

# SN74HCS595 シュミット・トリガ入力および3ステート出力レジスタ付き、8ビット・シフト・レジスタ

## 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)
  - 入力リーク電流:  $\pm 100$ nA (標準値)
- 6V で  $\pm 7.8$ mA の出力駆動能力
- 広い周囲温度範囲:  $-40^{\circ}\text{C} \sim +125^{\circ}\text{C}$ ,  $T_A$

## 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](#)

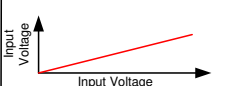
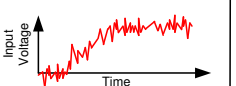
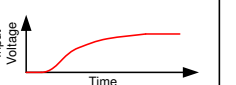

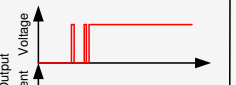
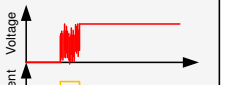
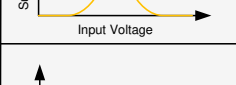

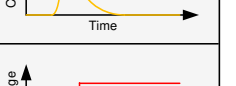
## 3 概要

SN74HCS595 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の 3 ステート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、それぞれ独立したクロックが供給されます。シフト・レジスタはダイレクト・オーバーライディング・クリア (SRCLR) 入力、シリアル (SER) 入力、カスケード用シリアル出力 ( $Q_H$ ) を備えています。出力イネーブル ( $\overline{OE}$ ) 入力が HIGH のとき、ストレージ・レジスタ出力は高インピーダンス状態になります。内部レジスタ・データおよびシリアル出力 ( $Q_H$ ) は、 $\overline{OE}$  入力の動作による影響を受けません。

### デバイス情報

部品番号	パッケージ (1)	本体サイズ (公称)
SN74HCS595PW	TSSOP (16)	5.00mm × 4.40mm
SN74HCS595D	SOIC (16)	9.90mm × 3.90mm
SN74HCS595BQB	WQFN (16)	3.60mm × 2.60mm
SN74HCS595DYY	SOT-23-THN (16)	4.20mm × 2.00mm

(1) 利用可能なすべての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。

	Low Power	Noise Rejection	Supports Slow Inputs
Input Voltage Waveforms			
Standard CMOS Input Response Waveforms			
Schmitt-trigger CMOS Input Response Waveforms			

### シュミット・トリガ入力の利点



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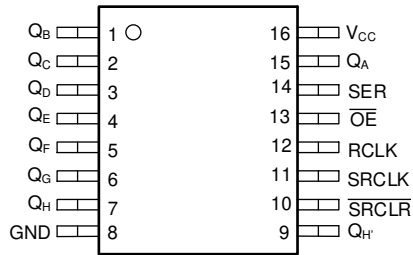
## 4 Revision History

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。

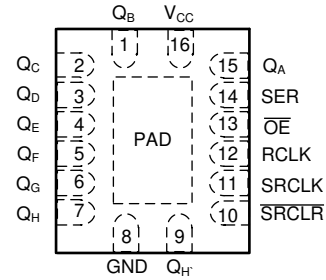
Changes from Revision * (August 2020) to Revision A (October 2020)	Page
• BQB および D パッケージを「アクティブ」ステータスに変更.....	1
• データシートのステータスを「量産データ」に変更.....	1

Changes from Revision A (October 2020) to Revision B (May 2021)	Page
• 「デバイス情報」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 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**

## ピン機能

ピン		種類	概要
名称	番号		
Q <sub>B</sub>	1	出力	Q <sub>B</sub> 出力
Q <sub>C</sub>	2	出力	Q <sub>C</sub> 出力
Q <sub>D</sub>	3	出力	Q <sub>D</sub> 出力
Q <sub>E</sub>	4	出力	Q <sub>E</sub> 出力
Q <sub>F</sub>	5	出力	Q <sub>F</sub> 出力
Q <sub>G</sub>	6	出力	Q <sub>G</sub> 出力
Q <sub>H</sub>	7	出力	Q <sub>H</sub> 出力
GND	8	—	グラウンド
Q <sub>H</sub>	9	出力	シリアル出力、カスケード用に使用可能
SRCLR	10	入力	シフトレジスタクリア、アクティブ Low
SRCLK	11	入力	シフトレジスタクロック、立ち上がりエッジがトリガされる
RCLK	12	入力	出力レジスタクロック、立ち上がりエッジがトリガされる
$\overline{OE}$	13	入力	出力イネーブル、アクティブ Low
SER	14	入力	シリアル入力
Q <sub>A</sub>	15	出力	Q <sub>A</sub> 出力
V <sub>CC</sub>	16	—	正電源
サーマルパッド <sup>(1)</sup>		—	サーマルパッドは GND に接続するか、フローティングのままにすることができます。他の信号や電源には接続しないでください。

1. BQB パッケージのみ。

## 6 Specifications

### 6.1 Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted)<sup>(1)</sup>

		MIN	MAX	UNIT
V <sub>CC</sub>	Supply voltage	-0.5	7	V
I <sub>IK</sub>	Input clamp current <sup>(2)</sup>	V <sub>I</sub> < -0.5 V or V <sub>I</sub> > V <sub>CC</sub> + 0.5 V		±20 mA
I <sub>OK</sub>	Output clamp current <sup>(2)</sup>	V <sub>I</sub> < -0.5 V or V <sub>I</sub> > V <sub>CC</sub> + 0.5 V		±20 mA
I <sub>O</sub>	Continuous output current	V <sub>O</sub> = 0 to V <sub>CC</sub>		±35 mA
	Continuous current through V <sub>CC</sub> or GND			±70 mA
T <sub>J</sub>	Junction temperature <sup>(3)</sup>			150 °C
T <sub>stg</sub>	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 <sub>(ESD)</sub>	Electrostatic discharge	Human-body model (HBM), per ANSI/ESDA/ JEDEC JS-001 <sup>(1)</sup>	±4000 V
		Charged-device model (CDM), per JEDEC specification JESD22-C101 <sup>(2)</sup>	±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 <sub>CC</sub>	Supply voltage	2	5	6	V
V <sub>I</sub>	Input voltage	0		V <sub>CC</sub>	V
V <sub>O</sub>	Output voltage	0		V <sub>CC</sub>	V
T <sub>A</sub>	Ambient temperature	-40		125	°C

### 6.4 Thermal Information

THERMAL METRIC <sup>(1)</sup>		SN74HCS595				UNIT
		PW (TSSOP)	D (SOIC)	BQB (WQFN)	DYY (SOT-23)	
		16 PINS	16 PINS	16 PINS	16 PINS	
R <sub>θJA</sub>	Junction-to-ambient thermal resistance	141.2	122.2	108.4	186.2	°C/W
R <sub>θJC(top)</sub>	Junction-to-case (top) thermal resistance	78.8	80.9	77.3	109.1	°C/W
R <sub>θJB</sub>	Junction-to-board thermal resistance	85.8	80.6	74.4	111.0	°C/W
Ψ <sub>JT</sub>	Junction-to-top characterization parameter	27.7	40.4	12.6	18.0	°C/W
Ψ <sub>JB</sub>	Junction-to-board characterization parameter	85.5	80.3	74.5	110.9	°C/W

THERMAL METRIC <sup>(1)</sup>		SN74HCS595				UNIT
		PW (TSSOP)	D (SOIC)	BQB (WQFN)	DYY (SOT-23)	
		16 PINS	16 PINS	16 PINS	16 PINS	
R <sub>θJC(bot)</sub>	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<sub>A</sub> = 25°C (unless otherwise noted).

PARAMETER		TEST CONDITIONS		V <sub>CC</sub>	MIN	TYP	MAX	UNIT
V <sub>T+</sub>	Positive switching threshold			2 V	0.7		1.5	V
				4.5 V	1.7		3.15	
				6 V	2.1		4.2	
V <sub>T-</sub>	Negative switching threshold			2 V	0.3		1.0	V
				4.5 V	0.9		2.2	
				6 V	1.2		3.0	
ΔV <sub>T</sub>	Hysteresis (V <sub>T+</sub> - V <sub>T-</sub> ) <sup>(1)</sup>			2 V	0.2		1.0	V
				4.5 V	0.4		1.4	
				6 V	0.6		1.6	
V <sub>OH</sub>	High-level output voltage	V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub>	I <sub>OH</sub> = -20 μA	2 V to 6 V	V <sub>CC</sub> - 0.1	V <sub>CC</sub> - 0.002		V
			I <sub>OH</sub> = -6 mA	4.5 V	4.0	4.3		
			I <sub>OH</sub> = -7.8 mA	6 V	5.4	5.75		
V <sub>OL</sub>	Low-level output voltage	V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub>	I <sub>OL</sub> = 20 μA	2 V to 6 V		0.002	0.1	V
			I <sub>OL</sub> = 6 mA	4.5 V		0.18	0.30	
			I <sub>OL</sub> = 7.8 mA	6 V		0.22	0.33	
I <sub>I</sub>	Input leakage current	V <sub>I</sub> = V <sub>CC</sub> or 0		6 V		±0.1	±1	μA
I <sub>OZ</sub>	Off-state (high-impedance state) output current	V <sub>O</sub> = V <sub>CC</sub> or 0		6 V		±0.5	±5	μA
I <sub>CC</sub>	Supply current	V <sub>I</sub> = V <sub>CC</sub> or 0, I <sub>O</sub> = 0		6 V		0.1	2	μA
C <sub>i</sub>	Input capacitance			2 V to 6 V			5	pF

(1) Guaranteed by design.

## 6.6 Timing Characteristics

C<sub>L</sub> = 50 pF; over operating free-air temperature range (unless otherwise noted). See [Parameter Measurement Information](#).

PARAMETER			V <sub>CC</sub>	Operating free-air temperature (T <sub>A</sub> )				UNIT
				25°C		-40°C to 125°C		
				MIN	MAX	MIN	MAX	
t <sub>w</sub>	Pulse duration	SRCLK or RCLK high or low	2 V	7		9	ns	
			4.5 V	7		7		
			6 V	7		7		
		SRCLR low	2 V	8		10		
			4.5 V	7		7		
			6 V	7		7		

$C_L = 50$  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	8		13	ns	
			4.5 V	4		5		
			6 V	3		4		
		SRCLK ↑ before RCLK ↑	2 V	11		18		
			4.5 V	5		7		
			6 V	4		6		
		SRCLR low before RCLK ↑	2 V	8		13		
			4.5 V	4		6		
			6 V	4		5		
		SRCLR high (inactive) before SRCLK ↑	2 V	8		13		
			4.5 V	4		6		
			6 V	4		5		
$t_h$	Hold time	SER after SRCLK ↑	2 V	0		0	ns	
			4.5 V	0		0		
			6 V	0		0		

## 6.7 Switching Characteristics

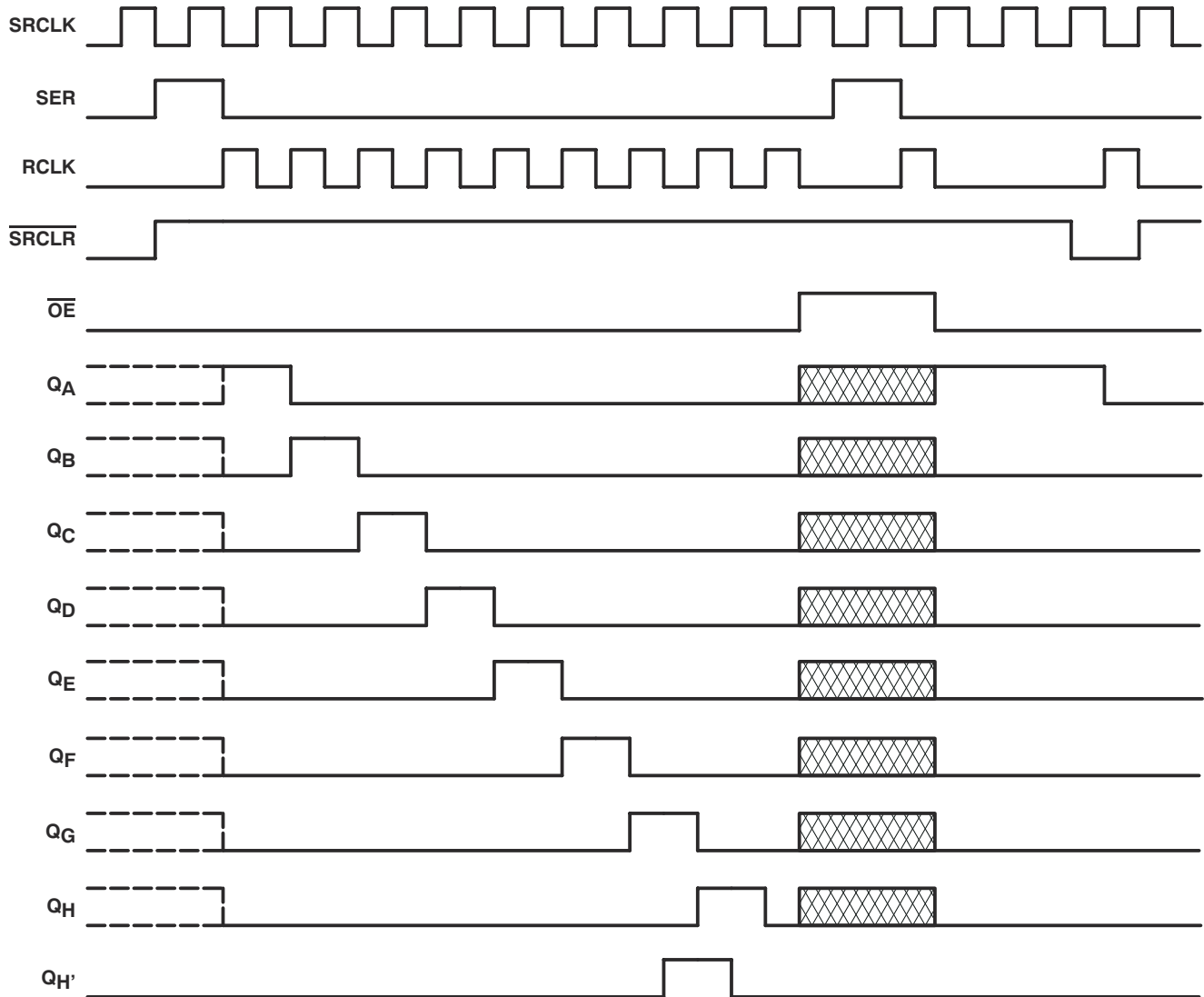
$C_L = 50$  pF; over operating free-air temperature range (unless otherwise noted). See [Parameter Measurement Information](#).


PARAMETER		FROM	TO	$V_{CC}$	Operating free-air temperature ( $T_A$ )					UNIT	
					25°C			–40°C to 125°C			
					MIN	TYP	MAX	MIN	TYP		MAX
$f_{max}$	Max switching frequency			2 V	35			19		MHz	
				4.5 V	110			60			
				6 V	130			75			
$t_{pd}$	Propagation delay	SRCLK	$Q_H$	2 V	14	19			28	ns	
				4.5 V	6	8			10		
				6 V	5	7			9		
		RCLK	$Q_A - Q_H$	2 V	16	21			37		
				4.5 V	6	9			12		
				6 V	6	8			10		
$t_{PHL}$	Propagation delay	SRCLR	$Q_H$	2 V	13	19			27	ns	
				4.5 V	6	8			11		
				6 V	6	8			10		
$t_{en}$	Enable time	$\overline{OE}$	$Q_A - Q_H$	2 V	12	18			27	ns	
				4.5 V	6	9			13		
				6 V	5	8			11		
$t_{dis}$	Disable time	$\overline{OE}$	$Q_A - Q_H$	2 V	13	16			20	ns	
				4.5 V	9	11			13		
				6 V	8	10			12		
$t_t$	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

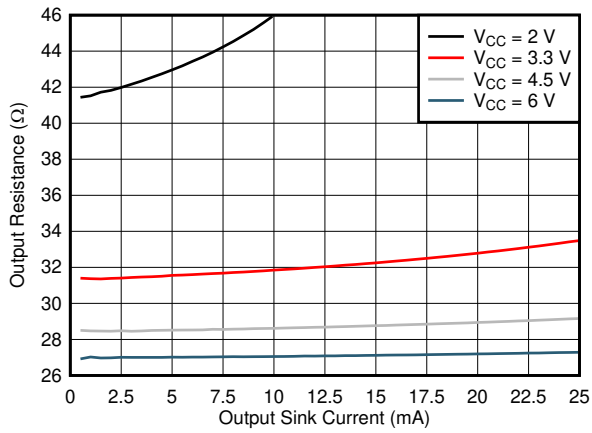


NOTE:  implies that the output is in 3-State mode.

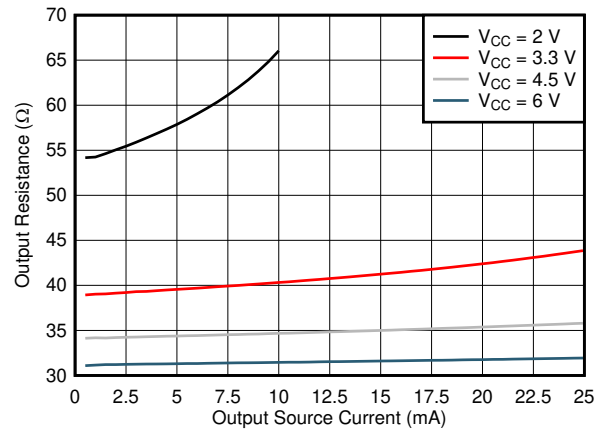
**6-1. Timing Diagram**

## 6.9 Typical Characteristics

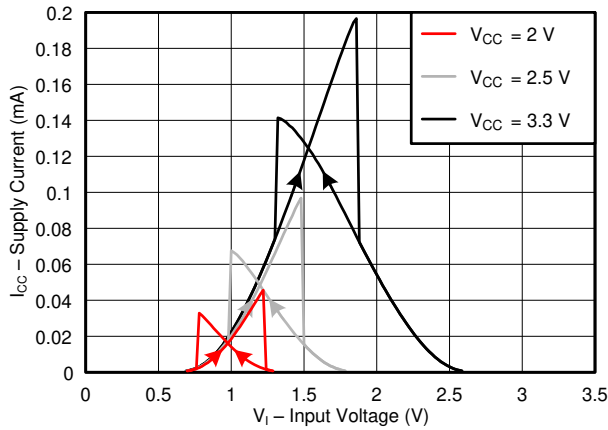
$T_A = 25^\circ\text{C}$



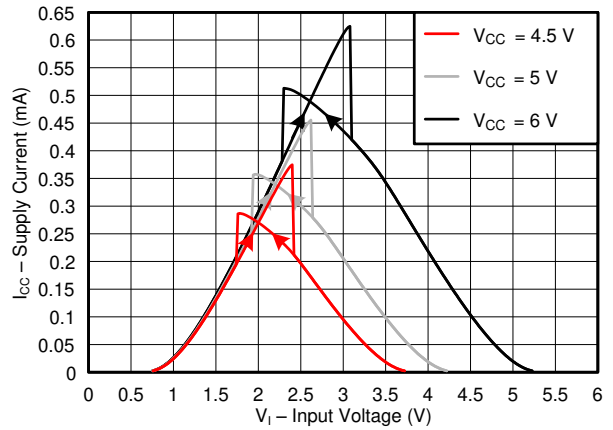
6-2. Output driver resistance in LOW state.



6-3. Output driver resistance in HIGH state.



6-4. Supply current across input voltage, 2-, 2.5-, and 3.3-V supply



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

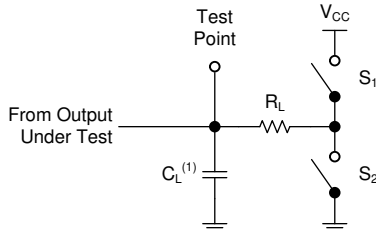


## 7 Parameter Measurement Information

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

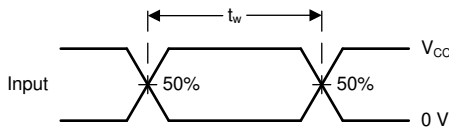
For clock inputs,  $f_{\text{max}}$  is measured when the input duty cycle is 50%.

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

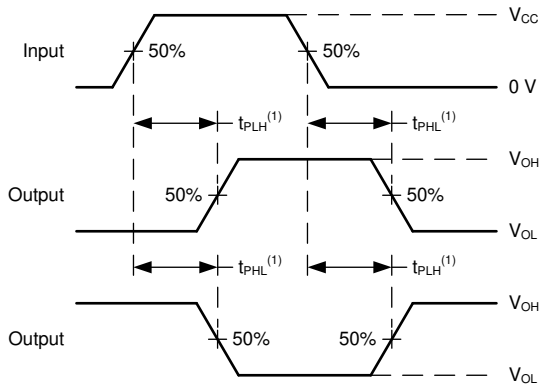


(1)  $C_L$  includes probe and test-fixture capacitance.

7-1. Load Circuit for 3-State Outputs

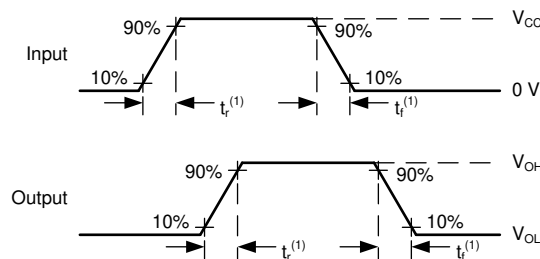


7-3. Voltage Waveforms, Pulse Duration



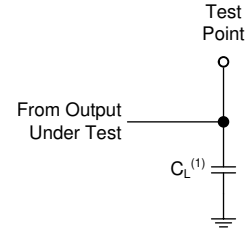
(1) The greater between  $t_{\text{PLH}}$  and  $t_{\text{PHL}}$  is the same as  $t_{\text{pd}}$ .

7-5. Voltage Waveforms Propagation Delays



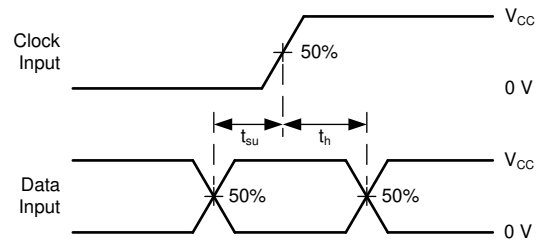
(1) The greater between  $t_r$  and  $t_f$  is the same as  $t_t$ .

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

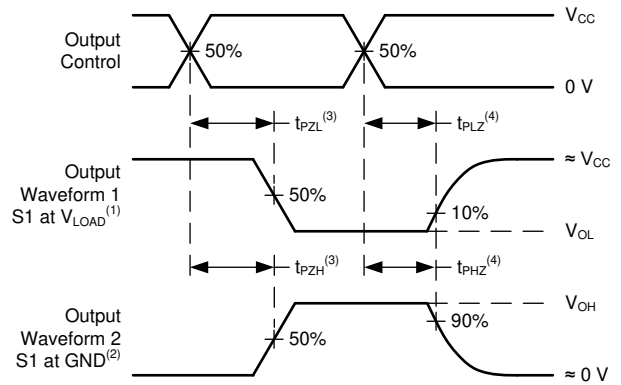


(1)  $C_L$  includes probe and test-fixture capacitance.

7-2. Load Circuit for Push-Pull Outputs



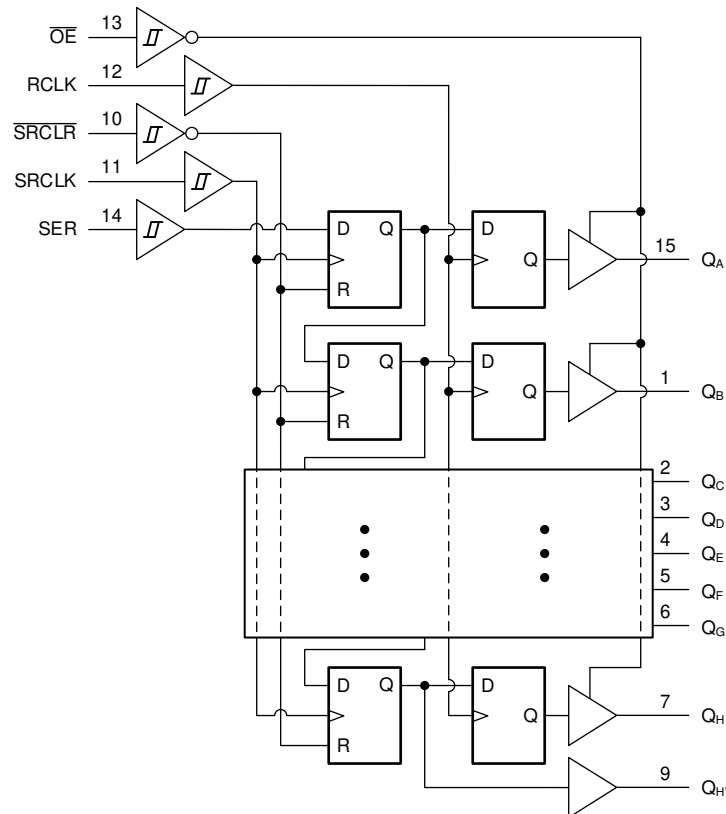
7-4. Voltage Waveforms, Setup and Hold Times



7-6. Voltage Waveforms Propagation Delays

## 8 Detailed Description

### 8.1 Functional Block Diagram



8-1. Logic Diagram (Positive Logic) for the SN74HCS595

## 8.2 Feature Description

### 8.2.1 Balanced CMOS 3-State Outputs

This device includes balanced CMOS 3-State outputs. The three states that these outputs can be in are driving high, driving low, and high impedance. 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.

When placed into the high-impedance mode, the output will neither source nor sink current, with the exception of minor leakage current as defined in the *Electrical Characteristics* table. In the high-impedance state, the output voltage is not controlled by the device and is dependent on external factors. If no other drivers are connected to the node, then this is known as a floating node and the voltage is unknown. A pull-up or pull-down resistor can be connected to the output to provide a known voltage at the output while it is in the high-impedance state. The value of the resistor will depend on multiple factors, including parasitic capacitance and power consumption limitations. Typically, a 10 kΩ resistor can be used to meet these requirements.

Unused 3-state CMOS outputs should be left disconnected.

### 8.2.2 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.

### 8.2.3 Latching Logic

This device includes latching logic circuitry. Latching circuits commonly include D-type latches and D-type flip-flops, but include all logic circuits that act as volatile memory.

When the device is powered on, the state of each latch is unknown. There is no default state for each latch at start-up.

The output state of each latching logic circuit only remains stable as long as power is applied to the device within the supply voltage range specified in the *Recommended Operating Conditions* table.

### 8.2.4 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.

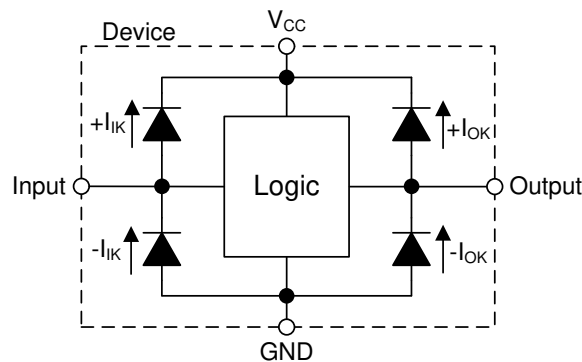


图 8-2. Electrical Placement of Clamping Diodes for Each Input and Output

## 8.3 Device Functional Modes

[Function Table](#) lists the functional modes of the SN74HCS595.

表 8-1. Function Table

INPUTS					FUNCTION
SER	SRCLK	SRCLR	RCLK	OE	
X	X	X	X	H	Outputs Q <sub>A</sub> – Q <sub>H</sub> are disabled
X	X	X	X	L	Outputs Q <sub>A</sub> – Q <sub>H</sub> are enabled.
X	X	L	X	X	Shift register is cleared.
L	↑	H	X	X	First stage of the shift register goes low. Other stages store the data of previous stage, respectively.
H	↑	H	X	X	First stage of the shift register goes high. Other stages store the data of previous stage, respectively.
X	X	H	↑	X	Shift-register data is stored in the storage register.

表 8-1. Function Table (continued)

INPUTS					FUNCTION
SER	SRCLK	SRCLR	RCLK	$\overline{OE}$	
X	↑	H	↑	X	Data in shift register is stored in the storage register, the data is then shifted through.

## 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となります。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 SN74HCS595 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 SN74HCS595 does not need a communication interface for control. It can be easily operated with simple GPIO pins.

The OE pin is used to easily disable the outputs when the displays need to be turned off or connected to a PWM signal to control brightness. However, this pin can be tied low and the outputs of the SN74HCS595 can be controlled accordingly to turn off all the outputs reducing the I/O needed to three. There is no practical limitation to how many SN74HCS595 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, the shift register needs to be cleared and then clocked into the output register. An RC can be connected to the  $\overline{\text{SRCLR}}$  pin as shown in the [Typical application block diagram](#) to initialize the shift register to all zeros. With the  $\overline{\text{OE}}$  pin pulled up with a resistor, this process can be performed while the outputs are in a high impedance state eliminating any erroneous data causing issues with the displays.

### 9.2 Typical Application

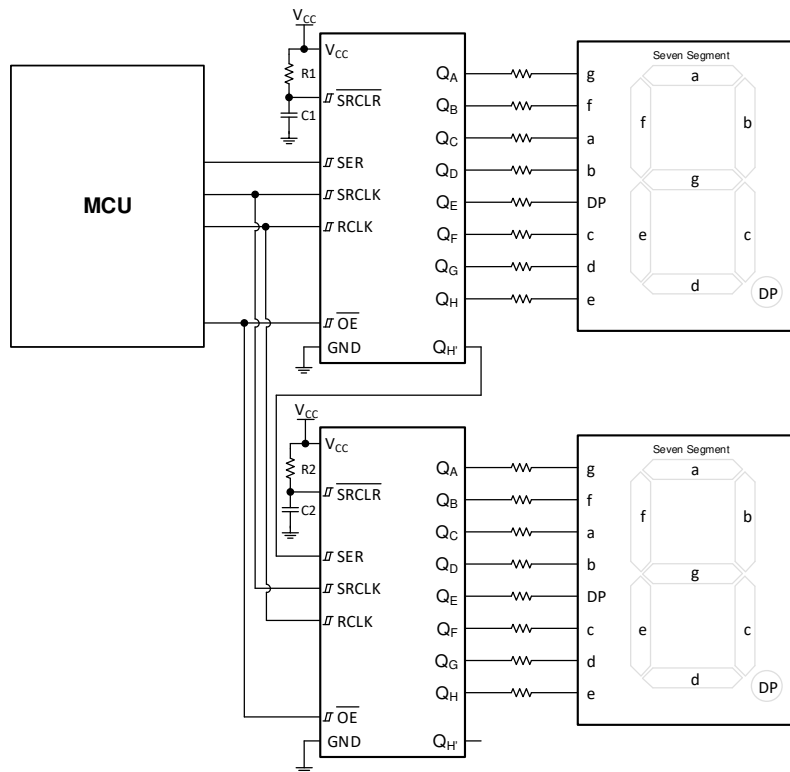


图 9-1. Typical application block diagram

## 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 SN74HCS595 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 SN74HCS595 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 SN74HCS595 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 SN74HCS595 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 SN74HCS595, as specified in the *Electrical Characteristics*, and the desired input transition rate. A 10-k $\Omega$  resistor value is often used due to these factors.

The SN74HCS595 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  $\leq 50$  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 SN74HCS595 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

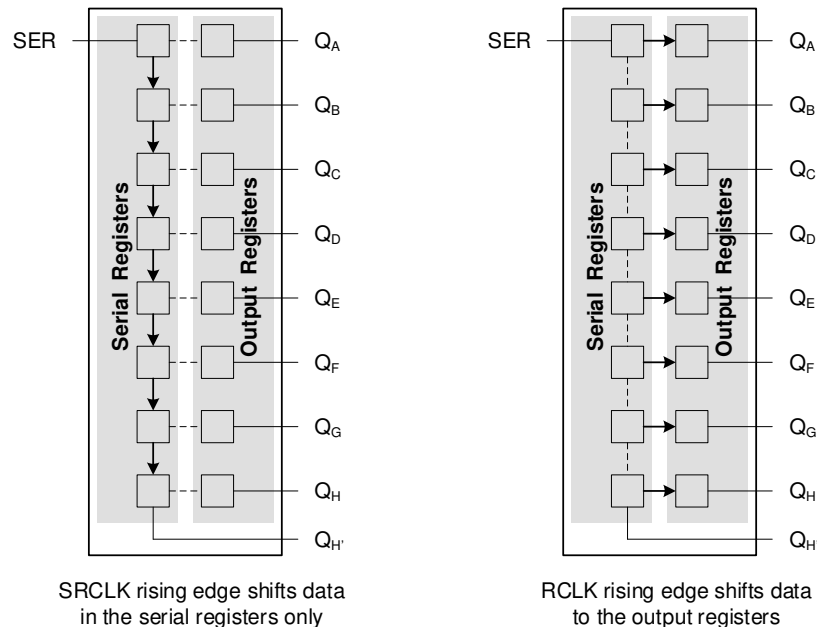


Figure 9-2. Simplified functional diagram showing clock operation

## 10 Power Supply Recommendations

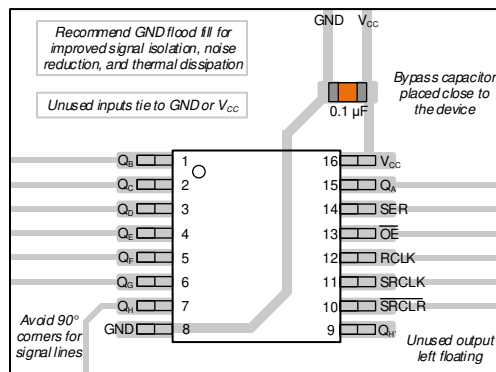
The power supply can be any voltage between the minimum and maximum supply voltage rating located in the *Recommended Operating Conditions*. Each  $V_{CC}$  terminal should have a good bypass capacitor to prevent power disturbance. A 0.1- $\mu\text{F}$  capacitor is recommended for this device. It is acceptable to parallel multiple bypass caps to reject different frequencies of noise. The 0.1- $\mu\text{F}$  and 1- $\mu\text{F}$  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



11-1. Example layout for the SN74HCS595.



## 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、設計に必要な支援を迅速に得ることができます。

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### 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 Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead finish/ Ball material (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
SN74HCS595BQBR	ACTIVE	WQFN	BQB	16	3000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	HCS595	<a href="#">Samples</a>
SN74HCS595DR	ACTIVE	SOIC	D	16	2500	RoHS & Green	NIPDAU   SN	Level-1-260C-UNLIM	-40 to 125	HCS595	<a href="#">Samples</a>
SN74HCS595DYR	ACTIVE	SOT-23-THIN	DYY	16	3000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	HCS595	<a href="#">Samples</a>
SN74HCS595PWR	ACTIVE	TSSOP	PW	16	2000	RoHS & Green	NIPDAU   SN	Level-1-260C-UNLIM	-40 to 125	HCS595	<a href="#">Samples</a>

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

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

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

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

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

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "-" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

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

**Important Information and Disclaimer:**The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and

continues to take reasonable steps to provide representative 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 SN74HCS595 :**

- Automotive : [SN74HCS595-Q1](#)

NOTE: Qualified Version Definitions:

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

**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
SN74HCS595BQBR	WQFN	BQB	16	3000	180.0	12.4	2.8	3.8	1.2	4.0	12.0	Q1
SN74HCS595DR	SOIC	D	16	2500	330.0	16.4	6.5	10.3	2.1	8.0	16.0	Q1
SN74HCS595DYR	SOT-23-THIN	DYY	16	3000	330.0	12.4	4.8	3.6	1.6	8.0	12.0	Q3
SN74HCS595PWR	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)
SN74HCS595BQBR	WQFN	BQB	16	3000	210.0	185.0	35.0
SN74HCS595DR	SOIC	D	16	2500	356.0	356.0	35.0
SN74HCS595DYYR	SOT-23-THIN	DYY	16	3000	336.6	336.6	31.8
SN74HCS595PWR	TSSOP	PW	16	2000	356.0	356.0	35.0

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.



4220204/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

PW0016A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



LAND PATTERN EXAMPLE  
EXPOSED METAL SHOWN  
SCALE: 10X



SOLDER MASK DETAILS

4220204/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

PW0016A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



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

4220204/A 02/2017

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.

## 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



NOTES:

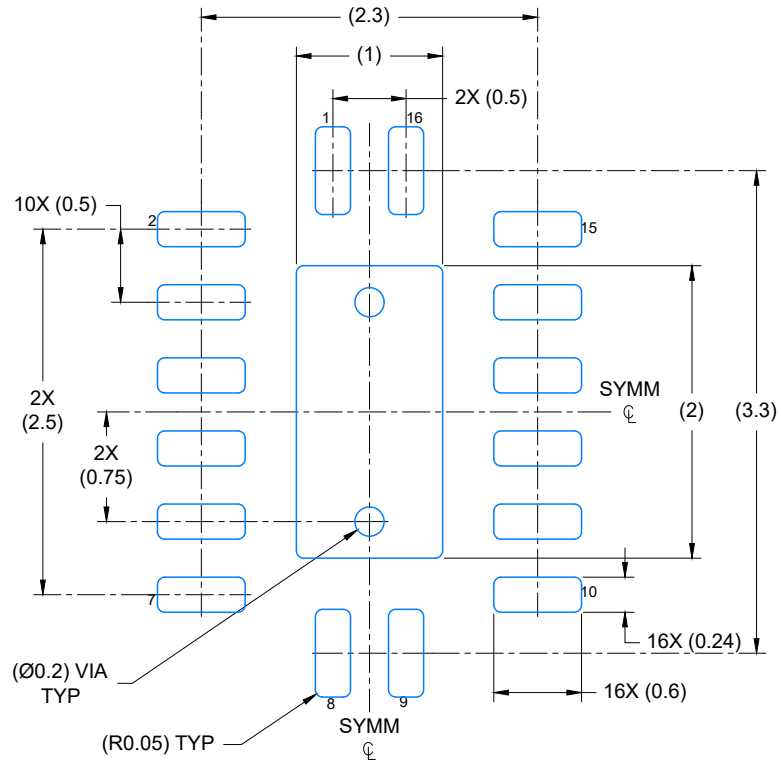
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. The package thermal pad must be soldered to the printed circuit board for optimal thermal and mechanical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

# EXAMPLE BOARD LAYOUT

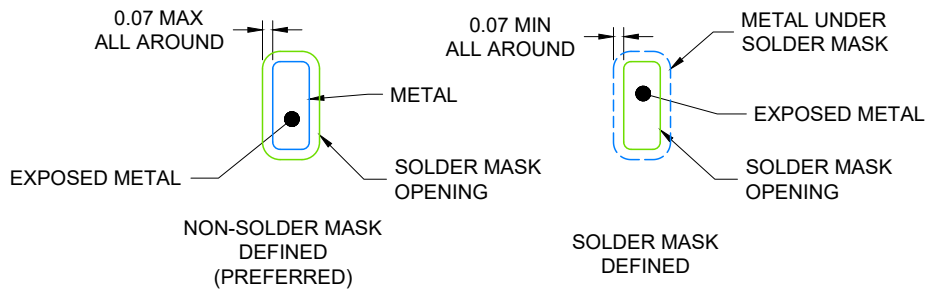
**BQB0016A**

**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)

- 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](http://www.ti.com/lit/slua271)).
- 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



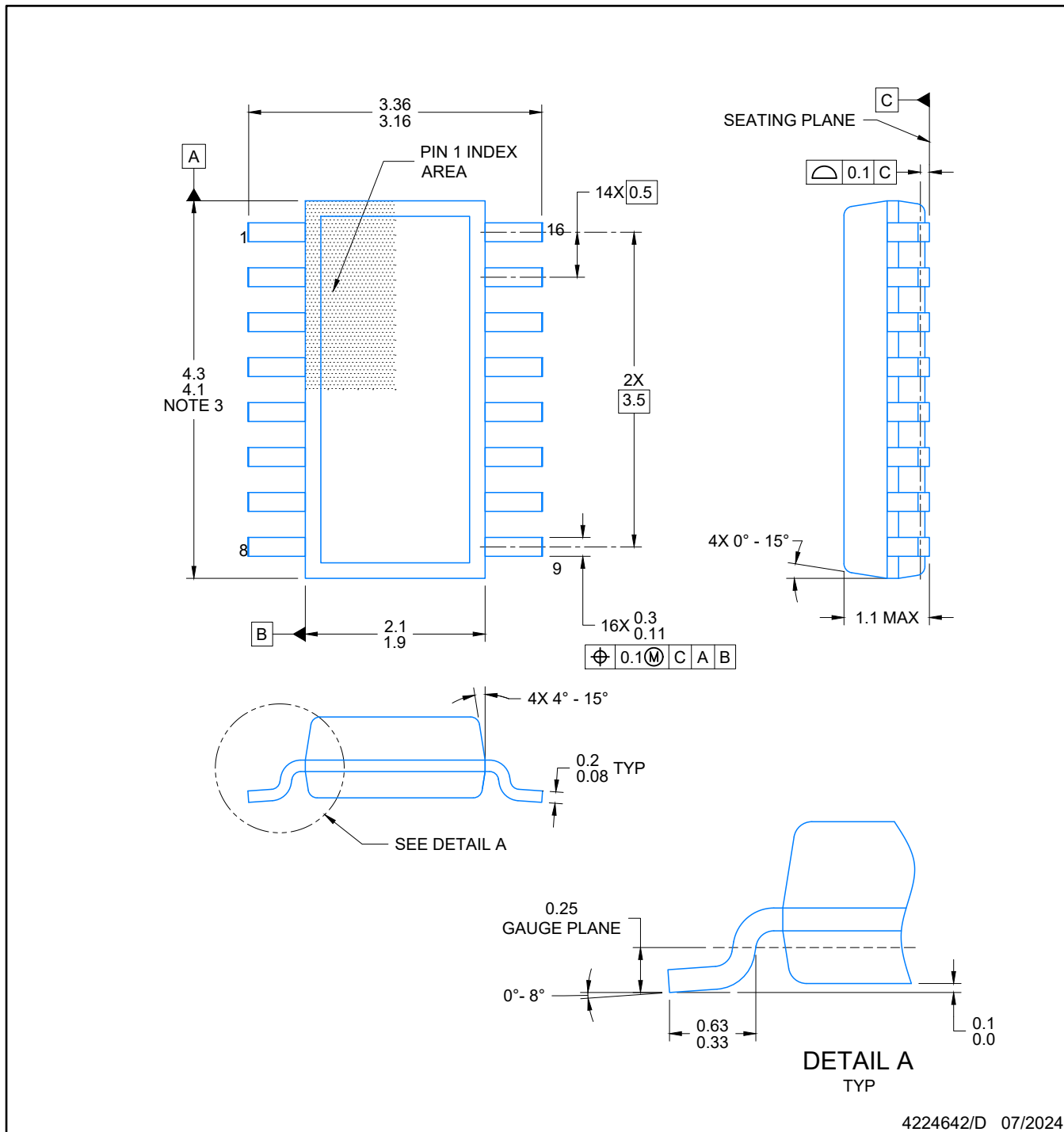
**SOLDER PASTE EXAMPLE**  
 BASED ON 0.125 mm THICK STENCIL

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

4224640/A 11/2018

NOTES: (continued)

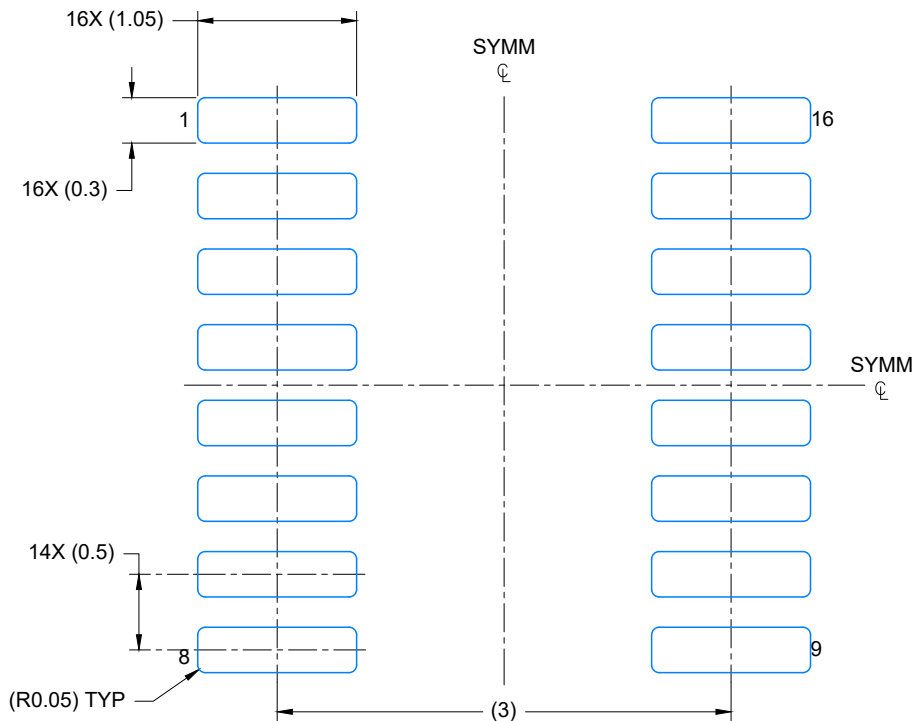
- 6. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.



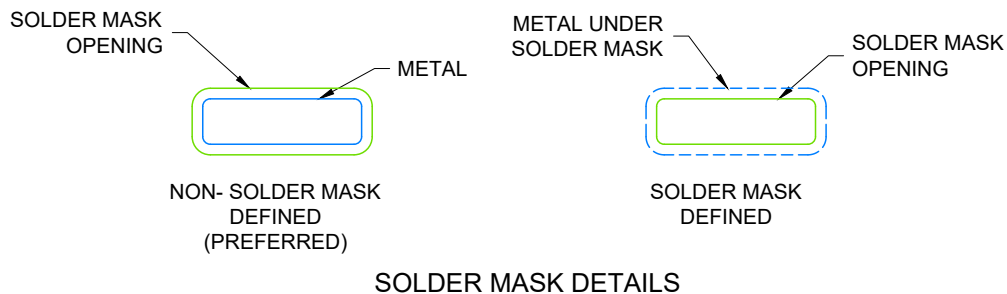
4224642/D 07/2024

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

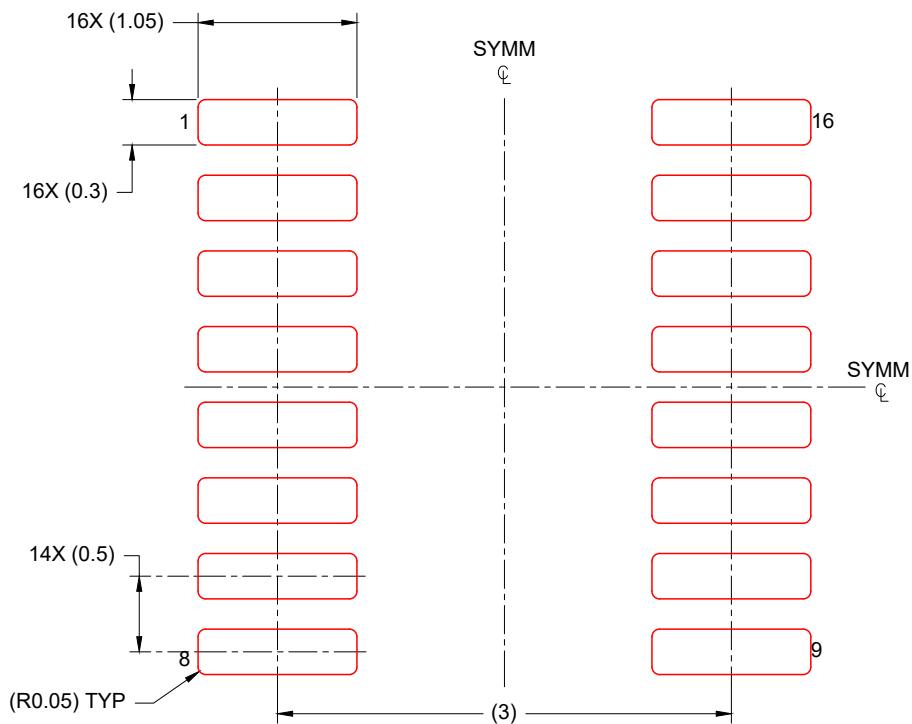


4224642/D 07/2024

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.





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.

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