

28-BIT TO 56-BIT REGISTERED BUFFER WITH ADDRESS-PARITY TEST

FEATURES

- Member of the Texas Instruments Widebus+™ Family
- Pinout Optimizes DDR2 DIMM PCB Layout
- 1-to-2 Outputs Supports Stacked DDR2 DIMMs
- One Device Per DIMM Required
- Chip-Select Inputs Gate the Data Outputs from Changing State and Minimizes System Power Consumption
- Output Edge-Control Circuitry Minimizes Switching Noise in an Unterminated Line
- Supports SSTL_18 Data Inputs
- Differential Clock (CLK and $\overline{\text{CLK}}$) Inputs

- Supports LVCMOS Switching Levels on the Chip-Select Gate-Enable, Control, and $\overline{\text{RESET}}$ Inputs
- Checks Parity on DIMM-Independent Data Inputs
- Supports Industrial Temperature Range (-40°C to 85°C)
- $\overline{\text{RESET}}$ Input Disables Differential Input Receivers, Resets All Registers, and Forces All Outputs Low, Except QERR

APPLICATIONS

- DDR2 registered DIMM

DESCRIPTION

This 28-bit 1:2 configurable registered buffer is designed for 1.7-V to 1.9-V V_{CC} operation. One device per DIMM is required to drive up to 18 SDRAM loads or two devices per DIMM are required to drive up to 36 SDRAM loads.

All inputs are SSTL_18, except the chip-select gate-enable (CSGEN), control (C), and reset ($\overline{\text{RESET}}$) inputs, which are LVCMOS. All outputs are edge-controlled circuits optimized for unterminated DIMM loads, and meet SSTL_18 specifications, except the open-drain error (QERR) output.

The 74SSTUB32868 operates from a differential clock (CLK and $\overline{\text{CLK}}$). Data are registered at the crossing of CLK going high and $\overline{\text{CLK}}$ going low.

The 74SSTUB32868 accepts a parity bit from the memory controller on the parity bit (PAR_IN) input, compares it with the data received on the DIMM-independent D-inputs (D1–D5, D7, D9–D12, D17–D28 when C = 0; or D1–D12, D17–D20, D22, D24–D28 when C = 1) and indicates whether a parity error has occurred on the open-drain QERR pin (active low). The convention is even parity, i.e., valid parity is defined as an even number of ones across the DIMM-independent data inputs combined with the parity input bit. To calculate parity, all DIMM-independent D-inputs must be tied to a known logic state.

The 74SSTUB32868 includes a parity checking function. Parity, which arrives one cycle after the data input to which it applies, is checked on the PAR_IN input of the device. Two clock cycles after the data are registered, the corresponding QERR signal is generated.

ORDERING INFORMATION

| T_A | PACKAGE ⁽¹⁾ | | ORDERABLE PART NUMBER | TOP-SIDE MARKING |
|---------------|------------------------|---------------|-----------------------|------------------|
| -40°C to 85°C | TFBGA-ZRH | Tape and Reel | 74SSTUB32868ZRHR | SB868 |

(1) For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI website at www.ti.com.



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

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These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

DESCRIPTION (CONTINUED)

If an error occurs and the \overline{QERR} output is driven low, it stays latched low for a minimum of two clock cycles or until \overline{RESET} is driven low. If two or more consecutive parity errors occur, the \overline{QERR} output is driven low and latched low for a clock duration equal to the parity error duration or until \overline{RESET} is driven low. If a parity error occurs on the clock cycle before the device enters the low-power mode (LPM) and the \overline{QERR} output is driven low, it stays latched low for the LPM duration plus two clock cycles or until \overline{RESET} is driven low. The DIMM-dependent signals ($\overline{DCKE0}$, $\overline{DCKE1}$, $\overline{DODT0}$, $\overline{DODT1}$, $\overline{DCS0}$ and $\overline{DCS1}$) are not included in the parity check computation.

The C input controls the pinout configuration from register-A configuration (when low) to register-B configuration (when high). The C input should not be switched during normal operation. It should be hard-wired to a valid low or high level to configure the register in the desired mode.

In the DDR2 RDIMM application, \overline{RESET} is specified to be completely asynchronous with respect to CLK and \overline{CLK} . Therefore, no timing relationship can be ensured between the two. When entering reset, the register is cleared and the data outputs is driven low quickly, relative to the time to disable the differential input receivers. However, when coming out of reset, the register becomes active quickly, relative to the time to enable the differential input receivers. As long as the data inputs are low, and the clock is stable during the time from the low-to-high transition of \overline{RESET} until the input receivers are fully enabled, the design of the 74SSTUB32868 must ensure that the outputs remain low, thus ensuring no glitches on the output.

To ensure defined outputs from the register before a stable clock has been supplied, \overline{RESET} must be held in the low state during power up.

The device supports low-power standby operation. When \overline{RESET} is low, the differential input receivers are disabled, and undriven (floating) data, clock, and reference voltage (V_{REF}) inputs are allowed. In addition, when \overline{RESET} is low, all registers are reset and all outputs are forced low except \overline{QERR} . The LVCMOS \overline{RESET} and C inputs always must be held at a valid logic high or low level.

The device also supports low-power active operation by monitoring both system chip select ($\overline{DCS0}$ and $\overline{DCS1}$) and CSGEN inputs and will gate the Qn outputs from changing states when CSGEN, $\overline{DCS0}$, and $\overline{DCS1}$ inputs are high. If CSGEN, $\overline{DCS0}$ or $\overline{DCS1}$ input is low, the Qn outputs function normally. Also, if both $\overline{DCS0}$ and $\overline{DCS1}$ inputs are high, the device will gate the \overline{QERR} output from changing states. If either $\overline{DCS0}$ or $\overline{DCS1}$ is low, the \overline{QERR} output functions normally. The \overline{RESET} input has priority over the $\overline{DCS0}$ and $\overline{DCS1}$ control and when driven low forces the Qn outputs low, and the \overline{QERR} output high. If the chip-select control functionality is not desired, then the CSGEN input can be hard-wired to ground, in which case, the setup-time requirement for $\overline{DCS0}$ and $\overline{DCS1}$ would be the same as for the other D data inputs. To control the low-power mode with $\overline{DCS0}$ and $\overline{DCS1}$ only, then the CSGEN input should be pulled up to V_{CC} through a pullup resistor.

The two V_{REF} pins (A5 and AB5) are connected together internally by approximately 150 Ω . However, it is necessary to connect only one of the two V_{REF} pins to the external V_{REF} power supply. An unused V_{REF} pin should be terminated with a V_{REF} coupling capacitor.

ABSOLUTE MAXIMUM RATINGS

 over operating free-air temperature range (unless otherwise noted)⁽¹⁾

| | | VALUE | UNIT |
|------------------|--|-------------------------------|------|
| V _{CC} | Supply voltage range | -0.5 to 2.5 | V |
| V _I | Input voltage range (see notes ⁽²⁾ and ⁽³⁾) | -0.5 to V _{CC} + 0.5 | V |
| V _O | Output voltage range (see notes ⁽²⁾ and ⁽³⁾) | -0.5 to V _{CC} + 0.5 | V |
| I _{IK} | Input clamp current (V _I < 0, V _I > V _{CC}) | ±50 | mA |
| I _{OK} | Output clamp current (V _I < 0, V _O > V _{CC}) | ±50 | mA |
| I _O | Continuous output current (V _O = 0 to V _{CC}) | ±50 | mA |
| I _{CC} | Continuous current through each V _{CC} or GND | ±100 | mA |
| R _{θJA} | Thermal resistance, junction-to-ambient (see note ⁽⁴⁾) | No airflow | 46.8 |
| | | Airflow 200 ft/min | 42.9 |
| R _{θJC} | Thermal resistance, junction-to-case (see note ⁽⁴⁾) | No airflow | 17.9 |
| T _{stg} | Storage temperature range | -65 to 150 | °C |

- (1) Stresses beyond those listed under *absolute maximum ratings* may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under *recommended operating conditions* is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
- (2) The input and output negative voltage ratings may be exceeded if the input and output clamp-current ratings are observed.
- (3) This value is limited to 2.5 V maximum.
- (4) The package thermal impedance is calculated in accordance with JESD 51-7.

RECOMMENDED OPERATING CONDITIONS

 over operating free-air temperature range (unless otherwise noted)⁽¹⁾

| | | MIN | NOM | MAX | UNIT | |
|--|---------------------------------|--|---------------------------|--------------------------|-----------------|----|
| SUPPLY VOLTAGES, CURRENTS AND TEMPERATURE RANGE | | | | | | |
| V _{CC} | Supply voltage | 1.7 | | | 1.9 | V |
| V _{REF} | Reference voltage | 0.49 x V _{CC} | 0.5 x V _{CC} | 0.51 x V _{CC} | V | |
| V _{TT} | Termination voltage | V _{REF} - 40 mV | V _{REF} | V _{REF} + 40 mV | V | |
| V _I | Input voltage | 0 | | | V _{CC} | V |
| V _{IH} | AC high-level input voltage | Data inputs, $\overline{\text{DCSn}}$, PAR_IN | V _{REF} + 250 mV | | V | |
| V _{IL} | AC low-level input voltage | Data inputs, $\overline{\text{DCSn}}$, PAR_IN | V _{REF} - 250 mV | | V | |
| V _{IH} | DC high-level input voltage | Data inputs, $\overline{\text{DCSn}}$, PAR_IN | V _{REF} + 125 mV | | V | |
| V _{IL} | DC low-level input voltage | Data inputs, $\overline{\text{DCSn}}$, PAR_IN | V _{REF} - 125 mV | | V | |
| V _{IH} | High-level input voltage | $\overline{\text{RESET}}$, CSGEN, C | 0.65 x V _{CC} | | V | |
| V _{IL} | Low-level input voltage | $\overline{\text{RESET}}$, CSGEN, C | 0.35 x V _{CC} | | V | |
| V _{ICR} | Common-mode input voltage range | CLK, $\overline{\text{CLK}}$ | 0.675 | | 1.125 | V |
| V _{I(PP)} | Peak-to-peak input voltage | CLK, $\overline{\text{CLK}}$ | 0.6 | | V | |
| I _{OH} | High-level output current | Q outputs | | | -8 | mA |
| I _{OL} | Low-level output current | Q outputs | | | 8 | mA |
| | | $\overline{\text{QERR}}$ output | 30 | | | |
| T _A | Operating free-air temperature | -40 | | | 85 | °C |

- (1) The $\overline{\text{RESET}}$ and Cn inputs of the device must be held at valid logic voltage levels (not floating) to ensure proper device operation. The differential inputs must not be floating unless $\overline{\text{RESET}}$ is low. See the TI application report, Implications of Slow or Floating CMOS Inputs, literature number [SCBA004](#).

ELECTRICAL CHARACTERISTICS

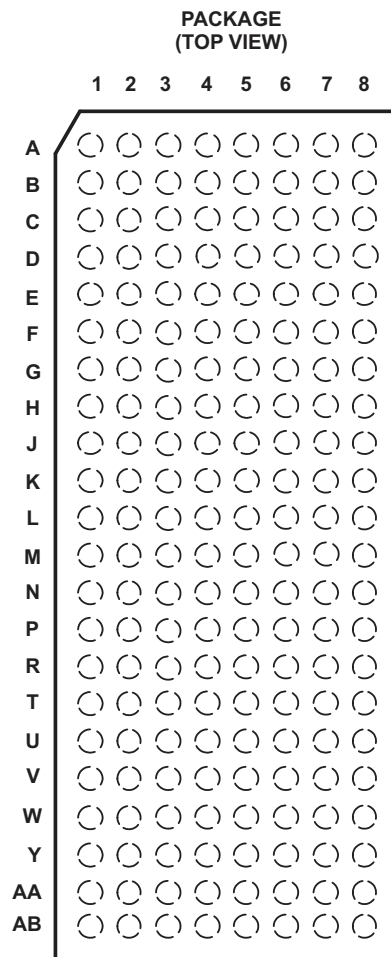
over operating free-air temperature range (unless otherwise noted)

| PARAMETER | | TEST CONDITION | V _{CC} | MIN | TYP ⁽¹⁾ | MAX | UNIT |
|----------------------|--|--|--------------------|-----------------------|--------------------|-----|-----------------------|
| V _{OH} | Q outputs | I _{OH} = -100 μA | 1.7 V to 1.9 V | V _{CC} - 0.2 | | | V |
| | | I _{OH} = -6 mA | 1.7 V | 1.2 | | | |
| V _{OL} | Q outputs | I _{OL} = 100 μA | 1.7 V to 1.9 V | 0.2 | | | V |
| | | I _{OL} = 6 mA | 1.7 V | 0.5 | | | |
| | $\overline{\text{QERR}}$ | I _{OL} = 25 mA | 1.7 V | 0.5 | | | |
| I _I | PAR_IN | V _I = GND | 1.9 V | -5 | | | μA |
| | | V _I = V _{CC} | | 25 | | | |
| | All other inputs ⁽²⁾ | V _I = V _{CC} or GND | | ±5 | | | |
| I _{OZ} | $\overline{\text{QERR}}$ outputs | V _O = V _{CC} or GND | 1.9 V | ±10 | | | μA |
| I _{CC} | Static standby ⁽³⁾ | $\overline{\text{RESET}}$ = GND | 1.9 V | 200 ⁽³⁾ | | | μA |
| | Static operating | $\overline{\text{RESET}}$ = V _{CC} , V _I = V _{IH(AC)} or V _{IL(AC)} | | I _O = 0 | 80 | | |
| I _{CC(D)} | Dynamic operating – clock only | $\overline{\text{RESET}}$ = V _{CC} , V _I = V _{IH(AC)} or V _{IL(AC)} , CLK and $\overline{\text{CLK}}$ switching 50% duty cycle | I _O = 0 | 1.8 V | 64 | | μA/MHz |
| | Dynamic operating – per each data input | $\overline{\text{RESET}}$ = V _{CC} , V _I = V _{IH(AC)} or V _{IL(AC)} , CLK and $\overline{\text{CLK}}$ switching 50% duty cycle. One data input switching at one half clock frequency, 50% duty cycle | | | 37 | | μA/clock MHz/D inputs |
| I _{CC(DLP)} | Chip-select-enabled low-power active mode – clock only | $\overline{\text{RESET}}$ = V _{CC} , V _I = V _{IH(AC)} or V _{IL(AC)} , CLK and $\overline{\text{CLK}}$ switching 50% duty cycle | I _O = 0 | 1.8 V | 68 | | μA/MHz |
| | Chip-select-enabled low-power active mode | $\overline{\text{RESET}}$ = V _{CC} , V _I = V _{IH(AC)} or V _{IL(AC)} , CLK and $\overline{\text{CLK}}$ switching 50% duty cycle. One data input switching at one half clock frequency, 50% duty cycle | | | 2.7 | | μA/clock MHz/D inputs |
| C _I | Data inputs, DCSn, PAR_IN, CSGEN | V _I = V _{REF} ±250 mV | 1.8 V | 2 | 2.5 | 3 | pF |
| | CLK, $\overline{\text{CLK}}$ | V _{ICR} = 0.9 V, V _{I(PP)} = 600 mV | | 2 | 3 | | |
| | $\overline{\text{RESET}}$ | V _I = V _{CC} or GND | | 4 | | | |

(1) All typical values are at V_{CC} = 1.8 V, T_A = 25°C.

(2) Each V_{REF} pin (A5 or AB5) should be tested independently, with the other (untested) pin open.

(3) The maximum static standby current I_{CC} is 100 μA if the device is exposed to commercial temperature range (0°C to 70°C) only. For industrial temperature range (-40°C to 85°C), the static I_{CC} is 200 μA.

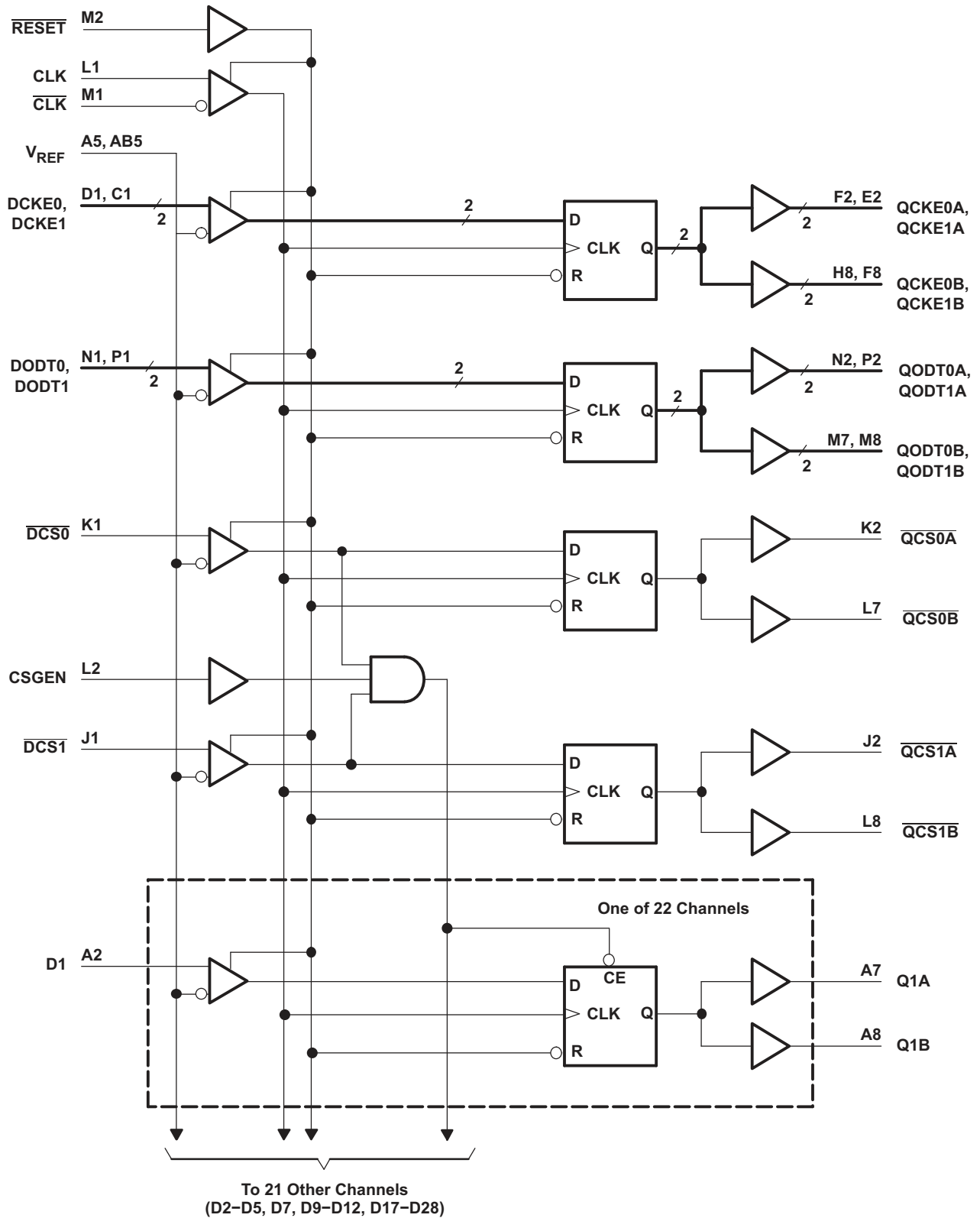


Terminal Assignment for Register-A (C = 0)

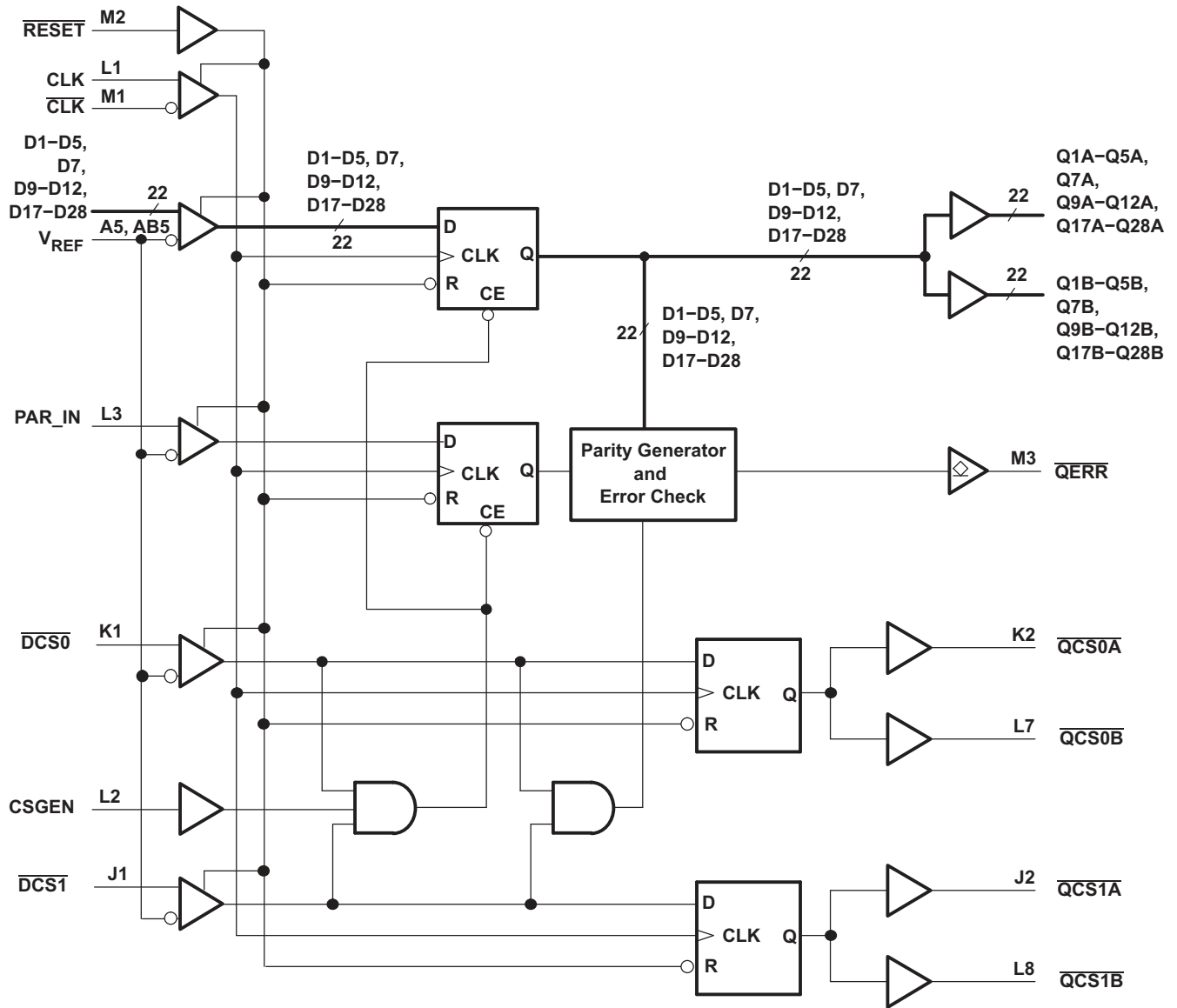
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|----|-------------------------|---------------------------|--------------------------|-----------------|------------------|-----------------|------------------|------------------|
| A | D2 | D1 | C | GND | V _{REF} | GND | Q1A | Q1B |
| B | D4 | D3 | V _{CC} | V _{CC} | V _{CC} | V _{CC} | Q2A | Q2B |
| C | D6 (DCKE1) | D5 | GND | GND | GND | GND | Q3A | Q3B |
| D | D8 (DCKE0) | D7 | V _{CC} | V _{CC} | V _{CC} | V _{CC} | Q4A | Q4B |
| E | D9 | Q6A (QCKE1A) | GND | GND | GND | GND | Q5A | Q5B |
| F | D10 | Q8A (QCKE0A) | V _{CC} | V _{CC} | V _{CC} | V _{CC} | Q7A | Q6B (QCKE1B) |
| G | D11 | Q10A | GND | GND | GND | GND | Q9A | Q7B |
| H | D12 | Q12A | V _{CC} | V _{CC} | V _{CC} | V _{CC} | Q11A | Q8B (QCKE0B) |
| J | D13 (DCS1) | Q13A (QCS1A) | GND | GND | GND | GND | Q10B | Q9B |
| K | D14 (DCS0) | Q14A (QCS0A) | V _{CC} | V _{CC} | V _{CC} | V _{CC} | Q12B | Q11B |
| L | CLK | CSGEN | PAR_IN | GND | GND | GND | Q14B (QCS0B) | Q13B (QCS1B) |
| M | $\overline{\text{CLK}}$ | $\overline{\text{RESET}}$ | $\overline{\text{QERR}}$ | V _{CC} | V _{CC} | V _{CC} | Q15B (QODT0B) | Q16B (QODT1B) |
| N | D15 (DODT0) | Q15A (QODT0A) | GND | GND | GND | GND | Q17B | Q18B |
| P | D16 (DODT1) | Q16A (QODT1A) | V _{CC} | V _{CC} | V _{CC} | V _{CC} | Q19B | Q20B |
| R | D17 | Q17A | GND | GND | GND | GND | Q18A | Q21B |
| T | D18 | Q19A | V _{CC} | V _{CC} | V _{CC} | V _{CC} | Q20A | Q22B |
| U | D19 | Q21A | GND | GND | GND | GND | Q22A | Q23B |
| V | D20 | Q23A | V _{CC} | V _{CC} | V _{CC} | V _{CC} | Q24A | Q24B |
| W | D21 | D22 | GND | GND | GND | GND | Q25A | Q25B |
| Y | D23 | D24 | V _{CC} | V _{CC} | V _{CC} | V _{CC} | Q26A | Q26B |
| AA | D25 | D26 | GND | GND | GND | GND | Q27A | Q27B |
| AB | D27 | D28 | NC | V _{CC} | V _{REF} | V _{CC} | Q28A | Q28B |

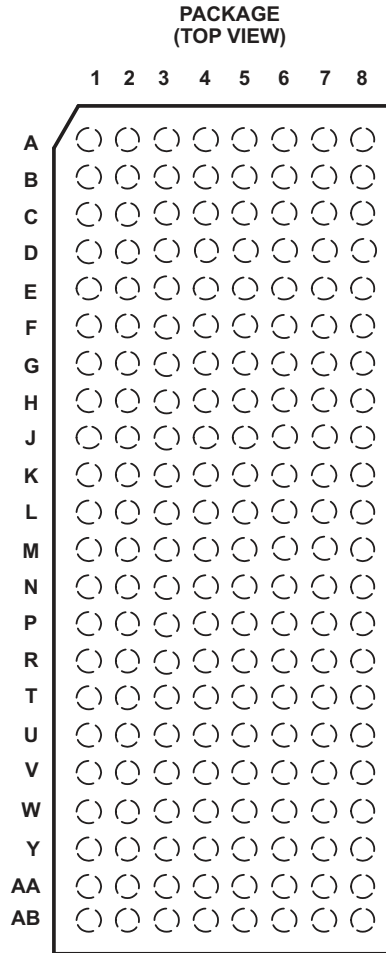
- A. Each pin name in parentheses indicates the DDR2 DIMM signal name.
- B. NC - No internal connection.

Logic Diagram for Register-A Configuration (Positive Logic); C = 0



Parity Logic Diagram for Register-A Configuration (Positive Logic); C = 0

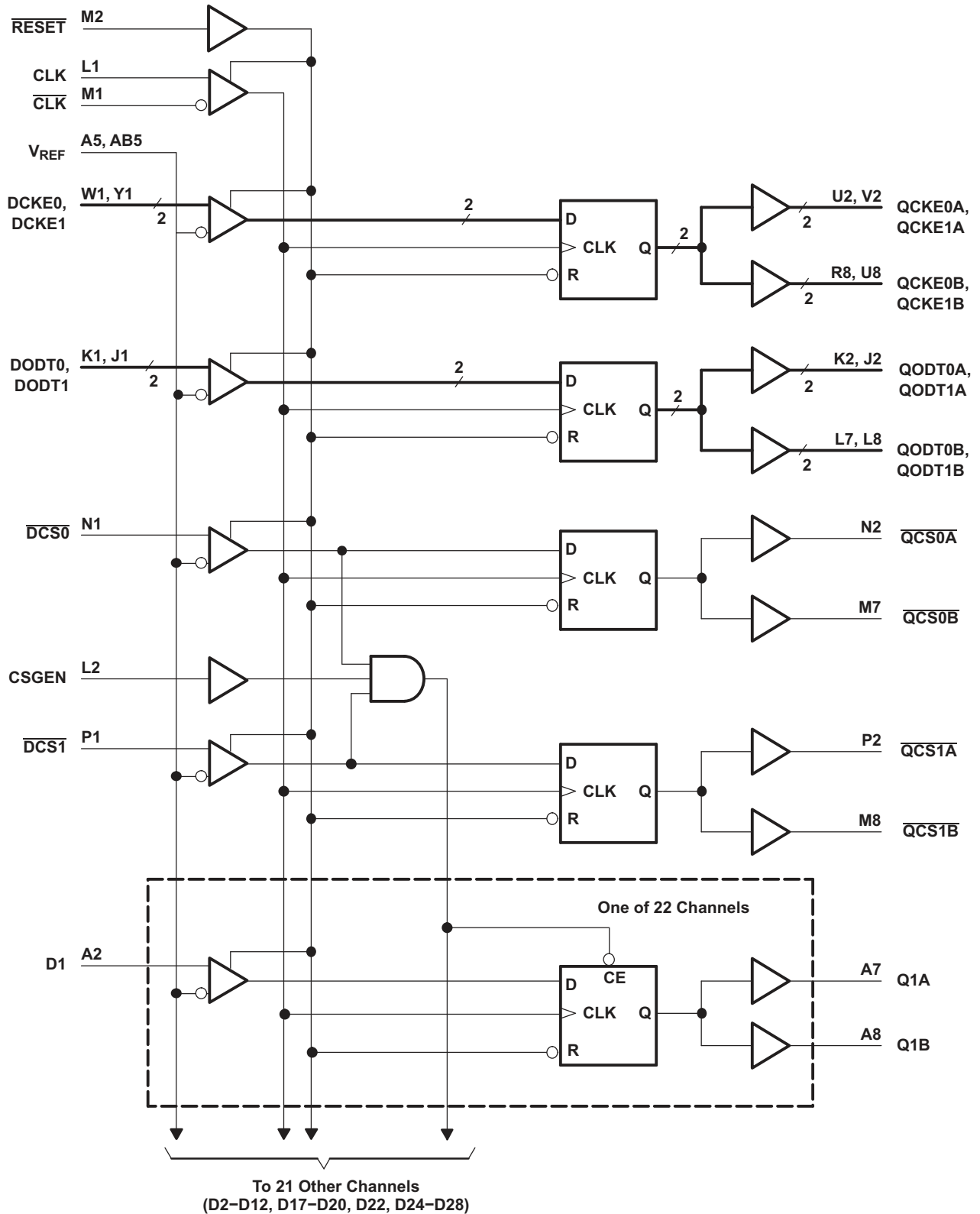




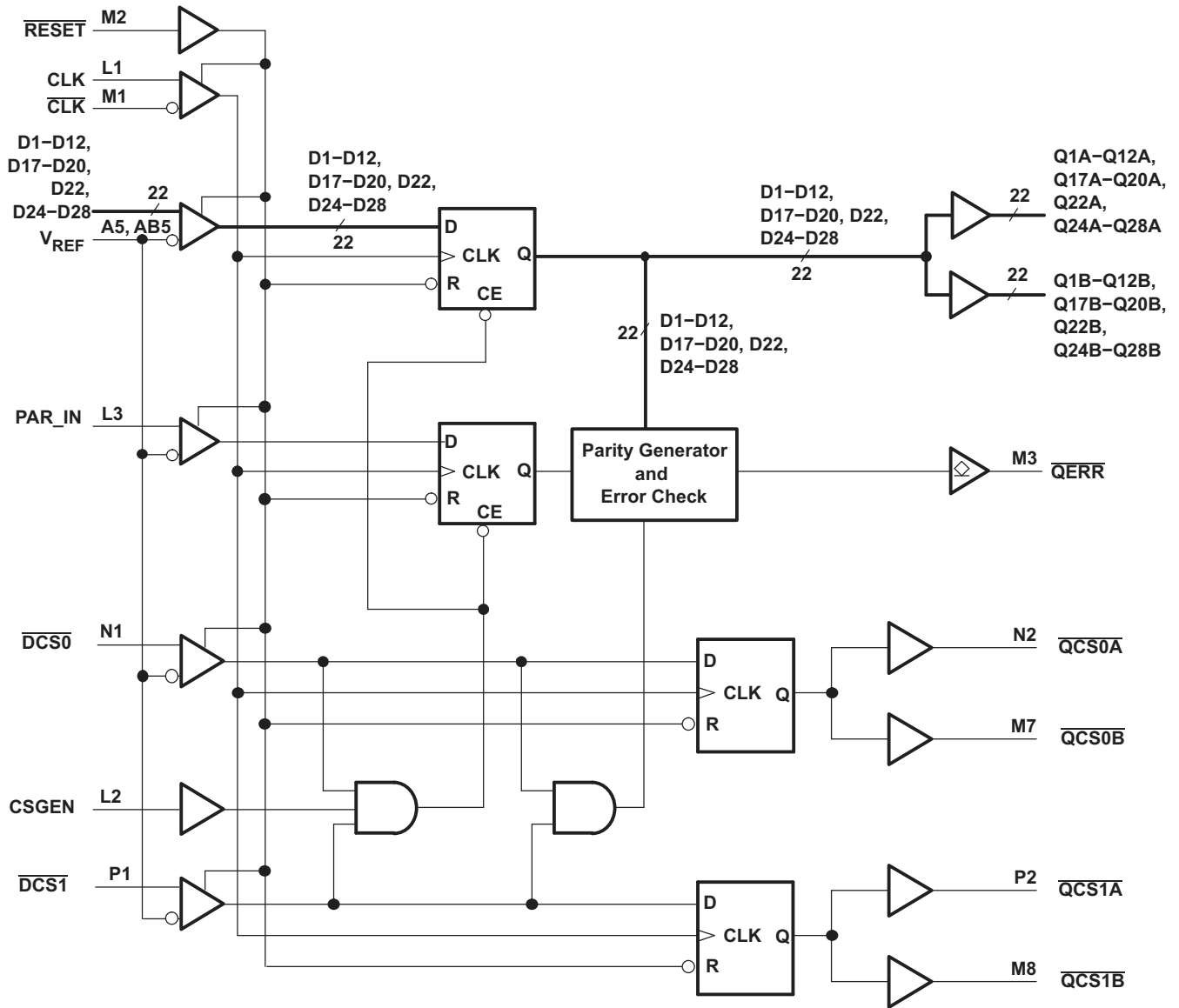
Terminal Assignment for Register-B (C = 1)

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|----|-------------------------|---------------------------|--------------------------|-----------------|------------------|-----------------|------------------|------------------|
| A | D2 | D1 | C | GND | V _{REF} | GND | Q1A | Q1B |
| B | D4 | D3 | V _{CC} | V _{CC} | V _{CC} | V _{CC} | Q2A | Q2B |
| C | D6 | D5 | GND | GND | GND | GND | Q3A | Q3B |
| D | D8 | D7 | V _{CC} | V _{CC} | V _{CC} | V _{CC} | Q4A | Q4B |
| E | D9 | Q6A | GND | GND | GND | GND | Q5A | Q5B |
| F | D10 | Q8A | V _{CC} | V _{CC} | V _{CC} | V _{CC} | Q7A | Q6B |
| G | D11 | Q10A | GND | GND | GND | GND | Q9A | Q7B |
| H | D12 | Q12A | V _{CC} | V _{CC} | V _{CC} | V _{CC} | Q11A | Q8B |
| J | D13 (DODT1) | Q13A (DODT1A) | GND | GND | GND | GND | Q10B | Q9B |
| K | D14 (DODT0) | Q14A (QODT0A) | V _{CC} | V _{CC} | V _{CC} | V _{CC} | Q12B | Q11B |
| L | CLK | CSGEN | PAR_IN | GND | GND | GND | Q14B (QODT0B) | Q13B (QODT1B) |
| M | $\overline{\text{CLK}}$ | $\overline{\text{RESET}}$ | $\overline{\text{QERR}}$ | V _{CC} | V _{CC} | V _{CC} | Q15B (QCS0B) | Q16B (QCS1B) |
| N | D15 (DCS0) | Q15A (QCS0A) | GND | GND | GND | GND | Q17B | Q18B |
| P | D16 (DCS1) | Q16A (QCS1A) | V _{CC} | V _{CC} | V _{CC} | V _{CC} | Q19B | Q20B |
| R | D17 | Q17A | GND | GND | GND | GND | Q18A | Q21B (QCKE0B) |
| T | D18 | Q19A | V _{CC} | V _{CC} | V _{CC} | V _{CC} | Q20A | Q22B |
| U | D19 | Q21A (QCKE0A) | GND | GND | GND | GND | Q22A | Q23B (QCKE1B) |
| V | D20 | Q23A (QCKE1A) | V _{CC} | V _{CC} | V _{CC} | V _{CC} | Q24A | Q24B |
| W | D21 (DCKE0) | D22 | GND | GND | GND | GND | Q25A | Q25B |
| Y | D23 (DCKE1) | D24 | V _{CC} | V _{CC} | V _{CC} | V _{CC} | Q26A | Q26B |
| AA | D25 | D26 | GND | GND | GND | GND | Q27A | Q27B |
| AB | D27 | D28 | NC | V _{CC} | V _{REF} | V _{CC} | Q28A | Q28B |

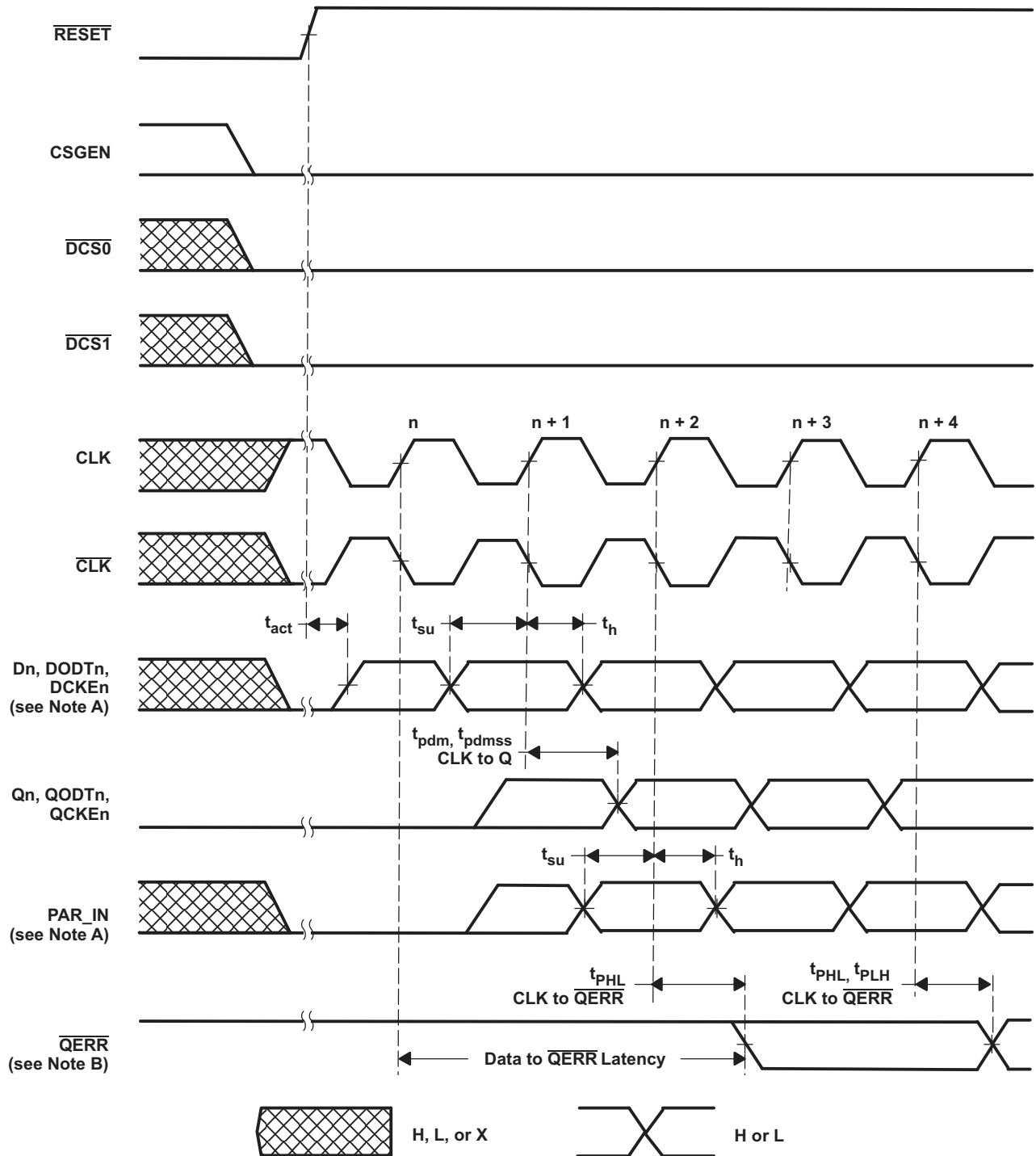
Logic Diagram for Register-B Configuration (Positive Logic); C = 1



Parity Logic Diagram for Register-B Configuration (Positive Logic); C = 1

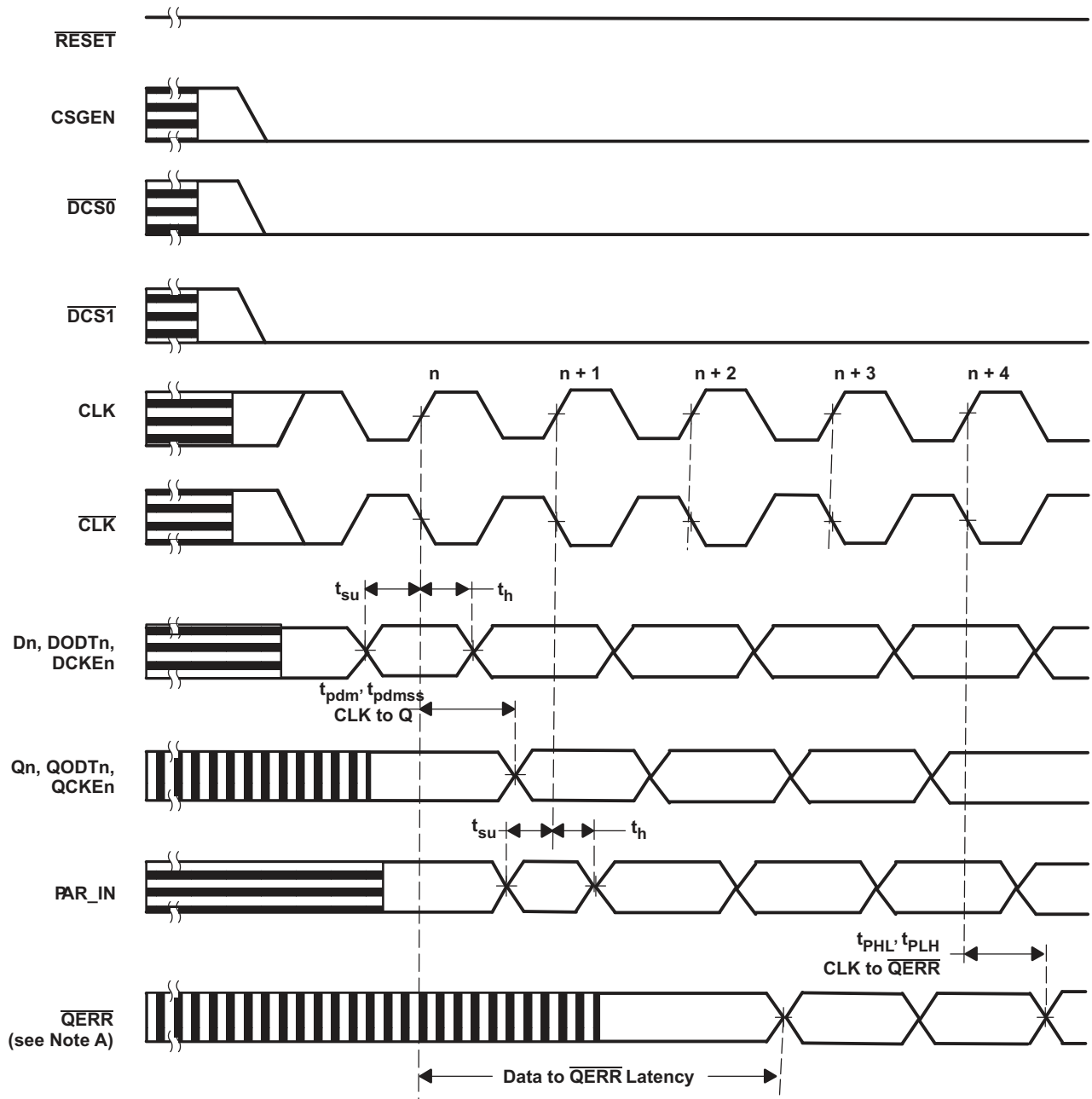


Timing Diagram for 74SSTUB32868 During Start-Up ($\overline{\text{RESET}}$ Switches From L to H)



- A. After $\overline{\text{RESET}}$ is switched from low to high, all data and PAR_IN input signals must be set and held low for a minimum time of t_{act} max, to avoid a false error.
- B. If the data is clocked in on the n -clock pulse, the $\overline{\text{QERR}}$ output signal is generated on the $n + 2$ clock pulse, and it is valid on the $n + 3$ clock pulse.

Timing Diagram for 74SSTUB32868 During Normal Operation ($\overline{\text{RESET}} = \text{H}$)



Unknown input event



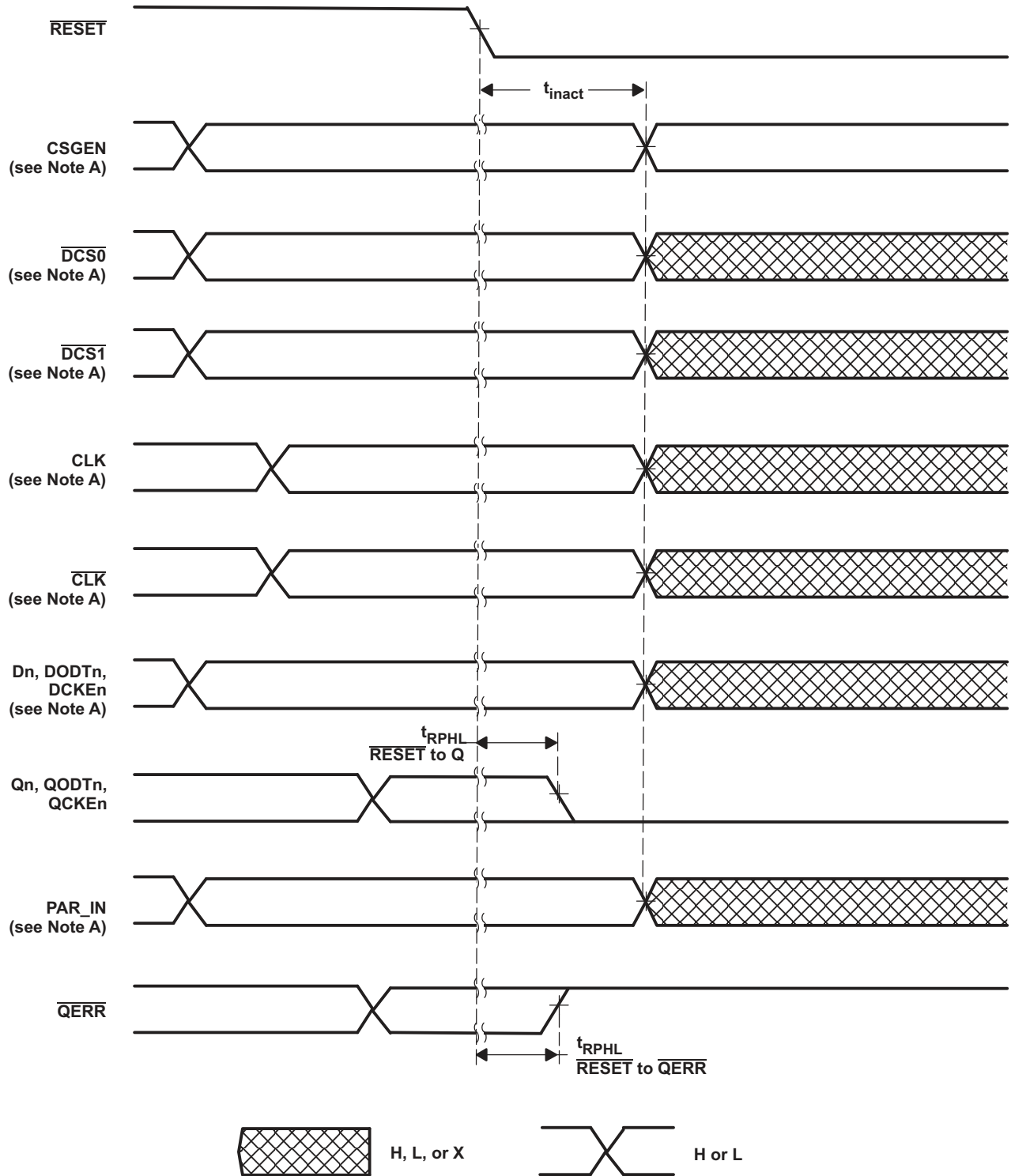
Output signal is dependent on the prior unknown input event



H or L

- A. If the data is clocked in on the n-clock pulse, the $\overline{\text{QERR}}$ output signal is generated on the n + 2 clock pulse, and it is valid on the n + 3 clock pulse. If an error occurs and the $\overline{\text{QERR}}$ output is driven low, it stays latched low for a minimum of two clock cycles or until $\overline{\text{RESET}}$ is driven low.

Timing Diagram for 74SSTUB32868 During Shut-Down ($\overline{\text{RESET}}$ Switches From H to L)



- A. After $\overline{\text{RESET}}$ is switched from high to low, all data and clock input signals must be held at logic levels (not floating) for a minimum time of t_{inact} max, to avoid a false error.

TERMINAL FUNCTIONS

| TERMINAL NAME | DESCRIPTION | ELECTRICAL CHARACTERISTICS |
|---|---|-----------------------------|
| GND | Ground | Ground input |
| V _{CC} | Power supply voltage | 1.8 V nominal |
| V _{REF} | Input reference voltage | 0.9 V nominal |
| CLK | Positive master clock input | Differential input |
| $\overline{\text{CLK}}$ | Negative master clock input | Differential input |
| C | Configuration control input - Register A or Register B | LVC MOS input |
| $\overline{\text{RESET}}$ | Asynchronous reset input – resets registers and disables V _{REF} , data and clock differential-input receivers. When RESET is low, all the Q outputs are forced low and the QERR output is forced high. | LVC MOS input |
| CSGEN | Chip select gate enable – When high, D1–D28 ⁽¹⁾ inputs are latched only when at least one chip select input is low during the rising edge of the clock. When low, the D1–D28 ⁽¹⁾ inputs are latched and redriven on every rising edge of the clock. | LVC MOS input |
| D1–D28 | Data input – clocked in on the crossing of the rising edge of CLK and the falling edge of CLK | SSTL_18 input |
| $\overline{\text{DCS0}}$, $\overline{\text{DCS1}}$ | Chip select inputs – These pins initiate DRAM address/command decodes, and as such at least one will be low when a valid address/command is present. The Register can be programmed to redrive all D inputs (CSGEN high) only when at least one chip select input is low. If CSGEN, $\overline{\text{DCS0}}$, and $\overline{\text{DCS1}}$ inputs are high, D1–D28 ⁽²⁾ inputs will be disabled. | SSTL_18 input |
| DODT0, DODT1 | The outputs of this register bit will not be suspended by the $\overline{\text{DCS0}}$ and $\overline{\text{DCS1}}$ control. | SSTL_18 input |
| DCKE0, DEKE1 | The outputs of this register bit will not be suspended by the $\overline{\text{DCS0}}$ and $\overline{\text{DCS1}}$ control. | SSTL_18 input |
| PAR_IN | Parity input – arrives one clock cycle after the corresponding data input. Pulldown resistor of typical 150kΩ to GND. | SSTL_18 input with pulldown |
| Q1–Q28 ⁽³⁾ | Data outputs that are suspended by the $\overline{\text{DCS0}}$ and $\overline{\text{DCS1}}$ control. | 1.8 V CMOS output |
| $\overline{\text{QCS0}}$, $\overline{\text{QCS1}}$ | Data output that will not be suspended by the $\overline{\text{DCS0}}$ and $\overline{\text{DCS1}}$ control. | 1.8 V CMOS output |
| QODT0, QODT1 | Data output that will not be suspended by the $\overline{\text{DCS0}}$ and $\overline{\text{DCS1}}$ control. | 1.8 V CMOS output |
| QCKE0, QEKE1 | Data output that will not be suspended by the $\overline{\text{DCS0}}$ and $\overline{\text{DCS1}}$ control. | 1.8 V CMOS output |
| $\overline{\text{QERR}}$ | Output error bit – generated two clock cycles after the corresponding data is registered. | Open-drain output |
| NC | No internal connection | |

- (1) Data inputs = D1–D5, D7, D9–D12, D17–D28 when C = 0.
Data inputs = D1–D12, D17–D20, D22, D24–D28 when C = 1.
- (2) Data inputs = D1–D5, D7, D9–D12, D17–D28 when C = 0.
Data inputs = D1–D12, D17–D20, D22, D24–D28 when C = 1.
- (3) Data outputs = Q1–Q5, Q7, Q9–Q12, Q17–Q28 when C = 0.
Data outputs = Q1–Q12, Q17–Q20, Q22, Q24–Q28 when C = 1.

FUNCTION TABLE

| INPUTS | | | | | | | OUTPUTS | | | |
|--------|---------------|---------------|---------------|---------------|---------------|------------------------|----------------|----------------|----------------|----------------|
| RESET | DCS0 | DCS1 | CSGEN | CLK | CLK | dn, DODTn, DCKEn | Qn | QCS0 | QCS1 | QODT, QCKE |
| H | L | L | X | ↑ | ↓ | L | L | L | L | L |
| H | L | L | X | ↑ | ↓ | H | H | L | L | H |
| H | L | L | X | L or H | L or H | X | Q ₀ | Q ₀ | Q ₀ | Q ₀ |
| H | L | H | X | ↑ | ↓ | L | L | L | H | L |
| H | L | H | X | ↑ | ↓ | H | H | L | H | H |
| H | L | H | X | L or H | L or H | X | Q ₀ | Q ₀ | Q ₀ | Q ₀ |
| H | H | L | X | ↑ | ↓ | L | L | H | L | L |
| H | H | L | X | ↑ | ↓ | H | H | H | L | H |
| H | H | L | X | L or H | L or H | X | Q ₀ | Q ₀ | Q ₀ | Q ₀ |
| H | H | H | L | ↑ | ↓ | L | L | H | H | L |
| H | H | H | L | ↑ | ↓ | H | H | H | H | H |
| H | H | H | L | L or H | L or H | X | Q ₀ | Q ₀ | Q ₀ | Q ₀ |
| H | H | H | H | ↑ | ↓ | L | Q ₀ | H | H | L |
| H | H | H | H | ↑ | ↓ | H | Q ₀ | H | H | H |
| H | H | H | H | L or H | L or H | X | Q ₀ | Q ₀ | Q ₀ | Q ₀ |
| L | X or floating | X or floating | X or floating | X or floating | X or floating | L | L | L | L | L |

PARITY AND STANDBY FUNCTION

| INPUTS | | | | | | | OUTPUTS | |
|--------|---------------|---------------|---------------|---------------|-----------------------------|-----------------------|----------------------------------|--|
| RESET | CLK | CLK | DCS0 | DCS1 | Σ OF INPUTS = H D1 - D22 | PAR_IN ⁽¹⁾ | QERR ⁽²⁾ | |
| H | ↑ | ↓ | L | X | Even | L | H | |
| H | ↑ | ↓ | L | X | Odd | L | L | |
| H | ↑ | ↓ | L | X | Even | H | L | |
| H | ↑ | ↓ | L | X | Odd | H | H | |
| H | ↑ | ↓ | X | L | Even | L | H | |
| H | ↑ | ↓ | X | L | Odd | L | L | |
| H | ↑ | ↓ | X | L | Even | H | L | |
| H | ↑ | ↓ | X | L | Odd | H | H | |
| H | ↑ | ↓ | H | H | X | X | QERR ₀ ⁽³⁾ | |
| H | L or H | L or H | X | X | X | X | QERR ₀ | |
| L | X or floating | X or floating | X or floating | X or floating | X | X or floating | H | |

- (1) PAR_IN arrives one clock cycle after the data to which it applies.
- (2) This transition assumes that QERR is high at the crossing of CLK going high and CLK going low. If QERR goes low, it stays latched low for a minimum of two clock cycles or until RESET is driven low. If two or more consecutive errors occur, the QERR output is driven low and latched low for a clock duration equal to the parity error duration or until RESET is driven low. For QERR computation, CSGEN is a "don't care".
- (3) If DCS0, DCS1 and CSGEN are driven high, the device is placed in a low-power mode (LPM). If a parity error occurs on the clock cycle before the device enters the LPM and the QERR output is driven low, it stays latched low for the LPM duration plus two clock cycles or until RESET is driven low.

TIMING REQUIREMENTS

over recommended ranges of supply voltage, load, and operating free-air temperature (see [Figure 1](#) and Note ⁽¹⁾)

| | | $V_{CC} = 1.8\text{ V} \pm 0.1\text{ V}$ | | |
|----------------------|--|--|-----|------|
| | | MIN | MAX | UNIT |
| $f_{(\text{clock})}$ | Clock frequency | | 410 | MHz |
| t_w | Pulse duration, CLK, CLK high or low | 1 | | ns |
| t_{act} | Differential inputs active time (see Note ⁽²⁾) | | 10 | ns |
| t_{inact} | Differential inputs inactive time (see Note ⁽³⁾) | | 15 | ns |
| t_{su} | Setup time | $\overline{\text{DCSn}}$ before $\text{CLK}\uparrow$, $\overline{\text{CLK}}\downarrow$, CSGEN high | 600 | ps |
| | | $\overline{\text{DCSn}}$ before $\text{CLK}\uparrow$, $\overline{\text{CLK}}\downarrow$, CSGEN low | 500 | |
| | | $\overline{\text{DODTn}}$, $\overline{\text{DCKEn}}$, and Data before $\text{CLK}\uparrow$, $\overline{\text{CLK}}\downarrow$ | 500 | |
| | | $\overline{\text{PAR_IN}}$ before $\text{CLK}\uparrow$, $\overline{\text{CLK}}\downarrow$ | 500 | |
| t_h | Hold time | $\overline{\text{DCSn}}$, $\overline{\text{DODTn}}$, $\overline{\text{DCKEn}}$, and Data after $\text{CLK}\uparrow$, $\overline{\text{CLK}}\downarrow$ | 400 | ps |
| | | $\overline{\text{PAR_IN}}$ after $\text{CLK}\uparrow$, $\overline{\text{CLK}}\downarrow$ | 400 | |

(1) All inputs slew rate is 1 V/ns $\pm 20\%$

(2) V_{REF} must be held at a valid input level and data inputs must be held low for a minimum time of t_{act} max, after $\overline{\text{RESET}}$ is taken high.

(3) V_{REF} , data, and clock inputs must be held at valid voltage levels (not floating) for a minimum time of t_{inact} max, after $\overline{\text{RESET}}$ is taken low.

SWITCHING CHARACTERISTICS

over recommended ranges of supply voltage, load, and operating free-air temperature (unless otherwise noted)

| | | | $V_{CC} = 1.8\text{ V} \pm 0.1\text{ V}$ | | |
|--|---------------------------------|--------------------------|--|-----|------|
| PARAMETER | FROM (INPUT) | TO (OUTPUT) | MIN | MAX | UNIT |
| f_{max} (see Figure 2) | | | 410 | | MHz |
| t_{pdm} ⁽¹⁾ (production test, see Figure 1) | CLK and $\overline{\text{CLK}}$ | Q | 0.5 | 1.0 | ns |
| t_{PLH} (see Figure 4) | CLK and $\overline{\text{CLK}}$ | $\overline{\text{QERR}}$ | 1.2 | 3 | ns |
| t_{PHL} (see Figure 4) | | | 1 | 2.4 | |
| t_{RPHL} ⁽²⁾ (see Figure 2) | $\overline{\text{RESET}}$ | Q | | 3 | ns |
| t_{RPLH} (see Figure 4) | $\overline{\text{RESET}}$ | $\overline{\text{QERR}}$ | | 3 | ns |

(1) The typical difference between min and max does not exceed 400 ps.

(2) Includes 350-ps test-load transmission line delay.

OUTPUT SLEW RATES

over operating free-air temperature range (unless otherwise noted) (see [Figure 3](#))

| | | | $V_{CC} = 1.8\text{ V} \pm 0.1\text{ V}$ | | |
|---------------------------------|------------|-------------|--|-----|------|
| PARAMETER | FROM | TO (OUTPUT) | MIN | MAX | UNIT |
| dV/dt_r | 20% | 80% | 1 | 5 | V/ns |
| dV/dt_f | 80% | 20% | 1 | 5 | V/ns |
| dV/dt_{Δ} ⁽¹⁾ | 20% to 80% | 20% to 80% | | 1 | V/ns |

(1) The difference between dV/dt_r (rising edge rate) and dV/dt_f (falling edge).

PARAMETER MEASUREMENT INFORMATION

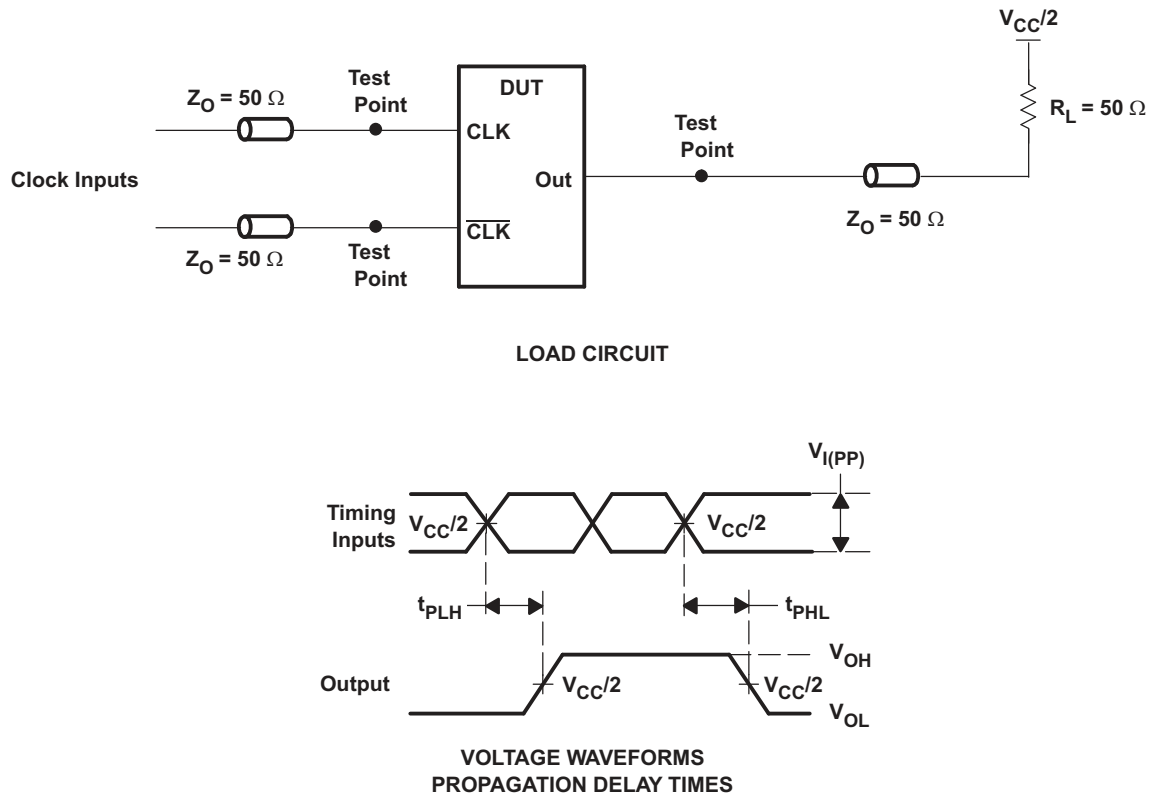


Figure 1. Output Load Circuit for Production Test

Propagation Delay (Design Goal as per JEDEC Specification)

| PARAMETER | FROM (INPUT) | TO (OUTPUT) | $V_{CC} = 1.8 \text{ V} \pm 0.1 \text{ V}$ | | UNIT |
|-------------------|---------------------------------|-------------|--|-----|------|
| | | | MIN | MAX | |
| $t_{pdm}^{(1)}$ | CLK and $\overline{\text{CLK}}$ | Q | 1.1 | 1.5 | ns |
| $t_{pdmss}^{(1)}$ | CLK and $\overline{\text{CLK}}$ | Q | | 1.6 | ns |

(1) Includes 350-ps test-load transmission line delay.

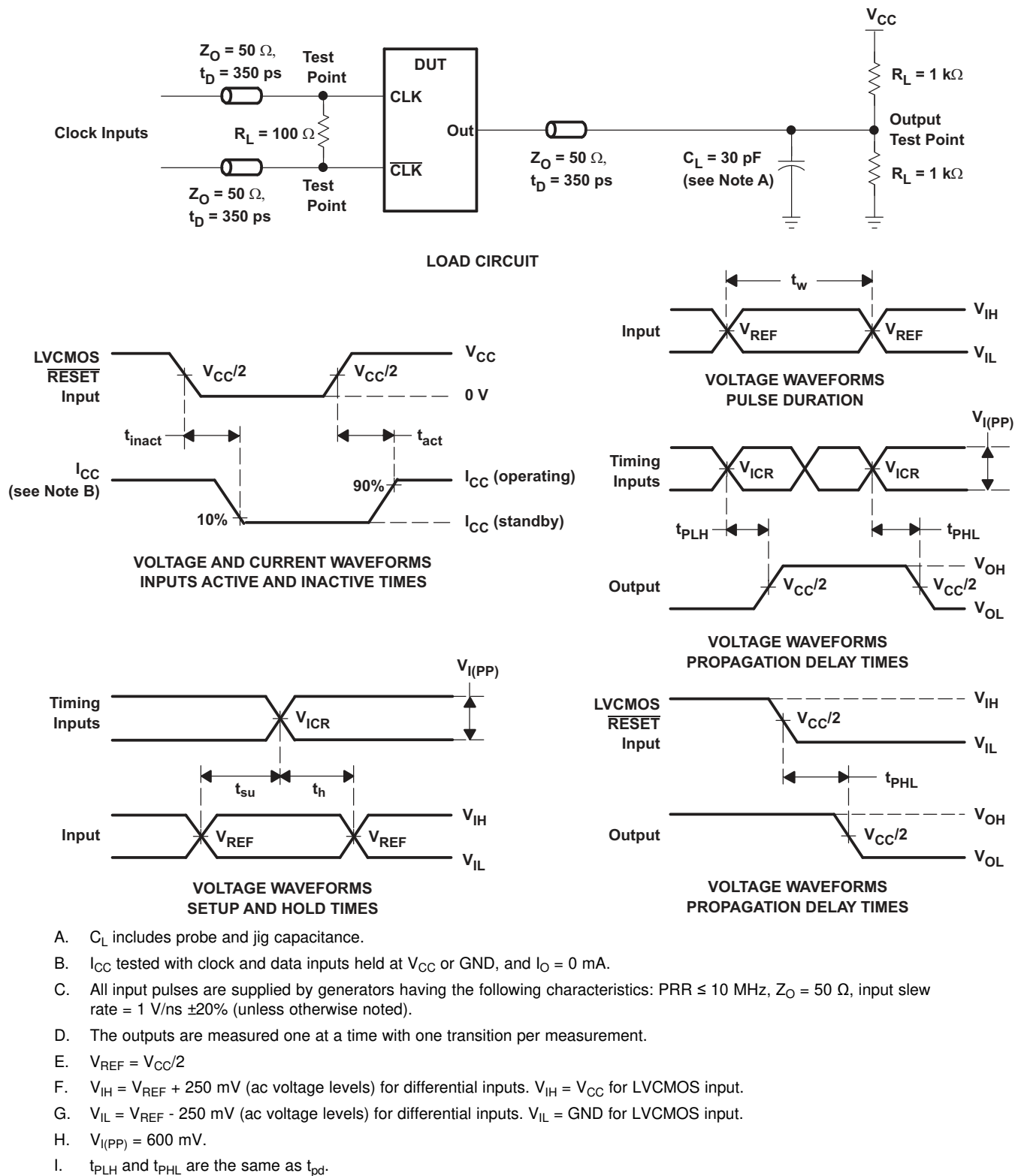
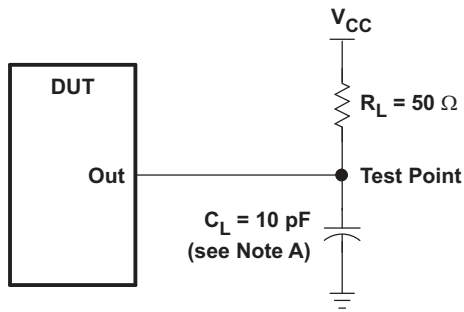
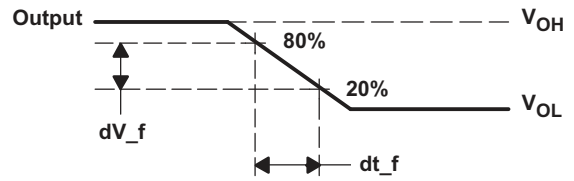


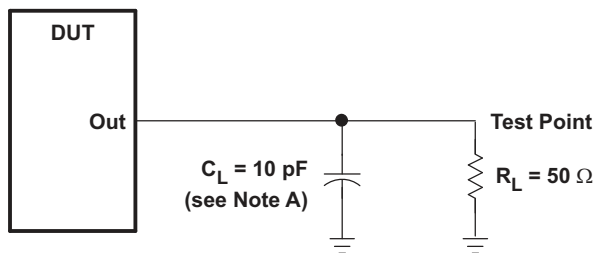
Figure 2. Data Output Load Circuit and Voltage Waveforms



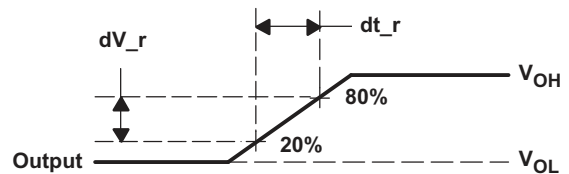
LOAD CIRCUIT
HIGH-TO-LOW SLEW-RATE MEASUREMENT



VOLTAGE WAVEFORMS
HIGH-TO-LOW SLEW-RATE MEASUREMENT



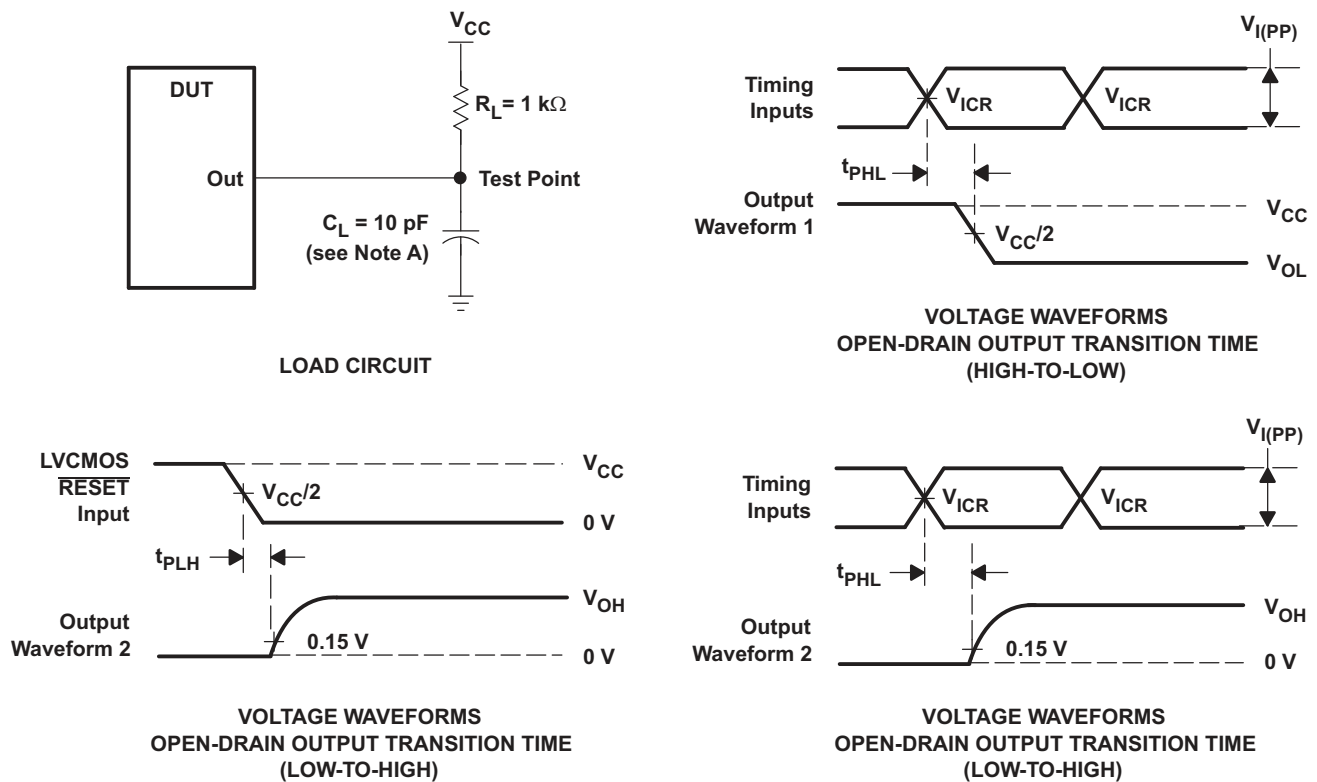
LOAD CIRCUIT
LOW-TO-HIGH SLEW-RATE MEASUREMENT



VOLTAGE WAVEFORMS
LOW-TO-HIGH SLEW-RATE MEASUREMENT

- A. C_L includes probe and jig capacitance.
- B. All input pulses are supplied by generators having the following characteristics:
 $PRR \leq 10$ MHz, $Z_O = 50 \Omega$, input slew rate = 1 V/ns $\pm 20\%$ (unless otherwise specified).

Figure 3. Data Output Slew-Rate Measurement Information



- A. C_L includes probe and jig capacitance.
- B. All input pulses are supplied by generators having the following characteristics:
 $PRR \leq 10$ MHz, $Z_O = 50 \Omega$, input slew rate = 1 V/ns $\pm 20\%$ (unless otherwise specified).
- C. t_{PLH} and t_{PHL} are the same as t_{pd} .

Figure 4. Error Output Load Circuit and Voltage Waveforms

PACKAGING INFORMATION

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead/Ball Finish (6) | MSL Peak Temp (3) | Op Temp (°C) | Device Marking (4/5) | Samples |
|------------------|---------------|--------------|--------------------|------|----------------|----------------------------|-------------------------|----------------------|--------------|-------------------------|----------------|
| 74SSTUB32868ZRHR | ACTIVE | NFBGA | ZRH | 176 | 1000 | Green (RoHS & no Sb/Br) | SNAGCU | Level-3-260C-168 HR | -40 to 85 | SB868 | Samples |

(1) The marketing status values are defined as follows:

ACTIVE: Product device recommended for new designs.

LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

PREVIEW: Device has been announced but is not in production. Samples may or may not be available.

OBSOLETE: TI has discontinued the production of the device.

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

TBD: The Pb-Free/Green conversion plan has not been defined.

Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

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TAPE AND REEL INFORMATION

QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE


*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Reel Diameter (mm) | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P1 (mm) | W (mm) | Pin1 Quadrant |
|------------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| 74SSTUB32868ZRHR | NFBGA | ZRH | 176 | 1000 | 330.0 | 24.4 | 6.3 | 15.3 | 1.65 | 12.0 | 24.0 | Q1 |

TAPE AND REEL BOX DIMENSIONS

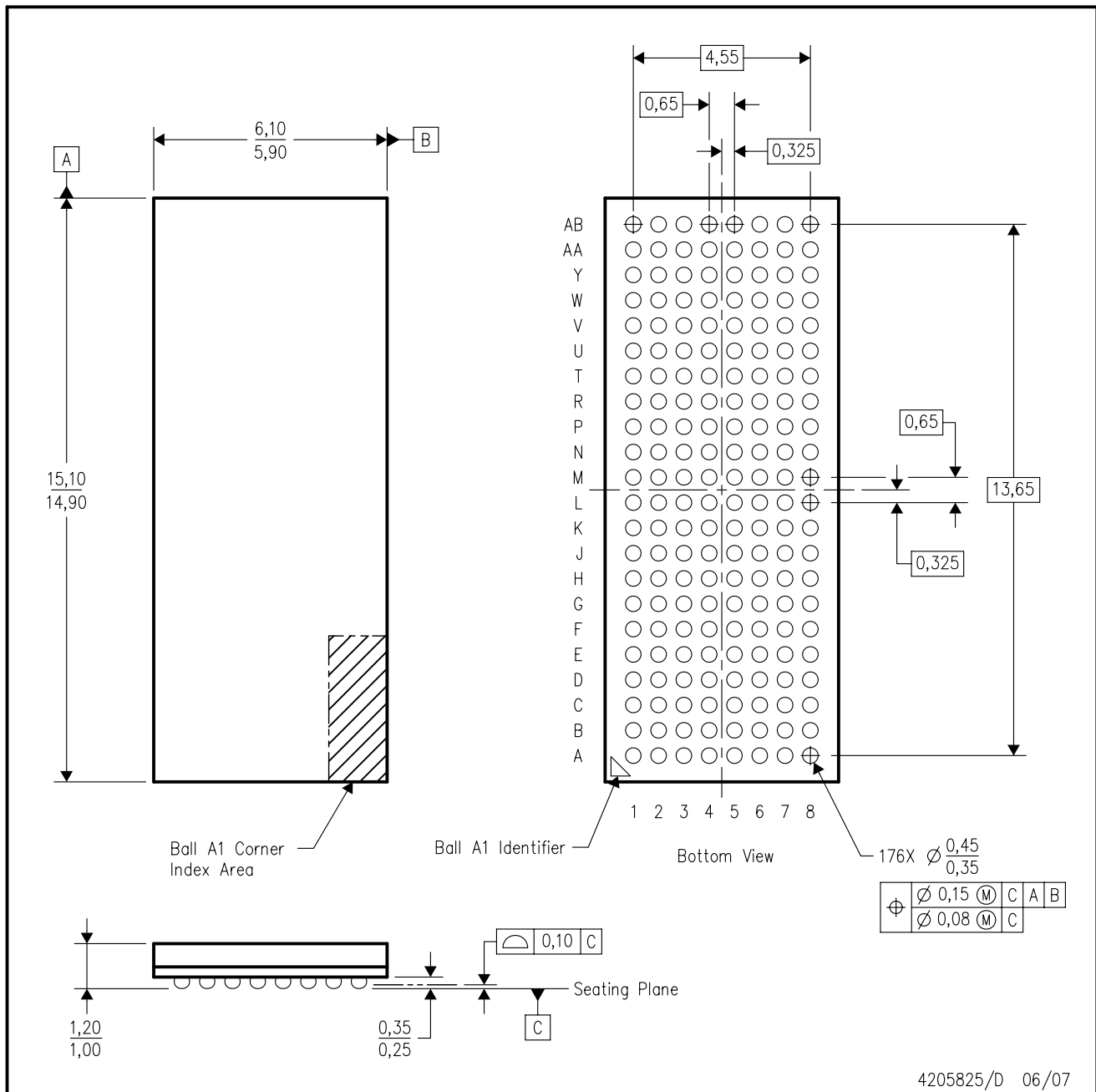


*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|------------------|--------------|-----------------|------|------|-------------|------------|-------------|
| 74SSTUB32868ZRHR | NFBGA | ZRH | 176 | 1000 | 336.6 | 336.6 | 31.8 |

ZRH (R-PBGA-N176)

PLASTIC BALL GRID ARRAY



4205825/D 06/07

- NOTES:
- A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M-1994.
 - B. This drawing is subject to change without notice.
 - C. Complies to JEDEC MO-246 variation B.
 - D. This package is lead-free. Refer to the 176 GRH package (drawing 4205824) for tin-lead (SnPb).

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