

# 具有施密特触发输入、三态输出和直通引脚排列的 SN74HCS541 八路缓冲器和线路驱动器

## 1 特性

- 宽工作电压范围：2V 至 6V
- 施密特触发输入可耐受慢速或高噪声输入信号
- 低功耗
  - $I_{CC}$  典型值为 100nA
  - 输入漏电流典型值为  $\pm 100$ nA
- 电压为 6V 时，输出驱动为  $\pm 7.8$ mA
- 更宽泛的工作环境温度范围：-40°C 至 +125°C， $T_A$

## 2 应用

- 启用或禁用数字信号
- 消除缓慢或嘈杂输入信号
- 在控制器复位期间保持信号
- 对开关进行去抖

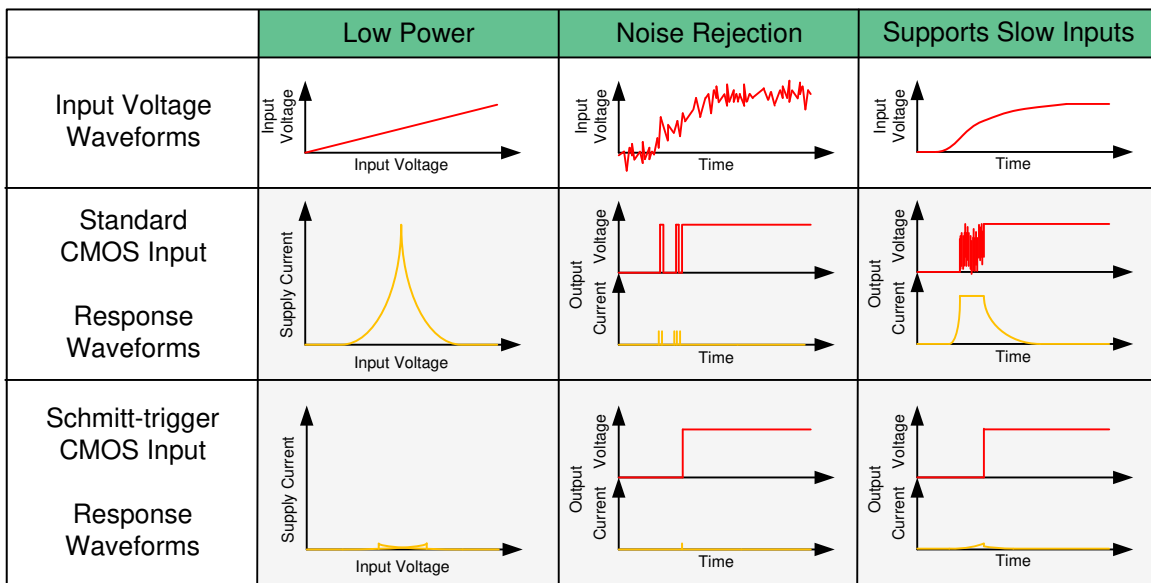
## 3 说明

SN74HCS541 包含三态输出和施密特触发输入的八路缓冲器。低电平有效输出能够使引脚 ( $\overline{OE1}$  和  $\overline{OE2}$ ) 控制所有八个通道，并配置为使输出都必须为低电平才能有效。

### 封装信息

| 器件型号       | 封装 <sup>(1)</sup> | 封装尺寸 (标称值)      |
|------------|-------------------|-----------------|
| SN74HCS541 | RKS ( VQFN , 20 ) | 4.50mm × 2.50mm |
|            | DGS ( SOT , 20 )  | 5.10mm × 3.00mm |

(1) 如需了解所有可用封装，请参阅数据表末尾的可订购产品附录。



施密特触发输入的优势

## Table of Contents

|                                                  |          |                                                                  |           |
|--------------------------------------------------|----------|------------------------------------------------------------------|-----------|
| <b>1 特性</b> .....                                | <b>1</b> | 8.3 Feature Description.....                                     | <b>8</b>  |
| <b>2 应用</b> .....                                | <b>1</b> | 8.4 Device Functional Modes.....                                 | <b>10</b> |
| <b>3 说明</b> .....                                | <b>1</b> | <b>9 Application and Implementation</b> .....                    | <b>11</b> |
| <b>4 Revision History</b> .....                  | <b>2</b> | 9.1 Application Information.....                                 | <b>11</b> |
| <b>5 Pin Configuration and Functions</b> .....   | <b>3</b> | 9.2 Typical Application.....                                     | <b>11</b> |
| <b>6 Specifications</b> .....                    | <b>4</b> | <b>10 Power Supply Recommendations</b> .....                     | <b>13</b> |
| 6.1 Absolute Maximum Ratings.....                | <b>4</b> | <b>11 Layout</b> .....                                           | <b>13</b> |
| 6.2 ESD Ratings.....                             | <b>4</b> | 11.1 Layout Guidelines.....                                      | <b>13</b> |
| 6.3 Recommended Operating Conditions.....        | <b>4</b> | 11.2 Layout Example.....                                         | <b>14</b> |
| 6.4 Thermal Information.....                     | <b>4</b> | <b>12 Device and Documentation Support</b> .....                 | <b>15</b> |
| 6.5 Electrical Characteristics.....              | <b>5</b> | 12.1 Documentation Support.....                                  | <b>15</b> |
| 6.6 Switching Characteristics.....               | <b>5</b> | 12.2 接收文档更新通知.....                                               | <b>15</b> |
| 6.7 Operating Characteristics.....               | <b>5</b> | 12.3 支持资源.....                                                   | <b>15</b> |
| 6.8 Typical Characteristics.....                 | <b>6</b> | 12.4 Trademarks.....                                             | <b>15</b> |
| <b>7 Parameter Measurement Information</b> ..... | <b>7</b> | 12.5 Electrostatic Discharge Caution.....                        | <b>15</b> |
| <b>8 Detailed Description</b> .....              | <b>8</b> | 12.6 术语表.....                                                    | <b>15</b> |
| 8.1 Overview.....                                | <b>8</b> | <b>13 Mechanical, Packaging, and Orderable Information</b> ..... | <b>15</b> |
| 8.2 Functional Block Diagram.....                | <b>8</b> |                                                                  |           |

## 4 Revision History

注：以前版本的页码可能与当前版本的页码不同

| <b>Changes from Revision A (August 2022) to Revision B (October 2022)</b>             | <b>Page</b> |
|---------------------------------------------------------------------------------------|-------------|
| • 删除了可湿性侧面.....                                                                       | <b>1</b>    |
| • Added DGS (SOT) package to Pin Configuration.....                                   | <b>3</b>    |
| • Added DGS (SOT) package to Thermal Information.....                                 | <b>4</b>    |
| <b>Changes from Revision * (October 2021) to Revision A (August 2022)</b>             | <b>Page</b> |
| • Updated the <i>Example Layout for the SN74HCS541 in the RKS Package</i> figure..... | <b>14</b>   |

## 5 Pin Configuration and Functions

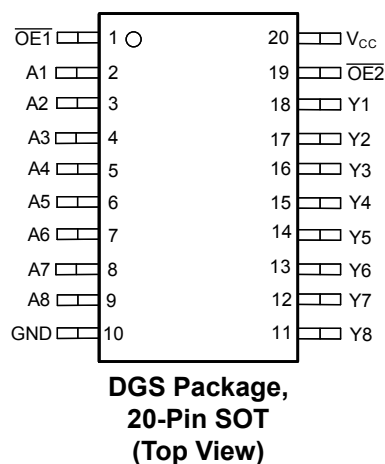
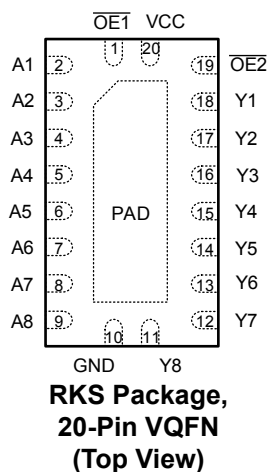


表 5-1. Pin Functions

| PIN                        |     | TYPE <sup>(1)</sup> | DESCRIPTION                                                                                           |
|----------------------------|-----|---------------------|-------------------------------------------------------------------------------------------------------|
| NAME                       | NO. |                     |                                                                                                       |
| OE1                        | 1   | I                   | Output enable input 1, active low                                                                     |
| A1                         | 2   | I                   | Input for channel 1                                                                                   |
| A2                         | 3   | I                   | Input for channel 2                                                                                   |
| A3                         | 4   | I                   | Input for channel 3                                                                                   |
| A4                         | 5   | I                   | Input for channel 4                                                                                   |
| A5                         | 6   | I                   | Input for channel 5                                                                                   |
| A6                         | 7   | I                   | Input for channel 6                                                                                   |
| A7                         | 8   | I                   | Input for channel 7                                                                                   |
| A8                         | 9   | I                   | Input for channel 8                                                                                   |
| GND                        | 10  | G                   | Ground                                                                                                |
| Y8                         | 11  | O                   | Output for channel 8                                                                                  |
| Y7                         | 12  | O                   | Output for channel 7                                                                                  |
| Y6                         | 13  | O                   | Output for channel 6                                                                                  |
| Y5                         | 14  | O                   | Output for channel 5                                                                                  |
| Y4                         | 15  | O                   | Output for channel 4                                                                                  |
| Y3                         | 16  | O                   | Output for channel 3                                                                                  |
| Y2                         | 17  | O                   | Output for channel 2                                                                                  |
| Y1                         | 18  | O                   | Output for channel 1                                                                                  |
| OE2                        | 19  | I                   | Output enable input 2, active low                                                                     |
| V <sub>CC</sub>            | 20  | P                   | Positive supply                                                                                       |
| Thermal Pad <sup>(2)</sup> |     | —                   | The thermal pad can be connect to GND or left floating. Do not connect to any other signal or supply. |

(1) I = Input, O = Output, I/O = Input or Output, G = Ground, P = Power.

(2) RKS package only.

## 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>O</sub> < -0.5 V or V <sub>O</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   |
| I <sub>CC</sub>  | 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) Operation outside the *Absolute Maximum Ratings* may cause permanent device damage. Absolute maximum ratings do not imply functional operation of the device at these or any other conditions beyond those listed under *Recommended Operating Conditions*. If briefly operating outside the *Recommended Operating Conditions* but within the *Absolute Maximum Ratings*, the device may not sustain damage, but it may not be fully functional. Operating the device in this manner may affect device reliability, functionality, performance, and shorten the device lifetime.
- (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 ANSI/ESDA/JEDEC JS-002 <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> |                                              | SN74HCS541 |           | UNIT |
|-------------------------------|----------------------------------------------|------------|-----------|------|
|                               |                                              | RKS (VQFN) | DGS (SOT) |      |
|                               |                                              | 20 PINS    | 20 PINS   |      |
| R <sub>θJA</sub>              | Junction-to-ambient thermal resistance       | 83.2       | 130.6     | °C/W |
| R <sub>θJC(top)</sub>         | Junction-to-case (top) thermal resistance    | 82.6       | 68.7      | °C/W |
| R <sub>θJB</sub>              | Junction-to-board thermal resistance         | 57.4       | 85.4      | °C/W |
| Ψ <sub>JT</sub>               | Junction-to-top characterization parameter   | 14.5       | 10.5      | °C/W |
| Ψ <sub>JB</sub>               | Junction-to-board characterization parameter | 56.4       | 85.0      | °C/W |
| R <sub>θJC(bot)</sub>         | Junction-to-case (bottom) thermal resistance | 40.0       | 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          | V             |
|              |                                                 |                                |                             | 4.5 V      | 0.9                            |            | 2.2        |               |
|              |                                                 |                                |                             | 6 V        | 1.2                            |            | 3          |               |
| $\Delta V_T$ | Hysteresis ( $V_{T+} - V_{T-}$ )                |                                |                             | 2 V        | 0.2                            |            | 1          | 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                              | 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       | 0.3        |               |
|              |                                                 |                                | $I_{OL} = 7.8\ \text{mA}$   | 6 V        |                                | 0.22       | 0.33       |               |
| $I_I$        | Input leakage current                           | $V_I = V_{CC}$ or 0            |                             | 6 V        |                                | $\pm 100$  | $\pm 1000$ | nA            |
| $I_{OZ}$     | Off-state (high-impedance state) output current | $V_O = V_{CC}$ or 0            |                             | 6 V        |                                | $\pm 0.01$ | $\pm 2$    | $\mu\text{A}$ |
| $I_{CC}$     | Supply current                                  | $V_I = V_{CC}$ or 0, $I_O = 0$ |                             | 6 V        |                                | 0.1        | 2          | $\mu\text{A}$ |
| $C_i$        | Input capacitance                               |                                |                             | 2 V to 6 V |                                |            | 5          | pF            |

## 6.6 Switching Characteristics

over operating free-air temperature range; typical values measured at  $T_A = 25^\circ\text{C}$  (unless otherwise noted). See *Parameter Measurement Information*.  $C_L = 50\ \text{pF}$ .

| PARAMETER |                   | FROM (INPUT)    | TO (OUTPUT) | $V_{CC}$ | MIN | TYP | MAX | UNIT |
|-----------|-------------------|-----------------|-------------|----------|-----|-----|-----|------|
| $t_{pd}$  | Propagation delay | A               | Y           | 2 V      |     | 13  | 45  | ns   |
|           |                   |                 |             | 4.5 V    |     | 7   | 18  |      |
|           |                   |                 |             | 6 V      |     | 6   | 16  |      |
| $t_{en}$  | Enable time       | $\overline{OE}$ | Y           | 2 V      |     | 15  | 44  | ns   |
|           |                   |                 |             | 4.5 V    |     | 7   | 22  |      |
|           |                   |                 |             | 6 V      |     | 6   | 18  |      |
| $t_{dis}$ | Disable time      | $\overline{OE}$ | Y           | 2 V      |     | 12  | 30  | ns   |
|           |                   |                 |             | 4.5 V    |     | 9   | 20  |      |
|           |                   |                 |             | 6 V      |     | 8   | 19  |      |
| $t_t$     | Transition-time   |                 | Any         | 2 V      |     | 9   | 16  | ns   |
|           |                   |                 |             | 4.5 V    |     | 5   | 9   |      |
|           |                   |                 |             | 6 V      |     | 4   | 8   |      |

## 6.7 Operating Characteristics

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

| PARAMETER |                                        | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|-----------|----------------------------------------|-----------------|-----|-----|-----|------|
| $C_{pd}$  | Power dissipation capacitance per gate | No load         |     | 20  |     | pF   |

## 6.8 Typical Characteristics

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

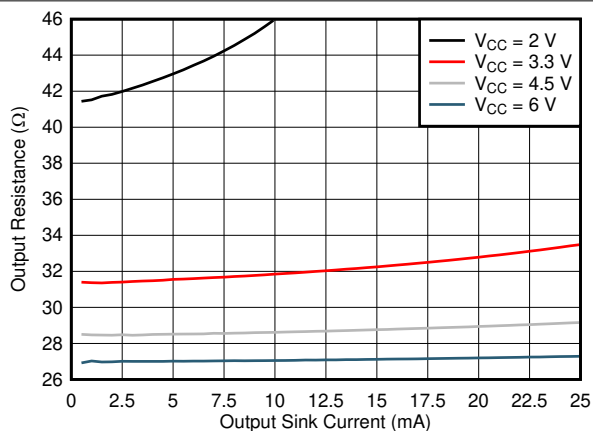


图 6-1. Output Driver Resistance in LOW State

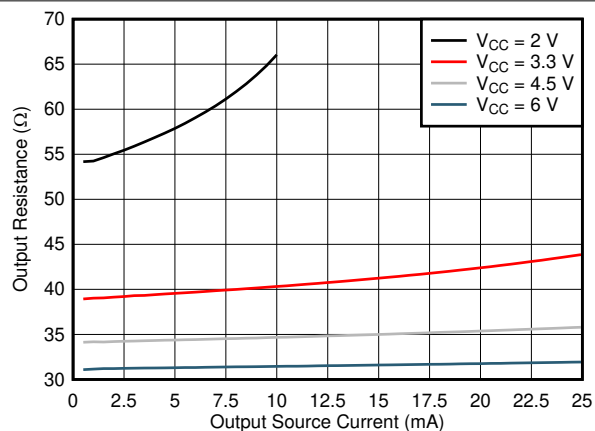


图 6-2. Output Driver Resistance in HIGH State

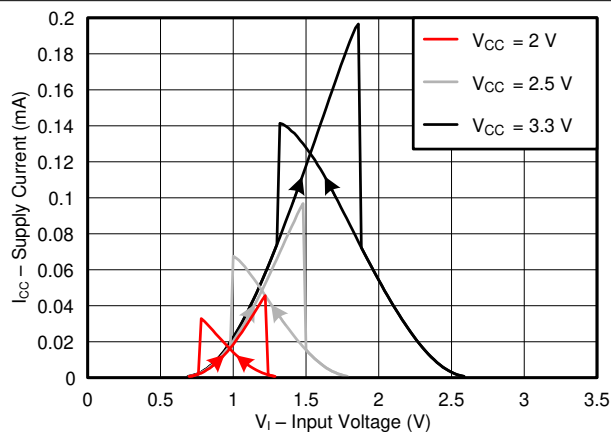


图 6-3. Supply Current Across Input Voltage, 2-, 2.5-, and 3.3-V Supply

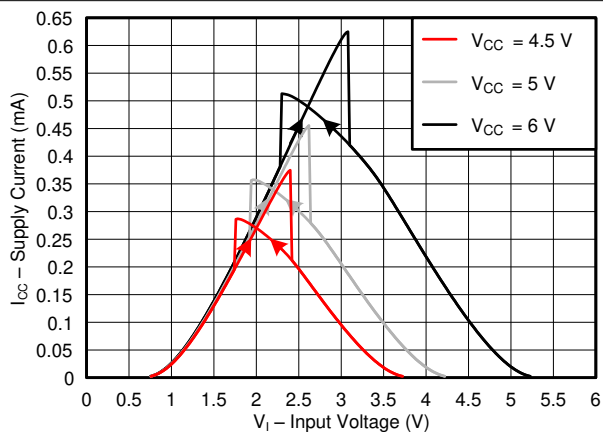


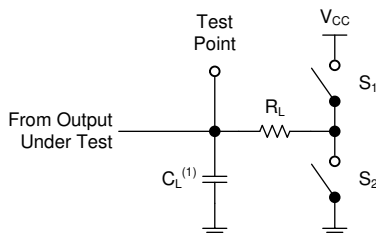
图 6-4. Supply Current Across Input Voltage, 4.5-, 5-, and 6-V Supply

## 7 Parameter Measurement Information

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

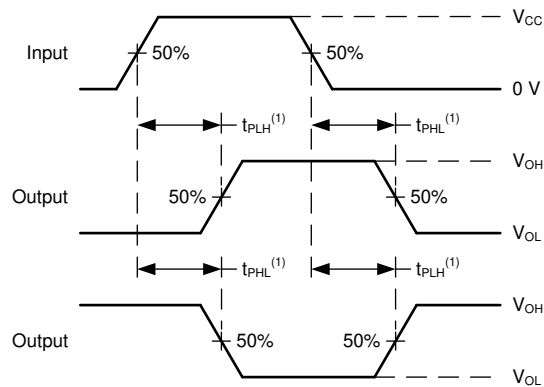
For clock inputs,  $f_{\max}$  is measured when the input duty cycle is 50%.

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



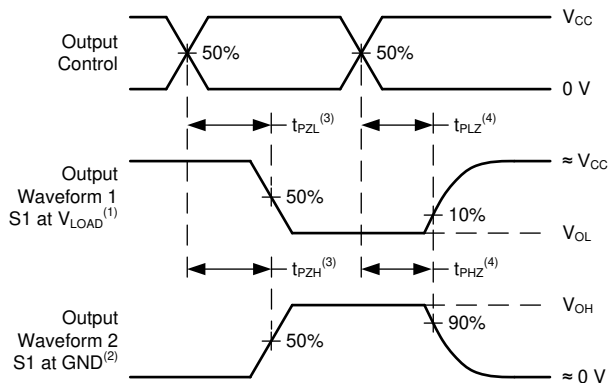
(1)  $C_L$  includes probe and test-fixture capacitance.

**图 7-1. Load Circuit for 3-State Outputs**

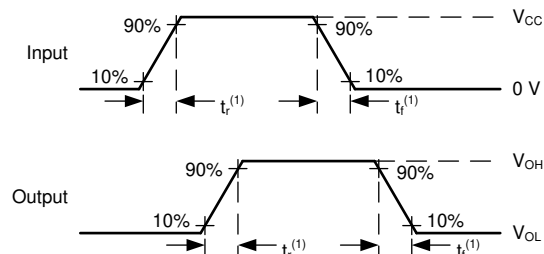


(1) The greater between  $t_{PLH}^{(1)}$  and  $t_{PHL}^{(1)}$  is the same as  $t_{pd}$ .

**图 7-2. Voltage Waveforms Propagation Delays**



**图 7-3. Voltage Waveforms Propagation Delays**



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

**图 7-4. Voltage Waveforms, Input and Output Transition Times**

## 8 Detailed Description

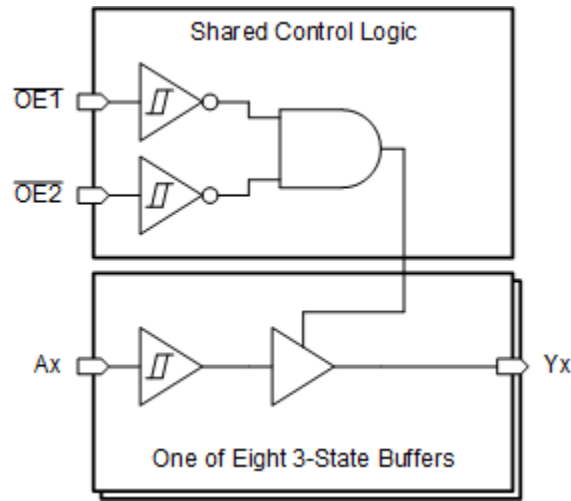
### 8.1 Overview

The SN74HCS541 contains eight buffers with 3-state outputs and Schmitt-trigger inputs. The active low output enable pins ( $\overline{OE1}$  and  $\overline{OE2}$ ) control all eight channels, and are configured so that both must be low for the outputs to be active.

When the outputs are enabled, the outputs are actively driving low or high.

When the outputs are disabled, the outputs are set into the high-impedance state.

### 8.2 Functional Block Diagram



### 8.3 Feature Description

#### 8.3.1 Balanced CMOS 3-State Outputs

This device includes balanced CMOS 3-state outputs. Driving high, driving low, and high impedance are the three states that these outputs can be in. 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-k $\Omega$  resistor can be used to meet these requirements.

Unused 3-state CMOS outputs should be left disconnected.

#### 8.3.2 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.

### 8.3.3 Open-Drain CMOS Outputs

This device includes open-drain CMOS outputs. Open-drain outputs can only drive the output low. When in the high logical state, open-drain outputs will be in a high-impedance state. 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 state, 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 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 k $\Omega$  resistor can be used to meet these requirements.

Unused open-drain CMOS outputs should be left disconnected.

### 8.3.4 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  $\Delta V_T$  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](#).

### 8.3.5 TTL 兼容型 CMOS 输入

此器件包括 TTL 兼容型 CMOS 输入。这些输入专门设计为通过降低的输入电压阈值与 TTL 逻辑器件连接。

TTL 兼容型 CMOS 输入为高阻抗，通常建模为与输入电容并联的电阻器，如 *电气特性* 中所示。最坏情况下的电阻是根据 *绝对最大额定值* 中给出的最大输入电压和 *电气特性* 中给出的最大输入漏电流，使用欧姆定律 ( $R = V \div I$ ) 计算得出的。

TTL 兼容型 CMOS 输入要求输入信号在有效逻辑状态之间快速转换，如 *建议运行条件* 表中的输入转换时间或速率所定义。不符合此规范将导致功耗过大并可能导致振荡。有关更多详细信息，请参阅 [CMOS 输入缓慢变化或悬空的影响](#) 应用报告。

在运行期间，任何时候都不要让 TTL 兼容型 CMOS 输入悬空。未使用的输入必须在  $V_{CC}$  或 GND 端接。如果系统不会一直主动驱动输入，可以添加上拉或下拉电阻器，以在这些时间段提供有效的输入电压。电阻值将取决于多种因素；但建议使用 10k $\Omega$  电阻器，这通常可以满足所有要求。

### 8.3.6 Standard CMOS Inputs

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

Standard CMOS inputs require that input signals transition between valid logic states quickly, as defined by the input transition time or rate in the *Recommended Operating Conditions* table. Failing to meet this specification

will result in excessive power consumption and could cause oscillations. More details can be found in [Implications of Slow or Floating CMOS Inputs](#).

Do not leave standard CMOS inputs floating at any time during operation. Unused inputs must be terminated at  $V_{CC}$  or GND. If a system will not be actively driving an input at all times, then a pull-up or pull-down resistor can be added to provide a valid input voltage during these times. The resistor value will depend on multiple factors; a 10-k $\Omega$  resistor, however, is recommended and will typically meet all requirements.

### 8.3.7 Clamp Diode Structure

As shown in [图 8-1](#), the inputs and outputs to this device have both positive and negative clamping diodes.

**CAUTION**

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.

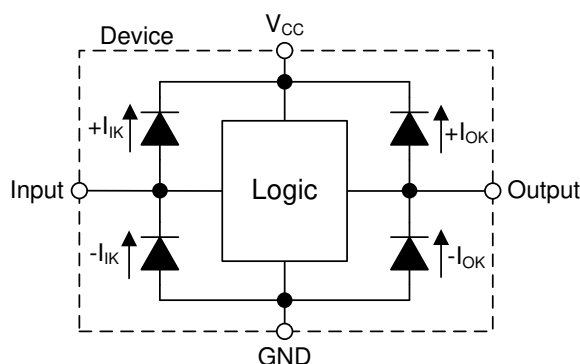


图 8-1. Electrical Placement of Clamping Diodes for Each Input and Output

## 8.4 Device Functional Modes

表 8-1. Function Table

| INPUTS <sup>(1)</sup> |     |   | OUTPUT <sup>(2)</sup> |
|-----------------------|-----|---|-----------------------|
| OE1                   | OE2 | A | Y                     |
| L                     | L   | L | L                     |
| L                     | L   | H | H                     |
| H                     | X   | X | Z                     |
| X                     | H   | X | Z                     |

(1) L = input low, H = input high, X = do not care

(2) L = output low, H = output high, Z = high impedance

## 9 Application and Implementation

### 备注

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, as well as validating and testing their design implementation to confirm system functionality.

### 9.1 Application Information

The SN74HCS541 can be used to drive signals over relatively long traces or transmission lines. In order to reduce ringing caused by impedance mismatches between the driver, transmission line, and receiver, a series damping resistor placed in series with the transmitter's output can be used. The figure in the *Application Curve* section shows the received signal with three separate resistor values. Just a small amount of resistance can make a significant impact on signal integrity in this type of application.

### 9.2 Typical Application

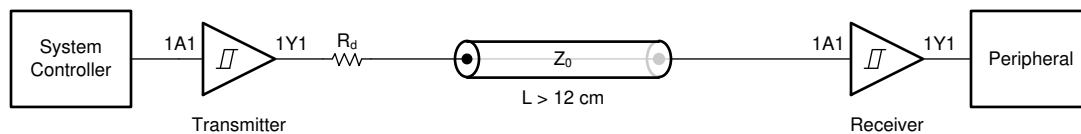


图 9-1. Typical Application Block Diagram

#### 9.2.1 Design Requirements

- All signals in the system operate at 5 V
- Avoid unstable state by not having LOW signals on both inputs
- Q output is HIGH when  $\bar{S}$  is LOW
  - Q output remains HIGH until  $\bar{R}$  is LOW

##### 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* section.

The positive voltage supply must be capable of sourcing current equal to the total current to be sourced by all outputs of the SN74HCS541 plus the maximum static supply current,  $I_{CC}$ , listed in the *Electrical Characteristics*, and any transient current required for switching. The logic device can only source as much current that is provided by the positive supply source. Be sure to not 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 SN74HCS541 plus the maximum supply current,  $I_{CC}$ , listed in the *Electrical Characteristics*, and any transient current required for switching. The logic device can only sink as much current that can be sunk into its ground connection. Be sure to not exceed the maximum total current through GND listed in the *Absolute Maximum Ratings*.

The SN74HCS541 can drive a load with a total capacitance less than or equal to 50 pF while still meeting all of the data sheet specifications. Larger capacitive loads can be applied; however, it is not recommended to exceed 50 pF.

The SN74HCS541 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](#).

#### CAUTION

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. The unused inputs 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 will 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 drive current of the controller, leakage current into the SN74HCS541 (as specified in the *Electrical Characteristics*), and the desired input transition rate limits the resistor size. A 10-k  $\Omega$  resistor value is often used due to these factors.

The SN74HCS541 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 the *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; it will, however, ensure optimal performance. This can be accomplished by providing short, appropriately sized traces from the SN74HCS541 to one or more of the receiving devices.
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  $M\Omega$ ; much larger than the minimum calculated previously.
4. Thermal issues are rarely a concern for logic gates; the power consumption and thermal increase, however, can be calculated using the steps provided in the application report, [CMOS Power Consumption and Cpd Calculation](#).

## 9.2.3 Application Curves

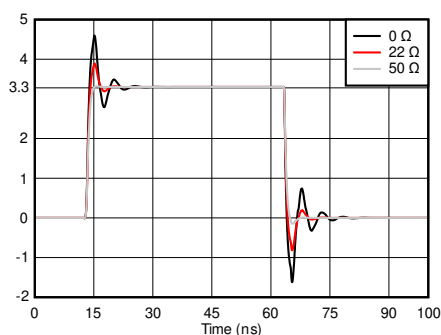


图 9-2. Simulated Signal Integrity at the Receiver With Different Damping Resistor ( $R_d$ ) Values

## 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- $\mu$ F capacitor is recommended for this device. It is acceptable to parallel multiple bypass capacitors to reject different frequencies of noise. The 0.1- $\mu$ F and 1- $\mu$ 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 the following layout example.

## 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

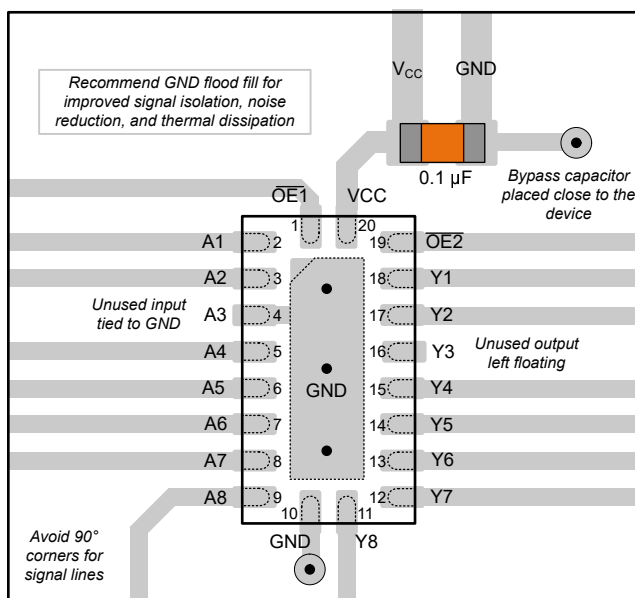


图 11-1. Example Layout for the SN74HCS541 in the RKS Package

## 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](#)
- Texas Instruments, [CMOS Power Consumption and  \$C\_{pd}\$  Calculation application report](#)
- Texas Instruments, [Designing With Logic application report](#)

### 12.2 接收文档更新通知

要接收文档更新通知，请导航至 [ti.com](#) 上的器件产品文件夹。点击 [订阅更新](#) 进行注册，即可每周接收产品信息更改摘要。有关更改的详细信息，请查看任何已修订文档中包含的修订历史记录。

### 12.3 支持资源

[TI E2E™ 支持论坛](#) 是工程师的重要参考资料，可直接从专家获得快速、经过验证的解答和设计帮助。搜索现有解答或提出自己的问题可获得所需的快速设计帮助。

链接的内容由各个贡献者“按原样”提供。这些内容并不构成 TI 技术规范，并且不一定反映 TI 的观点；请参阅 TI 的 [《使用条款》](#)。

### 12.4 Trademarks

TI E2E™ is a trademark of Texas Instruments.

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### 12.5 Electrostatic Discharge Caution



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

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

### 12.6 术语表

[TI 术语表](#) 本术语表列出并解释了术语、首字母缩略词和定义。

## 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<br>(1) | Material type<br>(2) | Package   Pins   | Package qty   Carrier | RoHS<br>(3) | Lead finish/<br>Ball material<br>(4) | MSL rating/<br>Peak reflow<br>(5) | Op temp (°C) | Part marking<br>(6) |
|--------------------------------|---------------|----------------------|------------------|-----------------------|-------------|--------------------------------------|-----------------------------------|--------------|---------------------|
| <a href="#">SN74HCS541DGSR</a> | Active        | Production           | VSSOP (DGS)   20 | 5000   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -40 to 125   | HS541               |
| SN74HCS541DGSR.A               | Active        | Production           | VSSOP (DGS)   20 | 5000   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -40 to 125   | HS541               |
| <a href="#">SN74HCS541RKSR</a> | Active        | Production           | VQFN (RKS)   20  | 3000   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -40 to 125   | HCS541              |
| SN74HCS541RKSR.A               | Active        | Production           | VQFN (RKS)   20  | 3000   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -40 to 125   | HCS541              |
| SN74HCS541RKSRG4               | Active        | Production           | VQFN (RKS)   20  | 3000   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -40 to 125   | HCS541              |
| SN74HCS541RKSRG4.A             | Active        | Production           | VQFN (RKS)   20  | 3000   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -40 to 125   | HCS541              |

<sup>(1)</sup> **Status:** For more details on status, see our [product life cycle](#).

<sup>(2)</sup> **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.

<sup>(3)</sup> **RoHS values:** Yes, No, RoHS Exempt. See the [TI RoHS Statement](#) for additional information and value definition.

<sup>(4)</sup> **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.

<sup>(5)</sup> **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.

<sup>(6)</sup> **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.

**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 SN74HCS541 :**

- Automotive : [SN74HCS541-Q1](#)

NOTE: Qualified Version Definitions:

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

## TAPE AND REEL INFORMATION



\*All dimensions are nominal

| Device           | Package Type | Package Drawing | Pins | SPQ  | Reel Diameter (mm) | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P1 (mm) | W (mm) | Pin1 Quadrant |
|------------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| SN74HCS541DGSR   | VSSOP        | DGS             | 20   | 5000 | 330.0              | 16.4               | 5.4     | 5.4     | 1.45    | 8.0     | 16.0   | Q1            |
| SN74HCS541RKSR   | VQFN         | RKS             | 20   | 3000 | 180.0              | 12.4               | 2.8     | 4.8     | 1.2     | 4.0     | 12.0   | Q1            |
| SN74HCS541RKSRG4 | VQFN         | RKS             | 20   | 3000 | 180.0              | 12.4               | 2.8     | 4.8     | 1.2     | 4.0     | 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) |
|------------------|--------------|-----------------|------|------|-------------|------------|-------------|
| SN74HCS541DGSR   | VSSOP        | DGS             | 20   | 5000 | 353.0       | 353.0      | 32.0        |
| SN74HCS541RKSR   | VQFN         | RKS             | 20   | 3000 | 210.0       | 185.0      | 35.0        |
| SN74HCS541RKSRG4 | VQFN         | RKS             | 20   | 3000 | 210.0       | 185.0      | 35.0        |

## GENERIC PACKAGE VIEW

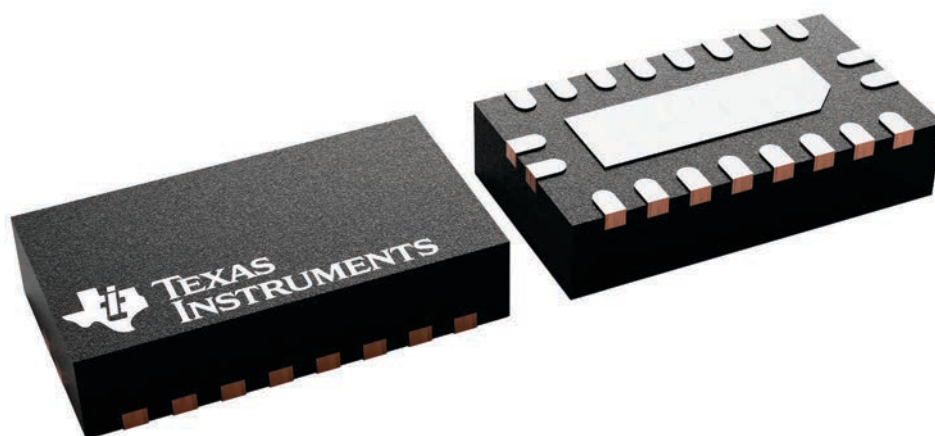
**RKS 20**

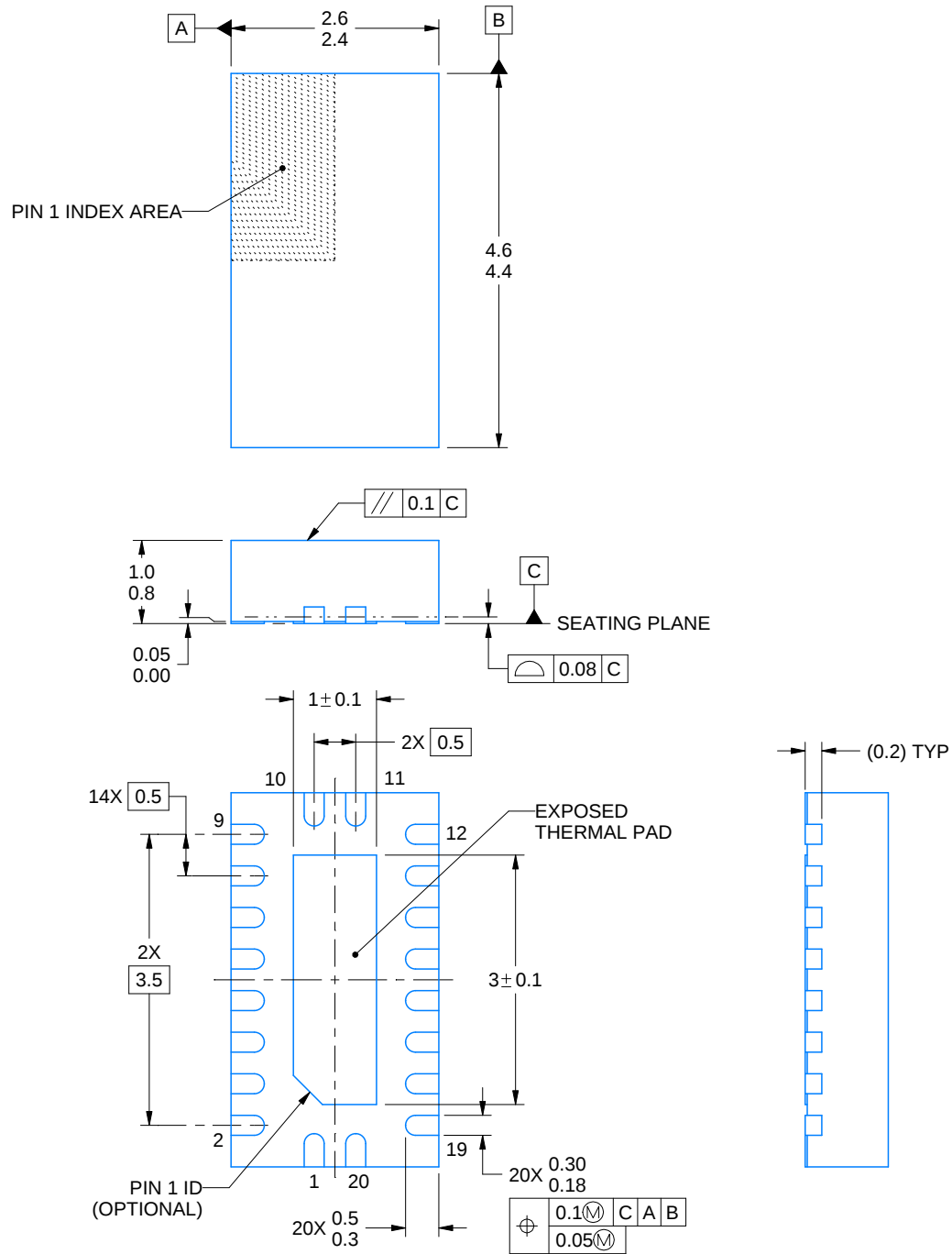
**VQFN - 1 mm max height**

2.5 x 4.5, 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.





4222490/B 02/2021

## NOTES:

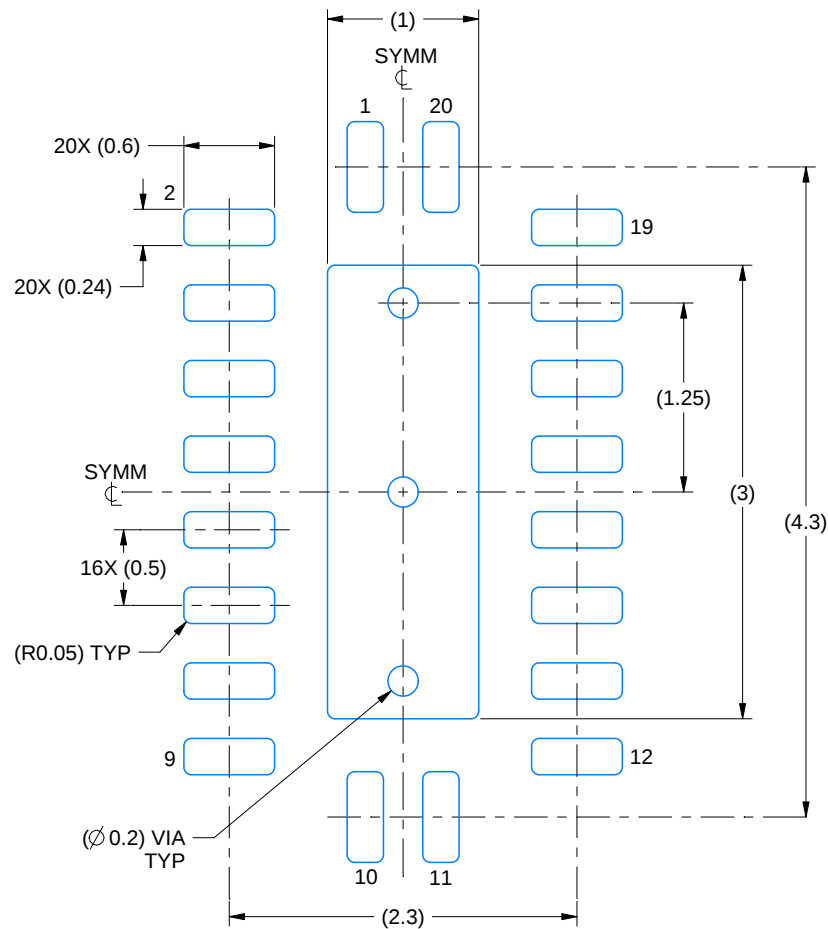
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. The package thermal pad must be soldered to the printed circuit board for thermal and mechanical performance.

# EXAMPLE BOARD LAYOUT

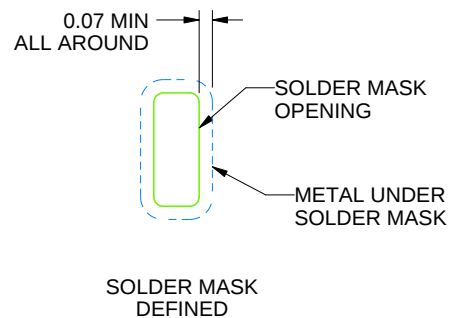
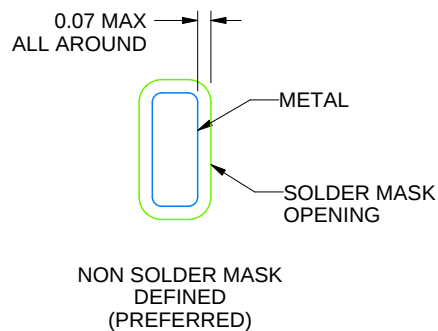
RKS0020A

VQFN - 1 mm max height

PLASTIC QUAD FLATPACK - NO LEAD



LAND PATTERN EXAMPLE  
SCALE:20X



SOLDER MASK DETAILS

4222490/B 02/2021

NOTES: (continued)

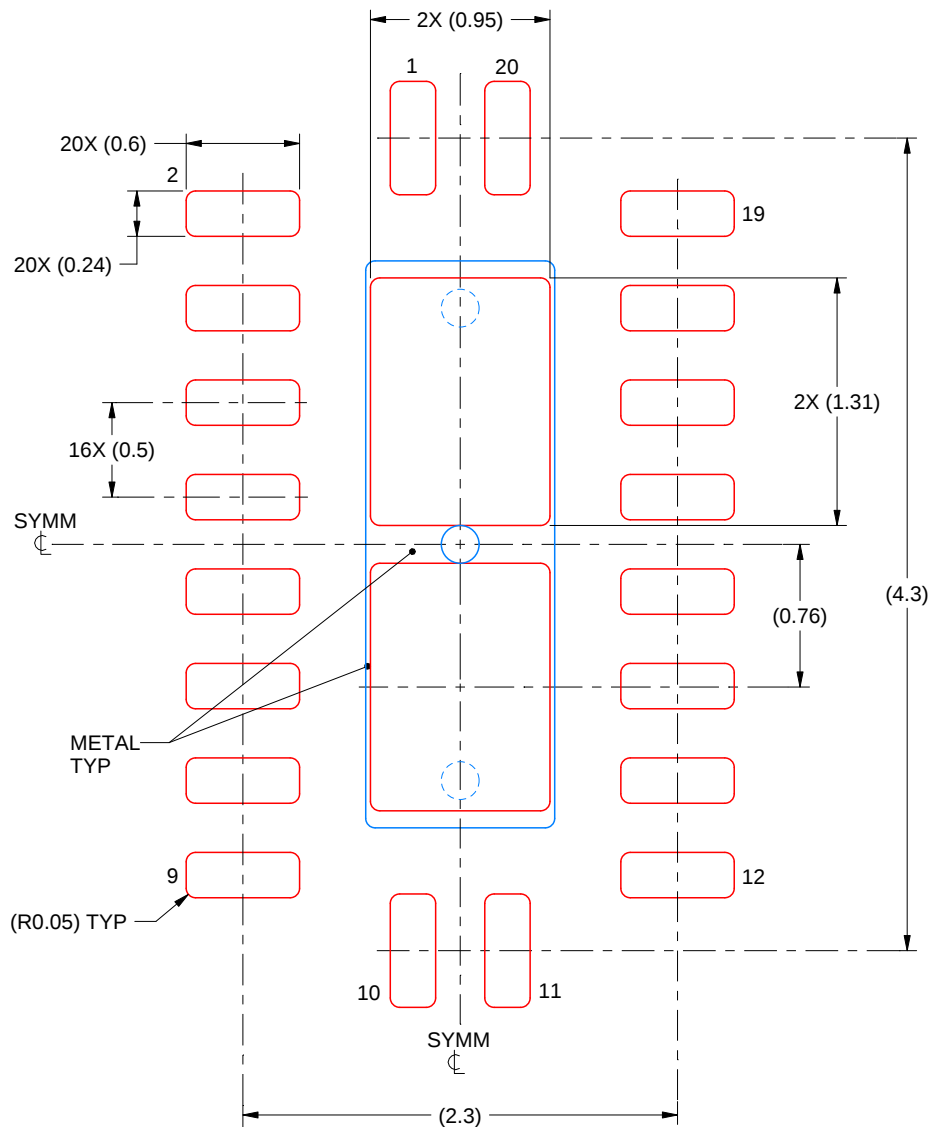
4. This package is designed to be soldered to a thermal pad on the board. For more information, see Texas Instruments literature number SLUA271 ([www.ti.com/lit/sluea271](http://www.ti.com/lit/sluea271)).
5. Vias are optional depending on application, refer to device data sheet. If some or all are implemented, recommended via locations are shown.

# EXAMPLE STENCIL DESIGN

RKS0020A

VQFN - 1 mm max height

PLASTIC QUAD FLATPACK - NO LEAD



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

EXPOSED PAD  
83% PRINTED SOLDER COVERAGE BY AREA  
SCALE:25X

4222490/B 02/2021

NOTES: (continued)

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



4226367/A 10/2020

## NOTES:

PowerPAD is a trademark of Texas Instruments.

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. No JEDEC registration as of September 2020.
5. Features may differ or may not be present.

# EXAMPLE BOARD LAYOUT

DGS0020A

VSSOP - 1.1 mm max height

SMALL OUTLINE PACKAGE



4226367/A 10/2020

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.
8. This package is designed to be soldered to a thermal pad on the board. For more information, see Texas Instruments literature numbers SLMA002 ([www.ti.com/lit/slma002](http://www.ti.com/lit/slma002)) and SLMA004 ([www.ti.com/lit/slma004](http://www.ti.com/lit/slma004)).
9. Size of metal pad may vary due to creepage requirement.
10. Vias are optional depending on application, refer to device data sheet. It is recommended that vias under paste be filled, plugged or tented.

# EXAMPLE STENCIL DESIGN

DGS0020A

VSSOP - 1.1 mm max height

SMALL OUTLINE PACKAGE



SOLDER PASTE EXAMPLE  
BASED ON 0.125 mm THICK STENCIL  
SCALE: 16X

4226367/A 10/2020

NOTES: (continued)

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

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