

SN74SSTV16859

13-BIT TO 26-BIT REGISTERED BUFFER WITH SSTL_2 INPUTS AND OUTPUTS

SCES297D – FEBRUARY 2000 – REVISED AUGUST 2004

- Member of the Texas Instruments Widebus™ Family
- 1-to-2 Outputs to Support Stacked DDR DIMMs
- Supports SSTL_2 Data Inputs
- Outputs Meet SSTL_2 Class II Specifications
- Differential Clock (CLK and $\overline{\text{CLK}}$) Inputs
- Supports LVCMOS Switching Levels on the $\overline{\text{RESET}}$ Input
- $\overline{\text{RESET}}$ Input Disables Differential Input Receivers, Resets All Registers, and Forces All Outputs Low
- Pinout Optimizes DIMM PCB Layout
- Latch-Up Performance Exceeds 100 mA Per JESD 78, Class II
- ESD Protection Exceeds JESD 22
 - 2000-V Human-Body Model (A114-A)
 - 200-V Machine Model (A115-A)

**DGG PACKAGE
(TOP VIEW)**

| | | | |
|------------------|----|----|---------------------------|
| Q13A | 1 | 64 | V _{DDQ} |
| Q12A | 2 | 63 | GND |
| Q11A | 3 | 62 | D13 |
| Q10A | 4 | 61 | D12 |
| Q9A | 5 | 60 | V _{CC} |
| V _{DDQ} | 6 | 59 | V _{DDQ} |
| GND | 7 | 58 | GND |
| Q8A | 8 | 57 | D11 |
| Q7A | 9 | 56 | D10 |
| Q6A | 10 | 55 | D9 |
| Q5A | 11 | 54 | GND |
| Q4A | 12 | 53 | D8 |
| Q3A | 13 | 52 | D7 |
| Q2A | 14 | 51 | $\overline{\text{RESET}}$ |
| GND | 15 | 50 | GND |
| Q1A | 16 | 49 | $\overline{\text{CLK}}$ |
| Q13B | 17 | 48 | CLK |
| V _{DDQ} | 18 | 47 | V _{DDQ} |
| Q12B | 19 | 46 | V _{CC} |
| Q11B | 20 | 45 | V _{REF} |
| Q10B | 21 | 44 | D6 |
| Q9B | 22 | 43 | GND |
| Q8B | 23 | 42 | D5 |
| Q7B | 24 | 41 | D4 |
| Q6B | 25 | 40 | D3 |
| GND | 26 | 39 | GND |
| V _{DDQ} | 27 | 38 | V _{DDQ} |
| Q5B | 28 | 37 | V _{CC} |
| Q4B | 29 | 36 | D2 |
| Q3B | 30 | 35 | D1 |
| Q2B | 31 | 34 | GND |
| Q1B | 32 | 33 | V _{DDQ} |

description/ordering information

This 13-bit to 26-bit registered buffer is designed for 2.3-V to 2.7-V V_{CC} operation.

All inputs are SSTL_2, except the LVCMOS reset ($\overline{\text{RESET}}$) input. All outputs are SSTL_2, Class II compatible.

The SN74SSTV16859 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.

ORDERING INFORMATION

| T _A | PACKAGE† | | ORDERABLE PART NUMBER | TOP-SIDE MARKING |
|----------------|---------------------------------|---------------|-----------------------|------------------|
| 0°C to 70°C | QFN – RGQ (Tin–Pb Finish) | Tape and reel | SN74SSTV16859RGQR | SS859 |
| | QFN – RGQ (Matte–Tin Finish) | | SN74SSTV16859RGQ8 | |
| | TSSOP – DGG | Tape and reel | SN74SSTV16859DGGR | SSTV16859 |

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



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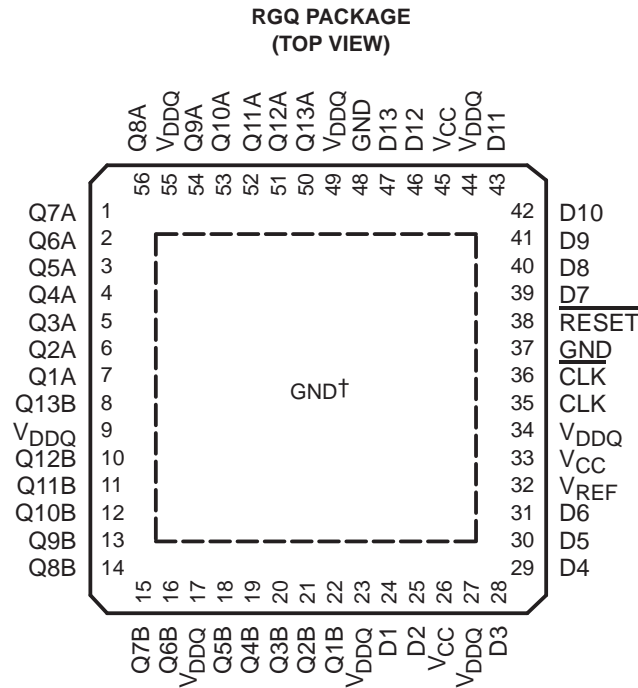
SN74SSTV16859
13-BIT TO 26-BIT REGISTERED BUFFER
WITH SSTL 2 INPUTS AND OUTPUTS

SCES297D – FEBRUARY 2000 – REVISED AUGUST 2004

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 $\overline{\text{RESET}}$ input always must be held at a valid logic high or low level.

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.



† The center die pad must be connected to GND.

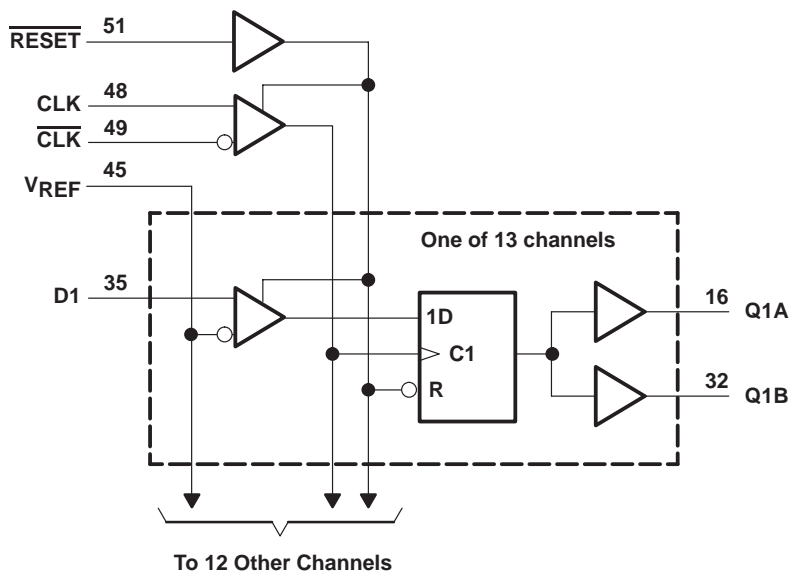
FUNCTION TABLE

| INPUTS | | | | OUTPUT |
|---------------------------|---------------|-------------------------|---------------|--------|
| $\overline{\text{RESET}}$ | CLK | $\overline{\text{CLK}}$ | D | Q |
| 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 |

SN74SSTV16859
13-BIT TO 26-BIT REGISTERED BUFFER
WITH SSTL 2 INPUTS AND OUTPUTS

SCES297D – FEBRUARY 2000 – REVISED AUGUST 2004

logic diagram (positive logic)



Pin numbers shown are for the DGG package.

absolute maximum ratings over operating free-air temperature range (unless otherwise noted)†

| | |
|--|-----------------------------|
| Supply voltage range, V_{CC} or V_{DDQ} | -0.5 V to 3.6 V |
| Input voltage range, V_I (see Notes 1 and 2) | -0.5 V to $V_{CC} + 0.5$ V |
| Output voltage range, V_O (see Notes 1 and 2) | -0.5 V to $V_{DDQ} + 0.5$ V |
| Input clamp current, I_{IK} ($V_I < 0$) | -50 mA |
| Output clamp current, I_{OK} ($V_O < 0$ or $V_O > V_{DDQ}$) | ± 50 mA |
| Continuous output current, I_O ($V_O = 0$ to V_{DDQ}) | ± 50 mA |
| Continuous current through each V_{CC} , V_{DDQ} , or GND | ± 100 mA |
| Package thermal impedance, θ_{JA} (see Note 3): DGG package | 55°C/W |
| (see Note 4): RGQ package | 22°C/W |
| Storage temperature range, T_{stg} | -65°C to 150°C |

† 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.

- NOTES:
1. The input and output negative-voltage ratings may be exceeded if the input and output clamp-current ratings are observed.
 2. This value is limited to 3.6 V maximum.
 3. The package thermal impedance is calculated in accordance with JESD 51-7.
 4. The package thermal impedance is calculated in accordance with JESD 51-5.

SN74SSTV16859

13-BIT TO 26-BIT REGISTERED BUFFER WITH SSTL 2 INPUTS AND OUTPUTS

SCES297D – FEBRUARY 2000 – REVISED AUGUST 2004

recommended operating conditions (see Note 5)

| | | MIN | NOM | MAX | UNIT | |
|--------------------|--|--------------------------|------------------|---------------------------|------|---|
| V _{CC} | Supply voltage | V _{DDQ} | | 2.7 | V | |
| V _{DDQ} | Output supply voltage | 2.3 | | 2.7 | V | |
| V _{REF} | Reference voltage (V _{REF} = V _{DDQ} /2) | 1.15 | 1.25 | 1.35 | 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 | | V _{REF} + 310 mV | V | |
| V _{IL} | AC low-level input voltage | Data inputs | | V _{REF} – 310 mV | V | |
| V _{IH} | DC high-level input voltage | Data inputs | | V _{REF} + 150 mV | V | |
| V _{IL} | DC low-level input voltage | Data inputs | | V _{REF} – 150 mV | V | |
| V _{IH} | High-level input voltage | RESET | | 1.7 | V | |
| V _{IL} | Low-level input voltage | RESET | | 0.7 | V | |
| V _{ICR} | Common-mode input voltage range | CLK, CLK | | 0.97 | 1.53 | V |
| V _{I(PP)} | Peak-to-peak input voltage | CLK, CLK | | 360 | mV | |
| I _{OH} | High-level output current | | | –20 | mA | |
| I _{OL} | Low-level output current | | | 20 | | |
| T _A | Operating free-air temperature | 0 | | 70 | °C | |

NOTE 5: The RESET input 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 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‡ | MAX | UNIT |
|-------------------|---|--|-------------------|------------------------|------|------|------------|
| V _{IK} | | I _I = –18 mA | 2.3 V | | | –1.2 | V |
| V _{OH} | | I _{OH} = –100 μA | 2.3 V to 2.7 V | V _{DDQ} – 0.2 | | | V |
| | | I _{OH} = –16 mA | 2.3 V | 1.95 | | | |
| V _{OL} | | I _{OL} = 100 μA | 2.3 V to 2.7 V | | | 0.2 | V |
| | | I _{OL} = 16 mA | 2.3 V | | | 0.35 | |
| I _I | All inputs | V _I = V _{CC} or GND | 2.7 V | | | ±5 | μA |
| I _{CC} | Static standby | RESET = GND | 2.7 V | | | 10 | μA |
| | Static operating | RESET = V _{CC} , V _I = V _{IH(AC)} or V _{IL(AC)} | | | | 40 | |
| 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 | 2.5 V | | | 30 | μA/ MHz |
| | Dynamic operating – per each data input | RESET = V _{CC} , V _I = V _{IH(AC)} or V _{IL(AC)} , CLK and CLK switching 50% duty cycle, One data input switching at one-half clock frequency, 50% duty cycle | | | | 10 | |
| r _{OH} | Output high | I _{OH} = –20 mA | 2.3 V to 2.7 V | 7 | | 20 | Ω |
| r _{OL} | Output low | I _{OL} = 20 mA | 2.3 V to 2.7 V | 7 | | 20 | Ω |
| r _{O(Δ)} | r _{OH} – r _{OL} | I _O = 20 mA, T _A = 25°C, One output | 2.5 V | | | 6 | Ω |
| C _i § | Data inputs | V _I = V _{REF} ± 310 mV | 2.5 V | 2.5 | 3 | 3.5 | pF |
| | CLK, CLK | V _{ICR} = 1.25 V, V _{I(PP)} = 360 mV | | 2.5 | 3 | 3.5 | |
| | RESET | V _I = V _{CC} or GND | | 3 | | | |

† For this test condition, V_{DDQ} always is equal to V_{CC}.

‡ All typical values are at V_{CC} = 2.5 V, T_A = 25°C.

§ Measured with 50-MHz input frequency for the QFN package and 10-MHz input frequency for the TSSOP package



SN74SSTV16859
13-BIT TO 26-BIT REGISTERED BUFFER
WITH SSTL 2 INPUTS AND OUTPUTS

SCES297D – FEBRUARY 2000 – REVISED AUGUST 2004

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

| | | $V_{CC} = 2.5\text{ V}$ $\pm 0.2\text{ V}^\dagger$ | | UNIT |
|--------------------|--|---|-----|------|
| | | MIN | MAX | |
| f_{clock} | Clock frequency | 200 | | MHz |
| t_w | Pulse duration, CLK, $\overline{\text{CLK}}$ high or low | 2.5 | | ns |
| t_{act} | Differential inputs active time (see Note 6) | 22 | | ns |
| t_{inact} | Differential inputs inactive time (see Note 7) | 22 | | ns |
| t_{su} | Setup time, fast slew rate (see Notes 8 and 10) | 0.75 | | ns |
| | Setup time, slow slew rate (see Notes 9 and 10) | 0.9 | | |
| t_h | Hold time, fast slew rate (see Notes 8 and 10) | 0.75 | | ns |
| | Hold time, slow slew rate (see Notes 9 and 10) | 0.9 | | |

[†] For this test condition, V_{DDQ} always is equal to V_{CC} .

- NOTES:
6. V_{REF} must be held at a valid input level, and data inputs must be held low for a minimum time of $t_{\text{act}} \text{ max}$, after $\overline{\text{RESET}}$ is taken high.
 7. V_{REF} , data, and clock inputs must be held at valid voltage levels (not floating) for a minimum time of $t_{\text{inact}} \text{ max}$, after $\overline{\text{RESET}}$ is taken low.
 8. For data signal input slew rate $\geq 1\text{ V/ns}$
 9. For data signal input slew rate $\geq 0.5\text{ V/ns}$ and $< 1\text{ V/ns}$
 10. CLK, $\overline{\text{CLK}}$ signals input slew rates are $\geq 1\text{ V/ns}$.

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

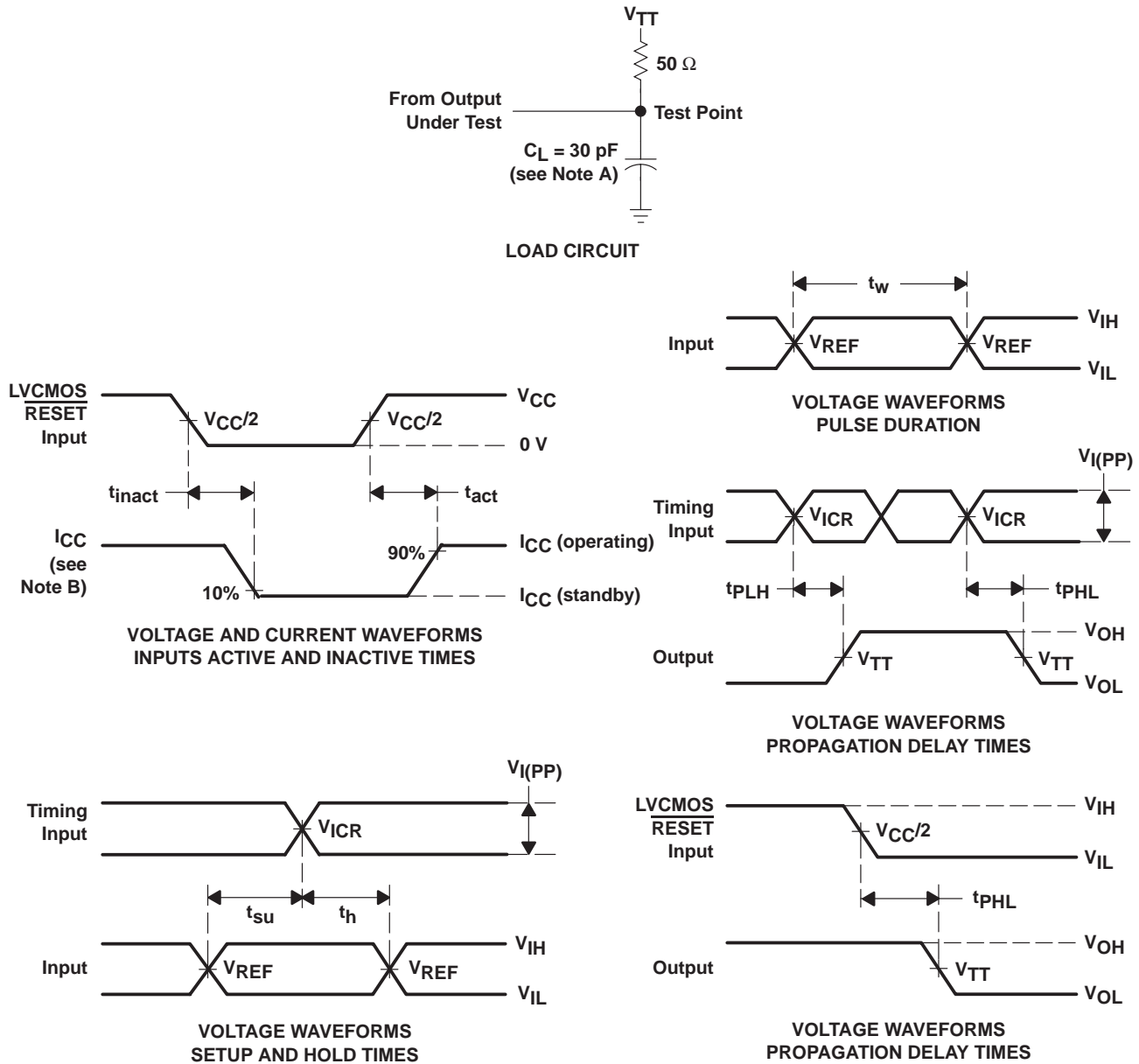
| PARAMETER | FROM (INPUT) | TO (OUTPUT) | $V_{CC} = 2.5\text{ V}$ $\pm 0.2\text{ V}^\dagger$ | | UNIT |
|------------------|---------------------------------|----------------|---|-----|------|
| | | | MIN | MAX | |
| f_{max} | | | 200 | | MHz |
| t_{pd} | CLK and $\overline{\text{CLK}}$ | Q | 1.1 | 2.8 | ns |
| t_{PHL} | $\overline{\text{RESET}}$ | Q | 5 | | ns |

[†] For this test condition, V_{DDQ} always is equal to V_{CC} .

SN74SSTV16859
13-BIT TO 26-BIT REGISTERED BUFFER
WITH SSTL 2 INPUTS AND OUTPUTS

SCES297D – FEBRUARY 2000 – REVISED AUGUST 2004

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. $V_{TT} = V_{REF} = V_{DDQ}/2$
 - F. $V_{IH} = V_{REF} + 310 \text{ mV}$ (ac voltage levels) for differential inputs. $V_{IH} = V_{CC}$ for LVC MOS input.
 - G. $V_{IL} = V_{REF} - 310 \text{ mV}$ (ac voltage levels) for differential inputs. $V_{IL} = \text{GND}$ for LVC MOS input.
 - H. t_{PLH} and t_{PHL} are the same as t_{pd} .

Figure 1. Load Circuit and Voltage Waveforms

PACKAGING INFORMATION

| Orderable part number | Status (1) | Material type (2) | Package Pins | Package qty Carrier | RoHS (3) | Lead finish/ Ball material (4) | MSL rating/ Peak reflow (5) | Op temp (°C) | Part marking (6) |
|-----------------------------------|---------------|----------------------|------------------|-----------------------|-------------|--------------------------------------|-----------------------------------|--------------|---------------------|
| SN74SSTV16859DGGR | Active | Production | TSSOP (DGG) 64 | 2000 LARGE T&R | Yes | NIPDAU | Level-2-260C-1 YEAR | 0 to 70 | SSTV16859 |
| SN74SSTV16859RGQ8 | Obsolete | Production | VQFN (RGQ) 56 | - | - | Call TI | Call TI | 0 to 70 | SS859 |

(1) **Status:** For more details on status, see our [product life cycle](#).

(2) **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

(3) **RoHS values:** Yes, No, RoHS Exempt. See the [TI RoHS Statement](#) for additional information and value definition.

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

(5) **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

(6) **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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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 |
|-------------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| SN74SSTV16859DGGR | TSSOP | DGG | 64 | 2000 | 330.0 | 24.4 | 8.4 | 17.3 | 1.7 | 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) |
|-------------------|--------------|-----------------|------|------|-------------|------------|-------------|
| SN74SSTV16859DGGR | TSSOP | DGG | 64 | 2000 | 356.0 | 356.0 | 45.0 |

DGG (R-PDSO-G**)

PLASTIC SMALL-OUTLINE PACKAGE

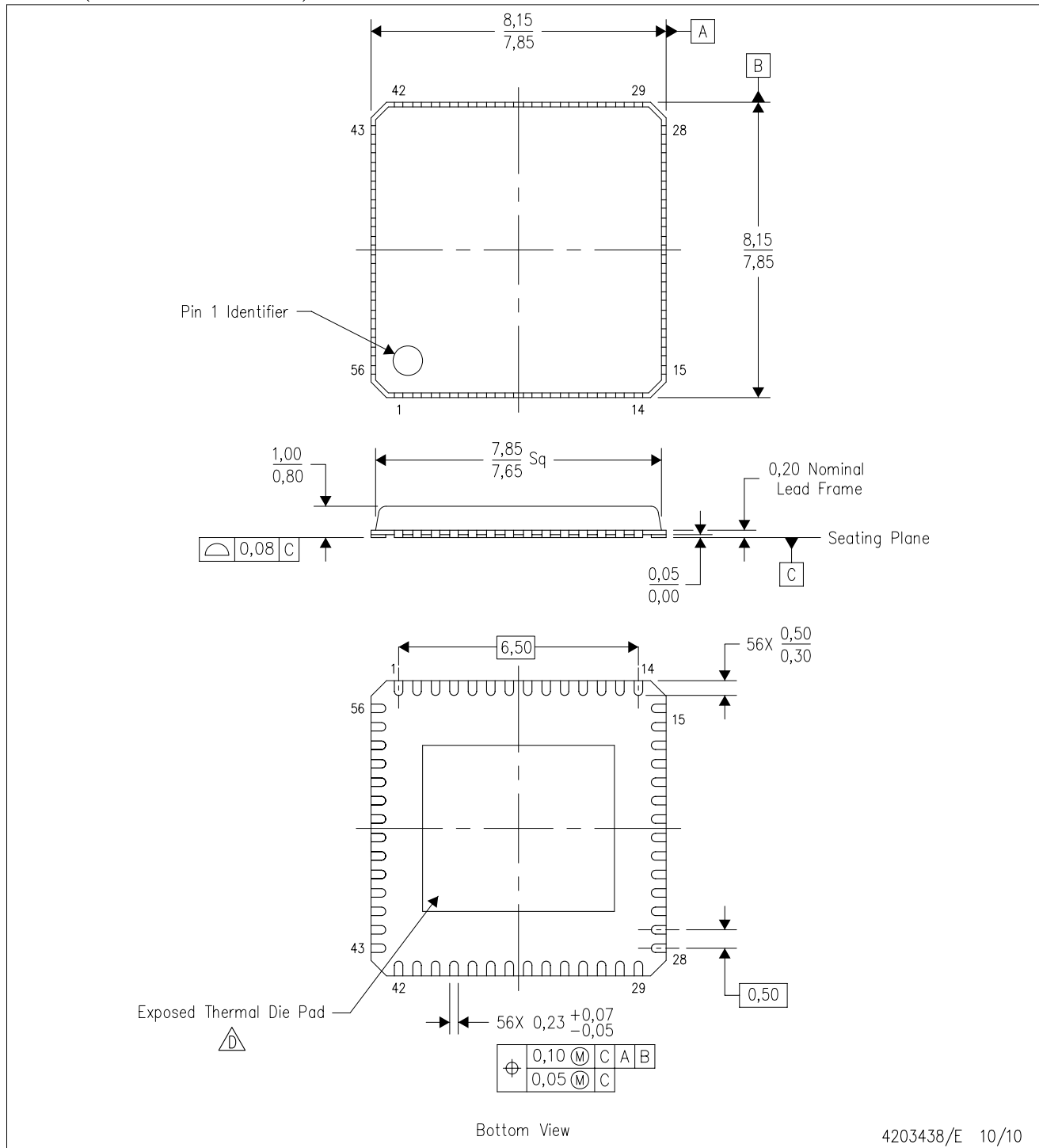
48 PINS SHOWN



- NOTES: A. All linear dimensions are in millimeters.
 B. This drawing is subject to change without notice.
 C. Body dimensions do not include mold protrusion not to exceed 0,15.
 D. Falls within JEDEC MO-153

RGQ (S-PVQFN-N56)

PLASTIC QUAD FLATPACK NO-LEAD



4203438/E 10/10

- NOTES:
- All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M-1994.
 - This drawing is subject to change without notice.
 - QFN (Quad Flatpack No-Lead) Package configuration.
 - The package thermal pad must be soldered to the board for thermal and mechanical performance. See the Product Data Sheet for details regarding the exposed thermal pad dimensions.
 - Package complies to JEDEC MO-220 variation VLLD-2.

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