

TLC5925 Low-Power 16-Channel Constant-Current LED Sink Driver

1 Features

- 16 Constant-Current Output Channels
- Constant Output Current Invariant to Load Voltage Change
- Excellent Output Current Accuracy:
 - Between Channels: $< \pm 4\%$ (Max)
 - Between ICs: $< \pm 6\%$ (Max)
- Constant Output Current Range: 3 mA to 45 mA
- Output Current Adjusted By External Resistor
- Fast Response of Output Current, \overline{OE} (Min): 100 ns
- 30-MHz Clock Frequency
- Schmitt-Trigger Inputs
- 3.3-V to 5-V Supply Voltage
- Thermal Shutdown for Overtemperature Protection
- ESD Performance: 1-kV HBM

2 Applications

- Gaming Machine and Entertainment
- General LED Applications
- LED Display Systems
- Signs LED Lighting
- White Goods

3 Description

The TLC5925 is designed for LED displays and LED lighting applications. The TLC5925 contains a 16-bit shift register and data latches, which convert serial input data into parallel output format. At the TLC5925 output stage, 16 regulated-current ports provide uniform and constant current for driving LEDs within a wide range of VF variations. Used in system design for LED display applications (such as, LED panels), the TLC5925 provides great flexibility and device performance. Users can adjust the output current from 3 mA to 45 mA through an external resistor, R_{ext} , which gives flexibility in controlling the light intensity of LEDs. TLC5925 is designed for up to 17 V at the output port. The high clock frequency, 30 MHz, also satisfies the system requirements of high-volume data transmission.

The serial data is transferred into TLC5925 via SDI, shifted in the shift register, and transferred out via SDO. LE can latch the serial data in the shift register to the output latch. \overline{OE} enables the output drivers to sink current.

Device Information (1)

| PART NUMBER | PACKAGE | BODY SIZE (NOM) |
|-------------|------------|--------------------|
| TLC5925 | SSOP (24) | 8.65 mm x 3.90 mm |
| | SOIC (24) | 15.40 mm x 7.50 mm |
| | TSSOP (24) | 7.80 mm x 4.40 mm |

(1) For all available packages, see the orderable addendum at the end of the datasheet.

Typical Application

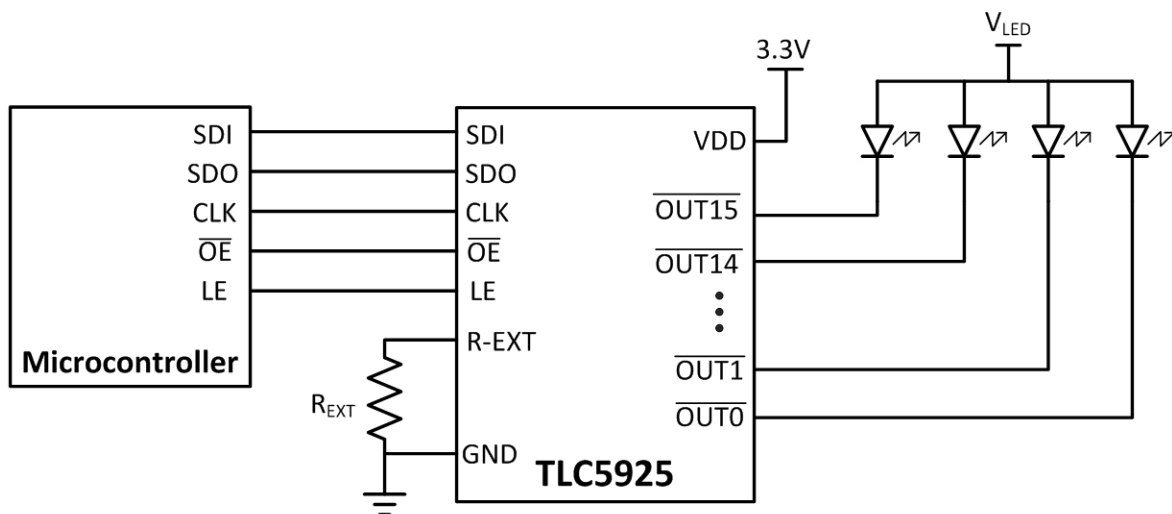


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4 Revision History

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

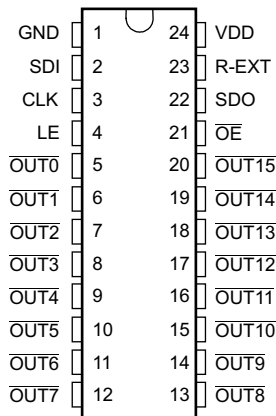
Changes from Revision A (March 2013) to Revision B

Page

- Added *Pin Configuration and Functions* section, *ESD Ratings* table, *Feature Description* section, *Device Functional Modes*, *Application and Implementation* section, *Power Supply Recommendations* section, *Layout* section, *Device and Documentation Support* section, and *Mechanical, Packaging, and Orderable Information* section **1**

5 Pin Configuration and Functions

**DBQ, DW, or PWP Package
24-Pin SSOP, SOIC, or TSSOP
Top View**



Pin Functions

| PIN | | I/O | DESCRIPTION |
|--------------------|-----|-----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| NAME | NO. | | |
| CLK | 3 | I | Clock input for data shift on rising edge |
| GND | 1 | — | Ground for control logic and current sink |
| LE | 4 | I | Data strobe input Serial data is transferred to the respective latch when LE is high. The data is latched when LE goes low. LE has an internal pull-down resistor. |
| \overline{OE} | 21 | I | Output enable When \overline{OE} is active (low), the output drivers are enabled. When \overline{OE} is high, all output drivers are turned OFF (blanked). \overline{OE} has an internal pullup resistor. |
| $\overline{OUT0}$ | 5 | O | Constant-current outputs |
| $\overline{OUT1}$ | 6 | | |
| $\overline{OUT2}$ | 7 | | |
| $\overline{OUT3}$ | 8 | | |
| $\overline{OUT4}$ | 9 | | |
| $\overline{OUT5}$ | 10 | | |
| $\overline{OUT6}$ | 11 | | |
| $\overline{OUT7}$ | 12 | | |
| $\overline{OUT8}$ | 13 | | |
| $\overline{OUT9}$ | 14 | | |
| $\overline{OUT10}$ | 15 | | |
| $\overline{OUT11}$ | 16 | | |
| $\overline{OUT12}$ | 17 | | |
| $\overline{OUT13}$ | 18 | | |
| $\overline{OUT14}$ | 19 | | |
| $\overline{OUT15}$ | 20 | | |
| R-EXT | 23 | I | Input used to connect an external resistor (R_{ext}) for setting output currents |
| SDI | 2 | I | Serial-data input to the Shift register |
| SDO | 22 | O | Serial-data output to the following SDI of next driver IC or to the microcontroller |
| VDD | 24 | I | Supply voltage |

6 Specifications

6.1 Absolute Maximum Ratings

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

| | | MIN | MAX | UNIT |
|------------------|--------------------------------------|------|-----------------------|------|
| V _{DD} | Supply voltage | 0 | 7 | V |
| V _I | Input voltage | -0.4 | V _{DD} + 0.4 | V |
| V _O | Output voltage | -0.5 | 20 | V |
| I _{OUT} | Output current | | 45 | mA |
| I _{GND} | GND terminal current | | 750 | mA |
| T _A | Free-air operating temperature range | -40 | 125 | °C |
| T _J | Operating junction temperature range | -40 | 150 | °C |
| T _{stg} | Storage temperature range | -55 | 150 | °C |

- (1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions*. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

6.2 ESD Ratings

| | | VALUE | UNIT |
|--------------------|-------------------------|--------------------------------------------------------------------------------|-------|
| V _(ESD) | Electrostatic discharge | Human body model (HBM), per ANSI/ESDA/JEDEC JS-001 ⁽¹⁾ | ±1000 |
| | | Charged-device model (CDM), per JEDEC specification JESD22-C101 ⁽²⁾ | ±500 |

- (1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.
 (2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

6.3 Recommended Operating Conditions

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

| | | | MIN | MAX | UNIT |
|-----------------|---------------------------|-----------------------------------------------------------|------------------------|-----------------------|------|
| V _{DD} | Supply voltage | | 3 | 5.5 | V |
| V _O | Output voltage | $\overline{\text{OUT}}_0$ to $\overline{\text{OUT}}_{15}$ | | 17 | V |
| I _O | Output current | DC test circuit | V _O ≥ 0.6 V | 3 | mA |
| | | | V _O ≥ 1 V | 45 | |
| I _{OH} | High-level output current | SDO | -1 | | mA |
| I _{OL} | Low-level output current | SDO | 1 | | mA |
| V _{IH} | High-level input voltage | CLK, $\overline{\text{OE}}$, LE, and SDI | 0.7 × V _{DD} | V _{DD} | V |
| V _{IL} | Low-level input voltage | CLK, $\overline{\text{OE}}$, LE, and SDI | GND | 0.3 × V _{DD} | V |
| t _R | Rise Time | CLK | | 500 | ns |
| t _F | Fall Time | CLK | | 500 | ns |

6.4 Thermal Information

| THERMAL METRIC ⁽¹⁾ | | | TLC5925 | | | UNIT |
|-------------------------------|----------------------------------------------|--------------------------------------------------------|---------------|--------------|---------------|------|
| | | | DBQ (SSOP) | DW (SOIC) | PW (TSSOP) | |
| | | | 24 PINS | 24 PINS | 24 PINS | |
| R _{θJA} | Junction-to-ambient thermal resistance | Mounted on JEDEC 1-layer board (JESD 51-3), No airflow | 99.8 | 80.5 | 118.8 | °C/W |
| | | Mounted on JEDEC 4-layer board (JESD 51-7), No airflow | 61 | 45.5 | 87.9 | °C/W |
| R _{θJC(top)} | Junction-to-case (top) thermal resistance | | 52.9 | 45.0 | 44.9 | °C/W |
| R _{θJB} | Junction-to-board thermal resistance | | 41.5 | 44.8 | 52.9 | °C/W |
| Ψ _{JT} | Junction-to-top characterization parameter | | 16.4 | 21.7 | 6.7 | °C/W |
| Ψ _{JB} | Junction-to-board characterization parameter | | 41.2 | 44.4 | 52.5 | °C/W |
| R _{θJC(bot)} | Junction-to-case (bottom) thermal resistance | | n/a | n/a | n/a | °C/W |

(1) For more information about traditional and new thermal metrics, see the *Semiconductor and IC Package Thermal Metrics* application report, [SPRA953](#).

6.5 Electrical Characteristics: V_{DD} = 3 V

V_{DD} = 3 V, T_J = –40°C to 125°C (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|--------------------------------------|---------------------------------------------|---------------------------------------------------------------------------------------------------|------------------------|-----|-----------------------|------|
| V _{DD} | Input voltage | | 3 | | 5.5 | V |
| V _O | Output voltage | | | | 17 | V |
| I _O | Output current | V _O ≥ 0.6 V | 3 | | | mA |
| | | V _O ≥ 1 V | | | 45 | |
| I _{OH} | High-level output current, source | | -1 | | | mA |
| I _{OL} | Low-level output current, sink | | 1 | | | |
| V _{IH} | High-level input voltage | | 0.7 × V _{DD} | | V _{DD} | V |
| V _{IL} | Low-level input voltage | | GND | | 0.3 × V _{DD} | |
| I _{leak} | Output leakage current | V _{OH} = 17 V | T _J = 25°C | | 0.5 | μA |
| | | | T _J = 125°C | | 2 | |
| V _{OH} | High-level output voltage | SDO, I _{OL} = –1 mA | V _{DD} – 0.4 | | | V |
| V _{OL} | Low-level output voltage | SDO, I _{OH} = 1 mA | | | 0.4 | V |
| I _{O(1)} | Output current 1 | V _{OUT} = 0.6 V, R _{ext} = 1680 Ω | 13 | | | mA |
| | Output current error, die-die | I _{OL} = 13 mA, V _O = 0.6 V, R _{ext} = 1680 Ω, T _J = 25°C | ±3% | | ±6% | |
| | Output current error, channel-to-channel | I _{OL} = 13 mA, V _O = 0.6 V, R _{ext} = 1680 Ω, T _J = 25°C | ±1.5% | | ±4% | |
| I _{O(2)} | Output current 2 | V _O = 0.8 V, R _{ext} = 840 Ω | 26 | | | mA |
| | Output current error, die-die | I _{OL} = 26 mA, V _O = 0.8 V, R _{ext} = 840 Ω, T _J = 25°C | ±3% | | ±6% | |
| | Output current error, channel-to-channel | I _{OL} = 26 mA, V _O = 0.8 V, R _{ext} = 840 Ω, T _J = 25°C | ±1.5% | | ±4% | |
| I _{OUT} vs V _{OUT} | Output current vs output voltage regulation | V _O = 1 V to 3 V, I _O = 13 mA | ±0.1 | | | %V |
| | | V _{DD} = 3.0 V to 5.5 V, I _O = 13 mA to 45 mA | ±1 | | | |
| | Pullup resistance | \overline{OE} | 500 | | | kΩ |
| | Pulldown resistance | LE | 500 | | | kΩ |
| T _{sd} | Overtemperature shutdown ⁽¹⁾ | | 150 | 175 | 200 | °C |
| T _{hys} | Restart temperature hysteresis | | 15 | | | °C |
| I _{DD} | Supply current | R _{ext} = Open | 7 | | 10 | mA |
| | | R _{ext} = 1680 Ω | 9 | | 12 | |
| | | R _{ext} = 840 Ω | 11 | | 13 | |
| C _{IN} | Input capacitance | V _I = V _{DD} or GND, CLK, SDI, SDO, \overline{OE} | | | 10 | pF |

(1) Specified by design

6.6 Electrical Characteristics: $V_{DD} = 5.5\text{ V}$

 $V_{DD} = 5.5\text{ V}$, $T_J = -40^\circ\text{C}$ to 125°C (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|------------------------|---------------------------------------------|------------------------------------------------------------------------------------------------------|---------------------------|-------------|---------------------|------------------|
| V_{DD} | Input voltage | | 3 | | 5.5 | V |
| V_O | Output voltage | | | | 17 | V |
| I_O | Output current | $V_O \geq 0.6\text{ V}$ | 3 | | | mA |
| | | $V_O \geq 1\text{ V}$ | | | 45 | |
| I_{OH} | High-level output current, source | | -1 | | | mA |
| I_{OL} | Low-level output current, sink | | 1 | | | |
| V_{IH} | High-level input voltage | | $0.7 \times V_{DD}$ | | V_{DD} | V |
| V_{IL} | Low-level input voltage | | GND | | $0.3 \times V_{DD}$ | |
| I_{leak} | Output leakage current | $V_{OH} = 17\text{ V}$ | $T_J = 25^\circ\text{C}$ | | 0.5 | μA |
| | | | $T_J = 125^\circ\text{C}$ | | 2 | |
| V_{OH} | High-level output voltage | SDO, $I_{OL} = -1\text{ mA}$ | $V_{DD} - 0.4$ | | | V |
| V_{OL} | Low-level output voltage | SDO, $I_{OH} = 1\text{ mA}$ | | | 0.4 | V |
| $I_{O(1)}$ | Output current 1 | $V_{OUT} = 0.6\text{ V}$, $R_{ext} = 1680\ \Omega$ | | 13 | | mA |
| | Output current error, die-die | $I_{OL} = 13\text{ mA}$, $V_O = 0.6\text{ V}$, $R_{ext} = 1680\ \Omega$, $T_J = 25^\circ\text{C}$ | | $\pm 3\%$ | $\pm 6\%$ | |
| | Output current error, channel-to-channel | $I_{OL} = 13\text{ mA}$, $V_O = 0.6\text{ V}$, $R_{ext} = 1680\ \Omega$, $T_J = 25^\circ\text{C}$ | | $\pm 1.5\%$ | $\pm 4\%$ | |
| $I_{O(2)}$ | Output current 2 | $V_O = 0.8\text{ V}$, $R_{ext} = 840\ \Omega$ | | 26 | | mA |
| | Output current error, die-die | $I_{OL} = 26\text{ mA}$, $V_O = 0.8\text{ V}$, $R_{ext} = 840\ \Omega$, $T_J = 25^\circ\text{C}$ | | $\pm 3\%$ | $\pm 6\%$ | |
| | Output current error, channel-to-channel | $I_{OL} = 26\text{ mA}$, $V_O = 0.8\text{ V}$, $R_{ext} = 840\ \Omega$, $T_J = 25^\circ\text{C}$ | | $\pm 1.5\%$ | $\pm 4\%$ | |
| I_{OUT} vs V_{OUT} | Output current vs output voltage regulation | $V_O = 1\text{ V}$ to 3 V , $I_O = 26\text{ mA}$ | | ± 0.1 | | %V |
| | | $V_{DD} = 3.0\text{ V}$ to 5.5 V , $I_O = 13\text{ mA}$ to 45 mA | | ± 1 | | |
| | Pullup resistance | \overline{OE} | | 500 | | k Ω |
| | Pulldown resistance | LE | | 500 | | k Ω |
| T_{sd} | Overtemperature shutdown ⁽¹⁾ | | 150 | 175 | 200 | $^\circ\text{C}$ |
| T_{hys} | Restart temperature hysteresis | | | 15 | | $^\circ\text{C}$ |
| I_{DD} | Supply current | $R_{ext} = \text{Open}$ | | 9 | 11 | mA |
| | | $R_{ext} = 1680\ \Omega$ | | 12 | 14 | |
| | | $R_{ext} = 840\ \Omega$ | | 14 | 16 | |
| C_{IN} | Input capacitance | $V_I = V_{DD}$ or GND, CLK, SDI, SDO, \overline{OE} | | | 10 | pF |

(1) Specified by design

6.7 Power Dissipation and Thermal Impedance

| | | | MIN | MAX | UNIT |
|-------|-------------------|-----------------------------------------------------------------------------------------------------------------|-------------|-----|------|
| P_D | Power dissipation | Mounted on JEDEC 4-layer board (JESD 51-7), No airflow, $T_A = 25^\circ\text{C}$, $T_J = 125^\circ\text{C}$ | DBQ package | 1.6 | W |
| | | | DW package | 2.2 | |
| | | | PW package | 1.1 | |

6.8 Timing Requirements

 $V_{DD} = 3\text{ V to }5.5\text{ V}$ (unless otherwise noted)

| | | MIN | MAX | UNIT |
|--------------|------------------------------------|-----|-----|------|
| $t_{w(L)}$ | LE pulse duration | 15 | | ns |
| $t_{w(CLK)}$ | CLK pulse duration | 15 | | ns |
| $t_{w(OE)}$ | \overline{OE} pulse duration | 300 | | ns |
| $t_{su(D)}$ | Setup time for SDI | 3 | | ns |
| $t_{h(D)}$ | Hold time for SDI | 2 | | ns |
| $t_{su(L)}$ | Setup time for LE | 5 | | ns |
| $t_{h(L)}$ | Hold time for LE | 5 | | ns |
| f_{CLK} | Clock frequency, Cascade operation | | 30 | MHz |

6.9 Switching Characteristics: $V_{DD} = 3\text{ V}$

 $V_{DD} = 3\text{ V}$, $T_J = -40^\circ\text{C to }125^\circ\text{C}$ (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|--------------|--------------------------------------------------------------------------|-----|-----|-----|------|
| t_{PLH1} | Low-to-high propagation delay time, CLK to \overline{OUTn} | 30 | 45 | 60 | ns |
| t_{PLH2} | Low-to-high propagation delay time, LE to \overline{OUTn} | 30 | 45 | 60 | ns |
| t_{PLH3} | Low-to-high propagation delay time, \overline{OE} to \overline{OUTn} | 30 | 45 | 60 | ns |
| t_{PLH4} | Low-to-high propagation delay time, CLK to SDO | | 30 | 40 | ns |
| t_{PHL1} | High-to-low propagation delay time, CLK to \overline{OUTn} | 40 | 65 | 100 | ns |
| t_{PHL2} | High-to-low propagation delay time, LE to \overline{OUTn} | 40 | 65 | 100 | ns |
| t_{PHL3} | High-to-low propagation delay time, \overline{OE} to \overline{OUTn} | 40 | 65 | 100 | ns |
| t_{PHL4} | High-to-low propagation delay time, CLK to SDO | | 30 | 40 | ns |
| $t_{w(CLK)}$ | Pulse duration, CLK | 15 | | | ns |
| $t_{w(L)}$ | Pulse duration, LE | 15 | | | ns |
| $t_{w(OE)}$ | Pulse duration, \overline{OE} | 300 | | | ns |
| $t_{h(D)}$ | Hold time, SDI | 2 | | | ns |
| $t_{su(D)}$ | Setup time, SDI | 3 | | | ns |
| $t_{h(L)}$ | Hold time, LE | 5 | | | ns |
| $t_{su(L)}$ | Setup time, LE | 5 | | | ns |
| t_r | Rise time, CLK ⁽¹⁾ | | | 500 | ns |
| t_f | Fall time, CLK ⁽¹⁾ | | | 500 | ns |
| t_{or} | Rise time, outputs (off) | 35 | 50 | 70 | ns |
| t_{of} | Rise time, outputs (on) | 15 | 50 | 120 | ns |
| f_{CLK} | Clock frequency | | | 30 | MHz |

$V_{IH} = V_{DD}$, $V_{IL} = \text{GND}$,
 $R_{ext} = 840\ \Omega$, $V_L = 4\text{ V}$,
 $R_L = 88\ \Omega$, $C_L = 10\text{ pF}$

(1) If the devices are connected in cascade and t_r or t_f is large, it may be critical to achieve the timing required for data transfer between two cascaded devices.

6.10 Switching Characteristics: $V_{DD} = 5.5\text{ V}$

 $V_{DD} = 5.5\text{ V}$, $T_J = -40^\circ\text{C}$ to 125°C (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---------------------|----------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|-----|-----|------|
| t_{PLH1} | Low-to-high propagation delay time, CLK to $\overline{\text{OUTn}}$ | $V_{IH} = V_{DD}$, $V_{IL} = \text{GND}$, $R_{\text{ext}} = 840\ \Omega$, $V_L = 4\text{ V}$, $R_L = 88\ \Omega$, $C_L = 10\text{ pF}$ | 20 | 35 | 55 | ns |
| t_{PLH2} | Low-to-high propagation delay time, LE to $\overline{\text{OUTn}}$ | | 20 | 35 | 55 | ns |
| t_{PLH3} | Low-to-high propagation delay time, $\overline{\text{OE}}$ to $\overline{\text{OUTn}}$ | | 20 | 35 | 55 | ns |
| t_{PLH4} | Low-to-high propagation delay time, CLK to SDO | | | 20 | 30 | ns |
| t_{PHL1} | High-to-low propagation delay time, CLK to $\overline{\text{OUTn}}$ | | 15 | 28 | 42 | ns |
| t_{PHL2} | High-to-low propagation delay time, LE to $\overline{\text{OUTn}}$ | | 15 | 28 | 42 | ns |
| t_{PHL3} | High-to-low propagation delay time, $\overline{\text{OE}}$ to $\overline{\text{OUTn}}$ | | 15 | 28 | 42 | ns |
| t_{PHL4} | High-to-low propagation delay time, CLK to SDO | | | 20 | 30 | ns |
| $t_{w(\text{CLK})}$ | Pulse duration, CLK | | 10 | | | ns |
| $t_{w(\text{L})}$ | Pulse duration LE | | 10 | | | ns |
| $t_{w(\text{OE})}$ | Pulse duration, $\overline{\text{OE}}$ | | 200 | | | ns |
| $t_{h(\text{D})}$ | Hold time, SDI | | 2 | | | ns |
| $t_{su(\text{D})}$ | Setup time, SDI | | 3 | | | ns |
| $t_{h(\text{L})}$ | Hold time, LE | | 5 | | | ns |
| $t_{su(\text{L})}$ | Setup time, LE | | 5 | | | ns |
| t_r | Rise time, CLK ⁽¹⁾ | | | | 500 | ns |
| t_f | Fall time, CLK ⁽¹⁾ | | | | 500 | ns |
| t_{or} | Rise time, outputs (off) | | 25 | 45 | 65 | ns |
| t_{of} | Rise time, outputs (on) | | 7 | 12 | 20 | ns |
| f_{CLK} | Clock frequency | | Cascade operation | | | 30 |

(1) If the devices are connected in cascade and t_r or t_f is large, it may be critical to achieve the timing required for data transfer between two cascaded devices.

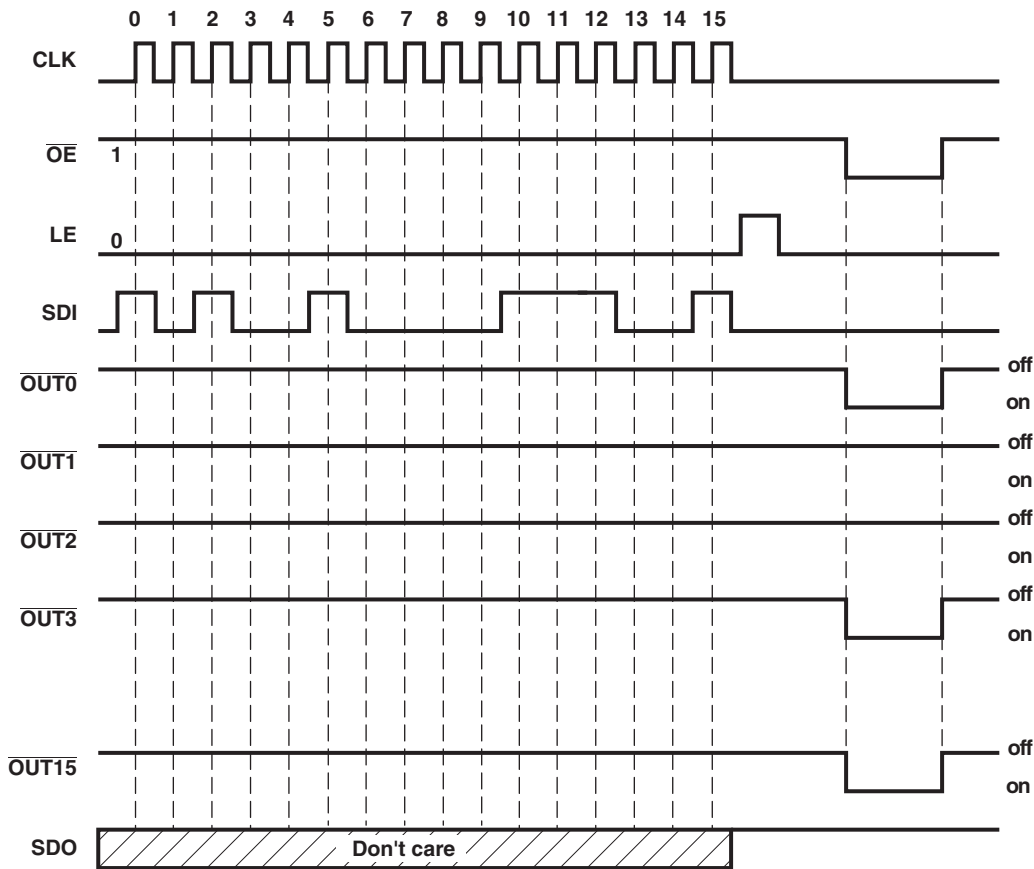


Figure 1. Timing Diagram

6.11 Typical Characteristics

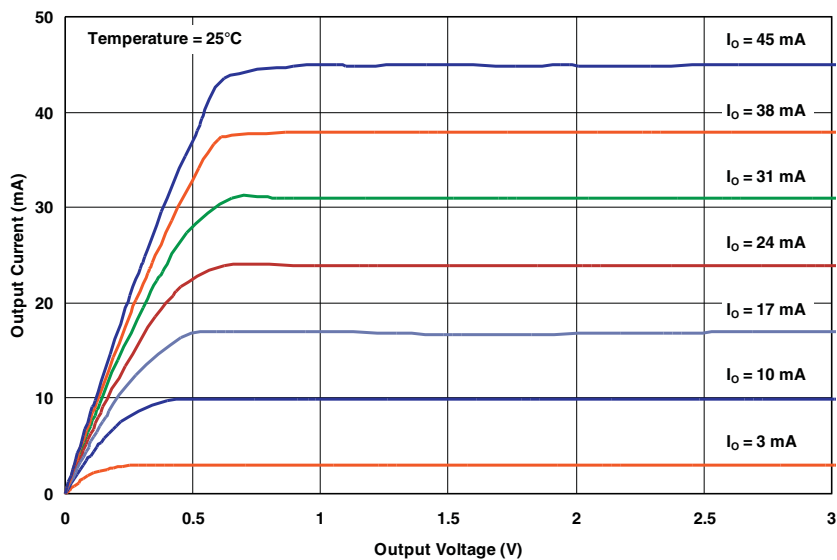


Figure 2. Output Current vs Output Voltage

7 Parameter Measurement Information

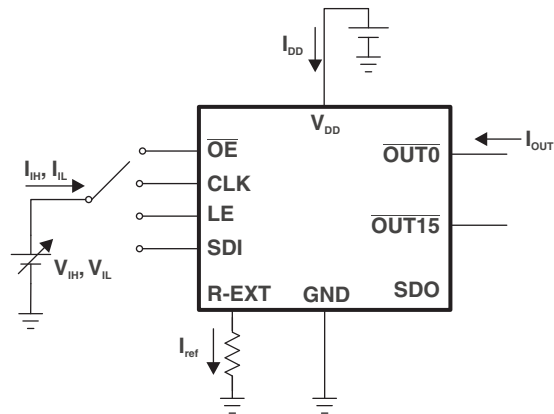


Figure 3. Test Circuit for Electrical Characteristics

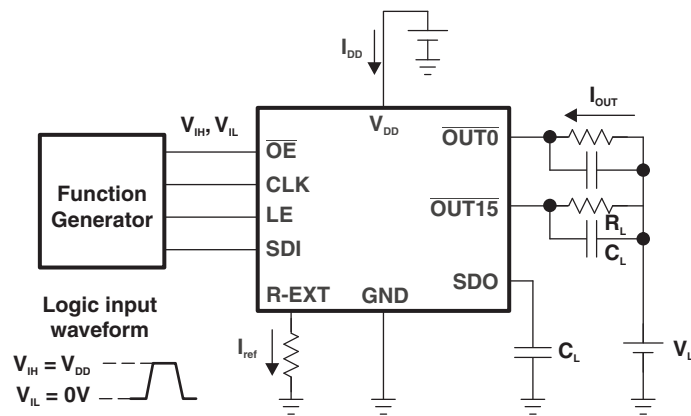


Figure 4. Test Circuit for Switching Characteristics

Parameter Measurement Information (continued)

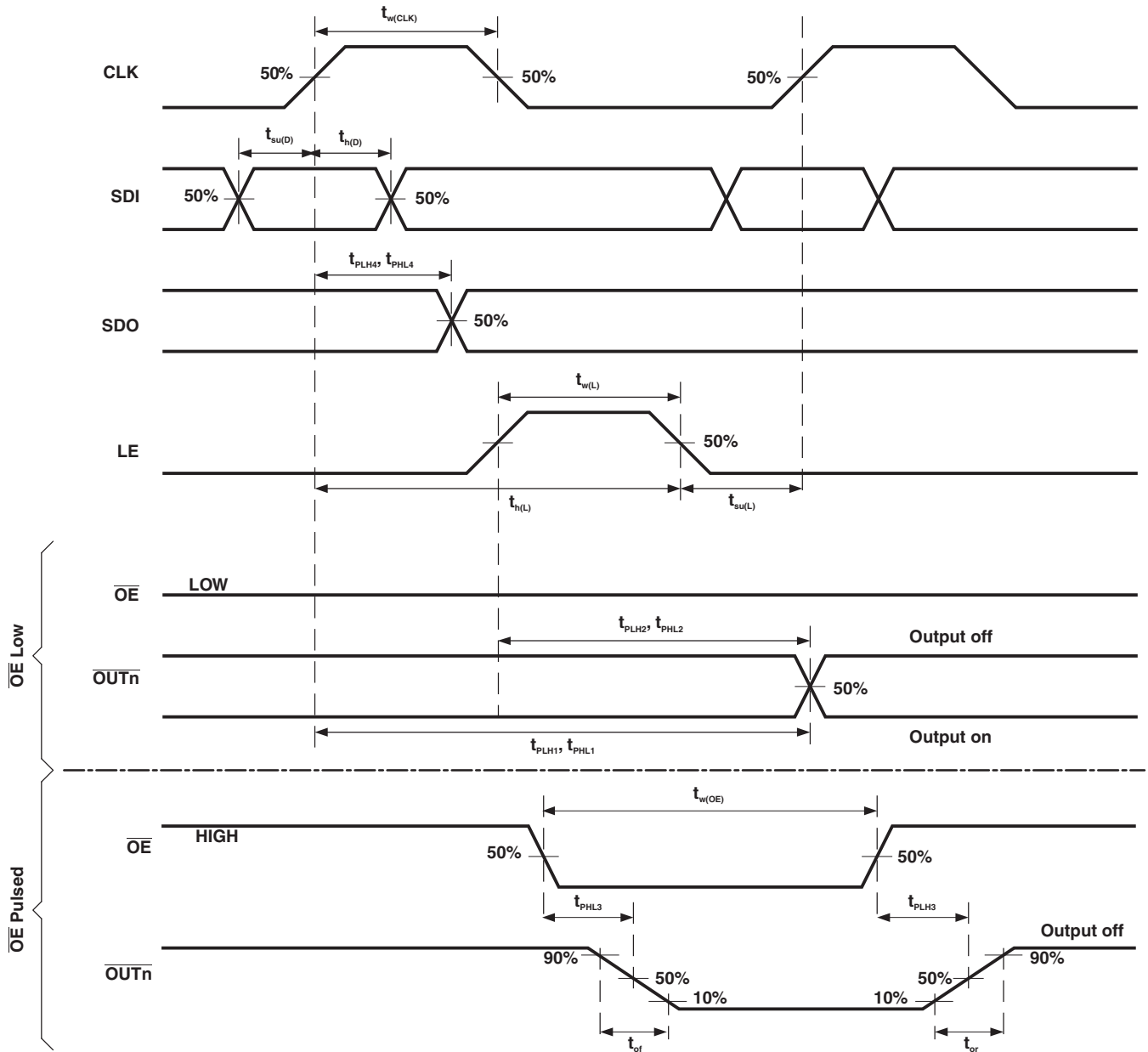


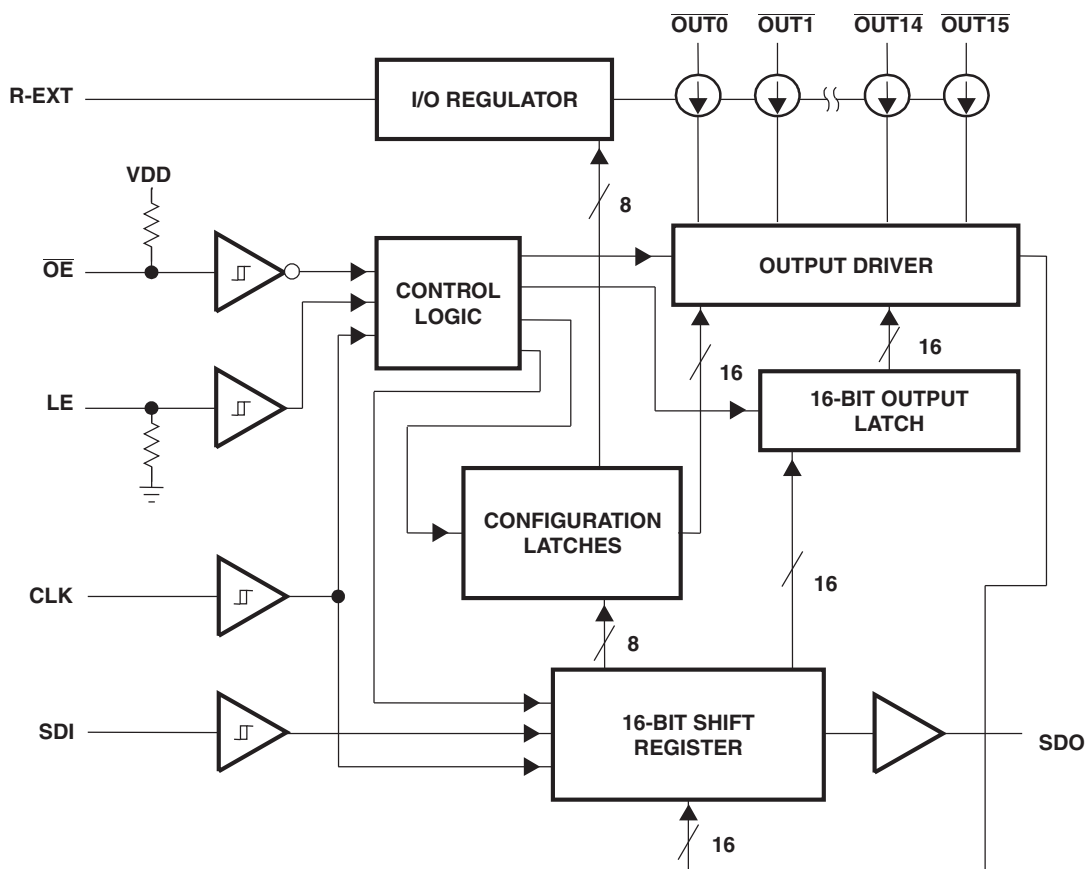
Figure 5. Normal Mode Timing Waveforms

8 Detailed Description

8.1 Overview

The TLC5925 is a 16-channel LED driver designed for LED displays and LED lighting applications. The TLC5925 contains a 16-bit shift register and data latches, which convert serial input data into parallel output format. At the TLC5925 output stage, 16 regulated-current ports provide uniform and constant current for driving LEDs within a wide range of V_F variations. Used in system design for LED display applications (for example, LED panels), the TLC5925 provides great flexibility and device performance. Users can adjust the output current from 3 mA to 45 mA through an external resistor, REXT, which gives flexibility in controlling the light intensity of LEDs. TLC59025 is designed for up to 17 V at the output port. The high clock frequency, 30 MHz, also satisfies the system requirements of high-volume data transmission.

8.2 Functional Block Diagram



8.3 Feature Description

8.3.1 Constant Current

In LED display applications, TLC5925 provides nearly no current variations from channel to channel and from IC to IC. While $I_{OUT} \leq 45$ mA, the maximum current skew between channels is less than $\pm 5\%$ and between ICs is less than $\pm 6\%$.

8.4 Device Functional Modes

The table below lists the functional modes for the TLC5925.

Table 1. Truth Table in Normal Operation

| CLK | LE | \overline{OE} | SDI | $\overline{OUT0}... \overline{OUT15}... \overline{OUT15}$ | SDO |
|-----|----|-----------------|--------|-----------------------------------------------------------|---------|
| ↑ | H | L | Dn | Dn...Dn – 7...Dn – 15 | Dn – 15 |
| ↑ | L | L | Dn + 1 | No change | Dn – 14 |
| ↑ | H | L | Dn + 2 | Dn + 2...Dn – 5...Dn – 13 | Dn – 13 |
| ↓ | X | L | Dn + 3 | Dn + 2...Dn – 5...Dn – 13 | Dn – 13 |
| ↓ | X | H | Dn + 3 | off | Dn – 13 |

9 Application and Implementation

NOTE

Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

9.1 Application Information

9.1.1 Turning on the LEDs

To turn on an LED connected to one of the outputs of the device, the output must be pulled low. To do this, the SDI signal must let the device know which outputs should be activated. Using the rising edge of CLK, the logic level of the SDI signal latches the desired state of each output into the shift register. Once this is complete, the LE signal must be toggled from low to high then back to low. Once /OE is pulled down, the corresponding outputs will be pulled low and the LEDs will be turned on. The below diagram shows outputs 0, 3, 4, 5, 10, 13, and 15 being activated.

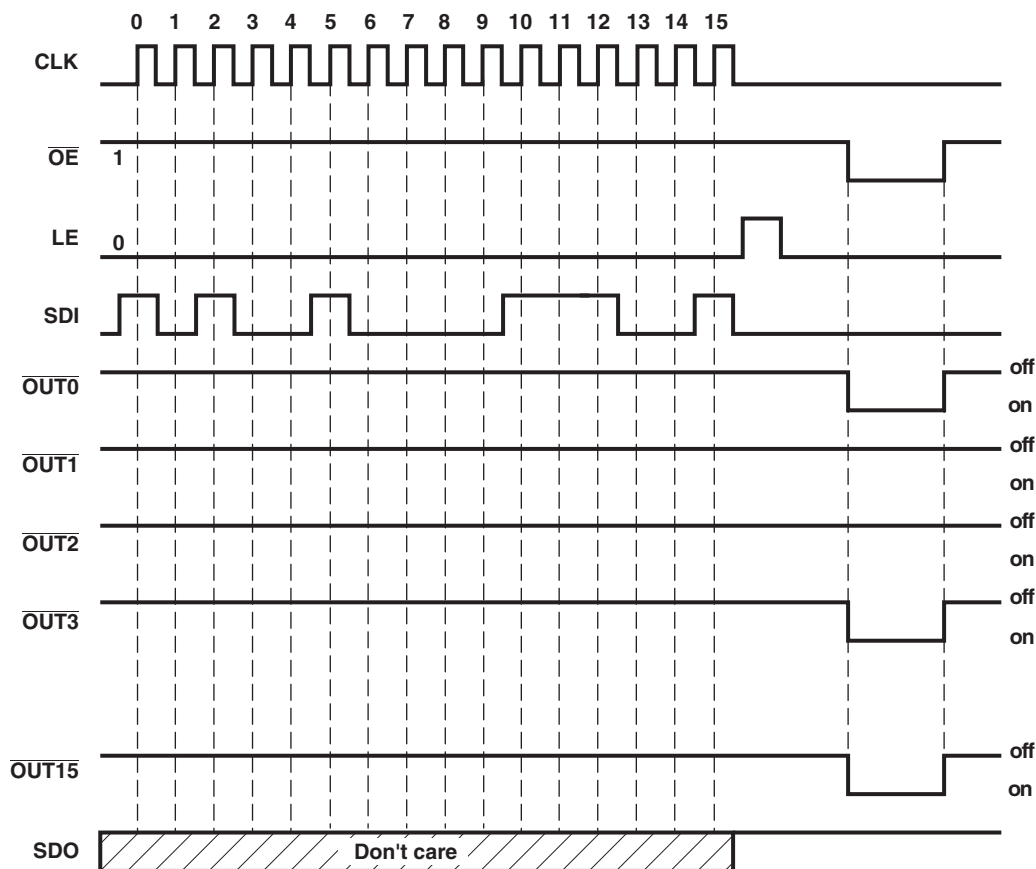


Figure 6. Timing Diagram

Application Information (continued)

9.1.2 Propagation Delay Times

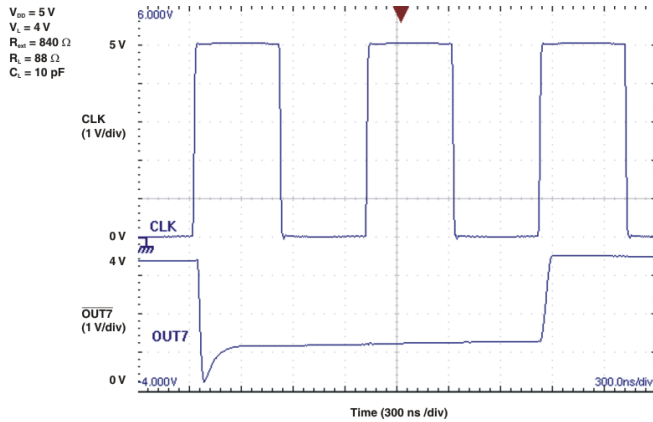


Figure 7. CLK to $\overline{\text{OUT7}}$

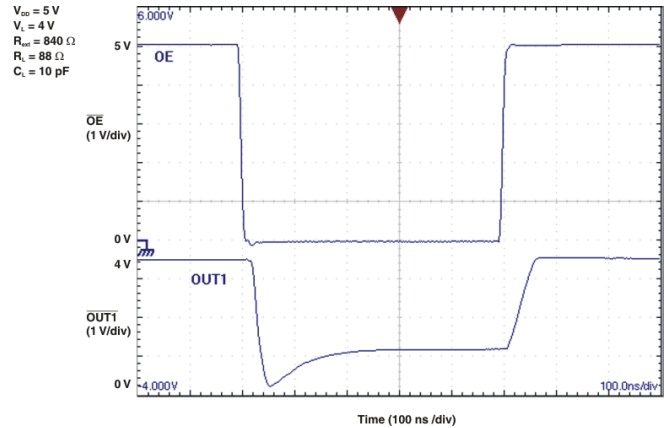


Figure 8. $\overline{\text{OE}}$ to $\overline{\text{OUT1}}$

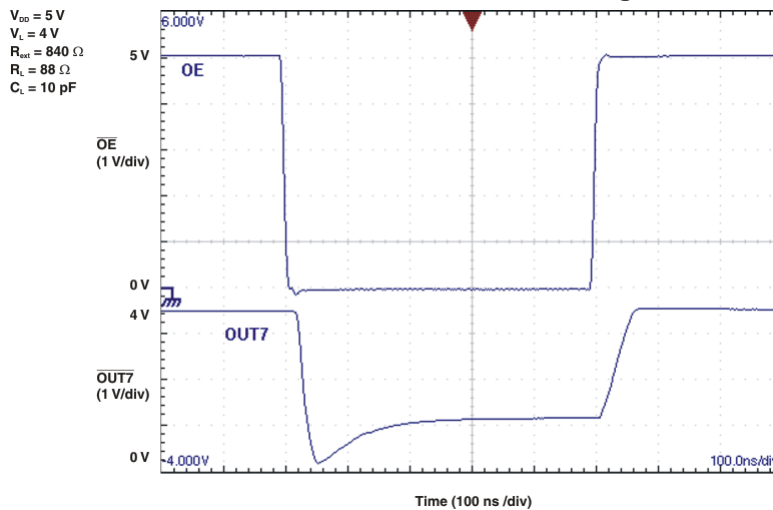
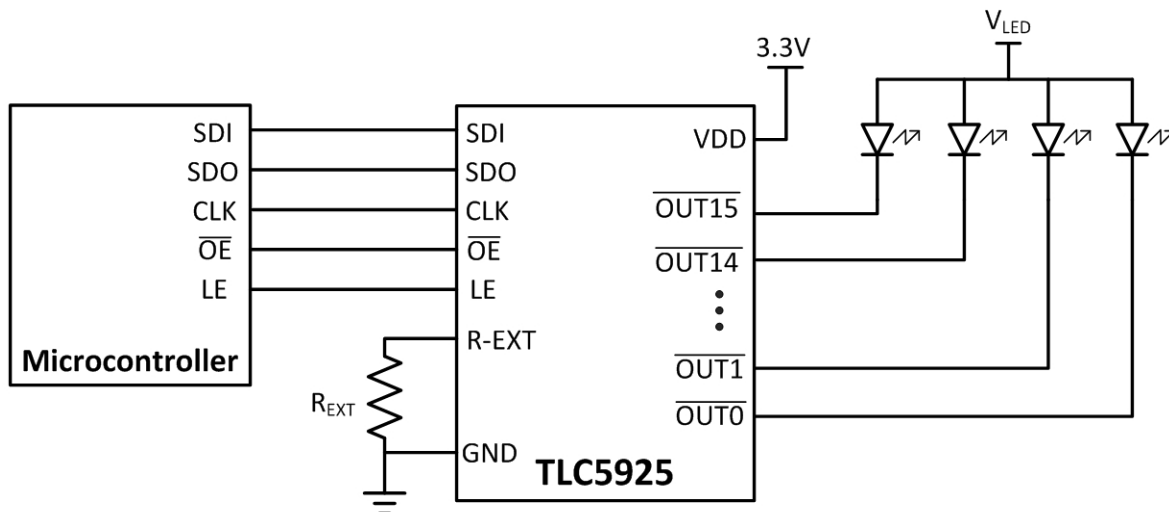


Figure 9. $\overline{\text{OE}}$ to $\overline{\text{OUT7}}$

9.2 Typical Application



Typical Application (continued)

9.2.1 Design Requirements

For the following design procedure, the input voltage (VDD) is between 3 V and 5.5 V.

9.2.2 Detailed Design Procedure

9.2.2.1 Adjusting Output Current

TLC5925 sets I_{OUT} based on the external resistor R_{ext} . Users can follow the below formulas to calculate the target output current $I_{OUT,target}$ in the saturation region:

$I_{OUT,target} = (1.21 \text{ V} / R_{ext}) \times 18$, where R_{ext} is the external resistance connected between R-EXT and GND.

Therefore, the default current is approximately 26 mA at 840 Ω and 13 mA at 1680 Ω .

9.2.3 Application Curve

The default relationship after power on between $I_{OUT,target}$ and R_{ext} is shown in [Figure 10](#).

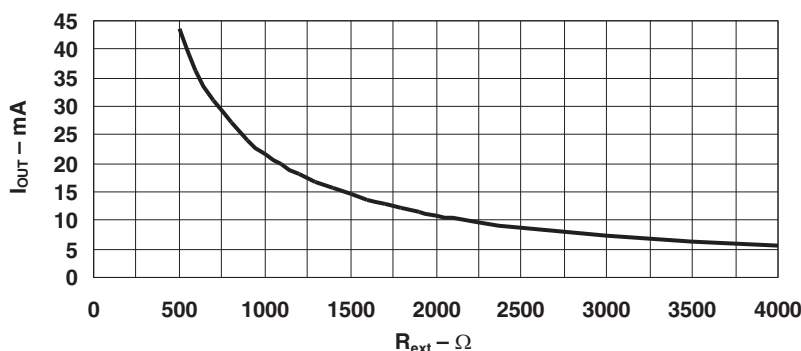


Figure 10. Default Relationship Curve Between $I_{OUT,target}$ and R_{ext} After Power Up

10 Power Supply Recommendations

The TLC5925 is designed to operate with a VDD range between 3 V and 5.5 V.

11 Layout

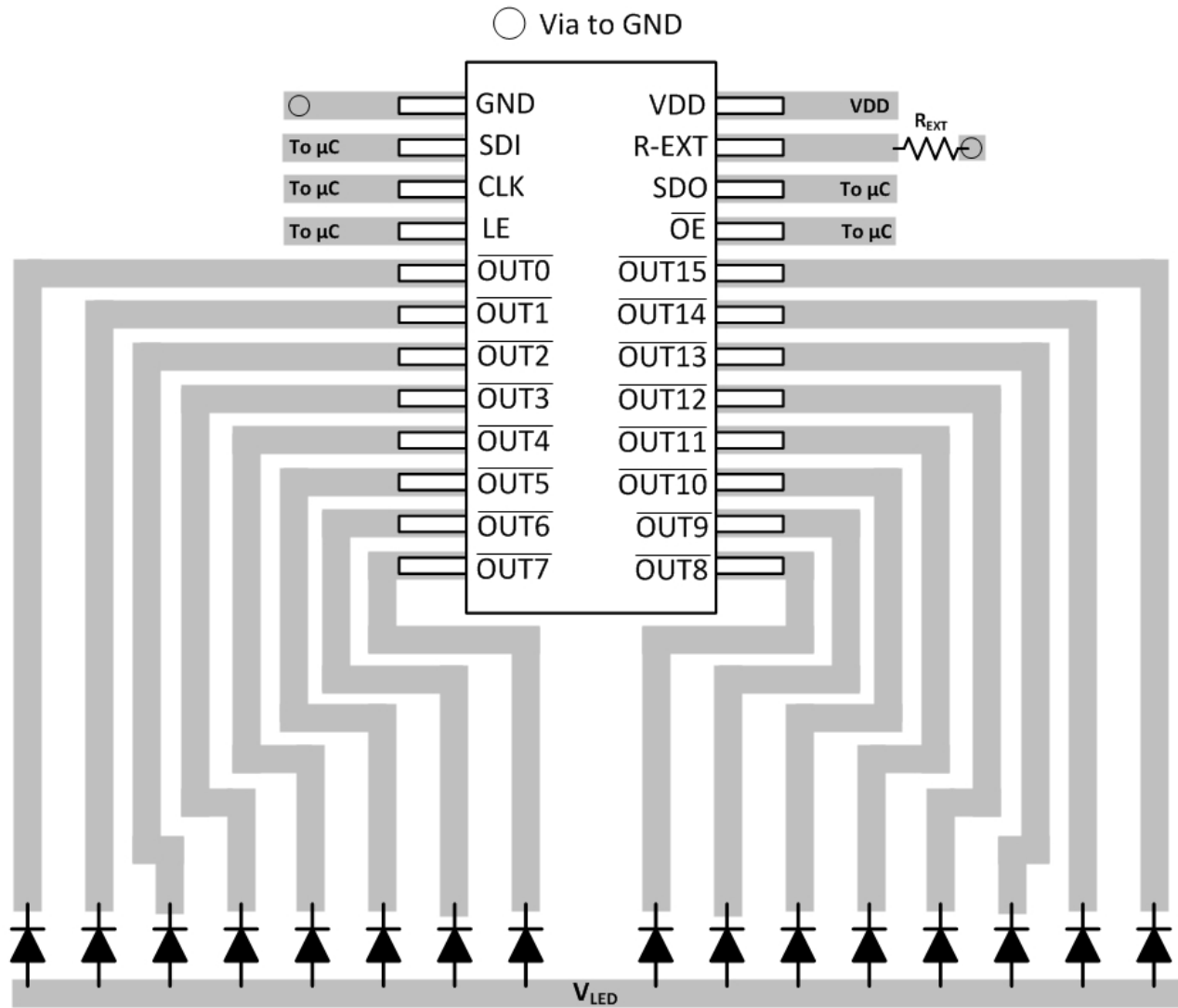
11.1 Layout Guidelines

The SDI, CLK, SDO, LE, and OE signals should all be kept from potential noise sources.

All traces carrying power through the LEDs should be wide enough to handle necessary currents.

All LED current passes through the device and into the ground node. There must be a strong connection between the device ground and the circuit board ground.

11.2 Layout Example



12 Device and Documentation Support

12.1 Community Resources

The following links connect to TI community resources. Linked contents are provided "AS IS" by the respective contributors. They do not constitute TI specifications and do not necessarily reflect TI's views; see TI's [Terms of Use](#).

TI E2E™ Online Community *TI's Engineer-to-Engineer (E2E) Community*. Created to foster collaboration among engineers. At e2e.ti.com, you can ask questions, share knowledge, explore ideas and help solve problems with fellow engineers.

Design Support *TI's Design Support* Quickly find helpful E2E forums along with design support tools and contact information for technical support.

12.2 Trademarks

E2E is a trademark of Texas Instruments.
All other trademarks are the property of their respective owners.

12.3 Electrostatic Discharge Caution



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

12.4 Glossary

[SLYZ022](#) — *TI Glossary*.

This glossary lists and explains terms, acronyms, and definitions.

13 Mechanical, Packaging, and Orderable Information

The following pages include mechanical, packaging, and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the left-hand navigation.

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) |
|------------------------------|---------------|----------------------|-----------------|-----------------------|-------------|--------------------------------------|-----------------------------------|--------------|---------------------|
| TLC5925IDBQR | Active | Production | SSOP (DBQ) 24 | 2500 LARGE T&R | Yes | NIPDAU | Level-2-260C-1 YEAR | -40 to 125 | TLC5925I |
| TLC5925IDBQR.B | Active | Production | SSOP (DBQ) 24 | 2500 LARGE T&R | Yes | NIPDAU | Level-2-260C-1 YEAR | -40 to 125 | TLC5925I |
| TLC5925IDBQRG4 | Active | Production | SSOP (DBQ) 24 | 2500 LARGE T&R | Yes | NIPDAU | Level-2-260C-1 YEAR | -40 to 125 | TLC5925I |
| TLC5925IDBQRG4.B | Active | Production | SSOP (DBQ) 24 | 2500 LARGE T&R | Yes | NIPDAU | Level-2-260C-1 YEAR | -40 to 125 | TLC5925I |
| TLC5925IDWR | Active | Production | SOIC (DW) 24 | 2000 LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | TLC5925I |
| TLC5925IDWR.B | Active | Production | SOIC (DW) 24 | 2000 LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | TLC5925I |
| TLC5925IDWRG4 | Active | Production | SOIC (DW) 24 | 2000 LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | TLC5925I |
| TLC5925IPWR | Active | Production | TSSOP (PW) 24 | 2000 LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | Y5925 |
| TLC5925IPWR.B | Active | Production | TSSOP (PW) 24 | 2000 LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | Y5925 |
| TLC5925IPWRG4 | Active | Production | TSSOP (PW) 24 | 2000 LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | Y5925 |

(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 |
|----------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| TLC5925IDBQR | SSOP | DBQ | 24 | 2500 | 330.0 | 16.4 | 6.5 | 9.0 | 2.1 | 8.0 | 16.0 | Q1 |
| TLC5925IDBQRG4 | SSOP | DBQ | 24 | 2500 | 330.0 | 16.4 | 6.5 | 9.0 | 2.1 | 8.0 | 16.0 | Q1 |
| TLC5925IDWR | SOIC | DW | 24 | 2000 | 330.0 | 24.4 | 10.75 | 15.7 | 2.7 | 12.0 | 24.0 | Q1 |
| TLC5925IPWR | TSSOP | PW | 24 | 2000 | 330.0 | 16.4 | 6.95 | 8.3 | 1.6 | 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) |
|----------------|--------------|-----------------|------|------|-------------|------------|-------------|
| TLC5925IDBQR | SSOP | DBQ | 24 | 2500 | 353.0 | 353.0 | 32.0 |
| TLC5925IDBQRG4 | SSOP | DBQ | 24 | 2500 | 353.0 | 353.0 | 32.0 |
| TLC5925IDWR | SOIC | DW | 24 | 2000 | 350.0 | 350.0 | 43.0 |
| TLC5925IPWR | TSSOP | PW | 24 | 2000 | 353.0 | 353.0 | 32.0 |

DW (R-PDSO-G24)

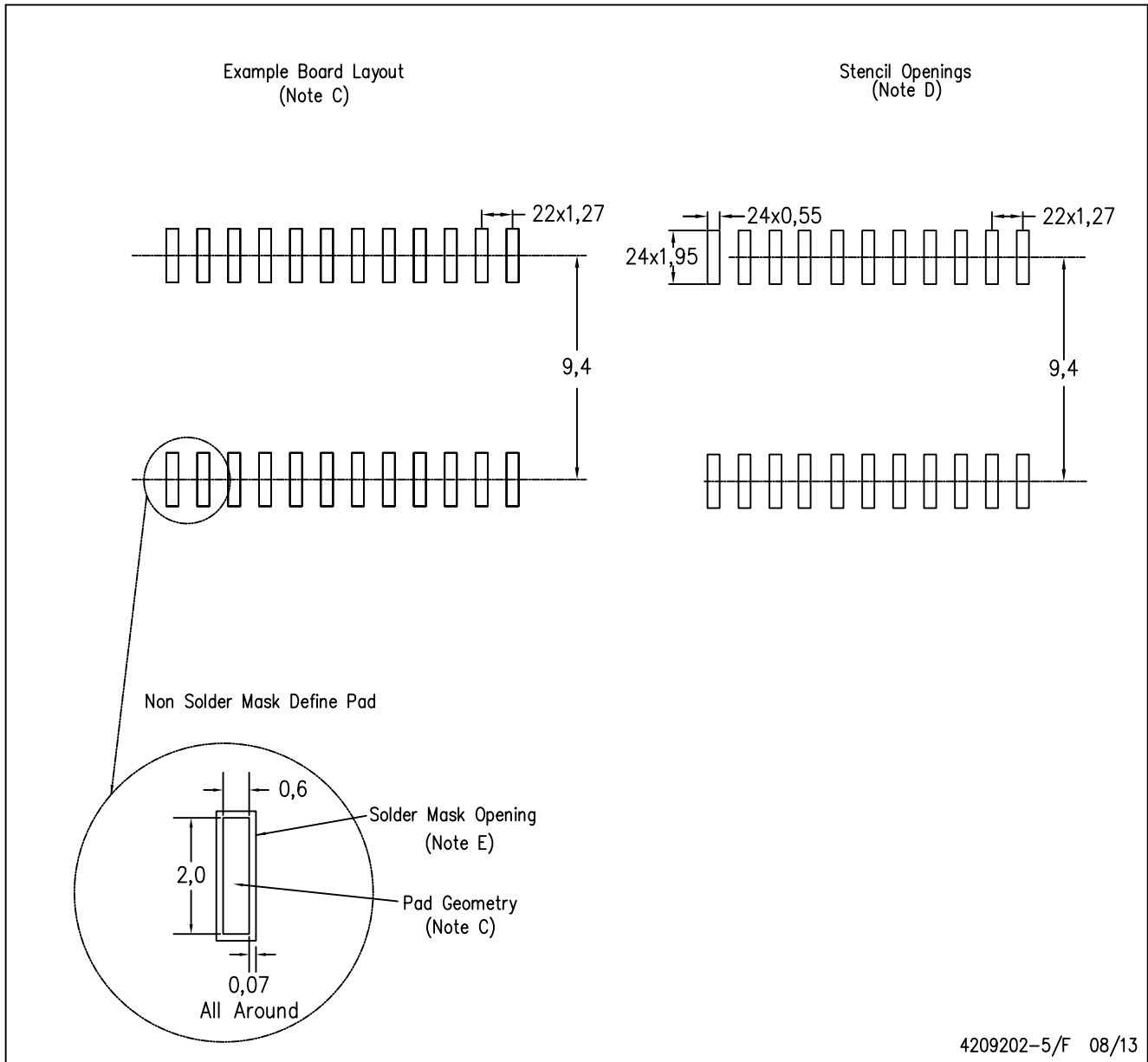
PLASTIC SMALL OUTLINE



- NOTES:
- All linear dimensions are in inches (millimeters). Dimensioning and tolerancing per ASME Y14.5M-1994.
 - This drawing is subject to change without notice.
 - Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0,15).
 - Falls within JEDEC MS-013 variation AD.

DW (R-PDSO-G24)

PLASTIC SMALL OUTLINE

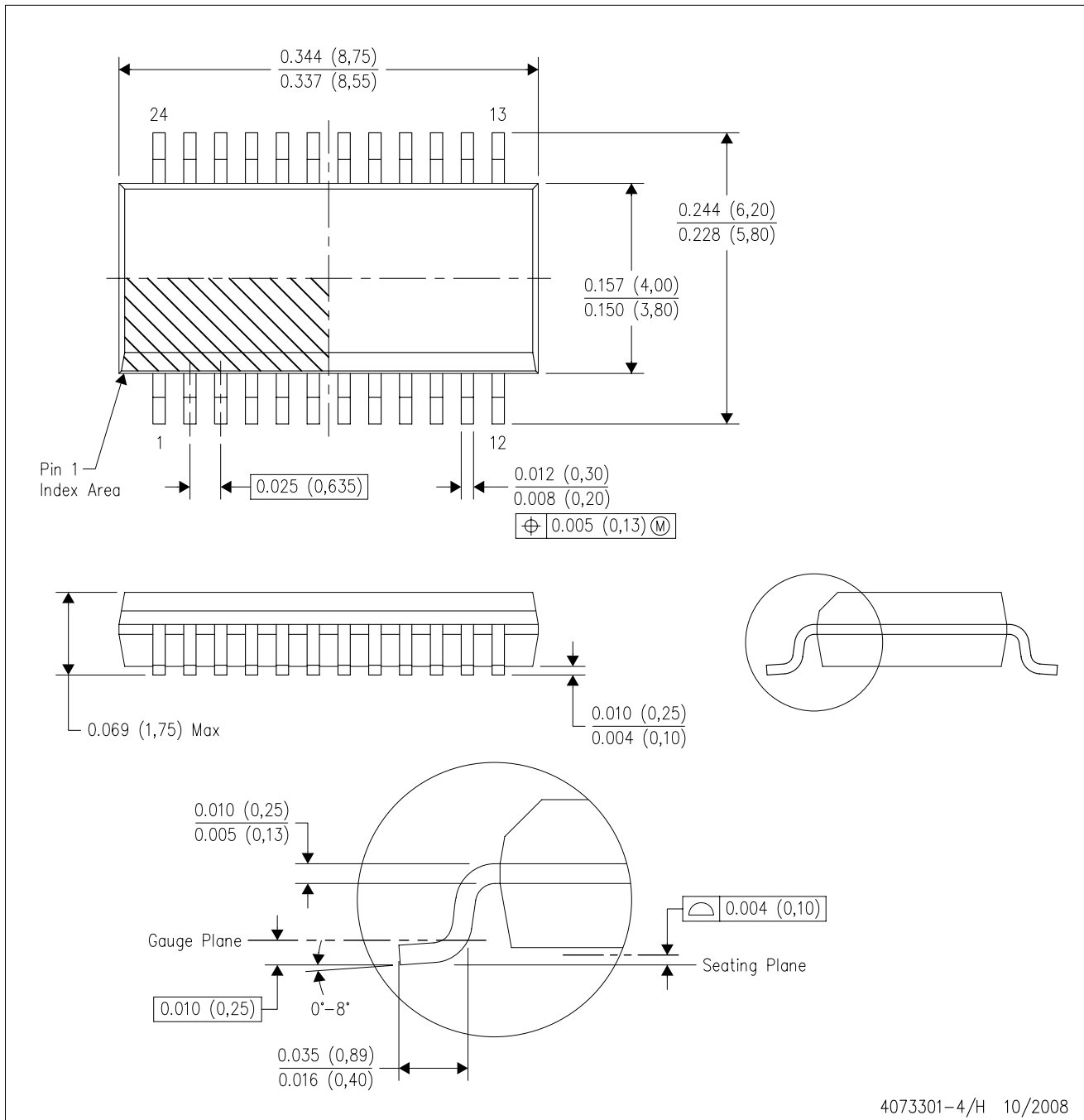


4209202-5/F 08/13

- NOTES:
- A. All linear dimensions are in millimeters.
 - B. This drawing is subject to change without notice.
 - C. Refer to IPC7351 for alternate board design.
 - D. 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
 - E. Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.

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.

PW0024A



PACKAGE OUTLINE
TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



4220208/A 02/2017

NOTES:

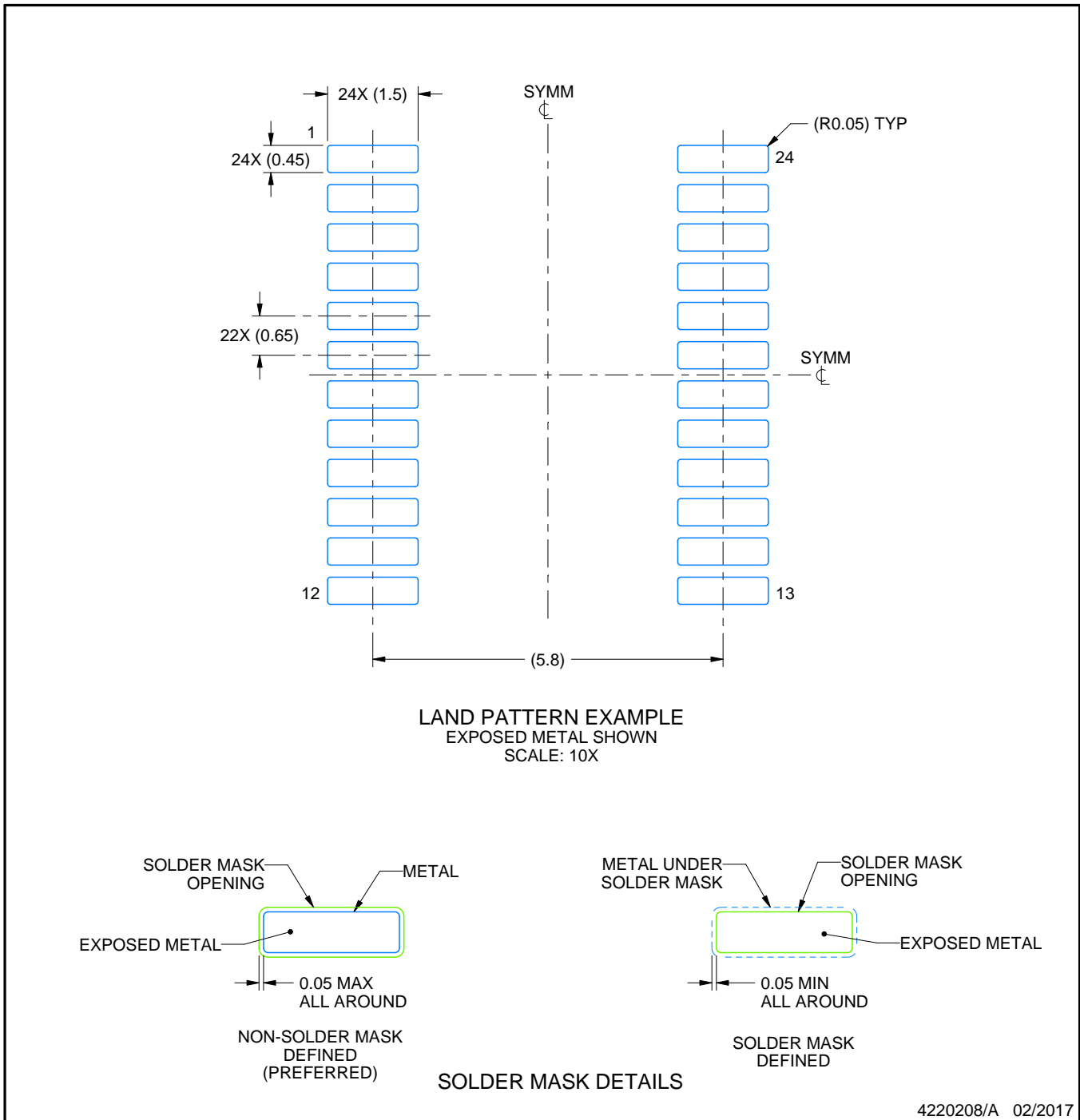
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.
4. This dimension does not include interlead flash. Interlead flash shall not exceed 0.25 mm per side.
5. Reference JEDEC registration MO-153.

EXAMPLE BOARD LAYOUT

PW0024A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



4220208/A 02/2017

NOTES: (continued)

- 6. Publication IPC-7351 may have alternate designs.
- 7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

EXAMPLE STENCIL DESIGN

PW0024A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



NOTES: (continued)

8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
9. Board assembly site may have different recommendations for stencil design.

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Last updated 10/2025