

SN74LV244A 具有三态输出的八路缓冲器和驱动器

1 特性

- V_{CC} 工作范围为 2V 至 5.5V
- 5V 时 t_{pd} 最大值为 6.5 ns
- V_{OLP} (输出接地反弹) 典型值小于 0.8V ($V_{CC} = 3.3V$, $T_A = 25^\circ C$)
- V_{OHV} (输出 V_{OH} 下冲) 典型值大于 2.3V ($V_{CC} = 3.3V$, $T_A = 25^\circ C$)
- 支持所有端口上的混合模式电压运行
- I_{off} 支持局部断电模式运行
- 闩锁性能超过 250mA, 符合 JESD 17 规范

2 应用

- 服务器和网络交换机
- LED 显示屏
- 电信基础设施
- 电机驱动控制板

3 说明

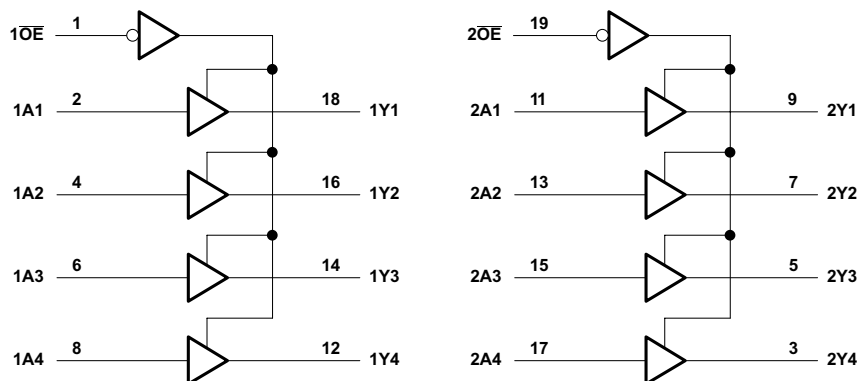
SN74LV244A 八路缓冲器和线路驱动器在 2V 至 5.5V V_{CC} 电压下运行。

SN74LV244A 器件专门设计用于提高三态存储器地址驱动器、时钟驱动器以及总线导向接收器和发射器的性能和密度。这些器件配置为两个具有独立输出使能 (OE) 输入的 4 位线路驱动器。

封装信息⁽¹⁾

器件型号	封装	封装尺寸 (标称值)
SN74LV244A	DGV (TVSOP, 20)	5.00mm × 4.40mm
	DW (SOIC, 20)	12.80mm × 7.50mm
	NS (SO, 20)	12.60mm × 5.30mm
	PW (TSSOP, 20)	6.50mm × 4.40mm
	RGY (VQFN, 20)	4.50mm × 3.50mm
	RKS (VQFN, 20)	4.50mm × 2.50mm
	DGS (VSSOP, 20)	5.10mm × 3.00mm

(1) 如需了解所有可用封装, 请参阅数据表末尾的可订购产品附录。



逻辑图 (正逻辑)



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4 Revision History

注：以前版本的页码可能与当前版本的页码不同

Changes from Revision O (November 2022) to Revision P (January 2023)	Page
• 向数据表添加了 <i>DGS</i> 封装信息.....	1
Changes from Revision N (September 2015) to Revision O (December 2022)	Page
• 更新了整个文档中的表格、图和交叉参考的编号格式.....	1
• 向数据表中添加了 <i>RKS</i> 封装.....	1
• Updated the <i>Typical Characteristics</i> section.....	9
• Added the <i>Balanced CMOS 3-State Outputs, Standard CMOS Inputs, Partial Power Down (I_{off}), and Clamp Diode Structure</i> sections.....	11
• Removed the <i>Design Requirements</i> section.....	13
• Added the <i>Power Considerations, Input Considerations, and Output Considerations</i> sections.....	13
• Updated the <i>Power Supply Recommendations</i> section.....	16
• Updated the <i>Layout Guidelines</i> and <i>Layout Example</i> section.....	16
Changes from Revision M (June 2013) to Revision N (September 2015)	Page
• 添加了器件信息表、引脚功能表、ESD 等级表、热性能信息表、详细说明部分、应用和实施部分、电源相关建议部分、布局部分、器件和文档支持部分，以及机械、封装和可订购信息部分.....	1
• Removed the $T_A = -40^\circ\text{C}$ to 85°C test conditions with the same values as the $T_A = -40^\circ\text{C}$ to 125°C Recommended test conditions in the <i>Electrical Characteristics</i> and <i>Switching Characteristics</i> tables.....	7
• Removed the word 'Recommended' in the $T_A = -40^\circ\text{C}$ to 125°C Recommended test conditions in the <i>Electrical Characteristics</i> and <i>Switching Characteristics</i> tables.....	7

5 Pin Configuration and Functions

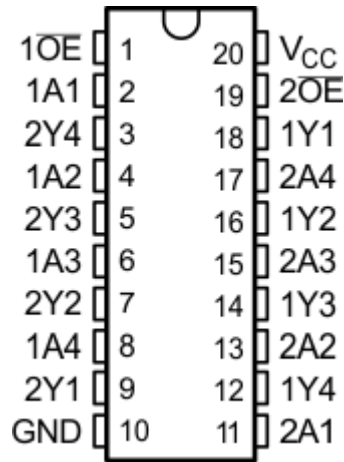


图 5-1. DB, DGV, DW, NS, PW, or DGS Package, 20-Pin SSOP, TVSOP, SOIC, SO, TSSOP, or VSSOP (Top View)

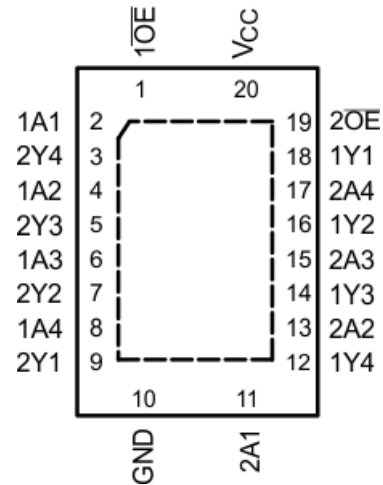


图 5-2. RGY and RKS Package, 20-Pin VQFN With Exposed Thermal Pad (Top View)

表 5-1. Pin Functions

PIN		TYPE ⁽¹⁾	DESCRIPTION
NAME	NO.		
1A1	2	I	Input
1A2	4	I	Input
1A3	6	I	Input
1A4	8	I	Input
1 OE	1	I	Output enable
1Y1	18	O	Output
1Y2	16	O	Output
1Y3	14	O	Output
1Y4	12	O	Output
2A1	11	I	Input
2A2	13	I	Input
2A3	15	I	Input
2A4	17	I	Input
2 OE	19	I	Output enable
2Y1	9	O	Output
2Y2	7	O	Output
2Y3	5	O	Output
2Y4	3	O	Output
GND	10	—	Ground
V _{CC}	20	—	Power pin
Thermal pad ⁽²⁾		—	The thermal pad can be connected to GND or left floating. Do not connect to any other signal or supply.

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

(2) RKS 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}		±35	mA
	Continuous current through V _{CC} or GND			±70	mA
T _J	Junction temperature		- 65	150	°C
T _{stg}	Storage temperature		- 65	150	°C

- (1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions* is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
- (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 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)⁽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 2.7 V	V _{CC} × 0.7		
		V _{CC} = 3 V to 3.6 V	V _{CC} × 0.7		
		V _{CC} = 4.5 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 2.7 V	V _{CC} × 0.3		
		V _{CC} = 3 V to 3.6 V	V _{CC} × 0.3		
		V _{CC} = 4.5 V to 5.5 V	V _{CC} × 0.3		
V _I	Input voltage	0	5.5	V	
V _O	Output voltage	High or low state	0	V _{CC}	V
		3-state	0	5.5	
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	-8		
		V _{CC} = 4.5 V to 5.5 V	-16		
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	8		
		V _{CC} = 4.5 V to 5.5 V	16		
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. Refer to the TI application report, *Implications of Slow or Floating CMOS Inputs*, [SCBA004](#).

6.4 Thermal Information

THERMAL METRIC ⁽¹⁾		SN74LV244A								UNIT
		DB (SSOP)	DGV (TVSOP)	DW (SOIC)	NS (SO)	PW (TSSOP)	RGY (VQFN)	RKS (VQFN)	DGS (VSSOP)	
		20 PINS	20 PINS	20 PINS	20 PINS	20 PINS	20 PINS	20 PINS	20 PINS	
R _{θJA}	Junction-to-ambient thermal resistance	94.7	115.9	79.4	76.9	102.6	34.9	75.2	125.5	°C/W
R _{θJC(top)}	Junction-to-case (top) thermal resistance	56.7	31.1	43.8	43.4	36.7	43.1	79.4	80.0	°C/W
R _{θJB}	Junction-to-board thermal resistance	49.9	57.4	47.2	44.5	53.6	12.7	47.8	63.8	°C/W
ψ _{JT}	Junction-to-top characterization parameter	18.7	1.0	18.8	17.0	2.4	0.9	14.6	8.4	°C/W
ψ _{JB}	Junction-to-board characterization parameter	49.5	56.7	46.7	44.1	53.1	12.8	47.8	79.9	°C/W

THERMAL METRIC ⁽¹⁾		SN74LV244A								UNIT
		DB (SSOP)	DGV (TVSOP)	DW (SOIC)	NS (SO)	PW (TSSOP)	RGY (VQFN)	RKS (VQFN)	DGS (VSSOP)	
		20 PINS	20 PINS	20 PINS	20 PINS	20 PINS	20 PINS	20 PINS	20 PINS	
$R_{\theta JC(bot)}$	Junction-to-case (bottom) thermal resistance	N/A	N/A	N/A	N/A	N/A	7.8	31.5	N/A	°C/W

- (1) For more information about traditional and new thermal metrics, see the *Semiconductor and IC Package Thermal Metrics* application report, [SPRA953](#).

6.5 Electrical Characteristics

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

PARAMETER		TEST CONDITIONS	V _{CC}	MIN	TYP	MAX	UNIT
V _{OH}	High level output voltage	I _{OH} = -50 μA	2 V to 5.5 V	V _{CC} - 0.1			V
		I _{OH} = -2 mA	2.3 V	2			
		I _{OH} = -8 mA	3 V	2.48			
		I _{OH} = 16 mA	4.5 V	3.8			
V _{OL}	Low level output voltage	I _{OL} = 50 μA	2 V to 5.5 V			0.1	V
		I _{OL} = 2 mA	2.3 V			0.4	
		I _{OL} = 8 mA	3 V			0.44	
		I _{OL} = 16 mA	4.5 V			0.55	
I _I	Input leakage current	V _I = 5.5 V or GND	0 to 5.5 V			±1	μA
I _{OZ}	Off-State (High-Impedance State) Output Current (of a 3-State Output)	V _O = V _{CC} or GND	5.5 V			±5	μA
I _{CC}	Supply current	V _I = V _{CC} or GND, I _O = 0	5.5 V			20	μA
I _{off}	Input/Output Power-Off Leakage Current	V _I or V _O = 0 to 5.5 V	0			5	μA
C _i	Input capacitance	V _I = V _{CC} or GND	3.3 V		2.3		pF

6.6 Noise Characteristics

V_{CC} = 3.3 V, C_L = 50 pF, T_A = 25°C⁽¹⁾

		MIN	TYP	MAX	UNIT
V _{OL(P)}	Quiet output, maximum dynamic		0.55		V
V _{OL(V)}	Quiet output, minimum dynamic		-0.5		V
V _{OH(V)}	Quiet output, minimum dynamic		2.9		V
V _{IH(D)}	High-level dynamic input voltage	2.31			V
V _{IL(D)}	Low-level dynamic input voltage			0.99	V

(1) Characteristics are for surface-mount packages only.

6.7 Operating Characteristics

T_A = 25°C

PARAMETER		TEST CONDITIONS	V _{CC}	TYP	UNIT
C _{pd}	Power dissipation capacitance	C _L = 50 pF f = 10 MHz	3.3 V	14	pF
			5 V	16	

6.8 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	
t_{pd}	A	Y	$C_L = 15\text{ pF}$		7.5	12.5	1		15	ns
			$C_L = 50\text{ pF}$		9.5	15.3	1		18	
t_{en}	\overline{OE}	Y	$C_L = 15\text{ pF}$		8.9	14.6	1		17	ns
			$C_L = 50\text{ pF}$		10.8	17.8	1		21	
t_{dis}	\overline{OE}	Y	$C_L = 15\text{ pF}$		9.1	14.1	1		16	ns
			$C_L = 50\text{ pF}$		13.4	19.2	1		21	
$t_{sk(o)}$			$C_L = 50\text{ pF}$			2			2	ns

6.9 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	
t_{pd}	A	Y	$C_L = 15\text{ pF}$		5.4	8.4	1		10	ns
			$C_L = 50\text{ pF}$		6.8	11.9	1		13.5	
t_{en}	\overline{OE}	Y	$C_L = 15\text{ pF}$		6.3	10.6	1		12.5	ns
			$C_L = 50\text{ pF}$		7.8	14.1	1		16	
t_{dis}	\overline{OE}	Y	$C_L = 15\text{ pF}$		7.6	11.7	1		13	ns
			$C_L = 50\text{ pF}$		11	16	1		18	
$t_{sk(o)}$			$C_L = 50\text{ pF}$			1.5			1.5	ns

6.10 Switching Characteristics: $V_{CC} = 5\text{ V} \pm 0.5\text{ V}$

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	
t_{pd}	A	Y	$C_L = 15\text{ pF}$		3.9	5.5	1		6.5	ns
			$C_L = 50\text{ pF}$		4.9	7.5	1		8.5	
t_{en}	\overline{OE}	Y	$C_L = 15\text{ pF}$		4.5	7.3	1		8.5	ns
			$C_L = 50\text{ pF}$		5.6	9.3	1		10.5	
t_{dis}	\overline{OE}	Y	$C_L = 15\text{ pF}$		6.5	12.2	1		13.5	ns
			$C_L = 50\text{ pF}$		8.8	14.2	1		15.5	
$t_{sk(o)}$			$C_L = 50\text{ pF}$			1			1	ns

6.11 Typical Characteristics

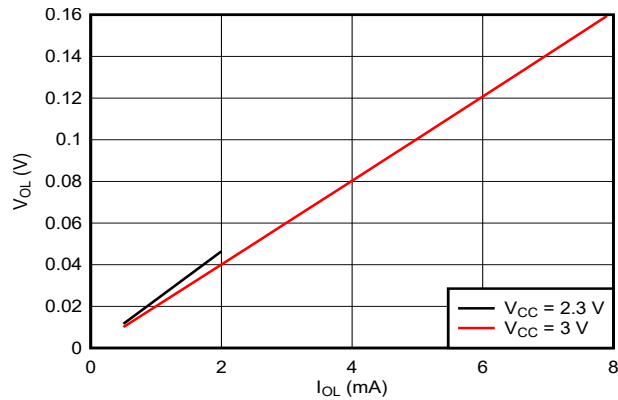


图 6-1. Output Voltage in LOW state, 2.3- and 3-V Supply

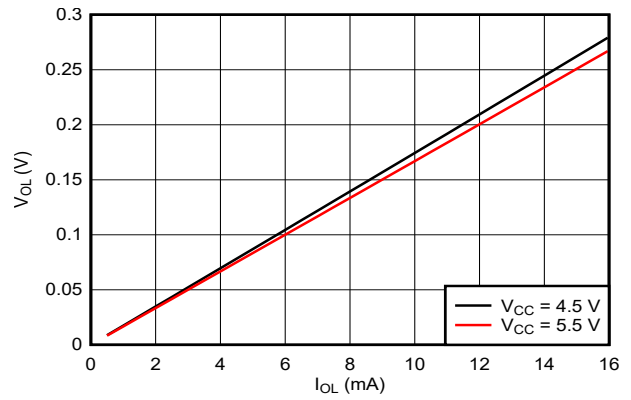


图 6-2. Output Voltage in LOW state, 4.5- and 5.5-V Supply

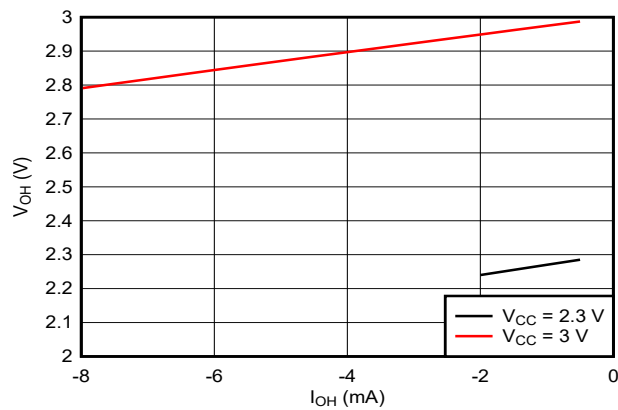


图 6-3. Output Voltage in HIGH state, 2.3- and 3-V Supply

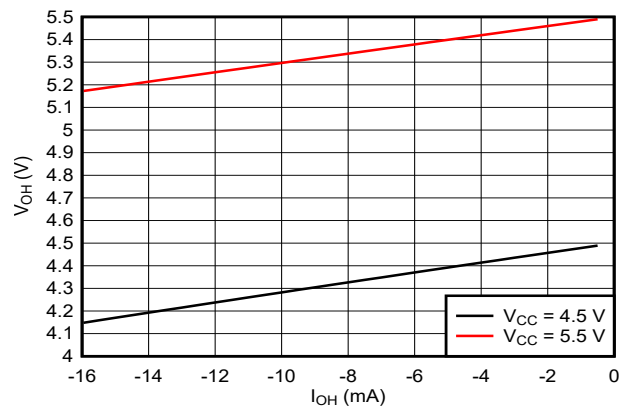


图 6-4. Output Voltage in HIGH state, 4.5- and 5.5-V Supply

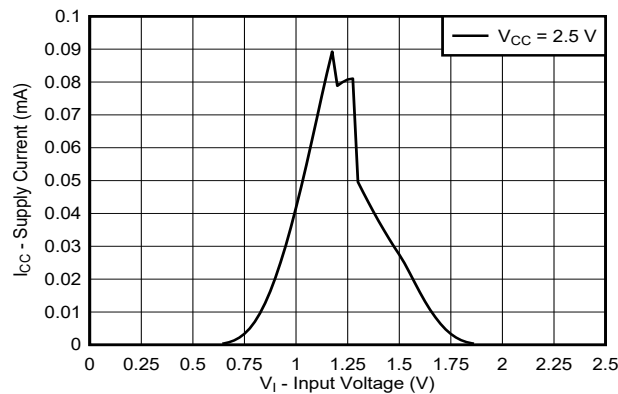


图 6-5. Supply Current across Input Voltage, 2.5-V Supply

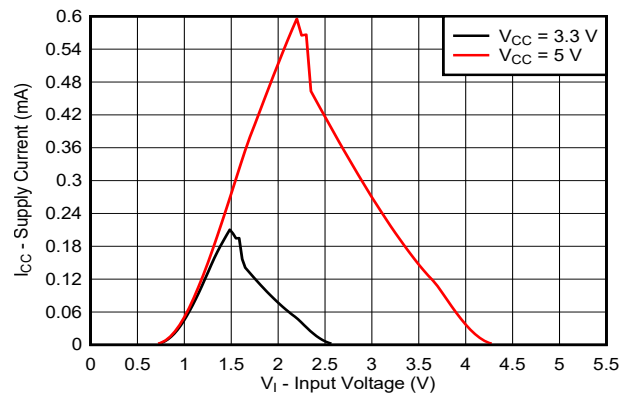
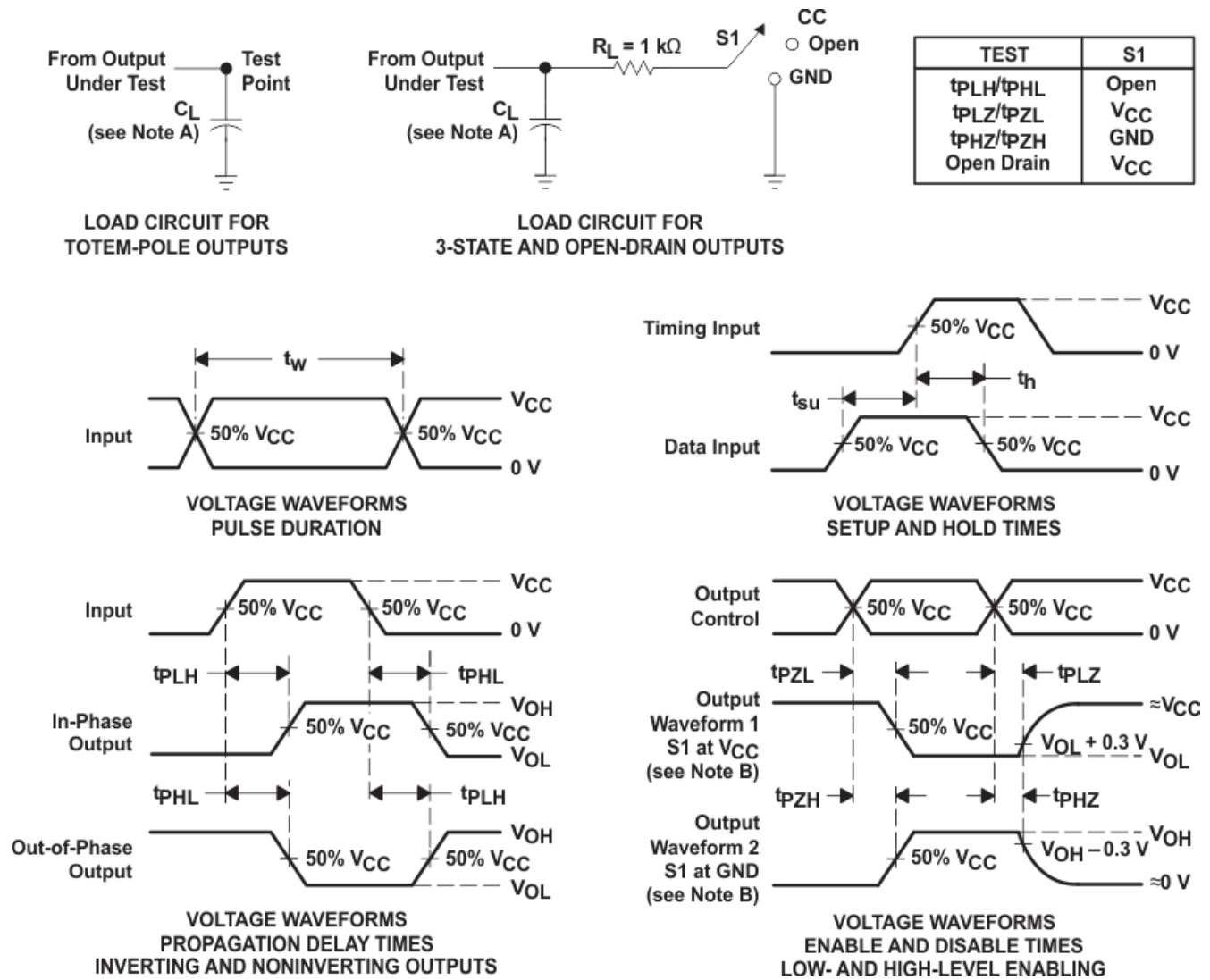


图 6-6. Supply Current across Input Voltage, 3.3- and 5-V Supply

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: $PRR \leq 1\text{ MHz}$, $Z_O = 50\ \Omega$, $t_r \leq 3\text{ ns}$, $t_f \leq 3\text{ ns}$.
- 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.

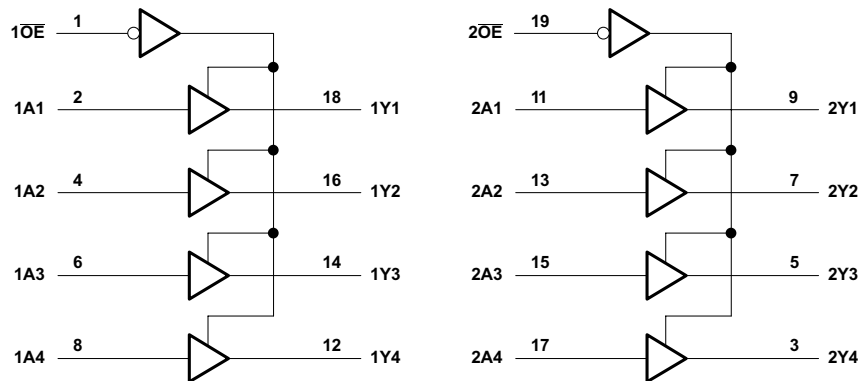
图 7-1. Load Circuit and Voltage Waveforms

8 Detailed Description

8.1 Overview

The SN74LV244 devices are octal buffers grouped in fours, with each group having its own enable pin. The LV family supports high current drive of about 16 mA, thus making it suitable for driving digital signals over longer board lengths. This device is generally used to buffer or incorporate delays between the signals between two microcontroller or peripheral devices.

8.2 Functional Block Diagram



8.3 Feature Description

8.3.1 Balanced CMOS 3-State Outputs

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

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

Unused 3-state CMOS outputs should be left disconnected.

8.3.2 Standard CMOS Inputs

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

Standard CMOS inputs require that input signals transition between valid logic states quickly, as defined by the input transition time or rate in the *Recommended Operating Conditions* table. Failing to meet this specification will result in excessive power consumption and could cause oscillations. More details can be found in [Implications of Slow or Floating CMOS Inputs](#).

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

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 Clamp Diode Structure

图 8-1 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.

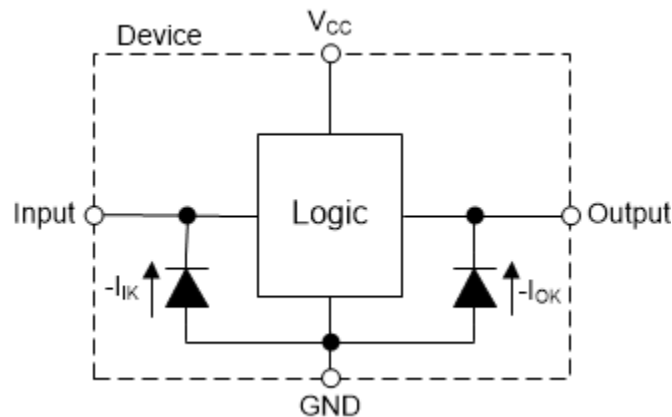


图 8-1. Electrical Placement of Clamping Diodes for Each Input and Output

8.4 Device Functional Modes

The SN74LV244A devices are organized as two 4-bit line drivers with separate output-enable (\overline{OE}) inputs. When \overline{OE} is low, the device passes data from the A inputs to the Y outputs. When \overline{OE} is high, the outputs are in the high-impedance state. To ensure the high-impedance state during power up or power down, \overline{OE} must be tied to V_{CC} through a pullup resistor; the minimum value of the resistor is determined by the current-sinking capability of the driver.

表 8-1. Function Table

INPUTS ⁽¹⁾		OUTPUTS ⁽²⁾
\overline{OE}	A	Y
L	L	L
L	H	H
H	X	Z

(1) H = High Voltage Level, L = Low Voltage Level, X = Do Not Care

(2) H = Driving High, L = Driving Low, Z = High Impedance State

9 Application and Implementation

备注

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

9.1 Application Information

The SN74LV244A device can be used as an 8-channel buffer to drive signals from one controller to another device. Buffers are typically used for signals running on long traces on printed circuit boards or going through connectors linking two printed circuit boards together. Buffers are also used to create delay between the lines to match the edges of two clock or data signals. The high-current capability of the SN74LV244A device also allows a controller to drive LEDs up to 16 mA.

9.2 Typical Application

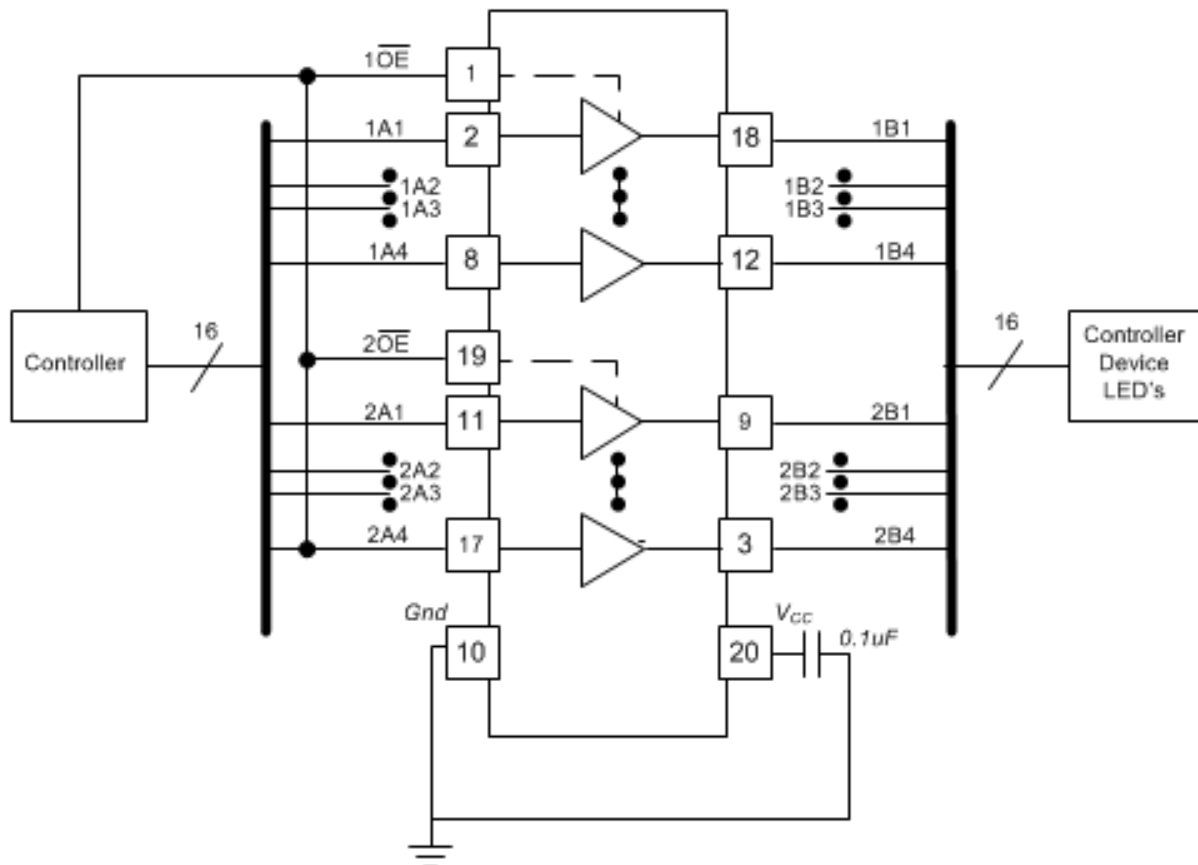


图 9-1. Typical Application Diagram

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 SN74LV244A 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 SN74LV244A 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 SN74LV244A 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 SN74LV244A 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 SN74LV244A (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 SN74LV244A 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 SN74LV244A 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 Curve

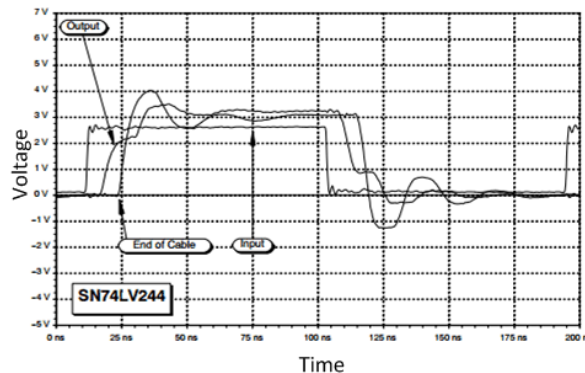


图 9-2. SN74LV244A Transient response

9.3 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 $0.1\text{-}\mu\text{F}$ capacitor; if there are multiple V_{CC} terminals, then TI recommends a $0.01\text{-}\mu\text{F}$ or $0.022\text{-}\mu\text{F}$ capacitor for each power terminal. Multiple bypass capacitors can be paralleled to reject different frequencies of noise. Frequencies of $0.1\text{ }\mu\text{F}$ and $1\text{ }\mu\text{F}$ are commonly used in parallel. The bypass capacitor must be installed as close as possible to the power terminal for best results.

9.4 Layout

9.4.1 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_{CC} , whichever makes more sense for the logic function or is more convenient.

9.4.2 Layout Example

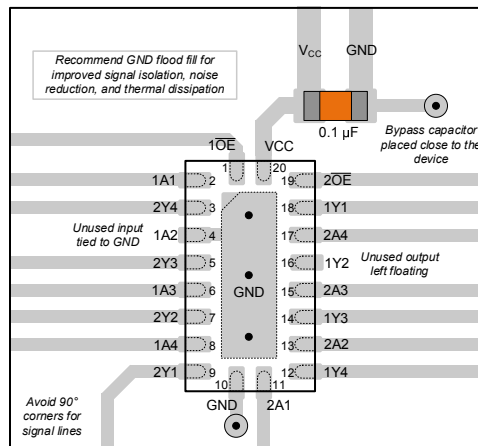


图 9-3. Layout Example for the SN74LV244A in the RKS Package

10 Device and Documentation Support

10.1 Documentation Support

10.1.1 Related Documentation

For related documentation, see the following:

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

10.2 接收文档更新通知

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

10.3 支持资源

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

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

10.4 Trademarks

TI E2E™ is a trademark of Texas Instruments.

所有商标均为其各自所有者的财产。

10.5 静电放电警告



静电放电 (ESD) 会损坏这个集成电路。德州仪器 (TI) 建议通过适当的预防措施处理所有集成电路。如果不遵守正确的处理和安装程序，可能会损坏集成电路。

ESD 的损坏小至导致微小的性能降级，大至整个器件故障。精密的集成电路可能更容易受到损坏，这是因为非常细微的参数更改都可能会导致器件与其发布的规格不相符。

10.6 术语表

[TI 术语表](#) 本术语表列出并解释了术语、首字母缩略词和定义。

11 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 Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead finish/ Ball material (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
SN74LV244ADBR	ACTIVE	SSOP	DB	20	2000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	LV244A	Samples
SN74LV244ADBRE4	ACTIVE	SSOP	DB	20	2000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	LV244A	Samples
SN74LV244ADBRG4	ACTIVE	SSOP	DB	20	2000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	LV244A	Samples
SN74LV244ADGSR	ACTIVE	VSSOP	DGS	20	5000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	L244A	Samples
SN74LV244ADGVR	ACTIVE	TVSOP	DGV	20	2000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	LV244A	Samples
SN74LV244ADW	ACTIVE	SOIC	DW	20	25	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	LV244A	Samples
SN74LV244ADWE4	ACTIVE	SOIC	DW	20	25	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	LV244A	Samples
SN74LV244ADWG4	ACTIVE	SOIC	DW	20	25	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	LV244A	Samples
SN74LV244ADWR	ACTIVE	SOIC	DW	20	2000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	LV244A	Samples
SN74LV244ADWRG4	ACTIVE	SOIC	DW	20	2000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	LV244A	Samples
SN74LV244ANSR	ACTIVE	SO	NS	20	2000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	74LV244A	Samples
SN74LV244APW	ACTIVE	TSSOP	PW	20	70	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	LV244A	Samples
SN74LV244APWG4	ACTIVE	TSSOP	PW	20	70	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	LV244A	Samples
SN74LV244APWR	ACTIVE	TSSOP	PW	20	2000	RoHS & Green	NIPDAU SN	Level-1-260C-UNLIM	-40 to 125	LV244A	Samples
SN74LV244APWRE4	ACTIVE	TSSOP	PW	20	2000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	LV244A	Samples
SN74LV244APWRG3	ACTIVE	TSSOP	PW	20	2000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 125	LV244A	Samples
SN74LV244APWRG4	ACTIVE	TSSOP	PW	20	2000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	LV244A	Samples
SN74LV244APWT	ACTIVE	TSSOP	PW	20	250	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	LV244A	Samples
SN74LV244ARGYR	ACTIVE	VQFN	RGY	20	3000	RoHS & Green	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	LV244A	Samples
SN74LV244ARKSR	ACTIVE	VQFN	RKS	20	3000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	LV244A	Samples

(1) The marketing status values are defined as follows:

ACTIVE: Product device recommended for new designs.

LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

PREVIEW: Device has been announced but is not in production. Samples may or may not be available.

OBSOLETE: TI has discontinued the production of the device.

(2) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".

RoHS Exempt: TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.

Green: TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of ≤ 1000 ppm threshold. Antimony trioxide based flame retardants must also meet the ≤ 1000 ppm threshold requirement.

(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) Lead finish/Ball material - Orderable Devices 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.

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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 SN74LV244A :

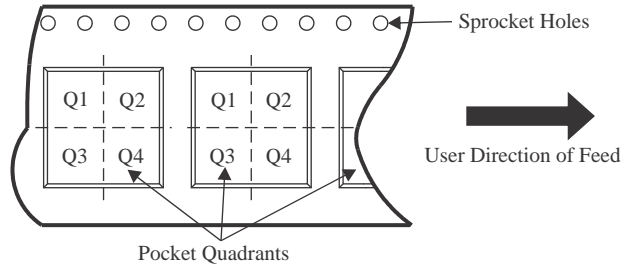
● Automotive : [SN74LV244A-Q1](#)

● Enhanced Product : [SN74LV244A-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

QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE


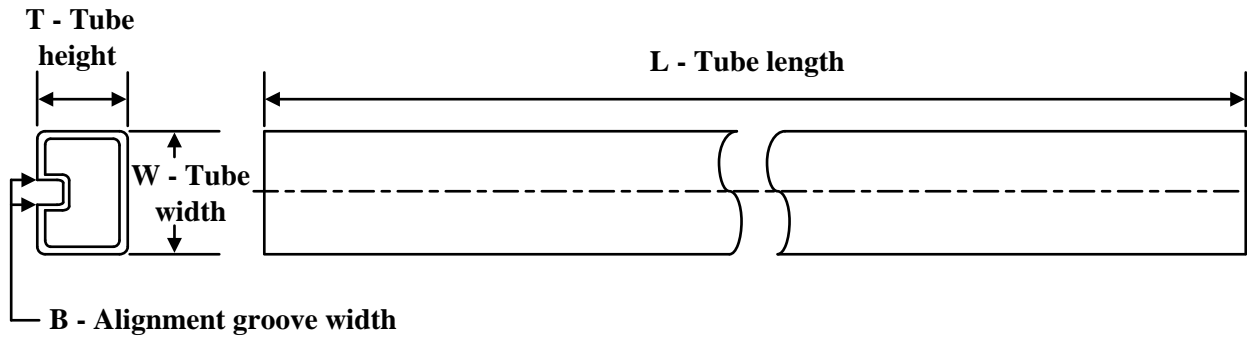
*All dimensions are nominal

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
SN74LV244ADBR	SSOP	DB	20	2000	330.0	16.4	8.2	7.5	2.5	12.0	16.0	Q1
SN74LV244ADGSR	VSSOP	DGS	20	5000	330.0	16.4	5.4	5.4	1.45	8.0	16.0	Q1
SN74LV244ADGVR	TVSOP	DGV	20	2000	330.0	12.4	6.9	5.6	1.6	8.0	12.0	Q1
SN74LV244ADWR	SOIC	DW	20	2000	330.0	24.4	10.8	13.3	2.7	12.0	24.0	Q1
SN74LV244ANSR	SO	NS	20	2000	330.0	24.4	8.4	13.0	2.5	12.0	24.0	Q1
SN74LV244APWR	TSSOP	PW	20	2000	330.0	16.4	6.95	7.0	1.4	8.0	16.0	Q1
SN74LV244APWR	TSSOP	PW	20	2000	330.0	16.4	6.95	7.1	1.6	8.0	16.0	Q1
SN74LV244APWRG3	TSSOP	PW	20	2000	330.0	16.4	6.95	7.1	1.6	8.0	16.0	Q1
SN74LV244APWRG4	TSSOP	PW	20	2000	330.0	16.4	6.95	7.0	1.4	8.0	16.0	Q1
SN74LV244APWT	TSSOP	PW	20	250	330.0	16.4	6.95	7.1	1.6	8.0	16.0	Q1
SN74LV244ARGYR	VQFN	RGY	20	3000	330.0	12.4	3.8	4.8	1.6	8.0	12.0	Q1
SN74LV244ARKSR	VQFN	RKS	20	3000	180.0	12.4	2.8	4.8	1.2	4.0	12.0	Q1

TAPE AND REEL BOX DIMENSIONS


*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
SN74LV244ADBR	SSOP	DB	20	2000	356.0	356.0	35.0
SN74LV244ADGSR	VSSOP	DGS	20	5000	356.0	356.0	35.0
SN74LV244ADGVR	TVSOP	DGV	20	2000	356.0	356.0	35.0
SN74LV244ADWR	SOIC	DW	20	2000	367.0	367.0	45.0
SN74LV244ANSR	SO	NS	20	2000	367.0	367.0	45.0
SN74LV244APWR	TSSOP	PW	20	2000	356.0	356.0	35.0
SN74LV244APWR	TSSOP	PW	20	2000	364.0	364.0	27.0
SN74LV244APWRG3	TSSOP	PW	20	2000	364.0	364.0	27.0
SN74LV244APWRG4	TSSOP	PW	20	2000	356.0	356.0	35.0
SN74LV244APWT	TSSOP	PW	20	250	356.0	356.0	35.0
SN74LV244ARGYR	VQFN	RGY	20	3000	356.0	356.0	35.0
SN74LV244ARKSR	VQFN	RKS	20	3000	210.0	185.0	35.0

TUBE


*All dimensions are nominal

Device	Package Name	Package Type	Pins	SPQ	L (mm)	W (mm)	T (μm)	B (mm)
SN74LV244ADW	DW	SOIC	20	25	507	12.83	5080	6.6
SN74LV244ADWE4	DW	SOIC	20	25	507	12.83	5080	6.6
SN74LV244ADWG4	DW	SOIC	20	25	507	12.83	5080	6.6
SN74LV244APW	PW	TSSOP	20	70	530	10.2	3600	3.5
SN74LV244APWG4	PW	TSSOP	20	70	530	10.2	3600	3.5

DB0020A



PACKAGE OUTLINE

SSOP - 2 mm max height

SMALL OUTLINE PACKAGE



4214851/B 08/2019

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-150.

EXAMPLE BOARD LAYOUT

DB0020A

SSOP - 2 mm max height

SMALL OUTLINE PACKAGE



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE: 10X



4214851/B 08/2019

NOTES: (continued)

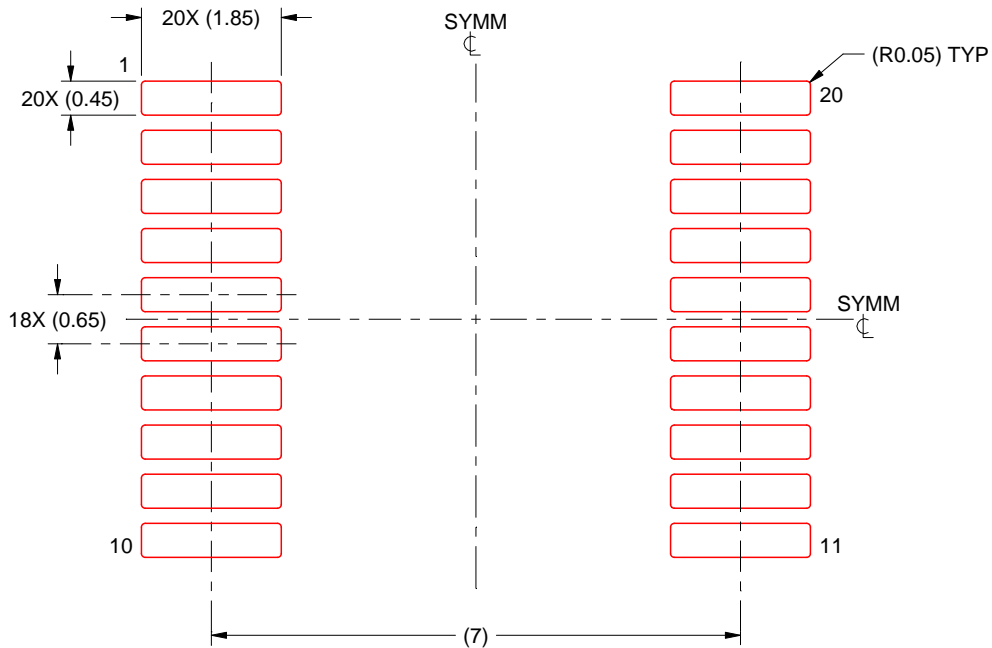
6. Publication IPC-7351 may have alternate designs.
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

EXAMPLE STENCIL DESIGN

DB0020A

SSOP - 2 mm max height

SMALL OUTLINE PACKAGE



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

4214851/B 08/2019

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

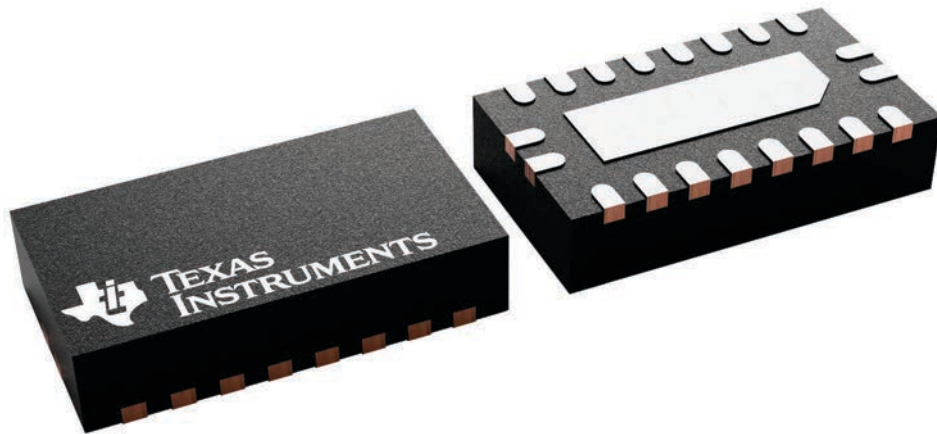
RKS 20

VQFN - 1 mm max height

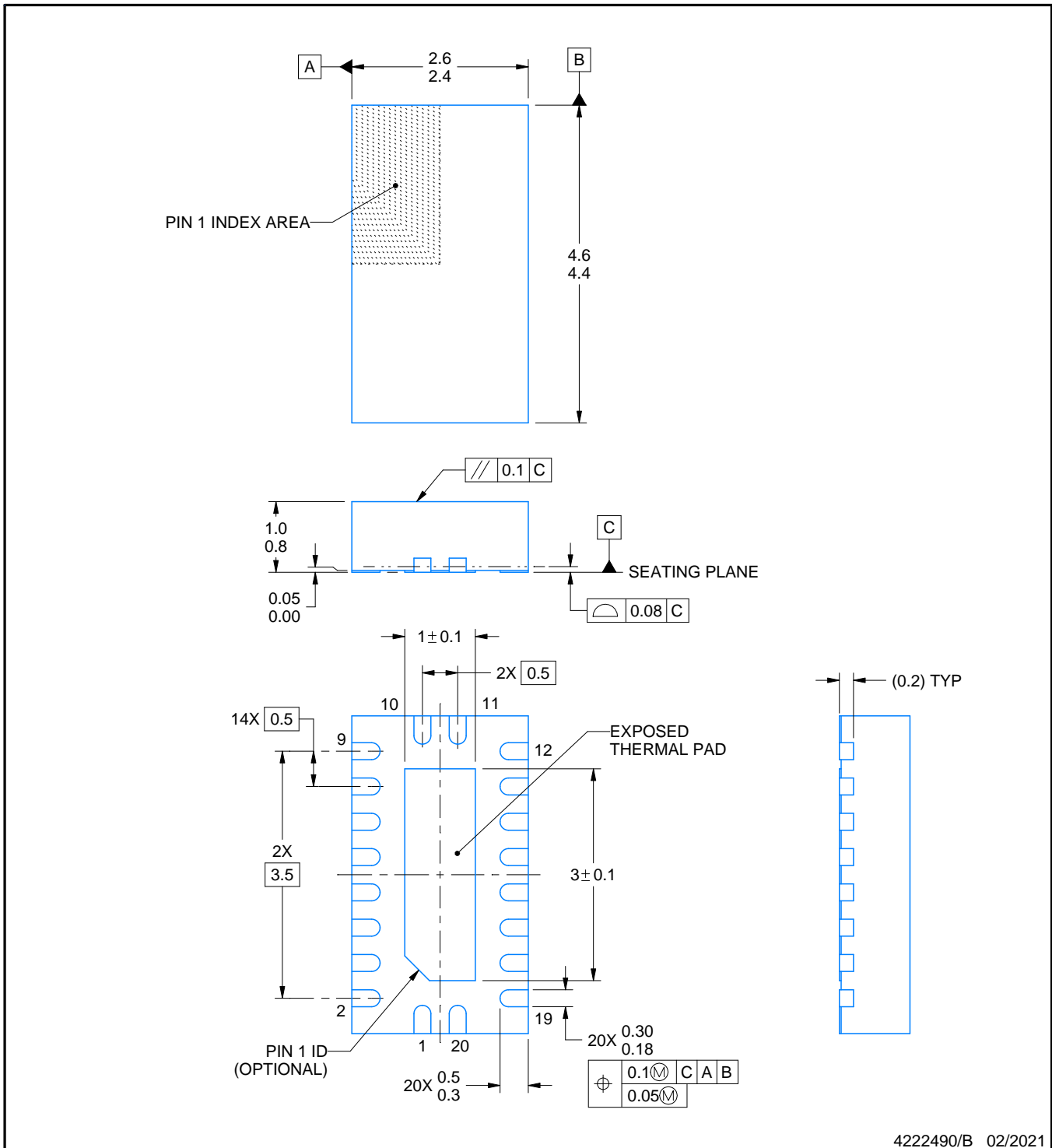
2.5 x 4.5, 0.5 mm pitch

PLASTIC QUAD FLATPACK - NO LEAD

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



4226872/A



NOTES:

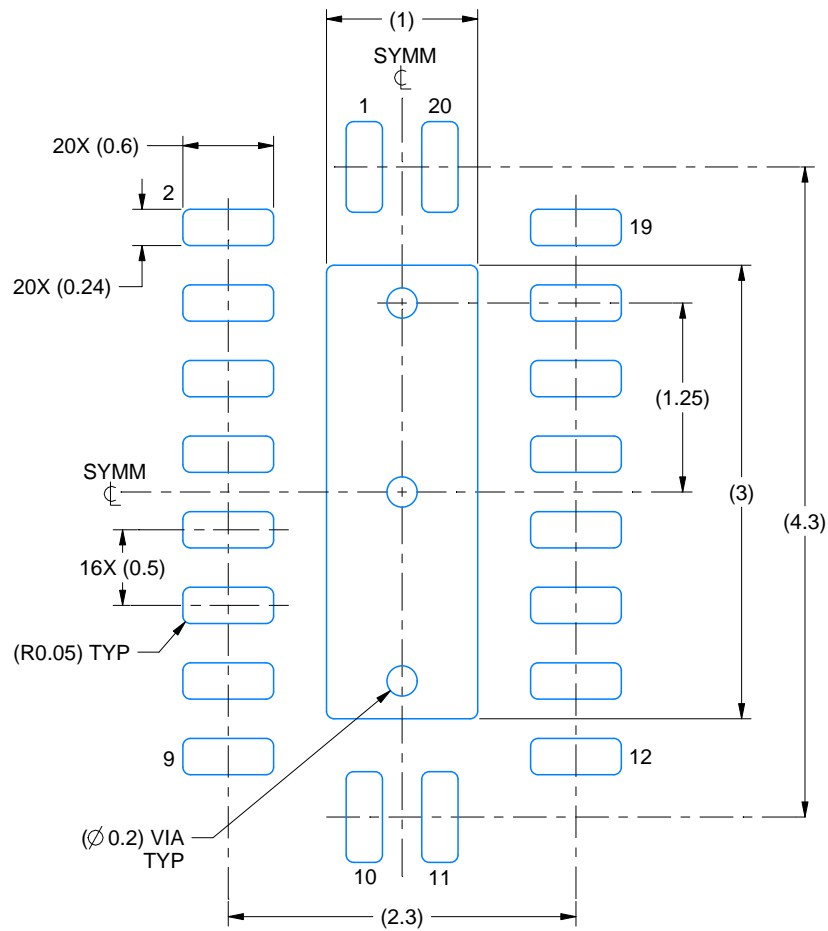
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. The package thermal pad must be soldered to the printed circuit board for thermal and mechanical performance.

EXAMPLE BOARD LAYOUT

RKS0020A

VQFN - 1 mm max height

PLASTIC QUAD FLATPACK - NO LEAD



LAND PATTERN EXAMPLE
SCALE:20X



SOLDER MASK DETAILS

4222490/B 02/2021

NOTES: (continued)

- 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).
- Vias are optional depending on application, refer to device data sheet. If some or all are implemented, recommended via locations are shown.

EXAMPLE STENCIL DESIGN

RKS0020A

VQFN - 1 mm max height

PLASTIC QUAD FLATPACK - NO LEAD



SOLDER PASTE EXAMPLE
 BASED ON 0.125 mm THICK STENCIL

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

4222490/B 02/2021

NOTES: (continued)

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

MECHANICAL DATA

NS (R-PDSO-G**)

PLASTIC SMALL-OUTLINE PACKAGE

14-PINS SHOWN



- NOTES:
- A. All linear dimensions are in millimeters.
 - B. This drawing is subject to change without notice.
 - C. Body dimensions do not include mold flash or protrusion, not to exceed 0,15.

GENERIC PACKAGE VIEW

RGY 20

VQFN - 1 mm max height

3.5 x 4.5, 0.5 mm pitch

PLASTIC QUAD FGLATPACK - NO LEAD

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



4225264/A



4225320/A 09/2019

NOTES:

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

EXAMPLE BOARD LAYOUT

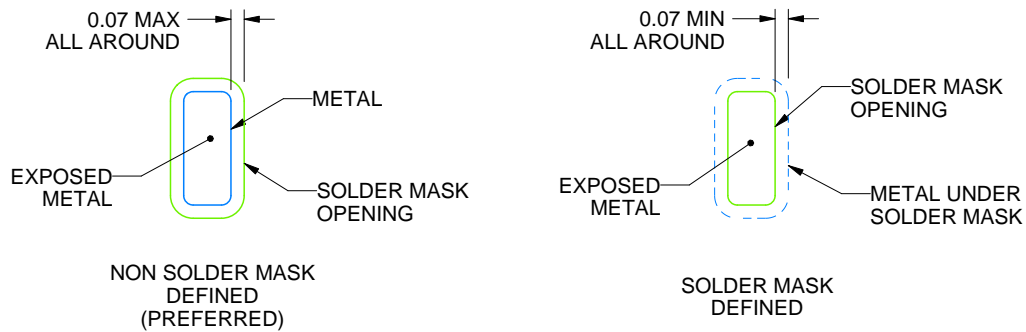
RGY0020A

VQFN - 1 mm max height

PLASTIC QUAD FLATPACK - NO LEAD



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:18X



SOLDER MASK DETAILS

4225320/A 09/2019

NOTES: (continued)

- 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).
- 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.

EXAMPLE STENCIL DESIGN

RGY0020A

VQFN - 1 mm max height

PLASTIC QUAD FLATPACK - NO LEAD



SOLDER PASTE EXAMPLE
 BASED ON 0.125 mm THICK STENCIL

EXPOSED PAD 21
 78% PRINTED SOLDER COVERAGE BY AREA UNDER PACKAGE
 SCALE:20X

4225320/A 09/2019

NOTES: (continued)

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

DW0020A



PACKAGE OUTLINE

SOIC - 2.65 mm max height

SOIC



4220724/A 05/2016

NOTES:

1. All linear dimensions are in millimeters. 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 0.43 mm per side.
5. Reference JEDEC registration MS-013.

EXAMPLE BOARD LAYOUT

DW0020A

SOIC - 2.65 mm max height

SOIC



LAND PATTERN EXAMPLE
SCALE:6X



SOLDER MASK DETAILS

4220724/A 05/2016

NOTES: (continued)

- 6. Publication IPC-7351 may have alternate designs.
- 7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

EXAMPLE STENCIL DESIGN

DW0020A

SOIC - 2.65 mm max height

SOIC



SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE:6X

4220724/A 05/2016

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.

PW0020A



PACKAGE OUTLINE

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



4220206/A 02/2017

NOTES:

- All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
- This drawing is subject to change without notice.
- 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.
- This dimension does not include interlead flash. Interlead flash shall not exceed 0.25 mm per side.
- Reference JEDEC registration MO-153.

EXAMPLE BOARD LAYOUT

PW0020A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE: 10X



SOLDER MASK DETAILS

4220206/A 02/2017

NOTES: (continued)

- 6. Publication IPC-7351 may have alternate designs.
- 7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

EXAMPLE STENCIL DESIGN

PW0020A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



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

4220206/A 02/2017

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.

PW (R-PDSO-G20)

PLASTIC SMALL OUTLINE



- NOTES:
- A. All linear dimensions are in millimeters.
 - B. This drawing is subject to change without notice.
 - C. Publication IPC-7351 is recommended for alternate design.
 - D. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC-7525 for other stencil recommendations.
 - E. Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.

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