



## 16-Channel, Constant-Current LED Driver with Switching Delay

Check for Samples: [TLC59284](#)

### FEATURES

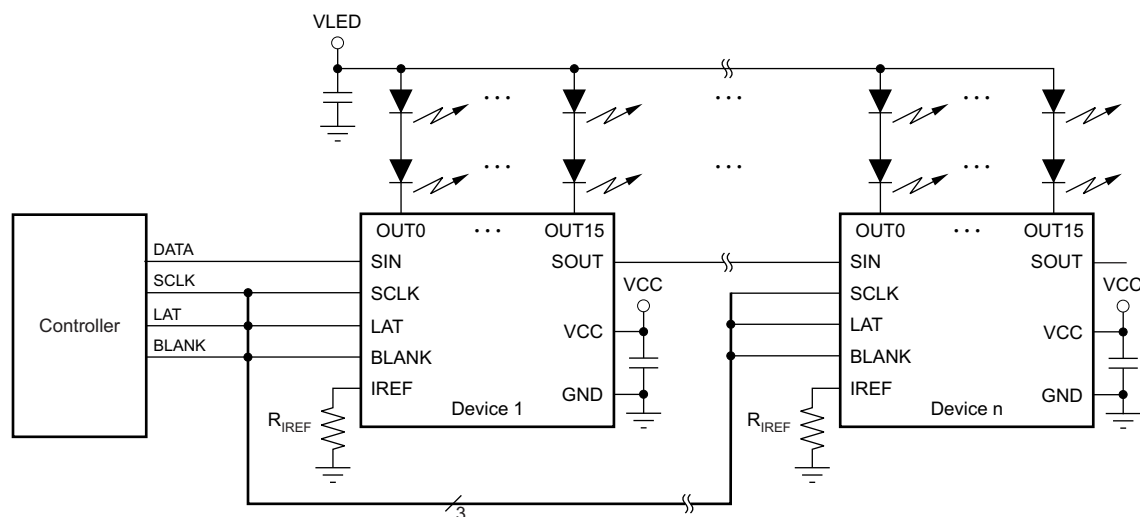
- 16-Channel, Constant-Current Sink Output with On and Off Control
- Constant-Current Sink Capability:
  - 35 mA ( $V_{CC} \leq 3.6$  V)
  - 45 mA ( $V_{CC} > 3.6$  V)
- LED Power-Supply Voltage: Up to 10 V
- $V_{CC}$ : 3 V to 5.5 V
- Constant-Current Accuracy:
  - Channel-to-Channel:  $\pm 1.4\%$  (typ),  $\pm 3\%$  (max)
  - Device-to-Device:  $\pm 2\%$  (typ),  $\pm 4\%$  (max)
- CMOS Logic Level I/O
- Data Transfer Rate: 35 MHz
- BLANK Pulse Width: 50 ns
- Switching Delay for Noise Reduction
- Operating Temperature:  $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$

### APPLICATIONS

- Video Displays
- Message Boards

### DESCRIPTION

The TLC59284 is a 16-channel, constant-current sink light-emitting diode (LED) driver. Each channel can be individually controlled with a simple serial communications protocol that is compatible with 3.3-V or 5-V CMOS logic levels, depending on the operating VCC. When the serial data buffer is loaded, a LAT rising edge transfers the data to the OUTn outputs. The BLANK pin can be used to turn off all OUTn outputs during power-on and output data latching to prevent unwanted image displays during these times. The constant-current value of all 16 channels is set by a single external resistor.



Typical Application Circuit (Multiple Daisy-Chained TLC59284s)



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This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

### PACKAGE AND ORDERING INFORMATION<sup>(1)</sup>

| PRODUCT  | PACKAGE-LEAD     | ORDERING NUMBER | TRANSPORT MEDIA, QUANTITY |
|----------|------------------|-----------------|---------------------------|
| TLC59284 | SSOP-24, QSOP-24 | TLC59284DBQR    | Tape and Reel, 2500       |
|          |                  | TLC59284DBQ     | Tube, 50                  |

- (1) For the most current package and ordering information, see the Package Option Addendum at the end of this document, or visit the device product folder at [www.ti.com](http://www.ti.com).

### ABSOLUTE MAXIMUM RATINGS<sup>(1)(2)</sup>

Over operating free-air temperature range, unless otherwise noted.

|                                       |                                  | VALUE |                | UNIT |
|---------------------------------------|----------------------------------|-------|----------------|------|
|                                       |                                  | MIN   | MAX            |      |
| Supply voltage                        | $V_{CC}$                         | -0.3  | +6             | V    |
| Input voltage range, $V_{IN}$         | SIN, SCLK, LAT, BLANK, IREF      | -0.3  | $V_{CC} + 0.3$ | V    |
| Output voltage range, $V_{OUT}$       | Output range, SOUT               | -0.3  | $V_{CC} + 0.3$ | V    |
|                                       | Output range, OUT0 to OUT15      | -0.3  | +11            | V    |
| Current, $I_{OUT}$                    | Output (dc), OUT0 to OUT15       |       | +50            | mA   |
| Temperature                           | Operating junction, $T_{J(MAX)}$ |       | +150           | °C   |
|                                       | Storage range, $T_{stg}$         | -55   | +150           | °C   |
| Electrostatic discharge (ESD) ratings | Human body model (HBM)           |       | 4000           | V    |
|                                       | Charged device model (CDM)       |       | 2000           | V    |

- (1) Stresses above these ratings may cause permanent damage. Exposure to absolute maximum conditions for extended periods may degrade device reliability. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those specified is not supported.
- (2) All voltage values are with respect to network ground terminal.

### THERMAL INFORMATION

| THERMAL METRIC <sup>(1)</sup> |                                              | TLC59284 | UNITS |
|-------------------------------|----------------------------------------------|----------|-------|
|                               |                                              | DBQ      |       |
|                               |                                              | 24 PINS  |       |
| $\theta_{JA}$                 | Junction-to-ambient thermal resistance       | 91.5     | °C/W  |
| $\theta_{JCTop}$              | Junction-to-case (top) thermal resistance    | 55.2     |       |
| $\theta_{JB}$                 | Junction-to-board thermal resistance         | 44.9     |       |
| $\psi_{JT}$                   | Junction-to-top characterization parameter   | 16.8     |       |
| $\psi_{JB}$                   | Junction-to-board characterization parameter | 44.5     |       |
| $\theta_{JCbott}$             | Junction-to-case (bottom) thermal resistance | N/A      |       |

- (1) For more information about traditional and new thermal metrics, see the *IC Package Thermal Metrics* application report, [SPRA953](http://www.ti.com/lit/zip/SPRA953).

## RECOMMENDED OPERATING CONDITIONS

At  $T_A = -40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$ , unless otherwise noted.

| PARAMETER                                           |                              |                    | TEST CONDITIONS                                | TLC59284              |                       | UNIT |
|-----------------------------------------------------|------------------------------|--------------------|------------------------------------------------|-----------------------|-----------------------|------|
|                                                     |                              |                    |                                                | MIN                   | MAX                   |      |
| DC CHARACTERISTICS (V <sub>CC</sub> = 3 V to 5.5 V) |                              |                    |                                                |                       |                       |      |
| V <sub>CC</sub>                                     | Supply voltage               |                    |                                                | 3                     | 5.5                   | V    |
| V <sub>O</sub>                                      | Voltage applied to output    |                    | OUT0 to OUT15                                  |                       | 10                    | V    |
| V <sub>IH</sub>                                     | Input voltage                | High               | SIN, SCLK, LAT, BLANK                          | 0.7 × V <sub>CC</sub> | V <sub>CC</sub>       | V    |
| V <sub>IL</sub>                                     |                              | Low                | SIN, SCLK, LAT, BLANK                          | GND                   | 0.3 × V <sub>CC</sub> | V    |
| I <sub>OH</sub>                                     | Output current               | High               | SOUT                                           |                       | −2                    | mA   |
| I <sub>OL</sub>                                     |                              | Low                | SOUT                                           |                       | 2                     | mA   |
| I <sub>OLC</sub>                                    | Constant output sink current |                    | OUT0 to OUT15, 3 V ≤ V <sub>CC</sub> ≤ 3.6 V   | 2                     | 35                    | mA   |
|                                                     |                              |                    | OUT0 to OUT15, 3.6 V < V <sub>CC</sub> ≤ 5.5 V | 2                     | 45                    | mA   |
| T <sub>A</sub>                                      | Temperature range            | Operating free-air |                                                | −40                   | +85                   | °C   |
| T <sub>J</sub>                                      |                              | Operating junction |                                                | −40                   | +125                  | °C   |
| AC CHARACTERISTICS (V <sub>CC</sub> = 3 V to 5.5 V) |                              |                    |                                                |                       |                       |      |
| f <sub>CLK</sub> (SCLK)                             | Data shift clock frequency   |                    | SCLK                                           |                       | 35                    | MHz  |
| t <sub>WH0</sub>                                    | Pulse duration               |                    | SCLK                                           | 10                    |                       | ns   |
| t <sub>WL0</sub>                                    |                              |                    | SCLK                                           | 10                    |                       | ns   |
| t <sub>WH1</sub>                                    |                              |                    | LAT                                            | 20                    |                       | ns   |
| t <sub>WH2</sub>                                    |                              |                    | BLANK                                          | 100                   |                       | ns   |
| t <sub>WL2</sub>                                    |                              |                    | BLANK                                          | 50                    |                       | ns   |
| t <sub>SU0</sub>                                    |                              | Setup time         | SIN↑↓ – SCLK↑                                  | 4                     |                       | ns   |
| t <sub>SU1</sub>                                    | LAT↓ – SCLK↑                 |                    | 10                                             |                       | ns                    |      |
| t <sub>H0</sub>                                     | Hold time                    | SIN↑↓ – SCLK↑      | 4                                              |                       | ns                    |      |
| t <sub>H1</sub>                                     |                              | LAT↓ – SCLK↑       | 10                                             |                       | ns                    |      |

## ELECTRICAL CHARACTERISTICS

All minimum and maximum specifications are at  $T_A = -40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$  and  $V_{CC} = 3\text{ V}$  to  $5.5\text{ V}$ , unless otherwise noted. Typical specifications are at  $T_A = +25^{\circ}\text{C}$  and  $V_{CC} = 3.3\text{ V}$ .

| PARAMETER          |                                   |                                   | TEST CONDITIONS                                                                                                                                      | TLC59284              |      |                 | UNIT |
|--------------------|-----------------------------------|-----------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|------|-----------------|------|
|                    |                                   |                                   |                                                                                                                                                      | MIN                   | TYP  | MAX             |      |
| V <sub>OH</sub>    | Output voltage                    | High                              | I <sub>OH</sub> = −2 mA at SOUT                                                                                                                      | V <sub>CC</sub> − 0.4 |      | V <sub>CC</sub> | V    |
| V <sub>OL</sub>    |                                   | Low                               | I <sub>OL</sub> = 2 mA at SOUT                                                                                                                       |                       |      | 0.4             | V    |
| V <sub>IREF</sub>  | Reference voltage output          |                                   | R <sub>IREF</sub> = 1.5 kΩ, T <sub>A</sub> = +25°C                                                                                                   | 1.208                 |      |                 | V    |
| I <sub>IN</sub>    | Input current                     |                                   | V <sub>IN</sub> = V <sub>CC</sub> or GND at SIN and SCLK                                                                                             | −1                    |      | 1               | μA   |
| I <sub>CC0</sub>   | Supply current (V <sub>CC</sub> ) |                                   | SIN, SCLK, LAT = GND, BLANK = V <sub>OUTn</sub> = V <sub>CC</sub> , R <sub>IREF</sub> = open                                                         | 1                     |      | 2               | mA   |
| I <sub>CC1</sub>   |                                   |                                   | SIN, SCLK, LAT = GND, BLANK = V <sub>OUTn</sub> = V <sub>CC</sub> , R <sub>IREF</sub> = 3 kΩ (I <sub>OUT</sub> = 17.6 mA target)                     | 3                     |      | 4               | mA   |
| I <sub>CC2</sub>   |                                   |                                   | All OUTn = ON, SIN, SCLK, LAT, BLANK = GND, V <sub>OUTn</sub> = 0.8 V, R <sub>IREF</sub> = 3 kΩ                                                      | 7                     |      | 9               | mA   |
| I <sub>CC3</sub>   |                                   |                                   | All OUTn = ON, SIN, SCLK, LAT, BLANK = GND, V <sub>OUTn</sub> = 0.8 V, R <sub>IREF</sub> = 1.5 kΩ (I <sub>OUT</sub> = 35.3 mA target)                | 8                     |      | 11              | mA   |
| I <sub>OLC</sub>   | Constant output current           |                                   | All OUTn = ON, V <sub>OUTn</sub> = V <sub>OUTfix</sub> = 0.8 V, R <sub>IREF</sub> = 1.5 kΩ, T <sub>A</sub> = +25°C (see <a href="#">Figure 8</a> )   | 32.9                  | 35.3 | 37.7            | mA   |
| I <sub>OLKG0</sub> | Output leakage current            |                                   | All OUTn = OFF, V <sub>OUTn</sub> = V <sub>OUTfix</sub> = 10 V, BLANK = V <sub>CC</sub> , R <sub>IREF</sub> = 1.5 kΩ (see <a href="#">Figure 8</a> ) |                       |      |                 |      |
|                    |                                   |                                   | T <sub>J</sub> = +25°C                                                                                                                               |                       |      | 0.1             | μA   |
|                    |                                   |                                   | T <sub>J</sub> = +85°C                                                                                                                               |                       |      | 0.2             | μA   |
|                    |                                   |                                   | T <sub>J</sub> = +125°C                                                                                                                              |                       | 0.07 | 0.5             | μA   |
| ΔI <sub>OLC0</sub> | Constant-current error            | Channel-to-channel <sup>(1)</sup> | All OUTn = ON, V <sub>OUTn</sub> = V <sub>OUTfix</sub> = 0.8 V, R <sub>IREF</sub> = 1.5 kΩ, T <sub>A</sub> = +25°C (see <a href="#">Figure 8</a> )   | ±1.4                  |      | ±3              | %    |
| ΔI <sub>OLC1</sub> |                                   | Device-to-device <sup>(2)</sup>   | All OUTn = ON, V <sub>OUTn</sub> = V <sub>OUTfix</sub> = 0.8 V, R <sub>IREF</sub> = 1.5 kΩ, T <sub>A</sub> = +25°C (see <a href="#">Figure 8</a> )   | ±2                    |      | ±4              | %    |
| ΔI <sub>OLC2</sub> | Line regulation <sup>(3)</sup>    |                                   | All OUTn = ON, V <sub>OUTn</sub> = V <sub>OUTfix</sub> = 0.8 V, R <sub>IREF</sub> = 1.5 kΩ, V <sub>CC</sub> = 3 V to 5.5 V                           | ±0.05                 |      | ±1              | %/V  |
| ΔI <sub>OLC3</sub> | Load regulation <sup>(4)</sup>    |                                   | All OUTn = ON, V <sub>OUTn</sub> = 0.8 V to 3 V, V <sub>OUTfix</sub> = 0.8 V, R <sub>IREF</sub> = 1.5 kΩ                                             | ±0.5                  |      | ±1              | %/V  |
| R <sub>PUP</sub>   | Resistor                          | Pull-up                           | BLANK                                                                                                                                                | 250                   | 500  | 750             | kΩ   |
| R <sub>PDWN</sub>  |                                   | Pull-down                         | LAT                                                                                                                                                  | 250                   | 500  | 750             | kΩ   |

(1) The deviation of each output from the average of OUT0 to OUT15 constant-current. Deviation is calculated by the formula:

$$\Delta (\%) = \left[ \frac{I_{OUTn}}{\frac{(I_{OUT0} + I_{OUT1} + \dots + I_{OUT14} + I_{OUT15})}{16}} - 1 \right] \times 100$$

(2) The deviation of the OUT0 to OUT15 constant-current average from the ideal constant-current value. Deviation is calculated by the following formula:

$$\Delta (\%) = \left[ \frac{\frac{(I_{OUT0} + I_{OUT1} + \dots + I_{OUT14} + I_{OUT15})}{16} - (\text{Ideal Output Current})}{\text{Ideal Output Current}} \right] \times 100$$

Ideal current is calculated by the formula:

$$I_{OUT(\text{IDEAL})} = 43.8 \times \left[ \frac{1.208\text{ V}}{R_{IREF}} \right]$$

(3) Line regulation is calculated by this equation:

$$\Delta (\%/V) = \left[ \frac{(I_{OUTn} \text{ at } V_{CC} = 5.5\text{ V}) - (I_{OUTn} \text{ at } V_{CC} = 3\text{ V})}{(I_{OUTn} \text{ at } V_{CC} = 3\text{ V})} \right] \times \frac{100}{5.5\text{ V} - 3\text{ V}}$$

(4) Load regulation is calculated by the equation:

$$\Delta (\%/V) = \left[ \frac{(I_{OUTn} \text{ at } V_{OUTn} = 3\text{ V}) - (I_{OUTn} \text{ at } V_{OUTn} = 1\text{ V})}{(I_{OUTn} \text{ at } V_{OUTn} = 1\text{ V})} \right] \times \frac{100}{3\text{ V} - 1\text{ V}}$$

## SWITCHING CHARACTERISTICS

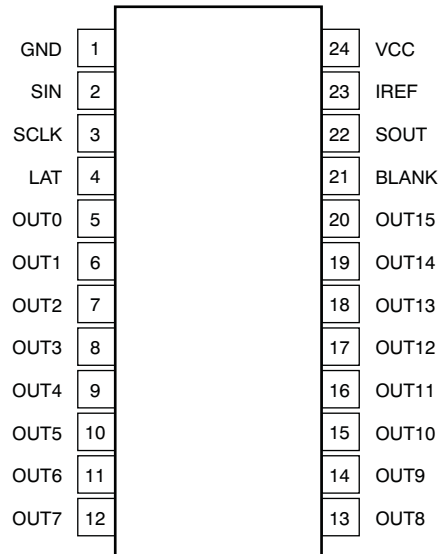
All minimum and maximum specifications are at  $T_A = -40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$ ,  $V_{CC} = 3\text{ V}$  to  $5.5\text{ V}$ ,  $C_L = 15\text{ pF}$ ,  $R_L = 110\ \Omega$ ,  $R_{IREF} = 1.5\text{ k}\Omega$ , and  $V_{LED} = 5.0\text{ V}$ , unless otherwise noted. Typical values are at  $T_A = +25^{\circ}\text{C}$  and  $V_{CC} = 3.3\text{ V}$ .

| PARAMETER     |                                     | TEST CONDITIONS                                                                                                           | TLC59284 |     |     | UNIT |
|---------------|-------------------------------------|---------------------------------------------------------------------------------------------------------------------------|----------|-----|-----|------|
|               |                                     |                                                                                                                           | MIN      | TYP | MAX |      |
| $t_{R0}$      | Rise time                           | SOUT (see Figure 7)                                                                                                       |          | 3   | 10  | ns   |
| $t_{R1}$      |                                     | OUT $n$ (see Figure 6)                                                                                                    |          | 44  |     | ns   |
| $t_{F0}$      | Fall time                           | SOUT (see Figure 7)                                                                                                       |          | 3   | 10  | ns   |
| $t_{F1}$      |                                     | OUT $n$ (see Figure 6)                                                                                                    |          | 44  |     | ns   |
| $t_{D0}$      | Propagation delay time              | SCLK $\uparrow$ to SOUT $\uparrow\downarrow$                                                                              |          | 11  | 20  | ns   |
| $t_{D1}$      |                                     | LAT $\uparrow$ or BLANK $\uparrow\downarrow$ to OUT0 on or off, $T_A = +25^{\circ}\text{C}$                               |          | 60  | 100 | ns   |
| $t_{D2}$      |                                     | Grouped OUT $n$ on or off to next group on or off, $T_A = +25^{\circ}\text{C}$                                            |          | 2   |     | ns   |
| $t_{ON\_ERR}$ | Output on-time error <sup>(1)</sup> | Output on or off latch data = all '1', 50-ns BLANK GND level pulse, $V_{CC} = 3.3\text{ V}$ , $T_A = +25^{\circ}\text{C}$ | -45      |     | 45  | ns   |

- (1) Output on-time error ( $t_{ON\_ERR}$ ) is calculated by the formula:  $t_{ON\_ERR}\text{ (ns)} = t_{OUT\_ON} - \text{BLANK low-level one-shot pulse width (}t_{WL2}\text{)}$ .  $t_{OUT\_ON}$  indicates the actual on-time of the constant-current output.

## PIN CONFIGURATIONS

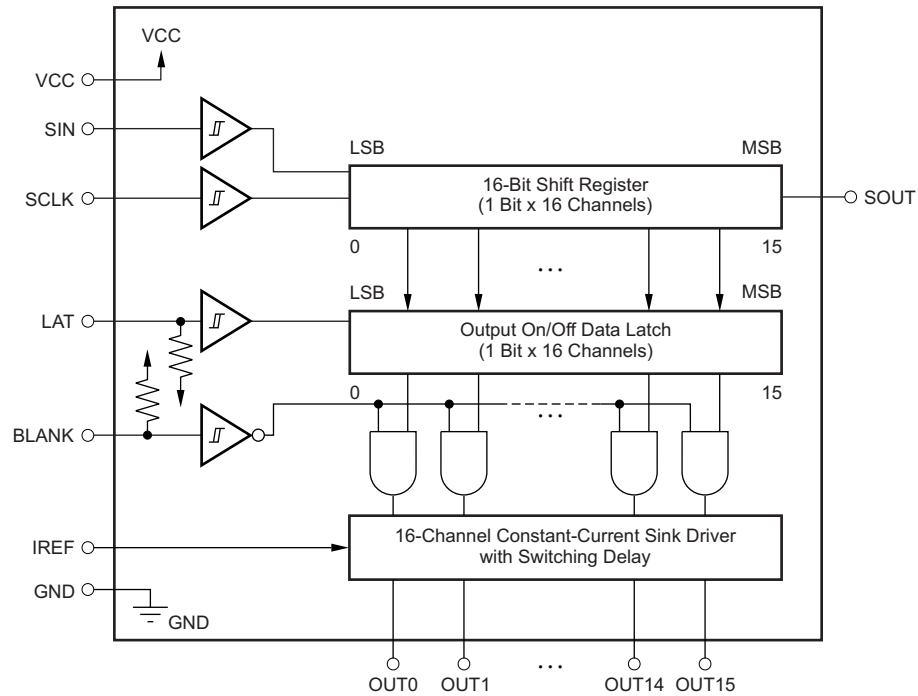
**DBQ PACKAGE  
SSOP-24 AND QSOP-24  
(TOP VIEW)**



## PIN DESCRIPTIONS

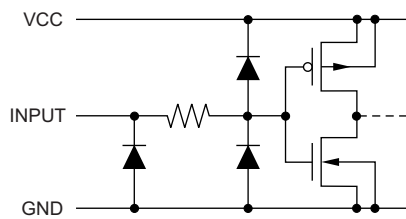
| PIN   |        | I/O | DESCRIPTION                                                                                                                                                                                                                                                                                                                                                                                                                       |
|-------|--------|-----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| NAME  | NUMBER |     |                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| BLANK | 21     | I   | All outputs empty (blank); Schmitt buffer input. When BLANK is high, all constant-current outputs (OUT0 to OUT15) are forced off. When BLANK is low, all constant-current outputs are controlled by the data in the output on or off data latch. This pin is internally pulled up to $V_{CC}$ with a 500-k $\Omega$ (typ) resistor.                                                                                               |
| GND   | 1      | —   | Power ground                                                                                                                                                                                                                                                                                                                                                                                                                      |
| IREF  | 23     | I/O | Constant-current value setting, the OUT0 to OUT15 sink constant-current outputs are set to the desired values by connecting an external resistor between IREF and GND.                                                                                                                                                                                                                                                            |
| LAT   | 4      | I   | Level-triggered latch; Schmitt buffer input. The data in the 16-bit shift register continue to transfer to the output on or off data latch while LAT is high. Therefore, if the data in the 16-bit shift register are changed when LAT is high, the data in the data latch are also changed. The data in the data latch are held when LAT is low. This pin is internally pulled down to GND with a 500-k $\Omega$ (typ) resistor. |
| OUT0  | 5      | O   | Constant-current output. Each output can be tied together with others to increase the constant-current. Different voltages can be applied to each output.                                                                                                                                                                                                                                                                         |
| OUT1  | 6      | O   | Constant-current output                                                                                                                                                                                                                                                                                                                                                                                                           |
| OUT2  | 7      | O   | Constant-current output                                                                                                                                                                                                                                                                                                                                                                                                           |
| OUT3  | 8      | O   | Constant-current output                                                                                                                                                                                                                                                                                                                                                                                                           |
| OUT4  | 9      | O   | Constant-current output                                                                                                                                                                                                                                                                                                                                                                                                           |
| OUT5  | 10     | O   | Constant-current output                                                                                                                                                                                                                                                                                                                                                                                                           |
| OUT6  | 11     | O   | Constant-current output                                                                                                                                                                                                                                                                                                                                                                                                           |
| OUT7  | 12     | O   | Constant-current output                                                                                                                                                                                                                                                                                                                                                                                                           |
| OUT8  | 13     | O   | Constant-current output                                                                                                                                                                                                                                                                                                                                                                                                           |
| OUT9  | 14     | O   | Constant-current output                                                                                                                                                                                                                                                                                                                                                                                                           |
| OUT10 | 15     | O   | Constant-current output                                                                                                                                                                                                                                                                                                                                                                                                           |
| OUT11 | 16     | O   | Constant-current output                                                                                                                                                                                                                                                                                                                                                                                                           |
| OUT12 | 17     | O   | Constant-current output                                                                                                                                                                                                                                                                                                                                                                                                           |
| OUT13 | 18     | O   | Constant-current output                                                                                                                                                                                                                                                                                                                                                                                                           |
| OUT14 | 19     | O   | Constant-current output                                                                                                                                                                                                                                                                                                                                                                                                           |
| OUT15 | 20     | O   | Constant-current output                                                                                                                                                                                                                                                                                                                                                                                                           |
| SCLK  | 3      | I   | Serial data shift clock; Schmitt buffer input.<br>All data in the 16-bit shift register are shifted toward the MSB by a 1-bit SCLK synchronization.                                                                                                                                                                                                                                                                               |
| SIN   | 2      | I   | Serial data input for driver on or off control; Schmitt buffer input.<br>When SIN is high, the LSB is set to '1' for only one SCLK input rising edge. If two SCLK rising edges are input while SIN is high, then the 16-bit shift register LSB and LSB+1 are set to '1'. When SIN is low, the LSB is set to '0' at the SCLK input rising edge.                                                                                    |
| SOUT  | 22     | O   | Serial data output. This output is connected to the 16-bit shift register MSB. SOUT data changes at the SCLK rising edge.                                                                                                                                                                                                                                                                                                         |
| VCC   | 24     | —   | Power-supply voltage                                                                                                                                                                                                                                                                                                                                                                                                              |

## FUNCTIONAL BLOCK DIAGRAM

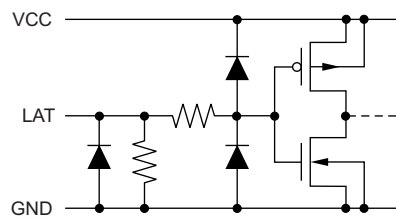


## PARAMETER MEASUREMENT INFORMATION

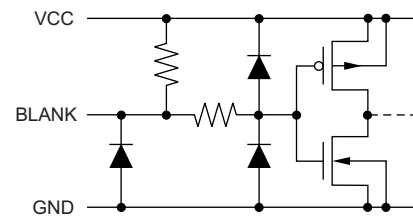
### PIN-EQUIVALENT INPUT AND OUTPUT SCHEMATIC DIAGRAMS



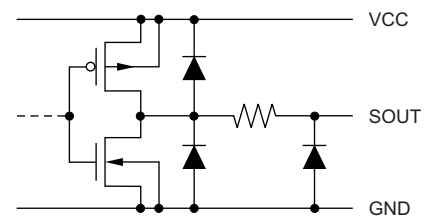
**Figure 1. SIN and SCLK**



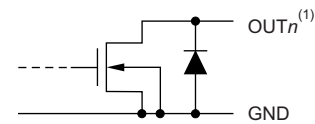
**Figure 2. LAT**



**Figure 3. BLANK**



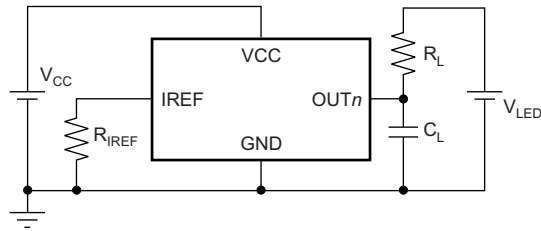
**Figure 4. SOUT**



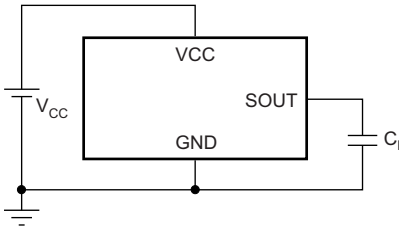
(1)  $n = 0$  to 15.

**Figure 5. OUT0 Through OUT15**

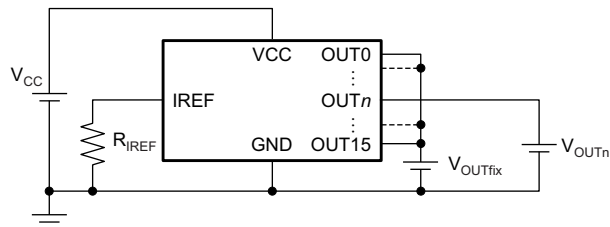
## TEST CIRCUITS



**Figure 6. OUT<sub>n</sub> Rise and Fall Time Test Circuit**

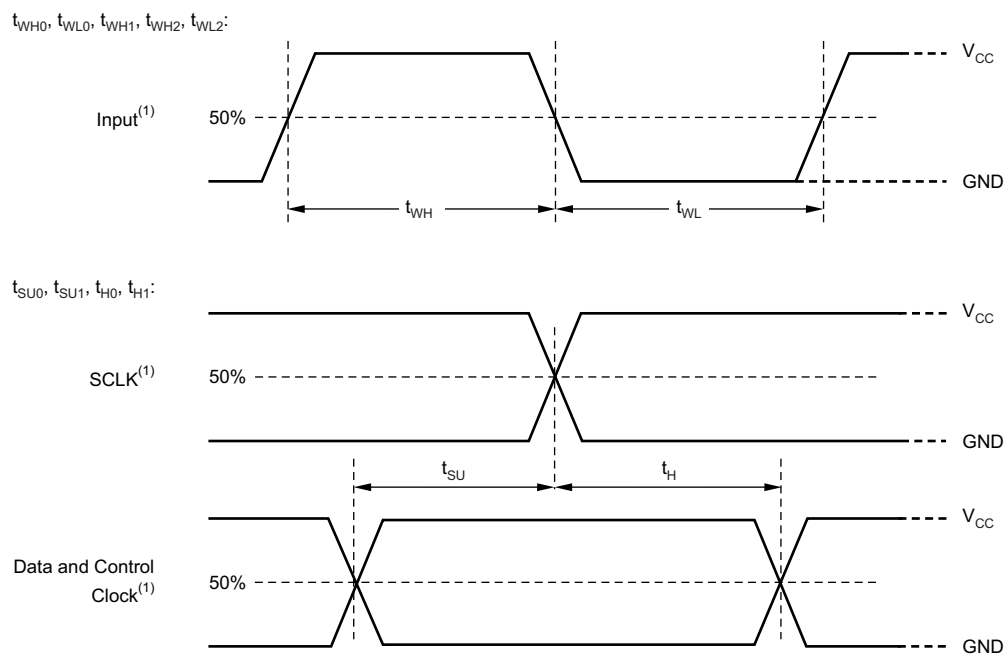


**Figure 7. SOUT Rise and Fall Time Test Circuit**



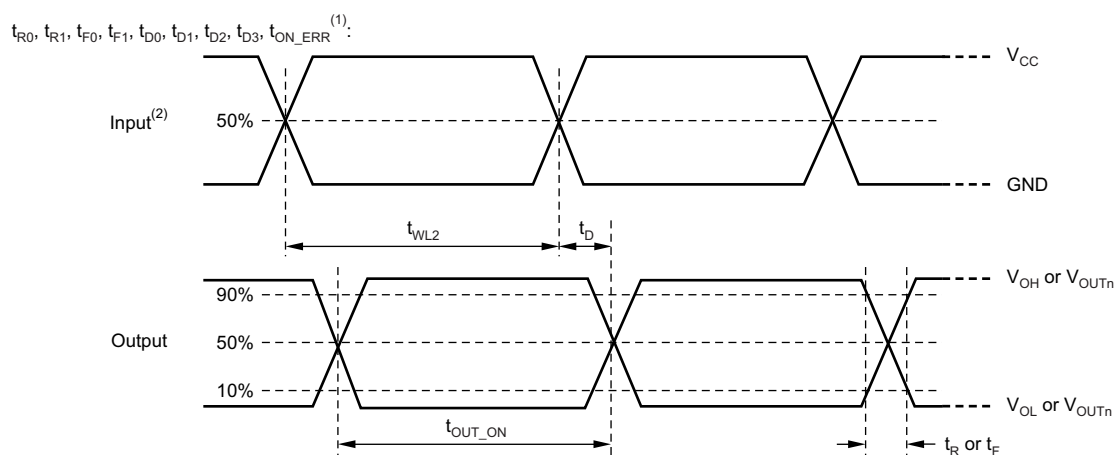
**Figure 8. OUT<sub>n</sub> Constant-Current Test Circuit**

## TIMING DIAGRAMS



(1) Input pulse rise and fall time is 1 ns to 3 ns.

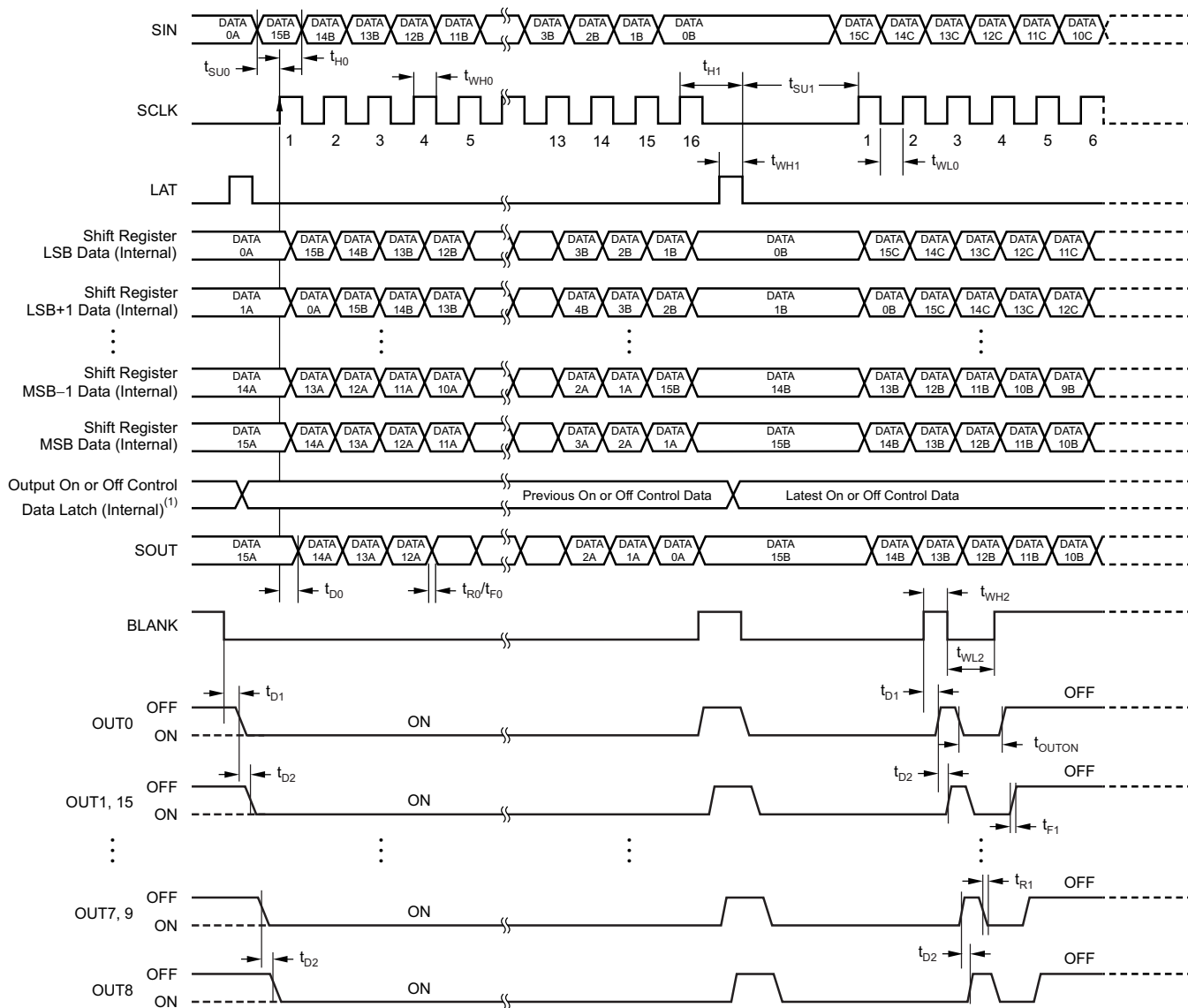
Figure 9. Input Timing Diagram



(1)  $t_{ON\_ERR}$  is calculated by  $t_{OUT\_ON} - t_{WL2}$ .

(2) Input pulse rise and fall time is 1 ns to 3 ns.

Figure 10. Output Timing Diagram



(1) Output on or off data = FFFFh.

(2)  $t_{ON\_ERR} = t_{OUTON} - t_{WL2}$ .

Figure 11. Data Write and Output On or Off Timing Diagram

## TYPICAL CHARACTERISTICS

At  $T_A = +25^\circ\text{C}$  and  $V_{CC} = 3.3\text{ V}$ , unless otherwise noted.

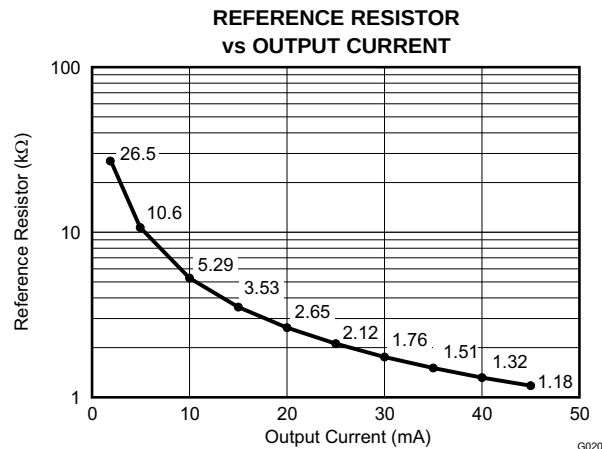


Figure 12.

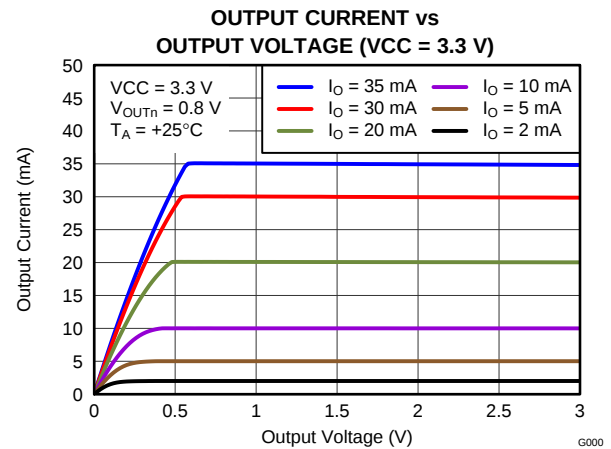


Figure 13.

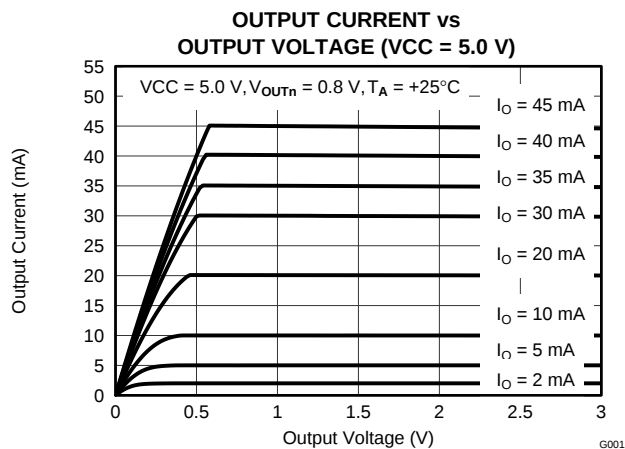


Figure 14.

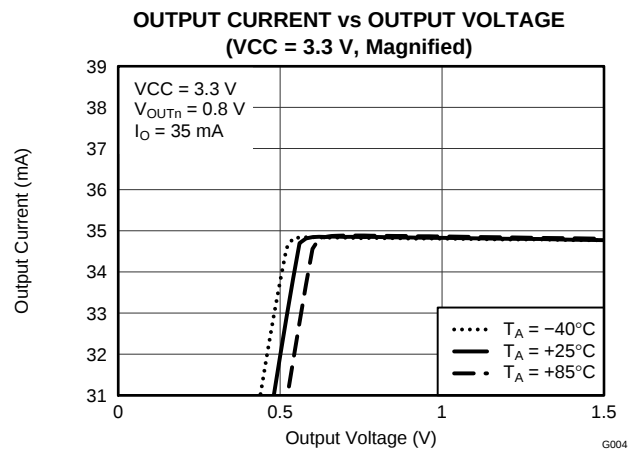


Figure 15.

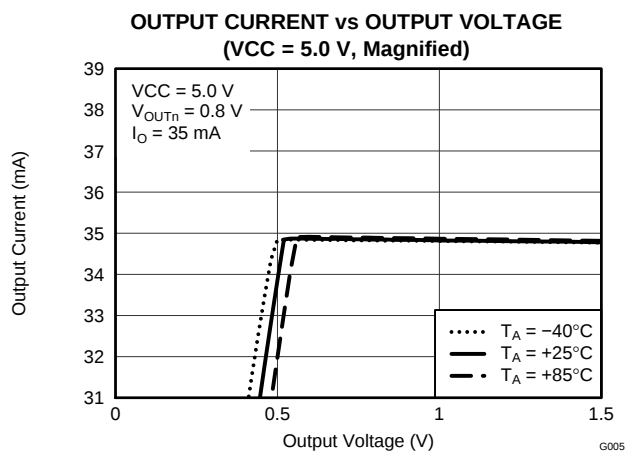


Figure 16.

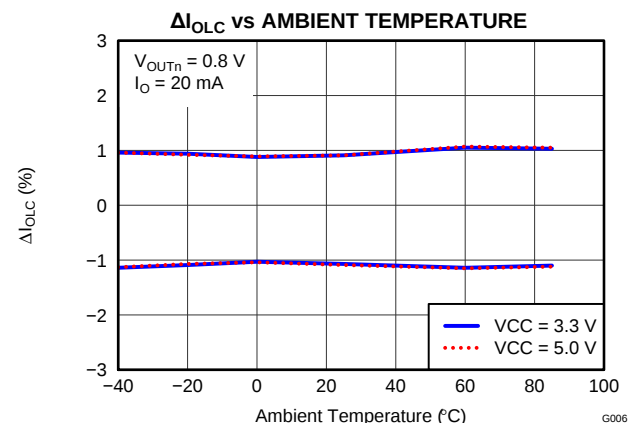


Figure 17.

## TYPICAL CHARACTERISTICS (continued)

At  $T_A = +25^\circ\text{C}$  and  $V_{CC} = 3.3\text{ V}$ , unless otherwise noted.

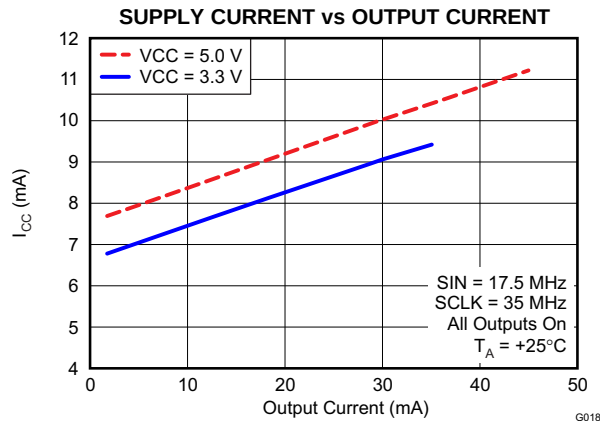


Figure 18.

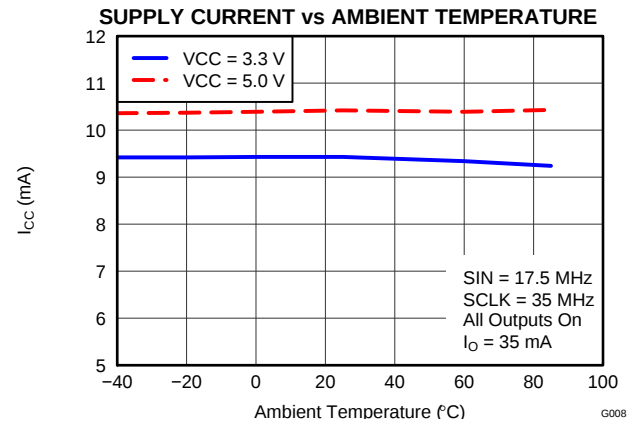


Figure 19.

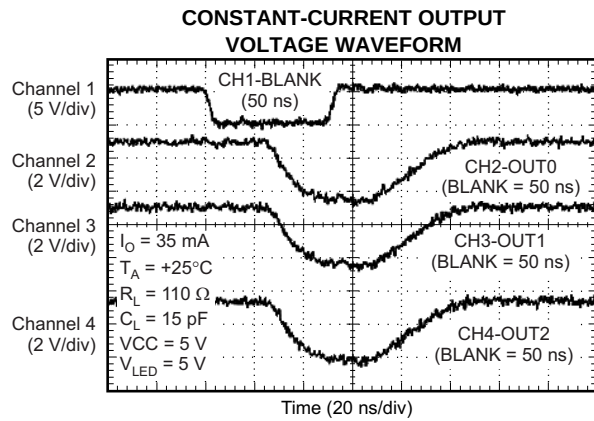


Figure 20.

## DETAILED DESCRIPTION

### CONSTANT SINK CURRENT VALUE SETTING

The constant-current values are determined by an external resistor ( $R_{IREF}$ ) placed between IREF and GND. The resistor ( $R_{IREF}$ ) value is calculated by [Equation 1](#).

$$R_{IREF} (k\Omega) = \frac{V_{IREF} (V)}{I_{OLC} (mA)} \times 43.8$$

Where:

$V_{IREF}$  = the internal reference voltage on the IREF pin (typically 1.208 V) (1)

$I_{OLC}$  must be set in the range of 2 mA to 35 mA when  $V_{CC}$  is less than 3.6 V. Also, when  $V_{CC}$  is equal to 3.6 V or greater,  $I_{OLC}$  must be set in the range of 2 mA to 45 mA. The constant sink current characteristic for the external resistor value is illustrated in [Figure 12](#). [Table 1](#) describes the constant-current output versus external resistor value.

**Table 1. Constant-Current Output versus External Resistor Value**

| $I_{OLC} (mA)$                      | $R_{IREF} (k\Omega, \text{Typical})$ |
|-------------------------------------|--------------------------------------|
| 45 ( $V_{CC} > 3.6 \text{ V}$ only) | 1.18                                 |
| 40 ( $V_{CC} > 3.6 \text{ V}$ only) | 1.32                                 |
| 35                                  | 1.51                                 |
| 30                                  | 1.76                                 |
| 25                                  | 2.12                                 |
| 20                                  | 2.65                                 |
| 15                                  | 3.53                                 |
| 10                                  | 5.29                                 |
| 5                                   | 10.6                                 |
| 2                                   | 26.5                                 |

### CONSTANT-CURRENT DRIVER ON OR OFF CONTROL

When BLANK is low, the corresponding output is turned on if the data in the on or off control data latch are '1' and remains off if the data are '0'. When BLANK is high, all outputs are forced off. This control is shown in [Table 2](#).

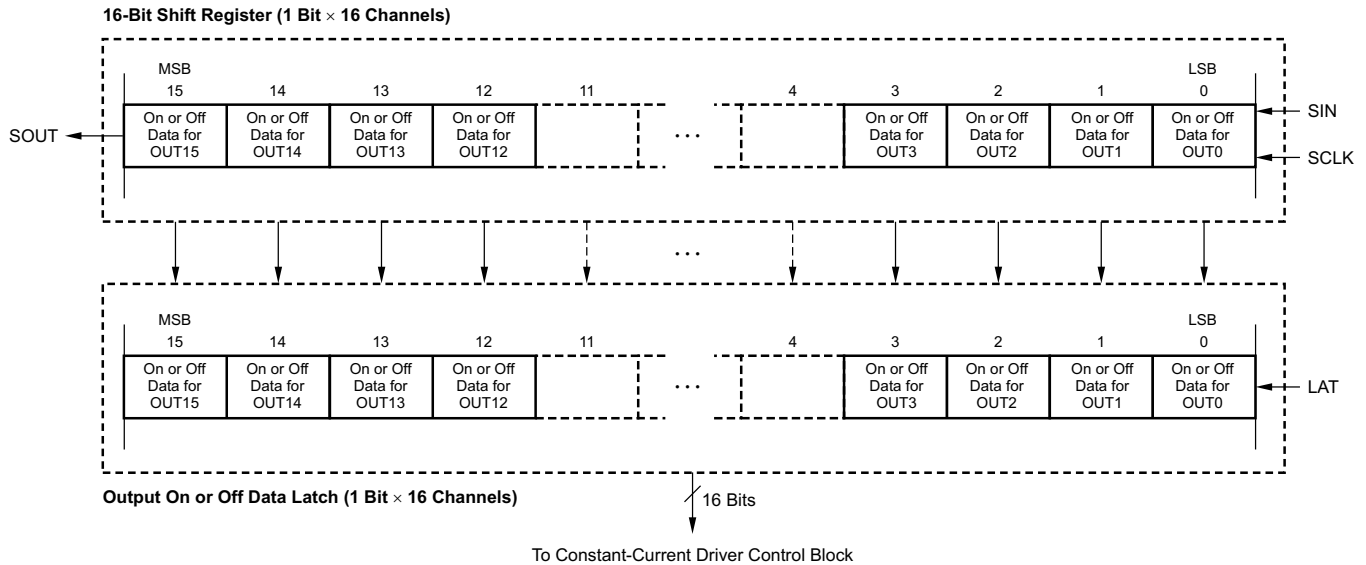
**Table 2. Output On or Off Control Data Truth Table**

| OUTPUT ON OR OFF DATA | CONSTANT-CURRENT OUTPUT STATUS |
|-----------------------|--------------------------------|
| 0                     | Off                            |
| 1                     | On                             |

When the device is initially powered on, the data in the 16-bit shift register and output on or off data latch are not set to default values. Therefore, the output on or off data must be written to the data latch before turning the constant-current output on. **BLANK should be high when powered on because the constant-current may be turned on as a result of random data in the output on or off data latch.**

## REGISTER CONFIGURATION

The TLC59284 has a 16-bit shift register and an output on or off data latch. Both the shift register and data latch are 16 bits long and are used to turn the constant-current outputs on and off. [Figure 21](#) shows the shift register and data latch configuration. The data at the SIN pin are shifted into the 16-bit shift register LSB at the rising edge of the SCLK pin; SOUT data change at the SCLK rising edge.



**Figure 21. 16-Bit Shift Register and Output On or Off Data Latch Configuration**

The output on or off data in the 16-bit shift register continue to transfer to the output on or off data latch while LAT is high. Therefore, if the data in the 16-bit shift register are changed when LAT is high, the data in the data latch are also changed. The data in the data latch are held when LAT is low. When the device initially powers on, the data in the output on or off shift register and latch are not set to default values; on or off control data must be written to the on or off control data latch before turning the constant-current output on. All constant-current outputs are forced off when BLANK is high. The OUT $n$  on or off outputs are controlled by the data in the output on or off data latch. The writing data truth table and timing diagram are shown in [Table 3](#) and [Figure 22](#), respectively.

**Table 3. Truth Table in Operation**

| SCLK | LAT  | BLANK | SIN    | OUT0...OUT7...OUT15       | SOUT    |
|------|------|-------|--------|---------------------------|---------|
| ↑    | High | Low   | Dn     | Dn...Dn – 7...Dn – 15     | Dn – 15 |
| ↑    | Low  | Low   | Dn + 1 | No change                 | Dn – 14 |
| ↑    | High | Low   | Dn + 2 | Dn + 2...Dn – 5...Dn – 13 | Dn – 13 |
| ↓    | —    | Low   | Dn + 3 | Dn + 2...Dn – 5...Dn – 13 | Dn – 13 |
| ↓    | —    | High  | Dn + 3 | Off                       | Dn – 13 |

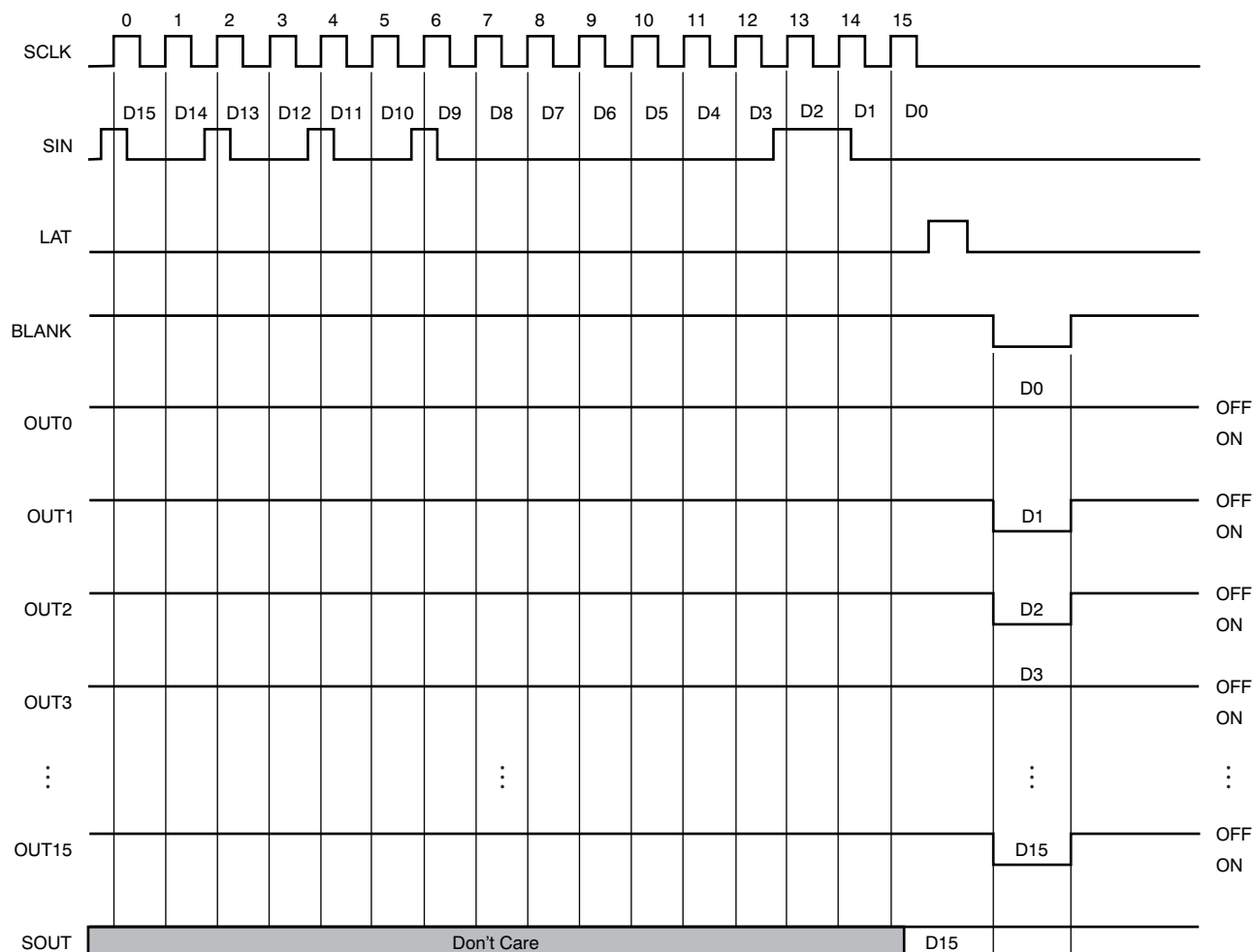


Figure 22. Operation Timing Diagram

## NOISE REDUCTION

Large surge currents may flow through the device and board if all 16 outputs turn on or off simultaneously. These large current surges can induce detrimental noise and electromagnetic interference (EMI) into other circuits. The TLC59284 independently turns on or off the outputs for each group with a 1-ns (typ) delay time; see [Figure 11](#). The 16 outputs are grouped into nine groups of either one or two outputs: group 1 (OUT0), group 2 (OUT1 and OUT15), group 3 (OUT2 and OUT14), group 4 (OUT3 and OUT13), group 5 (OUT4 and OUT12), group 6 (OUT5 and OUT11), group 7 (OUT6 and OUT10), group 8 (OUT7 and OUT9), and group 9 (OUT8). Both turn-on and turn-off times are delayed when BLANK transitions from low to high or high to low. Also when output-on and -off data are changed at the LAT rising edge while BLANK is low, both turn-on and turn-off times are delayed. However, the state of each output is controlled by the data in the output on or off data latch and the BLANK level.

## REVISION HISTORY

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

| Changes from Original (October 2012) to Revision A                                     | Page              |
|----------------------------------------------------------------------------------------|-------------------|
| • Changed HBM ESD rating maximum specification in Absolute Maximum Ratings table ..... | <a href="#">2</a> |
| • Changed $I_{CC2}$ maximum specification in Electrical Characteristics table .....    | <a href="#">4</a> |

## PACKAGING INFORMATION

| Orderable Device | Status<br>(1) | Package Type | Package<br>Drawing | Pins | Package<br>Qty | Eco Plan<br>(2) | Lead finish/<br>Ball material<br>(6) | MSL Peak Temp<br>(3) | Op Temp (°C) | Device Marking<br>(4/5) | Samples                 |
|------------------|---------------|--------------|--------------------|------|----------------|-----------------|--------------------------------------|----------------------|--------------|-------------------------|-------------------------|
| TLC59284DBQ      | ACTIVE        | SSOP         | DBQ                | 24   | 50             | RoHS & Green    | NIPDAU                               | Level-2-260C-1 YEAR  | -40 to 85    | TLC59284                | <a href="#">Samples</a> |
| TLC59284DBQR     | ACTIVE        | SSOP         | DBQ                | 24   | 2500           | RoHS & Green    | NIPDAU                               | Level-2-260C-1 YEAR  | -40 to 85    | TLC59284                | <a href="#">Samples</a> |

<sup>(1)</sup> 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.

<sup>(2)</sup> **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".

**RoHS Exempt:** TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.

**Green:** TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

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

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

<sup>(5)</sup> 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.

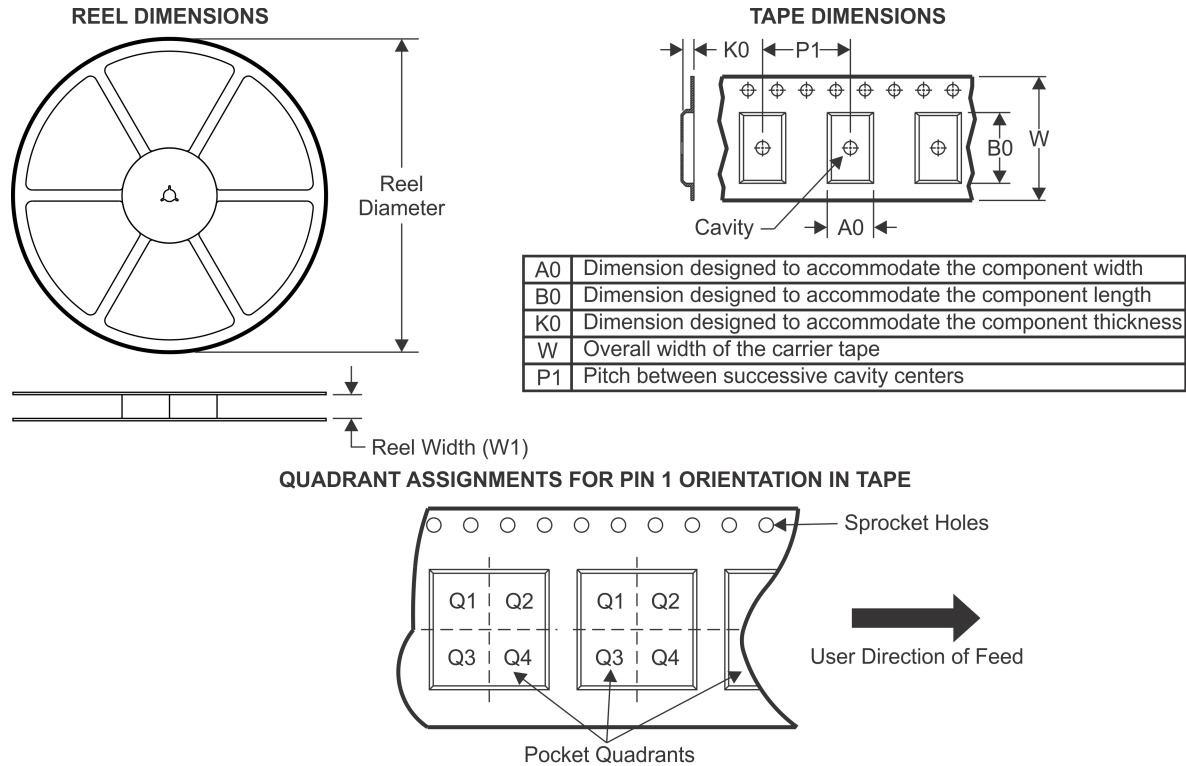
<sup>(6)</sup> Lead finish/Ball material - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

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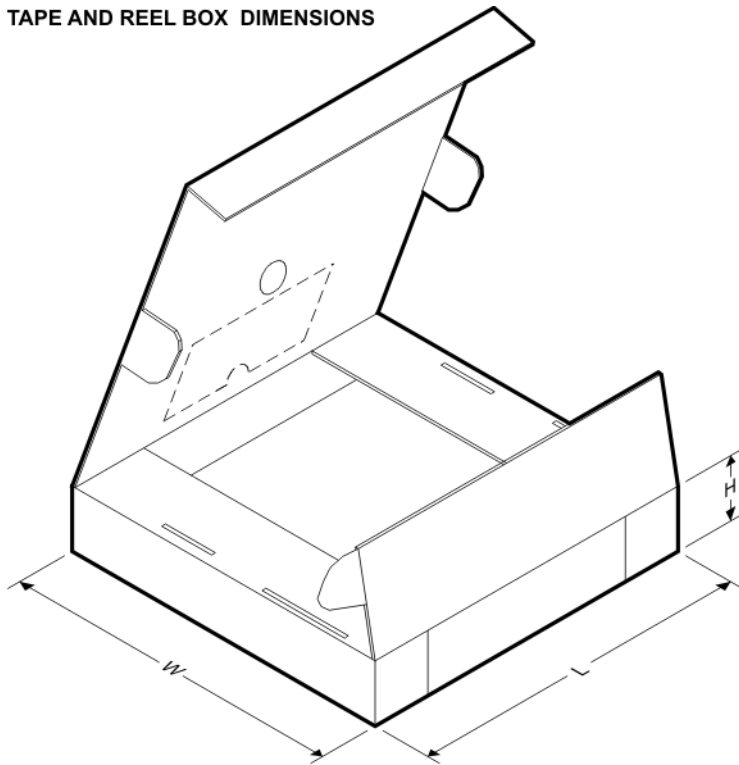
## TAPE AND REEL INFORMATION



\*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 |
|--------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| TLC59284DBQR | SSOP         | DBQ             | 24   | 2500 | 330.0              | 16.4               | 6.5     | 9.0     | 2.1     | 8.0     | 16.0   | Q1            |

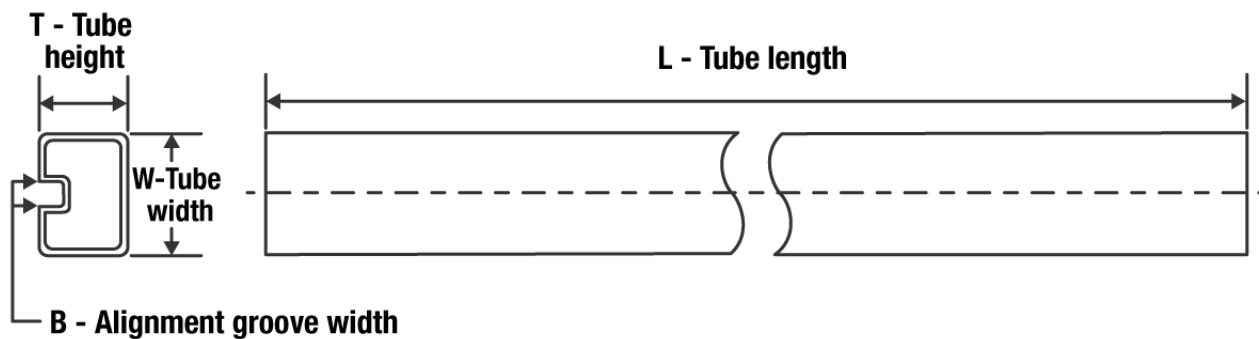
## TAPE AND REEL BOX DIMENSIONS



\*All dimensions are nominal

| Device       | Package Type | Package Drawing | Pins | SPQ  | Length (mm) | Width (mm) | Height (mm) |
|--------------|--------------|-----------------|------|------|-------------|------------|-------------|
| TLC59284DBQR | SSOP         | DBQ             | 24   | 2500 | 853.0       | 449.0      | 35.0        |

## TUBE

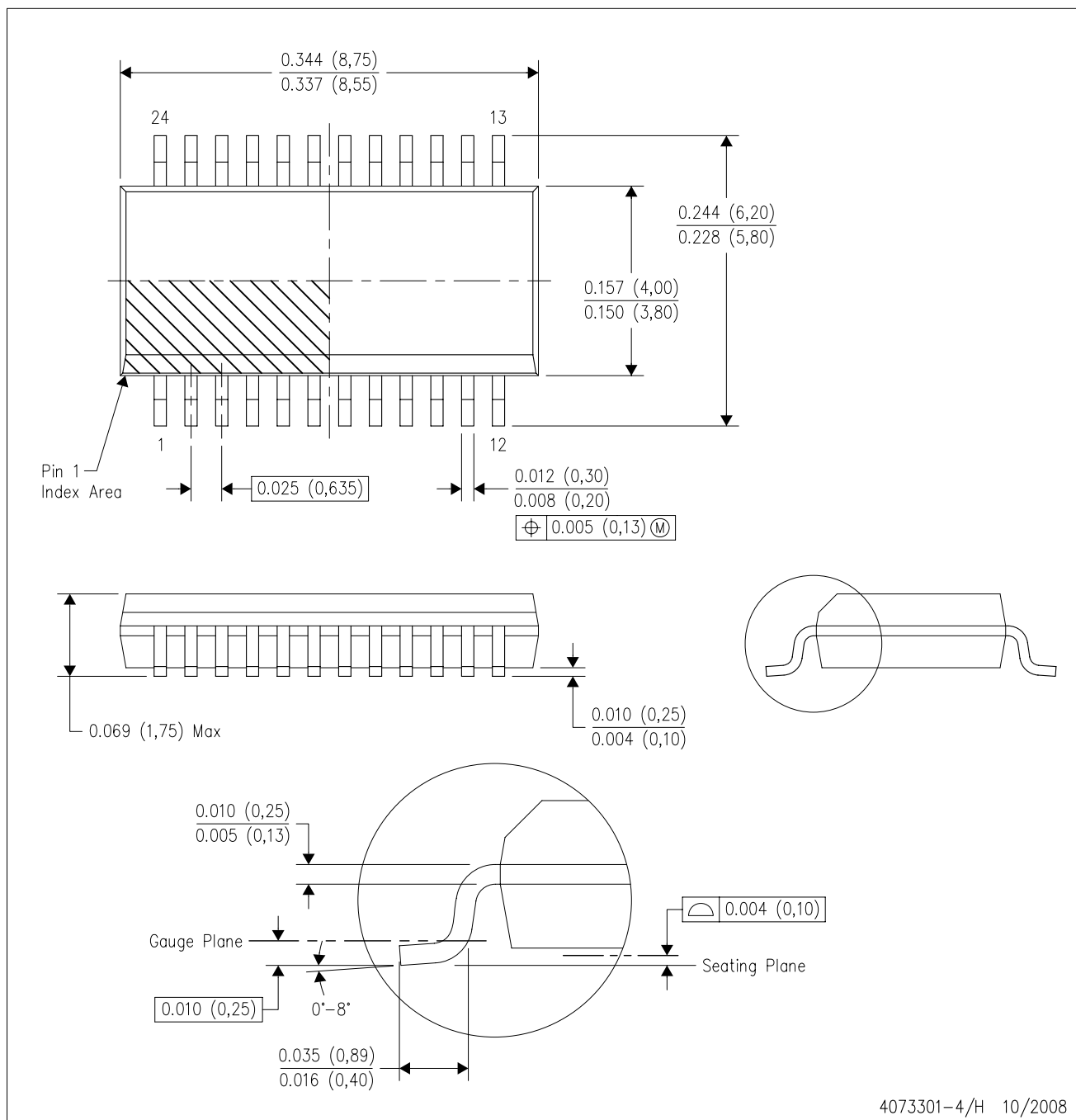


\*All dimensions are nominal

| Device      | Package Name | Package Type | Pins | SPQ | L (mm) | W (mm) | T (μm) | B (mm) |
|-------------|--------------|--------------|------|-----|--------|--------|--------|--------|
| TLC59284DBQ | DBQ          | SSOP         | 24   | 50  | 506.6  | 8      | 3940   | 4.32   |

DBQ (R-PDSO-G24)

PLASTIC SMALL-OUTLINE PACKAGE



- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  - C. Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0,15) per side.
  - D. Falls within JEDEC MO-137 variation AE.

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