

## SN74HCT165-Q1 汽车类 8 位并行负载移位寄存器

### 1 特性

- 符合面向汽车应用的 AEC-Q100 标准：
  - 器件温度等级 1：
    - $-40^{\circ}\text{C}$  至  $+125^{\circ}\text{C}$ ,  $T_A$
  - 器件 HBM ESD 分类等级 2
  - 器件 CDM ESD 分类等级 C6
- 兼容 LSTTL 输入逻辑
  - $V_{IL(\text{max})} = 0.8\text{V}$ ,  $V_{IH(\text{min})} = 2\text{V}$
- 兼容 CMOS 输入逻辑
  - 在电压为  $V_{OL}$ 、 $V_{OH}$  时,  $I_I \leq 1\mu\text{A}$
- 工作电压为 4.5 V 至 5.5 V
- 支持多达 10 个 LSTTL 负载的扇出
- 直接覆盖负载 (数据) 输入
- 门控时钟输入

### 2 应用

- 增加微控制器上的输入数量

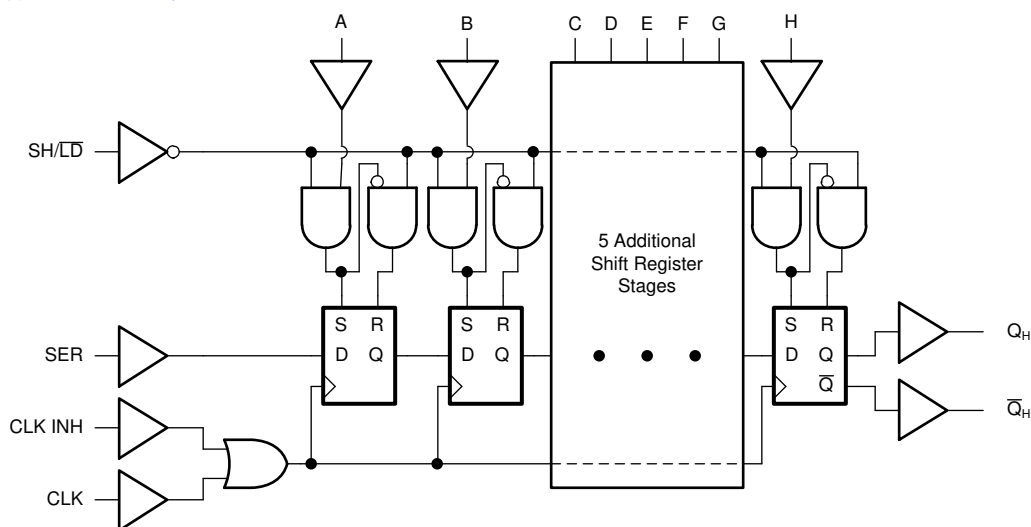
### 3 说明

SN74HCT165-Q1 是一款并行或串行输入/串行输出 8 位移位寄存器。当移位/负载 (SH/LD) 输入为低电平时, 可支持八个单独的直接数据 (A-H) 输入, 从而实现在每个级的并行输入。SN74HCT165-Q1 还具有时钟抑制 (CLK INH) 功能和辅助串行 ( $\bar{Q}_H$ ) 输出。

#### 器件信息

| 器件型号            | 封装 <sup>(1)</sup> | 封装尺寸 (标称值)      |
|-----------------|-------------------|-----------------|
| SN74HCT165PW-Q1 | TSSOP (16)        | 5.00mm × 4.40mm |

(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。



正逻辑图



## Table of Contents

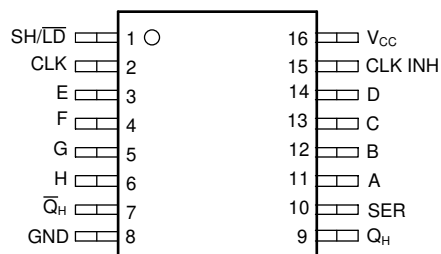
|                                                  |          |                                                                  |           |
|--------------------------------------------------|----------|------------------------------------------------------------------|-----------|
| <b>1 特性</b> .....                                | <b>1</b> | 8.3 Feature Description.....                                     | <b>10</b> |
| <b>2 应用</b> .....                                | <b>1</b> | 8.4 Device Functional Modes.....                                 | <b>11</b> |
| <b>3 说明</b> .....                                | <b>1</b> | <b>9 Application and Implementation</b> .....                    | <b>12</b> |
| <b>4 Revision History</b> .....                  | <b>2</b> | 9.1 Application Information.....                                 | <b>12</b> |
| <b>5 Pin Configuration and Functions</b> .....   | <b>3</b> | 9.2 Typical Application.....                                     | <b>12</b> |
| <b>6 Specifications</b> .....                    | <b>4</b> | <b>10 Power Supply Recommendations</b> .....                     | <b>15</b> |
| 6.1 Absolute Maximum Ratings.....                | <b>4</b> | <b>11 Layout</b> .....                                           | <b>15</b> |
| 6.2 ESD Ratings.....                             | <b>4</b> | 11.1 Layout Guidelines.....                                      | <b>15</b> |
| 6.3 Recommended Operating Conditions.....        | <b>4</b> | 11.2 Layout Example.....                                         | <b>15</b> |
| 6.4 Thermal Information.....                     | <b>4</b> | <b>12 Device and Documentation Support</b> .....                 | <b>16</b> |
| 6.5 Electrical Characteristics.....              | <b>5</b> | 12.1 Documentation Support.....                                  | <b>16</b> |
| 6.6 Timing Characteristics.....                  | <b>5</b> | 12.2 接收文档更新通知.....                                               | <b>16</b> |
| 6.7 Switching Characteristics.....               | <b>6</b> | 12.3 支持资源.....                                                   | <b>16</b> |
| 6.8 Typical Characteristics.....                 | <b>7</b> | 12.4 Trademarks.....                                             | <b>16</b> |
| <b>7 Parameter Measurement Information</b> ..... | <b>8</b> | 12.5 Electrostatic Discharge Caution.....                        | <b>16</b> |
| <b>8 Detailed Description</b> .....              | <b>9</b> | 12.6 术语表.....                                                    | <b>16</b> |
| 8.1 Overview.....                                | <b>9</b> | <b>13 Mechanical, Packaging, and Orderable Information</b> ..... | <b>16</b> |
| 8.2 Functional Block Diagram.....                | <b>9</b> |                                                                  |           |

## 4 Revision History

注：以前版本的页码可能与当前版本的页码不同

| Changes from Revision * (October 2021) to Revision A (December 2021) | Page     |
|----------------------------------------------------------------------|----------|
| • 将数据表的状态从 <b>预告信息</b> 更新为 <b>量产数据</b> .....                         | <b>1</b> |

## 5 Pin Configuration and Functions



**图 5-1. PW Package  
16-Pin TSSOP  
Top View**

**表 5-1. Pin Functions**

| PIN              |     | TYPE <sup>(1)</sup> | DESCRIPTION                                                     |
|------------------|-----|---------------------|-----------------------------------------------------------------|
| NAME             | NO. |                     |                                                                 |
| SH/LD            | 1   | I                   | Enable shifting when input is high, load data when input is low |
| CLK              | 2   | I                   | Clock, rising edge triggered                                    |
| E                | 3   | I                   | Parallel input E                                                |
| F                | 4   | I                   | Parallel input F                                                |
| G                | 5   | I                   | Parallel input G                                                |
| H                | 6   | I                   | Parallel input H                                                |
| $\overline{Q}_H$ | 7   | O                   | Inverted serial output                                          |
| GND              | 8   | —                   | Ground                                                          |
| $Q_H$            | 9   | O                   | Serial output                                                   |
| SER              | 10  | I                   | Serial input                                                    |
| A                | 11  | I                   | Parallel input A                                                |
| B                | 12  | I                   | Parallel input B                                                |
| C                | 13  | I                   | Parallel input C                                                |
| D                | 14  | I                   | Parallel input D                                                |
| CLK INH          | 15  | I                   | Clock inhibit input                                             |
| V <sub>CC</sub>  | 16  | —                   | Positive supply                                                 |

(1) Signal Types: I = Input, O = Output, I/O = Input or Output.

## 6 Specifications

### 6.1 Absolute Maximum Ratings

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

|           |                                                   |                                     | MIN  | MAX | UNIT |
|-----------|---------------------------------------------------|-------------------------------------|------|-----|------|
| $V_{CC}$  | Supply voltage                                    |                                     | -0.5 | 7   | V    |
| $I_{IK}$  | Input clamp current <sup>(2)</sup>                | $V_I < 0$ or $V_I > V_{CC} + 0.5$ V | -20  | 20  | mA   |
| $I_{OK}$  | Output clamp current <sup>(2)</sup>               | $V_O < 0$ or $V_O > V_{CC} + 0.5$ V | -20  | 20  | mA   |
| $I_O$     | Continuous output current                         | $V_O = 0$ to $V_{CC}$               | -35  | 35  | mA   |
| $I_{CC}$  | Continuous output current through $V_{CC}$ or GND |                                     | -70  | 70  | mA   |
| $T_J$     | Junction temperature                              |                                     |      | 150 | °C   |
| $T_{stg}$ | 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.

### 6.2 ESD Ratings

|             |                         |                                                                                           | VALUE | UNIT |
|-------------|-------------------------|-------------------------------------------------------------------------------------------|-------|------|
| $V_{(ESD)}$ | Electrostatic discharge | Human body model (HBM), per AEC Q100-002 <sup>(1)</sup><br>HBM ESD Classification Level 2 | ±4000 | V    |
|             |                         | Charged device model (CDM), per AEC Q100-011<br>CDM ESD Classification Level C4B          | ±1500 |      |

- (1) AEC Q100-002 indicate that HBM stressing shall be in accordance with the ANSI/ESDA/JEDEC JS-001 specification.

### 6.3 Recommended Operating Conditions

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

|                     |                                     |                          | MIN | NOM | MAX      | UNIT |
|---------------------|-------------------------------------|--------------------------|-----|-----|----------|------|
| $V_{CC}$            | Supply voltage                      |                          | 4.5 | 5   | 5.5      | V    |
| $V_{IH}$            | High-level input voltage            | $V_{CC} = 4.5$ V to 5.5V | 2   |     |          | V    |
| $V_{IL}$            | Low-level input voltage             | $V_{CC} = 4.5$ V to 5.5V |     |     | 0.8      | V    |
| $V_I$               | Input voltage                       |                          | 0   |     | $V_{CC}$ | V    |
| $V_O$               | Output voltage                      |                          | 0   |     | $V_{CC}$ | V    |
| $\Delta t/\Delta v$ | Input transition rise and fall rate | $V_{CC} = 4.5$ V to 5.5V |     |     | 500      | ns/V |
| $T_A$               | Ambient temperature                 |                          | -40 |     | 125      | °C   |

### 6.4 Thermal Information

| THERMAL METRIC <sup>(1)</sup> |                                              | SN74HCT165-Q1 | UNIT |
|-------------------------------|----------------------------------------------|---------------|------|
|                               |                                              | PW (TSSOP)    |      |
|                               |                                              | 16 PINS       |      |
| $R_{\theta JA}$               | Junction-to-ambient thermal resistance       | 131.8         | °C/W |
| $R_{\theta JC(top)}$          | Junction-to-case (top) thermal resistance    | 69.8          | °C/W |
| $R_{\theta JB}$               | Junction-to-board thermal resistance         | 76.5          | °C/W |
| $\Psi_{JT}$                   | Junction-to-top characterization parameter   | 20.9          | °C/W |
| $\Psi_{JB}$                   | Junction-to-board characterization parameter | 76.1          | °C/W |

## 6.4 Thermal Information (continued)

| THERMAL METRIC <sup>(1)</sup> |                                              | SN74HCT165-Q1 | UNIT |
|-------------------------------|----------------------------------------------|---------------|------|
|                               |                                              | PW (TSSOP)    |      |
|                               |                                              | 16 PINS       |      |
| $R_{\theta JC(bot)}$          | Junction-to-case (bottom) thermal resistance | 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 (unless otherwise noted)

| PARAMETER       |                                                   | TEST CONDITIONS                            |                                                    | $T_A = 25^\circ\text{C}$ |     |           | $-40^\circ\text{C to } 125^\circ\text{C}$ |     |            | UNIT          |
|-----------------|---------------------------------------------------|--------------------------------------------|----------------------------------------------------|--------------------------|-----|-----------|-------------------------------------------|-----|------------|---------------|
|                 |                                                   |                                            |                                                    | MIN                      | TYP | MAX       | MIN                                       | TYP | MAX        |               |
| $V_{OH}$        | High-level output voltage                         | $V_I = V_{IH} \text{ or } V_{IL}$          | $I_{OH} = -20 \mu\text{A}, V_{CC} = 4.5 \text{ V}$ | 4.4                      |     |           | 4.4                                       |     |            | V             |
|                 |                                                   |                                            | $I_{OH} = -4 \text{ mA}, V_{CC} = 4.5 \text{ V}$   | 3.98                     |     |           | 3.84                                      |     |            | V             |
| $V_{OL}$        | Low-level output voltage                          | $V_I = V_{IH} \text{ or } V_{IL}$          | $I_{OL} = 20 \mu\text{A}, V_{CC} = 4.5 \text{ V}$  |                          |     | 0.1       |                                           |     | 0.1        | V             |
|                 |                                                   |                                            | $I_{OL} = 4 \text{ mA}, V_{CC} = 4.5 \text{ V}$    |                          |     | 0.26      |                                           |     | 0.33       | V             |
| $I_I$           | Input leakage current                             | $V_I = V_{CC} \text{ or } 0$               | $V_{CC} = 5.5 \text{ V}$                           |                          |     | $\pm 100$ |                                           |     | $\pm 1000$ | nA            |
| $I_{OZ}$        | Off-State (High-Impedance State) Output Current   | $V_O = V_{CC} \text{ or } 0, Q_A-Q_H$      | $V_{CC} = 5.5 \text{ V}$                           |                          |     | $\pm 0.5$ |                                           |     | $\pm 5$    | $\mu\text{A}$ |
| $I_{CC}$        | Supply current                                    | $V_I = V_{CC} \text{ or } 0, I_O = 0$      | $V_{CC} = 5.5 \text{ V}$                           |                          |     | 8         |                                           |     | 80         | $\mu\text{A}$ |
| $\Delta I_{CC}$ | Additional Quiescent Device Current Per Input Pin | $V_I = V_{CC} - 2.1 \text{ V}$             | $V_{CC} = 4.5 \text{ V to } 5.5 \text{ V}$         |                          |     | 126.2     |                                           |     | 157.5      | $\mu\text{A}$ |
|                 |                                                   | $V_I = 0.5 \text{ V or } 2.4 \text{ V}$    | $V_{CC} = 5.5 \text{ V}$                           |                          |     | 2.4       |                                           |     | 2.9        | mA            |
| $C_i$           | Input capacitance                                 | $V_{CC} = 4.5 \text{ V to } 5.5 \text{ V}$ | $V_{CC} = 4.5 \text{ V to } 5.5 \text{ V}$         |                          |     | 10        |                                           |     |            | pF            |
| $C_O$           | Output capacitance                                | $V_{CC} = 4.5 \text{ V to } 5.5 \text{ V}$ | $V_{CC} = 4.5 \text{ V to } 5.5 \text{ V}$         |                          |     | 20        |                                           |     |            | pF            |
| $C_{pd}$        | Power dissipation capacitance per gate            | No load                                    |                                                    |                          |     | 50        |                                           |     |            | pF            |

## 6.6 Timing Characteristics

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

| PARAMETER   |                 | CONDITION                      | $V_{CC}$ | $T_A = 25^\circ\text{C}$ |     | $-40^\circ\text{C to } 125^\circ\text{C}$ |     | UNIT |
|-------------|-----------------|--------------------------------|----------|--------------------------|-----|-------------------------------------------|-----|------|
|             |                 |                                |          | MIN                      | MAX | MIN                                       | MAX |      |
| $f_{clock}$ | Clock frequency |                                | 4.5 V    |                          | 31  |                                           | 25  | MHz  |
| $t_w$       | Pulse duration  | SH/ $\overline{\text{LD}}$ low | 4.5 V    | 20                       |     | 25                                        |     | ns   |
|             |                 |                                | 5.5 V    | 20                       |     | 25                                        |     |      |
|             |                 | CLK high or low                | 4.5 V    | 18                       |     | 23                                        |     |      |
|             |                 |                                | 5.5 V    | 18                       |     | 23                                        |     |      |

## 6.6 Timing Characteristics (continued)

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

| PARAMETER       |            | CONDITION                       | V <sub>CC</sub> | T <sub>A</sub> = 25°C |     | -40°C to 125°C |     | UNIT |
|-----------------|------------|---------------------------------|-----------------|-----------------------|-----|----------------|-----|------|
|                 |            |                                 |                 | MIN                   | MAX | MIN            | MAX |      |
| t <sub>su</sub> | Setup time | SH/LD high before CLK↑          | 4.5 V           | 20                    |     | 25             |     | ns   |
|                 |            |                                 | 5.5 V           | 20                    |     | 25             |     |      |
|                 |            | SER before CLK↑                 | 4.5 V           | 20                    |     | 25             |     |      |
|                 |            |                                 | 5.5 V           | 20                    |     | 25             |     |      |
|                 |            | CLK INH low before CLK↑         | 4.5 V           | 20                    |     | 25             |     |      |
|                 |            |                                 | 5.5 V           | 20                    |     | 25             |     |      |
|                 |            | CLK INH high before CLK↑        | 4.5 V           | 20                    |     | 25             |     |      |
|                 |            |                                 | 5.5 V           | 20                    |     | 25             |     |      |
|                 |            | Data before SH/LD↓              | 4.5 V           | 20                    |     | 25             |     |      |
|                 |            |                                 | 5.5 V           | 20                    |     | 25             |     |      |
| t <sub>h</sub>  | Hold time  | Ser data after CLK↑ or CLK INH↑ | 4.5 V           | 7                     |     | 9              |     | ns   |
|                 |            |                                 | 5.5 V           | 7                     |     | 9              |     |      |
|                 |            | PAR data after SH/LD↓           | 4.5 V           | 7                     |     | 9              |     |      |
|                 |            |                                 | 5.5 V           | 7                     |     | 9              |     |      |

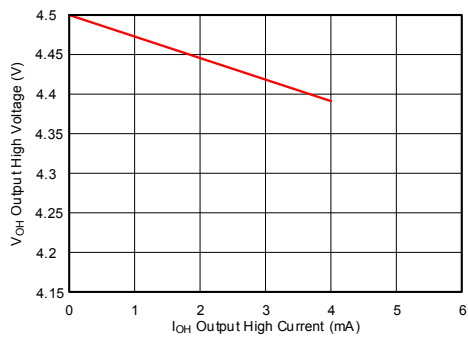
## 6.7 Switching Characteristics

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

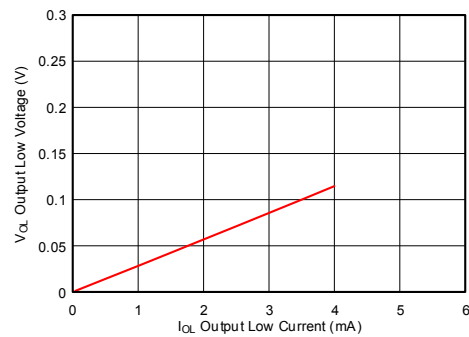
| PARAMETER        |                   | FROM (INPUT) | TO (OUTPUT)                      | V <sub>CC</sub> | T <sub>A</sub> = 25°C |     |     | -40°C to 125°C |     |     | UNIT |
|------------------|-------------------|--------------|----------------------------------|-----------------|-----------------------|-----|-----|----------------|-----|-----|------|
|                  |                   |              |                                  |                 | MIN                   | TYP | MAX | MIN            | TYP | MAX |      |
| f <sub>max</sub> |                   |              |                                  | 4.5 V           | 31                    |     |     | 25             |     |     | MHz  |
| t <sub>pd</sub>  | Propagation delay | SH/LD        | Q <sub>H</sub> or Q <sub>H</sub> | 4.5 V           |                       |     | 40  |                |     | 60  | ns   |
|                  |                   |              |                                  | 5.5 V           |                       |     | 40  |                |     | 60  |      |
|                  |                   | CLK          | Q <sub>H</sub> or Q <sub>H</sub> | 4.5 V           |                       |     | 40  |                |     | 60  |      |
|                  |                   |              |                                  | 5.5 V           |                       |     | 40  |                |     | 60  |      |
|                  |                   | H            | Q <sub>H</sub> or Q <sub>H</sub> | 4.5 V           |                       |     | 35  |                |     | 53  |      |
|                  |                   |              |                                  | 5.5 V           |                       |     | 35  |                |     | 53  |      |
| t <sub>t</sub>   | Transition-time   |              | Any output                       | 4.5 V           |                       |     | 12  |                |     | 15  | ns   |
|                  |                   |              | Any output                       | 5.5 V           |                       |     | 14  |                |     | 17  |      |

## 6.8 Typical Characteristics

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



**图 6-1. Typical Output Voltage in the High State ( $V_{OH}$ )**



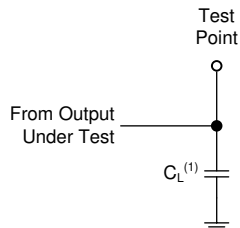
**图 6-2. Typical Output Voltage in the Low State ( $V_{OL}$ )**

## 7 Parameter Measurement Information

Phase relationships between waveforms were chosen arbitrarily. All input pulses are supplied by generators having the following characteristics:  $PRR \leq 1 \text{ MHz}$ ,  $Z_O = 50 \Omega$ ,  $t_t < 6 \text{ ns}$ .

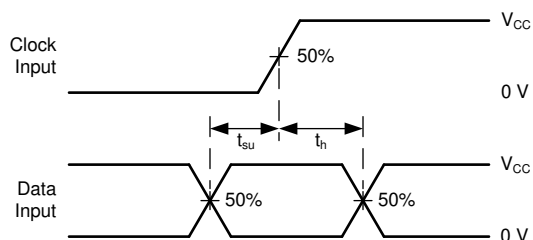
For clock inputs,  $f_{\text{max}}$  is measured when the input duty cycle is 50%.

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

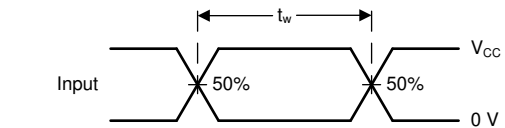


(1)  $C_L$  includes probe and test-fixture capacitance.

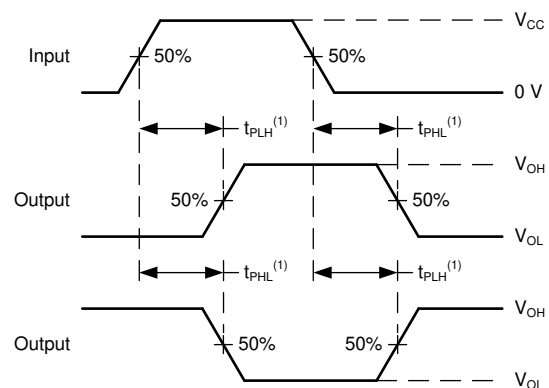
**图 7-1. Load Circuit for Push-Pull Outputs**



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

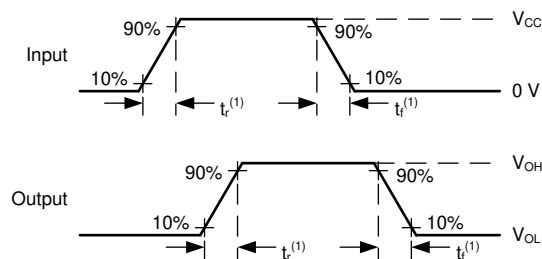


**图 7-2. Voltage Waveforms, Pulse Duration**



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

**图 7-4. Voltage Waveforms Propagation Delays**



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

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

## 8 Detailed Description

### 8.1 Overview

The SN74HCT165-Q1 is a parallel- or serial-in, serial-out 8-bit shift register.

This device has two modes of operation: load data, and shift data.

When the shift or load ( $SH/\overline{LD}$ ) input is held in the low state, the internal registers are loaded with data from the eight lettered inputs (A-H). This operation is asynchronous. In this state, the output (Q) will have the same state as the input H, while the inverted output ( $\overline{Q}$ ) will have the opposite state.

When the shift or load ( $SH/\overline{LD}$ ) input is held in the high state, the internal registers hold their current state until a clock pulse is received. On the rising edge of the clock (CLK) input, data from the serial input will be loaded into the first register, and the data in the internal registers will be shifted by one place. The last register will lose its value. The output (Q) will always be in the same state as the last register, and the inverted output ( $\overline{Q}$ ) will have the opposite state. The clock inhibit (CLK INH) input can be held high to prevent clock pulses from being detected. CLK and CLK INH are interchangeable inputs.

### 8.2 Functional Block Diagram

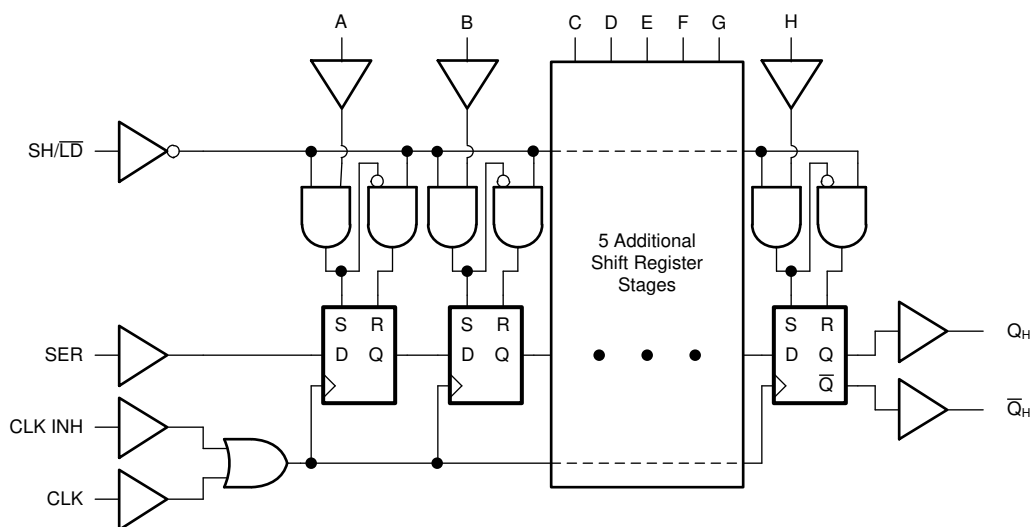


图 8-1. Logic Diagram (Positive Logic) for SN74HCT165-Q1

## 8.3 Feature Description

### 8.3.1 Balanced CMOS Push-Pull Outputs

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

Unused push-pull CMOS outputs should be left disconnected.

### 8.3.2 TTL-Compatible CMOS Inputs

This device includes TTL-compatible CMOS inputs. These inputs are specifically designed to interface with TTL logic devices by having a reduced input voltage threshold.

TTL-compatible 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 ( $R = V \div I$ ).

TTL-compatible 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 the [Implications of Slow or Floating CMOS Inputs](#) application report.

Do not leave TTL-compatible 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, 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; however, a 10-k $\Omega$  resistor is recommended and will typically meet all requirements.

### 8.3.3 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.

### 8.3.4 Clamp Diode Structure

The inputs and outputs to this device have both positive and negative clamping diodes as depicted in [Figure 8-2](#).

#### 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.

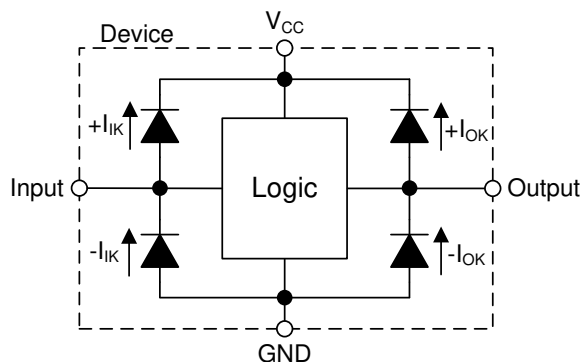


图 8-2. Electrical Placement of Clamping Diodes for Each Input and Output

## 8.4 Device Functional Modes

The [Operating Mode Table](#) and the [Output Function Table](#) list the functional modes of the SN74HCT165-Q1.

表 8-1. Operating Mode Table

| INPUTS <sup>(1)</sup> |     |         | FUNCTION             |
|-----------------------|-----|---------|----------------------|
| SH/LD                 | CLK | CLK INH |                      |
| L                     | X   | X       | Parallel load        |
| H                     | H   | X       | No change            |
| H                     | X   | H       | No change            |
| H                     | L   | ↑       | Shift <sup>(2)</sup> |
| H                     | ↑   | L       | Shift <sup>(2)</sup> |

(1) H = High Voltage Level, L = Low Voltage Level, X = Do not care, ↑ = Low to High transition.

(2) Shift : Content of each internal register shifts towards serial output Q<sub>H</sub>. Data at SER is shifted into the first register.

表 8-2. Output Function Table

| INTERNAL REGISTERS <sup>(1) (2)</sup> |   | OUTPUTS <sup>(2)</sup> |    |
|---------------------------------------|---|------------------------|----|
| A — G                                 | H | Q                      | Q̄ |
| X                                     | L | L                      | H  |
| X                                     | H | H                      | L  |

(1) Internal registers refer to the shift registers inside the device. These values are set by either loading data from the parallel inputs, or by clocking data in from the serial input.

(2) H = High Voltage Level, L = Low Voltage Level, X = Do not care.

## 9 Application and Implementation

### 备注

以下应用部分中的信息不属于 TI 器件规格的范围，TI 不担保其准确性和完整性。TI 的客户应负责确定器件是否适用于其应用。客户应验证并测试其设计，以确保系统功能。

### 9.1 Application Information

The SN74HCT165-Q1 is a parallel-input shift register, which can be used to reduce the number of required inputs on a system controller very significantly in some applications. Parallel data is loaded into the shift register, then the stored data can be loaded into a serial input of the system controller by clocking the shift register.

Multiple shift registers can be cascaded to provide more data inputs while still only using a single serial input to the system controller. This process is primarily limited by the required data input rate and timing characteristics of the selected shift register, as defined in the *Timing Characteristics* and *Switching Characteristics* tables.

An example block diagram is shown for using a single shift register in the *Typical Application Block Diagram* below.

### 9.2 Typical Application

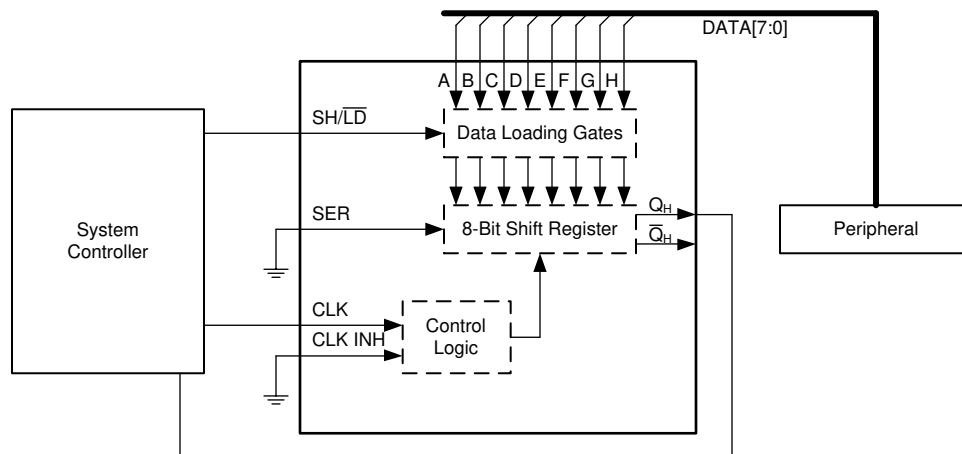


图 9-1. Typical Application Block Diagram

#### 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 SN74HCT165-Q1 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 SN74HCT165-Q1 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 SN74HCT165-Q1 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 SN74HCT165-Q1 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 the [CMOS Power Consumption and Cpd Calculation](#) application report.

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

#### 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  $V_{IL(max)}$  to be considered a logic LOW, and  $V_{IH(min)}$  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 SN74HCT165-Q1, 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 SN74HCT165-Q1 has CMOS inputs and thus requires fast input transitions to operate correctly, as defined in the *Recommended Operating Conditions* table. Slow input transitions can cause oscillations, additional power consumption, and reduction in device reliability.

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 SN74HCT165-Q1 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

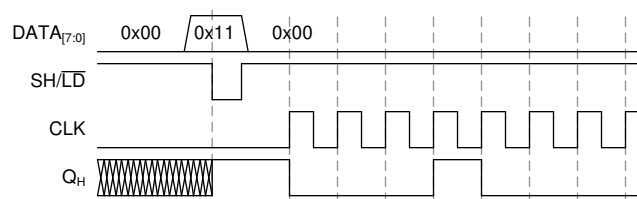


图 9-2. Application Timing Diagram

## 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

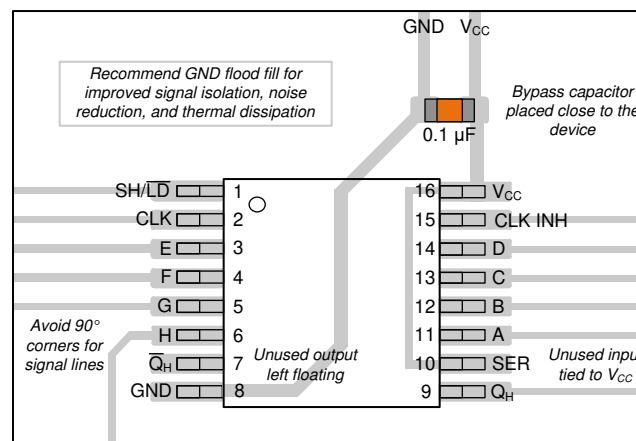


图 11-1. Example Layout for the SN74HCT165-Q1 in the PW Package

## 12 Device and Documentation Support

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

### 12.1 Documentation Support

#### 12.1.1 Related Documentation

For related documentation, see the following:

- Texas Instruments, [HCMOS Design Considerations application report](#)
- 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](https://www.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.

所有商标均为其各自所有者的财产。

### 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="#">SN74HCT165QPWRQ1</a> | Active        | Production           | TSSOP (PW)   16 | 2000   LARGE T&R      | Yes         | NIPDAU   SN                          | Level-1-260C-UNLIM                | -40 to 125   | HT165Q              |
| SN74HCT165QPWRQ1.A               | Active        | Production           | TSSOP (PW)   16 | 2000   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -40 to 125   | HT165Q              |

<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.

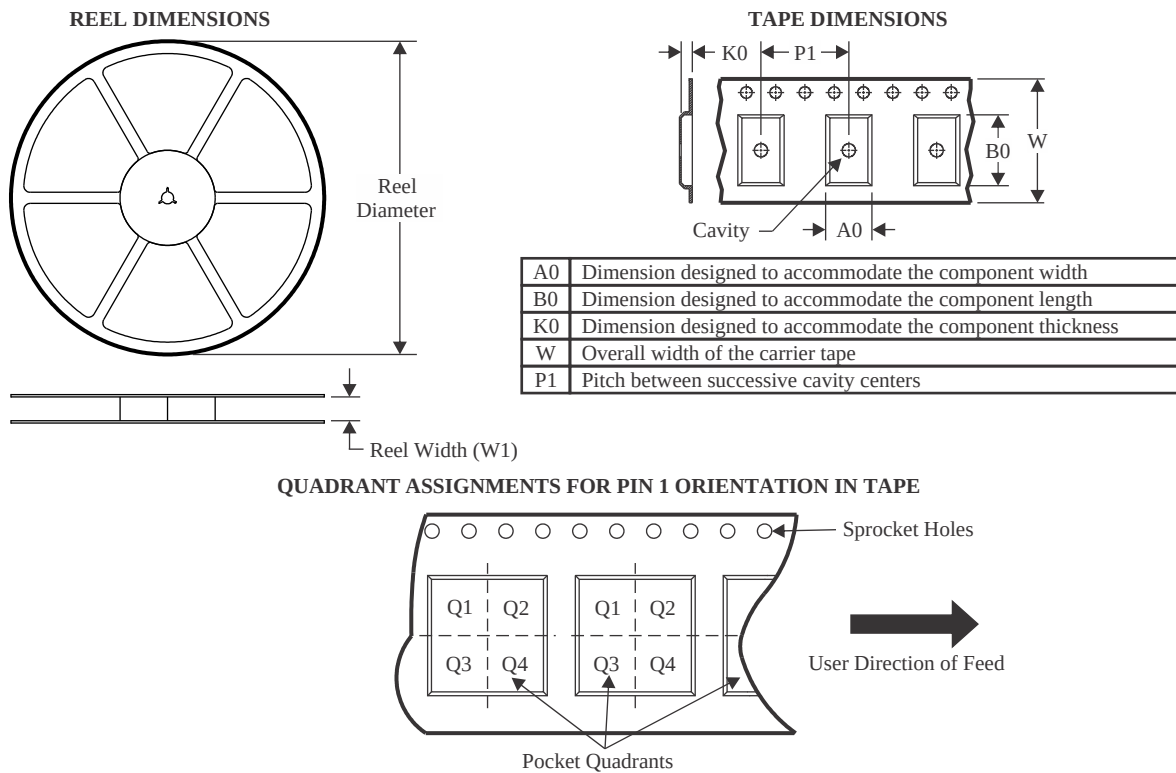
### OTHER QUALIFIED VERSIONS OF SN74HCT165-Q1 :

- Catalog : [SN74HCT165](#)

NOTE: Qualified Version Definitions:

- Catalog - TI's standard catalog product

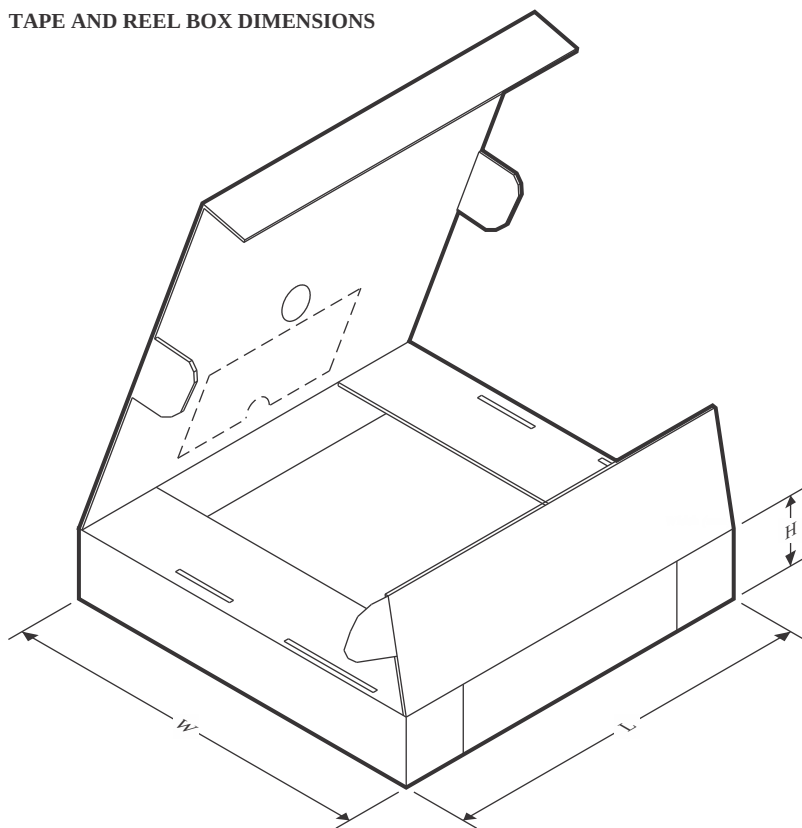
## TAPE AND REEL INFORMATION



\*All dimensions are nominal

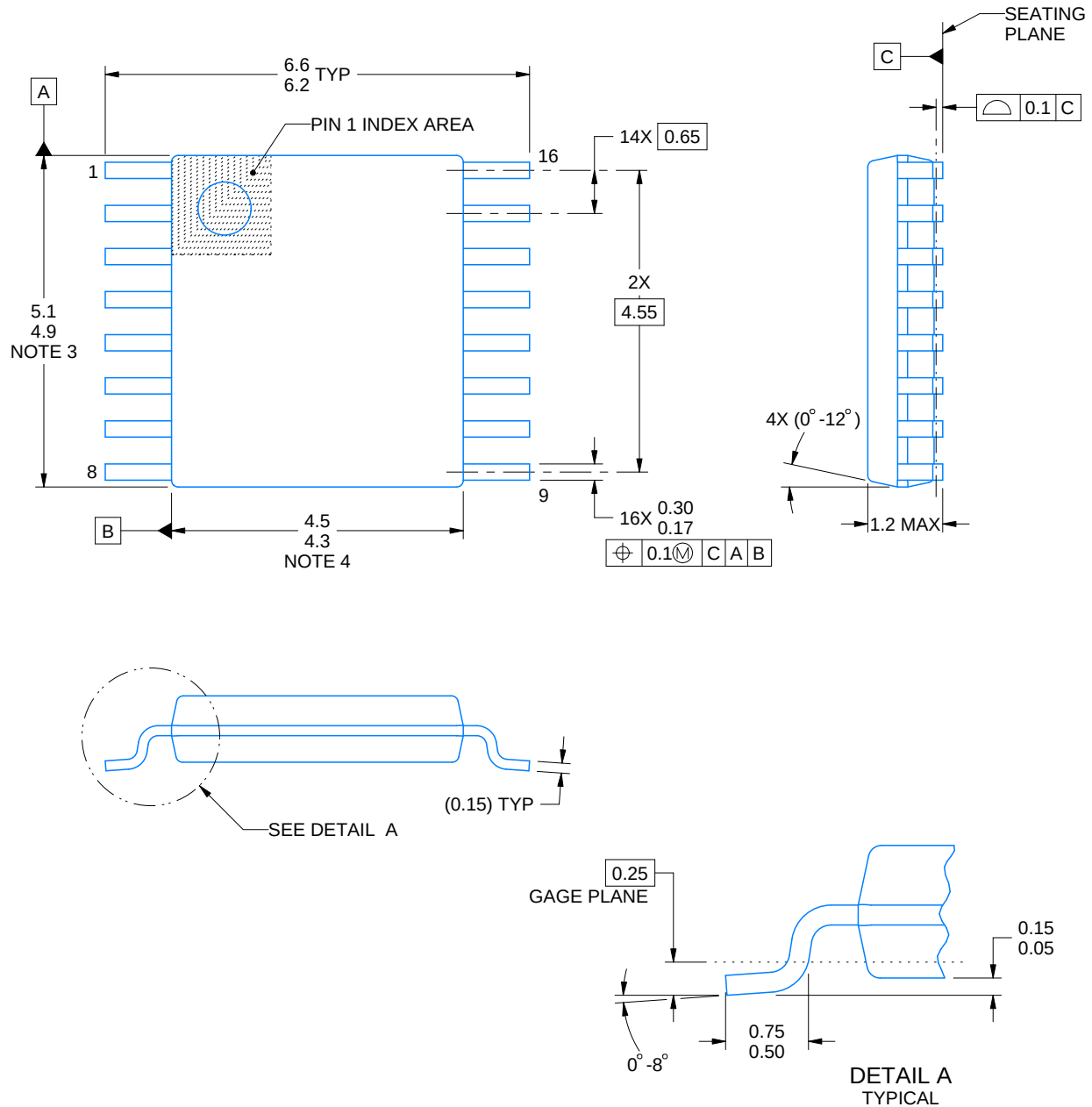
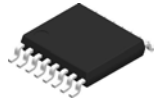
| Device           | Package Type | Package Drawing | Pins | SPQ  | Reel Diameter (mm) | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P1 (mm) | W (mm) | Pin1 Quadrant |
|------------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| SN74HCT165QPWRQ1 | TSSOP        | PW              | 16   | 2000 | 330.0              | 12.4               | 6.9     | 5.6     | 1.6     | 8.0     | 12.0   | Q1            |
| SN74HCT165QPWRQ1 | 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) |
|------------------|--------------|-----------------|------|------|-------------|------------|-------------|
| SN74HCT165QPWRQ1 | TSSOP        | PW              | 16   | 2000 | 356.0       | 356.0      | 35.0        |
| SN74HCT165QPWRQ1 | TSSOP        | PW              | 16   | 2000 | 353.0       | 353.0      | 32.0        |



4220204/B 12/2023

## NOTES:

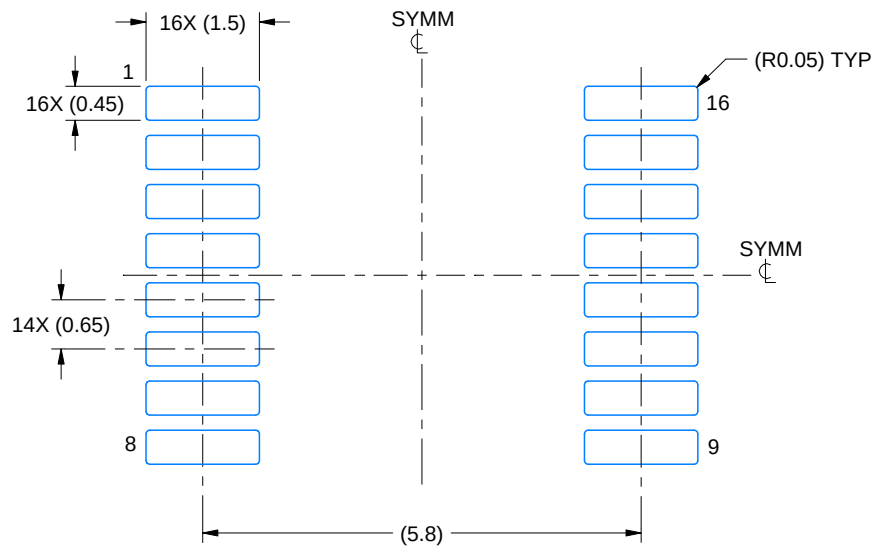
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or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

# EXAMPLE BOARD LAYOUT

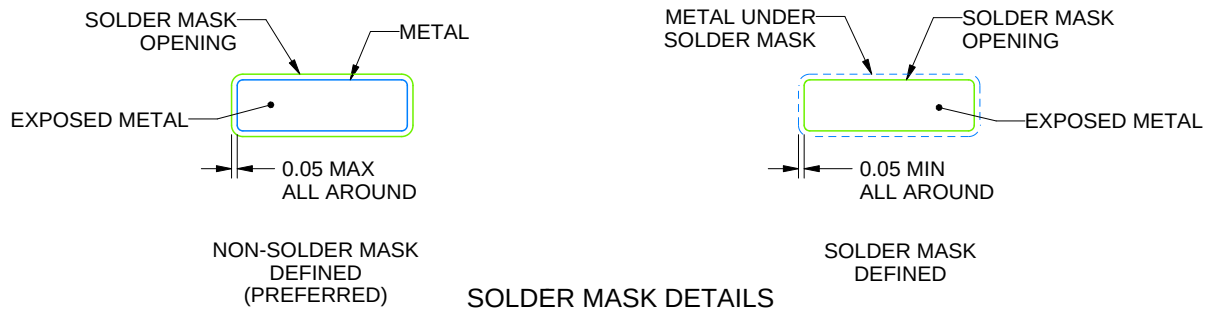
PW0016A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



LAND PATTERN EXAMPLE  
EXPOSED METAL SHOWN  
SCALE: 10X



4220204/B 12/2023

NOTES: (continued)

6. Publication IPC-7351 may have alternate designs.

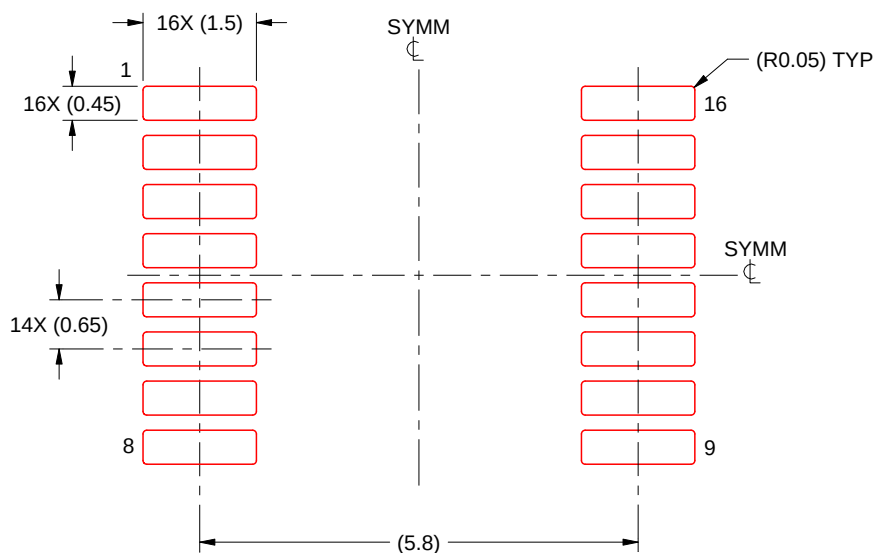
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

# EXAMPLE STENCIL DESIGN

PW0016A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



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

4220204/B 12/2023

NOTES: (continued)

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

## 重要通知和免责声明

TI“按原样”提供技术和可靠性数据（包括数据表）、设计资源（包括参考设计）、应用或其他设计建议、网络工具、安全信息和其他资源，不保证没有瑕疵且不做任何明示或暗示的担保，包括但不限于对适销性、与某特定用途的适用性或不侵犯任何第三方知识产权的暗示担保。

这些资源可供使用 TI 产品进行设计的熟练开发人员使用。您将自行承担以下全部责任：(1) 针对您的应用选择合适的 TI 产品，(2) 设计、验证并测试您的应用，(3) 确保您的应用满足相应标准以及任何其他安全、安保法规或其他要求。

这些资源如有变更，恕不另行通知。TI 授权您仅可将这些资源用于研发本资源所述的 TI 产品的相关应用。严禁以其他方式对这些资源进行复制或展示。您无权使用任何其他 TI 知识产权或任何第三方知识产权。对于因您对这些资源的使用而对 TI 及其代表造成的任何索赔、损害、成本、损失和债务，您将全额赔偿，TI 对此概不负责。

TI 提供的产品受 [TI 销售条款](#)、[TI 通用质量指南](#) 或 [ti.com](#) 上其他适用条款或 TI 产品随附的其他适用条款的约束。TI 提供这些资源并不会扩展或以其他方式更改 TI 针对 TI 产品发布的适用的担保或担保免责声明。除非德州仪器 (TI) 明确将某产品指定为定制产品或客户特定产品，否则其产品均为按确定价格收入目录的标准通用器件。

TI 反对并拒绝您可能提出的任何其他或不同的条款。

版权所有 © 2026，德州仪器 (TI) 公司

最后更新日期：2025 年 10 月