

16-Channel, Constant-Current LED Driver with Pre-Charge FET

Check for Samples: [TLC59283](#)

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
- Pre-Charge FET for Ghosting Reduction
- Grouped Switching Delay for Noise Reduction
- Operating Temperature: -40°C to $+85^{\circ}\text{C}$

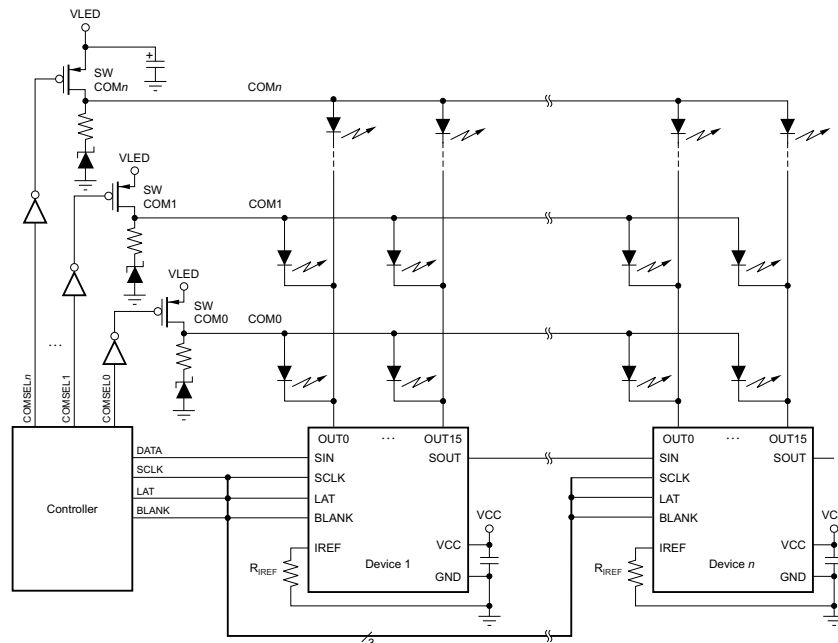
APPLICATIONS

- Video Displays
- Message Boards

DESCRIPTION

The TLC59283 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.

Each constant-current output has a pre-charge field-effect transistor (FET) that can reduce ghosting on the multiplexing (dynamic) drive LED display. Multiple TLC59283s can be cascaded together to control additional LEDs from the same processor.



Typical Application Circuit (Multiple Daisy-Chainned TLC59283s)



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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⁽¹⁾

| PRODUCT | PACKAGE-LEAD | ORDERING NUMBER | TRANSPORT MEDIA, QUANTITY |
|----------|---------------------|-----------------|---------------------------|
| TLC59283 | SSOP-24 and QSOP-24 | TLC59283DBQR | Tape and Reel, 2500 |
| | | TLC59283DBQ | Tube, 50 |
| TLC59283 | QFN-24 | TLC59283RGER | Tape and Reel, 3000 |
| | | TLC59283RGE | Tape and Reel, 250 |

(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.

ABSOLUTE MAXIMUM RATINGS⁽¹⁾⁽²⁾

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

| | | | VALUE | | UNIT |
|---------------------------------|---------------------|--|-------|-----------------------|------|
| | | | MIN | MAX | |
| Voltage | V _{CC} | Supply | -0.3 | +6 | V |
| | V _{IN} | Input range, SIN, SCLK, LAT, BLANK, IREF | -0.3 | V _{CC} + 0.3 | V |
| | 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 | T _{J(MAX)} | Operating junction | | +150 | °C |
| | T _{stg} | Storage range | -55 | +150 | °C |
| Electrostatic discharge ratings | ESD | Human body model (HBM) | | 3000 | 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 ⁽¹⁾ | | TLC59283 | | UNITS |
|-------------------------------|--|----------|---------|-------|
| | | DBQ | RGE | |
| | | 24 PINS | 24 PINS | |
| θ _{JA} | Junction-to-ambient thermal resistance | 91.5 | 42.9 | °C/W |
| θ _{JCtop} | Junction-to-case (top) thermal resistance | 55.2 | 55.3 | |
| θ _{JB} | Junction-to-board thermal resistance | 44.9 | 21.7 | |
| ψ _{JT} | Junction-to-top characterization parameter | 16.8 | 1.9 | |
| ψ _{JB} | Junction-to-board characterization parameter | 44.5 | 21.8 | |
| θ _{JCbot} | Junction-to-case (bottom) thermal resistance | N/A | 8.8 | |

(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/SRPA953).

RECOMMENDED OPERATING CONDITIONS

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

| PARAMETER | | | TEST CONDITIONS | TLC59283 | | UNIT |
|--|------------------------------------|------------------------------------|---|----------------------------------|---------------------|------------------|
| | | | | MIN | MAX | |
| DC CHARACTERISTICS ($V_{CC} = 3\text{ V to }5.5\text{ V}$) | | | | | | |
| V_{CC} | Supply voltage | | | 3 | 5.5 | V |
| V_O | Voltage applied to output | | OUT0 to OUT15 | | 10 | V |
| V_{IH} | Input voltage | High | SIN, SCLK, LAT, BLANK | $0.7 \times V_{CC}$ | V_{CC} | V |
| V_{IL} | | Low | SIN, SCLK, LAT, BLANK | GND | $0.3 \times V_{CC}$ | V |
| I_{OH} | Output current | High | SOUT | | -2 | mA |
| I_{OL} | | Low | SOUT | | 2 | mA |
| I_{OLC} | Constant output sink current | | OUT0 to OUT15, $3\text{ V} \leq V_{CC} \leq 3.6\text{ V}$ | 2 | 35 | mA |
| | | | OUT0 to OUT15, $3.6\text{ V} < V_{CC} \leq 5.5\text{ V}$ | 2 | 45 | mA |
| T_A | Temperature range | Operating free-air | | -40 | +85 | $^\circ\text{C}$ |
| T_J | | Operating junction | | -40 | +125 | $^\circ\text{C}$ |
| AC CHARACTERISTICS ($V_{CC} = 3\text{ V to }5.5\text{ V}$) | | | | | | |
| f_{CLK} (SCLK) | Data shift clock frequency | | SCLK | | 35 | MHz |
| t_{WH0} | Pulse duration | | SCLK | 10 | | ns |
| t_{WL0} | | | SCLK | 10 | | ns |
| t_{WH1} | | | LAT | 20 | | ns |
| t_{WH2} | | | BLANK | 100 | | ns |
| t_{WL2} | | | BLANK | 50 | | ns |
| t_{SU0} | | | Setup time | SIN \uparrow – SCLK \uparrow | 4 | |
| t_{SU1} | LAT \downarrow – SCLK \uparrow | 10 | | | ns | |
| t_{H0} | Hold time | SIN \uparrow – SCLK \uparrow | 4 | | ns | |
| t_{H1} | | LAT \downarrow – SCLK \uparrow | 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 V , unless otherwise noted. Typical specifications are at $T_A = +25^\circ\text{C}$ and $V_{CC} = 3.3\text{ V}$.

| PARAMETER | | | TEST CONDITIONS | TLC59283 | | | UNIT |
|-------------------|--------------------------------|-----------------------------------|--|---------------------------|----------------|----------------|---------------|
| | | | | MIN | TYP | MAX | |
| V_{OH} | Output voltage | High | $I_{OH} = -2\text{ mA}$ at SOUT | $V_{CC} - 0.4$ | | V_{CC} | V |
| V_{OL} | | Low | $I_{OL} = 2\text{ mA}$ at SOUT | | | 0.4 | V |
| V_{PCHG} | Pre-charged voltage | | $I_O = -10\text{ }\mu\text{A}$ | $V_{CC} - 2.0$ | $V_{CC} - 1.4$ | $V_{CC} - 0.8$ | V |
| V_{IREF} | Reference voltage output | | $R_{IREF} = 1.5\text{ k}\Omega$, $T_A = +25^\circ\text{C}$ | 1.208 | | | V |
| I_{IN} | Input current | | $V_{IN} = V_{CC}$ or GND at SIN and SCLK | -1 | | 1 | μA |
| I_{CC0} | Supply current (V_{CC}) | | SIN, SCLK, LAT = GND, BLANK = $V_{OUTn} = V_{CC}$, $R_{IREF} = \text{open}$ | | 1 | 2 | mA |
| I_{CC1} | | | SIN, SCLK, LAT = GND, BLANK = $V_{OUTn} = V_{CC}$, $R_{IREF} = 3\text{ k}\Omega$ ($I_{OUT} = 17.6\text{ mA}$ target) | | 3 | 4 | mA |
| I_{CC2} | | | All $OUTn = \text{ON}$, SIN, SCLK, LAT, BLANK = GND, $V_{OUTn} = 0.8\text{ V}$, $R_{IREF} = 3\text{ k}\Omega$ | | 7 | 9 | mA |
| I_{CC3} | | | All $OUTn = \text{ON}$, SIN, SCLK, LAT, BLANK = GND, $V_{OUTn} = 0.8\text{ V}$, $R_{IREF} = 1.5\text{ k}\Omega$ ($I_{OUT} = 35.3\text{ mA}$ target) | | 8 | 11 | mA |
| I_{OLC} | Constant output current | | All $OUTn = \text{ON}$, $V_{OUTn} = V_{OUTfix} = 0.8\text{ V}$, $R_{IREF} = 1.5\text{ k}\Omega$, $T_A = +25^\circ\text{C}$ (see Figure 8) | 32.9 | 35.3 | 37.7 | mA |
| I_{OLKG0} | Output leakage current | | All $OUTn = \text{OFF}$, $V_{OUTn} = V_{OUTfix} = 10\text{ V}$, BLANK = V_{CC} , $R_{IREF} = 1.5\text{ k}\Omega$ (see Figure 8) | | | | |
| | | | | $T_J = +25^\circ\text{C}$ | | 0.1 | μA |
| | | | | $T_J = +85^\circ\text{C}$ | | 0.2 | μA |
| | | | $T_J = +125^\circ\text{C}$ | 0.07 | 0.5 | μA | |
| ΔI_{OLC0} | Constant-current error | Channel-to-channel ⁽¹⁾ | All $OUTn = \text{ON}$, $V_{OUTn} = V_{OUTfix} = 0.8\text{ V}$, $R_{IREF} = 1.5\text{ k}\Omega$, $T_A = +25^\circ\text{C}$ (see Figure 8) | | ± 1.4 | ± 3 | % |
| ΔI_{OLC1} | | Device-to-device ⁽²⁾ | All $OUTn = \text{ON}$, $V_{OUTn} = V_{OUTfix} = 0.8\text{ V}$, $R_{IREF} = 1.5\text{ k}\Omega$, $T_A = +25^\circ\text{C}$ (see Figure 8) | | ± 2 | ± 4 | % |
| ΔI_{OLC2} | Line regulation ⁽³⁾ | | All $OUTn = \text{ON}$, $V_{OUTn} = V_{OUTfix} = 0.8\text{ V}$, $R_{IREF} = 1.5\text{ k}\Omega$, $V_{CC} = 3\text{ V}$ to 5.5 V | ± 0.05 | | ± 1 | %/V |
| ΔI_{OLC3} | Load regulation ⁽⁴⁾ | | All $OUTn = \text{ON}$, $V_{OUTn} = 0.8\text{ V}$ to 3 V , $V_{OUTfix} = 0.8\text{ V}$, $R_{IREF} = 1.5\text{ k}\Omega$ | ± 0.5 | | ± 1 | %/V |
| R_{PUP} | Resistor | Pull-up | BLANK | 250 | 500 | 750 | k Ω |
| R_{PDWN} | | Pull-down | LAT | 250 | 500 | 750 | k Ω |
| R_{PCHG} | Pre-charge FET on-resistance | | $V_{CC} = 5.0\text{ V}$, $V_{OUTn} = 0\text{ V}$, OUT0 to OUT15, BLANK = V_{CC} , $T_A = +25^\circ\text{C}$ | | 3 | 6 | k Ω |

- (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

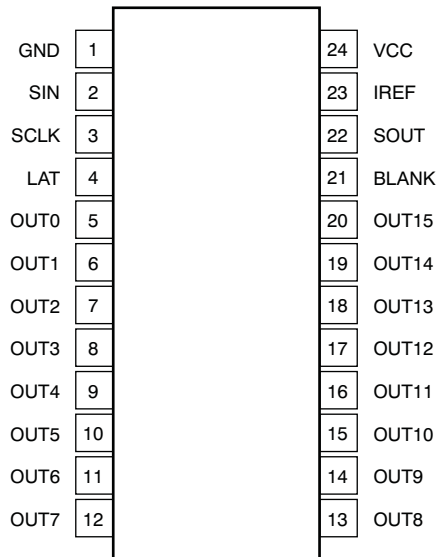
All minimum and maximum specifications are at $T_A = -40^{\circ}\text{C}$ to $+85^{\circ}\text{C}$, $V_{CC} = 3\text{ V}$ to 5.5 V , $C_L = 15\text{ pF}$, $R_L = 110\ \Omega$, $R_{IREF} = 1.5\text{ k}\Omega$, and $V_{LED} = 5.0\text{ V}$, unless otherwise noted. Typical values are at $T_A = +25^{\circ}\text{C}$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

| PARAMETER | TEST CONDITIONS | TLC59283 | | | 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 |
| 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 ⁽¹⁾ 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 | |

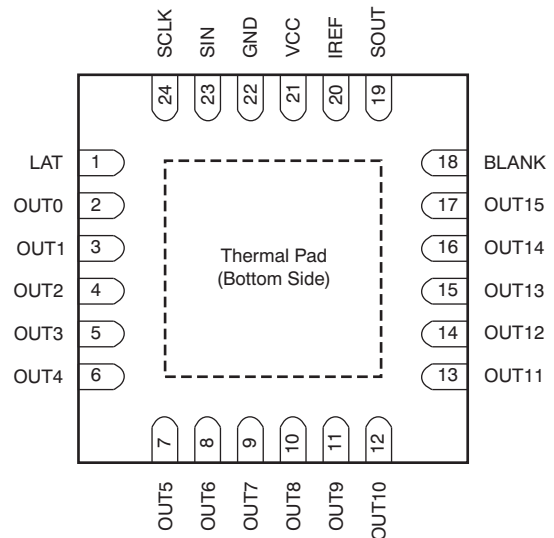
- (1) Output on-time error (t_{ON_ERR}) is calculated by the formula: t_{ON_ERR} (ns) = t_{OUT_ON} – BLANK low level one-shot pulse width (t_{WL2}). t_{OUT_ON} indicates the actual on-time of the constant-current output.

PIN CONFIGURATIONS

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



**RGE PACKAGE
QFN-24
(TOP VIEW)**

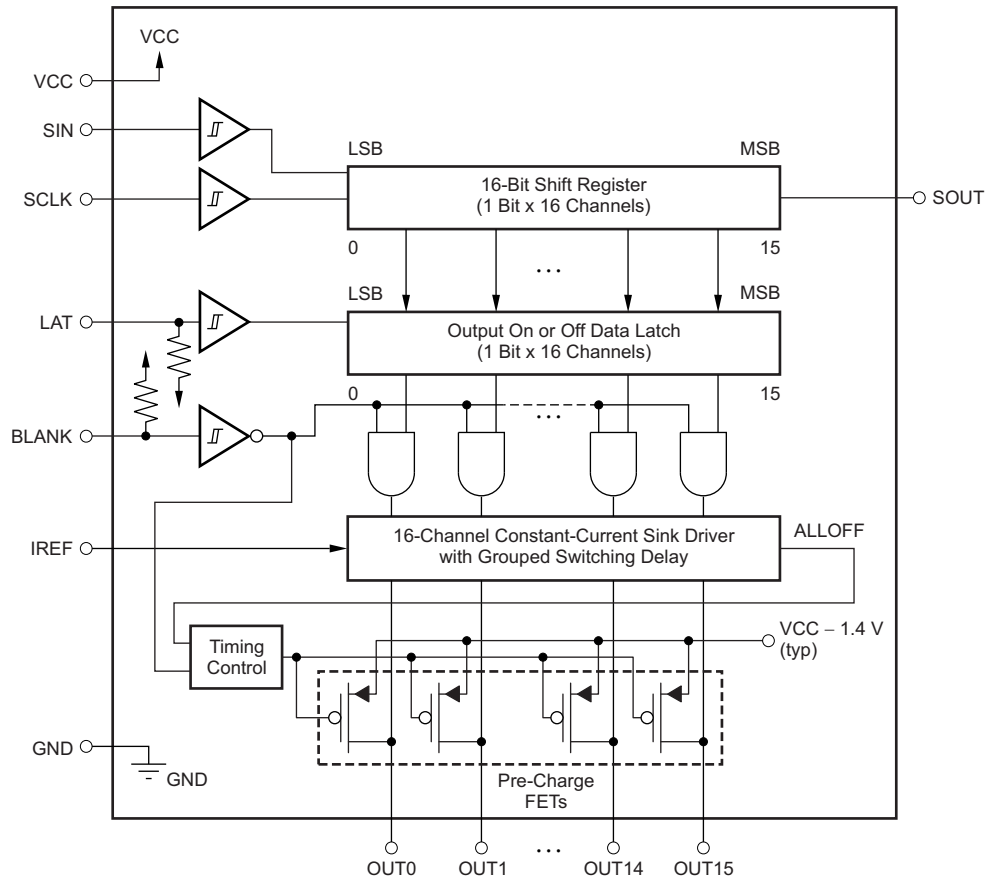


NOTE: Thermal pad is not connected to GND internally. The thermal pad must be connected to GND via the printed circuit board (PCB) pattern.

PIN DESCRIPTIONS

| NAME | PIN | | I/O | DESCRIPTION |
|-------|--------|-----|-----|---|
| | NUMBER | | | |
| | DBQ | RGE | | |
| BLANK | 21 | 18 | I | All outputs empty (blank); Schmitt buffer input. When BLANK is high, all constant-current outputs (OUT0 to OUT15) are forced off and all pre-charge FETs are turned on. When BLANK is low, all constant-current outputs are controlled by the data in the output on or off data latch and all pre-charge FETs are turned off. This pin is internally pulled up to V_{CC} with a 500-k Ω (typ) resistor. |
| GND | 1 | 22 | — | Power ground |
| IREF | 23 | 20 | 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 | 1 | 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 Ω (typ) resistor. |
| OUT0 | 5 | 2 | 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 | 3 | O | Constant-current output |
| OUT2 | 7 | 4 | O | Constant-current output |
| OUT3 | 8 | 5 | O | Constant-current output |
| OUT4 | 9 | 6 | O | Constant-current output |
| OUT5 | 10 | 7 | O | Constant-current output |
| OUT6 | 11 | 8 | O | Constant-current output |
| OUT7 | 12 | 9 | O | Constant-current output |
| OUT8 | 13 | 10 | O | Constant-current output |
| OUT9 | 14 | 11 | O | Constant-current output |
| OUT10 | 15 | 12 | O | Constant-current output |
| OUT11 | 16 | 13 | O | Constant-current output |
| OUT12 | 17 | 14 | O | Constant-current output |
| OUT13 | 18 | 15 | O | Constant-current output |
| OUT14 | 19 | 16 | O | Constant-current output |
| OUT15 | 20 | 17 | O | Constant-current output |
| SCLK | 3 | 24 | I | Serial data shift clock; Schmitt buffer input. All data in the 16-bit shift register are shifted toward the MSB by a 1-bit SCLK synchronization. |
| SIN | 2 | 23 | I | Serial data input for driver on or off control; Schmitt buffer input. 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 | 19 | 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 | 21 | — | Power-supply voltage |

FUNCTIONAL BLOCK DIAGRAM



PARAMETER MEASUREMENT INFORMATION

PIN-EQUIVALENT INPUT AND OUTPUT SCHEMATIC DIAGRAMS

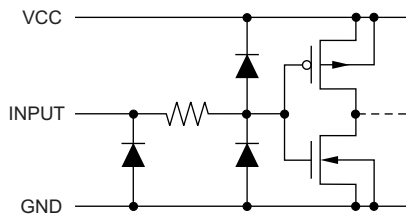


Figure 1. SIN and SCLK

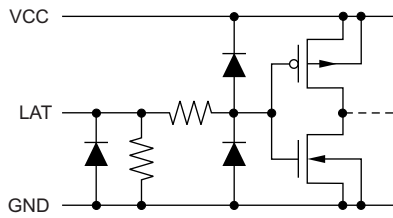


Figure 2. LAT

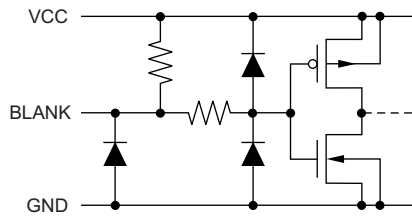


Figure 3. BLANK

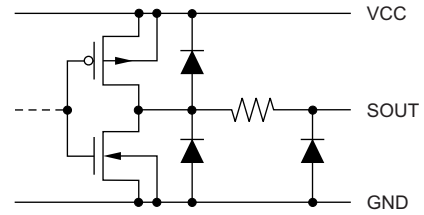
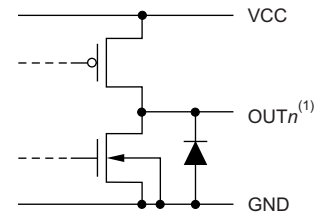


Figure 4. SOUT



(1) n = 0 to 15.

Figure 5. OUT0 Through OUT15

TEST CIRCUITS

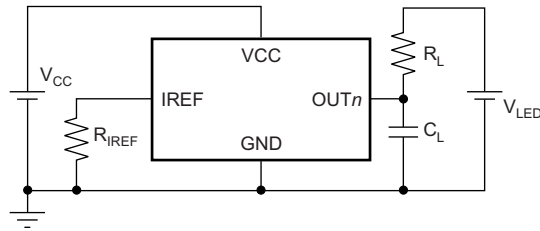


Figure 6. OUT_n Rise and Fall Time Test Circuit

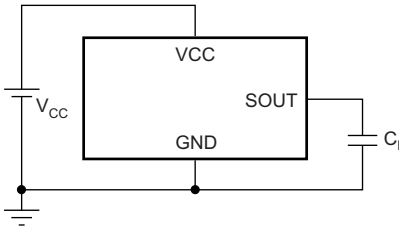


Figure 7. SOUT Rise and Fall Time Test Circuit

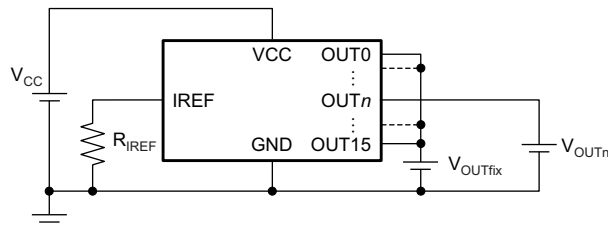
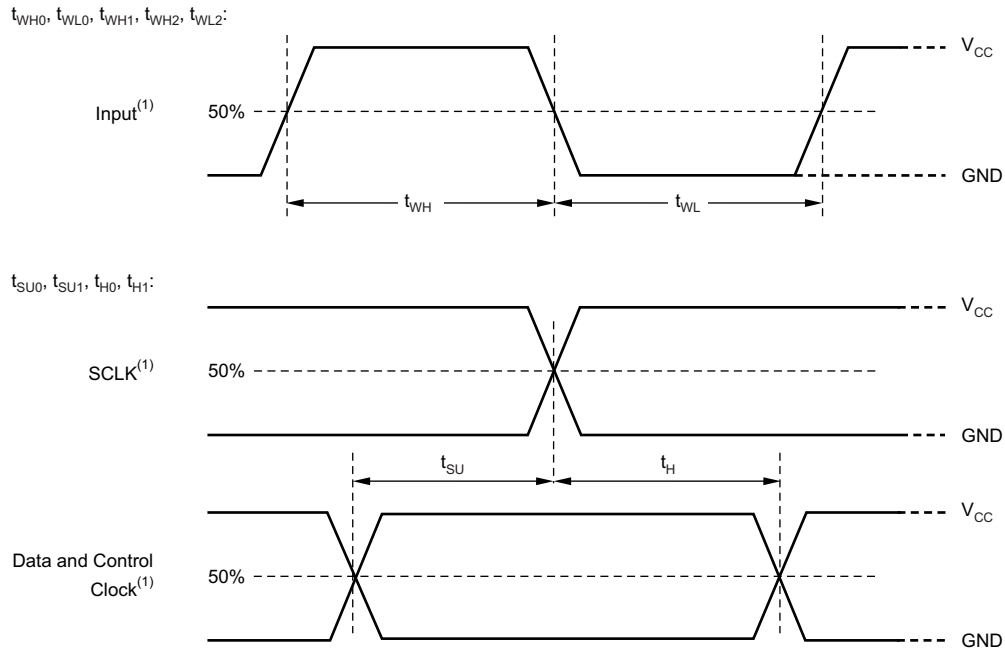


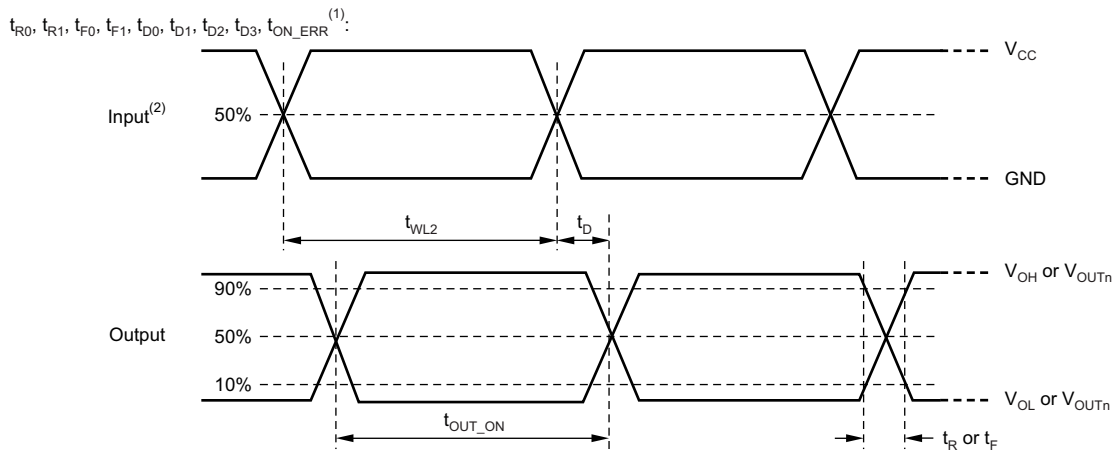
Figure 8. OUT_n Constant-Current Test Circuit

TIMING DIAGRAMS



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

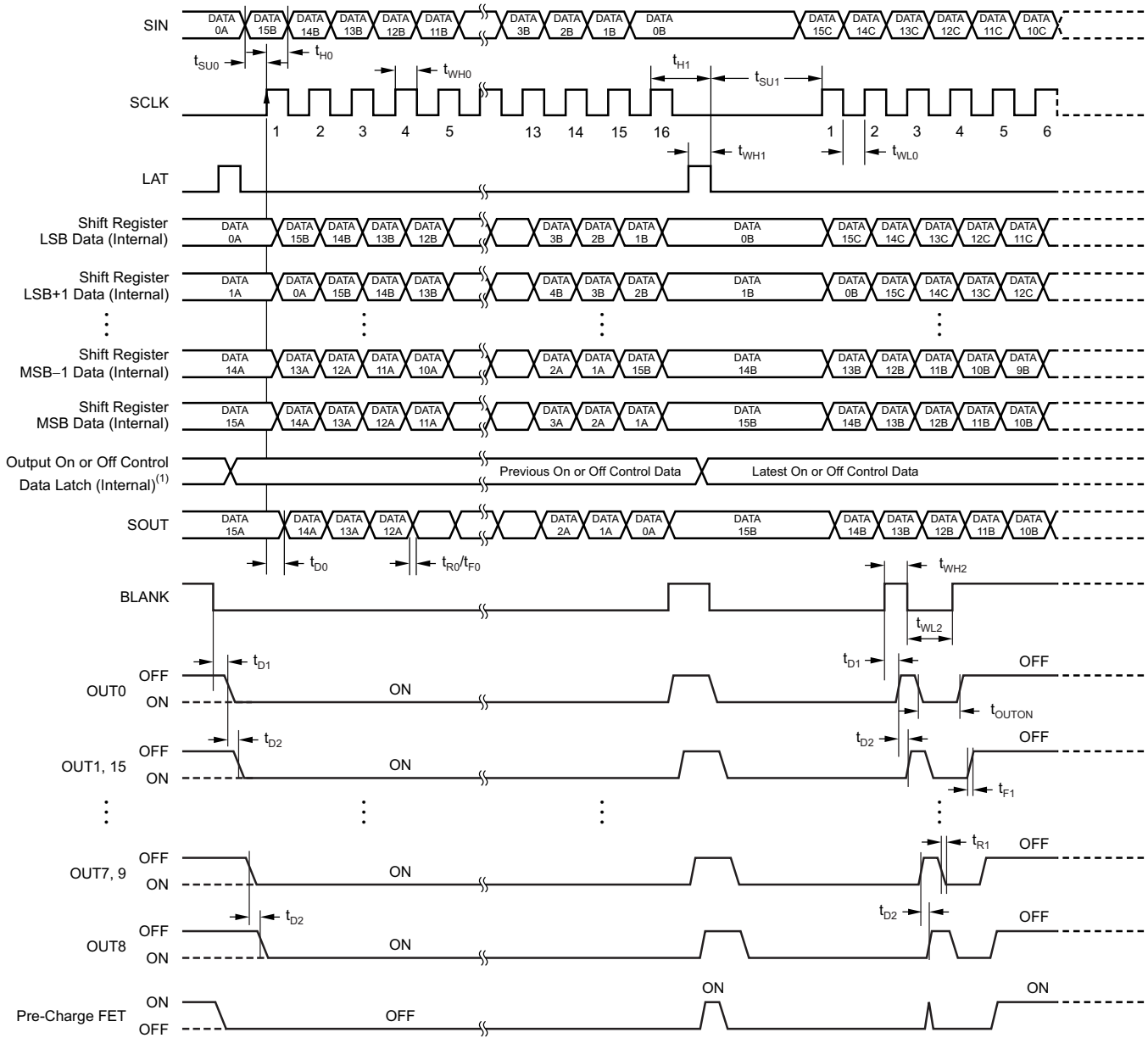
Figure 9. Input Timing Diagram



(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.

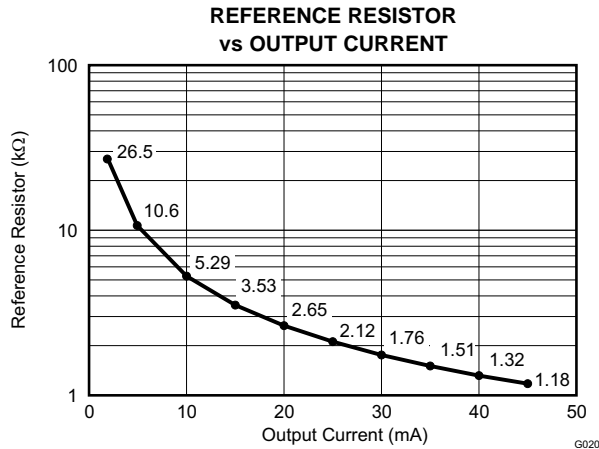


Figure 12.

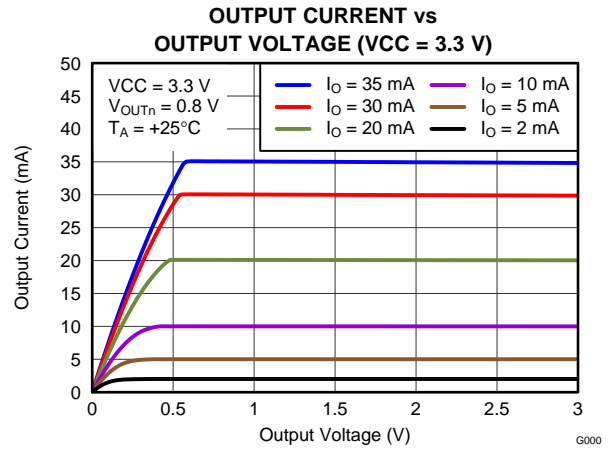


Figure 13.

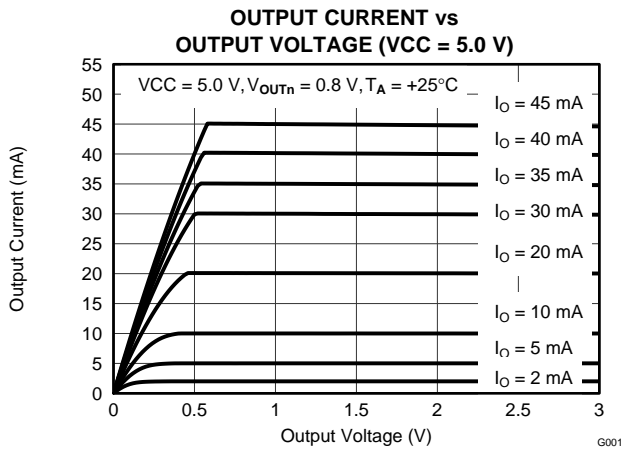


Figure 14.

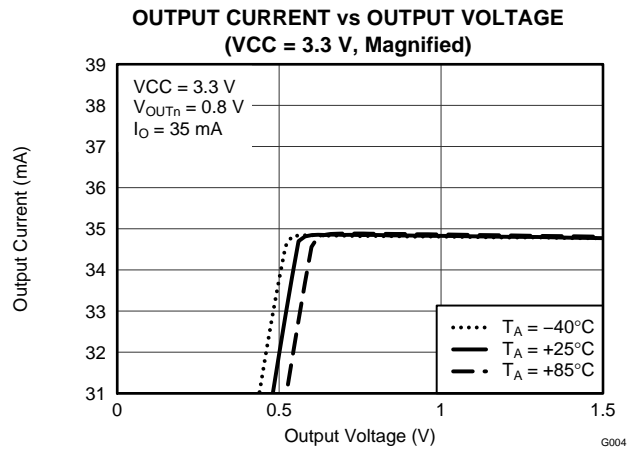


Figure 15.

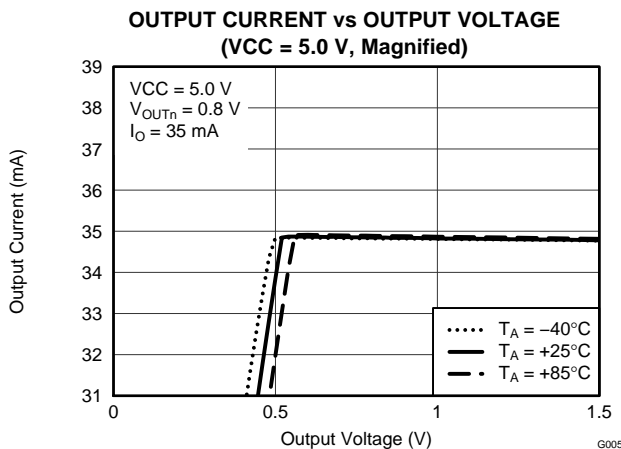


Figure 16.

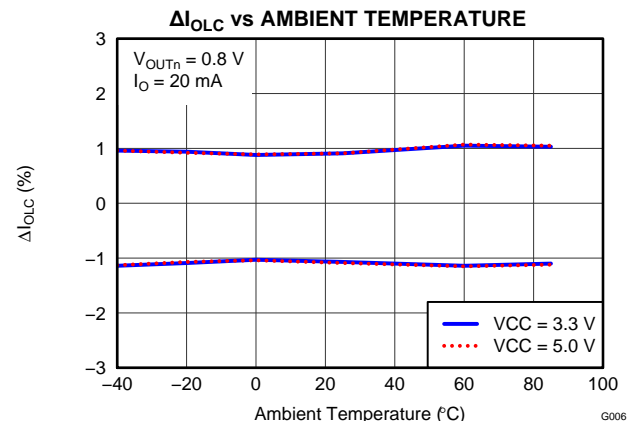


Figure 17.

TYPICAL CHARACTERISTICS (continued)

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

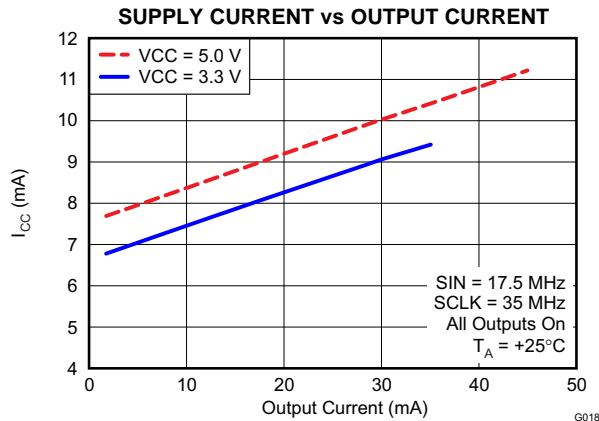


Figure 18.

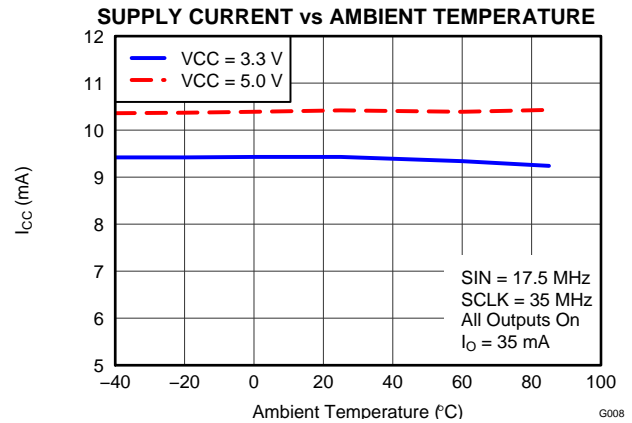


Figure 19.

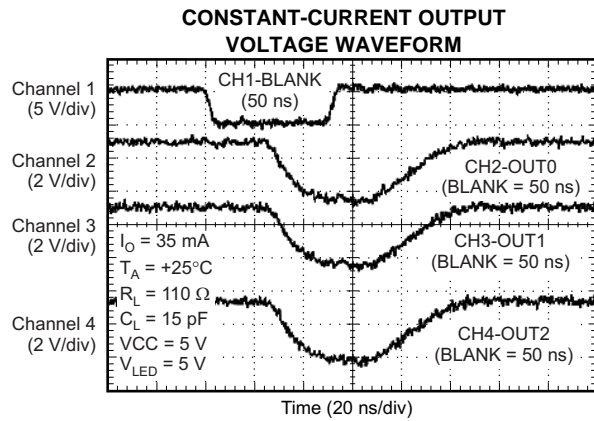


Figure 20.

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](#).

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

Where:

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

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 Ω , Typical) |
|-----------------------------|-----------------------------------|
| 45 ($V_{CC} > 3.6$ V only) | 1.18 |
| 40 ($V_{CC} > 3.6$ 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 TLC59283 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.

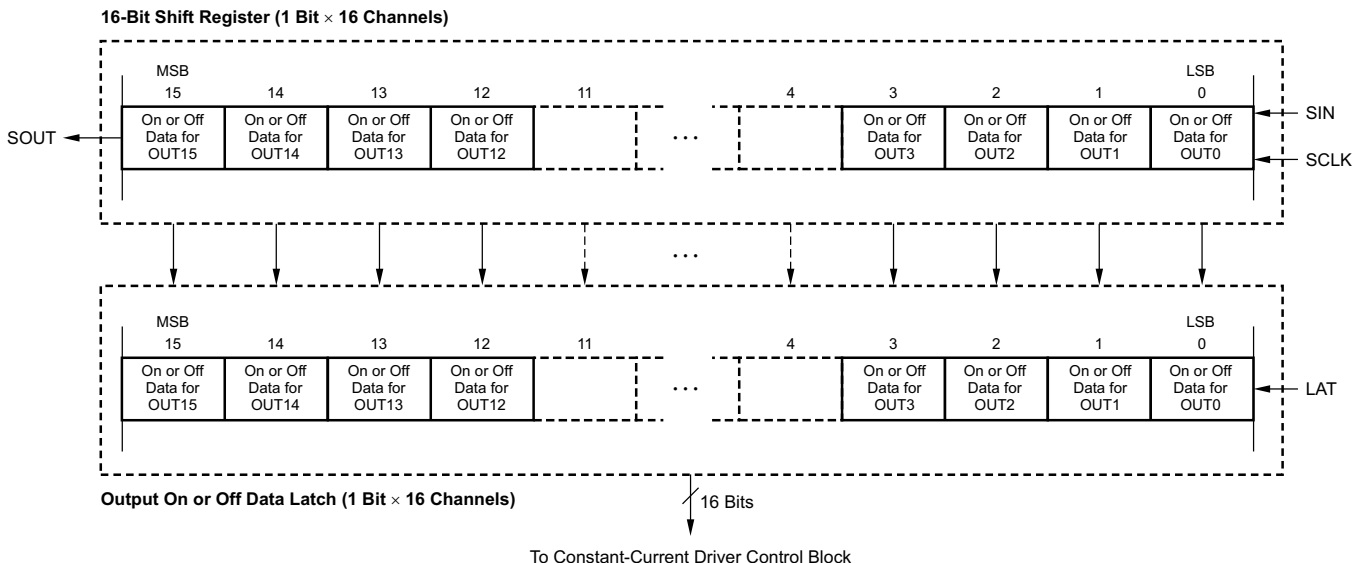


Figure 21. 16-Bit Shift Register and Output On or Off Data Latch Configuration

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 | D _n | D _n ...D _{n-7} ...D _{n-15} | D _{n-15} |
| ↑ | Low | Low | D _{n+1} | No change | D _{n-14} |
| ↑ | High | Low | D _{n+2} | D _{n+2} ...D _{n-5} ...D _{n-13} | D _{n-13} |
| ↓ | — | Low | D _{n+3} | D _{n+2} ...D _{n-5} ...D _{n-13} | D _{n-13} |
| ↓ | — | High | D _{n+3} | Off | D _{n-13} |

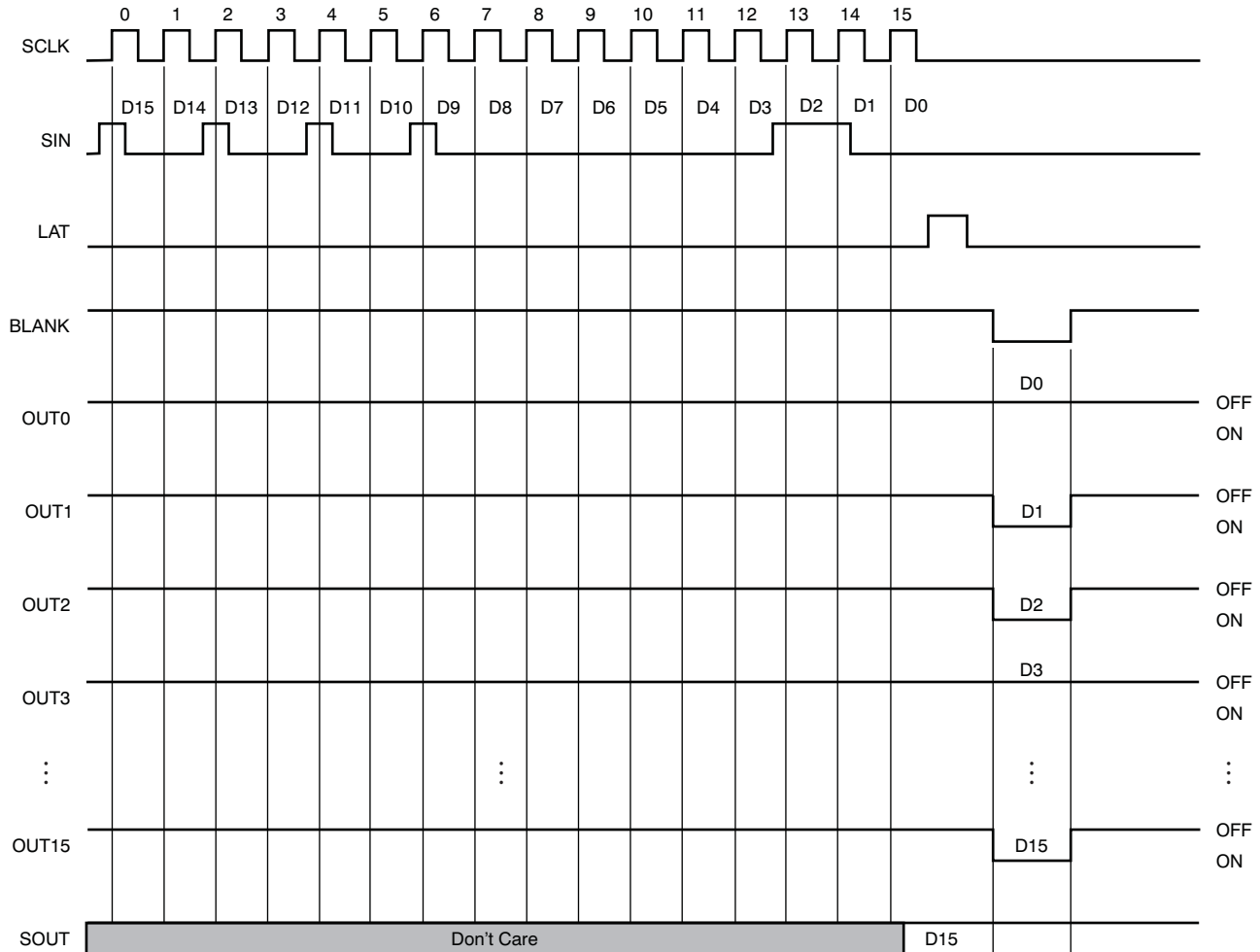


Figure 22. Operation Timing Diagram

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 TLC59283 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 (OUT9). 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.

Internal Pre-Charge FET

The internal pre-charge FET prevents ghosting of multiplexed LED modules. One cause of this phenomenon is the parasitic capacitance charging current of the constant-current outputs (OUT_n) and PCB wiring connected to OUT_n through the LED. One of the mechanisms is shown in [Figure 23](#).

In [Figure 23](#), the constant-current driver turns LED0-0 on at (1) and off at (2). After LED0-0 is turned off, the OUT_0 voltage is pulled up to V_{CHG} by LED0-0. This OUT_0 node has some parasitic capacitance (such as the constant-current driver output capacitance and the board layout capacitance shown as C0-2). After LED0-0 turns off, SWPMOS0 is turned off, SWNMOS0 is turned on for COM0, and COM0 is pulled down to GND. Because there is a parasitic capacitance between COM0 and OUT_0 , the OUT_0 voltage is also pulled down to GND. Afterwards, SWPMOS1 is turned on for the next common line (COM1). When SWPMOS1 turns on, the OUT_0 voltage is pulled up from the ground voltage to $V_{LED} - V_F$. The charge current (I_{CHRG}) flows to the parasitic capacitor (C0) through LED1-0, causing the LED to briefly turn on and creating a ghosting effect of LED1-0.

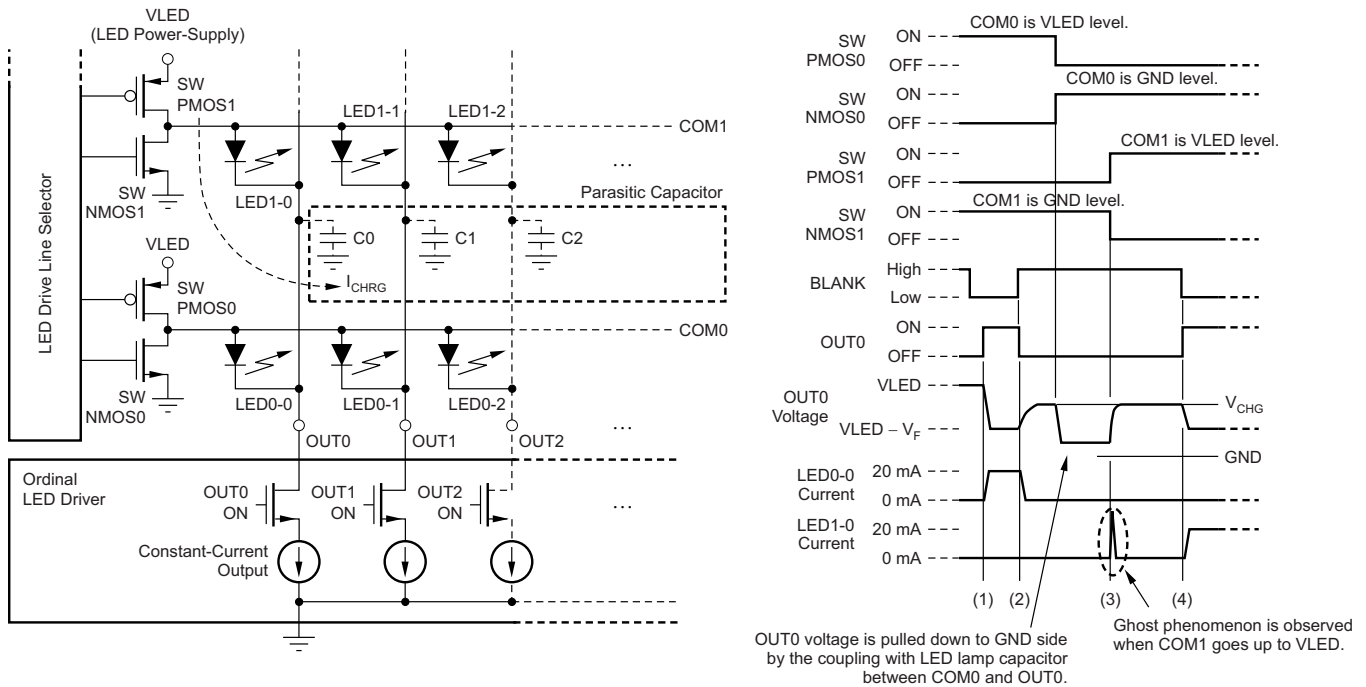


Figure 23. LED Ghost-Lighting Phenomenon Mechanism

The TLC59283 has an internal pre-charge FET to prevent ghosting, as shown in Figure 24. When a small delay after PWM control for a single common line completes, the FET pulls OUT_n up to V_{CC} . The charge current does not flow to C_0 through LED1-0 when SWMOS1 is turned on and the ghosting is eliminated at (3). However, depending on the LED anode voltage, the number of LEDs in series, the LED forward voltage, and the TLC59283 V_{CC} supply voltage, there may not be a great enough ghost-canceling effect.

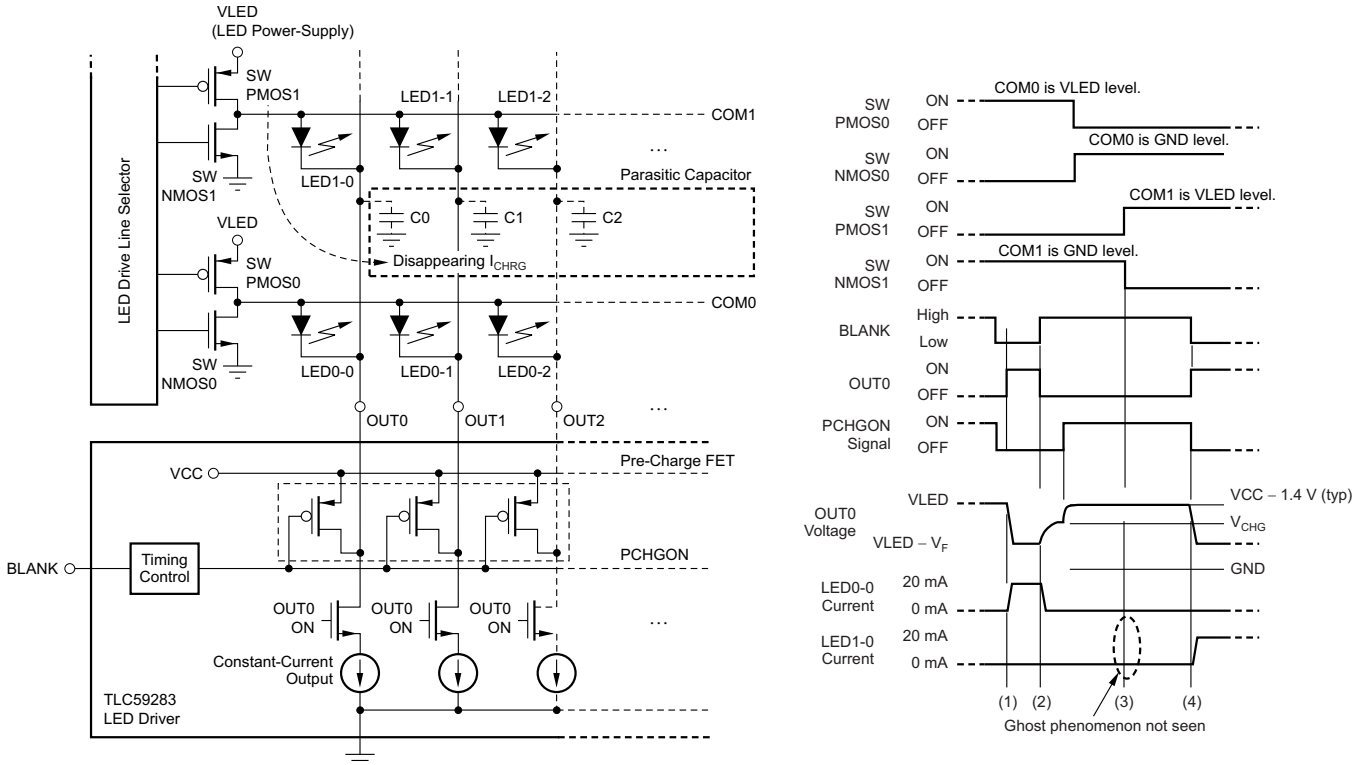


Figure 24. LED Ghost-Lighting Mechanism by Pre-Charge FET

HISTORY TABLE

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

| Changes from Revision A (June 2012) to Revision B | Page |
|--|-------------|
| • Changed HBM ESD rating maximum specification in the Absolute Maximum Ratings table | 2 |
| • Changed I_{CC2} typical and maximum specifications in Electrical Characteristics table | 4 |
| • Changed I_{CC3} typical specification in Electrical Characteristics table | 4 |

PACKAGING INFORMATION

| Orderable Device | Status ⁽¹⁾ | Package Type | Package Drawing | Pins | Package Qty | Eco Plan ⁽²⁾ | Lead/ Ball Finish | MSL Peak Temp ⁽³⁾ | Samples (Requires Login) |
|------------------|-----------------------|--------------|-----------------|------|-------------|----------------------------|----------------------|------------------------------|-----------------------------|
| TLC59283DBQ | ACTIVE | SSOP | DBQ | 24 | 50 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | |
| TLC59283DBQR | ACTIVE | SSOP | DBQ | 24 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | |
| TLC59283RGER | ACTIVE | VQFN | RGE | 24 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | |
| TLC59283RGET | ACTIVE | VQFN | RGE | 24 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | |

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

ACTIVE: Product device recommended for new designs.

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

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

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

OBSELETE: TI has discontinued the production of the device.

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

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

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

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

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

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

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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 |
|--------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| TLC59283DBQR | SSOP | DBQ | 24 | 2500 | 330.0 | 16.4 | 6.5 | 9.0 | 2.1 | 8.0 | 16.0 | Q1 |
| TLC59283RGER | VQFN | RGE | 24 | 3000 | 330.0 | 12.4 | 4.25 | 4.25 | 1.15 | 8.0 | 12.0 | Q2 |

TAPE AND REEL BOX DIMENSIONS

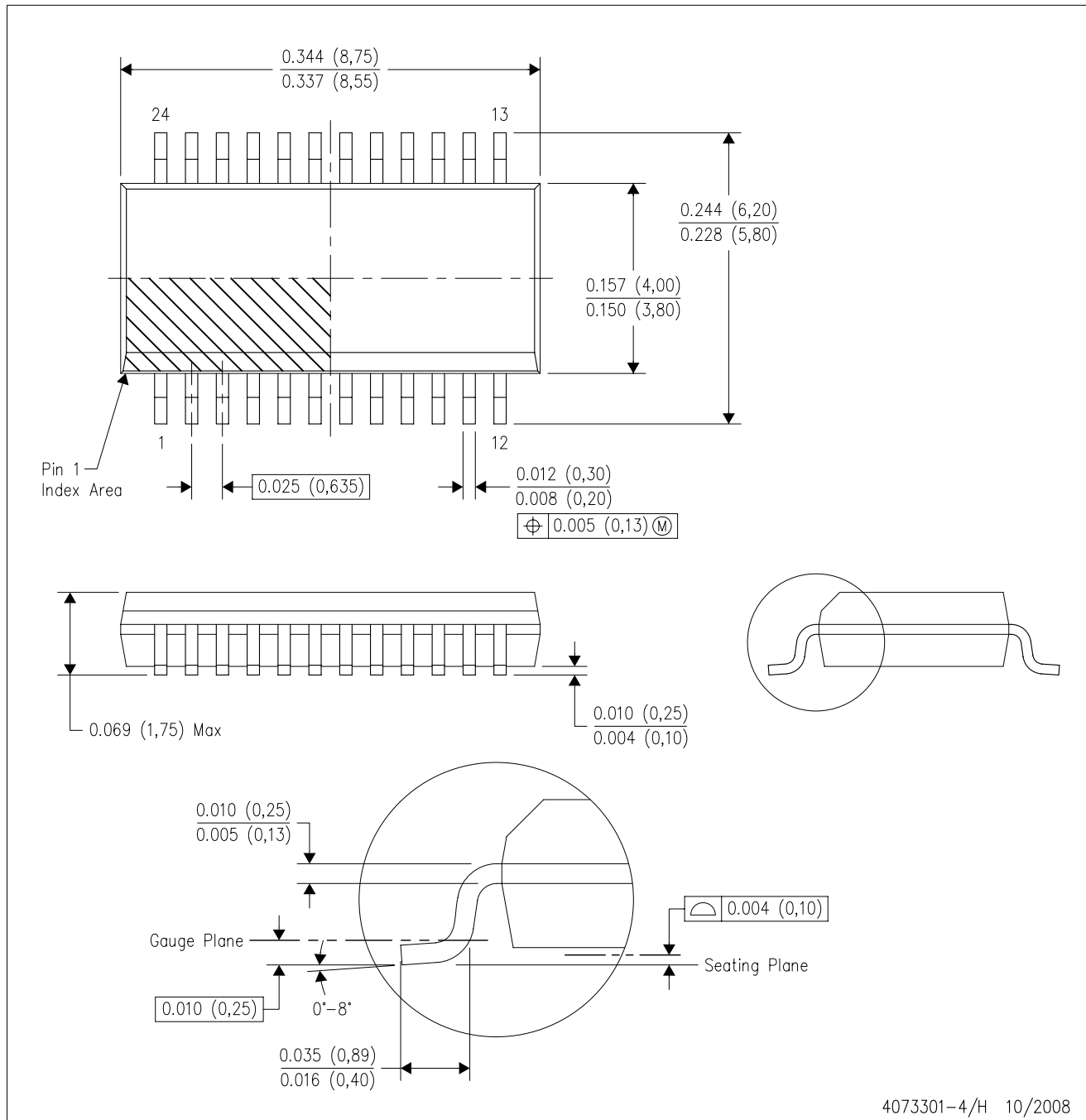


*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|--------------|--------------|-----------------|------|------|-------------|------------|-------------|
| TLC59283DBQR | SSOP | DBQ | 24 | 2500 | 367.0 | 367.0 | 38.0 |
| TLC59283RGER | VQFN | RGE | 24 | 3000 | 367.0 | 367.0 | 35.0 |

DBQ (R-PDSO-G24)

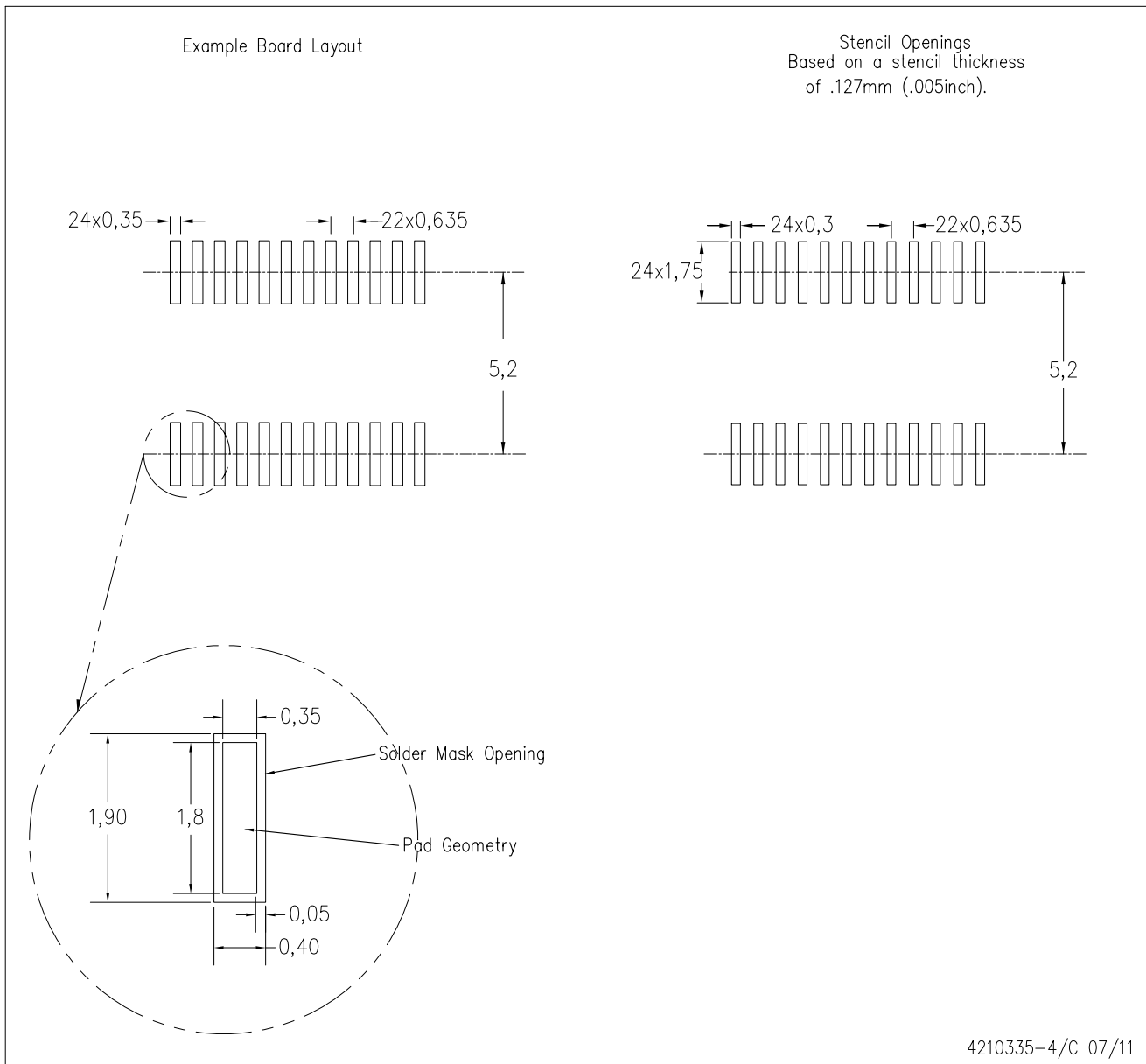
PLASTIC SMALL-OUTLINE PACKAGE



- 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.

DBQ (R-PDSO-G24)

PLASTIC SMALL OUTLINE PACKAGE



- NOTES:
- A. All linear dimensions are in millimeters.
 - B. This drawing is subject to change without notice.
 - C. Customers should place a note on the circuit board fabrication drawing not to alter the center solder mask defined pad.
 - D. Publication IPC-7351 is recommended for alternate designs.
 - E. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Example stencil design based on a 50% volumetric metal load solder paste. Refer to IPC-7525 for other stencil recommendations.

THERMAL PAD MECHANICAL DATA

RGE (S-PVQFN-N24)

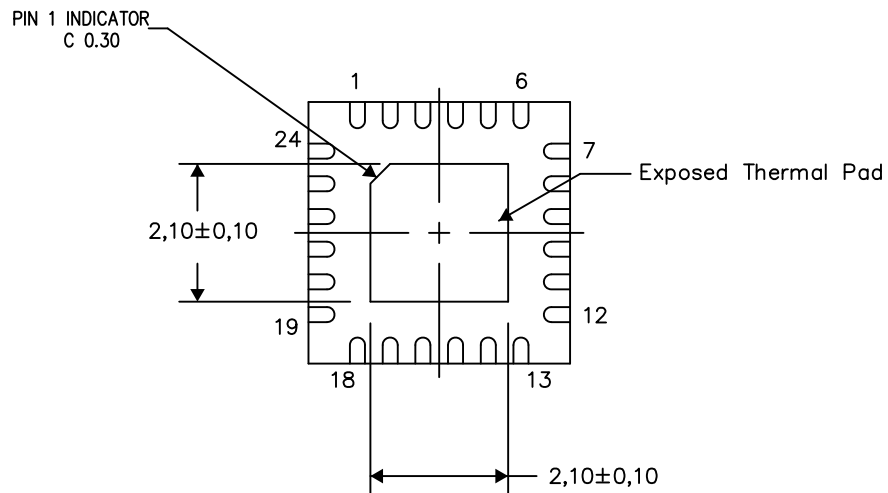
PLASTIC QUAD FLATPACK NO-LEAD

THERMAL INFORMATION

This package incorporates an exposed thermal pad that is designed to be attached directly to an external heatsink. The thermal pad must be soldered directly to the printed circuit board (PCB). After soldering, the PCB can be used as a heatsink. In addition, through the use of thermal vias, the thermal pad can be attached directly to the appropriate copper plane shown in the electrical schematic for the device, or alternatively, can be attached to a special heatsink structure designed into the PCB. This design optimizes the heat transfer from the integrated circuit (IC).

For information on the Quad Flatpack No-Lead (QFN) package and its advantages, refer to Application Report, QFN/SON PCB Attachment, Texas Instruments Literature No. SLUA271. This document is available at www.ti.com.

The exposed thermal pad dimensions for this package are shown in the following illustration.



Bottom View

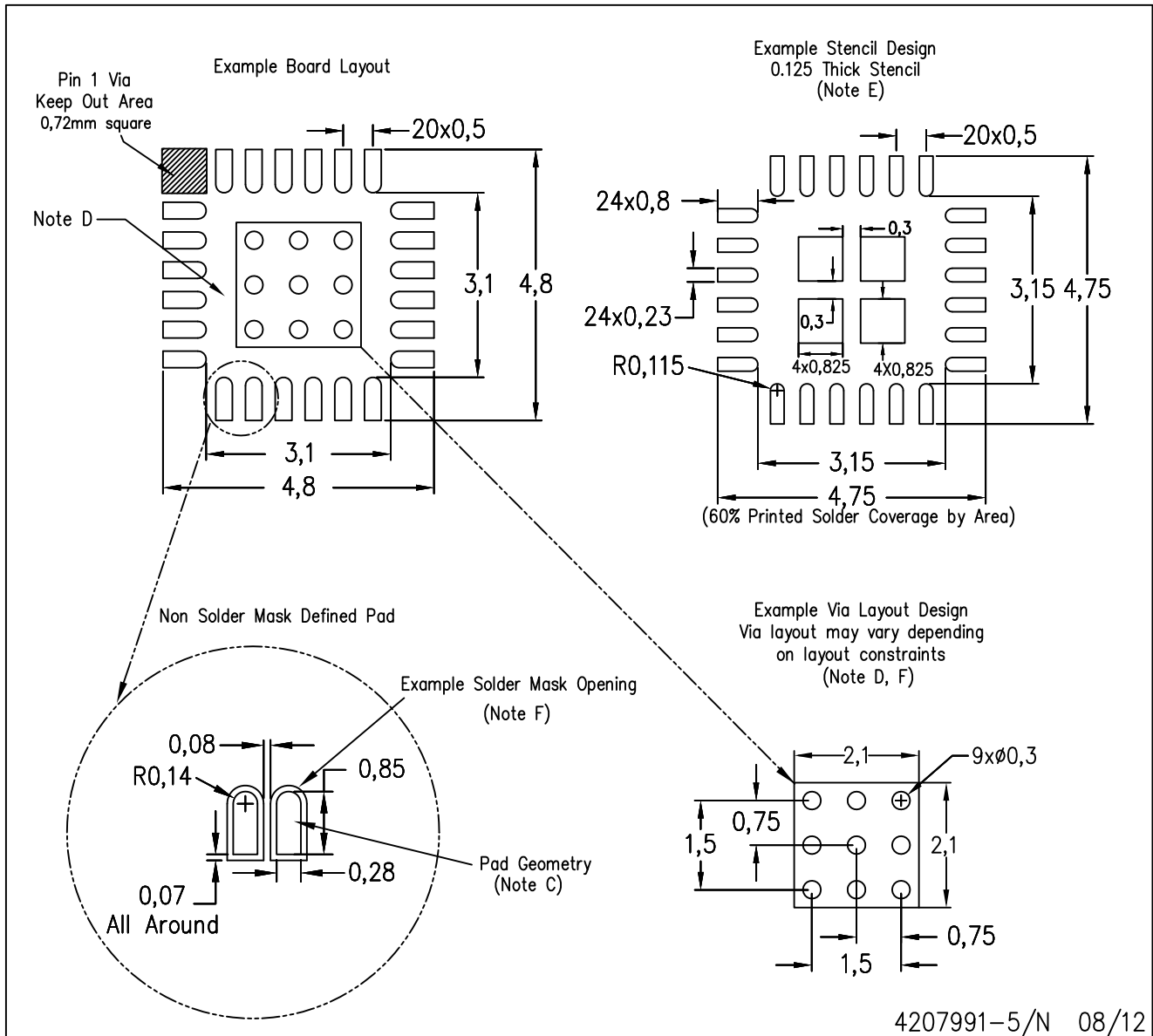
Exposed Thermal Pad Dimensions

4206344-6/AB 09/12

NOTES: A. All linear dimensions are in millimeters

RGE (S-PVQFN-N24)

PLASTIC QUAD FLATPACK NO-LEAD



- NOTES:
- All linear dimensions are in millimeters.
 - This drawing is subject to change without notice.
 - Publication IPC-7351 is recommended for alternate designs.
 - This package is designed to be soldered to a thermal pad on the board. Refer to Application Note, Quad Flat-Pack Packages, Texas Instruments Literature No. SLUA271, and also the Product Data Sheets for specific thermal information, via requirements, and recommended board layout. These documents are available at www.ti.com <<http://www.ti.com>>.
 - Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC 7525 for stencil design considerations.
 - Customers should contact their board fabrication site for recommended solder mask tolerances and via tenting recommendations for vias placed in the thermal pad.

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