

FEATURES

- Member of the Texas Instruments Widebus+™ Family
- Pinout Optimizes DDR2 DIMM PCB Layout
- Configurable as 25-Bit 1:1 or 14-Bit 1:2 Registered Buffer
- Chip-Select Inputs Gate Data Outputs From Changing State and Minimize System Power Consumption
- Output Edge-Control Circuitry Minimizes Switching Noise in Unterminated Line
- Supports SSTL_18 Data Inputs
- Differential Clock (CLK and $\overline{\text{CLK}}$) Inputs
- Supports LVCMOS Switching Levels on Control and $\overline{\text{RESET}}$ Inputs
- $\overline{\text{RESET}}$ Input Disables Differential Input Receivers, Resets All Registers, and Forces All Outputs Low
- Latch-Up Performance Exceeds 100 mA Per JESD 78, Class II
- ESD Protection Exceeds JESD 22
 - 5000-V Human-Body Model (A114-A)
 - 150-V Machine Model (A115-A)
 - 1000-V Charged-Device Model (C101)

DESCRIPTION/ORDERING INFORMATION

This 25-bit 1:1 or 14-bit 1:2 configurable registered buffer is designed for 1.7-V to 1.9-V V_{CC} operation. In the 1:1 pinout configuration, only 1 device per DIMM is required to drive 9 SDRAM loads. In the 1:2 pinout configuration, 2 devices per DIMM are required to drive 18 SDRAM loads.

All inputs are SSTL_18, except the LVCMOS reset ($\overline{\text{RESET}}$) and LVCMOS control (Cn) inputs. All outputs are edge-controlled circuits optimized for unterminated DIMM loads and meet SSTL_18 specifications.

The SN74SSTU32864E 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 C0 input controls the pinout configuration of the 1:2 pinout from register-A configuration (when low) to register-B configuration (when high). The C1 input controls the pinout configuration from 25-bit 1:1 (when low) to 14-bit 1:2 (when high). C0 and C1 must not be switched during normal operation. They must be hard-wired to a valid low or high level to configure the register in the desired mode. In the 25-bit 1:1 pinout configuration, the A6, D6, and H6 terminals are driven low and must not be used.

In the DDR2 RDIMM application, $\overline{\text{RESET}}$ is specified to be completely asynchronous with respect to CLK and $\overline{\text{CLK}}$. Therefore, no timing relationship can be ensured between the two. When entering reset, the register is cleared and the data outputs are 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 required 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 $\overline{\text{RESET}}$ until the input receivers are fully enabled, the design of the SN74SSTU32864E 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, $\overline{\text{RESET}}$ must be held in the low state during power up.

ORDERING INFORMATION

| T _A | PACKAGE ⁽¹⁾ | | ORDERABLE PART NUMBER | TOP-SIDE MARKING |
|----------------|------------------------|---------------|-----------------------|------------------|
| 0°C to 70°C | LFBGA – ZKE | Tape and reel | SN74SSTU32864EZKER | S864E |

(1) Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at www.ti.com/sc/package.



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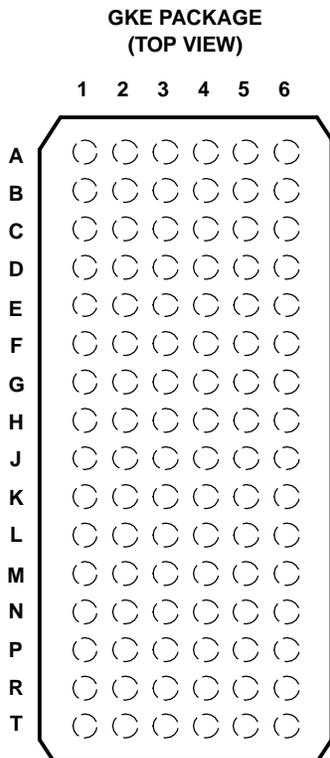
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DESCRIPTION/ORDERING INFORMATION (CONTINUED)

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

The device also supports low-power active operation by monitoring both system chip select ($\overline{\text{DCS}}$ and $\overline{\text{CSR}}$) inputs and will gate the Qn outputs from changing states when both $\overline{\text{DCS}}$ and $\overline{\text{CSR}}$ inputs are high. If either $\overline{\text{DCS}}$ or $\overline{\text{CSR}}$ input is low, then the Qn outputs function normally. The $\overline{\text{RESET}}$ input has priority over the $\overline{\text{DCS}}$ and $\overline{\text{CSR}}$ control and forces the output low. If the $\overline{\text{DCS}}$ control functionality is not desired, then the $\overline{\text{CSR}}$ input can be hard-wired to ground, in which case the setup-time requirement for $\overline{\text{DCS}}$ is the same as for the other D data inputs.

The two V_{REF} pins (A3 and T3) 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 must be terminated with a V_{REF} coupling capacitor.



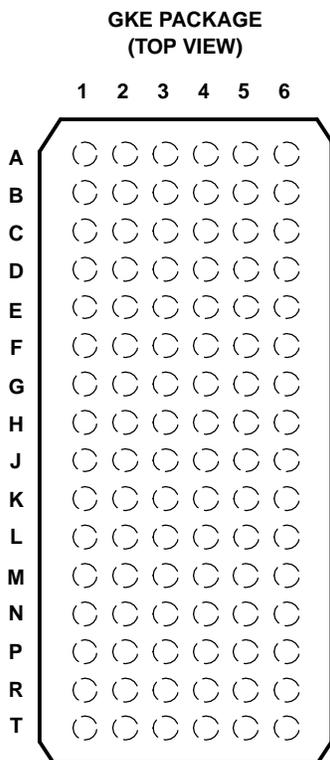
TERMINAL ASSIGNMENTS FOR 1:1 REGISTER (C0 = 0, C1 = 0)⁽¹⁾⁽²⁾⁽³⁾

| | 1 | 2 | 3 | 4 | 5 | 6 |
|----------|------------|--------------|------------------|-----------------|-----------|-----|
| A | D1 (DCKE) | NC | V _{REF} | V _{CC} | Q1 (QCKE) | DNU |
| B | D2 | D15 | GND | GND | Q2 | Q15 |
| C | D3 | D16 | V _{CC} | V _{CC} | Q3 | Q16 |
| D | D4 (DODT) | NC | GND | GND | Q4 (QODT) | DNU |
| E | D5 | D17 | V _{CC} | V _{CC} | Q5 | Q17 |
| F | D6 | D18 | GND | GND | Q6 | Q18 |
| G | NC | <u>RESET</u> | V _{CC} | V _{CC} | C1 | C0 |
| H | CLK | D7 (DCS) | GND | GND | Q7 (QCS) | DNU |
| J | <u>CLK</u> | <u>CSR</u> | V _{CC} | V _{CC} | NC | NC |
| K | D8 | D19 | GND | GND | Q8 | Q19 |
| L | D9 | D20 | V _{CC} | V _{CC} | Q9 | Q20 |
| M | D10 | D21 | GND | GND | Q10 | Q21 |
| N | D11 | D22 | V _{CC} | V _{CC} | Q11 | Q22 |
| P | D12 | D23 | GND | GND | Q12 | Q23 |
| R | D13 | D24 | V _{CC} | V _{CC} | Q13 | Q24 |
| T | D14 | D25 | V _{REF} | V _{CC} | Q14 | Q25 |

(1) Each pin name in parentheses indicates the DDR2 DIMM signal name.

(2) NC - No internal connection

(3) DNU - Do not use



TERMINAL ASSIGNMENTS FOR 1:2 REGISTER A (C0 = 0, C1 = 1)⁽¹⁾⁽²⁾⁽³⁾

| | 1 | 2 | 3 | 4 | 5 | 6 |
|----------|------------|--------------|------------------|-----------------|-------------|-------------|
| A | D1 (DCKE) | NC | V _{REF} | V _{CC} | Q1A (QCKEA) | Q1B (QCKEB) |
| B | D2 | DNU | GND | GND | Q2A | Q2B |
| C | D3 | DNU | V _{CC} | V _{CC} | Q3A | Q3B |
| D | D4 (DODT) | NC | GND | GND | Q4A (QODTA) | Q4B (QODTB) |
| E | D5 | DNU | V _{CC} | V _{CC} | Q5A | Q5B |
| F | D6 | DNU | GND | GND | Q6A | Q6B |
| G | NC | <u>RESET</u> | V _{CC} | V _{CC} | C1 | C0 |
| H | CLK | D7 (DCS) | GND | GND | Q7A (QCSA) | Q7B (QCSB) |
| J | <u>CLK</u> | <u>CSR</u> | V _{CC} | V _{CC} | NC | NC |
| K | D8 | DNU | GND | GND | Q8A | Q8B |
| L | D9 | DNU | V _{CC} | V _{CC} | Q9A | Q9B |
| M | D10 | DNU | GND | GND | Q10A | Q10B |
| N | D11 | DNU | V _{CC} | V _{CC} | Q11A | Q11B |
| P | D12 | DNU | GND | GND | Q12A | Q12B |
| R | D13 | DNU | V _{CC} | V _{CC} | Q13A | Q13B |
| T | D14 | DNU | V _{REF} | V _{CC} | Q14A | Q14B |

(1) Each pin name in parentheses indicates the DDR2 DIMM signal name.

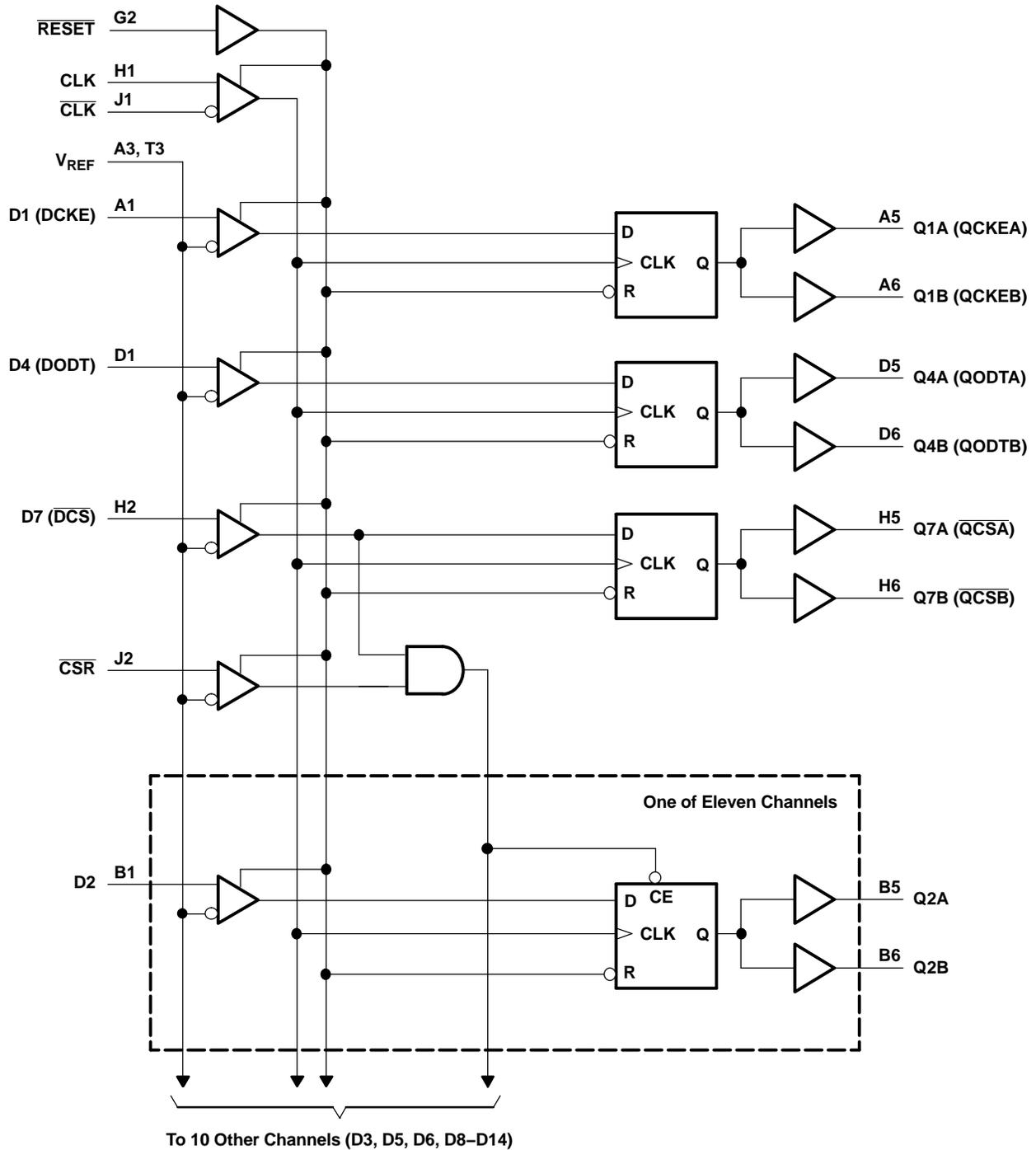
(2) NC - No internal connection

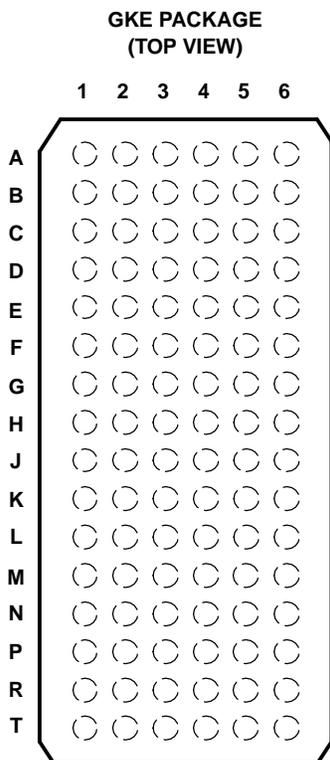
(3) DNU - Do not use

SN74SSTU32864E
25-BIT CONFIGURABLE REGISTERED BUFFER
WITH SSTL_18 INPUTS AND OUTPUTS

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LOGIC DIAGRAM 1:2 REGISTER-A CONFIGURATION (POSITIVE LOGIC)





TERMINAL ASSIGNMENTS FOR 1:2 REGISTER B (C0 = 1, C1 = 1)⁽¹⁾⁽²⁾⁽³⁾

| | 1 | 2 | 3 | 4 | 5 | 6 |
|----------|------------|--------------|------------------|-----------------|--------------|--------------|
| A | D1 | NC | V _{REF} | V _{CC} | Q1A | Q1B |
| B | D2 | DNU | GND | GND | Q2A | Q2B |
| C | D3 | DNU | V _{CC} | V _{CC} | Q3A | Q3B |
| D | D4 | NC | GND | GND | Q4A | Q4B |
| E | D5 | DNU | V _{CC} | V _{CC} | Q5A | Q5B |
| F | D6 | DNU | GND | GND | Q6A | Q6B |
| G | NC | <u>RESET</u> | V _{CC} | V _{CC} | C1 | C0 |
| H | CLK | D7 (DCS) | GND | GND | Q7A (QCSA) | Q7B (QCSB) |
| J | <u>CLK</u> | <u>CSR</u> | V _{CC} | V _{CC} | NC | NC |
| K | D8 | DNU | GND | GND | Q8A | Q8B |
| L | D9 | DNU | V _{CC} | V _{CC} | Q9A | Q9B |
| M | D10 | DNU | GND | GND | Q10A | Q10B |
| N | D11 (DODT) | DNU | V _{CC} | V _{CC} | Q11A (QODTA) | Q11B (QODTB) |
| P | D12 | DNU | GND | GND | Q12A | Q12B |
| R | D13 | DNU | V _{CC} | V _{CC} | Q13A | Q13B |
| T | D14 (DCKE) | DNU | V _{REF} | V _{CC} | Q14A (QCKEA) | Q14B (QCKEB) |

(1) Each pin name in parentheses indicates the DDR2 DIMM signal name.

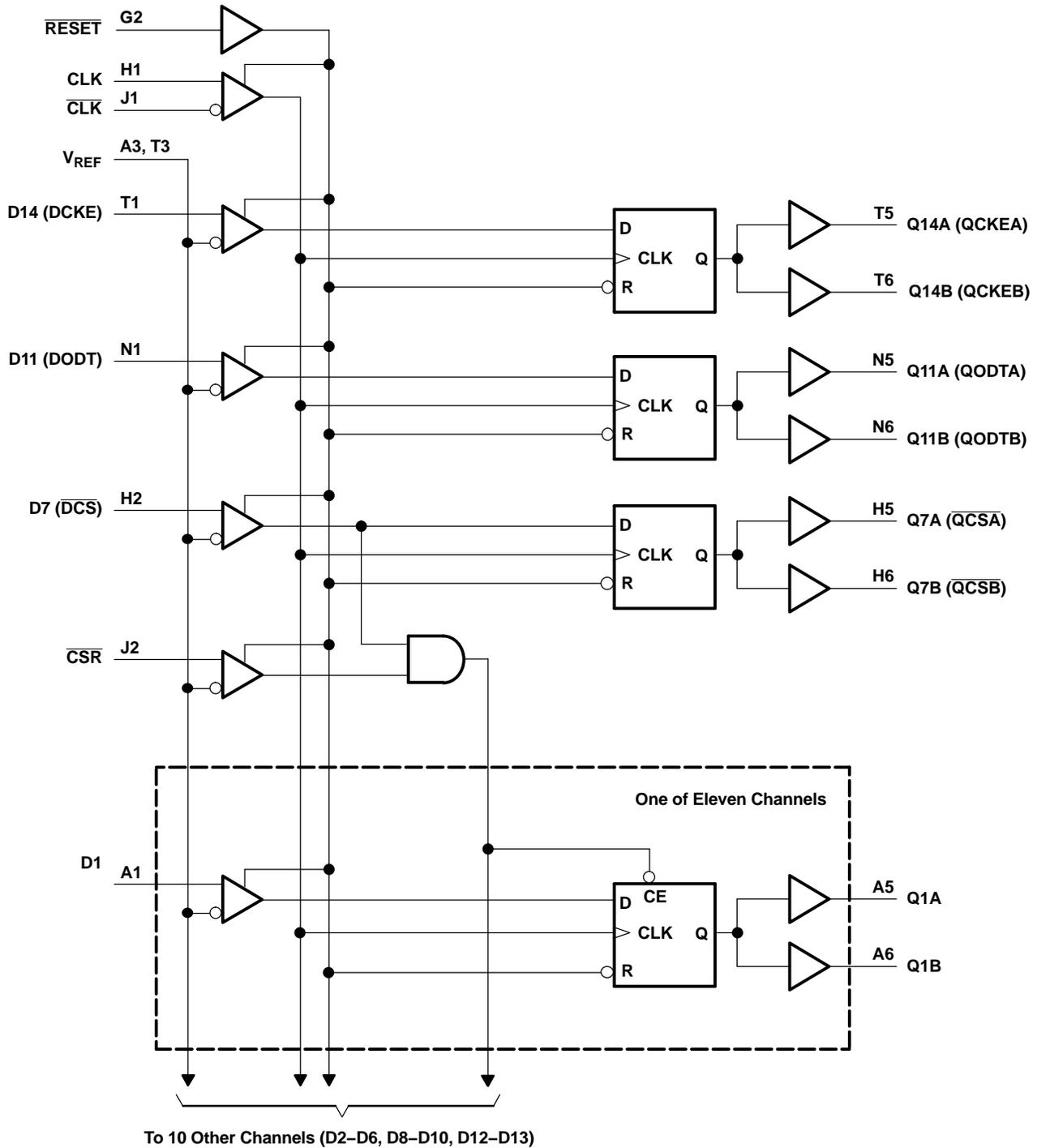
(2) NC - No internal connection

(3) DNU - Do not use

SN74SSTU32864E
25-BIT CONFIGURABLE REGISTERED BUFFER
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LOGIC DIAGRAM 1:2 REGISTER-B CONFIGURATION (POSITIVE LOGIC)



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 |
| C0, C1 | Configuration control inputs – Register A, Register B, 1:1, 1:2 select | LVC MOS inputs |
| $\overline{\text{RESET}}$ | Asynchronous reset input – resets registers and disables V _{REF} data and clock differential-input receivers. When $\overline{\text{RESET}}$ is low, all Q outputs are forced low. | LVC MOS input |
| D1–D25 | Data inputs – clocked in on the crossing of the rising edge of CLK and the falling edge of $\overline{\text{CLK}}$ | SSTL_18 inputs |
| $\overline{\text{CSR}}, \overline{\text{DCS}}$ | Chip select inputs – disables register clocking ⁽¹⁾ when both inputs are high | SSTL_18 inputs |
| DODT | The outputs of this register bit will not be suspended by the $\overline{\text{DCS}}$ and $\overline{\text{CSR}}$ control. | SSTL_18 input |
| DCKE | The outputs of this register bit will not be suspended by the $\overline{\text{DCS}}$ and $\overline{\text{CSR}}$ control. | SSTL_18 input |
| Q1–Q25 ⁽²⁾ | Data outputs that are suspended by the $\overline{\text{DCS}}$ and $\overline{\text{CSR}}$ control | 1.8-V CMOS outputs |
| $\overline{\text{QCS}}$ | Data output that will not be suspended by the $\overline{\text{DCS}}$ and $\overline{\text{CSR}}$ control | 1.8-V CMOS output |
| QODT | Data output that will not be suspended by the $\overline{\text{DCS}}$ and $\overline{\text{CSR}}$ control | 1.8-V CMOS output |
| QCKE | Data output that will not be suspended by the $\overline{\text{DCS}}$ and $\overline{\text{CSR}}$ control | 1.8-V CMOS output |
| NC | No internal connection | |
| DNU | Do not use – inputs are in standby-equivalent mode, and outputs are driven low. | |

- (1) Data inputs = D2, D3, D5, D6, D8–D25 when C0 = 0 and C1 = 0
 Data inputs = D2, D3, D5, D6, D8–D14 when C0 = 0 and C1 = 1
 Data inputs = D1–D6, D8–D10, D12, D13 when C0 = 1 and C1 = 1
- (2) Data outputs = Q2, Q3, Q5, Q6, Q8–Q25 when C0 = 0 and C1 = 0
 Data outputs = Q2, Q3, Q5, Q6, Q8–Q14 when C0 = 0 and C1 = 1
 Data outputs = Q1–Q6, Q8–Q10, Q12, Q13 when C0 = 1 and C1 = 1

FUNCTION TABLES

| INPUTS | | | | | | OUTPUT Qn |
|---------------------------|-------------------------|-------------------------|---------------|-------------------------|---------------|----------------|
| $\overline{\text{RESET}}$ | $\overline{\text{DCS}}$ | $\overline{\text{CSR}}$ | CLK | $\overline{\text{CLK}}$ | Dn | |
| H | L | X | ↑ | ↓ | L | L |
| H | L | X | ↑ | ↓ | H | H |
| H | X | L | ↑ | ↓ | L | L |
| H | X | L | ↑ | ↓ | H | H |
| H | H | H | ↑ | ↓ | X | Q ₀ |
| H | X | X | L or H | L or H | X | Q ₀ |
| L | X or floating | X or floating | X or floating | X or floating | X or floating | L |

| INPUTS | | | | OUTPUTS |
|---------------------------|---------------|-------------------------|--|--|
| $\overline{\text{RESET}}$ | CLK | $\overline{\text{CLK}}$ | DCKE, $\overline{\text{DCS}}$, DODT | QCKE, $\overline{\text{QCS}}$, QODT |
| H | ↑ | ↓ | H | H |
| H | ↑ | ↓ | L | L |
| H | L or H | L or H | X | Q ₀ |
| L | X or floating | X or floating | X or floating | L |

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Absolute Maximum Ratings⁽¹⁾

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

| | | MIN | MAX | UNIT |
|---------------|---|-----------------------------|----------------|---------|
| V_{CC} | Supply voltage range | -0.5 | 2.5 | V |
| V_I | Input voltage range ⁽²⁾⁽³⁾ | -0.5 | 2.5 | V |
| V_O | Output voltage range ⁽²⁾⁽³⁾ | -0.5 | $V_{CC} + 0.5$ | V |
| I_{IK} | Input clamp current | $V_I < 0$ or $V_I > V_{CC}$ | | ±50 mA |
| I_{OK} | Output clamp current | $V_O < 0$ or $V_O > V_{CC}$ | | ±50 mA |
| I_O | Continuous output current | $V_O = 0$ to V_{CC} | | ±50 mA |
| | Continuous current through each V_{CC} or GND | | | ±100 mA |
| θ_{JA} | Package thermal impedance ⁽⁴⁾ | | | 36 °C/W |
| T_{stg} | Storage temperature range | -65 | 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⁽¹⁾

| | | MIN | NOM | MAX | UNIT |
|-------------|---------------------------------|-------------------------------|---------------------|----------------------|------|
| V_{CC} | Supply voltage | 1.7 | | 1.9 | V |
| V_{REF} | Reference voltage | $0.49 \times V_{CC}$ | $0.5 \times V_{CC}$ | $0.51 \times V_{CC}$ | V |
| V_I | Input voltage | 0 | | V_{CC} | V |
| V_{IH} | AC high-level input voltage | Data inputs, \overline{CSR} | | $V_{REF} + 250$ mV | V |
| V_{IL} | AC low-level input voltage | Data inputs, \overline{CSR} | | $V_{REF} - 250$ mV | V |
| V_{IH} | DC high-level input voltage | Data inputs, \overline{CSR} | | $V_{REF} + 125$ mV | V |
| V_{IL} | DC low-level input voltage | Data inputs, \overline{CSR} | | $V_{REF} - 125$ mV | V |
| V_{IH} | High-level input voltage | \overline{RESET} , Cn | | $0.65 \times V_{CC}$ | V |
| V_{IL} | Low-level input voltage | \overline{RESET} , Cn | | $0.35 \times V_{CC}$ | V |
| V_{ICR} | Common-mode input voltage range | CLK, \overline{CLK} | | 0.675 | V |
| $V_{I(PP)}$ | Peak-to-peak input voltage | CLK, \overline{CLK} | | 600 | mV |
| I_{OH} | High-level output current | | | -8 | mA |
| I_{OL} | Low-level output current | | | 8 | mA |
| T_A | Operating free-air temperature | 0 | | 70 | °C |

- (1) The \overline{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{RESET} is low. Refer to the TI application report, *Implications of Slow or Floating CMOS Inputs*, literature number SCBA004.

Electrical Characteristics

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

| PARAMETER | | TEST CONDITIONS | V _{CC} | MIN | TYP ⁽¹⁾ | MAX | UNIT |
|--------------------|--|---|-----------------|-----------------------|--------------------|-----|----------------------|
| V _{OH} | | I _{OH} = -100 μA | 1.7 V to 1.9 V | V _{CC} - 0.2 | | | V |
| | | I _{OH} = -6 mA | 1.7 V | 1.3 | | | |
| V _{OL} | | I _{OL} = 100 μA | 1.7 V to 1.9 V | 0.2 | | | V |
| | | I _{OL} = 6 mA | 1.7 V | 0.4 | | | |
| I _I | All inputs ⁽²⁾ | V _I = V _{CC} or GND | 1.9 V | ±5 | | | μA |
| I _{CC} | Static standby | RESET = GND | 1.9 V | 100 | | | μA |
| | Static operating | RESET = V _{CC} , V _I = V _{IH(AC)} or V _{IL(AC)} | | 40 | | | mA |
| I _{CCD} | Dynamic operating – clock only | RESET = V _{CC} , V _I = V _{IH(AC)} or V _{IL(AC)} , CLK and CLK switching 50% duty cycle | 1.8 V | 33 | | | μA/MHz |
| | Dynamic operating – per each data input, 1:1 configuration | RESET = V _{CC} , V _I = V _{IH(AC)} or V _{IL(AC)} , CLK and CLK switching 50% duty cycle, | | 19 | | | μA/clock MHz/D input |
| | Dynamic operating – per each data input, 1:2 configuration | One data input switching at one-half clock frequency, 50% duty cycle | | 35 | | | |
| I _{CCDLP} | Chip-select-enabled low-power active mode, clock only | RESET = V _{CC} , V _I = V _{IH(AC)} or V _{IL(AC)} , CLK and CLK switching 50% duty cycle | 1.8 V | 34 | | | μA/MHz |
| | Chip-select-enabled low-power active mode, 1:1 configuration | RESET = V _{CC} , V _I = V _{IH(AC)} or V _{IL(AC)} , CLK and CLK switching 50% duty cycle, | | 2 | | | μA/clock MHz/D input |
| | Chip-select-enabled low-power active mode, 1:2 configuration | One data input switching at one-half clock frequency, 50% duty cycle | | 2 | | | |
| C _i | Data inputs, CSR | V _I = V _{REF} ± 250 mV | 1.8 V | 2.5 | 3 | 3.5 | pF |
| | CLK, CLK | V _{ICR} = 0.9 V, V _{I(PP)} = 600 mV | | 2 | 3 | | |
| | RESET | V _I = V _{CC} or GND | | 2.5 | | | |

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

(2) Each V_{REF} pin (A3 or T3) should be tested independently, with the other (untested) pin open. Since the two V_{REF} pins are connected internally, the total maximum input current on the V_{REF} input is doubled (±10 μA).

Timing Requirements⁽¹⁾

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

| | | MIN | MAX | UNIT |
|--------------------|--|--|-----|------|
| f _{clock} | Clock frequency | 500 | | MHz |
| t _w | Pulse duration, CLK, CLK high or low | 1 | | ns |
| t _{act} | Differential inputs active time ⁽²⁾ | 10 | | ns |
| t _{inact} | Differential inputs inactive time ⁽³⁾ | 15 | | ns |
| t _{su} | Setup time | DCS before CLK↑, CLK↓, CSR high; CSR before CLK↑, CLK↓, DCS high | | 0.6 |
| | | DCS before CLK↑, CLK↓, CSR low | | 0.5 |
| | | DODT, DCKE, and Data before CLK↑, CLK↓ | | 0.5 |
| t _h | Hold time | DCS, DODT, DCKE, and Data after CLK↑, CLK↓ | | 0.5 |

(1) All input slew rates are 1 V/ns ±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 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 RESET is taken low.

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WITH SSTL_18 INPUTS AND OUTPUTS

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Switching Characteristics

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

| PARAMETER | FROM (INPUT) | TO (OUTPUT) | $V_{CC} = 1.8\text{ V}$ $\pm 0.1\text{ V}$ | | UNIT |
|------------------|---------------------------------|----------------|---|------|------|
| | | | MIN | MAX | |
| f_{max} | | | 500 | | MHz |
| $t_{pdm}^{(1)}$ | CLK and $\overline{\text{CLK}}$ | Q | 1.41 | 2.15 | ns |
| $t_{pdms}^{(1)}$ | CLK and $\overline{\text{CLK}}$ | Q | 2.35 | | ns |
| $t_{RPHL}^{(1)}$ | $\overline{\text{RESET}}$ | Q | 3 | | ns |

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

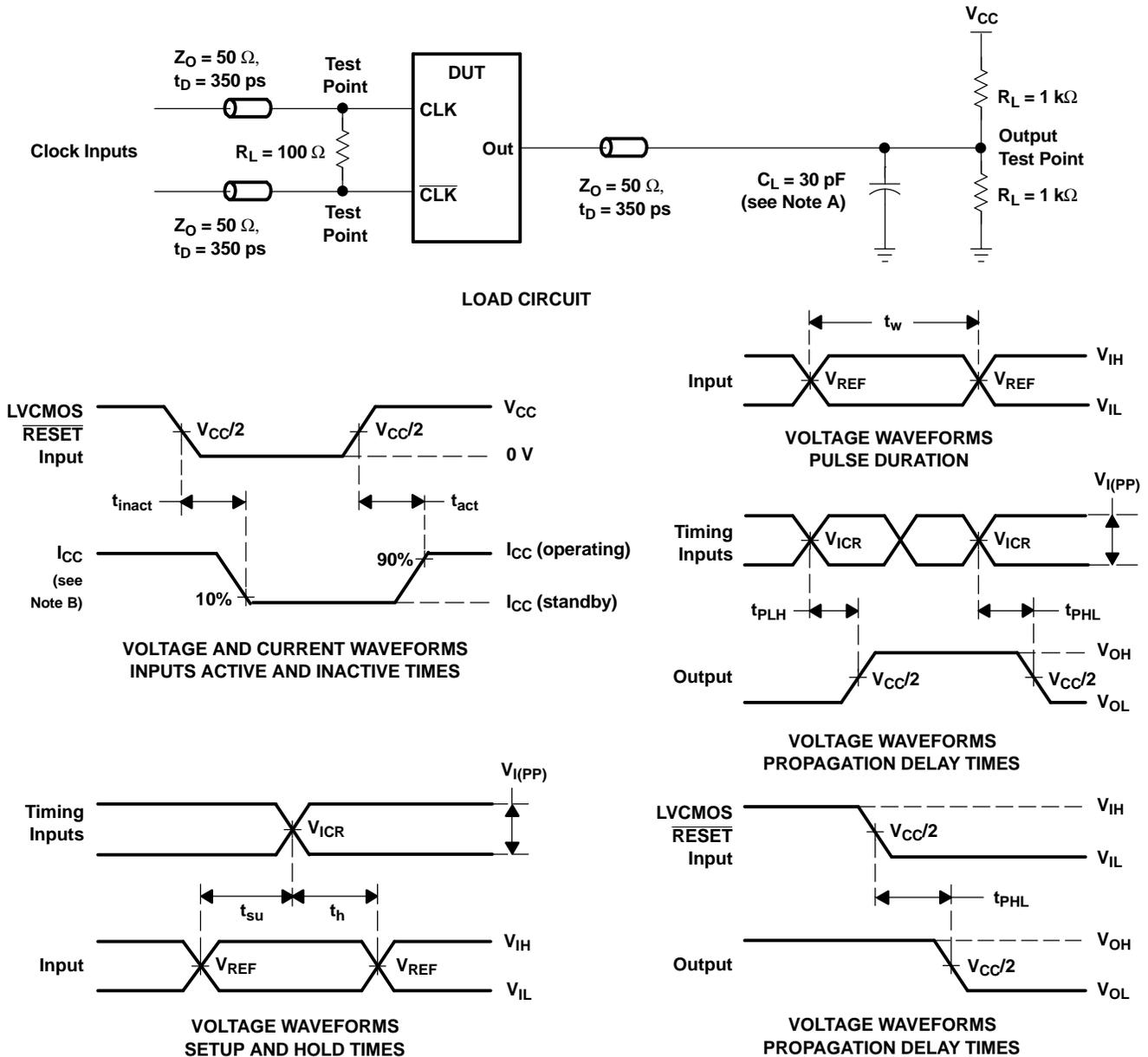
Output Slew Rates

over recommended operating free-air temperature range (unless otherwise noted) (see Figure 2)

| PARAMETER | FROM | TO | $V_{CC} = 1.8\text{ V}$ $\pm 0.1\text{ V}$ | | UNIT |
|------------------------|------------|------------|---|-----|------|
| | | | MIN | MAX | |
| dV/dt_r | 20% | 80% | 1 | 4 | V/ns |
| dV/dt_f | 80% | 20% | 1 | 4 | V/ns |
| $dV/dt_{\Delta}^{(1)}$ | 20% or 80% | 80% or 20% | 1 | | V/ns |

(1) Difference between dV/dt_r (rising edge rate) and dV/dt_f (falling edge rate)

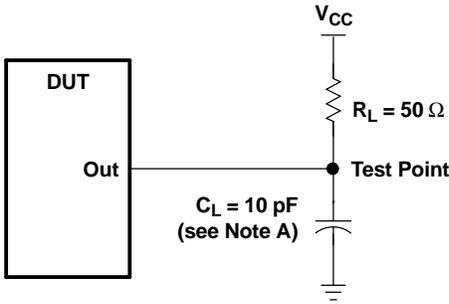
PARAMETER MEASUREMENT INFORMATION



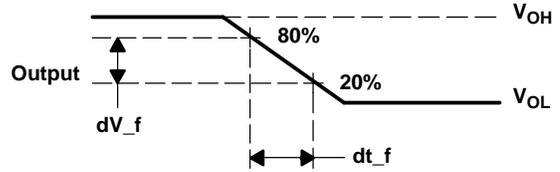
- NOTES: A. C_L includes probe and jig capacitance.
 B. I_{CC} tested with clock and data inputs held at V_{CC} or GND, and $I_O = 0 \text{ mA}$.
 C. All input pulses are supplied by generators having the following characteristics: $PRR \leq 10 \text{ MHz}$, $Z_O = 50 \Omega$, input slew rate = $1 \text{ V/ns} \pm 20\%$ (unless otherwise noted).
 D. The outputs are measured one at a time, with one transition per measurement.
 E. $V_{REF} = V_{CC}/2$
 F. $V_{IH} = V_{REF} + 250 \text{ mV}$ (ac voltage levels) for differential inputs. $V_{IH} = V_{CC}$ for LVC MOS input.
 G. $V_{IL} = V_{REF} - 250 \text{ mV}$ (ac voltage levels) for differential inputs. $V_{IL} = \text{GND}$ for LVC MOS input.
 H. $V_{I(PP)} = 600 \text{ mV}$
 I. t_{PLH} and t_{PHL} are the same as t_{pd} .

Figure 1. Load Circuit and Voltage Waveforms

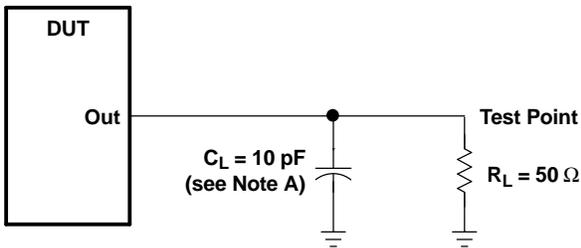
PARAMETER MEASUREMENT INFORMATION



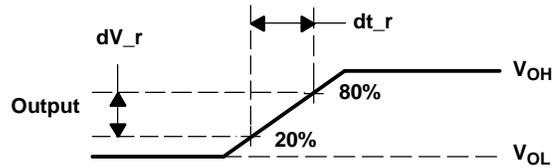
LOAD CIRCUIT
 HIGH-TO-LOW SLEW-RATE MEASUREMENT



VOLTAGE WAVEFORMS
 HIGH-TO-LOW SLEW-RATE MEASUREMENT



LOAD CIRCUIT
 LOW-TO-HIGH SLEW-RATE MEASUREMENT

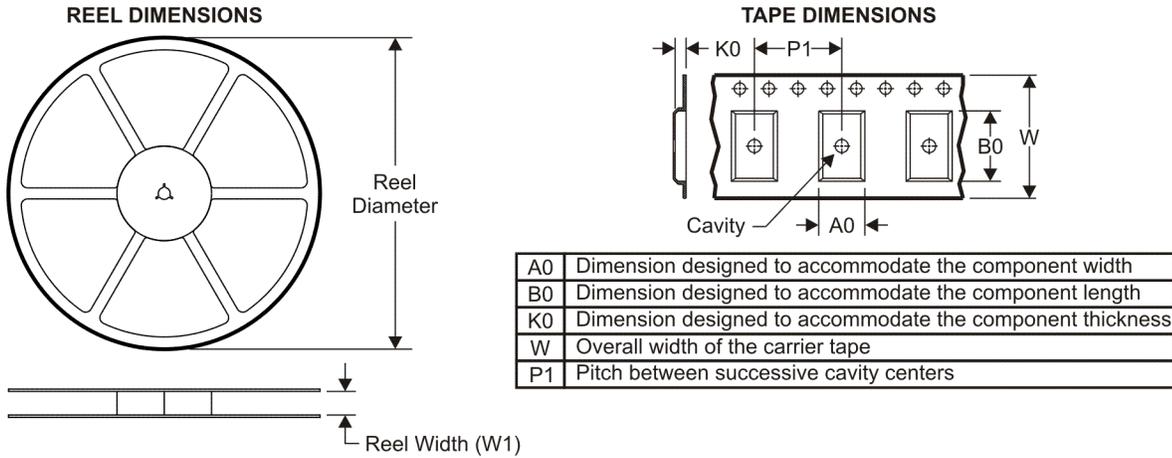


VOLTAGE WAVEFORMS
 LOW-TO-HIGH SLEW-RATE MEASUREMENT

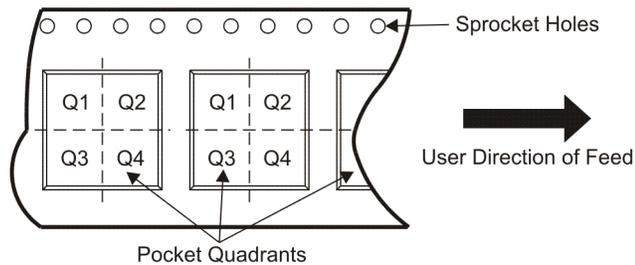
- NOTES: A. C_L includes probe and jig capacitance.
 B. All input pulses are supplied by generators having the following characteristics:
 PRR \leq 10 MHz, $Z_O = 50 \Omega$, input slew rate = 1 V/ns \pm 20% (unless otherwise specified).

Figure 2. Output Slew-Rate Measurement Information

TAPE AND REEL INFORMATION



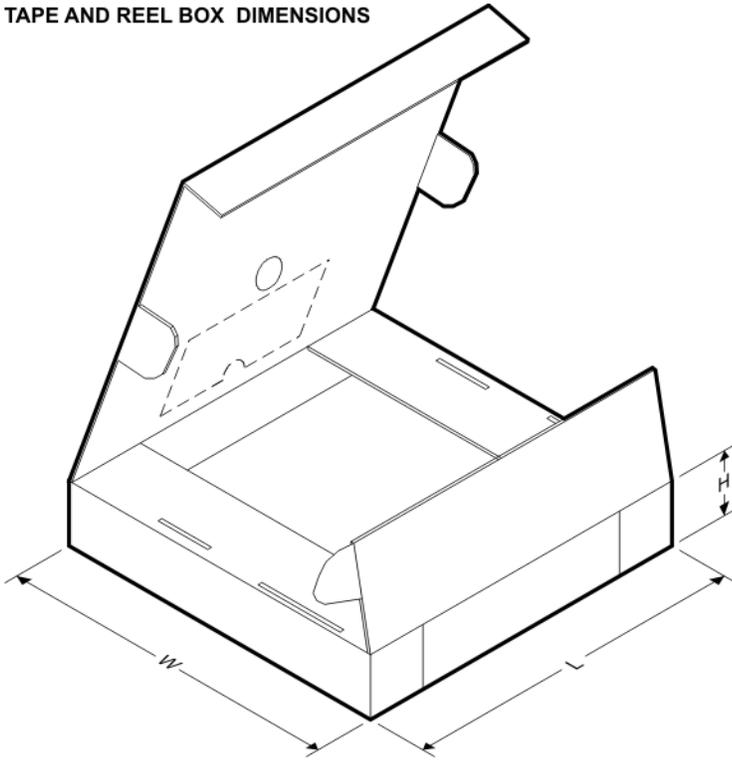
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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 |
|--------------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| SN74SSTU32864EZKER | LFBGA | ZKE | 96 | 1000 | 330.0 | 24.4 | 5.7 | 13.7 | 2.0 | 8.0 | 24.0 | Q1 |

TAPE AND REEL BOX DIMENSIONS

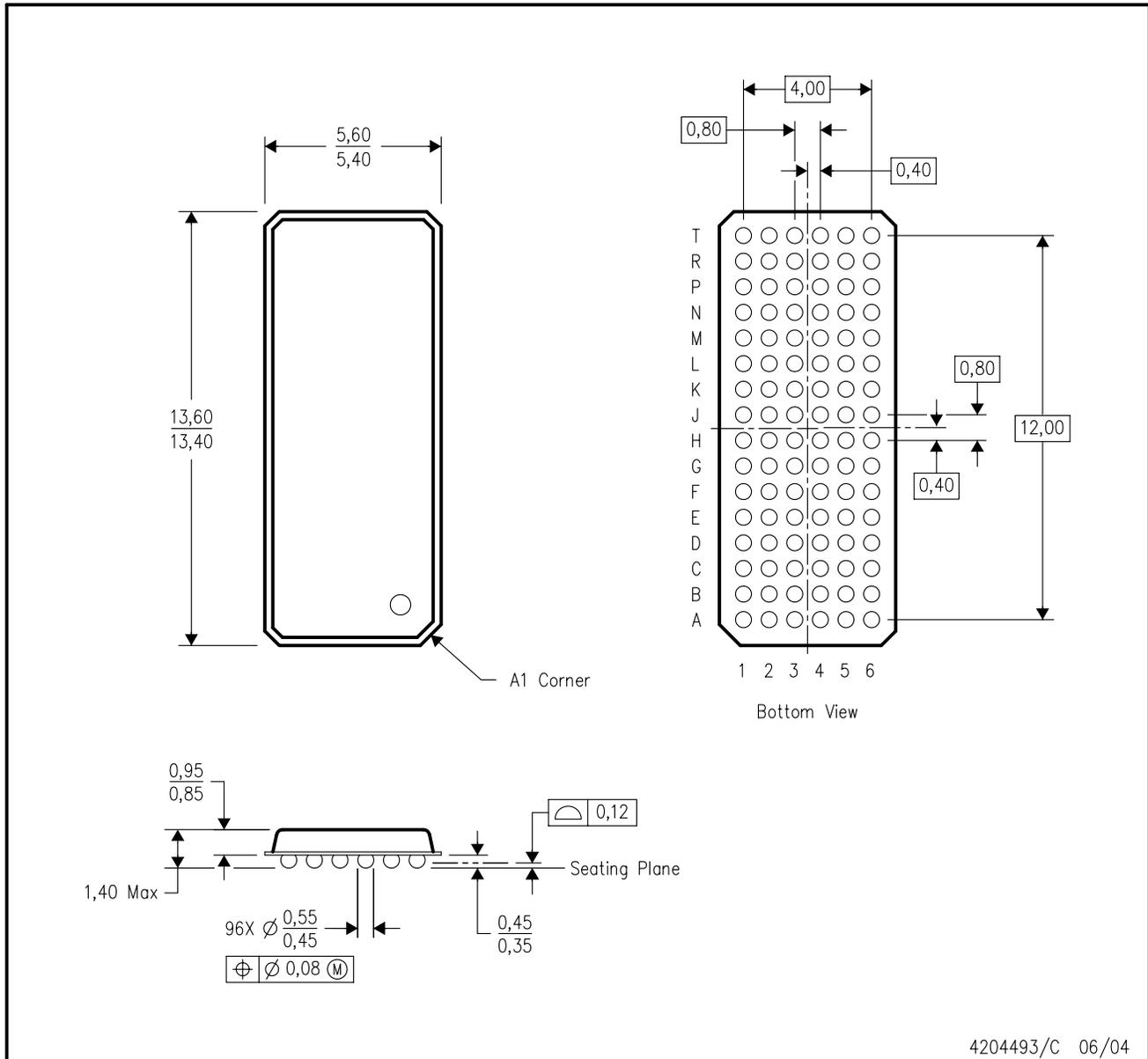


*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|--------------------|--------------|-----------------|------|------|-------------|------------|-------------|
| SN74SSTU32864EZKER | LFBGA | ZKE | 96 | 1000 | 346.0 | 346.0 | 41.0 |

ZKE (R-PBGA-N96)

PLASTIC BALL GRID ARRAY



- NOTES:
- A. All linear dimensions are in millimeters.
 - B. This drawing is subject to change without notice.
 - C. Falls within JEDEC MO-205 variation CC.
 - D. This package is lead-free. Refer to the 96 GKE package (drawing 4188953) for tin-lead (SnPb).

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