SN74LV2T74 Dual D-Type Flip-Flop With Integrated Translation

1 Features

- 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 17

2 Applications

- Convert a momentary switch to a toggle switch
- Hold a signal during controller reset
- Input slow edge-rate signals
- Operate in noisy environments
- Divide a clock signal by two

3 Description

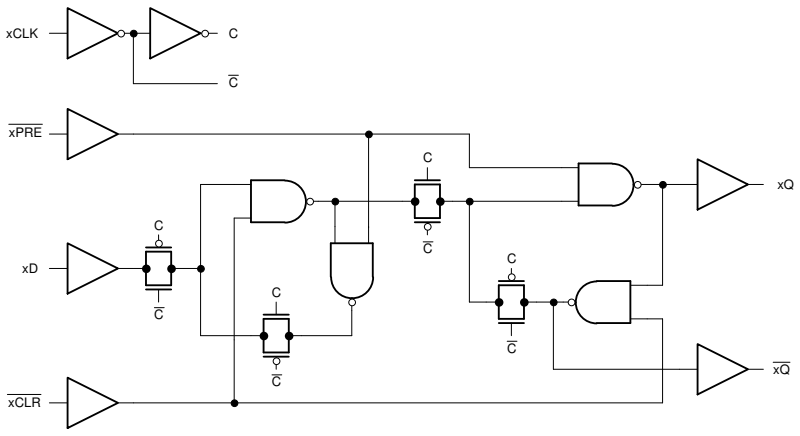
The SN74LV2T74 contains two independent D-type positive-edge-triggered flip-flops. A low level at the preset ($\overline{PRE}$) input sets the output high. A low level at the clear ($\overline{CLR}$) input resets the output low. Preset and clear functions are asynchronous and not dependent on the levels of the other inputs. When PRE and CLR are inactive (high), data at the data (D) input meeting the setup time requirements is transferred to the outputs (Q, $\overline{Q}$) on the positive-going edge of the clock (CLK) pulse. Clock triggering occurs at a voltage level and is not directly related to the rise time of the input clock (CLK) signal. Following the hold-time interval, data at the data (D) input can be changed without affecting the levels at the outputs (Q, $\overline{Q}$). 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.

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(1)	PACKAGE SIZE(2)	BODY SIZE (NOM)(3)
SN74LV2T74	BQA (WQFN, 14)	3 mm × 2.5 mm	3 mm × 2.5 mm
	PW (TSSOP, 14)	5 mm × 6.4 mm	5 mm × 4.4 mm

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



Simplified Logic Diagram (Positive Logic)

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4 Revision History

DATE	REVISION	NOTES
May 2023	*	Initial Release

5 Pin Configuration and Functions

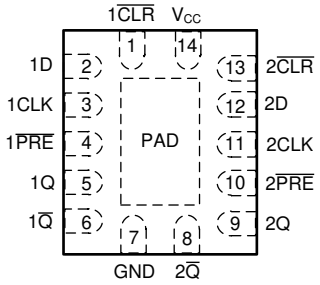


Figure 5-1. BQA Package, 14-Pin WQFN (Top View)

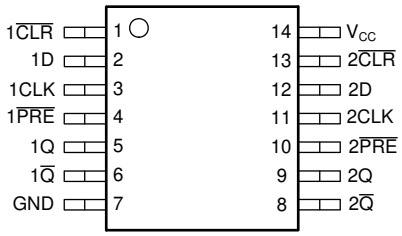


Figure 5-2. PW Package, 14-Pin TSSOP (Top View)

Table 5-1. Pin Functions

PIN		TYPE	DESCRIPTION
NAME	NO.		
1$\overline{CLR}$	1	Input	Clear for channel 1, active low
1D	2	Input	Data for channel 1
1CLK	3	Input	Clock for channel 1, rising edge triggered
1$\overline{PRE}$	4	Input	Preset for channel 1, active low
1Q	5	Output	Output for channel 1
1$\overline{Q}$	6	Output	Inverted output for channel 1
GND	7	—	Ground
2$\overline{Q}$	8	Output	Inverted output for channel 2
2Q	9	Output	Output for channel 2
2$\overline{PRE}$	10	Input	Preset for channel 2, active low
2CLK	11	Input	Clock for channel 2, rising edge triggered
2D	12	Input	Data for channel 2
2$\overline{CLR}$	13	Input	Clear for channel 2, active low
V_{CC}	14	—	Positive supply
Thermal Pad(1)		—	The thermal pad can be connected to GND or left floating. Do not connect to any other signal or supply

(1) BQA 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 range		–0.5	7	V
V_I	Input voltage range(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 range(2)		–0.5	V_{CC} + 0.5	V
I_{IK}	Input clamp current	V_I < -0.5 V		-20	mA
I_{OK}	Output clamp current	V_O < -0.5 V or V_O > V_{CC} + 0.5 V		±20	mA
I_O	Continuous output current	V_O = 0 to V_{CC}		±25	mA
	Continuous output 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 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 ANSI/ESDA/JEDEC JS-001(1)	±2000	V
		Charged-device model (CDM), per ANSI/ESDA/JEDEC JS-002(2)	±1000	

(1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.
(2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

6.3 Recommended Operating Conditions

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

PARAMETER	DESCRIPTION	CONDITION	MIN	MAX	UNIT
V_{CC}	Supply voltage		1.6	5.5	V
V_I	Input voltage		0	5.5	V
V_O	Output voltage		0	V_{CC}	V
V_{IH}	High-level input voltage	V_{CC} = 1.65 V to 2 V	1.1		V
		V_{CC} = 2.25 V to 2.75 V	1.28		
		V_{CC} = 3 V to 3.6 V	1.45		
		V_{CC} = 4.5 V to 5.5 V	2		
V_{IL}	Low-Level input voltage	V_{CC} = 1.65 V to 2 V		0.5	V
		V_{CC} = 2.25 V to 2.75 V		0.65	
		V_{CC} = 3 V to 3.6 V		0.75	
		V_{CC} = 4.5 V to 5.5 V		0.85	
I_O	Output current	V_{CC} = 1.6 V to 2 V		±3	mA
		V_{CC} = 2.25 V to 2.75 V		±7	
		V_{CC} = 3.3 V to 5.0 V		±15	
Δt/Δv	Input transition rise or fall rate	V_{CC} = 1.6 V to 5.0 V		20	ns/V
T_A	Operating free-air temperature		-40	125	°C

6.4 Thermal Information

THERMAL METRIC(1)		SN74LV2T74		UNIT
		BQA (WQFN)	PW (TSSOP)	
		14 PINS	14 PINS	
$R_{\theta JA}$	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
$R_{\theta JB}$	Junction-to-board thermal resistance	56.8	94.2	°C/W
Ψ_{JT}	Junction-to-top characterization parameter	9.9	28.0	°C/W
Y_{JB}	Junction-to-board characterization parameter	56.7	93.6	°C/W
$R_{\theta JC(bot)}$	Junction-to-case (bottom) thermal resistance	33.4	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	V_{CC}	T_A = 25°C			-40°C to 125°C			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
V_{OH}	I_{OH} = -50 µA	1.65 V to 5.5 V	V_{CC}-0.1			V_{CC}-0.1			V
	I_{OH} = -2 mA	1.65 V to 2 V	1.28	1.7 (1)		1.21			
	I_{OH} = -3 mA	2.25 V to 2.75 V	2	2.4(1)		1.93			
	I_{OH} = -5.5 mA	3 V to 3.6 V	2.6	3.08(1)		2.49			
	I_{OH} = -8 mA	4.5 V to 5.5 V	4.1	4.65(1)		3.95			
V_{OL}	I_{OL} = 50 µA	1.65 V to 5.5 V			0.1			0.1	V
	I_{OL} = 2 mA	1.65 V to 2 V		0.1(1)	0.2			0.25	
	I_{OL} = 3 mA	2.25 V to 2.75 V		0.1(1)	0.15			0.2	
	I_{OL} = 5.5 mA	3 V to 3.6 V		0.2(1)	0.2			0.25	
	I_{OL} = 8 mA	4.5 V to 5.5 V		0.3(1)	0.3			0.35	
I_I	V_I = 0 V or V_{CC}	0 V to 5.5 V			±0.1			±1	µA
I_{CC}	V_I = 0 V or V_{CC}, I_O = 0; open on loading	1.65 V to 5.5 V			2			20	µA
ΔI_{CC}	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
	One input at 0.3 V or 1.1 V, other inputs at 0 or V_{CC}, I_O = 0	1.8 V			10			20	µA
C_I	V_I = V_{CC} or GND	5 V		4	10			10	pF
C_O	V_O = V_{CC} or GND	5 V		3					pF
C_{PD} (2) (3)	No load, F = 1 MHz	5 V		14					pF

(1) Typical value at nearest nominal voltage (1.8 V, 2.5 V, 3.3 V, and 5 V)
(2) C_{PD} is used to determine the dynamic power consumption, per channel.
(3) $P_D = V_{CC}^2 \times F_I \times (C_{PD} + C_L)$ where F_I= input frequency, C_L= output load capacitance, V_{CC}= supply voltage.

6.6 Timing Characteristics 1.8-V V_{CC}

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

PARAMETER	DESCRIPTION	CONDITION	T_A = 25°C		-40°C to 125°C		UNIT
			MIN	MAX	MIN	MAX	
t_W	Pulse duration	$\overline{PRE}$ or $\overline{CLR}$ LOW	8		9		nS
t_W	Pulse duration	CLK	8		9		nS
t_{SU}	Setup time before CLK↑	Data	8		9		nS
t_{SU}	Setup time before CLK↑	$\overline{PRE}$ or $\overline{CLR}$ Inactive	7		7		nS
t_H	Hold time, data after CLK↑		0.5		0.5		nS

6.7 Timing Characteristics 2.5-V V_{CC}

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

PARAMETER	DESCRIPTION	CONDITION	T_A = 25°C		-40°C to 125°C		UNIT
			MIN	MAX	MIN	MAX	
t_W	Pulse duration	$\overline{PRE}$ or $\overline{CLR}$ LOW	7		8		nS
t_W	Pulse duration	CLK	7		8		nS
t_{SU}	Setup time before CLK↑	Data	7		8		nS
t_{SU}	Setup time before CLK↑	$\overline{PRE}$ or $\overline{CLR}$ Inactive	6		6		nS
t_H	Hold time, data after CLK↑		0.5		0.5		nS

6.8 Timing Characteristics 3.3-V V_{CC}

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

PARAMETER	DESCRIPTION	CONDITION	T_A = 25°C		-40°C to 125°C		UNIT
			MIN	MAX	MIN	MAX	
t_W	Pulse duration	$\overline{PRE}$ or $\overline{CLR}$ LOW	6		7		nS
t_W	Pulse duration	CLK	6		7		nS
t_{SU}	Setup time before CLK↑	Data	6		7		nS
t_{SU}	Setup time before CLK↑	$\overline{PRE}$ or $\overline{CLR}$ Inactive	5		5		nS
t_H	Hold time, data after CLK↑		0.5		0.5		nS

6.9 Timing Characteristics 5-V V_{CC}

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

PARAMETER	DESCRIPTION	CONDITION	T_A = 25°C		-40°C to 125°C		UNIT
			MIN	MAX	MIN	MAX	
t_W	Pulse duration	$\overline{PRE}$ or $\overline{CLR}$ LOW	5		5		nS
t_W	Pulse duration	CLK	5		5		nS
t_{SU}	Setup time before CLK↑	Data	5		5		nS
t_{SU}	Setup time before CLK↑	$\overline{PRE}$ or $\overline{CLR}$ Inactive	3		3		nS
t_H	Hold time, data after CLK↑		0.5		0.5		nS

6.10 Switching Characteristics 1.8-V V_{CC}

over operating free-air temperature range; typical values measured at T_A = 25°C (unless otherwise noted). See *Parameter Measurement Information*

PARAMETER	FROM (INPUT)	TO (OUTPUT)	LOAD CAPACITANCE	T_A = 25°C			-40°C to 125°C			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
F_{MAX}			C_L = 15 pF	34	53		30			MHz
			C_L = 50 pF	21	32		19			MHz
t_{PLH}	$\overline{PRE}$ or $\overline{CLR}$	Q or $\overline{Q}$	C_L = 15 pF		14.8	24.0	1		28.3	nS
t_{PHL}					14.8	24.0	1		28.3	nS
t_{PLH}	CLK	Q or $\overline{Q}$			13.1	23.2	1		27.3	nS
t_{PHL}					13.1	23.2	1		27.3	nS
t_{PLH}	$\overline{PRE}$ or $\overline{CLR}$	Q or $\overline{Q}$	C_L = 50 pF		19.7	30.8	1		35.1	nS
t_{PHL}					19.7	30.8	1		35.1	nS
t_{PLH}	CLK	Q or $\overline{Q}$			17.9	30.0	1		34.1	nS
t_{PHL}					17.9	30.0	1		34.1	nS

6.11 Switching Characteristics 2.5-V V_{CC}

over operating free-air temperature range; typical values measured at T_A = 25°C (unless otherwise noted). See *Parameter Measurement Information*

PARAMETER	FROM (INPUT)	TO (OUTPUT)	LOAD CAPACITANCE	T_A = 25°C			-40°C to 125°C			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
F_{MAX}			C_L = 15 pF	52	81		46			MHz
			C_L = 50 pF	33	49		29			MHz
t_{PLH}	$\overline{PRE}$ or $\overline{CLR}$	Q or $\overline{Q}$	C_L = 15 pF		9.9	16.0	1		18.9	nS
t_{PHL}					9.9	16.0	1		18.9	nS
t_{PLH}	CLK	Q or $\overline{Q}$			8.7	15.5	1		18.2	nS
t_{PHL}					8.7	15.5	1		18.2	nS
t_{PLH}	$\overline{PRE}$ or $\overline{CLR}$	Q or $\overline{Q}$	C_L = 50 pF		13.1	20.5	1		23.4	nS
t_{PHL}					13.1	20.5	1		23.4	nS
t_{PLH}	CLK	Q or $\overline{Q}$			12.0	20.0	1		22.8	nS
t_{PHL}					12.0	20.0	1		22.8	nS

6.12 Switching Characteristics 3.3-V V_{CC}

over operating free-air temperature range; typical values measured at T_A = 25°C (unless otherwise noted). See *Parameter Measurement Information*

PARAMETER	FROM (INPUT)	TO (OUTPUT)	LOAD CAPACITANCE	T_A = 25°C			-40°C to 125°C			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
F_{MAX}			C_L = 15 pF	80	125		70			MHz
			C_L = 50 pF	50	75		45			MHz
t_{PLH}	$\overline{PRE}$ or $\overline{CLR}$	Q or $\overline{Q}$	C_L = 15 pF		7.6	12.3	1		14.5	nS
t_{PHL}					7.6	12.3	1		14.5	nS
t_{PLH}	CLK	Q or $\overline{Q}$			6.7	11.9	1		14	nS
t_{PHL}					6.7	11.9	1		14	nS
t_{PLH}	$\overline{PRE}$ or $\overline{CLR}$	Q or $\overline{Q}$	C_L = 50 pF		10.1	15.8	1		18	nS
t_{PHL}					10.1	15.8	1		18	nS
t_{PLH}	CLK	Q or $\overline{Q}$			9.2	15.4	1		17.5	nS
t_{PHL}					9.2	15.4	1		17.5	nS

6.13 Switching Characteristics 5-V V_{CC}

over operating free-air temperature range; typical values measured at T_A = 25°C (unless otherwise noted). See *Parameter Measurement Information*

PARAMETER	FROM (INPUT)	TO (OUTPUT)	LOAD CAPACITANCE	T_A = 25°C			-40°C to 125°C			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
F_{MAX}			C_L = 15 pF	130	170		110			MHz
			C_L = 50 pF	90	140		75			MHz
t_{PLH}	$\overline{PRE}$ or $\overline{CLR}$	Q or $\overline{Q}$	C_L = 15 pF		4.8	7.7	1		9	nS
t_{PHL}					4.8	7.7	1		9	nS
t_{PLH}	CLK	Q or $\overline{Q}$			4.6	7.3	1		8.5	nS
t_{PHL}					4.6	7.3	1		8.5	nS
t_{PLH}	$\overline{PRE}$ or $\overline{CLR}$	Q or $\overline{Q}$	C_L = 50 pF		6.3	9.7	1		11	nS
t_{PHL}					6.3	9.7	1		11	nS
t_{PLH}	CLK	Q or $\overline{Q}$			6.1	9.3	1		10	nS
t_{PHL}					6.1	9.3	1		10	nS

6.14 Noise Characteristics

VCC = 5 V, CL = 50 pF, TA = 25°C

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

6.15 Typical Characteristics

T_A = 25°C (unless otherwise noted)

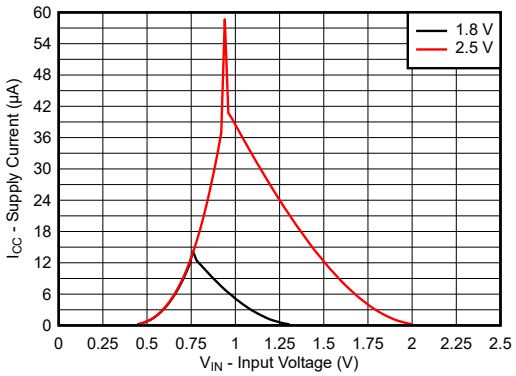


Figure 6-1. Supply Current Across Input Voltage 1.8-V and 2.5-V Supply

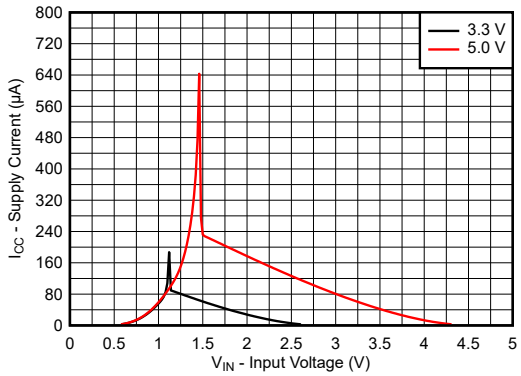


Figure 6-2. Supply Current Across Input Voltage 3.3-V and 5.0-V Supply

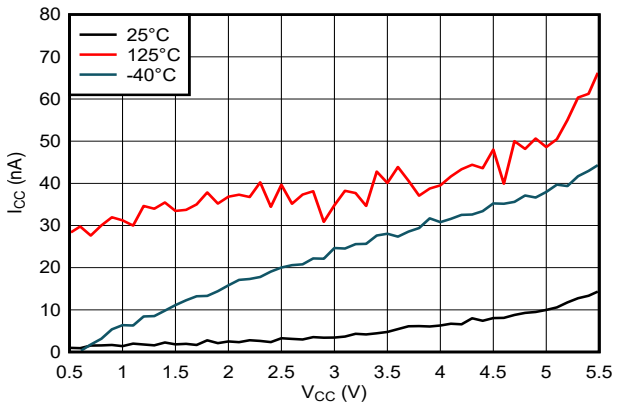


Figure 6-3. Supply Current Across Supply Voltage

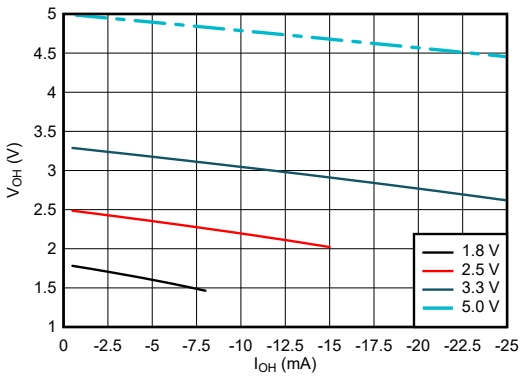


Figure 6-4. Output Voltage vs Current in HIGH State

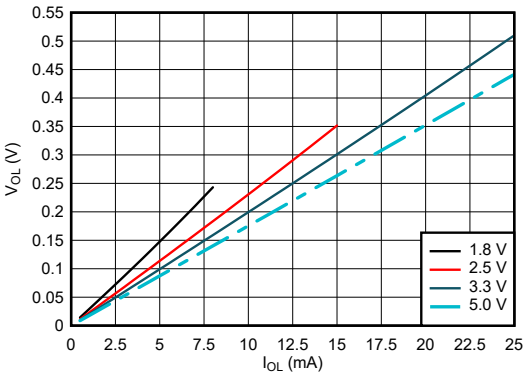


Figure 6-5. Output Voltage vs Current in LOW State

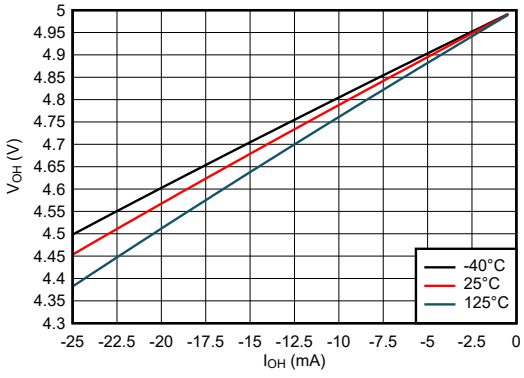


Figure 6-6. Output Voltage vs Current in HIGH State; 5-V Supply

6.15 Typical Characteristics (continued)

T_A = 25°C (unless otherwise noted)

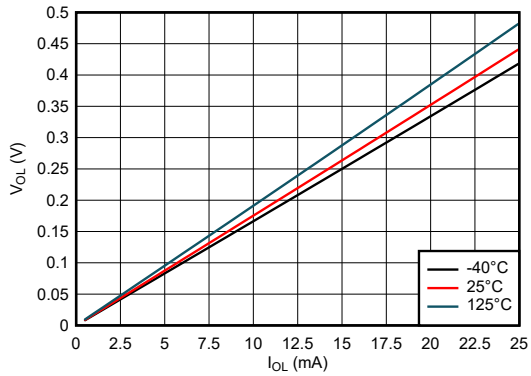


Figure 6-7. Output Voltage vs Current in LOW State; 5-V Supply

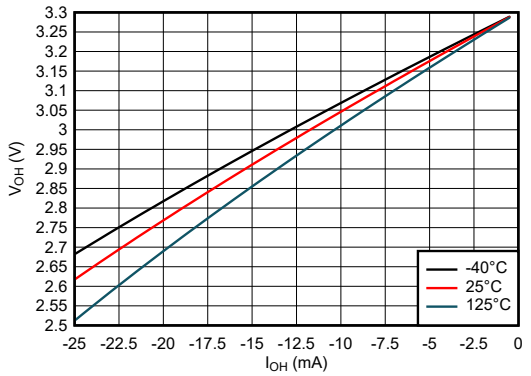


Figure 6-8. Output Voltage vs Current in HIGH State; 3.3-V Supply

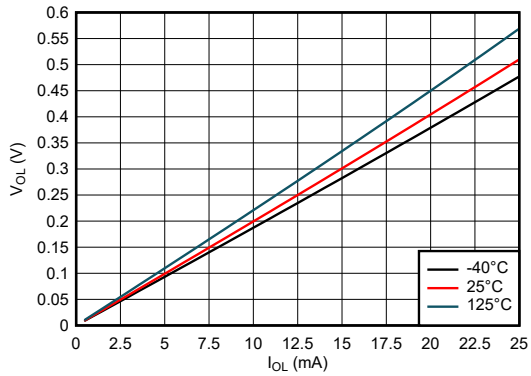


Figure 6-9. Output Voltage vs Current in LOW State; 3.3-V Supply

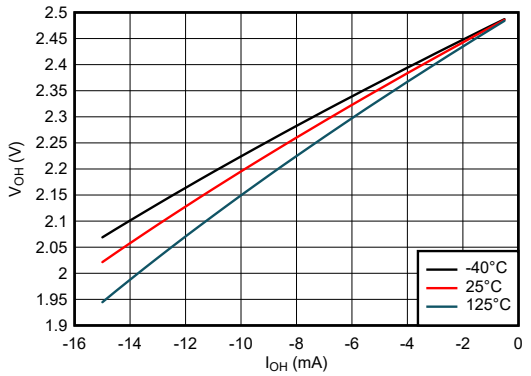


Figure 6-10. Output Voltage vs Current in HIGH State; 2.5-V Supply

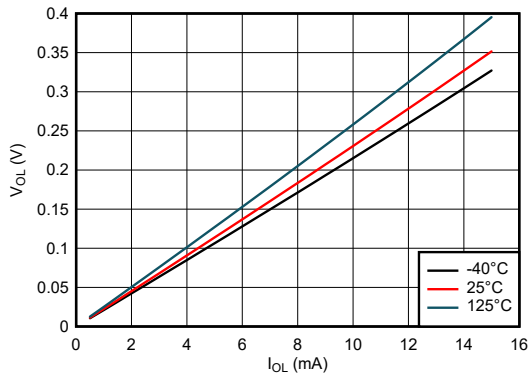


Figure 6-11. Output Voltage vs Current in LOW State; 2.5-V Supply

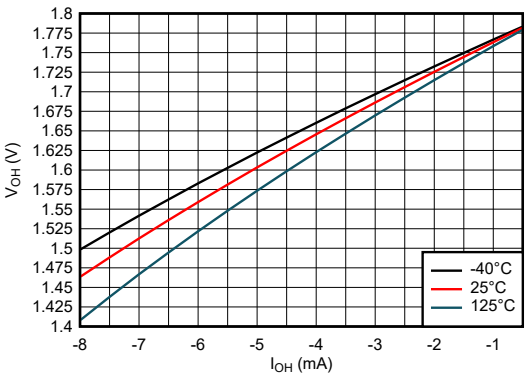


Figure 6-12. Output Voltage vs Current in HIGH State; 1.8-V Supply

6.15 Typical Characteristics (continued)

T_A = 25°C (unless otherwise noted)

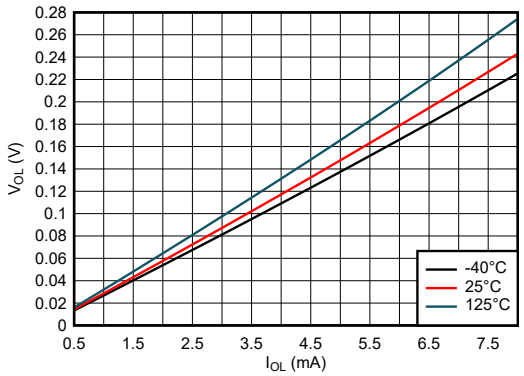


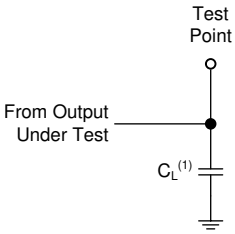
Figure 6-13. Output Voltage vs Current in LOW State; 1.8-V Supply

7 Parameter Measurement Information

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

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

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



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

Figure 7-1. Load Circuit for Push-Pull Outputs

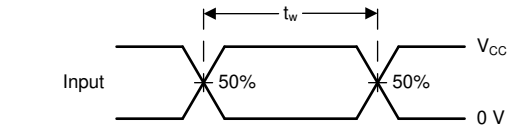


Figure 7-2. Voltage Waveforms, Pulse Duration

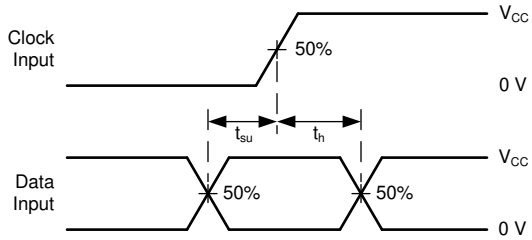
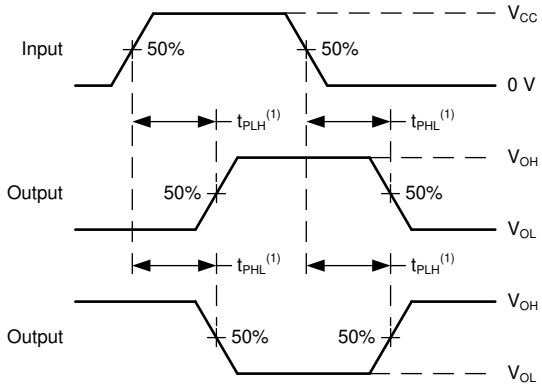
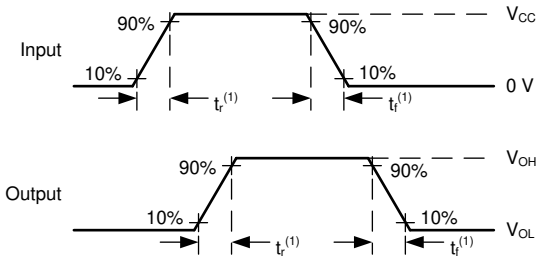


Figure 7-3. Voltage Waveforms, Setup and Hold Times



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

Figure 7-4. Voltage Waveforms Propagation Delays



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

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

8 Detailed Description

8.1 Overview

Figure 8-1 shows the SN74LV2T74. As the SN74LV2T74 is a dual D-Type positive-edge-triggered flip-flop with clear and preset, the following diagram describes one of the two device flip-flops.

8.2 Functional Block Diagram

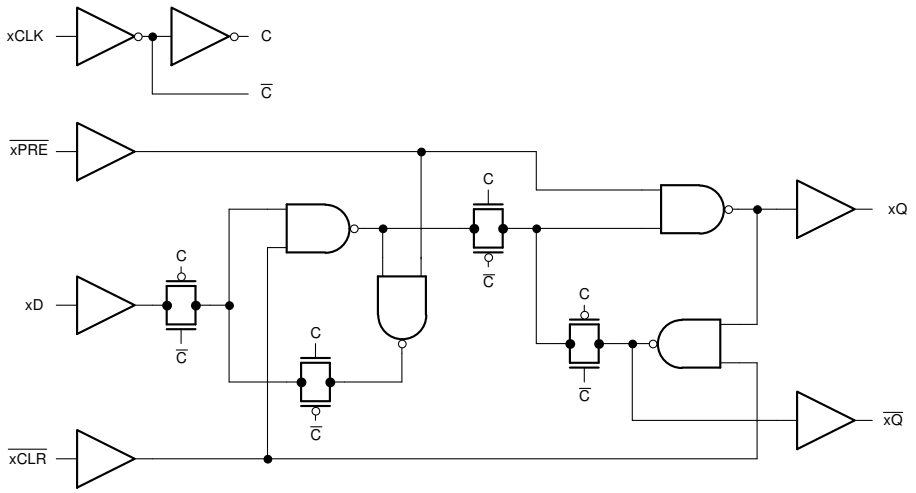


Figure 8-1. Logic Diagram (Positive Logic) for One Channel of SN74LV2T74

8.3 Feature Description

8.3.1 Balanced CMOS 3-State Outputs

This device includes balanced CMOS 3-state outputs. Driving high, driving low, and high impedance are the three states that these outputs can be in. The term *balanced* indicates that the device can sink and source similar currents. The drive capability of this device may create fast edges into light loads, so routing and load conditions should be considered to prevent ringing. Additionally, the outputs of this device are capable of driving larger currents than the device can sustain without being damaged. It is important for the output power of the device to be limited to avoid damage due to overcurrent. The electrical and thermal limits defined in the *Absolute Maximum Ratings* must be followed at all times.

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

Unused 3-state CMOS outputs should be left disconnected.

8.3.2 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 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.

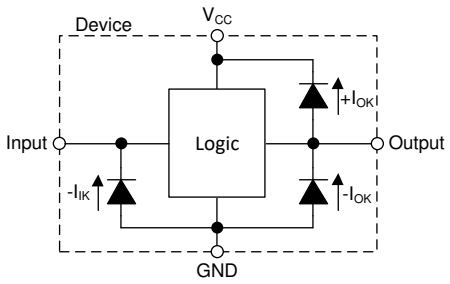


Figure 8-2. Electrical Placement of Clamping Diodes for Each Input and Output

8.3.3 LVxT Enhanced Input Voltage

The SN74LV2T74 belongs to TI'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. To ensure 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 8-3 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 ÷ 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-kΩ resistor is recommended and will typically meet all requirements.

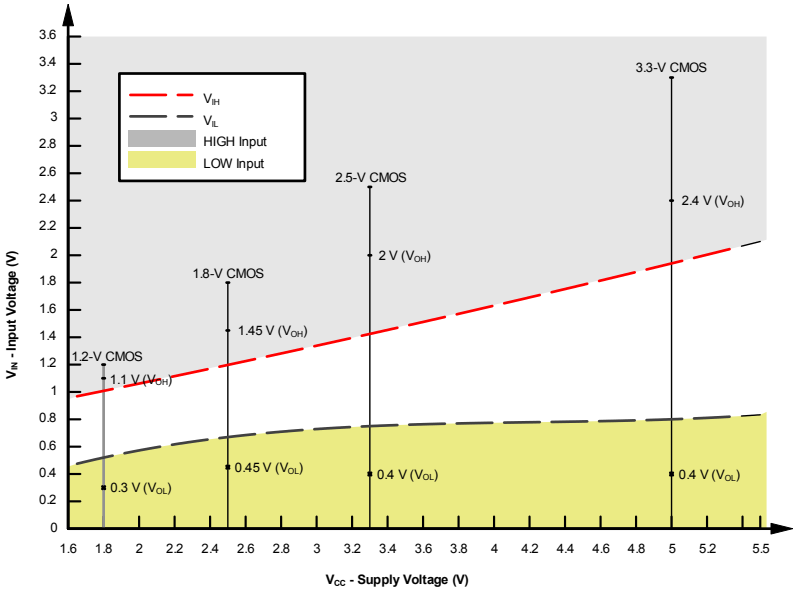


Figure 8-3. LVxT Input Voltage Levels

8.3.3.1 Down Translation

Signals can be translated down using the SN74LV2T74. The voltage applied at the 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. As shown in Figure 8-3, 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 8-4 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_{CC} – Inputs from 3.3 V and 5.0 V
- 3.3-V V_{CC} – Inputs from 5.0 V

8.3.3.2 Up Translation

Input signals can be up translated using the SN74LV2T74. 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 SN74LV2T74, $V_{IH(MIN)}$ 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 8-4, 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_{CC} – Inputs from 1.2 V
- 2.5-V V_{CC} – Inputs from 1.8 V
- 3.3-V V_{CC} – Inputs from 1.8 V and 2.5 V
- 5.0-V V_{CC} – Inputs from 2.5 V and 3.3 V

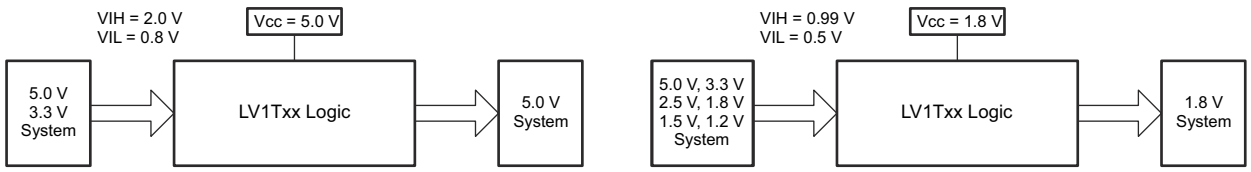


Figure 8-4. LVxT Up and Down Translation Example

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.

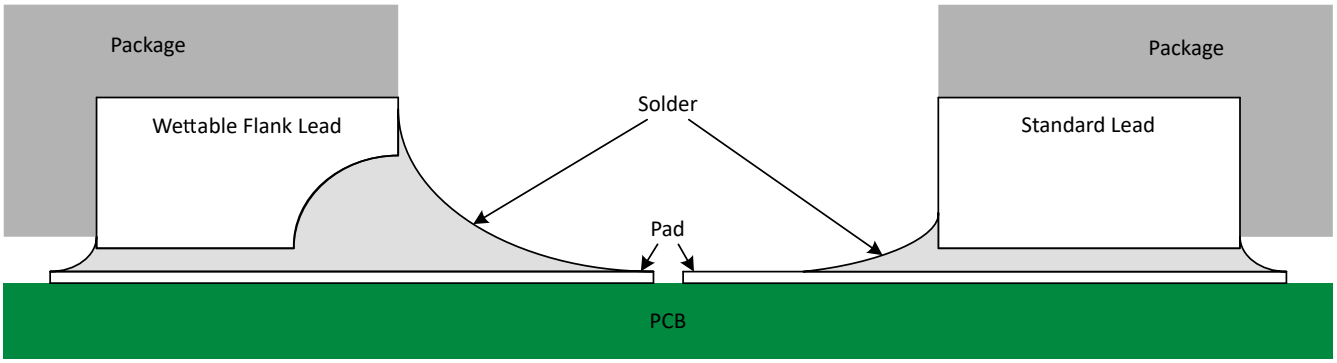


Figure 8-5. Simplified Cutaway View of Wettable-Flank QFN Package and Standard QFN Package After Soldering

Wettable flanks help improve side wetting after soldering, which makes QFN packages easier to inspect with automatic optical inspection (AOI). As shown in Figure 8-5, 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.

8.4 Device Functional Modes

Table 8-1 lists the functional modes of the SN74LV2T74.

Table 8-1. Function Table

INPUTS				OUTPUTS(1)	
$\overline{PRE}$	$\overline{CLR}$	CLK	D	Q	$\overline{Q}$
L	H	X	X	H	L
H	L	X	X	L	H
L	L	X	X	H(1)	H(1)
H	H	↑	H	H	L
H	H	↑	L	L	H
H	H	L	X	Q_0	$\overline{Q}_0$

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

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

Toggle switches are typically large, mechanically complex and relatively expensive. It is desirable to use a momentary switch instead because they are small, mechanically simple and low cost. Some systems require a toggle switch's functionality but are space or cost constrained and must use a momentary switch instead. External Schmitt-trigger buffers are used to remove noisy inputs into the (CLK) and (D) inputs.

If the data input (D) of the SN74LV2T74 is tied to the inverted output ($\overline{Q}$), then each clock pulse will cause the value at the output (Q) to toggle. The momentary switch can be debounced and directly connected to the clock input (CLK) to toggle the output.

9.2 Typical Application

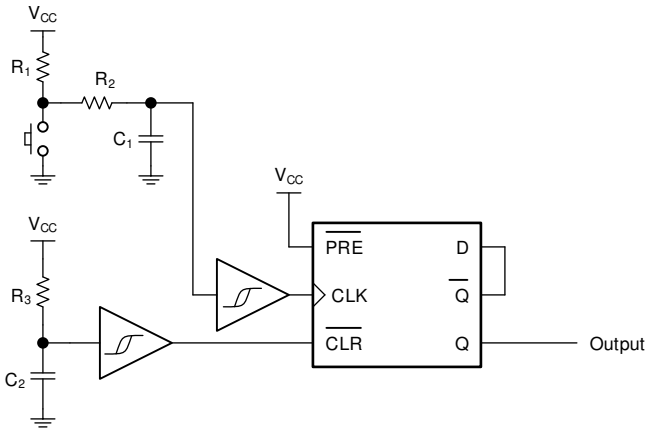


Figure 9-1. Typical Application Block Diagram

9.2.1 Design Requirements

9.2.1.1 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 SN74LV2T74 (as specified in the *Electrical Characteristics*), and the desired input transition rate limits the resistor size. A 10-kΩ resistor value is often used due to these factors.

The SN74LV2T74 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.

9.2.1.2 Output Considerations

The positive supply voltage is used to produce the output HIGH voltage. Drawing current from the output will decrease the output voltage as specified by the V_{OH} specification in the *Electrical Characteristics*. The ground voltage is used to produce the output LOW voltage. Sinking current into the output will increase the output voltage as specified by the V_{OL} specification in the *Electrical Characteristics*.

Push-pull outputs that could be in opposite states, even for a very short time period, should never be connected directly together. This can cause excessive current and damage to the device.

Two channels within the same device with the same input signals can be connected in parallel for additional output drive strength.

Unused outputs can be left floating. Do not connect outputs directly to V_{CC} or ground.

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

9.2.2 Detailed Design Procedure

1. Add a decoupling capacitor from V_{CC} to GND. The capacitor needs to be placed physically close to the device and electrically close to both the V_{CC} and GND pins. An example layout is shown in the *Layout* section.
2. Ensure the capacitive load at the output is ≤ 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 SN74LV2T74 to one or more of the receiving devices.
3. Ensure the resistive load at the output is larger than (V_{CC} / $I_{O(max)}$) Ω. 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 MΩ; much larger than the minimum calculated previously.
4. Thermal issues are rarely a concern for logic gates; the power consumption and thermal increase, however, can be calculated using the steps provided in the application report, *CMOS Power Consumption and Cpd Calculation*.

9.2.3 Application Curves

Figure 9-2 shows an example of a single button press bouncing and causing the output to toggle multiple times. This will cause issues in the desired application. Figure 9-3 shows 4 button presses with an added debounce circuit, fixing the unwanted toggling and allowing for proper toggle switch operation.

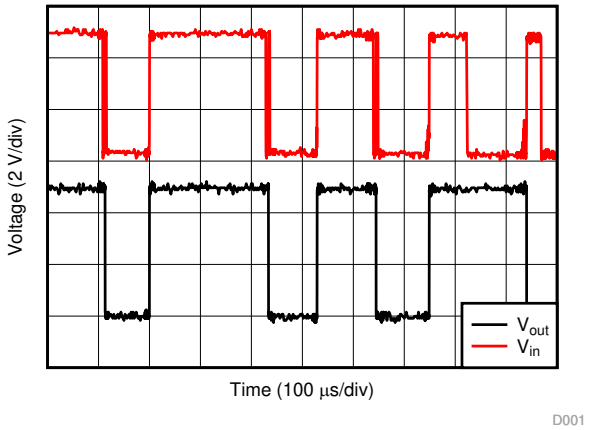


Figure 9-2. Circuit Response Without RC Debounce
V_{in}: = CLK Input, V_{out} := Q Output

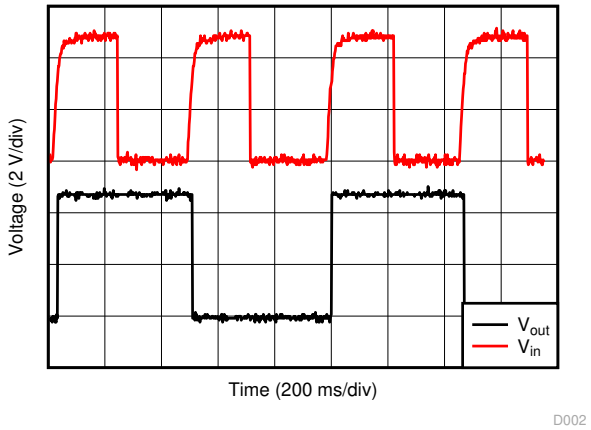


Figure 9-3. Circuit Response with RC Debounce
V_{in}: = CLK Input, V_{out} := Q Output

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-µF capacitor is recommended for this device. It is acceptable to parallel multiple bypass capacitors to reject different frequencies of noise. The 0.1-µF and 1-µF capacitors are commonly used in parallel. The bypass capacitor should be installed as close to the power terminal as possible for best results, as shown in the following layout example.

11 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.

11.1 Documentation Support

11.1.1 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

11.2 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.

11.3 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.

Linked content is provided "AS IS" by the respective contributors. They do not constitute TI specifications and do not necessarily reflect TI's views; see TI's Terms of Use.

11.4 Trademarks

TI E2E™ is a trademark of Texas Instruments.
All trademarks are the property of their respective owners.

11.5 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.

11.6 Glossary

TI Glossary	This glossary lists and explains terms, acronyms, and definitions.

12 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)
SN74LV2T74BQAR	Active	Production	WQFN (BQA) | 14	3000 | LARGE T&R	Yes	SELECTIVE AG (TOP SIDE)	Level-1-260C-UNLIM	-40 to 125	LV2T74
SN74LV2T74BQAR.A	Active	Production	WQFN (BQA) | 14	3000 | LARGE T&R	Yes	SELECTIVE AG (TOP SIDE)	Level-1-260C-UNLIM	-40 to 125	LV2T74
SN74LV2T74PWR	Active	Production	TSSOP (PW) | 14	3000 | LARGE T&R	Yes	NIPDAU | SN	Level-1-260C-UNLIM	-40 to 125	LV2T74
SN74LV2T74PWR.A	Active	Production	TSSOP (PW) | 14	3000 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	LV2T74

(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.

OTHER QUALIFIED VERSIONS OF SN74LV2T74 :

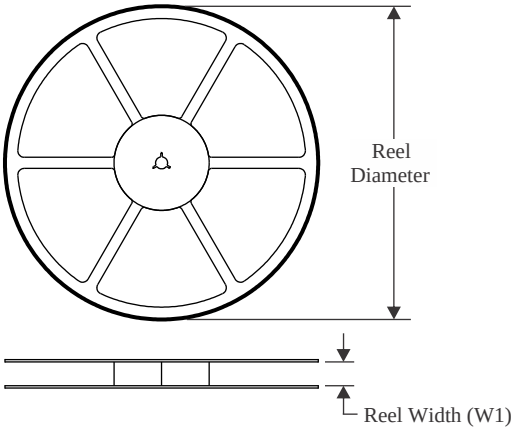
- Automotive : SN74LV2T74-Q1
- Enhanced Product : SN74LV2T74-EP

NOTE: Qualified Version Definitions:

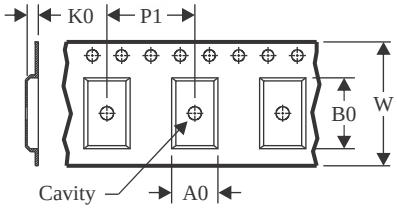
- Automotive - Q100 devices qualified for high-reliability automotive applications targeting zero defects
- Enhanced Product - Supports Defense, Aerospace and Medical Applications

TAPE AND REEL INFORMATION

REEL DIMENSIONS

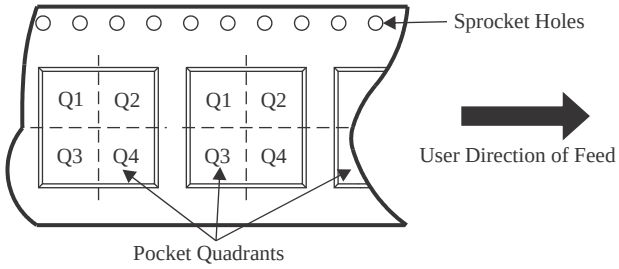


TAPE DIMENSIONS



A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

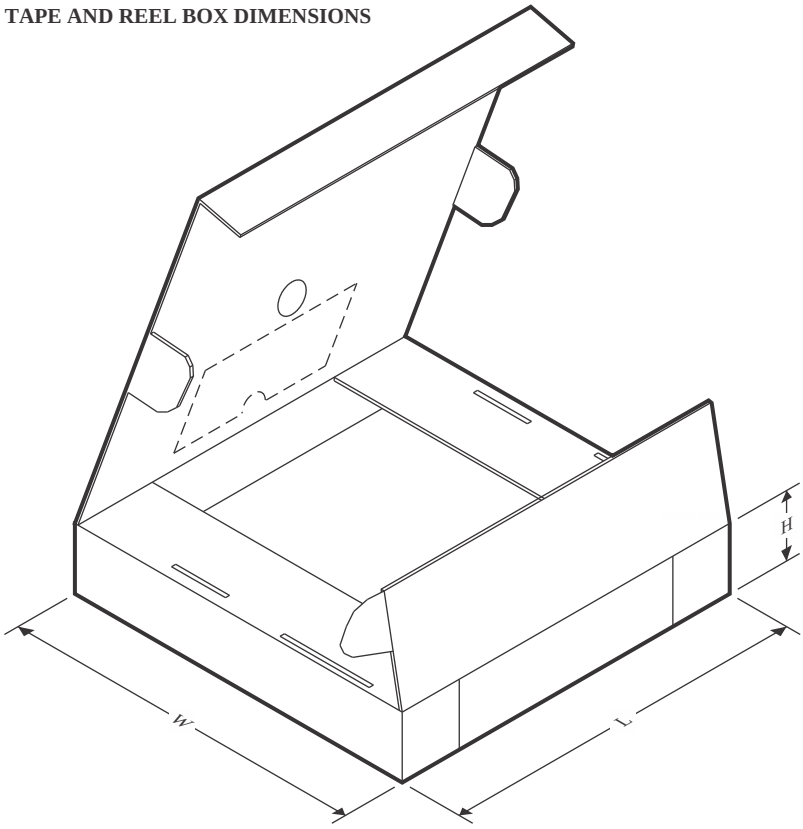
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
SN74LV2T74BQAR	WQFN	BQA	14	3000	180.0	12.4	2.8	3.3	1.1	4.0	12.0	Q1
SN74LV2T74PWR	TSSOP	PW	14	3000	330.0	12.4	6.9	5.6	1.6	8.0	12.0	Q1

TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

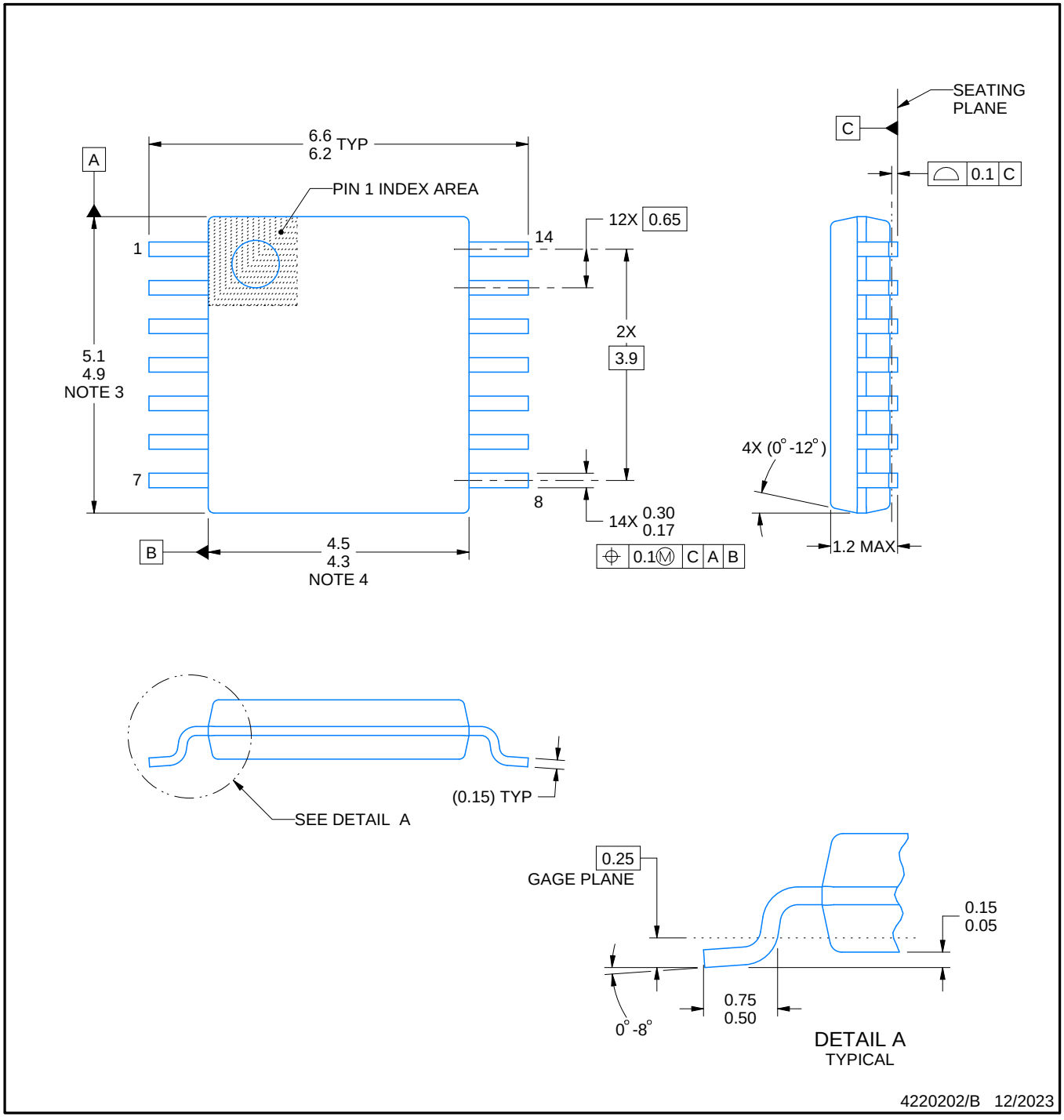
Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
SN74LV2T74BQAR	WQFN	BQA	14	3000	210.0	185.0	35.0
SN74LV2T74PWR	TSSOP	PW	14	3000	353.0	353.0	32.0

PACKAGE OUTLINE

PW0014A

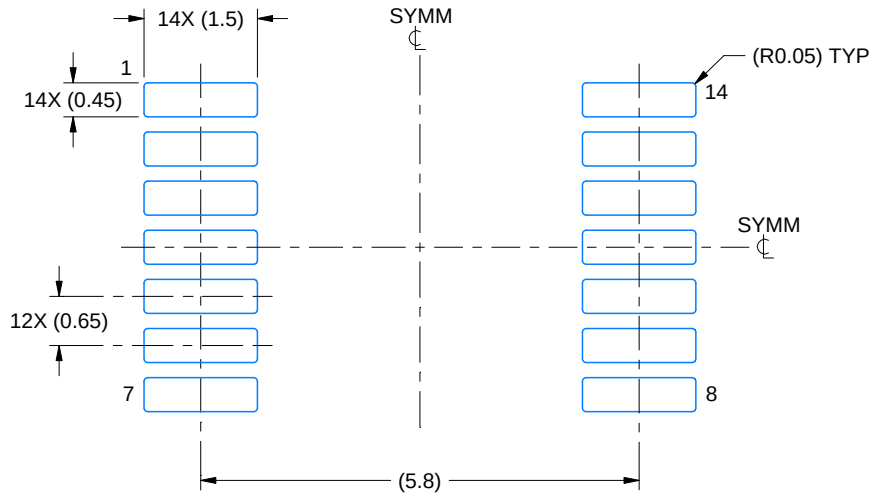
TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE

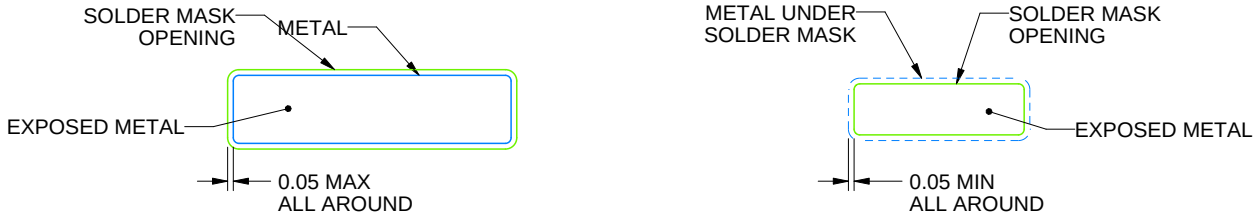


NOTES:

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.



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE: 10X

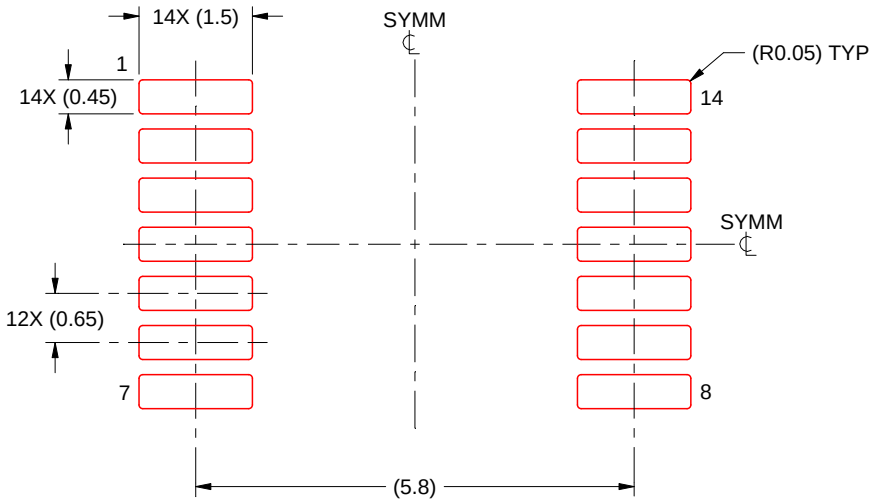


SOLDER MASK DETAILS

4220202/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.



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

4220202/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.

GENERIC PACKAGE VIEW

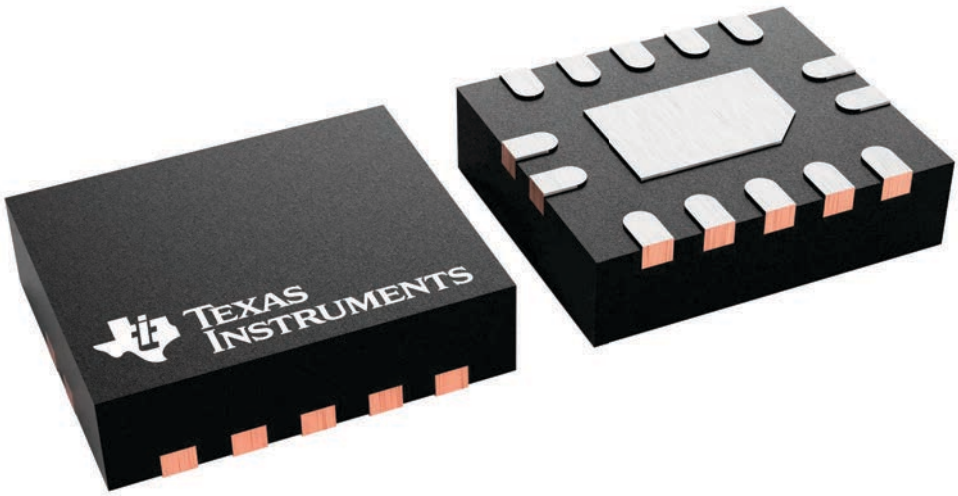
BQA 14

WQFN - 0.8 mm max height

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.

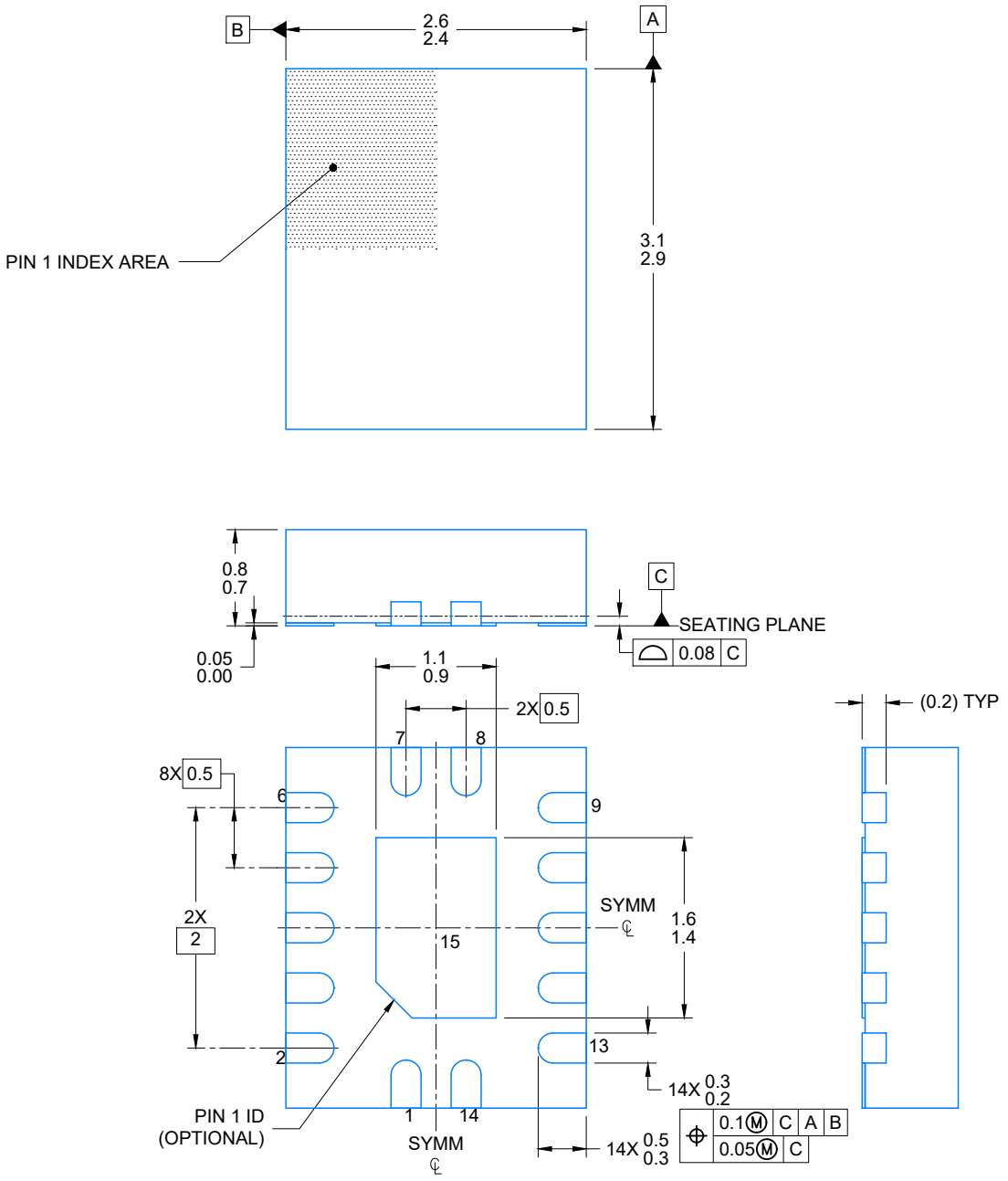


PACKAGE OUTLINE

BQA0014A

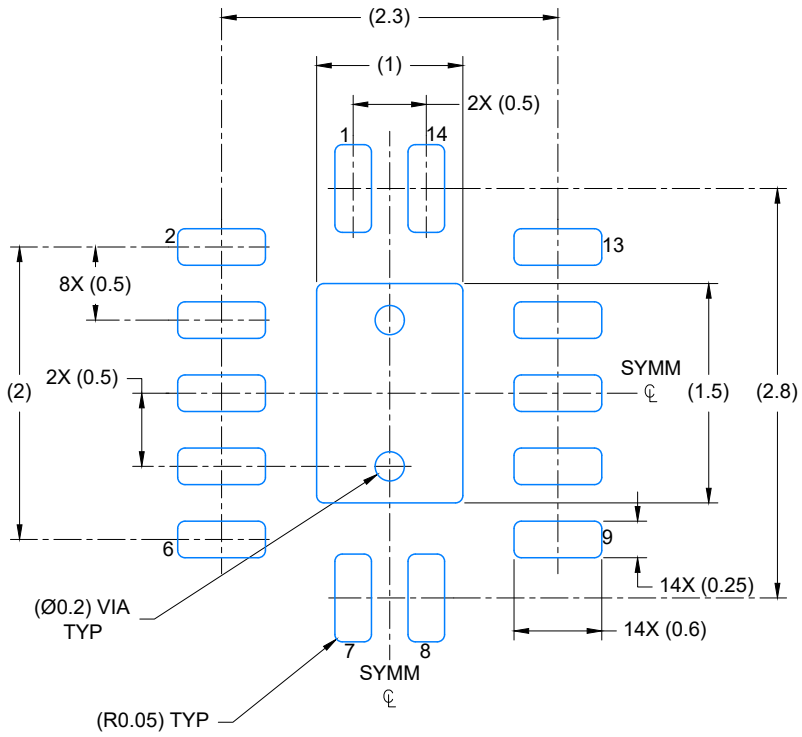
WQFN - 0.8 mm max height

PLASTIC QUAD FLAT PACK-NO LEAD

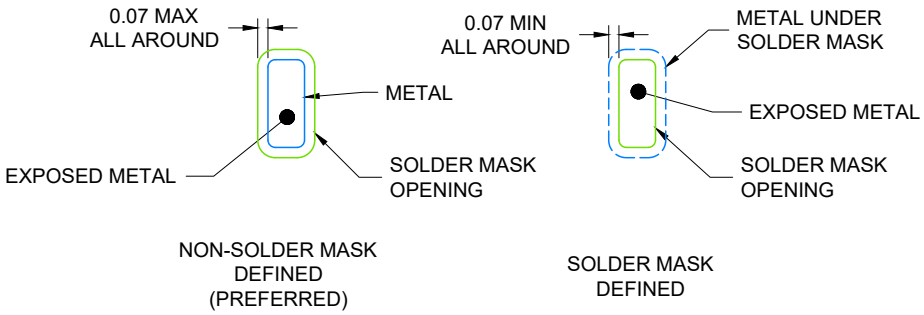


NOTES:

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 optimal thermal and mechanical performance.



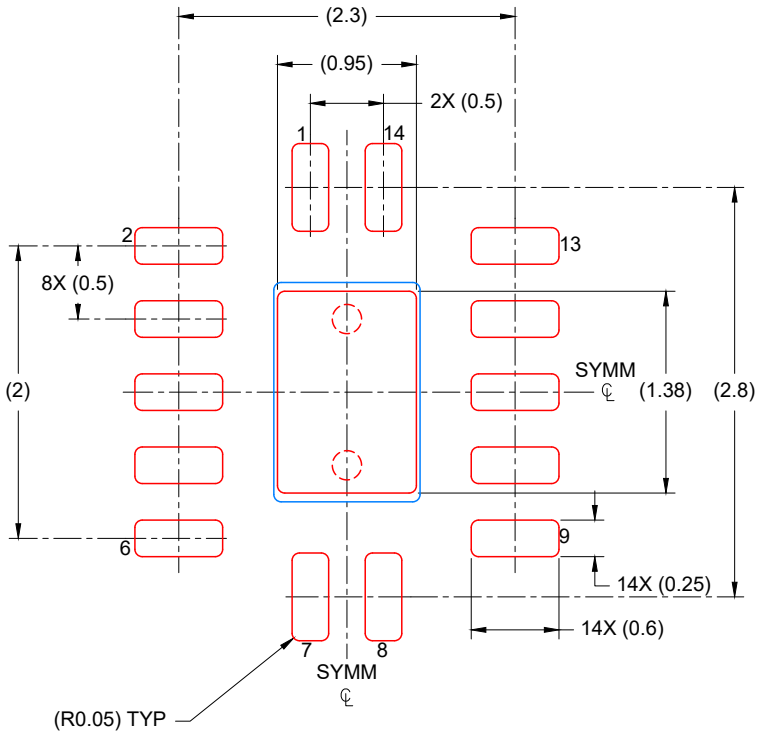
LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE: 20X



4224636/A 11/2018

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.



SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL

EXPOSED PAD
88% PRINTED COVERAGE BY AREA
SCALE: 20X

4224636/A 11/2018

NOTES: (continued)

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

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