R1QL, R1QM, R1QP series, ODT is disabled in EXTEST, SAMPLE-Z or SAMPLE mode.

Boundary Scan Order

| Bit # | Ball ID | Signal names | | | Bit # | Ball ID | Signal names | | |
|-------|---------|-----------------|-----------------|-----------------|-------|---------|--------------|-----------|-----------|
| | | x9 | x18 | x36 | | | x9 | x18 | x36 |
| 1 | 6R | /C or NC or ODT | /C or NC or ODT | /C or NC or ODT | 36 | 10E | NC | NC | DQ15 |
| 2 | 6P | C or QVLD | C or QVLD | C or QVLD | 37 | 10D | NC | NC | NC |
| 3 | 6N | SA | SA | SA | 38 | 9E | NC | NC | NC |
| 4 | 7P | SA | SA | SA | 39 | 10C | NC | DQ7 | DQ17 |
| 5 | 7N | SA | SA | SA | 40 | 11D | NC | NC | DQ16 |
| 6 | 7R | SA | SA | SA | 41 | 9C | NC | NC | NC |
| 7 | 8R | SA | SA | SA | 42 | 9D | NC | NC | NC |
| 8 | 8P | SA | SA | SA | 43 | 11B | DQ4 | DQ8 | DQ8 |
| 9 | 9R | SA | SA | SA | 44 | 11C | NC | NC | DQ7 |
| 10 | 11P | DQ0 | DQ0 | DQ0 | 45 | 9B | NC | NC | NC |
| 11 | 10P | NC | NC | DQ9 | 46 | 10B | NC | NC | NC |
| 12 | 10N | NC | NC | NC | 47 | 11A | CQ | CQ | CQ |
| 13 | 9P | NC | NC | NC | 48 | 10A | SA | SA | NC |
| 14 | 10M | NC | DQ1 | DQ11 | 49 | 9A | SA | SA | SA |
| 15 | 11N | NC | NC | DQ10 | 50 | 8B | SA | SA | SA |
| 16 | 9M | NC | NC | NC | 51 | 7C | SA | SA | SA |
| 17 | 9N | NC | NC | NC | 52 | 6C | SA | SA0 or NC | SA0 or NC |
| 18 | 11L | DQ1 | DQ2 | DQ2 | 53 | 8A | /LD | /LD | /LD |
| 19 | 11M | NC | NC | DQ1 | 54 | 7A | NC | NC | /BW1 |
| 20 | 9L | NC | NC | NC | 55 | 7B | /BW | /BW0 | /BW0 |
| 21 | 10L | NC | NC | NC | 56 | 6B | K | K | K |
| 22 | 11K | NC | DQ3 | DQ3 | 57 | 6A | /K | /K | /K |
| 23 | 10K | NC | NC | DQ12 | 58 | 5B | NC | NC | /BW3 |
| 24 | 9J | NC | NC | NC | 59 | 5A | NC | /BW1 | /BW2 |
| 25 | 9K | NC | NC | NC | 60 | 4A | R-/W | R-/W | R-/W |
| 26 | 10J | DQ2 | DQ4 | DQ13 | 61 | 5C | SA | SA | SA |
| 27 | 11J | NC | NC | DQ4 | 62 | 4B | SA | SA | SA |
| 28 | 11H | ZQ | ZQ | ZQ | 63 | 3A | SA | SA | SA |
| 29 | 10G | NC | NC | NC | 64 | 2A | NC | NC | NC |
| 30 | 9G | NC | NC | NC | 65 | 1A | /CQ | /CQ | /CQ |
| 31 | 11F | NC | DQ5 | DQ5 | 66 | 2B | NC | DQ9 | DQ27 |
| 32 | 11G | NC | NC | DQ14 | 67 | 3B | NC | NC | DQ18 |
| 33 | 9F | NC | NC | NC | 68 | 1C | NC | NC | NC |
| 34 | 10F | NC | NC | NC | 69 | 1B | NC | NC | NC |
| 35 | 11E | DQ3 | DQ6 | DQ6 | 70 | 3D | NC | DQ10 | DQ19 |

Boundary Scan Order

| Bit # | Ball ID | Signal names | | | Bit # | Ball ID | Signal names | | |
|-------|---------|--------------|-------|-------|-------|---------|---------------|---------------|---------------|
| | | x9 | x18 | x36 | | | x9 | x18 | x36 |
| 71 | 3C | NC | NC | DQ28 | 91 | 2L | DQ7 | DQ15 | DQ33 |
| 72 | 1D | NC | NC | NC | 92 | 3L | NC | NC | DQ24 |
| 73 | 2C | NC | NC | NC | 93 | 1M | NC | NC | NC |
| 74 | 3E | DQ5 | DQ11 | DQ20 | 94 | 1L | NC | NC | NC |
| 75 | 2D | NC | NC | DQ29 | 95 | 3N | NC | DQ16 | DQ25 |
| 76 | 2E | NC | NC | NC | 96 | 3M | NC | NC | DQ34 |
| 77 | 1E | NC | NC | NC | 97 | 1N | NC | NC | NC |
| 78 | 2F | NC | DQ12 | DQ30 | 98 | 2M | NC | NC | NC |
| 79 | 3F | NC | NC | DQ21 | 99 | 3P | DQ8 | DQ17 | DQ26 |
| 80 | 1G | NC | NC | NC | 100 | 2N | NC | NC | DQ35 |
| 81 | 1F | NC | NC | NC | 101 | 2P | NC | NC | NC |
| 82 | 3G | DQ6 | DQ13 | DQ22 | 102 | 1P | NC | NC | NC |
| 83 | 2G | NC | NC | DQ31 | 103 | 3R | SA | SA | SA |
| 84 | 1H | /DOFF | /DOFF | /DOFF | 104 | 4R | SA | SA | SA |
| 85 | 1J | NC | NC | NC | 105 | 4P | SA | SA | SA |
| 86 | 2J | NC | NC | NC | 106 | 5P | SA | SA | SA |
| 87 | 3K | NC | DQ14 | DQ23 | 107 | 5N | SA | SA | SA |
| 88 | 3J | NC | NC | DQ32 | 108 | 5R | SA | SA | SA |
| 89 | 2K | NC | NC | NC | 109 | — | INTER- NAL | INTER- NAL | INTER- NAL |
| 90 | 1K | NC | NC | NC | — | — | — | — | — |

Notes:

In boundary scan mode,

1. Clock balls (K, /K, C, /C) are referenced to each other and must be at opposite logic levels for reliable operation.
2. CQ and /CQ data are synchronized to the respective C and /C (except EXTEST, SAMPLE-Z).
3. If C and /C tied high, CQ is generated with respect to K and /CQ is generated with respect to /K (except EXTEST, SAMPLE-Z).

ID Register

| # | Revision number (31 : 29) | | | Type number (28 : 12) | | | | | | | | | | | | Vendor JEDEC code (11 : 1) | | | | | | | Start bit (0) → | | | | | | | | | |
|--------|---------------------------|----|----|-----------------------|----|----|----|----|----|----|----|----|----|----|----|----------------------------|----|----|----|----|----|----|-----------------|---|---|---|---|---|---|---|---|---|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| Symbol | R | R | R | 0 | C | M | M | M | A | W | W | 0 | 1 | Q | Q | Q | B | O | S | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 |

| | | | | |
|--------------|---|---|------------|--|
| R R R | | | | |
| 0 | 0 | 0 | Revision 0 | |
| 0 | 0 | 1 | Revision 1 | |
| 0 | 1 | 0 | Revision 2 | |
| 0 | 1 | 1 | Revision 3 | |
| : | : | : | | |

| | | |
|----------|------------------------|--|
| Q | | |
| 0 | II (QDR-II, DDR-II) | |
| 1 | II+ (QDR-II+, DDR-II+) | |

| | | |
|----------|-----|--|
| Q | | |
| 0 | DDR | |
| 1 | QDR | |

| | | |
|----------|----------------------------|--|
| C | | |
| 0 | 36M&72M w/o ODT, 144M,288M | |
| 1 | 36M&72M w/ ODT | |

| | | |
|----------|---------------------------------------|--|
| Q | | |
| 0 | Latency=1.5 (@II), Latency=2.0 (@II+) | |
| 1 | Latency=2.5 (@II+) | |

| | | | |
|--------------|---|---|-----------------|
| M M M | | | |
| 0 | 1 | 0 | Density = 36Mb |
| 0 | 1 | 1 | Density = 72Mb |
| 1 | 0 | 1 | Density = 144Mb |
| 1 | 1 | 0 | Density = 288Mb |

| | | |
|----------|-----------------------------|--|
| B | | |
| 0 | Burst Length = 2 word burst | |
| 1 | Burst Length = 4 word burst | |

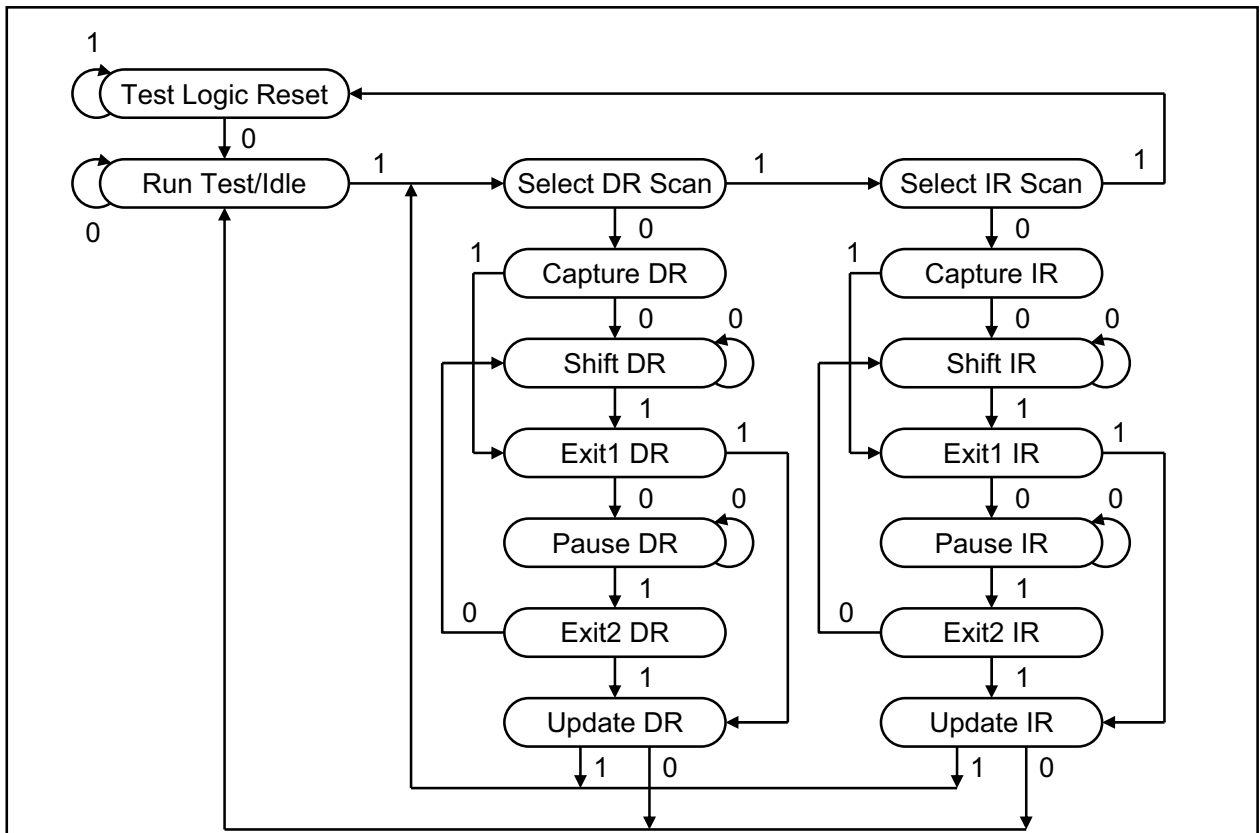
| | | |
|----------|-------------|--|
| O | | |
| 0 | without ODT | |
| 1 | with ODT | |

| | | |
|----------|----------------------------|--|
| A | | |
| 0 | 144M&288M w/o ODT, 36M,72M | |
| 1 | 144M&288M w/ ODT | |

| | | |
|----------|--------------|--|
| S | | |
| 0 | Common I/O | |
| 1 | Separate I/O | |

| | | |
|------------|---|-----|
| W W | | |
| 0 | 0 | x9 |
| 1 | 0 | x18 |
| 1 | 1 | x36 |

TAP Controller State Diagram



Notes:

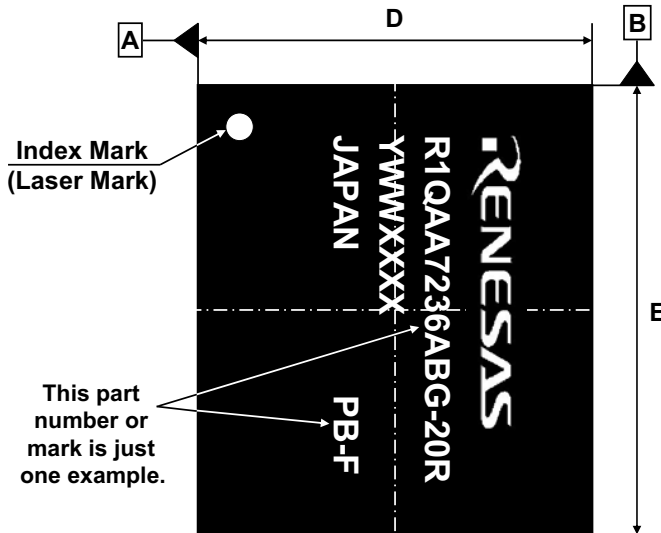
The value adjacent to each state transition in this figure represents the signal present at TMS at the time of a rising edge at TCK.

No matter what the original state of the controller, it will enter Test-Logic-Reset when TMS is held high for at least five rising edges of TCK.

Package Dimensions and Marking Information

Both Pb parts and Pb-free parts are available.

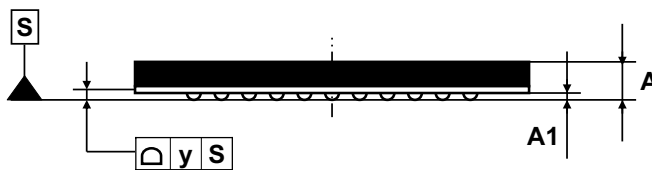
| JEITA Package Code | Renesas Code | Previous Code | Mass (typ.) |
|----------------------|--------------|---------------|-------------|
| P-LBGA165-15x17-1.00 | PLBG0165FD-A | 165FHE | 0.6 g |



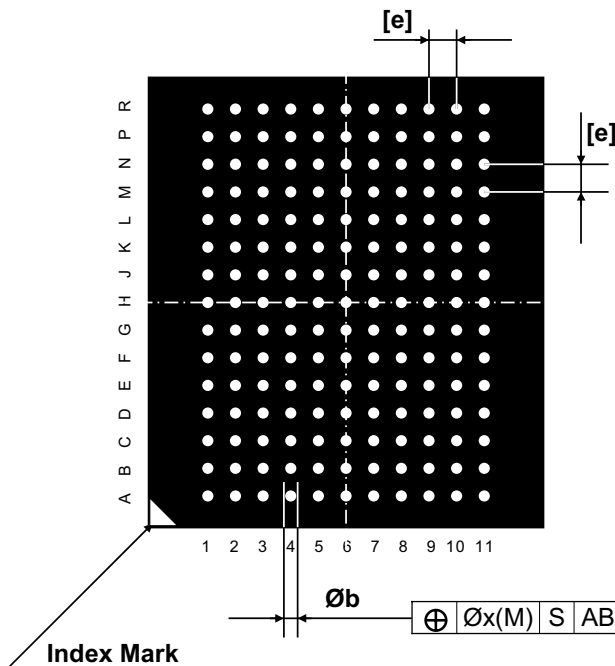
Top View

Marking Information

- 1st row : Vender name (RENESAS)
- 2nd row: Part number
- 3rd row : Y : Year code
WW : Week code
XXXX : Renesas internal use
- 4th row : Country name (JAPAN)
+ "None" --- Pb parts
+ "PB-F" --- Pb-free parts



Side View



Bottom View

| Reference Symbol | Dimension in mm | | |
|------------------|-----------------|------|------|
| | Min | Nom | Max |
| D | 14.9 | 15.0 | 15.1 |
| E | 16.9 | 17.0 | 17.1 |
| A | - | - | 1.4 |
| A1 | 0.27 | 0.32 | 0.37 |
| [e] | - | 1.0 | - |
| b | 0.45 | 0.5 | 0.55 |
| x | - | - | 0.2 |
| y | - | - | 0.15 |

Revision History (1)

| Rev. | Date | # | Comment |
|------------------|-----------|---|--|
| Rev. 0.00a | '08.10.08 | 1 | Initial issue. |
| Rev. 0.00b | '08.10.09 | 1 | Corrected typos in "DC Characteristics": VOH/VOL= VDDQ/2±1.12 → ±0.12. |
| Rev. 0.00c | '08.11.19 | 1 | Added "Speed Bin Table". Added "ODT timing chart" to QDR11+ and DDR11+ series. |
| Rev. 0.00d | '08.11.28 | 1 | Corrected typos in "General Description": ODT pin = Q0~Qn → D0~Dn. |
| | | 2 | Updated "Recommended DC Operating Conditions": Vref =0.68~0.95V → 0.7~0.8V (11+ series). |
| | | 3 | Added comment to "Thermal Resistance" section: These are reference values. |
| Rev. 0.00e | '08.12.07 | 1 | Added "Generation Number Table". |
| Rev. 0.00f -1 | '09.02.09 | 1 | Changed Marking Name in "Part Number Definition Table". |
| | | 2 | Added marking information to "Package Dimension Information" section. |
| | | 3 | Corrected ODT On/Off timing in "ODT pin" table. |
| | | 4 | Updated minimum frequency of QDR11+ and DDR11+ series. |
| | | 5 | Changed pin name in "Pin Arrangement" of DDR11+ series: SA0/SA1 → NC. |
| | | 6 | Added the row to "K Truth Table": RL=2.0 and RL=2.5. |
| Rev. 0.00g -1 | '09.02.24 | 1 | Updated SET-UP cycles: 11+ series DLL lock time = 20us → 2048 cycle. |
| | | 2 | Added comment to "ODT on/off Timing Chart" section: ODT on/off switching timings are edge aligned with CQ or /CQ. |
| | | 3 | Updated "Thermal Resistance". |
| Rev. 0.00h | '09.03.04 | 1 | Added "-50" speed bin to QDR 11 B2 x18/x36 series. |
| Rev. 0.00i | '09.06.15 | 1 | Updated "Package Dimensions": Mass=0.7→0.6g, A(max)=1.46→1.4mm. |
| | | 2 | Updated "Operating/Standby Supply Currents". |
| Rev. 0.01a | '09.10.25 | 1 | Added comment to "Power-up and Initialization Sequence" section: Apply Vref after Vddq or at the same time as Vddq. |
| | | 2 | Updated "Speed Bin Table". |
| Rev. 0.02a | '10.02.01 | 1 | Added "Renesas QDR SRAM Homepage URL" to notes of front page. |
| | | 2 | Updated "Power-up and Initialization Sequence". |
| | | 3 | Updated "DLL Constraints". |
| | | 4 | Updated "Operating Supply Current" and "Standby Supply Current". |
| | | 5 | Updated "Thermal Resistance". |
| | | 6 | Changed remarks of "AC Characteristics" on "Control signals". |
| Rev. 0.03a | '10.04.01 | 1 | Changed company name, RENESAS logo and base color from those of Renesas Technology to Renesas Electronics. |
| | | 2 | Changed vender name marking in "Package Dimensions and Marking Information" section. |
| | | 3 | Added "A" generation to 72M series. |
| Rev. 0.04a | '10.06.10 | 1 | Changed the pin description for NC pin. |
| | | 2 | Changed note 4 of "TAP Controller Instruction Set": "Clock recovery initialization cycles are required after boundary scan" |
| Rev. 0.05a | '10.06.25 | 1 | Changed Vddq range of 11+ series: Vddq=1.5±0.1V → 1.4V ~ Vdd. |
| | | 2 | Added Note.8 and Note.9 to AC Characteristics table for 11+ series. |
| | | 3 | Updated Speed Bin Table for 144M. |
| Rev. 0.05b | '10.07.02 | 1 | Added Note.2 to Generation Number Table. |
| | | 2 | Updated Speed Bin Table for 36M and 72M. |
| Rev. 0.05c | '10.07.24 | 1 | Updated Operating Supply Current and Standby Supply Current Table for 36M and 72M. |
| Rev. 0.06a | '10.09.20 | 1 | Changed Initialization Sequence: Initial cycle of 11+ series = 2048cycles → 20us. |
| Rev. 0.07a | '10.10.06 | 1 | Added Note.9 to AC Characteristics table for 11 series. |
| Rev. 0.07b | '10.10.30 | 1 | Updated AC Characteristics for the series of RL=2.0. |
| | | 2 | Updated Speed Bin Table for 72M/36M/144M. |
| | | 3 | Added R1QNA, R1QPA series to 144M QDR lineup. |
| | | 4 | Changed JTAG/ID Register (ID Code): #27="0": 36M&72M w/o ODT, 144M, 288M "1": 36M&72M w/ ODT #23="0": 144M&288M w/o ODT, 36M, 72M "1": 144M&288M w/ ODT #(26, 25, 24)="100"→"101" (144M), "101"→"110" (288M). |

Revision History (2)

| Rev. | Date | # | Comment |
|------------|-----------|---|---|
| Rev. 0.08a | '11.05.23 | 1 | Added Note.7 to tQVLD in AC Characteristics table for 11+ series. |
| | | 2 | Changed description of tQVLD in AC Characteristics table for RL=2 series: CQ high to QVLD valid → /CQ high to QVLD valid. |
| | | 3 | Updated Remarks 4 of AC Characteristics table. |
| | | 4 | Updated tKHKH(max) in AC Characteristics table for QDR11+ B2 series. |
| | | 5 | Added 13 x15 mm package lineup to 36M 11+ & 72M 11/11+ series. |
| Rev. 0.08b | '11.07.17 | 1 | Updated "Package Dimensions" for 13 x15 mm package. |
| | | 2 | Updated "Thermal Resistance" for 13 x15 mm package. |
| | | 3 | Changed Title: "Ordering Informaion" → "Part Number Definition", "Speed Bin Table" → "Renesas **M QDR/DDR SRAM Lineup" |
| Rev. 0.09a | '11.09.14 | 1 | Updated Specification for ODT Option 2. |

NOTES:

1. This document is provided for reference purposes only so that Renesas customers may select the appropriate Renesas products for their use. Renesas neither makes warranties or representations with respect to the accuracy or completeness of the information contained in this document nor grants any license to any intellectual property rights or any other rights of Renesas or any third party with respect to the information in this document.
2. Renesas shall have no liability for damages or infringement of any intellectual property or other rights arising out of the use of any information in this document, including, but not limited to, product data, diagrams, charts, programs, algorithms, and application circuit examples.
3. You should not use the products or the technology described in this document for the purpose of military applications such as the development of weapons of mass destruction or for the purpose of any other military use. When exporting the products or technology described herein, you should follow the applicable export control laws and regulations, and procedures required by such laws and regulations.
4. All information included in this document such as product data, diagrams, charts, programs, algorithms, and application circuit examples, is current as of the date this document is issued. Such information, however, is subject to change without any prior notice. Before purchasing or using any Renesas products listed in this document, please confirm the latest product information with a Renesas sales office. Also, please pay regular and careful attention to additional and different information to be disclosed by Renesas such as that disclosed through our website. (<http://www.renesas.com>)
5. Renesas has used reasonable care in compiling the information included in this document, but Renesas assumes no liability whatsoever for any damages incurred as a result of errors or omissions in the information included in this document.
6. When using or otherwise relying on the information in this document, you should evaluate the information in light of the total system before deciding about the applicability of such information to the intended application. Renesas makes no representations, warranties or guarantees regarding the suitability of its products for any particular application and specifically disclaims any liability arising out of the application and use of the information in this document or Renesas products.
7. The products described in this document are intended for usage in general electronics applications (computer, personal equipment, office equipment, measuring equipment, industrial robotics, domestic appliances, etc.). The products are not designed, manufactured, tested or warranted for applications or otherwise in systems the failure or malfunction of which may cause a direct threat to human life or create a risk of human injury or which require especially high quality and reliability such as safety systems, or equipment or systems for transportation and traffic, healthcare, combustion control, aerospace and aeronautics, nuclear power, or undersea communication transmission. Unintended usage of the products shall be made at the customer's own risk. Renesas shall have no liability for damages arising out of the uses set forth above.
8. Notwithstanding the preceding paragraph, you should not use Renesas products for the purposes listed below:
 - (1) artificial life support devices or systems
 - (2) surgical implantations
 - (3) healthcare intervention (e.g., excision, administration of medication, etc.)
 - (4) any other purposes that pose a direct threat to human lifeRenesas shall have no liability for damages arising out of the uses set forth in the above and purchasers who elect to use Renesas products in any of the foregoing applications shall indemnify and hold harmless Renesas Electronics Corp., its affiliated companies and their officers, directors, and employees against any and all damages arising out of such applications.
9. You should use the products described herein within the range specified by Renesas, especially with respect to the maximum rating, operating supply voltage range, movement power voltage range, heat radiation characteristics, installation and other product characteristics. Renesas shall have no liability for malfunctions or damages arising out of the use of Renesas products beyond such specified ranges.
10. Although Renesas endeavors to improve the quality and reliability of its products, IC products have specific characteristics such as the occurrence of failure at a certain rate and malfunctions under certain use conditions. Please be sure to implement safety measures to guard against the possibility of physical injury, and injury or damage caused by fire in the event of the failure of a Renesas product, such as safety design for hardware and software including but not limited to redundancy, fire control and malfunction prevention, appropriate treatment for aging degradation or any other applicable measures. Among others, since the evaluation of microcomputer software alone is very difficult, please evaluate the safety of the final products or system manufactured by you.
11. In case Renesas products listed in this document are detached from the products to which the Renesas products are attached or affixed, the risk of accident such as swallowing by infants and small children is very high. You should implement safety measures so that Renesas products may not be easily detached from your products. Renesas shall have no liability for damages arising out of such detachment.
12. This document may not be reproduced or duplicated, in any form, in whole or in part, without prior written approval from Renesas.
13. Please contact a Renesas sales office if you have any questions regarding the information contained in this document, Renesas semiconductor products, or if you have any other inquiries.

**Renesas Sales Offices**<http://www.renesas.com>Refer to "<http://www.renesas.com/>" for the latest and detailed information.**Renesas Electronics America Inc.**2880 Scott Boulevard Santa Clara, CA 95050-2554, U.S.A.
Tel: +1-408-588-6000, Fax: +1-408-588-6130**Renesas Electronics Canada Limited**1101 Nicholson Road, Newmarket, Ontario L3Y 9C3, Canada
Tel: +1-905-898-5441, Fax: +1-905-898-3220**Renesas Electronics Europe Limited**Dukes Meadow, Millboard Road, Bourne End, Buckinghamshire,
SL8 5FH, U.K
Tel: +44-1628-585-100, Fax: +44-1628-585-900**Renesas Electronics Europe GmbH**Arcadiastrasse 10, 40472 Düsseldorf, Germany
Tel: +49-211-6503-0, Fax: +49-211-6503-1327**Renesas Electronics (China) Co., Ltd.**7th Floor, Quantum Plaza, No.27 ZhiChunLu Haidian District,
Beijing 100083, P.R.China
Tel: +86-10-8235-1155, Fax: +86-10-8235-7679**Renesas Electronics (Shanghai) Co., Ltd.**Unit 204, 205, AZIA Center, No.1233 Lujiazui Ring Rd., Pudong District,
Shanghai 200120, China
Tel: +86-21-5877-1818, Fax: +86-21-6887-7858 / -7898**Renesas Electronics Hong Kong Limited**Unit 1601-1613, 16/F., Tower 2, Grand Century Place,
193 Prince Edward Road West, Mongkok, Kowloon, Hong Kong
Tel: +852-2886-9318, Fax: +852 2886-9022/9044**Renesas Electronics Taiwan Co., Ltd.**7F, No. 363 Fu Shing North Road Taipei, Taiwan, R.O.C.
Tel: +886-2-8175-9600, Fax: +886 2-8175-9670**Renesas Electronics Singapore Pte. Ltd.**1 harbourFront Avenue, #06-10, keppel Bay Tower, Singapore 098632
Tel: +65-6213-0200, Fax: +65-6278-8001**Renesas Electronics Malaysia Sdn.Bhd.**Unit 906, Block B, Menara Amcorp, Amcorp Trade Centre, No. 18,
Jln Persiaran Barat, 46050 Petaling Jaya, Selangor Darul Ehsan, Malaysia
Tel: +60-3-7955-9390, Fax: +60-3-7955-9510**Renesas Electronics Korea Co., Ltd.**11F., Samik Laviel' or Bldg., 720-2 Yeoksam-Dong, Kangnam-Ku,
Seoul 135-080, Korea
Tel: +82-2-558-3737, Fax: +82-2-558-5141