









SN74LV6T17-Q1 SCLS933 - JUNE 2023

# SN74LV6T17-Q1 Automotive Hex Schmitt-Trigger Buffers with Integrated Translation

### 1 Features

- AEC-Q100 qualified for automotive applications:
  - Device temperature grade 1: -40°C to +125°C
  - Device HBM ESD classification level 2
  - Device CDM ESD classification level C4B
- Available in wettable flank QFN (WBQA) package
- Wide operating range of 1.8 V to 5.5 V
- Single-supply voltage translator (refer to LVxT Enhanced Input Voltage):
  - Up translation:
    - 1.2 V to 1.8 V
    - 1.5 V to 2.5 V
    - 1.8 V to 3.3 V
    - 3.3 V to 5.0 V
  - Down translation:
    - 5.0 V, 3.3 V, 2.5 V to 1.8 V
    - 5.0 V, 3.3 V to 2.5 V
    - 5.0 V to 3.3 V
- 5.5-V tolerant input pins
- Supports standard pinouts
- Up to 150 Mbps with 5-V or 3.3-V  $V_{CC}$
- Latch-up performance exceeds 250 mA per JESD

# 2 Applications

- Enable or disable a digital signal
- Controlling an indicator LED
- Translation between communication modules and system controllers

# 3 Description

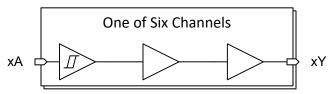
The SN74LV6T17-Q1 device contains six independent Buffers with Schmitt-trigger inputs. Each gate performs the Boolean function Y = A in positive logic. The output level is referenced to the supply voltage (V<sub>CC</sub>) and supports 1.8-V, 2.5-V, 3.3-V, and 5-V CMOS levels.

The input is designed with a lower threshold circuit to support up translation for lower voltage CMOS inputs (for example, 1.2 V input to 1.8 V output or 1.8 V input to 3.3 V output). In addition, the 5-V tolerant input pins enable down translation (for example, 3.3 V to 2.5 V output).

### **Package Information**

PART NUMBER	PACKAGE <sup>(1)</sup>	PACKAGE SIZE <sup>(2)</sup>	BODY SIZE (NOM)(3)	
SN74LV6T17-Q1	BQA (WQFN, 14)	3 mm × 2.5 mm	3 mm × 2.5 mm	
31474EV0117-Q1	PW (TSSOP, 14)	5 mm × 6.4 mm	5 mm × 4.4 mm	

- For all available packages, see the orderable addendum at (1) the end of the data sheet.
- The package size (length × width) is a nominal value and (2) includes pins, where applicable.
- The body size (length × width) is a nominal value and does not include pins.



Simplified Logic Diagram (Positive Logic)



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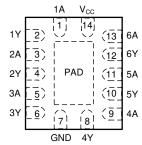
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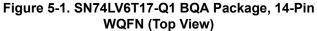
# **4 Revision History**

DATE	REVISION	NOTES
June 2023	*	Initial Release



# **5 Pin Configuration and Functions**





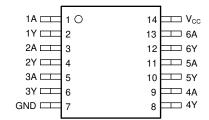


Figure 5-2. SN74LV6T17-Q1 PW Package, 14-Pin TSSOP (Top View)

Table 5-1. Pin Functions

PIN		TYPE <sup>(1)</sup>	DESCRIPTION	
NAME	BQA	PW	ITPE	DESCRIPTION
1A			I	Channel 1, Input A
1Y			0	Channel 1, Ouput Y
2A			I	Channel 2, Input A
2Y			0	Channel 2, Ouput Y
3A <sub>CC</sub>			I	Channel 3, Input A
3Y			0	Channel 3, Ouput Y
GND			G	Ground
4Y			0	Channel 4, Output Y
4A			I	Channel 4, Input A
5Y			0	Channel 5, Output Y
5A			I	Channel 5, Input A
6Y			0	Channel 6, Output Y
6A			I	Channel 6, Input A
V <sub>CC</sub>			Р	Positive Supply
Thermal Pa	d <sup>(2)</sup>		_	The thermal pad can be connected to GND or left floating. Do not connect to any other signal or supply.

I = input, O = output, I/O = input or output, G = ground, P = power.

<sup>(2)</sup> BQA package only.



# **6 Specifications**

# **6.1 Absolute Maximum Ratings**

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

			MIN	MAX	UNIT
V <sub>CC</sub>	Supply voltage range		-0.5	7	V
VI	Input voltage range <sup>(2)</sup>		-0.5	7	V
Vo	Voltage range applied to any outp	Voltage range applied to any output in the high-impedance or power-off state <sup>(2)</sup>		7	V
Vo	Output voltage range <sup>(2)</sup>		-0.5	V <sub>CC</sub> + 0.5	V
I <sub>IK</sub>	Input clamp current	V <sub>I</sub> < -0.5 V		-20	mA
I <sub>OK</sub>	Output clamp current	$V_{O}$ < -0.5 V or $V_{O}$ > $V_{CC}$ + 0.5 V		±20	mA
Io	Continuous output current	$V_O = 0$ to $V_{CC}$		±25	mA
	Continuous output current through V <sub>CC</sub> or GND			±50	mA
T <sub>stg</sub>	Storage temperature	Storage temperature		150	°C

<sup>(1)</sup> 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.

# 6.2 ESD Ratings

			VALUE	UNIT
Floatractatio	Human body model (HBM), per AEC Q100-002 HBM ESD Classification Level 2 <sup>(1)</sup>	±2000		
V <sub>(ESD)</sub>	V <sub>(ESD)</sub> Electrostatic discharge	Charged device model (CDM), per AEC Q100-011 CDM ESD Classification Level C4B	±1000	V

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

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



# **6.3 Recommended Operating Conditions**

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

Spec	Description	Condition	MIN	MAX	UNIT
V <sub>CC</sub>	Supply voltage	'	1.6	5.5	V
V <sub>I</sub>	Input voltage		0	5.5	V
Vo	Output voltage		0	V <sub>CC</sub>	V
	V <sub>CC</sub> = 1.65 V to 2 V	1.1			
\/	High lovel input veltage	V <sub>CC</sub> = 2.25 V to 2.75 V	1.28		V
$V_{IH}$	High-level input voltage	V <sub>CC</sub> = 3 V to 3.6 V	1.45		V
		V <sub>CC</sub> = 4.5 V to 5.5 V	2		
	V <sub>CC</sub> = 1.65 V to 2 V		0.5		
V/	Low-Level input voltage	V <sub>CC</sub> = 2.25 V to 2.75 V		0.65	V
$V_{IL}$		V <sub>CC</sub> = 3 V to 3.6 V		0.75	V
		V <sub>CC</sub> = 4.5 V to 5.5 V		0.85	
		V <sub>CC</sub> = 1.6 V to 2 V		±3	
Io	Output current	V <sub>CC</sub> = 2.25 V to 2.75 V		±7	mA
		V <sub>CC</sub> = 3.3 V to 5.0 V		±15	
Δt/Δν	Input transition rise or fall rate	V <sub>CC</sub> = 1.6 V to 5.0 V		20	ns/V
T <sub>A</sub>	Operating free-air temperature		-40	125	°C

# **6.4 Thermal Information**

		SN74LV	SN74LV6T17-Q1			
THERMAL METRIC(1)		BQA (WQFN)	PW (TSSOP)	UNIT		
		14 PINS	14 PINS			
R <sub>θJA</sub>	Junction-to-ambient thermal resistance	88.3	151.0	°C/W		
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	90.9	80.0	°C/W		
R <sub>0JB</sub>	Junction-to-board thermal resistance	56.8	94.2	°C/W		
$\Psi_{JT}$	Junction-to-top characterization parameter	9.9	28.0	°C/W		
Y <sub>JB</sub>	Junction-to-board characterization parameter	56.7	93.6	°C/W		
R <sub>0JC(bot)</sub>	Junction-to-case (bottom) thermal resistance	33.4	N/A	°C/W		

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)

PARAMET	TEGT COMPITIONS	v	T <sub>A</sub> =	: 25°C	-40°C t	o 125°C	UNIT
ER	TEST CONDITIONS	V <sub>cc</sub>	MIN	TYP MAX	MIN	TYP MAX	UNII
		1.65 V to 2 V	0.6	1.2	0.5	1.27	
	Positive-going input threshold	2.25 V to 2.75 V	0.73	1.39	0.64	1.44	
$V_{T+}$	voltage	3 V to 3.6 V	0.88	1.59	0.80	1.63	V
		4.5 V to 5.5 V	1.15	2.03	1.1	2.07	
		1.65 V to 2 V	0.225	0.685	0.185	0.755	
	Negative-going input threshold	2.25 V to 2.75 V	0.295	0.775	0.265	0.805	
V <sub>T-</sub>	voltage	3 V to 3.6 V	0.385	0.875	0.345	0.895	V
		4.5 V to 5.5 V	0.535	1.075	0.495	1.085	
		1.65 V to 2 V	0.35	0.68	0.28	0.8	
A) /	Libertanneis (V	2.25 V to 2.75 V	0.4	0.77	0.33	0.87	
$\Delta V_T$	Hysteresis (V <sub>T+</sub> - V <sub>T-</sub> )	3 V to 3.6 V	0.44	0.88	0.38	0.91	V
		4.5 V to 5.5 V	0.53	1.2	0.51	1.4	
	I <sub>OH</sub> = -50 uA	1.65 V to 5.5 V	V <sub>CC</sub> -0.1		V <sub>CC</sub> -0.1		
	I <sub>OH</sub> = -2 mA	1.65 V to 2 V	1.28	1.7 (1)	1.21		
$V_{OH}$	I <sub>OH</sub> = -3 mA	2.25 V to 2.75 V	2	2.4 <sup>(1)</sup>	1.93		V
	I <sub>OH</sub> = -5.5 mA	3 V to 3.6 V	2.6	3.08 <sup>(1)</sup>	2.49		
	I <sub>OH</sub> = -8 mA	4.5 V to 5.5 V	4.1	4.65 <sup>(1)</sup>	3.95		
	I <sub>OL</sub> = 50 uA	1.65 V to 5.5 V		0.1		0.1	
	I <sub>OL</sub> = 2 mA	1.65 V to 2 V		0.1(1) 0.2		0.25	
$V_{OL}$	I <sub>OL</sub> = 3 mA	2.25 V to 2.75 V		0.1 <sup>(1)</sup> 0.15		0.2	V
	I <sub>OL</sub> = 5.5 mA	3 V to 3.6 V		0.2 <sup>(1)</sup> 0.2		0.25	
	I <sub>OL</sub> = 8 mA	4.5 V to 5.5 V		0.3 <sup>(1)</sup> 0.3		0.35	
I <sub>I</sub>	V <sub>I</sub> = 0 V or V <sub>CC</sub>	0 V to 5.5 V		±0.1		±1	μΑ
I <sub>CC</sub>	V <sub>I</sub> = 0 V or V <sub>CC</sub> , I <sub>O</sub> = 0; open on loading	1.65 V to 5.5 V		2		20	μA
<b>A.</b> I.	One input at 0.3 V or 3.4 V, other inputs at 0 or $V_{CC}$ , $I_{O} = 0$	5.5 V		1.35		1.5	mA
ΔI <sub>CC</sub>	One input at 0.3 V or 1.1 V, other inputs at 0 or V <sub>CC</sub> , I <sub>O</sub> = 0	1.8 V		10		20	μA
Cı	V <sub>I</sub> = V <sub>CC</sub> or GND	5 V		4 10		10	pF
Co	V <sub>O</sub> = V <sub>CC</sub> or GND	5 V		3			pF
C <sub>PD</sub> (2) (3)	No load, F = 1Mhz	5 V		14			pF

 <sup>(1)</sup> Typical value at nearest nominal voltage (1.8 V, 2.5 V, 3.3 V, and 5 V)
 (2) C<sub>PD</sub> is used to determine the dynamic power consumption, per channel.
 (3) P<sub>D</sub>= V<sub>CC</sub> <sup>2</sup>xF<sub>I</sub>x(C<sub>PD</sub>+ C<sub>L</sub>) where F<sub>I</sub>= input frequency, C<sub>L</sub>= output load capacitance, V<sub>CC</sub>= supply voltage.



# **6.6 Switching Characteristics**

over operating free-air temperature range; (unless otherwise noted). See Parameter Measurement Information

PARAMETER	FROM TO (OUTPUT) VCC CAPACITANCE	LOAD	DAD T <sub>A</sub> = 25°C		С	-40°C to 125°C		UNIT			
FANAMETER	(INPUT)	10 (0011-01)	V <sub>cc</sub>	CAPACITANCE	MIN	TYP	MAX	MIN	TYP	MAX	
			1.8 V	C <sub>L</sub> = 15pF	8.85	14	19.7	7.45	15.5	22.8	
			1.0 V	C <sub>L</sub> = 50pF	10.8	17.1	23.3	9.07	18.4	26.7	
		Υ	2.5 V	C <sub>L</sub> = 15pF	6.44	8.9	11	5.42	9.6	13.4	
	A			C <sub>L</sub> = 50pF	7.94	10.8	13.2	6.59	11.7	16	nS
t <sub>PD</sub>				C <sub>L</sub> = 15pF	5.24	6.9	8.4	4.42	7.5	10.2	
			3.3 V	C <sub>L</sub> = 50pF	6.58	8.5	10.1	5.41	9.1	12.2	
			E \/	C <sub>L</sub> = 15pF	4.09	5.1	6.2	3.29	5.5	7.7	
			J V	C <sub>L</sub> = 50pF	5.06	6.4	7.7	4.07	6.9	9.4	

# **6.7 Noise Characteristics**

VCC = 5 V, CL = 50 pF, TA = 25°C

PARAMETER	DESCRIPTION	MIN	TYP	MAX	UNIT
V <sub>OL(P)</sub>	Quiet output, maximum dynamic V <sub>OL</sub>		0.9	0.8	V
V <sub>OL(V)</sub>	Quiet output, minimum dynamic V <sub>OL</sub>	-0.8	-0.3		V
V <sub>OH(V)</sub>	Quiet output, minimum dynamic V <sub>OH</sub>	4.4	5		V
V <sub>IH(D)</sub>	High-level dynamic input voltage	2.1			V
V <sub>IL(D)</sub>	Low-level dynamic input voltage			0.5	V

# 7 Typical Characteristics

T<sub>A</sub> = 25°C (unless otherwise noted)

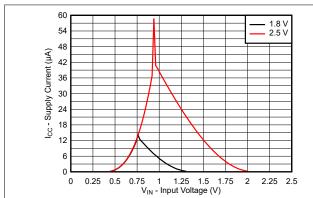
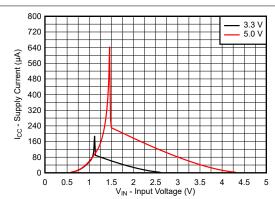


Figure 7-1. Supply Current Across Input Voltage 1.8-V and 2.5-V | Figure 7-2. Supply Current Across Input Voltage 3.3-V and 5.0-V Supply

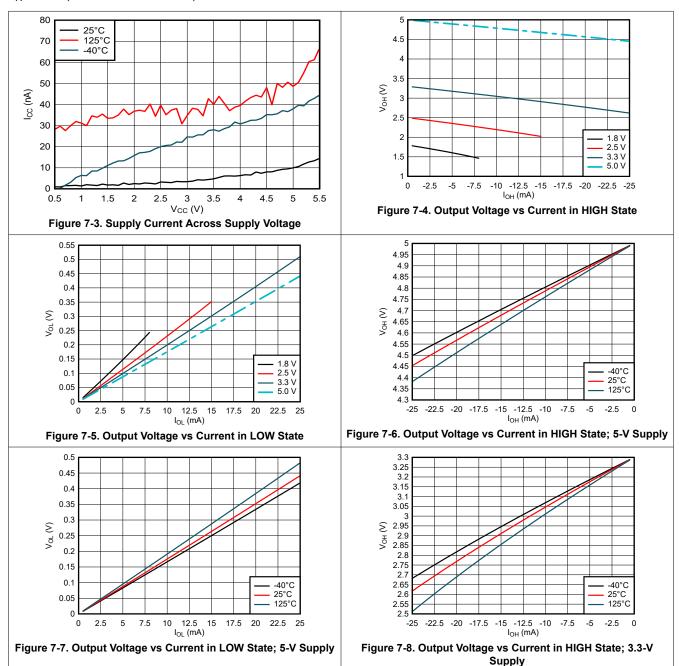


Supply



# 7 Typical Characteristics (continued)

T<sub>A</sub> = 25°C (unless otherwise noted)



# 7 Typical Characteristics (continued)

T<sub>A</sub> = 25°C (unless otherwise noted)

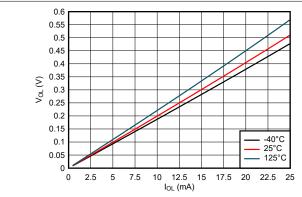


Figure 7-9. Output Voltage vs Current in LOW State; 3.3-V Supply

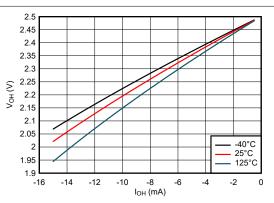


Figure 7-10. Output Voltage vs Current in HIGH State; 2.5-V Supply

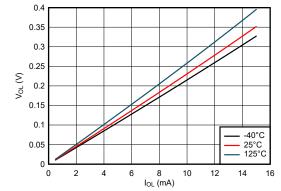


Figure 7-11. Output Voltage vs Current in LOW State; 2.5-V Supply

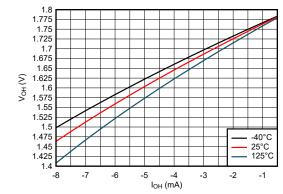


Figure 7-12. Output Voltage vs Current in HIGH State; 1.8-V Supply

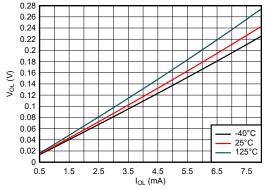


Figure 7-13. Output Voltage vs Current in LOW State; 1.8-V Supply

 $V_{\text{OL}}$ 

# **8 Parameter Measurement Information**

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

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.

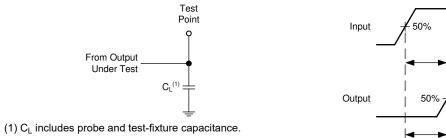


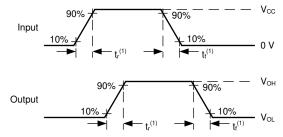
Figure 8-1. Load Circuit for Push-Pull Outputs

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

50%

Figure 8-2. Voltage Waveforms Propagation Delays

50%



Output

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

Figure 8-3. Voltage Waveforms, Input and Output Transition Times

# 9 Detailed Description

## 9.1 Overview

The SN74LV6T17-Q1 device contains six independent Buffers with Schmitt-trigger inputs. Each gate performs the Boolean function Y = A in positive logic. The output level is referenced to the supply voltage ( $V_{CC}$ ) and supports 1.8-V, 2.5-V, 3.3-V, and 5-V CMOS levels.

## 9.2 Functional Block Diagram



## 9.3 Feature Description

### 9.3.1 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.

### 9.3.2 Clamp Diode Structure

The outputs to this device have both positive and negative clamping diodes, and the inputs to this device have negative clamping diodes only as shown in Figure 9-1.

### **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.

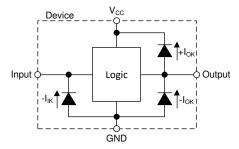


Figure 9-1. Electrical Placement of Clamping Diodes for Each Input and Output

# 9.3.3 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*.

#### 9.3.4 LVxT Enhanced Input Voltage

The SN74LV6T17-Q1 belongs to Tl's LVxT family of logic devices with integrated voltage level translation. This family of devices was designed with reduced input voltage thresholds to support up-translation, and inputs tolerant of signals with up to 5.5 V levels to support down-translation. The output voltage will always be referenced to the supply voltage ( $V_{CC}$ ), as described in the *Electrical Characteristics* table. For proper functionality, input signals must remain at or below the specified  $V_{IH(MIN)}$  level for a HIGH input state, and at or below the specified  $V_{IL(MAX)}$  for a LOW input state. Figure 9-2 shows the typical  $V_{IH}$  and  $V_{IL}$  levels for the LVxT family of devices, as well as the voltage levels for standard CMOS devices for comparison.

The 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  $(R = V \div I)$ .

The 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 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; however, a  $10-k\Omega$  resistor is recommended and will typically meet all requirements.

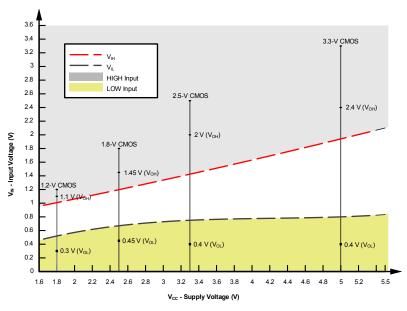


Figure 9-2. LVxT Input Voltage Levels

### 9.3.4.1 Down Translation

Signals can be translated down using the SN74LV6T17-Q1. The voltage applied at the V<sub>CC</sub> will determine the output voltage and the input thresholds as described in the *Recommended Operating Conditions* and *Electrical Characteristics* tables.

When connected to a high-impedance input, the output voltage will be approximately  $V_{CC}$  in the HIGH state, and 0 V in the LOW state. As shown in Figure 9-2, ensure that the input signals in the HIGH state are between  $V_{IH(MIN)}$  and 5.5 V, and input signals in the LOW state are lower than  $V_{IL(MAX)}$ .

As shown in Figure 9-3 for example, the standard CMOS inputs for devices operating at 5.0 V, 3.3 V or 2.5 V can be down-translated to match 1.8 V CMOS signals when operating from 1.8-V  $V_{CC}$ .

Down Translation Combinations are as follows:

- 1.8-V  $V_{CC}$  Inputs from 2.5 V, 3.3 V, and 5.0 V
- 2.5-V V<sub>CC</sub> Inputs from 3.3 V and 5.0 V
- 3.3-V V<sub>CC</sub> Inputs from 5.0 V

### 9.3.4.2 Up Translation

Input signals can be up translated using the SN74LV6T17-Q1. The voltage applied at  $V_{CC}$  will determine the output voltage and the input thresholds as described in the *Recommended Operating Conditions* and *Electrical Characteristics* tables. When connected to a high-impedance input, the output voltage will be approximately  $V_{CC}$  in the HIGH state, and 0 V in the LOW state.

The inputs have reduced thresholds that allow for input HIGH state levels which are much lower than standard values. For example, standard CMOS inputs for a device operating at a 5-V supply will have a  $V_{IH(MIN)}$  of 3.5 V. For the SN74LV6T17-Q1,  $V_{IH(MIN)}$  with a 5-V supply is only 2 V, which would allow for up-translation from a typical 2.5-V to 5-V signals.

As shown in Figure 9-3, ensure that the input signals in the HIGH state are above  $V_{IH(MIN)}$  and input signals in the LOW state are lower than  $V_{IL(MAX)}$ .

Up Translation Combinations are as follows:

- 1.8-V V<sub>CC</sub> Inputs from 1.2 V
- 2.5-V V<sub>CC</sub> Inputs from 1.8 V
- 3.3-V V<sub>CC</sub> Inputs from 1.8 V and 2.5 V
- 5.0-V V<sub>CC</sub> Inputs from 2.5 V and 3.3 V

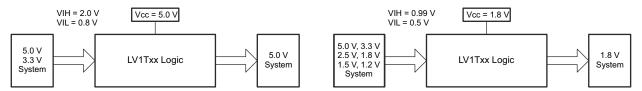


Figure 9-3. LVxT Up and Down Translation Example

### 9.3.5 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.

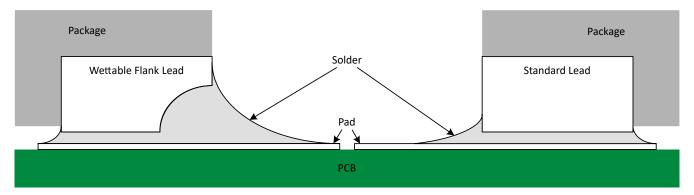


Figure 9-4. Simplified Cutaway View of Wettable-Flank QFN Package and Standard QFN Package After Soldering

Wettable flanks help improve side wetting after soldering, which makes QFN packages easier to inspect with automatic optical inspection (AOI). As shown in Figure 9-4, 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.

# 9.4 Device Functional Modes

Table 9-1 lists the functional modes of the SN74LV6T17-Q1.

**Table 9-1. Function Table** 

INPUT A <sup>(1)</sup>	OUTPUT Y
Н	Н
L	L

(1) H = high voltage level, L = low voltage level, X = do not care, Z = high impedance

# 10 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.

# 10.1 Application Information

The SN74LV6T17-Q1 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.

# **10.2 Typical Application**

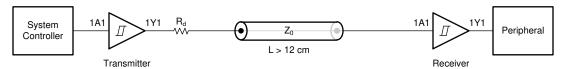


Figure 10-1. Typical Application Block Diagram

## 10.2.1 Design Requirements

### 10.2.1.1 Power Considerations

Ensure the desired supply voltage is within the range specified in the *Recommended Operating Conditions*. The supply voltage sets the electrical characteristics of the device 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 SN74LV6T17-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 SN74LV6T17-Q1 plus the maximum supply current, I<sub>CC</sub>, 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 SN74LV6T17-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 SN74LV6T17-Q1 can drive a load with total resistance described by  $R_L \ge V_O / I_O$ , 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 note.

Thermal increase can be calculated using the information provided in the *Thermal Characteristics of Standard Linear and Logic (SLL) Packages and Devices* application note.

## 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.

## 10.2.1.2 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 SN74LV6T17-Q1 (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 SN74LV6T17-Q1 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<sub>CC</sub> or ground is plotted in the *Typical Characteristics*.

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

### 10.2.1.3 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.



### 10.2.2 Detailed Design Procedure

- 1. Add a decoupling capacitor from V<sub>CC</sub> to GND. The capacitor needs to be placed physically close to the device and electrically close to both the V<sub>CC</sub> and GND pins. An example layout is shown in the Layout
- 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 SN74LV6T17-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.

# 10.2.3 Application Curves

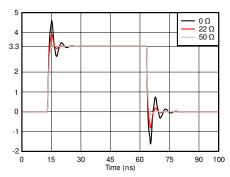


Figure 10-2. Simulated Signal Integrity at the Receiver With Different Damping Resistor (R<sub>d</sub>) Values

# 11 Layout

# 11.1 Layout Guidelines

When using multiple-input and multiple-channel logic devices, inputs must never 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<sub>CC</sub>, whichever makes more sense for the logic function or is more convenient.



# 11.2 Layout Example

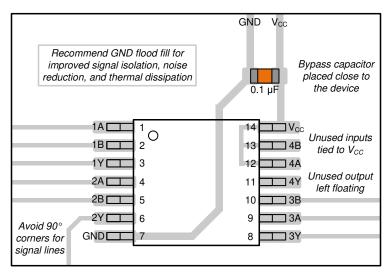


Figure 11-1. Example Layout for the SN74LV6T17-Q1

# 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, CMOS Power Consumption and Cpd Calculation application note
- Texas Instruments, Designing With Logic application note
- Texas Instruments, Thermal Characteristics of Standard Linear and Logic (SLL) Packages and Devices application note
- Texas Instruments, Implications of Slow or Floating CMOS Inputs application note

# 12.2 Receiving Notification of Documentation Updates

To receive notification of documentation updates, navigate to the device product folder on ti.com. Click on *Subscribe to updates* to register and receive a weekly digest of any product information that has changed. For change details, review the revision history included in 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.

15-Nov-2025 www.ti.com

### PACKAGING INFORMATION

Orderable part number	Status	Material type	Package   Pins	Package qty   Carrier	RoHS	Lead finish/ Ball material	MSL rating/ Peak reflow	Op temp (°C)	Part marking (6)
	('')	(2)			(0)	(4)	(5)		(0)
SN74LV6T17QPWRQ1	Active	Production	TSSOP (PW)   14	3000   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	LVT17Q
SN74LV6T17QPWRQ1.A	Active	Production	TSSOP (PW)   14	3000   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	LVT17Q
SN74LV6T17QWBQARQ1	Active	Production	WQFN (BQA)   14	3000   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	LVT17Q
SN74LV6T17QWBQARQ1.A	Active	Production	WQFN (BQA)   14	3000   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	LVT17Q

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

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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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 SN74LV6T17-Q1:

<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.

# PACKAGE OPTION ADDENDUM

www.ti.com 15-Nov-2025

Catalog: SN74LV6T17

● Enhanced Product : SN74LV6T17-EP

NOTE: Qualified Version Definitions:

Catalog - TI's standard catalog product

• Enhanced Product - Supports Defense, Aerospace and Medical Applications



SMALL OUTLINE PACKAGE



### NOTES:

- 1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.

  2. This drawing is subject to change without notice.

  3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not
- exceed 0.15 mm per side.
- 4. This dimension does not include interlead flash. Interlead flash shall not exceed 0.25 mm per side.
- 5. Reference JEDEC registration MO-153.



SMALL OUTLINE PACKAGE



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.



SMALL OUTLINE PACKAGE



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.



2.5 x 3, 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.



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PLASTIC QUAD FLATPACK - NO LEAD



### 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.



PLASTIC QUAD FLATPACK - NO LEAD



NOTES: (continued)

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



PLASTIC QUAD FLATPACK - NO LEAD



NOTES: (continued)

<sup>6.</sup> 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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