

SN74LV165A-Q1 Automotive Parallel-Load 8-Bit Shift Registers

1 Features

- AEC-Q100 qualified for automotive applications:
 - Device temperature grade 1:
 - 40°C to + 125°C, T_A
 - Device HBM ESD Classification Level 2
 - Device CDM ESD Classification Level C6
- Available in [wettable flank](#) QFN (WBQB) package
- 2 V to 5.5 V V_{CC} operation
- Maximum t_{pd} of 10.5 ns at 5 V
- Supports mixed-mode voltage operation on all ports
- I_{off} supports partial-power-down mode operation
- Latch-up performance exceeds 250 mA per JESD 17

2 Applications

- [Increase the number of inputs on a microcontroller](#)

3 Description

The SN74LV165A-Q1 device is a parallel-load, 8-bit shift registers designed for 2 V to 5.5 V V_{CC} operation.

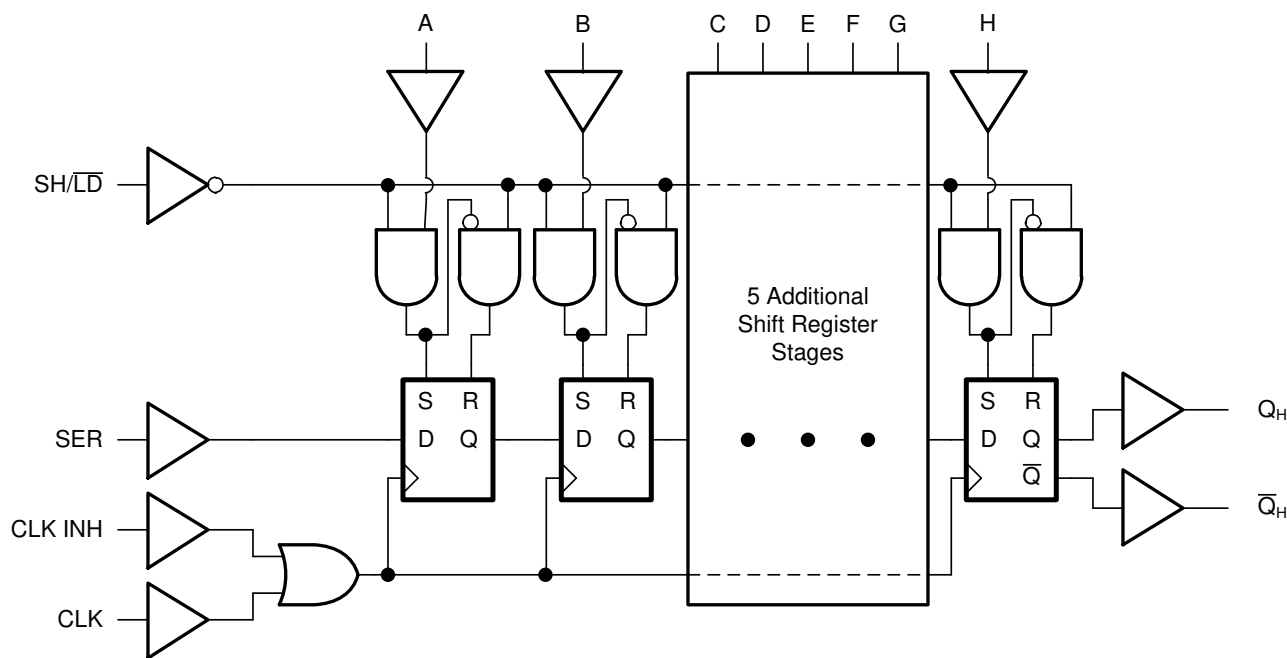
When the device is clocked, data is shifted toward the serial output Q_H . Parallel-in access to each stage is provided by eight individual direct data inputs that are enabled by a low level at the shift/load (SH/\overline{LD}) input. The SN74LV165A-Q1 devices features a clock-inhibit function and a complemented serial output, \overline{Q}_H .

This device is fully specified for partial-power-down applications using I_{off} . The I_{off} circuitry disables the outputs, preventing damaging current backflow through the devices when they are powered down.

Device Information⁽¹⁾

PART NUMBER	PACKAGE	BODY SIZE (NOM)
SN74LV165A-Q1	WBQB (WQFN, 16)	3.60 × 2.60 mm

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



Logic Diagram (Positive Logic)



Table of Contents

1 Features	1	8.1 Overview.....	11
2 Applications	1	8.2 Functional Block Diagram.....	11
3 Description	1	8.3 Feature Description.....	11
4 Revision History	2	8.4 Device Functional Modes.....	13
5 Pin Configuration and Functions	3	9 Application and Implementation	14
6 Specifications	4	9.1 Application Information.....	14
6.1 Absolute Maximum Ratings.....	4	9.2 Typical Application.....	14
6.2 ESD Ratings.....	4	10 Power Supply Recommendations	16
6.3 Recommended Operating Conditions.....	5	11 Layout	17
6.4 Thermal Information.....	5	11.1 Layout Guidelines.....	17
6.5 Electrical Characteristics.....	6	11.2 Layout Example.....	17
6.6 Timing Requirements, $V_{CC} = 2.5\text{ V} \pm 0.2\text{ V}$	6	12 Device and Documentation Support	18
6.7 Timing Requirements, $V_{CC} = 3.3\text{ V} \pm 0.3\text{ V}$	6	12.1 Related Documentation.....	18
6.8 Timing Requirements, $V_{CC} = 5\text{ V} \pm 0.5\text{ V}$	7	12.2 Receiving Notification of Documentation Updates..	18
6.9 Switching Characteristics, $V_{CC} = 2.5\text{ V} \pm 0.2\text{ V}$	8	12.3 Support Resources.....	18
6.10 Switching Characteristics, $V_{CC} = 3.3\text{ V} \pm 0.3\text{ V}$	8	12.4 Trademarks.....	18
6.11 Switching Characteristics, $V_{CC} = 5\text{ V} \pm 0.5\text{ V}$	8	12.5 Electrostatic Discharge Caution.....	18
6.12 Operating Characteristics.....	8	12.6 Glossary.....	18
6.13 Typical Characteristics.....	9	13 Mechanical, Packaging, and Orderable Information	18
7 Parameter Measurement Information	10		
8 Detailed Description	11		

4 Revision History

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

Changes from Revision * (July 2022) to Revision A (December 2022)	Page
• Changed the status of the data sheet from: <i>Advanced Information</i> to: <i>Production Data</i>	1
• Updated the <i>Detailed Design Procedure</i> section.....	16

5 Pin Configuration and Functions

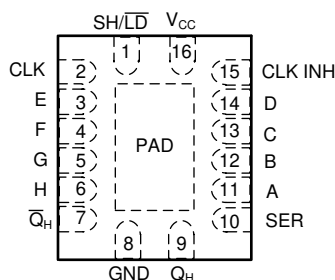


Figure 5-1. SN74LV165A: WBQB Package, 16-Pin WQFN (Top View)

Table 5-1. Pin Functions

PIN		TYPE ⁽¹⁾	DESCRIPTION
NAME	NO.		
A	11	I	Serial input A
B	12	I	Serial input B
C	13	I	Serial input C
CLK	2	I	Storage clock
CLK INH	15	I	Storage clock
D	14	I	Serial input D
E	3	I	Serial input E
F	4	I	Serial input F
G	5	I	Serial input G
GND	8	—	Ground pin
H	6	I	Serial input H
\overline{Q}_H	7	O	Output H, inverted
Q_H	9	O	Output H
SH/ \overline{LD}	1	I	Load Input
SER	10	I	Serial input
V_{CC}	16	—	Power pin
Thermal pad		—	Thermal Pad ⁽²⁾

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

(2) WBQB Package Only

6 Specifications

6.1 Absolute Maximum Ratings

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

			MIN	MAX	UNIT
V _{CC}	Supply voltage		–0.5	7	V
V _I	Input voltage ⁽²⁾		–0.5	7	V
V _O	Voltage range applied to any output in the high-impedance or power-off state ⁽²⁾		–0.5	7	V
V _O	Output voltage ⁽²⁾ ⁽³⁾		–0.5	V _{CC} + 0.5	V
I _{IK}	Input clamp current	V _I < 0		–20	mA
I _{OK}	Output clamp current	V _O < 0		–50	mA
I _O	Continuous output current	V _O = 0 to V _{CC}		±25	mA
	Continuous current through V _{CC} or GND			±50	mA
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 used outside the *Recommended Operating Conditions* but within the *Absolute Maximum Ratings*, the device may not be fully functional, and this may affect device reliability, functionality, performance, and shorten the device lifetime.
- (2) The input and output negative-voltage ratings may be exceeded if the input and output current ratings are observed.
- (3) This value is limited to 5.5 V maximum.

6.2 ESD Ratings

			VALUE	UNIT
V _(ESD)	Electrostatic discharge	Human body model (HBM), per AEC Q100-002 HBM ESD Classification Level 2 ⁽¹⁾	±4000	V
		Charged device model (CDM), per AEC Q100-011 CDM ESD Classification Level C4B	±2000	

- (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)⁽¹⁾

			MIN	MAX	UNIT
V _{CC}	Supply voltage		2	5.5	V
V _{IH}	High-level input voltage	V _{CC} = 2 V	1.5		V
		V _{CC} = 2.3 V to 5.5 V	V _{CC} × 0.7		
V _{IL}	Low-level input voltage	V _{CC} = 2 V		0.5	V
		V _{CC} = 2.3 V to 5.5 V		V _{CC} × 0.3	
V _I	Input voltage		0	5.5	V
V _O	Output voltage		0	V _{CC}	V
I _{OH}	High-level output current	V _{CC} = 2 V		–50	μA
		V _{CC} = 2.3 V to 2.7 V		–2	mA
		V _{CC} = 3 V to 3.6 V		–6	
		V _{CC} = 4.5 V to 5.5 V		–12	
I _{OL}	Low-level output current	V _{CC} = 2 V		50	μA
		V _{CC} = 2.3 V to 2.7 V		2	mA
		V _{CC} = 3 V to 3.6 V		6	
		V _{CC} = 4.5 V to 5.5 V		12	
Δt/Δv	Input transition rise or fall rate	V _{CC} = 2.3 V to 2.7 V		200	ns/V
		V _{CC} = 3 V to 3.6 V		100	
		V _{CC} = 4.5 V to 5.5 V		20	
T _A	Operating free-air temperature		–40	125	°C

(1) All unused inputs of the device must be held at V_{CC} or GND to ensure proper device operation. See [Implications of Slow or Floating CMOS Inputs](#).

6.4 Thermal Information

THERMAL METRIC ⁽¹⁾		SN74LV165A-Q1	UNIT
		WBQB (WQFN)	
		16 PINS	
R _{θJA}	Junction-to-ambient thermal resistance	86	°C/W
R _{θJC(top)}	Junction-to-case (top) thermal resistance	82.6	°C/W
R _{θJB}	Junction-to-board thermal resistance	54.9	°C/W
ψ _{JT}	Junction-to-top characterization parameter	9.5	°C/W
ψ _{JB}	Junction-to-board characterization parameter	54.9	°C/W
R _{θJC(bot)}	Junction-to-case (bottom) thermal resistance	32.5	°C/W

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

6.5 Electrical Characteristics

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

PARAMETER		V _{CC}	MIN	TYP	MAX	UNIT
V _{OH}	I _{OH} = −50 mA	2 V to 5.5 V	V _{CC} − 0.1			V
	I _{OH} = −2 mA	2.3 V	2			
	I _{OH} = −6 mA	3 V	2.48			
	I _{OH} = −12 mA	4.5 V	3.8			
V _{OL}	I _{OL} = 50 mA	2 V to 5.5 V			0.1	V
	I _{OL} = 2 mA	2.3 V			0.4	
	I _{OL} = 6 mA	3 V			0.44	
	I _{OL} = 12 mA	4.5 V			0.55	
I _I	V _I = 5.5 V or GND	0 V to 5.5 V			±1	μA
I _{CC}	V _I = V _{CC} or GND, I _O = 0	5.5 V			20	μA
I _{off}	V _I or V _O = 0 to 5.5 V	0 V			5	μA
C _i	V _I = V _{CC} or GND	3.3 V		1.7		pF

6.6 Timing Requirements, V_{CC} = 2.5 V ± 0.2 V

over recommended operating free-air temperature range (unless otherwise noted) (see [Figure 7-1](#))

PARAMETER		TEST CONDITION	25°C		–40°C to 125°C		UNIT
			MIN	MAX	MIN	MAX	
t _w	Pulse duration	CLK high or low	8.5		9		ns
		SH/ $\overline{\text{LD}}$ low	11		13		
t _{su}	Setup time	SH/ $\overline{\text{LD}}$ high before CLK↑	7		8.5		ns
		SER before CLK↑	8.5		9.5		
		CLK INH before CLK↑	7		7		
		Data before SH/ $\overline{\text{LD}}$ ↑	11.5		12		
t _h	Hold time	SER data after CLK↑	–1		0		ns
		Parallel data after SH/ $\overline{\text{LD}}$ ↑	0		0		
		SH/ $\overline{\text{LD}}$ high after CLK↑	0		0		

6.7 Timing Requirements, V_{CC} = 3.3 V ± 0.3 V

over recommended operating free-air temperature range (unless otherwise noted) (see [Figure 7-1](#))

PARAMETER		TEST CONDITION	25°C		–40°C to 125°C		UNIT
			MIN	MAX	MIN	MAX	
t _w	Pulse duration	CLK high or low	6		7		ns
		SH/ $\overline{\text{LD}}$ low	7.5		9		
t _{su}	Setup time	SH/ $\overline{\text{LD}}$ high before CLK↑	5		6		ns
		SER before CLK↑	5		6		
		CLK INH before CLK↑	5		5		
		Data before SH/ $\overline{\text{LD}}$ ↑	7.5		8.5		
t _h	Hold time	SER data after CLK↑	0		0		ns
		Parallel data after SH/ $\overline{\text{LD}}$ ↑	0.5		0.5		
		SH/ $\overline{\text{LD}}$ high after CLK↑	0		0		

6.8 Timing Requirements, $V_{CC} = 5\text{ V} \pm 0.5\text{ V}$

over recommended operating free-air temperature range (unless otherwise noted) (see Figure 7-1)

PARAMETER	TEST CONDITION	25°C		–40°C to 125°C		UNIT
		MIN	MAX	MIN	MAX	
t_w Pulse duration	CLK high or low	4		4		ns
	SH/ $\overline{\text{LD}}$ low	5		6		
t_{su} Setup time	SH/ $\overline{\text{LD}}$ high before CLK \uparrow	4		4		ns
	SER before CLK \uparrow	4		4		
	CLK INH before CLK \uparrow	3.5		3.5		
	Data before SH/ $\overline{\text{LD}}$ \uparrow	5		5		
t_h Hold time	SER data after CLK \uparrow	0.5		0.5		ns
	Parallel data after SH/ $\overline{\text{LD}}$ \uparrow	1		1		
	SH/ $\overline{\text{LD}}$ high after CLK \uparrow	0.5		0.5		

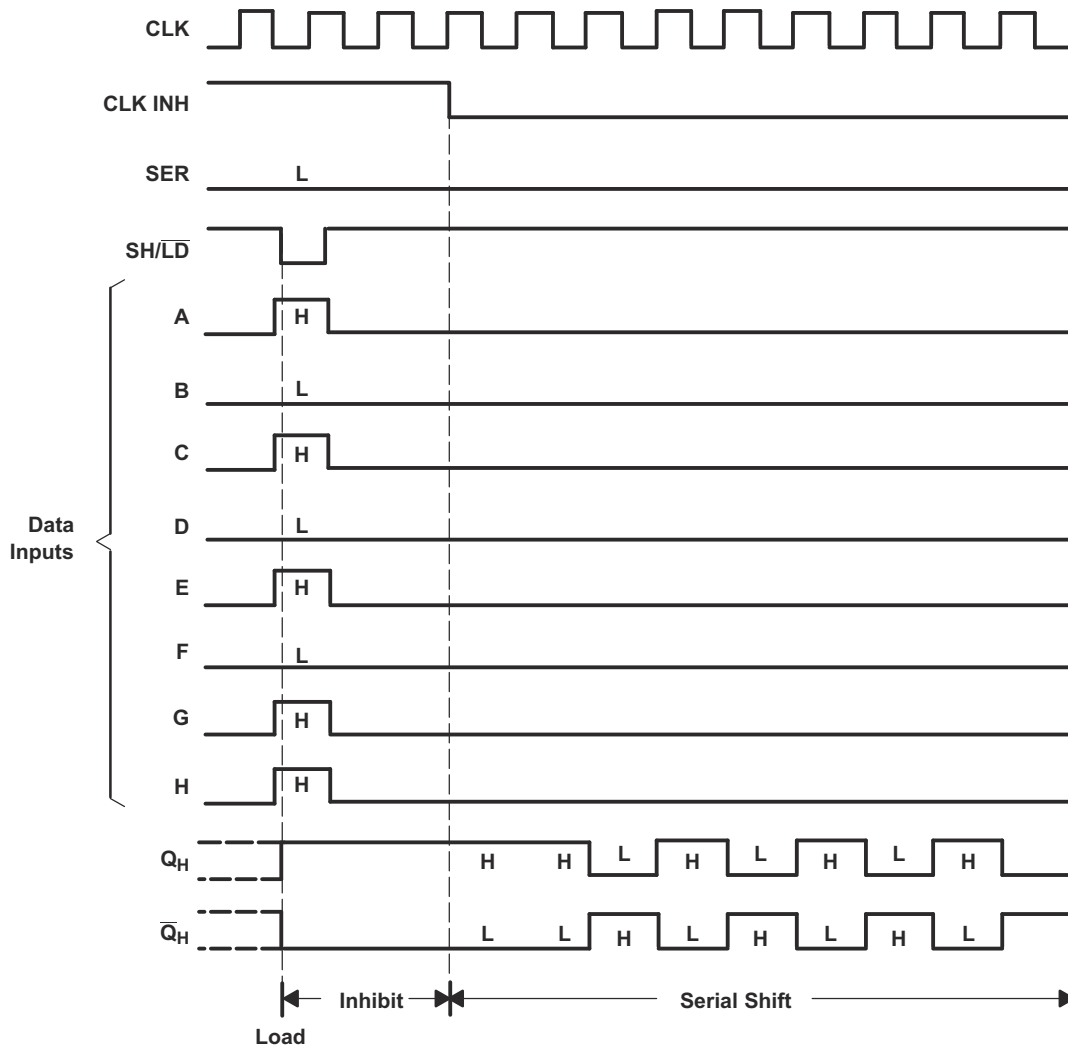


Figure 6-1. Typical Shift, Load, and Inhibit Sequences

6.9 Switching Characteristics, $V_{CC} = 2.5\text{ V} \pm 0.2\text{ V}$

over operating free-air temperature range (unless otherwise noted), (see [Figure 7-1](#))

PARAMETER	FROM (INPUT)	TO (OUTPUT)	LOAD CAP	25°C			–40°C to 125°C			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
f_{\max}			$C_L = 15\text{ pF}$	50	80		45			MHz
			$C_L = 50\text{ pF}$	40	65		35			
t_{pd}	CLK	Q_H or \overline{Q}	$C_L = 15\text{ pF}$		12.2	19.8	1		22	ns
	SH/ \overline{LD}				13.1	21.5	1		23.5	
	H				12.9	21.7	1		24	
t_{pd}	CLK	Q_H or \overline{Q}	$C_L = 50\text{ pF}$		15.3	23.3	1		26	ns
	SH/ \overline{LD}				16.1	25.1	1		28	
	H				15.9	25.3	1		28	

6.10 Switching Characteristics, $V_{CC} = 3.3\text{ V} \pm 0.3\text{ V}$

over operating free-air temperature range (unless otherwise noted), (see [Figure 7-1](#))

PARAMETER	FROM (INPUT)	TO (OUTPUT)	LOAD CAP	25°C			–40°C to 125°C			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
f_{\max}			$C_L = 15\text{ pF}$	65	115		55			MHz
			$C_L = 50\text{ pF}$	60	90		50			
t_{pd}	CLK	Q_H or \overline{Q}	$C_L = 15\text{ pF}$		8.6	15.4	1		18	ns
	SH/ \overline{LD}				9.1	15.8	1		18.5	
	H				8.9	14.1	1		16.5	
t_{pd}	CLK	Q_H or \overline{Q}	$C_L = 50\text{ pF}$		10.9	14.9	1		16.9	ns
	SH/ \overline{LD}				11.3	19.3	1		22	
	H				11.1	17.6	1		20	

6.11 Switching Characteristics, $V_{CC} = 5\text{ V} \pm 0.5\text{ V}$

over recommended operating free-air temperature range (unless otherwise noted), (see [Figure 7-1](#))

PARAMETER	FROM (INPUT)	TO (OUTPUT)	LOAD CAP	25°C			–40°C to 125°C			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
f_{\max}			$C_L = 15\text{ pF}$	110	165		90			MHz
			$C_L = 50\text{ pF}$	95	125		85			
t_{pd}	CLK	Q_H or \overline{Q}	$C_L = 15\text{ pF}$		6	9.9	1		11.5	ns
	SH/ \overline{LD}				6	9.9	1		11.5	
	H				6	9.9	1		10.5	
t_{pd}	CLK	Q_H or \overline{Q}	$C_L = 50\text{ pF}$		7.7	11.9	1		13.5	ns
	SH/ \overline{LD}				7.7	11.9	1		13.5	
	H				7.6	11	1		12.5	

6.12 Operating Characteristics

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

PARAMETER		TEST CONDITIONS		V_{CC}	TYP	UNIT
C_{pd}	Power dissipation capacitance	$C_L = 50\text{ pF}$	$f = 10\text{ MHz}$	3.3 V	36.1	pF
				5 V	37.5	

6.13 Typical Characteristics

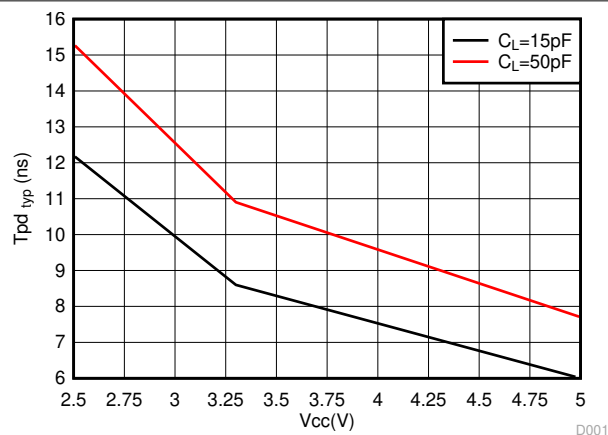
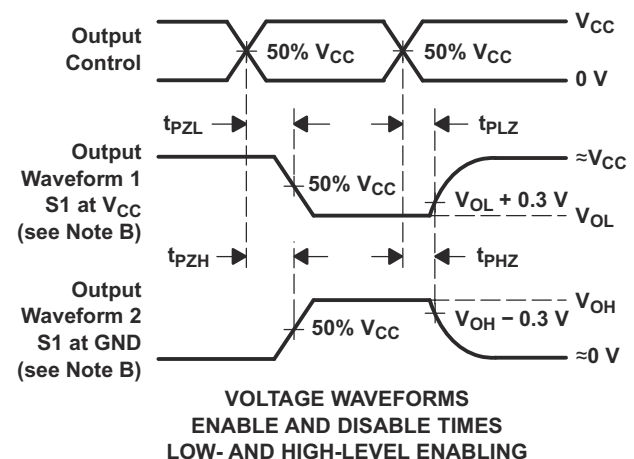
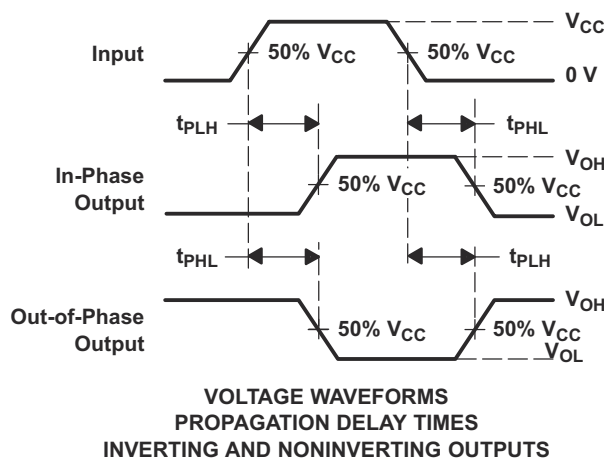
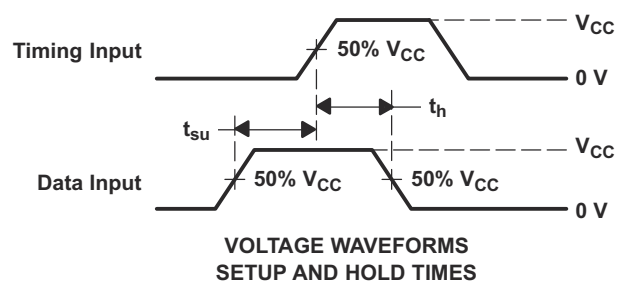
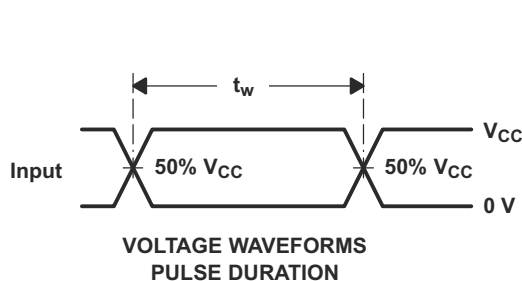
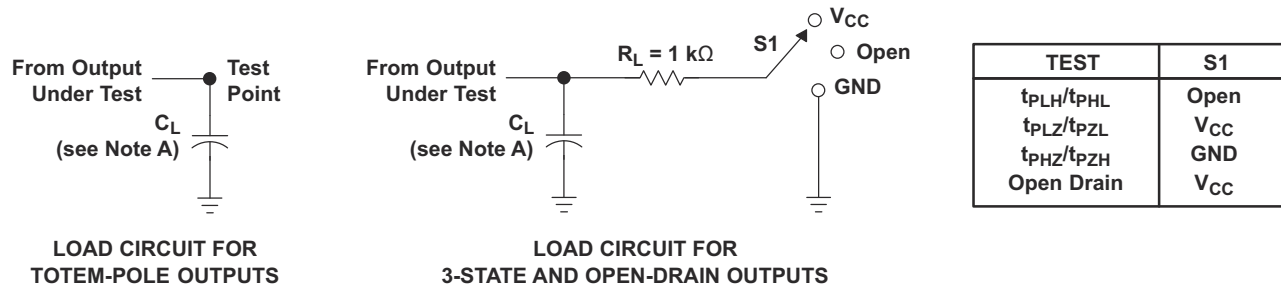


Figure 6-2. T_{PD} Typical (25°C) vs V_{CC}

7 Parameter Measurement Information



- A. C_L includes probe and jig capacitance.
- B. Waveform 1 is for an output with internal conditions such that the output is low, except when disabled by the output control. Waveform 2 is for an output with internal conditions such that the output is high, except when disabled by the output control.
- C. All input pulses are supplied by generators having the following characteristics: $PRR \leq 1 \text{ MHz}$, $Z_O = 50 \Omega$, $t_r \leq 3 \text{ ns}$, and $t_f \leq 3 \text{ ns}$.
- D. The outputs are measured one at a time, with one input transition per measurement.
- E. t_{PLZ} and t_{PHZ} are the same as t_{dis} .
- F. t_{PZL} and t_{PZH} are the same as t_{en} .
- G. t_{PHL} and t_{PLH} are the same as t_{pd} .
- H. All parameters and waveforms are not applicable to all devices.

Figure 7-1. Load Circuit and Voltage Waveforms

8 Detailed Description

8.1 Overview

The SN74LV165A-Q1 device is a parallel-load, 8-bit shift registers designed for 2 V to 5.5 V V_{CC} operation.

When the device is clocked, data is shifted toward the serial output Q_H . Parallel-in access to each stage is provided by eight individual direct data inputs that are enabled by a low level at the shift/load (SH/\overline{LD}) input. The SN74LV165A-Q1 features a clock-inhibit function and a complemented serial output, \overline{Q}_H .

Clocking is accomplished by a low-to-high transition of the clock (CLK) input while SH/\overline{LD} is held high and clock inhibit (CLK INH) is held low. The functions of CLK and CLK INH are interchangeable. Since a low CLK and a low-to-high transition of CLK INH accomplishes clocking, CLK INH must be changed to the high level only while CLK is high. Parallel loading is inhibited when SH/\overline{LD} is held high. The parallel inputs to the register are enabled while SH/\overline{LD} is held low, independently of the levels of CLK, CLK INH, or SER.

The SN74LV165A-Q1 is fully specified for partial-power-down applications using I_{off} . The I_{off} circuitry disables the outputs, preventing damaging current backflow through the devices when they are powered down.

8.2 Functional Block Diagram

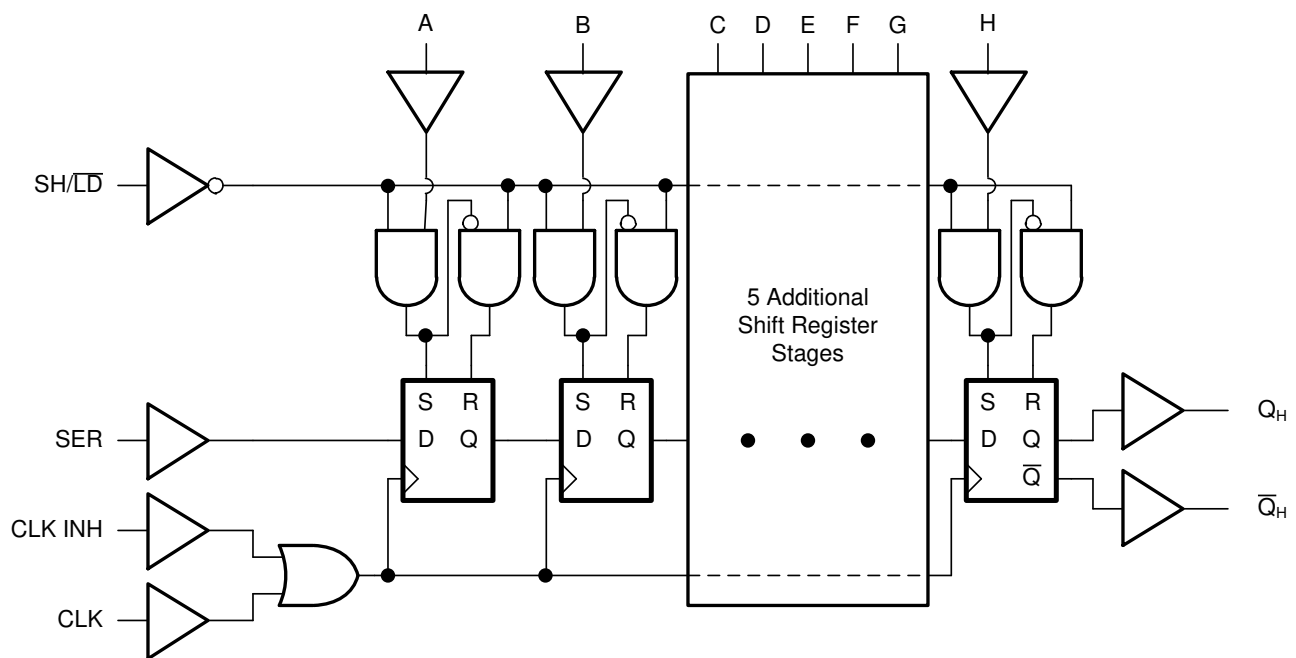


Figure 8-1. Logic Diagram (Positive Logic)

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 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.

8.3.3 Partial Power Down (I_{off})

This device includes circuitry to disable all outputs when the supply pin is held at 0 V. When disabled, the outputs will neither source nor sink current, regardless of the input voltages applied. The amount of leakage current at each output is defined by the I_{off} specification in the *Electrical Characteristics* table.

8.3.4 Wettable Flanks

This device includes wettable flanks for at least one package. See the *Features* section on the front page of the data sheet for which packages include this feature.

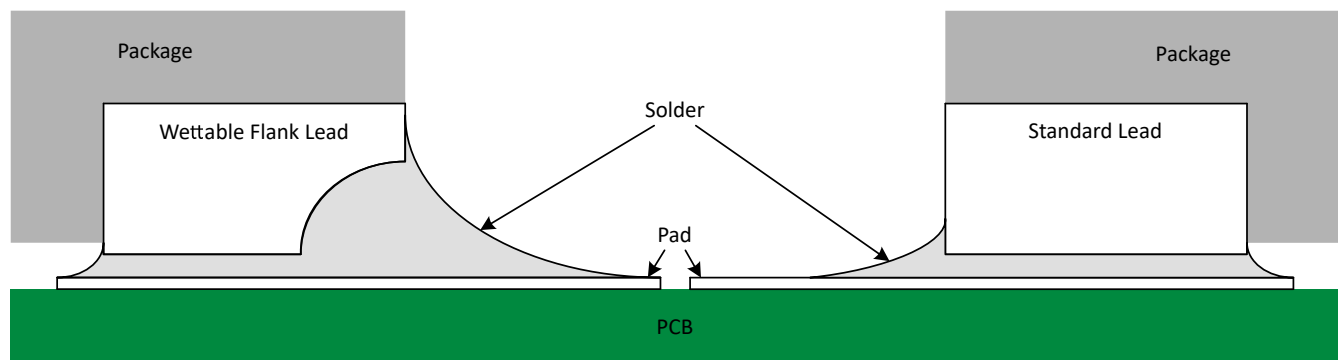


Figure 8-2. Simplified Cutaway View of Wettable-Flank QFN Package and Standard QFN Package After Soldering

Wettable flanks help improve side wetting after soldering, which makes QFN packages easier to inspect with automatic optical inspection (AOI). As shown in [Figure 8-2](#), a wettable flank can be dimpled or step-cut to provide additional surface area for solder adhesion which assists in reliably creating a side fillet. See the mechanical drawing for additional details.

8.3.5 Clamp Diode Structure

Figure 8-3 shows the inputs and outputs to this device have negative clamping diodes only.

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.

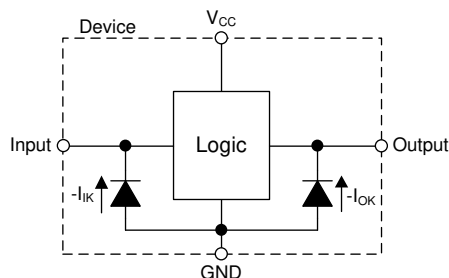


Figure 8-3. Electrical Placement of Clamping Diodes for Each Input and Output

8.4 Device Functional Modes

The [Operating Mode Table](#) and the [Output Function Table](#) list the functional modes of the SN74LV165A-Q1.

Table 8-1. Operating Mode Table

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

(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_H. Data at SER is shifted into the first register.

Table 8-2. Output Function Table

INTERNAL REGISTERS ^{(1) (2)}		OUTPUTS ⁽²⁾	
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

Note

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

9.1 Application Information

The SN74LV165A-Q1 is a low drive CMOS device that can be used for a multitude of bus interface type applications where output ringing is a concern. The low-drive and slow-edge rates minimize overshoot and undershoot on the outputs.

9.2 Typical Application

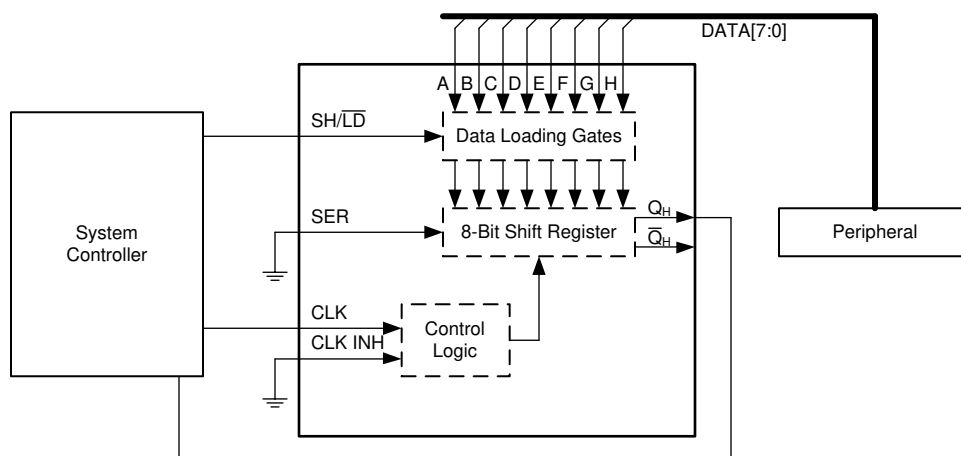


Figure 9-1. Input Expansion with Shift Registers

9.2.1 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 SN74LV165A-Q1 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 SN74LV165A-Q1 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 SN74LV165A-Q1 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 SN74LV165A-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 [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.

9.2.2 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. 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 SN74LV165A-Q1 (as specified in the *Electrical Characteristics*), and the desired input transition rate limits the resistor size. A 10-k Ω resistor value is often used due to these factors.

The SN74LV165A-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.

9.2.3 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.

9.2.4 Detailed Design Procedure

1. Add a decoupling capacitor from V_{CC} to GND. The capacitor needs to be placed physically close to the device and electrically close to both the V_{CC} and GND pins. An example layout is shown in the *Layout* section.
2. Ensure the capacitive load at the output is ≤ 50 pF. This is not a hard limit; it will, however, ensure optimal performance. This can be accomplished by providing short, appropriately sized traces from the SN74LV165A-Q1 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](#).

9.2.5 Application Curves

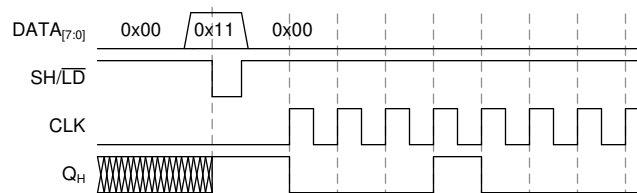


Figure 9-2. Application Timing Diagram

10 Power Supply Recommendations

The power supply can be any voltage between the minimum and maximum supply voltage rating located in the *Absolute Maximum Ratings* section. Each V_{CC} terminal must have a good bypass capacitor to prevent power disturbance. For devices with a single supply, TI recommends a 0.1- μ F capacitor; if there are multiple V_{CC} terminals, then TI recommends a 0.01- μ F or 0.022- μ F capacitor for each power terminal. Multiple bypass capacitors can be paralleled to reject different frequencies of noise. Frequencies of 0.1 μ F and 1 μ F are commonly used in parallel. The bypass capacitor must be installed as close as possible to the power terminal for best results.

11 Layout

11.1 Layout Guidelines

When using multiple bit logic devices, inputs should not float. In many cases, functions or parts of functions of digital logic devices are unused. Some examples are when only two inputs of a triple-input AND gate are used, or when 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

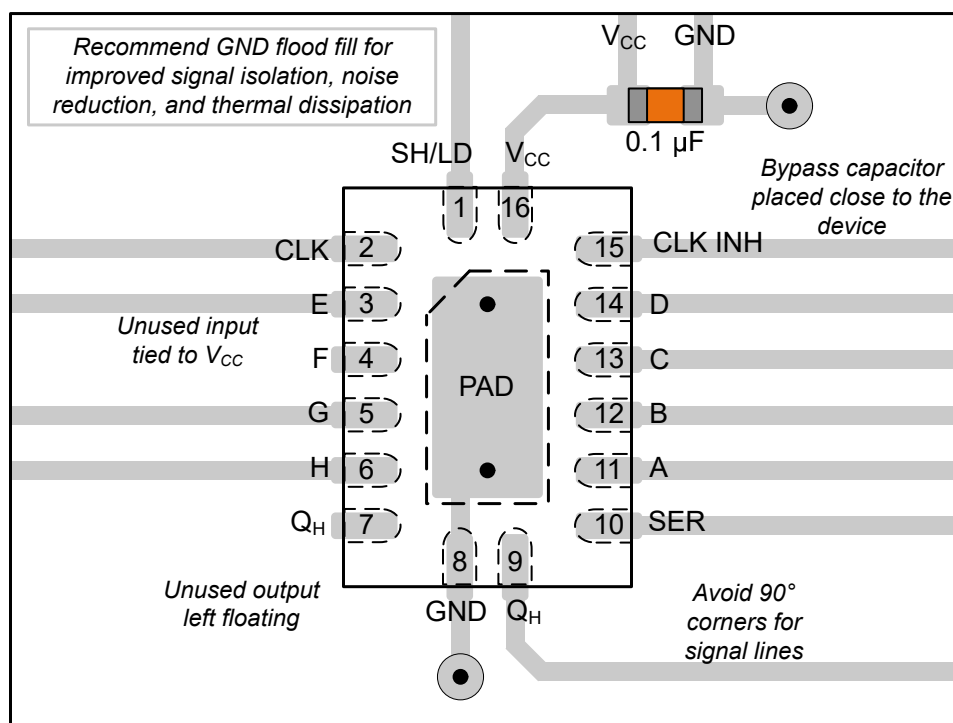


Figure 11-1. Layout Example for the SN74LV165A-Q1 in the WBQB Package

12 Device and Documentation Support

12.1 Related Documentation

For related documentation, see the following:

- Texas Instruments, [Power-Up Behavior of Clocked Devices](#)
- Texas Instruments, [Introduction to Logic](#)

12.2 Receiving Notification of Documentation Updates

To receive notification of documentation updates—including silicon errata—go to the product folder for your device on [ti.com](https://www.ti.com). In the upper right-hand corner, click the *Alert me* button. This registers you to receive a weekly digest of product information that has changed (if any). For change details, check the revision history of any revised document.

12.3 Support Resources

[TI E2E™ support forums](#) are an engineer's go-to source for fast, verified answers and design help — straight from the experts. Search existing answers or ask your own question to get the quick design help you need.

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12.4 Trademarks

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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 Glossary

[TI Glossary](#) This glossary lists and explains terms, acronyms, and definitions.

13 Mechanical, Packaging, and Orderable Information

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

PACKAGING INFORMATION

Orderable part number	Status (1)	Material type (2)	Package Pins	Package qty Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
SN74LV165AQWBQBRQ1	Active	Production	WQFN (BQB) 16	3000 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	LV165Q
SN74LV165AQWBQBRQ1.A	Active	Production	WQFN (BQB) 16	3000 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	LV165Q

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

⁽²⁾ **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

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

⁽⁴⁾ **Lead finish/Ball material:** Parts may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

⁽⁵⁾ **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

⁽⁶⁾ **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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OTHER QUALIFIED VERSIONS OF SN74LV165A-Q1 :

- Catalog : [SN74LV165A](#)

- Enhanced Product : [SN74LV165A-EP](#)

NOTE: Qualified Version Definitions:

- Catalog - TI's standard catalog product
- Enhanced Product - Supports Defense, Aerospace and Medical Applications

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
SN74LV165AQBQBRQ1	WQFN	BQB	16	3000	180.0	12.4	2.8	3.8	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)
SN74LV165AQWBQBRQ1	WQFN	BQB	16	3000	210.0	185.0	35.0

GENERIC PACKAGE VIEW

BQB 16

WQFN - 0.8 mm max height

2.5 x 3.5, 0.5 mm pitch

PLASTIC QUAD FLATPACK - NO LEAD

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



4226161/A

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

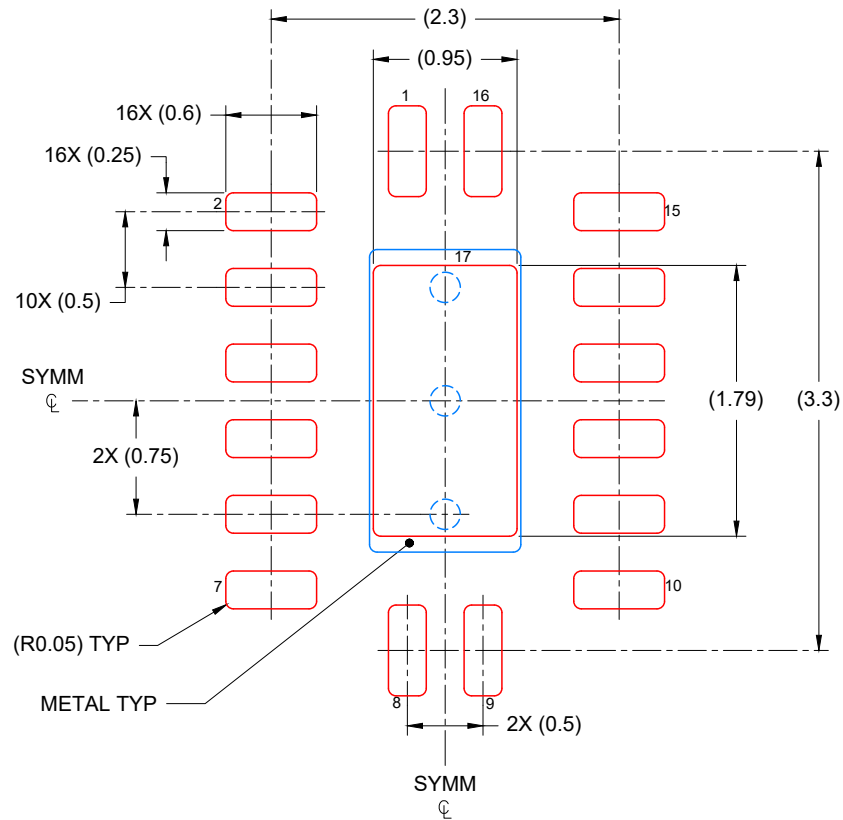
WQFN - 0.8 mm max height

The drawing shows a PCB layout with the following dimensions and features:

- Overall Dimensions:**
 - Width: 2.3
 - Height: 3.3
- Component Locations (Numbered):**
 - 1, 16: Top left components.
 - 2: Top left component below 1 and 16.
 - 15: Top right component.
 - 17: Center component.
 - 10: Bottom right component.
 - 7: Bottom left component.
 - 8, 9: Bottom center components.
- Dimensions and Spacing:**
 - 16X (0.6): Dimension for the top left section.
 - 16X (0.25): Dimension for the top left section.
 - 10X (0.5): Dimension for the top left section.
 - 2X (0.75): Dimension for the bottom left section.
 - 2X (0.5): Dimension for the bottom center section.
 - (1): Dimension for the top center section.
 - (2): Dimension for the right side section.
 - (3.3): Overall height dimension.
- Other Features:**
 - SYMM: Symmetry lines.
 - (R0.05) TYP: Typical radius dimension.
 - (Ø 0.2) VIA TYP: Typical via dimension.

4226135/A 08/2020

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



SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL

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

4226135/A 08/2020

NOTES: (continued)

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

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