

SN74HCS594 8 ビット・シフト・レジスタ、シュミット・トリガ入力/出力レジスタ付き

1 特長

- 広い動作電圧範囲: 2V~6V
- シュミット・トリガ入力により低速の信号またはノイズの多い信号に対応
- 低消費電力
 - I_{CC} : 100nA (標準値)
 - 入力リーグ電流: $\pm 100nA$ (標準値)
- 6V で $\pm 7.8mA$ の出力駆動能力
- 広い周囲温度範囲: -40°C~+125°C, T_A

2 アプリケーション

- 出力拡張
- LED マトリクス制御
- 7 セグメント・ディスプレイ制御
- 8 ビット・データ・ストレージ

3 概要

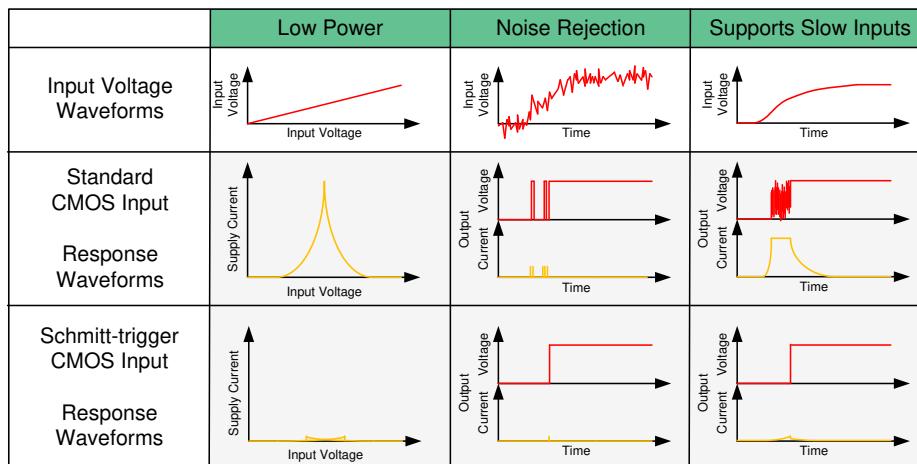
SN74HCS594 デバイスには 8 ビットのシリアル・イン、パラレル・アウトのシフト・レジスタが搭載されており、8 ビットの D タイプ・ストレージ・レジスタへデータを供給します。すべての入力はシュミット・トリガを備えているため、低速エッジまたはノイズの多い入力信号による誤ったデータ出力を解消できます。ストレージ・レジスタはパラレル出力を備えています。シフト・レジスタとストレージ・レジスタの両方に對して、独立したクロックとダイレクト・オーバーライディング・クリア (SRCLR, RCLR) 入力が提供されます。カスケード接続用にシリアル出力 (Q_H') が用意されています。

シフト・レジスタ (SRCLK) とストレージ・レジスタ (RCLK) クロックの両方がポジティブ・エッジ・トリガです。両方のクロックが一緒に接続されている場合、シフト・レジスタはストレージレジスタより 1 カウントパルス前になります。

デバイス情報

| 部品番号 | パッケージ (1) | 本体サイズ (公称) |
|---------------|-----------------|-----------------|
| SN74HCS594PW | TSSOP (16) | 5.00mm × 4.40mm |
| SN74HCS594D | SOIC (16) | 9.90mm × 3.90mm |
| SN74HCS594BQB | WQFN (16) | 3.60mm × 2.60mm |
| SN74HCS594DYY | SOT-23-THN (16) | 4.20mm × 2.00mm |

(1) 利用可能なパッケージについては、このデータシートの末尾にある注文情報を参照してください。



シュミット・トリガ入力の利点



英語版の TI 製品についての情報を翻訳したこの資料は、製品の概要を確認する目的で便宜的に提供しているものです。該当する正式な英語版の最新情報は、www.ti.com で閲覧でき、その内容が常に優先されます。TI では翻訳の正確性および妥当性につきましては一切保証いたしません。実際の設計などの前には、必ず最新版の英語版をご参考ください。

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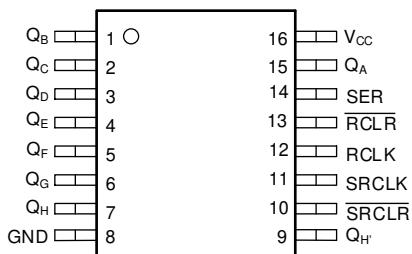
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4 Revision History

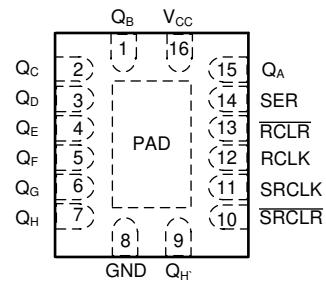
資料番号末尾の英字は改訂を表しています。その改訂履歴は英語版に準じています。

| Changes from Revision * (October 2020) to Revision A (May 2021) | Page |
|--|------|
| ・ 「製品情報」表に DYY パッケージを追加 | 1 |
| ・ Added DYY Package pinout diagram and information to <i>Pin Configuration and Functions</i> | 3 |
| ・ Added DYY and BQB Package to <i>Thermal Information</i> table | 4 |

5 Pin Configuration and Functions



D, PW, or DYY Package
16-Pin SOIC, TSSOP, or SOT-23
Top View



BQB Package
16-Pin WQFN
Transparent Top View

Pin Functions

| PIN | | TYPE | DESCRIPTION |
|----------------------------|-----|--------|---|
| NAME | NO. | | |
| Q _B | 1 | Output | Q _B output |
| Q _C | 2 | Output | Q _C output |
| Q _D | 3 | Output | Q _D output |
| Q _E | 4 | Output | Q _E output |
| Q _F | 5 | Output | Q _F output |
| Q _G | 6 | Output | Q _G output |
| Q _H | 7 | Output | Q _H output |
| GND | 8 | — | Ground |
| Q _{H'} | 9 | Output | Serial output, can be used for cascading |
| SRCLR | 10 | Input | Shift register clear, active low |
| SRCLK | 11 | Input | Shift register clock, rising edge triggered |
| RCLK | 12 | Input | Output register clock, rising edge triggered |
| RCLR | 13 | Input | Storage register clear, active low |
| SER | 14 | Input | Serial input |
| Q _A | 15 | Output | Q _A output |
| V _{cc} | 16 | — | Positive supply |
| Thermal Pad ⁽¹⁾ | | — | The thermal pad can be connect to GND or left floating. Do not connect to any other signal or supply. |

1. BQB package only.

6 Specifications

6.1 Absolute Maximum Ratings

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

| | | | MIN | MAX | UNIT |
|------------------|---|---|------|-----|------|
| V _{CC} | Supply voltage | | -0.5 | 7 | V |
| I _{IK} | Input clamp current ⁽²⁾ | V _I < -0.5 V or V _I > V _{CC} + 0.5 V | | ±20 | mA |
| I _{OK} | Output clamp current ⁽²⁾ | V _I < -0.5 V or V _I > V _{CC} + 0.5 V | | ±20 | mA |
| I _O | Continuous output current | V _O = 0 to V _{CC} | | ±35 | mA |
| | Continuous current through V _{CC} or GND | | | ±70 | mA |
| T _J | Junction temperature ⁽³⁾ | | | 150 | °C |
| T _{stg} | Storage temperature | | -65 | 150 | °C |

(1) Stresses beyond those listed under *Absolute Maximum Rating* 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 Condition*. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

(2) The input and output voltage ratings may be exceeded if the input and output current ratings are observed.

(3) Guaranteed by design.

6.2 ESD Ratings

| | | | VALUE | UNIT |
|--------------------|-------------------------|--|-------|------|
| V _(ESD) | Electrostatic discharge | Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001 ⁽¹⁾ | ±4000 | V |
| | | Charged-device model (CDM), per JEDEC specification JESD22-C101 ⁽²⁾ | ±1500 | |

(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 | NOM | MAX | UNIT |
|-----------------|---------------------|--|-----|-----------------|-----------------|------|
| V _{CC} | Supply voltage | | 2 | 5 | 6 | V |
| V _I | Input voltage | | 0 | V _{CC} | V _{CC} | V |
| V _O | Output voltage | | 0 | V _{CC} | V _{CC} | V |
| T _A | Ambient temperature | | -40 | | 125 | °C |

6.4 Thermal Information

| THERMAL METRIC ⁽¹⁾ | | SN74HCS594 | | | | UNIT |
|-------------------------------|--|------------|----------|------------|-----------|------|
| | | PW (TSSOP) | D (SOIC) | BQB (WQFN) | DYY (SOT) | |
| | | 16 PINS | 16 PINS | 16 PINS | 16 PINS | |
| R _{θJA} | Junction-to-ambient thermal resistance | 141.2 | 122.2 | 108.4 | 186.2 | °C/W |
| R _{θJC(top)} | Junction-to-case (top) thermal resistance | 78.8 | 80.9 | 77.3 | 109.1 | °C/W |
| R _{θJB} | Junction-to-board thermal resistance | 85.8 | 80.6 | 74.4 | 111.0 | °C/W |
| Ψ _{JT} | Junction-to-top characterization parameter | 27.7 | 40.4 | 12.6 | 18.0 | °C/W |
| Ψ _{JB} | Junction-to-board characterization parameter | 85.5 | 80.3 | 74.5 | 110.9 | °C/W |

| THERMAL METRIC ⁽¹⁾ | | SN74HCS594 | | | | UNIT |
|-------------------------------|--|------------|----------|------------|-----------|------|
| | | PW (TSSOP) | D (SOIC) | BQB (WQFN) | DYY (SOT) | |
| | | 16 PINS | 16 PINS | 16 PINS | 16 PINS | |
| $R_{\theta JC(bol)}$ | Junction-to-case (bottom) thermal resistance | N/A | N/A | 54.3 | N/A | °C/W |

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

6.5 Electrical Characteristics

over operating free-air temperature range; typical values measured at $T_A = 25^\circ\text{C}$ (unless otherwise noted).

| PARAMETER | | TEST CONDITIONS | | V _{CC} | MIN | TYP | MAX | UNIT |
|--------------|---|--------------------------------|----------------------------|-----------------|----------------|------------------|------------|---------------|
| V_{T+} | Positive switching threshold | | | 2 V | 0.7 | | 1.5 | V |
| | | | | 4.5 V | 1.7 | | 3.15 | |
| | | | | 6 V | 2.1 | | 4.2 | |
| V_{T-} | Negative switching threshold | | | 2 V | 0.3 | | 1.0 | V |
| | | | | 4.5 V | 0.9 | | 2.2 | |
| | | | | 6 V | 1.2 | | 3.0 | |
| ΔV_T | Hysteresis ($V_{T+} - V_{T-}$) ⁽¹⁾ | | | 2 V | 0.2 | | 1.0 | V |
| | | | | 4.5 V | 0.4 | | 1.4 | |
| | | | | 6 V | 0.6 | | 1.6 | |
| V_{OH} | High-level output voltage | $V_I = V_{IH}$ or V_{IL} | $I_{OH} = -20 \mu\text{A}$ | 2 V to 6 V | $V_{CC} - 0.1$ | $V_{CC} - 0.002$ | | V |
| | | | $I_{OH} = -6 \text{ mA}$ | 4.5 V | 4.0 | 4.3 | | |
| | | | $I_{OH} = -7.8 \text{ mA}$ | 6 V | 5.4 | 5.75 | | |
| V_{OL} | Low-level output voltage | $V_I = V_{IH}$ or V_{IL} | $I_{OL} = 20 \mu\text{A}$ | 2 V to 6 V | | 0.002 | 0.1 | V |
| | | | $I_{OL} = 6 \text{ mA}$ | 4.5 V | | 0.18 | 0.30 | |
| | | | $I_{OL} = 7.8 \text{ mA}$ | 6 V | | 0.22 | 0.33 | |
| I_I | Input leakage current | $V_I = V_{CC}$ or 0 | | 6 V | | ± 100 | ± 1000 | nA |
| I_{CC} | Supply current | $V_I = V_{CC}$ or 0, $I_O = 0$ | | 6 V | | 0.1 | 2 | μA |
| C_I | Input capacitance | | | 2 V to 6 V | | | 5 | pF |

(1) Guaranteed by design.

6.6 Timing Characteristics

$C_L = 50 \text{ pF}$; over operating free-air temperature range (unless otherwise noted). See [Parameter Measurement Information](#).

| PARAMETER | | V_{CC} | Operating free-air temperature (T_A) | | | | UNIT | |
|-------------|-----------------|------------------------------|--|-----|----------------|-----|------|--|
| | | | 25°C | | -40°C to 125°C | | | |
| | | | MIN | MAX | MIN | MAX | | |
| f_{clock} | Clock frequency | | 2 V | 32 | | 17 | | |
| | | | 4.5 V | 100 | | 54 | | |
| | | | 6 V | 115 | | 68 | | |
| t_w | Pulse duration | SRCLK or RCLK high or low | 2 V | 8 | 12 | | ns | |
| | | | 4.5 V | 6 | 7 | | | |
| | | | 6 V | 6 | 7 | | | |
| | | SRCLR or RCLR low | 2 V | 7 | 12 | | | |
| | | | 4.5 V | 6 | 7 | | | |
| | | | 6 V | 6 | 7 | | | |

$C_L = 50 \text{ pF}$; over operating free-air temperature range (unless otherwise noted). See [Parameter Measurement Information](#).

| PARAMETER | | V_{CC} | Operating free-air temperature (T_A) | | | | UNIT | |
|-----------|------------|---|--|-----|----------------|-----|------|--|
| | | | 25°C | | -40°C to 125°C | | | |
| | | | MIN | MAX | MIN | MAX | | |
| t_{SU} | Setup time | SER before SRCLK ↑ | 2 V | 11 | 16 | | ns | |
| | | | 4.5 V | 4 | 7 | | | |
| | | | 6 V | 4 | 5 | | | |
| | | SRCLK↑ before RCLK↑ | 2 V | 15 | 24 | | | |
| | | | 4.5 V | 5 | 9 | | | |
| | | | 6 V | 5 | 7 | | | |
| | | SRCLR low before RCLK↑ | 2 V | 16 | 27 | | | |
| | | | 4.5 V | 7 | 10 | | | |
| | | | 6 V | 5 | 8 | | | |
| | | SRCLR high (inactive) before SRCLK↑ | 2 V | 5 | 9 | | | |
| | | | 4.5 V | 3 | 5 | | | |
| | | | 6 V | 3 | 4 | | | |
| | | RCLR high (inactive) before RCLK↑ | 2 V | 8 | 12 | | | |
| | | | 4.5 V | 4 | 5 | | | |
| | | | 6 V | 3 | 4 | | | |
| t_h | Hold time | SER after SRCLK↑ | 2 V | 0 | 0 | | ns | |
| | | | 4.5 V | 0 | 0 | | | |
| | | | 6 V | 0 | 0 | | | |

6.7 Switching Characteristics

$C_L = 50 \text{ pF}$; over operating free-air temperature range (unless otherwise noted). See [Parameter Measurement Information](#).

| PARAMETER | | FROM | TO | V_{CC} | Operating free-air temperature (T_A) | | | | UNIT | |
|-----------|-------------------------|-------|---------------------------------|----------|--|-----|----------------|-----|------|--|
| | | | | | 25°C | | -40°C to 125°C | | | |
| | | | | | MIN | TYP | MAX | MIN | | |
| f_{max} | Max switching frequency | | | 2 V | 32 | | 17 | | MHz | |
| | | | | | 100 | | 54 | | | |
| | | | | | 115 | | 68 | | | |
| t_{pd} | Propagation delay | SRCLK | Q _{H'} | 2 V | 19 | 30 | | 45 | ns | |
| | | | | 4.5 V | 7 | 11 | | 17 | | |
| | | | | 6 V | 6 | 9 | | 12 | | |
| | | RCLK | Q _A - Q _H | 2 V | 19 | 30 | | 45 | | |
| | | | | 4.5 V | 7 | 11 | | 17 | | |
| | | | | 6 V | 6 | 9 | | 12 | | |
| t_{PHL} | Propagation delay | SRCLR | Q _{H'} | 2 V | 18 | 27 | | 55 | ns | |
| | | | | 4.5 V | 7 | 11 | | 17 | | |
| | | | | 6 V | 6 | 9 | | 15 | | |
| | | RCLR | Q _A - Q _H | 2 V | 18 | 27 | | 55 | | |
| | | | | 4.5 V | 7 | 11 | | 17 | | |
| | | | | 6 V | 6 | 9 | | 15 | | |
| t_t | Transition-time | | Any output | 2 V | 9 | | 16 | | ns | |
| | | | | 4.5 V | 5 | | 9 | | | |
| | | | | 6 V | 4 | | 8 | | | |

6.8 Operating Characteristics

over operating free-air temperature range; typical values measured at $T_A = 25^\circ\text{C}$ (unless otherwise noted).

| PARAMETER | TEST CONDITIONS | V_{CC} | MIN | TYP | MAX | UNIT |
|-----------|---|------------|-----|-----|-----|------|
| C_{pd} | Power dissipation capacitance per gate No load | 2 V to 6 V | | 40 | | pF |

6.9 Typical Characteristics

$T_A = 25^\circ\text{C}$

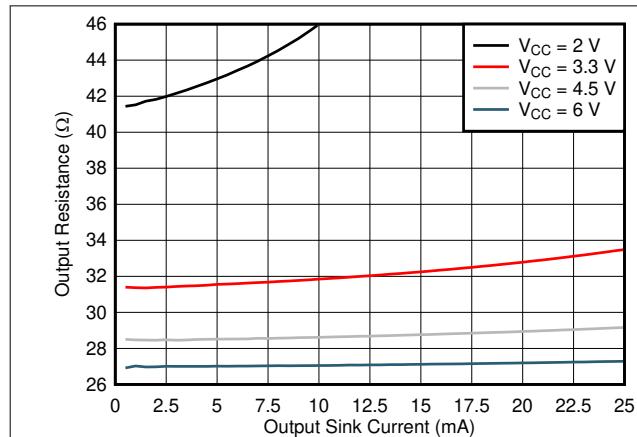


图 6-1. Output driver resistance in LOW state.

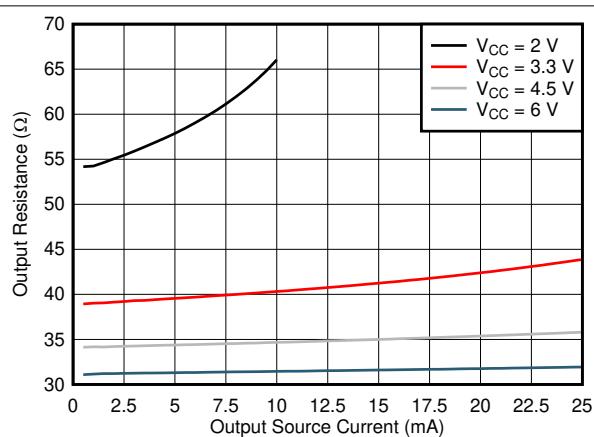


图 6-2. Output driver resistance in HIGH state.

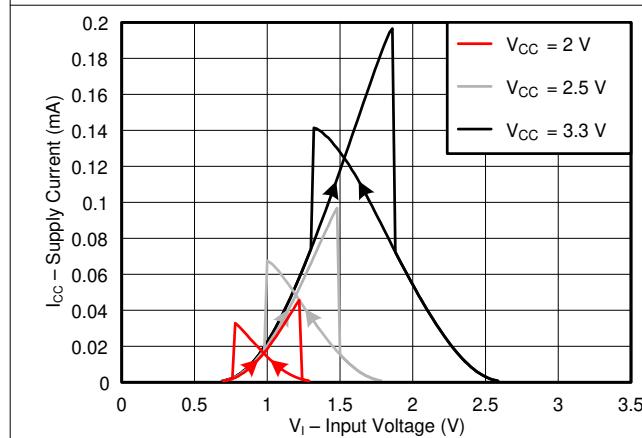


图 6-3. Supply current across input voltage, 2-, 2.5-, and 3.3-V supply

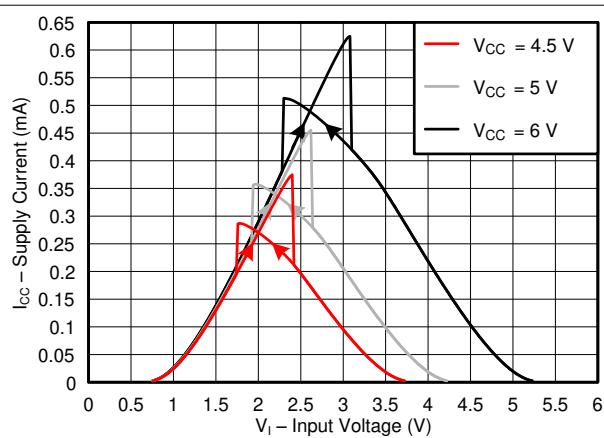


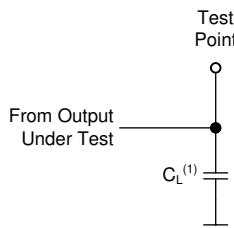
图 6-4. Supply current across input voltage, 4.5-, 5-, and 6-V supply

7 Parameter Measurement Information

Phase relationships between waveforms were chosen arbitrarily. All input pulses are supplied by generators having the following characteristics: PRR \leq 1 MHz, $Z_0 = 50 \Omega$, $t_t < 2.5$ ns.

For clock inputs, f_{max} is measured when the input duty cycle is 50%.

The outputs are measured one at a time with one input transition per measurement.



(1) C_L includes probe and test-fixture capacitance.

图 7-1. Load Circuit for Push-Pull Outputs

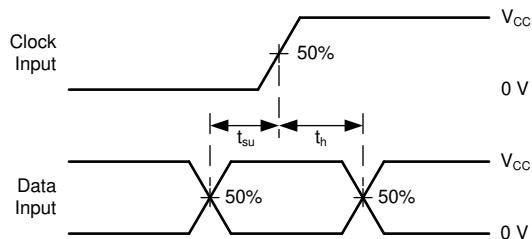


图 7-3. Voltage Waveforms, Setup and Hold Times

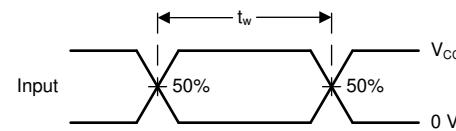
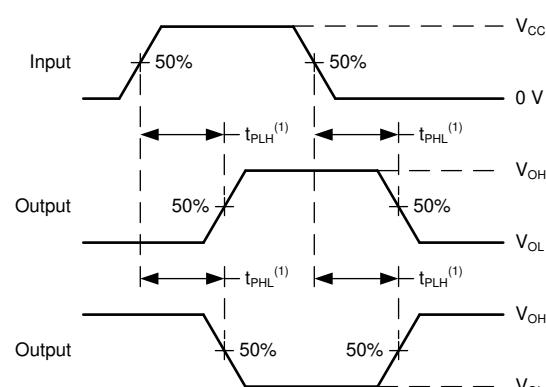
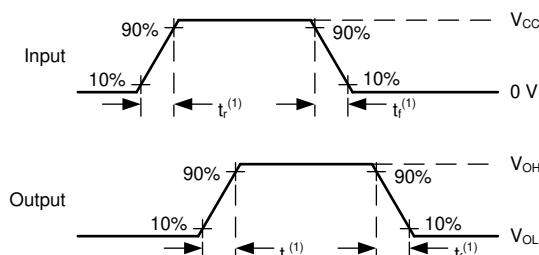


图 7-2. Voltage Waveforms, Pulse Duration



(1) The greater between t_{PLH} and t_{PHL} is the same as t_{pd} .

图 7-4. Voltage Waveforms Propagation Delays



(1) The greater between t_r and t_f is the same as t_t .

图 7-5. Voltage Waveforms, Input and Output Transition Times

8 Detailed Description

8.1 Overview

The SN74HCS594-Q1 is an 8-bit shift register that feeds an 8-bit D-type storage register. Both the shift register clock (SRCLK) and storage register clock (RCLK) are positive-edge triggered. If both clocks are connected together, the shift register always is one clock pulse ahead of the storage register. All inputs include Schmitt-triggers allowing for slow input transitions and providing more noise margin.

8.2 Functional Block Diagram

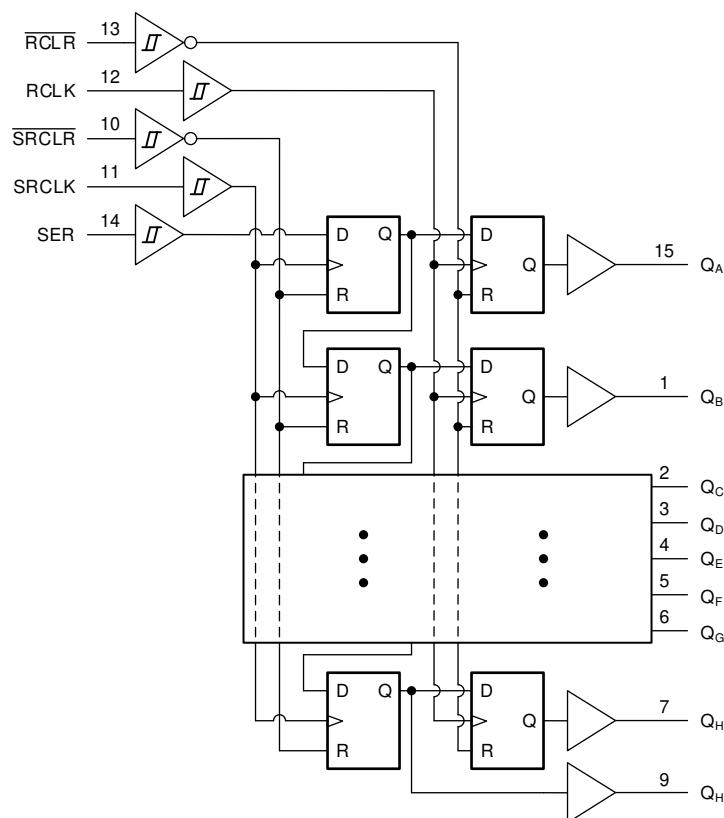


図 8-1. Logic Diagram (Positive Logic) for SN74HCS594

8.3 Feature Description

8.3.1 Balanced CMOS Push-Pull Outputs

This device includes balanced CMOS push-pull outputs. The term "balanced" indicates that the device can sink and source similar currents. The drive capability of this device may create fast edges into light loads so routing and load conditions should be considered to prevent ringing. Additionally, the outputs of this device are capable of driving larger currents than the device can sustain without being damaged. It is important for the output power of the device to be limited to avoid damage due to overcurrent. The electrical and thermal limits defined in the *Absolute Maximum Ratings* must be followed at all times.

Unused push-pull CMOS outputs should be left disconnected.

8.3.2 CMOS Schmitt-Trigger Inputs

This device includes inputs with the Schmitt-trigger architecture. These inputs are high impedance and are typically modeled as a resistor in parallel with the input capacitance given in the *Electrical Characteristics* table from the input to ground. The worst case resistance is calculated with the maximum input voltage, given in the *Absolute Maximum Ratings* table, and the maximum input leakage current, given in the *Electrical Characteristics* table, using Ohm's law ($R = V \div I$).

The Schmitt-trigger input architecture provides hysteresis as defined by ΔV_T in the *Electrical Characteristics* table, which makes this device extremely tolerant to slow or noisy inputs. While the inputs can be driven much slower than standard CMOS inputs, it is still recommended to properly terminate unused inputs. Driving the inputs with slow transitioning signals will increase dynamic current consumption of the device. For additional information regarding Schmitt-trigger inputs, please see [Understanding Schmitt Triggers](#).

8.3.3 Clamp Diode Structure

The inputs and outputs to this device have both positive and negative clamping diodes as depicted in [Electrical Placement of Clamping Diodes for Each Input and Output](#).

注意

Voltages beyond the values specified in the *Absolute Maximum Ratings* table can cause damage to the device. The input and output voltage ratings may be exceeded if the input and output clamp-current ratings are observed.

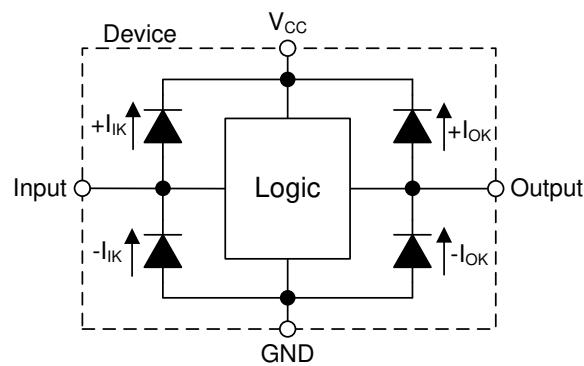


図 8-2. Electrical Placement of Clamping Diodes for Each Input and Output

8.4 Device Functional Modes

Function Table lists the functional modes of the SN74HCS594.

表 8-1. Function Table

| INPUTS ⁽¹⁾ | | | | | FUNCTION |
|-----------------------|-------|-------|------|------|--|
| SER | SRCLK | SRCLR | RCLK | RCLR | |
| X | X | X | X | L | Shift register is cleared. |
| X | X | L | X | X | Shift register is cleared. |
| L | ↑ | H | X | X | |
| H | ↑ | H | X | X | First stage of the shift register goes low. Other stages store the data of previous stage, respectively. |
| X | X | H | ↑ | X | First stage of the shift register goes low. Other stages store the data of previous stage, respectively. |
| X | ↑ | H | ↑ | X | First stage of the shift register goes high. Other stages store the data of previous stage, respectively. |

(1) H = High Voltage Level, L = Low Voltage Level, X = Don't Care

9 Application and Implementation

注

以下のアプリケーション情報は、TI の製品仕様に含まれるものではなく、TI ではその正確性または完全性を保証いたしません。個々の目的に対する製品の適合性については、お客様の責任で判断していただくことになります。お客様は自身の設計実装を検証しテストすることで、システムの機能を確認する必要があります。

9.1 Application Information

In this application, the SN74HCS594 is used to control seven-segment displays. Utilizing the serial output and combining a few of the input signals, this implementation reduces the number of I/O pins required to control the displays from sixteen to four. Unlike other I/O expanders, the SN74HCS594 does not need a communication interface for control. It can be easily operated with simple GPIO pins.

There is no practical limitation to how many SN74HCS594 devices can be cascaded. To add more, the serial output will need to be connected to the following serial input and the clocks will need to be connected accordingly. With separate control for the shift registers and output registers, the desired digit can be displayed while the data for the next digit is loaded into the shift register.

At power-up, the initial state of the shift registers and output registers are unknown. To give them a defined state, both registers need to be cleared. An RC can be connected to the SRCLR and RCLR pins as shown in the [Typical application block diagram](#) to initialize the shift and output registers to all zeros.

9.2 Typical Application

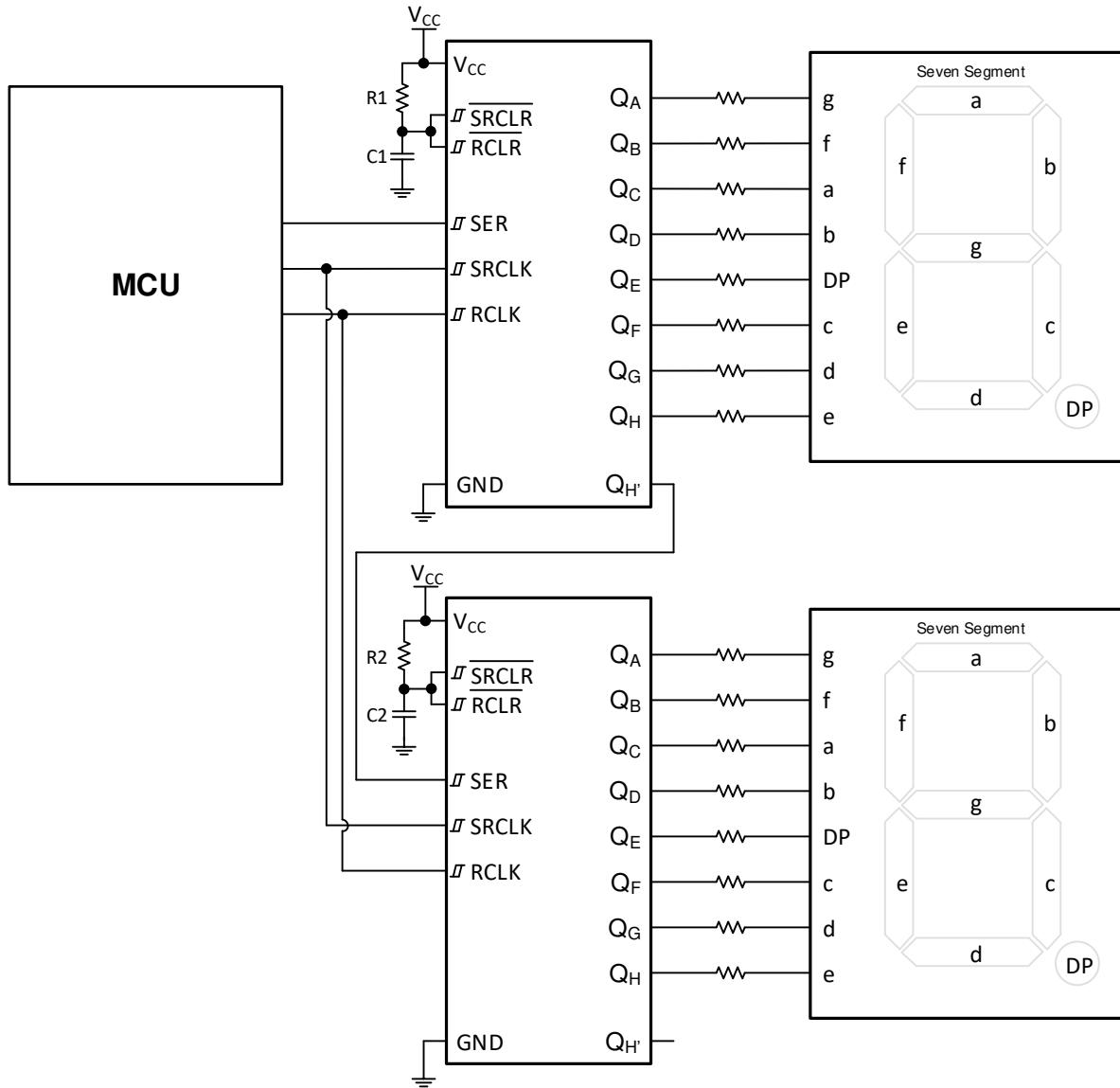


FIG 9-1. Typical application block diagram

9.2.1 Design Requirements

9.2.1.1 Power Considerations

Ensure the desired supply voltage is within the range specified in the *Recommended Operating Conditions*. The supply voltage sets the device's electrical characteristics as described in the *Electrical Characteristics*.

The positive voltage supply must be capable of sourcing current equal to the total current to be sourced by all outputs of the SN74HCS594 plus the maximum static supply current, I_{CC} , listed in *Electrical Characteristics* and any transient current required for switching. The logic device can only source as much current as is provided by the positive supply source. Be sure not to exceed the maximum total current through V_{CC} listed in the *Absolute Maximum Ratings*.

The ground must be capable of sinking current equal to the total current to be sunk by all outputs of the SN74HCS594 plus the maximum supply current, I_{CC} , listed in *Electrical Characteristics*, and any transient current required for switching. The logic device can only sink as much current as can be sunk into its ground

connection. Be sure not to exceed the maximum total current through GND listed in the *Absolute Maximum Ratings*.

The SN74HCS594 can drive a load with a total capacitance less than or equal to 50 pF while still meeting all of the datasheet specifications. Larger capacitive loads can be applied, however it is not recommended to exceed 50 pF.

The SN74HCS594 can drive a load with total resistance described by $R_L \geq V_O / I_O$, with the output voltage and current defined in the *Electrical Characteristics* table with V_{OH} and V_{OL} . When outputting in the high state, the output voltage in the equation is defined as the difference between the measured output voltage and the supply voltage at the V_{CC} pin.

Total power consumption can be calculated using the information provided in [CMOS Power Consumption and Cpd Calculation](#).

Thermal increase can be calculated using the information provided in [Thermal Characteristics of Standard Linear and Logic \(SLL\) Packages and Devices](#).

注意

The maximum junction temperature, $T_{J(max)}$ listed in the *Absolute Maximum Ratings*, is an additional limitation to prevent damage to the device. Do not violate any values listed in the *Absolute Maximum Ratings*. These limits are provided to prevent damage to the device.

9.2.1.2 Input Considerations

Input signals must cross $V_{t-(min)}$ to be considered a logic LOW, and $V_{t+(max)}$ to be considered a logic HIGH. Do not exceed the maximum input voltage range found in the *Absolute Maximum Ratings*.

Unused inputs must be terminated to either V_{CC} or ground. These can be directly terminated if the input is completely unused, or they can be connected with a pull-up or pull-down resistor if the input is to be used sometimes, but not always. A pull-up resistor is used for a default state of HIGH, and a pull-down resistor is used for a default state of LOW. The resistor size is limited by drive current of the controller, leakage current into the SN74HCS594, as specified in the *Electrical Characteristics*, and the desired input transition rate. A 10-k Ω resistor value is often used due to these factors.

The SN74HCS594 has no input signal transition rate requirements because it has Schmitt-trigger inputs.

Another benefit to having Schmitt-trigger inputs is the ability to reject noise. Noise with a large enough amplitude can still cause issues. To know how much noise is too much, please refer to the $\Delta V_{T(min)}$ in the *Electrical Characteristics*. This hysteresis value will provide the peak-to-peak limit.

Unlike what happens with standard CMOS inputs, Schmitt-trigger inputs can be held at any valid value without causing huge increases in power consumption. The typical additional current caused by holding an input at a value other than V_{CC} or ground is plotted in the *Typical Characteristics*.

Refer to the *Feature Description* section for additional information regarding the inputs for this device.

9.2.1.3 Output Considerations

The positive supply voltage is used to produce the output HIGH voltage. Drawing current from the output will decrease the output voltage as specified by the V_{OH} specification in the *Electrical Characteristics*. The ground voltage is used to produce the output LOW voltage. Sinking current into the output will increase the output voltage as specified by the V_{OL} specification in the *Electrical Characteristics*.

Push-pull outputs that could be in opposite states, even for a very short time period, should never be connected directly together. This can cause excessive current and damage to the device.

Two channels within the same device with the same input signals can be connected in parallel for additional output drive strength.

Unused outputs can be left floating. Do not connect outputs directly to V_{CC} or ground.

Refer to *Feature Description* section for additional information regarding the outputs for this device.

9.2.2 Detailed Design Procedure

1. Add a decoupling capacitor from V_{CC} to GND. The capacitor needs to be placed physically close to the device and electrically close to both the V_{CC} and GND pins. An example layout is shown in the *Layout* section.
2. Ensure the capacitive load at the output is ≤ 50 pF. This is not a hard limit, however it will ensure optimal performance. This can be accomplished by providing short, appropriately sized traces from the SN74HCS594 to the receiving device(s).
3. Ensure the resistive load at the output is larger than $(V_{CC} / I_{O(max)}) \Omega$. This will ensure that the maximum output current from the *Absolute Maximum Ratings* is not violated. Most CMOS inputs have a resistive load measured in megaohms; much larger than the minimum calculated above.
4. Thermal issues are rarely a concern for logic gates, however the power consumption and thermal increase can be calculated using the steps provided in the application report, [CMOS Power Consumption and Cpd Calculation](#).

9.2.3 Application Curve

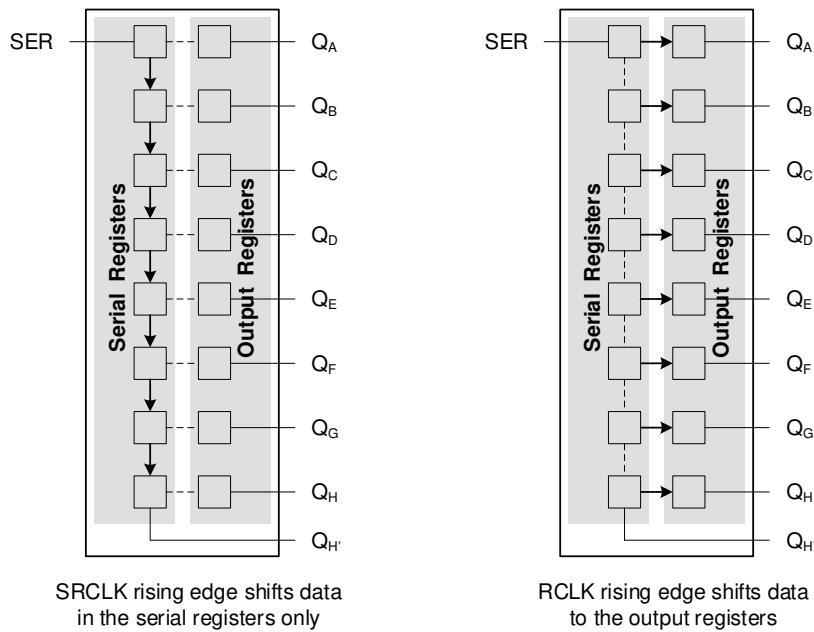


FIG 9-2. Simplified functional diagram showing clock operation

10 Power Supply Recommendations

The power supply can be any voltage between the minimum and maximum supply voltage rating located in the *Recommended Operating Conditions*. Each V_{CC} terminal should have a good bypass capacitor to prevent power disturbance. A 0.1- μ F capacitor is recommended for this device. It is acceptable to parallel multiple bypass caps to reject different frequencies of noise. The 0.1- μ F and 1- μ F capacitors are commonly used in parallel. The bypass capacitor should be installed as close to the power terminal as possible for best results, as shown in given example layout image.

11 Layout

11.1 Layout Guidelines

When using multiple-input and multiple-channel logic devices inputs must not ever be left floating. In many cases, functions or parts of functions of digital logic devices are unused; for example, when only two inputs of a triple-input AND gate are used or only 3 of the 4 buffer gates are used. Such unused input pins must not be left unconnected because the undefined voltages at the outside connections result in undefined operational states. All unused inputs of digital logic devices must be connected to a logic high or logic low voltage, as defined by the input voltage specifications, to prevent them from floating. The logic level that must be applied to any particular unused input depends on the function of the device. Generally, the inputs are tied to GND or V_{CC} , whichever makes more sense for the logic function or is more convenient.

11.2 Layout Example

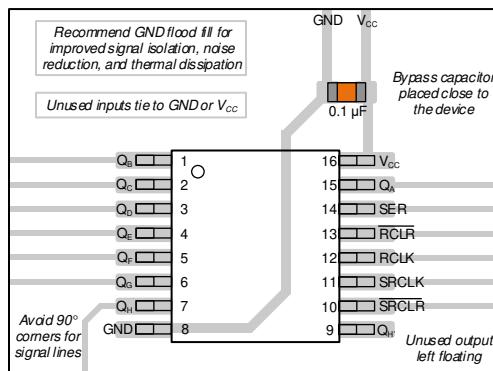


图 11-1. Example layout for the SN74HCS594 in the PW package.

12 Device and Documentation Support

TI offers an extensive line of development tools. Tools and software to evaluate the performance of the device, generate code, and develop solutions are listed below.

12.1 Documentation Support

12.1.1 Related Documentation

For related documentation see the following:

- Texas Instruments, *HCMOS Design Considerations* application report (SCLA007)
- Texas Instruments, *CMOS Power Consumption and C_{pd} Calculation* application report (SDYA009)
- Texas Instruments, *Designing With Logic* application report

12.2 ドキュメントの更新通知を受け取る方法

ドキュメントの更新についての通知を受け取るには、ti.com のデバイス製品フォルダを開いてください。「更新の通知を受け取る」をクリックして登録すると、変更されたすべての製品情報に関するダイジェストを毎週受け取れます。変更の詳細については、修正されたドキュメントに含まれている改訂履歴をご覧ください。

12.3 サポート・リソース

[TI E2E™ サポート・フォーラム](#)は、エンジニアが検証済みの回答と設計に関するヒントをエキスパートから迅速かつ直接得ることができる場所です。既存の回答を検索したり、独自の質問をしたりすることで、設計で必要な支援を迅速に得ることができます。

リンクされているコンテンツは、該当する貢献者により、現状のまま提供されるものです。これらは TI の仕様を構成するものではなく、必ずしも TI の見解を反映したものではありません。[TI の使用条件](#)を参照してください。

12.4 Trademarks

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12.5 静電気放電に関する注意事項



この IC は、ESD によって破損する可能性があります。テキサス・インスツルメンツは、IC を取り扱う際には常に適切な注意を払うことを推奨します。正しい取り扱いおよび設置手順に従わないと、デバイスを破損するおそれがあります。

ESD による破損は、わずかな性能低下からデバイスの完全な故障まで多岐にわたります。精密な IC の場合、パラメータがわずかに変化するだけで公表されている仕様から外れる可能性があるため、破損が発生しやすくなっています。

12.6 用語集

テキサス・インスツルメンツ用語集

この用語集には、用語や略語の一覧および定義が記載されています。

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) |
|--------------------------------|---------------|----------------------|---------------------------|-----------------------|-------------|--------------------------------------|-----------------------------------|--------------|---------------------|
| SN74HCS594BQBR | Active | Production | WQFN (BQB) 16 | 3000 LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | HCS594 |
| SN74HCS594BQBR.A | Active | Production | WQFN (BQB) 16 | 3000 LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | HCS594 |
| SN74HCS594DR | Active | Production | SOIC (D) 16 | 2500 LARGE T&R | Yes | NIPDAU SN | Level-1-260C-UNLIM | -40 to 125 | HCS594 |
| SN74HCS594DR.A | Active | Production | SOIC (D) 16 | 2500 LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | HCS594 |
| SN74HCS594DYYR | Active | Production | SOT-23-THIN (DYY) 16 | 3000 LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | HCS594 |
| SN74HCS594DYYR.A | Active | Production | SOT-23-THIN (DYY) 16 | 3000 LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | HCS594 |
| SN74HCS594PWR | Active | Production | TSSOP (PW) 16 | 2000 LARGE T&R | Yes | NIPDAU SN | Level-1-260C-UNLIM | -40 to 125 | HCS594 |
| SN74HCS594PWR.A | Active | Production | TSSOP (PW) 16 | 2000 LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | HCS594 |

⁽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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and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

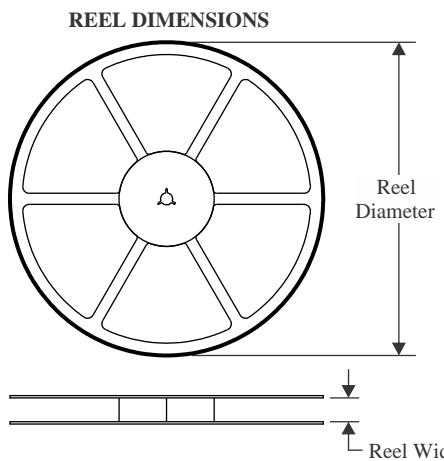
In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

OTHER QUALIFIED VERSIONS OF SN74HCS594 :

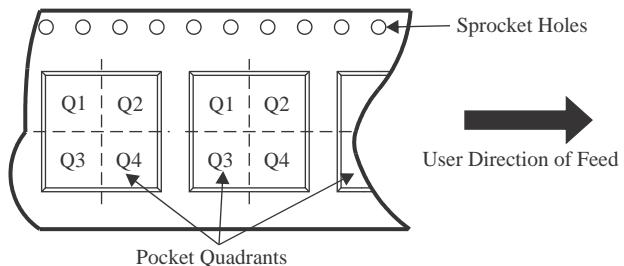
- Automotive : [SN74HCS594-Q1](#)

NOTE: Qualified Version Definitions:

- Automotive - Q100 devices qualified for high-reliability automotive applications targeting zero defects

TAPE AND REEL INFORMATION


| | |
|----|---|
| A0 | Dimension designed to accommodate the component width |
| B0 | Dimension designed to accommodate the component length |
| K0 | Dimension designed to accommodate the component thickness |
| W | Overall width of the carrier tape |
| P1 | Pitch between successive cavity centers |

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 |
|----------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| SN74HCS594BQBR | WQFN | BQB | 16 | 3000 | 180.0 | 12.4 | 2.8 | 3.8 | 1.2 | 4.0 | 12.0 | Q1 |
| SN74HCS594DR | SOIC | D | 16 | 2500 | 330.0 | 16.4 | 6.5 | 10.3 | 2.1 | 8.0 | 16.0 | Q1 |
| SN74HCS594DYYR | SOT-23-THIN | DYY | 16 | 3000 | 330.0 | 12.4 | 4.8 | 3.6 | 1.6 | 8.0 | 12.0 | Q3 |
| SN74HCS594PWR | TSSOP | PW | 16 | 2000 | 330.0 | 12.4 | 6.9 | 5.6 | 1.6 | 8.0 | 12.0 | Q1 |

TAPE AND REEL BOX DIMENSIONS


*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|----------------|--------------|-----------------|------|------|-------------|------------|-------------|
| SN74HCS594BQBR | WQFN | BQB | 16 | 3000 | 210.0 | 185.0 | 35.0 |
| SN74HCS594DR | SOIC | D | 16 | 2500 | 353.0 | 353.0 | 32.0 |
| SN74HCS594DYYR | SOT-23-THIN | DYY | 16 | 3000 | 336.6 | 336.6 | 31.8 |
| SN74HCS594PWR | TSSOP | PW | 16 | 2000 | 356.0 | 356.0 | 35.0 |

GENERIC PACKAGE VIEW

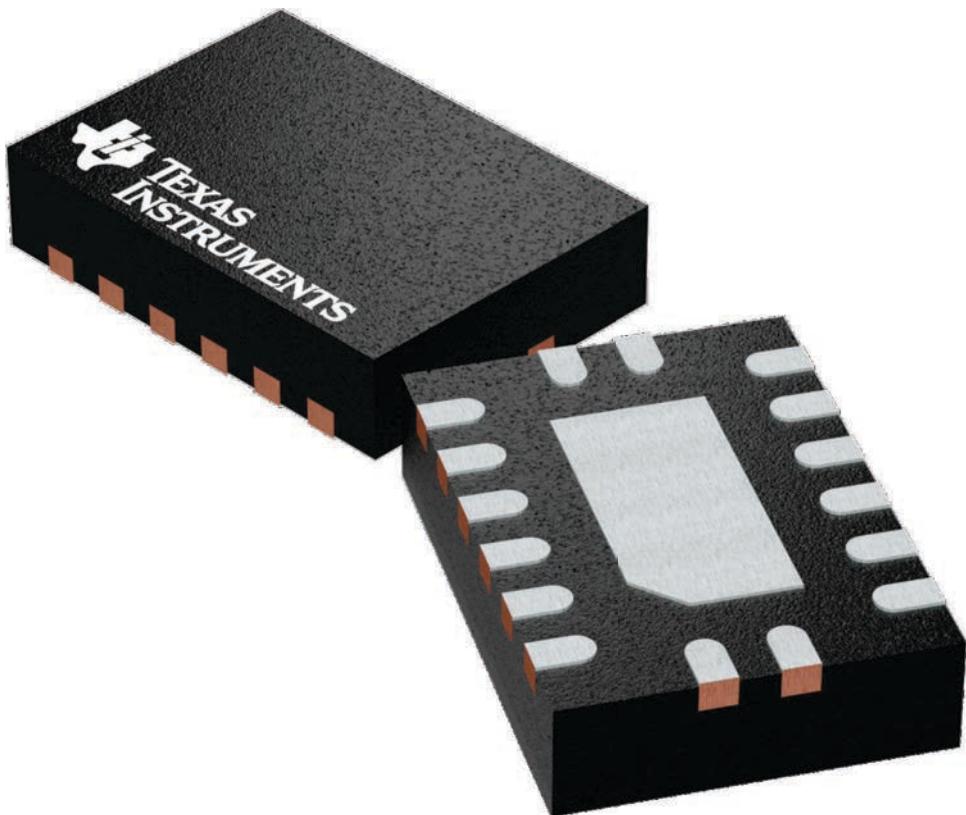
BQB 16

WQFN - 0.8 mm max height

2.5 x 3.5, 0.5 mm pitch

PLASTIC QUAD FLATPACK - NO LEAD

This image is a representation of the package family, actual package may vary.
Refer to the product data sheet for package details.

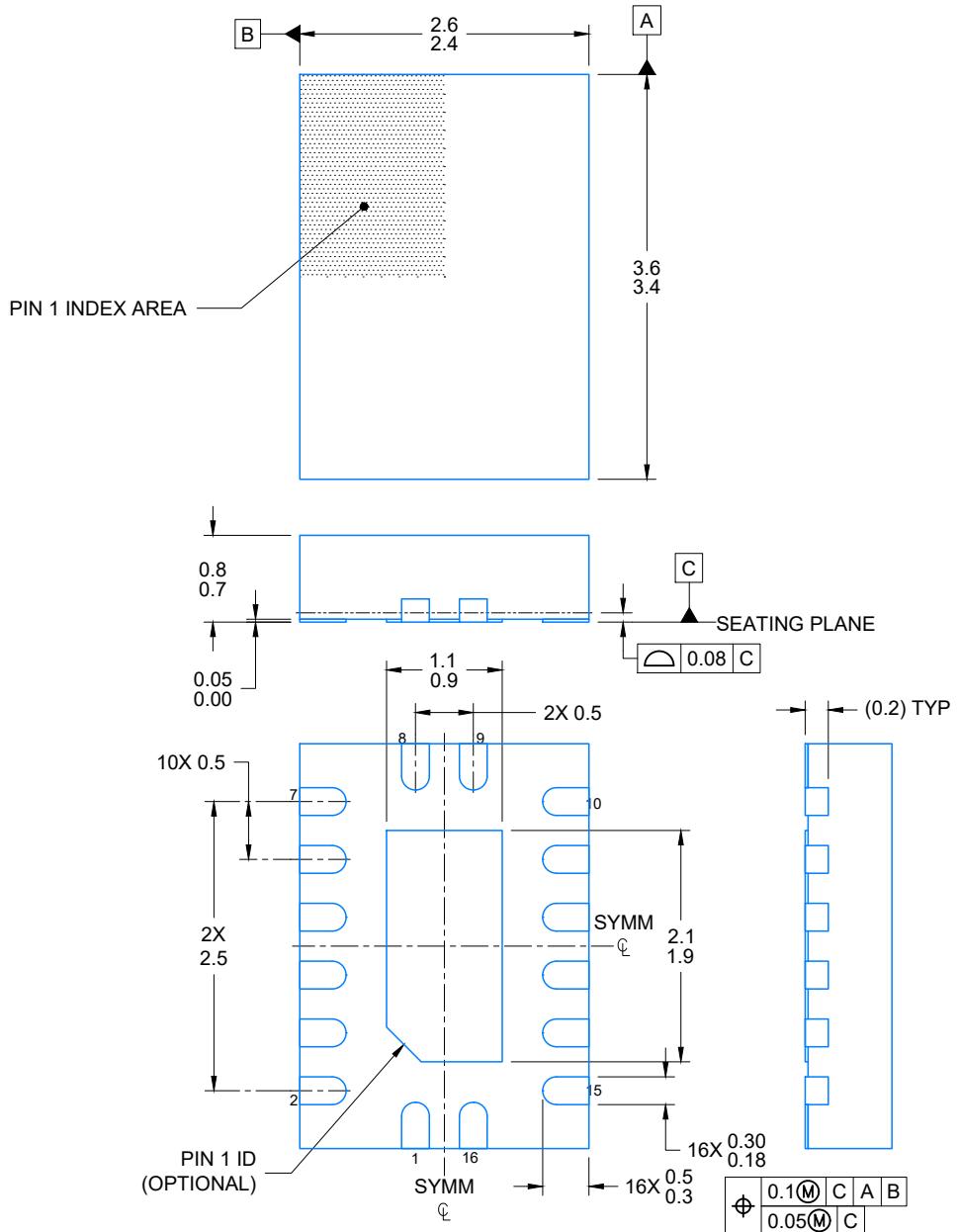


4226161/A

PACKAGE OUTLINE

WQFN - 0.8 mm max height

PLASTIC QUAD FLAT PACK-NO LEAD



4224640/A 11/2018

NOTES:

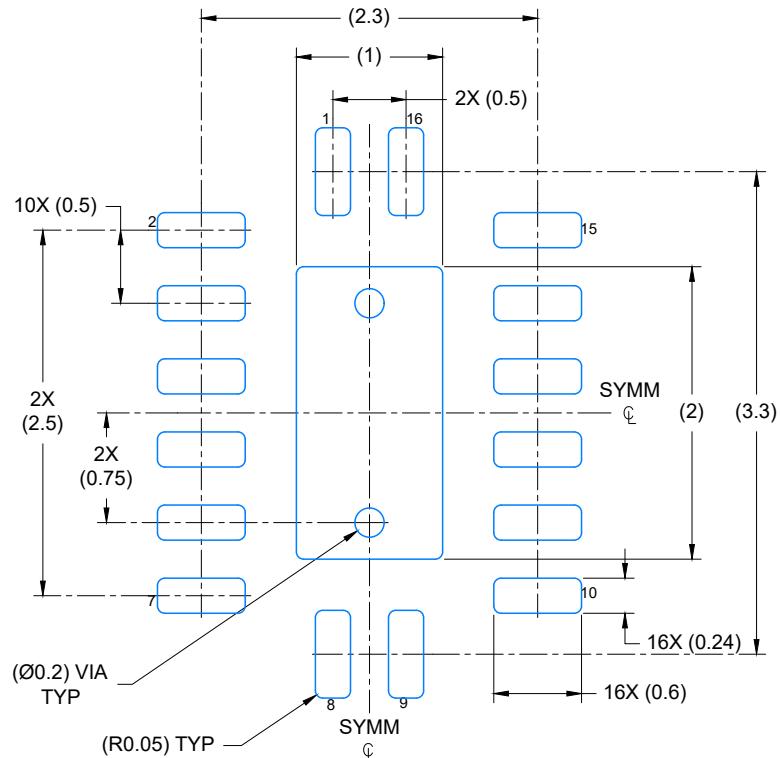
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. The package thermal pad must be soldered to the printed circuit board for optimal thermal and mechanical performance.

EXAMPLE BOARD LAYOUT

BQB0016A

WQFN - 0.8 mm max height

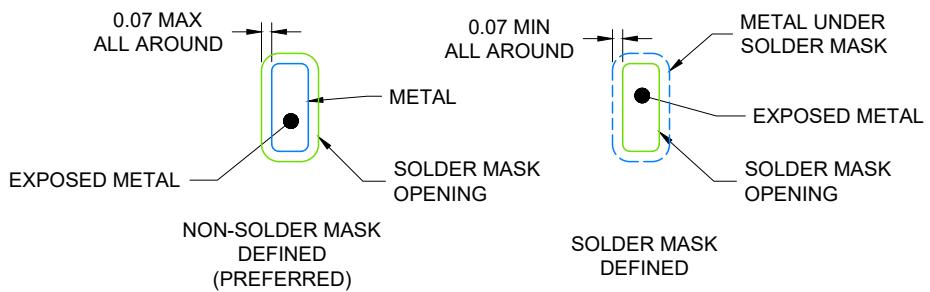
PLASTIC QUAD FLAT PACK-NO LEAD



LAND PATTERN EXAMPLE

EXPOSED METAL SHOWN

SCALE: 20X



4224640/A 11/2018

NOTES: (continued)

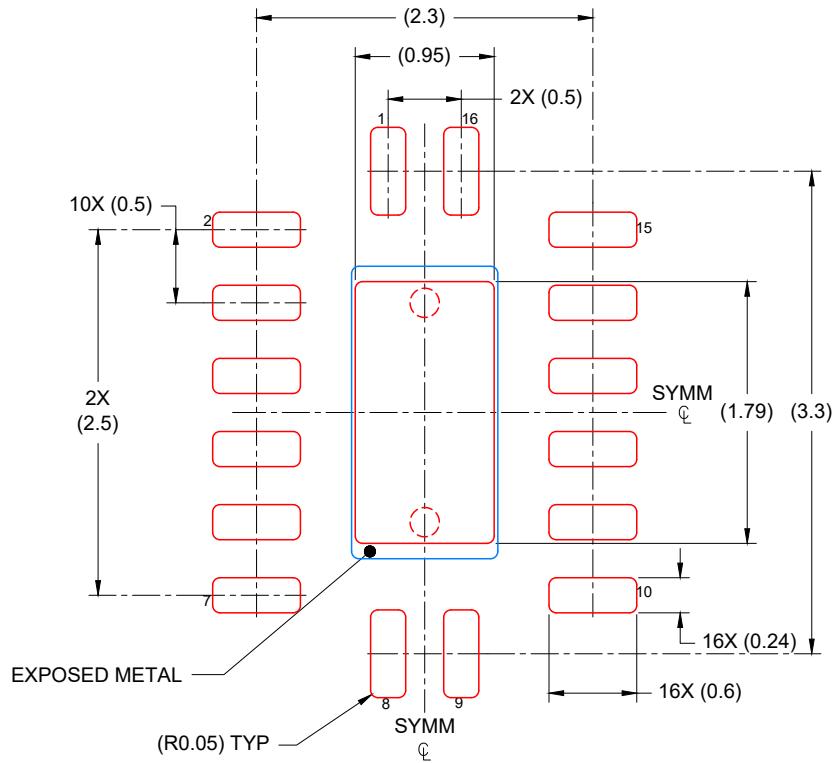
4. This package is designed to be soldered to a thermal pad on the board. For more information, see Texas Instruments literature number SLUA271 (www.ti.com/lit/slua271).
5. Vias are optional depending on application, refer to device data sheet. If any vias are implemented, refer to their locations shown on this view. It is recommended that vias under paste be filled, plugged or tented.

EXAMPLE STENCIL DESIGN

BQB0016A

WQFN - 0.8 mm max height

PLASTIC QUAD FLAT PACK-NO LEAD



SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL

EXPOSED PAD
85% PRINTED COVERAGE BY AREA
SCALE: 20X

4224640/A 11/2018

NOTES: (continued)

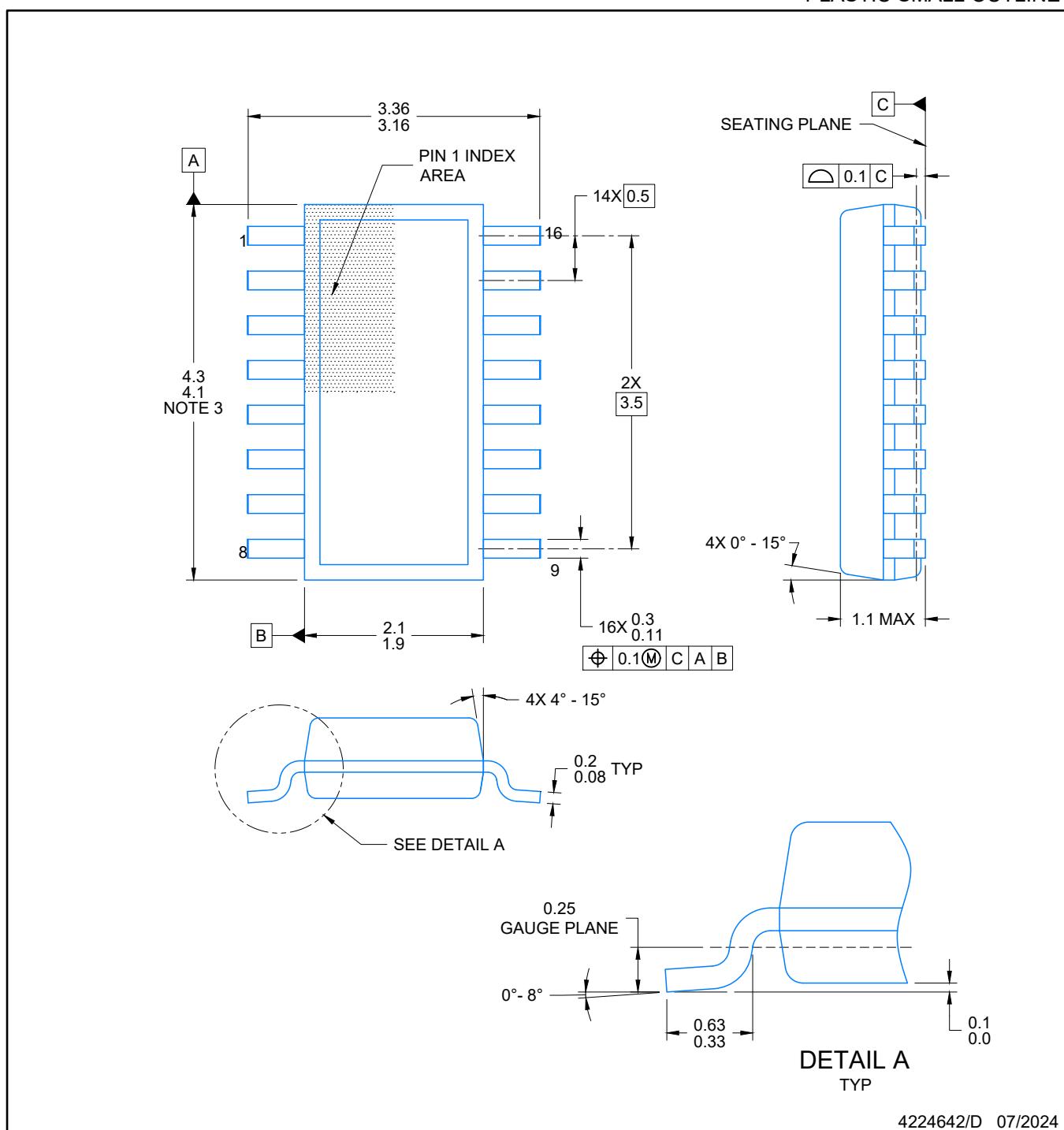
6. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.

PACKAGE OUTLINE

DYY0016A

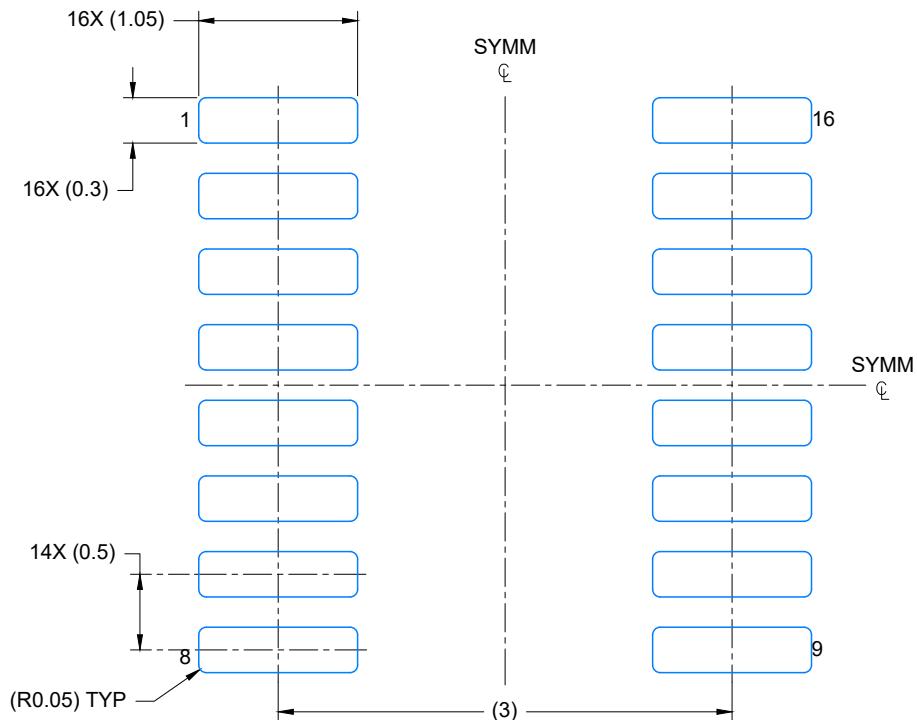
SOT-23-THIN - 1.1 mm max height

PLASTIC SMALL OUTLINE

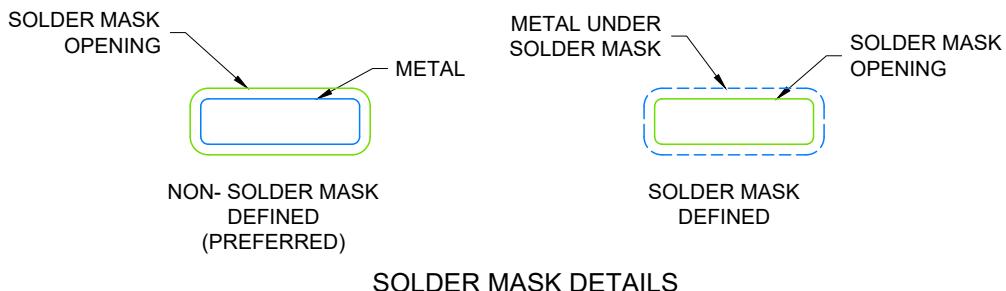


NOTES:

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 per side.
4. This dimension does not include interlead flash. Interlead flash shall not exceed 0.50 per side.
5. Reference JEDEC Registration MO-345, Variation AA



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE: 20X



4224642/D 07/2024

NOTES: (continued)

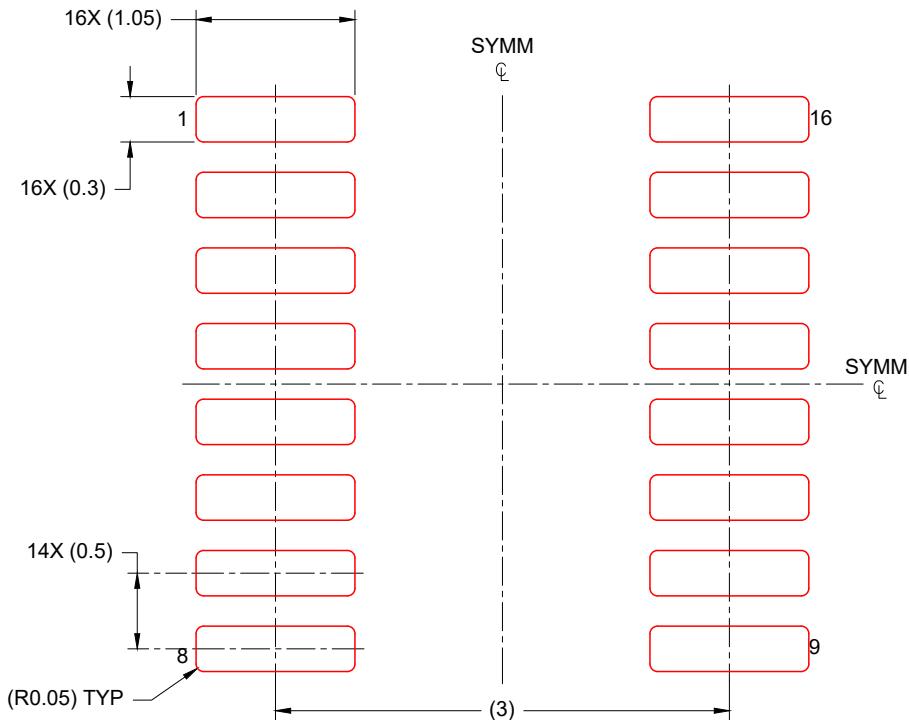
6. Publication IPC-7351 may have alternate designs.
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

EXAMPLE STENCIL DESIGN

SOT-23-THIN - 1.1 mm max height

DYY0016A

PLASTIC SMALL OUTLINE



SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE: 20X

4224642/D 07/2024

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.

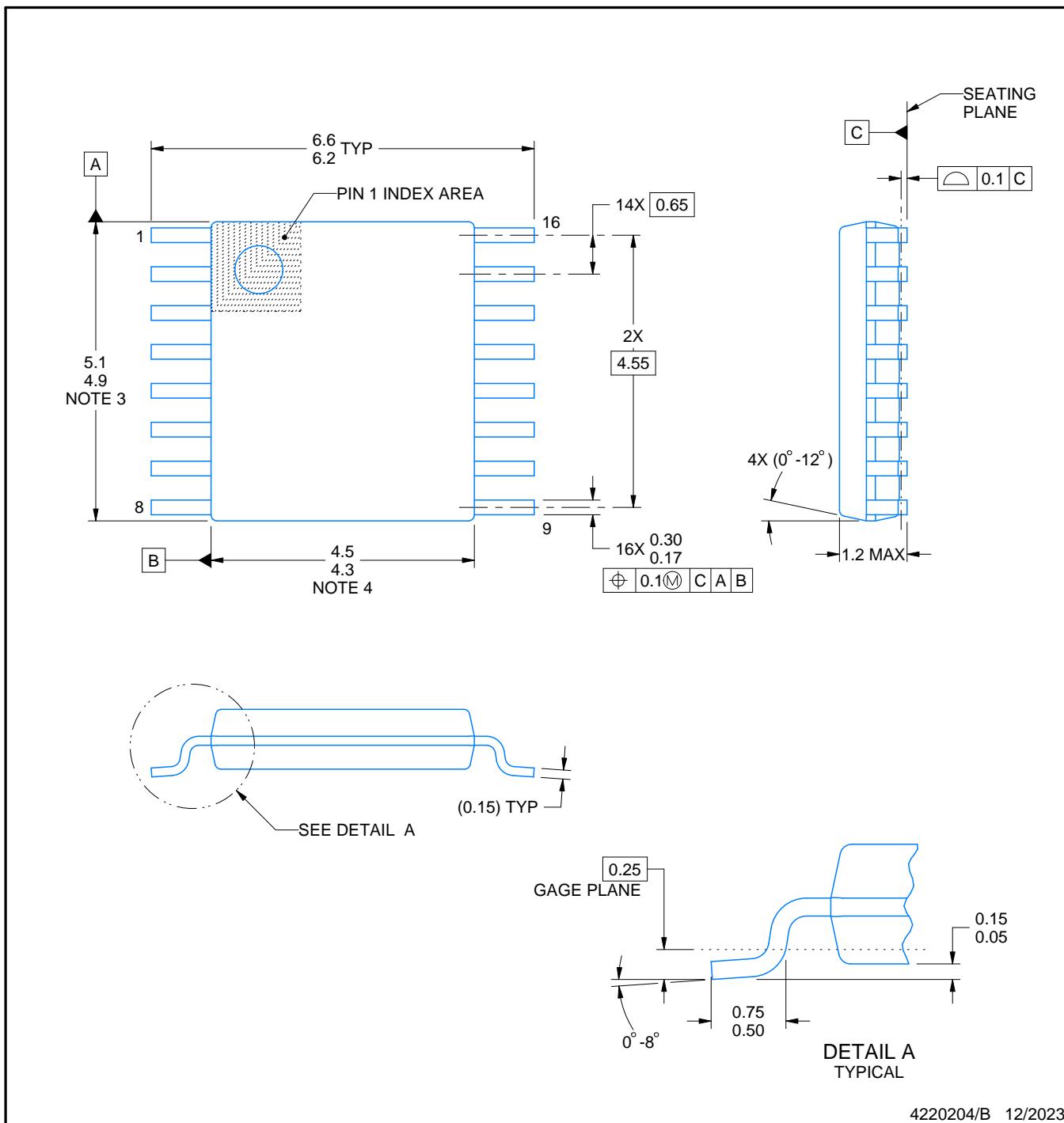
PACKAGE OUTLINE

PW0016A



TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



NOTES:

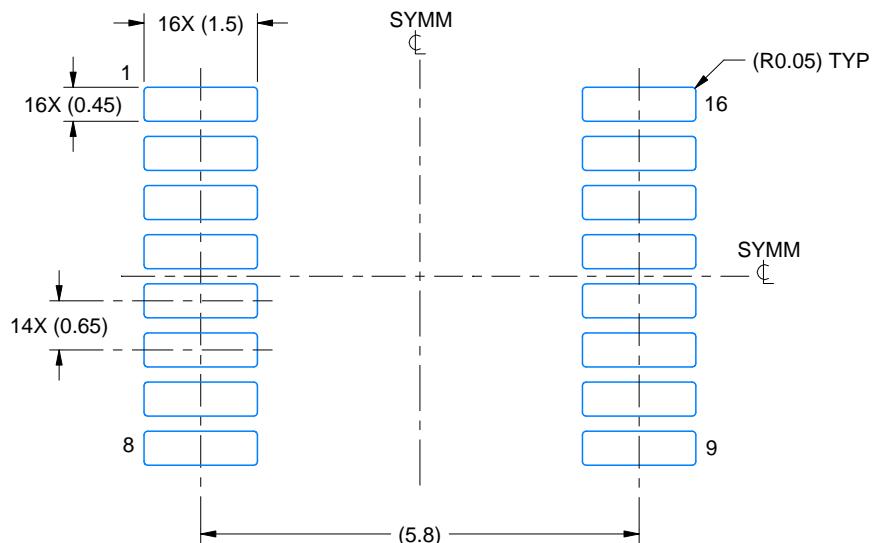
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or 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

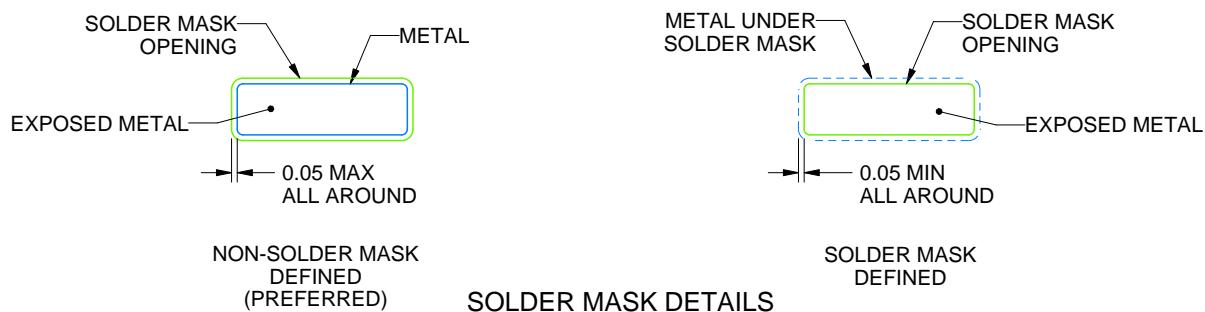
PW0016A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE: 10X



4220204/B 12/2023

NOTES: (continued)

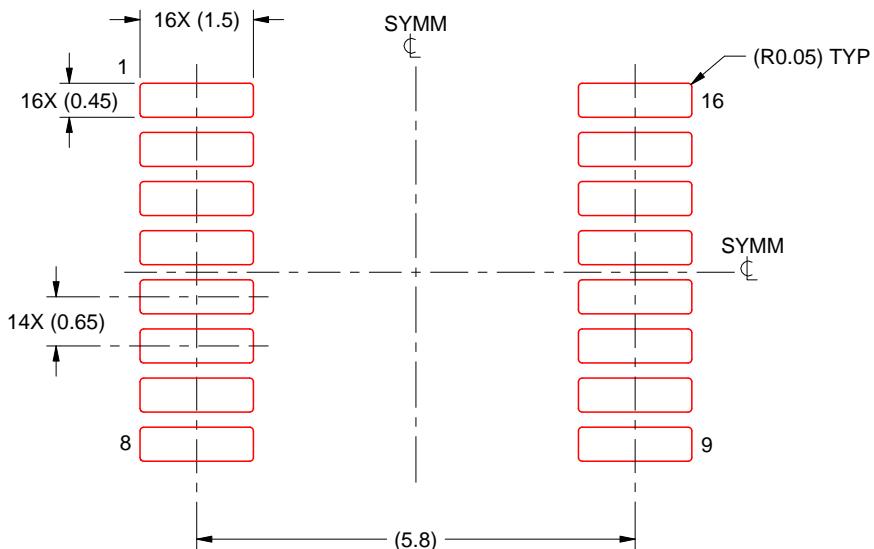
6. Publication IPC-7351 may have alternate designs.
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

EXAMPLE STENCIL DESIGN

PW0016A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE: 10X

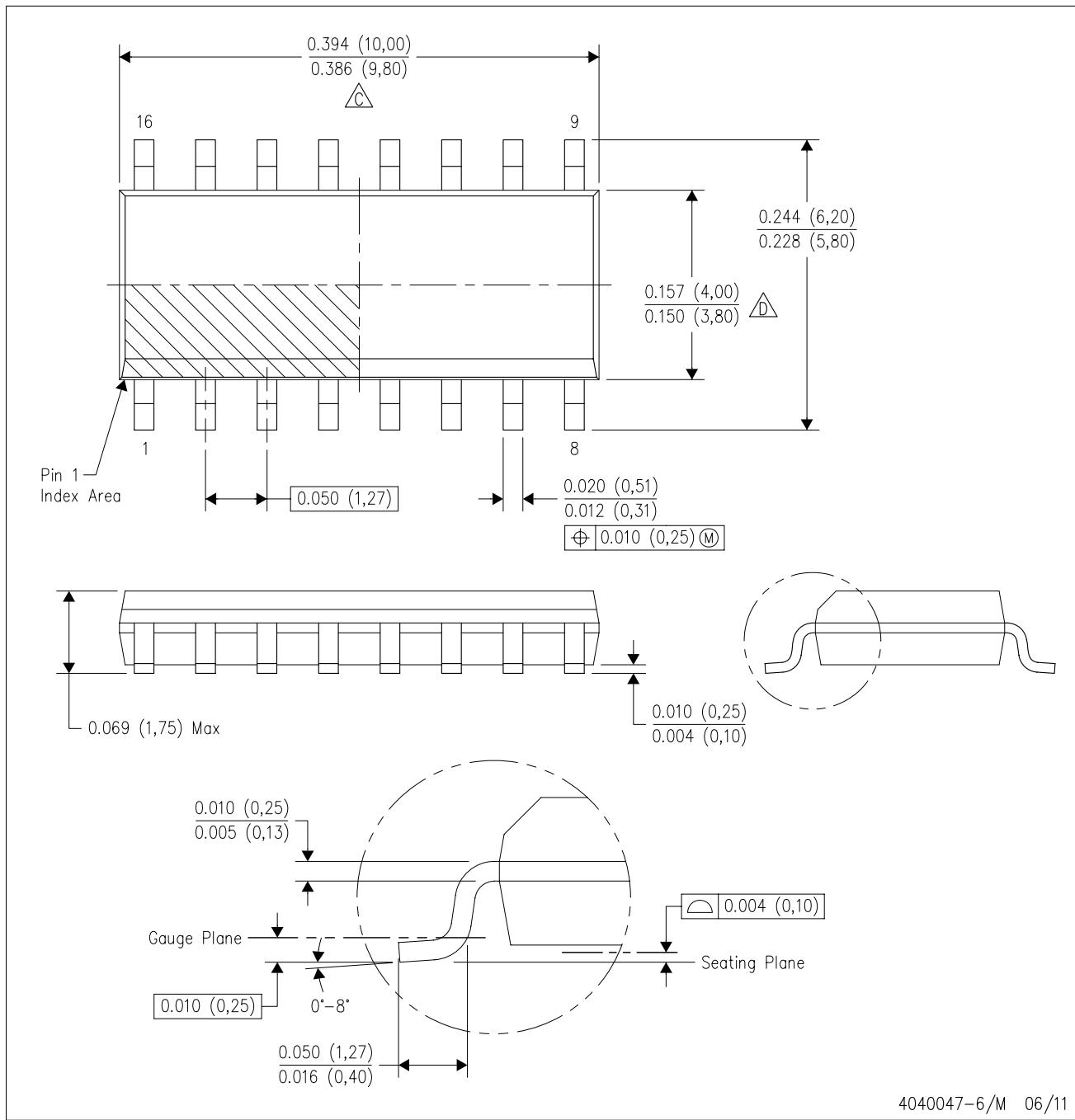
4220204/B 12/2023

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.

D (R-PDSO-G16)

PLASTIC SMALL OUTLINE



NOTES: A. All linear dimensions are in inches (millimeters).

B. This drawing is subject to change without notice.

C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.006 (0,15) each side.

D. Body width does not include interlead flash. Interlead flash shall not exceed 0.017 (0,43) each side.

E. Reference JEDEC MS-012 variation AC.

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