

SN74HCS240 Octal Inverting Line Drivers With Schmitt-Trigger Inputs and 3-State Outputs

1 Features

- Wide operating voltage range: 2V to 6V
- [Schmitt-trigger inputs](#) allow for slow or noisy input signals
- Low power consumption
 - Typical I_{CC} of 100nA
 - Typical input leakage current of ± 100 nA
- ± 7.8 mA output drive at 6V
- Extended ambient temperature range: -40°C to $+125^{\circ}\text{C}$, T_A

2 Applications

- [Enable or disable a digital signal](#)
- [Eliminate slow or noisy input signals](#)
- [Hold a signal during controller reset](#)
- [Debounce a switch](#)

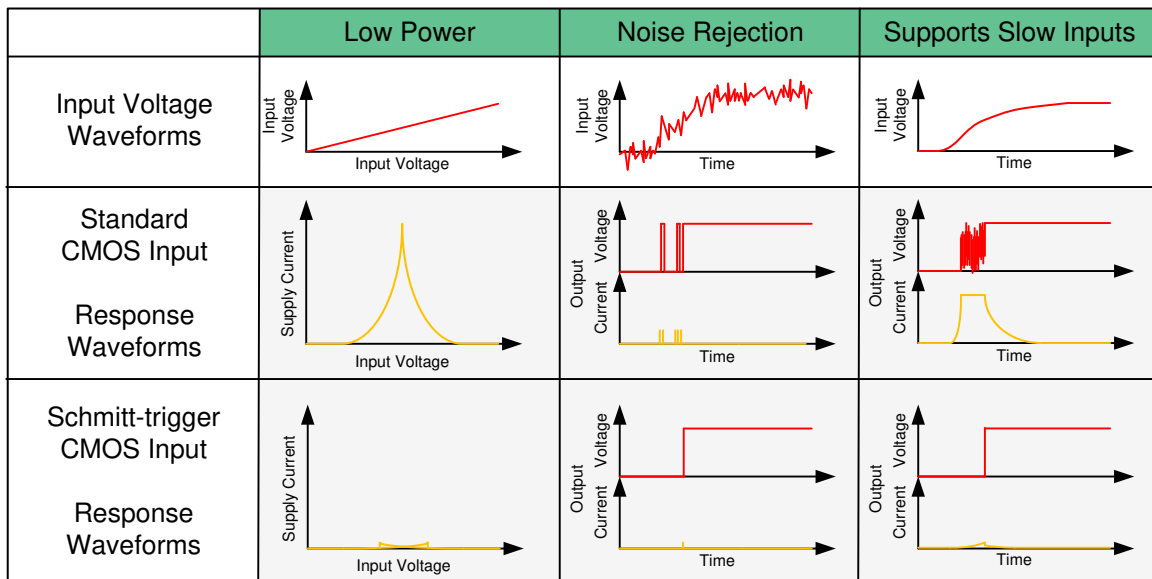
3 Description

This device contains eight independent inverting line drivers with 3-state outputs and Schmitt-trigger inputs. Each channel performs the Boolean function $Y = \bar{A}$ in positive logic. The channels are grouped in sets of four, with one OE pin controlling each set. The outputs can be put into a hi-Z state by applying a high on the associated OE pin.

Device Information

PART NUMBER	PACKAGE ⁽¹⁾	PACKAGE ⁽²⁾	BODY SIZE ⁽³⁾
SN74HCS240	DGS (VSSOP, 20)	5.1mm × 4.9mm	5.1mm × 3mm
	RKS (VQFN, 20)	4.50mm × 2.50mm	4.50mm × 2.50mm

- (1) For more information, see [Mechanical, Packaging, and Orderable Information](#).
- (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.



Benefits of Schmitt-trigger inputs



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4 Pin Configuration and Functions

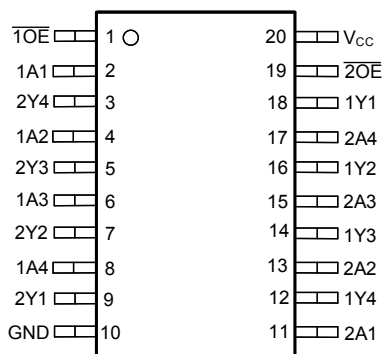


Figure 4-1. DGS Package, 20-Pin VSSOP (Top View)

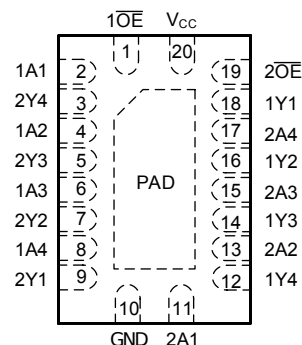


Figure 4-2. RKS Package, 20-Pin VQFN (Top View)

Pin Functions

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

(1) I = input, O = output, P = power, FB = feedback, GND = ground, N/A = not applicable

5 Specifications

5.1 Absolute Maximum Ratings

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

			MIN	MAX	UNIT
V_{CC}	Supply voltage		-0.5	7	V
I_{IK}	Input clamp current ⁽²⁾	$V_I < -0.5\text{ V}$ or $V_I > V_{CC} + 0.5\text{ V}$		±20	mA
I_{OK}	Output clamp current ⁽²⁾	$V_O < -0.5\text{ V}$ or $V_O > V_{CC} + 0.5\text{ V}$		±20	mA
I_O	Continuous output current	$V_O = 0$ to V_{CC}		±35	mA
I_{CC}	Continuous current through V_{CC} or GND			±70	mA
T_J	Junction temperature ⁽³⁾			150	°C
T_{stg}	Storage temperature		-65	150	°C

(1) Operation outside the *Absolute Maximum Ratings* may cause permanent device damage. Absolute maximum ratings do not imply functional operation of the device at these or any other conditions beyond those listed under *Recommended Operating Conditions*. If briefly operating outside the *Recommended Operating Conditions* but within the *Absolute Maximum Ratings*, the device may not sustain damage, but it may not be fully functional. Operating the device in this manner may affect device reliability, functionality, performance, and shorten the device lifetime.

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

(3) Assured by design.

5.2 ESD Ratings

			VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001 ⁽¹⁾	±4000	V
		Charged-device model (CDM), per ANSI/ESDA/JEDEC JS-002 ⁽²⁾	±1500	

(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.

5.3 Recommended Operating Conditions

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

		MIN	NOM	MAX	UNIT
V_{CC}	Supply voltage	2	5	6	V
V_I	Input voltage	0		V_{CC}	V
V_O	Output voltage	0		V_{CC}	V
T_A	Ambient temperature	-40		125	°C

5.4 Thermal Information

THERMAL METRIC ⁽¹⁾		SN74HCS240		UNIT
		DGS (VSSOP)	RKS (VQFN)	
		20 PINS	20 PINS	
$R_{\theta JA}$	Junction-to-ambient thermal resistance	130.6	83.2	°C/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	68.7	82.6	°C/W
$R_{\theta JB}$	Junction-to-board thermal resistance	85.4	57.4	°C/W
Ψ_{JT}	Junction-to-top characterization parameter	10.5	14.5	°C/W
Ψ_{JB}	Junction-to-board characterization parameter	85.0	56.4	°C/W
$R_{\theta JC(bot)}$	Junction-to-case (bottom) thermal resistance	N/A	40.0	°C/W

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

5.5 Electrical Characteristics

over operating free-air temperature range; typical values measured at $T_A = 25^\circ\text{C}$ (unless otherwise noted).

PARAMETER		TEST CONDITIONS		V_{CC}	MIN	TYP	MAX	UNIT
V_{T+}	Positive switching threshold			2 V	0.7		1.5	V
				4.5 V	1.7		3.15	
				6 V	2.1		4.2	
V_{T-}	Negative switching threshold			2 V	0.3		1	V
				4.5 V	0.9		2.2	
				6 V	1.2		3	
ΔV_T	Hysteresis ($V_{T+} - V_{T-}$)			2 V	0.2		1	V
				4.5 V	0.4		1.4	
				6 V	0.6		1.6	
V_{OH}	High-level output voltage	$V_I = V_{IH}$ or V_{IL}	$I_{OH} = -20\ \mu\text{A}$	2 V to 6 V	$V_{CC} - 0.1$	$V_{CC} - 0.002$		V
			$I_{OH} = -6\ \text{mA}$	4.5 V	4	4.3		
			$I_{OH} = -7.8\ \text{mA}$	6 V	5.4	5.75		
V_{OL}	Low-level output voltage	$V_I = V_{IH}$ or V_{IL}	$I_{OL} = 20\ \mu\text{A}$	2 V to 6 V		0.002	0.1	V
			$I_{OL} = 6\ \text{mA}$	4.5 V		0.18	0.3	
			$I_{OL} = 7.8\ \text{mA}$	6 V		0.22	0.33	
I_I	Input leakage current	$V_I = V_{CC}$ or 0		6 V		± 100	± 1000	nA
I_{OZ}	Off-state (high-impedance state) output current	$V_O = V_{CC}$ or 0		6 V		± 0.01	± 2	μA
I_{CC}	Supply current	$V_I = V_{CC}$ or 0, $I_O = 0$		6 V		0.1	2	μA
C_i	Input capacitance			2 V to 6 V			5	pF

5.6 Switching Characteristics

over operating free-air temperature range; typical values measured at $T_A = 25^\circ\text{C}$ (unless otherwise noted). See *Parameter Measurement Information*. $C_L = 50\ \text{pF}$.

PARAMETER		FROM (INPUT)	TO (OUTPUT)	V_{CC}	MIN	TYP	MAX	UNIT
t_{pd}	Propagation delay	A	Y	2 V		13	45	ns
				4.5 V		7	18	
				6 V		6	16	
t_{en}	Enable time	\overline{OE}	Y	2 V		15	44	ns
				4.5 V		7	22	
				6 V		6	18	
t_{dis}	Disable time	\overline{OE}	Y	2 V		12	30	ns
				4.5 V		9	20	
				6 V		8	19	
t_t	Transition-time		Any	2 V		9	16	ns
				4.5 V		5	9	
				6 V		4	8	

5.7 Operating Characteristics

over operating free-air temperature range; typical values measured at $T_A = 25^\circ\text{C}$ (unless otherwise noted).

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
C_{pd}	Power dissipation capacitance per gate	No load		20		pF

5.8 Typical Characteristics

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

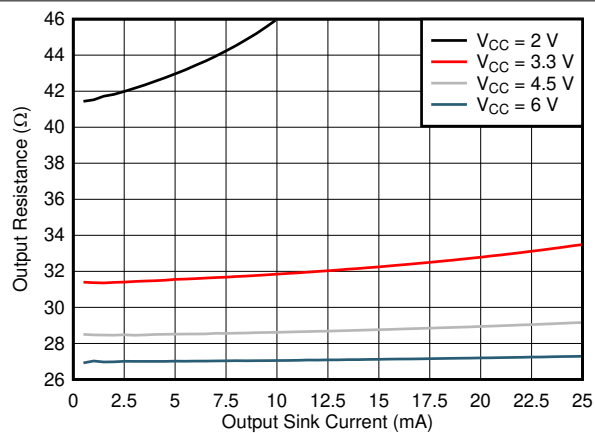


Figure 5-1. Output Driver Resistance in LOW State

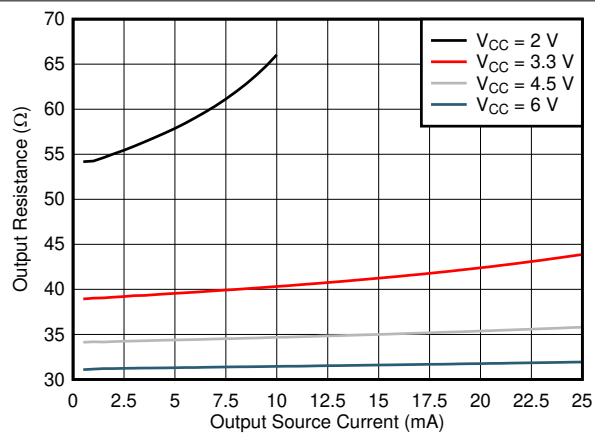


Figure 5-2. Output Driver Resistance in HIGH State

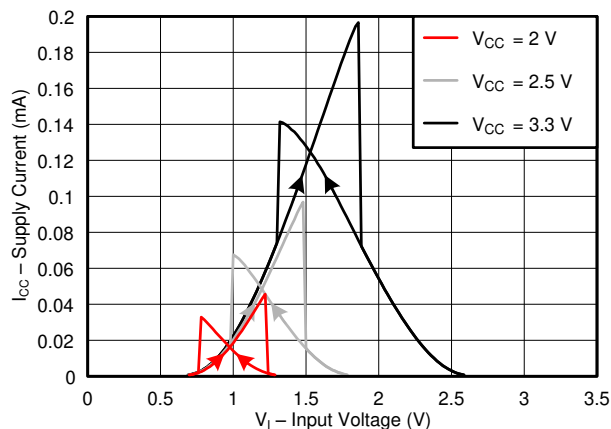


Figure 5-3. Supply Current Across Input Voltage, 2-, 2.5-, and 3.3-V Supply

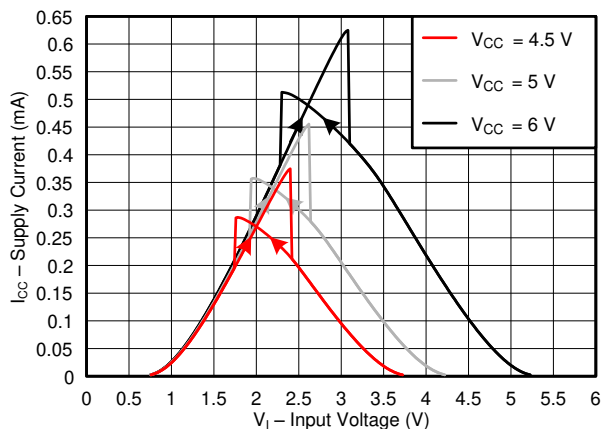


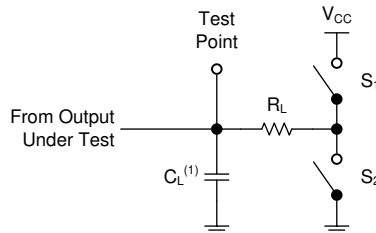
Figure 5-4. Supply Current Across Input Voltage, 4.5-, 5-, and 6-V Supply

6 Parameter Measurement Information

Phase relationships between waveforms were chosen arbitrarily. All input pulses are supplied by generators having the following characteristics: $PRR \leq 1 \text{ MHz}$, $Z_O = 50\Omega$, $t_f < 2.5 \text{ ns}$.

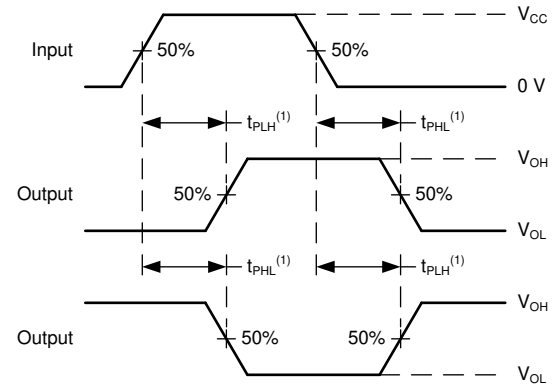
For clock inputs, f_{\max} is measured when the input duty cycle is 50%.

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



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

Figure 6-1. Load Circuit for 3-State Outputs



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

Figure 6-2. Voltage Waveforms Propagation Delays

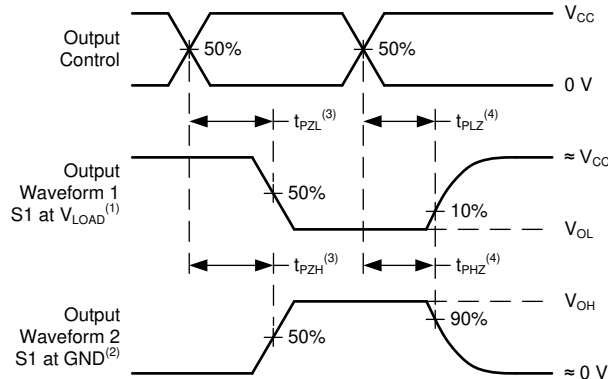
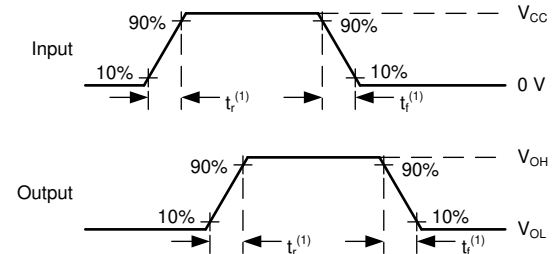


Figure 6-3. Voltage Waveforms Propagation Delays



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

Figure 6-4. Voltage Waveforms, Input and Output Transition Times

7 Detailed Description

7.1 Overview

The SN74HCS240 contains 8 individual high speed CMOS inverters with Schmitt-trigger inputs and 3-state outputs.

Each inverter performs the boolean logic function $xY_n = \overline{xA_n}$, with x being the bank number and n being the channel number.

Each output enable (\overline{xOE}) controls four inverters. When the \overline{xOE} pin is in the low state, the outputs of all inverters in the bank x are enabled. When the \overline{xOE} pin is in the high state, the outputs of all inverters in the bank x are disabled. All disabled output are placed into the high-impedance state.

To ensure the high-impedance state during power up or power down, both \overline{OE} pins should be tied to V_{CC} through a pull-up resistor; the minimum value of the resistor is determined by the current sinking capability of the driver and the leakage of the pin as defined in the *Electrical Characteristics* table.

7.2 Functional Block Diagram

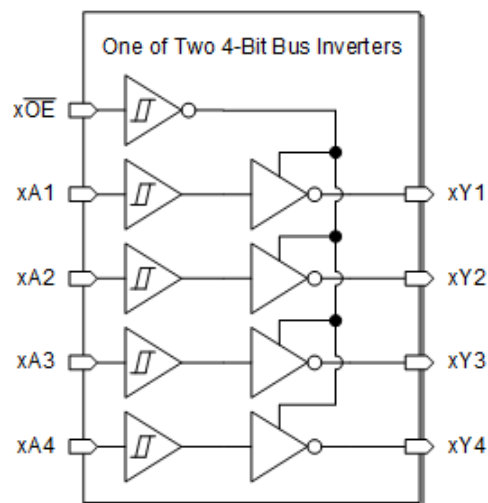


Figure 7-1. Logic Diagram (Positive Logic) for SN74HCS240

7.3 Feature Description

7.3.1 Feature Description

The SNx4HC132 has a wide operating range of 2 V to 6 V. The SNx4HC132 also has a low power consumption where the maximum I_{CC} is 20 μA .

7.3.1.1 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 state, 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 10kΩ resistor can be used to meet these requirements.

Unused 3-state CMOS outputs should be left disconnected.

7.3.1.2 Balanced CMOS Push-Pull Outputs

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

Unused push-pull CMOS outputs must be left disconnected.

7.3.1.3 Open-Drain CMOS Outputs

This device includes open-drain CMOS outputs. Open-drain outputs can only drive the output low. When in the high logical state, open-drain outputs will be in a high-impedance state. 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 state, 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 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 10kΩ resistor can be used to meet these requirements.

Unused open-drain CMOS outputs should be left disconnected.

7.3.1.4 CMOS Schmitt-Trigger Inputs

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

The Schmitt-trigger input architecture provides hysteresis as defined by ΔV_T in the *Electrical Characteristics* table, which makes this device extremely tolerant to slow or noisy inputs. While the inputs can be driven much slower than standard CMOS inputs, it is still recommended to properly terminate unused inputs. Driving the inputs with slow transitioning signals will increase dynamic current consumption of the device. For additional information regarding Schmitt-trigger inputs, please see [Understanding Schmitt Triggers](#).

7.3.1.5 TTL-Compatible CMOS Inputs

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

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

TTL-compatible CMOS inputs require that input signals transition between valid logic states quickly, as defined by the input transition time or rate in the *Recommended Operating Conditions* table. Failing to meet this

specification will result in excessive power consumption and could cause oscillations. More details can be found in the [Implications of Slow or Floating CMOS Inputs](#) application report.

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

7.3.1.6 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 10k Ω resistor, however, is recommended and will typically meet all requirements.

7.3.1.7 Clamp Diode Structure

As shown in [Figure 7-2](#), the inputs and outputs to this device have both positive and negative clamping diodes.

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.

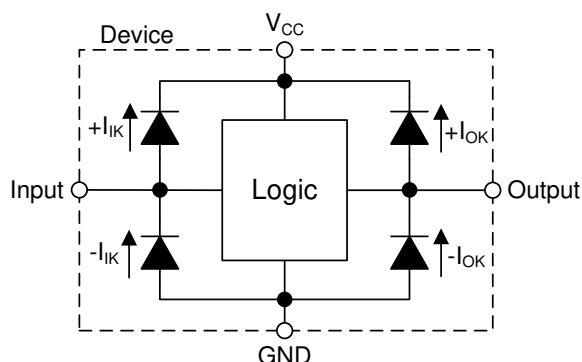


Figure 7-2. Electrical Placement of Clamping Diodes for Each Input and Output

7.4 Device Functional Modes

[Table 7-1](#) lists the functional modes of the SN74HCS240.

Table 7-1. Function Table

INPUTS ⁽¹⁾		OUTPUTS
OE	A	Y
L	L	H
L	H	L

Table 7-1. Function Table (continued)

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

(1) H = High Voltage Level, L = Low Voltage Level, X = Do Not Care, Z = High-Impedance State

8 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.

8.1 Application Information

The SN74HCS240 can be used to drive signals over relatively long traces or transmission lines. A series damping resistor placed in series with the transmitter's output can be used to reduce ringing caused by impedance mismatches between the driver, transmission line, and receiver. The figure in the *Application Curve* section shows the received signal with three separate resistor values. Just a small amount of resistance can make a significant impact on signal integrity in this type of application.

8.2 Typical Application

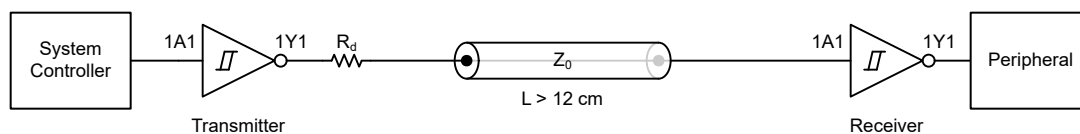


Figure 8-1. Typical application block diagram

8.2.1 Design Requirements

8.2.1.1 Power Considerations

Ensure the desired supply voltage is within the range specified in the *Recommended Operating Conditions*. The supply voltage sets the device's electrical characteristics of the device as described in the *Electrical Characteristics* section.

The positive voltage supply must be capable of sourcing current equal to the total current to be sourced by all outputs of the SN74HCS240 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. Ensure the maximum total current through V_{CC} listed in the *Absolute Maximum Ratings* is not exceeded.

The ground must be capable of sinking current equal to the total current to be sunk by all outputs of the SN74HCS240 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. Ensure the maximum total current through GND listed in the *Absolute Maximum Ratings* is not exceeded.

The SN74HCS240 can drive a load with a total capacitance less than or equal to 50pF while still meeting all of the data sheet specifications. Larger capacitive loads can be applied; however, it is not recommended to exceed 50pF.

The SN74HCS240 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.

8.2.1.2 Input Considerations

Input signals must cross $V_{t-(min)}$ to be considered a logic LOW, and $V_{t+(max)}$ to be considered a logic HIGH. Do not exceed the maximum input voltage range found in the *Absolute Maximum Ratings*.

Unused inputs must be terminated to either V_{CC} or ground. The unused inputs can be directly terminated if the input is completely unused, or they can be connected with a pull-up or pull-down resistor if the input will be used sometimes, but not always. A pull-up resistor is used for a default state of HIGH, and a pull-down resistor is used for a default state of LOW. The drive current of the controller, leakage current into the SN74HCS240 (as specified in the *Electrical Characteristics*), and the desired input transition rate limits the resistor size. A 10k Ω resistor value is often used due to these factors.

The SN74HCS240 has no input signal transition rate requirements because it has Schmitt-Trigger inputs.

Another benefit to having Schmitt-Trigger inputs is the ability to reject noise. Noise with a large enough amplitude can still cause issues. To know how much noise is too much, please refer to the $\Delta V_{T(min)}$ in the *Electrical Characteristics*. This hysteresis value will provide the peak-to-peak limit.

Unlike what happens with standard CMOS inputs, Schmitt-Trigger inputs can be held at any valid value without causing huge increases in power consumption. The typical additional current caused by holding an input at a value other than V_{CC} or ground is plotted in the *Typical Characteristics*.

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

8.2.1.3 Output Considerations

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

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

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

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

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

8.2.2 Detailed Design Procedure

1. Add a decoupling capacitor from V_{CC} to GND. The capacitor needs to be placed physically close to the device and electrically close to both the V_{CC} and GND pins. An example layout is shown in the *Layout* section.
2. Ensure the capacitive load at the output is $\leq 50\text{pF}$. This is not a hard limit; by design, however, it will optimize performance. This can be accomplished by providing short, appropriately sized traces from the SN74HCS240 to one or more of the receiving devices.
3. Ensure the resistive load at the output is larger than $(V_{CC} / I_{O(max)})\Omega$. Doing this will prevent the maximum output current from the *Absolute Maximum Ratings* from being violated. Most CMOS inputs have a resistive load measured in M Ω ; 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](#).

8.2.3 Application Curve

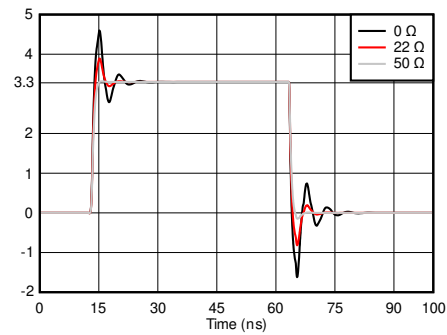


Figure 8-2. Simulated signal integrity at the reciever with different damping resistor (R_d) values

8.3 Power Supply Recommendations

The power supply can be any voltage between the minimum and maximum supply voltage rating located in the *Recommended Operating Conditions*. Each V_{CC} terminal should have a good bypass capacitor to prevent power disturbance. A $0.1\mu\text{F}$ capacitor is recommended for this device. It is acceptable to parallel multiple bypass capacitors to reject different frequencies of noise. The $0.1\mu\text{F}$ and $1\mu\text{F}$ capacitors are commonly used in parallel. The bypass capacitor should be installed as close to the power terminal as possible for best results, as shown in the following layout example.

8.4 Layout

8.4.1 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.

8.4.2 Layout Example

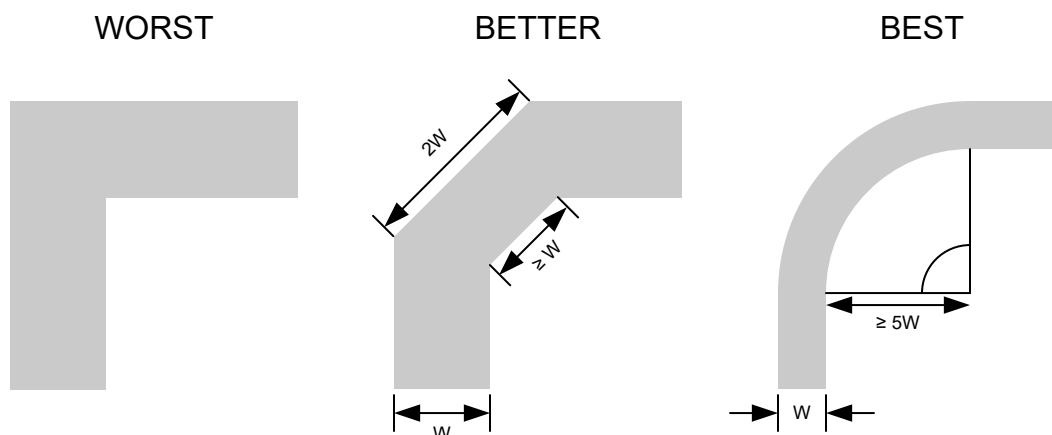


Figure 8-3. Example trace corners for improved signal integrity

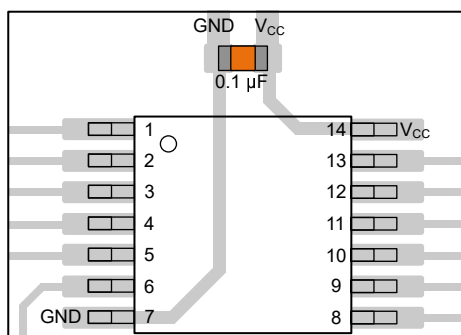


Figure 8-4. Example bypass capacitor placement for TSSOP and similar packages

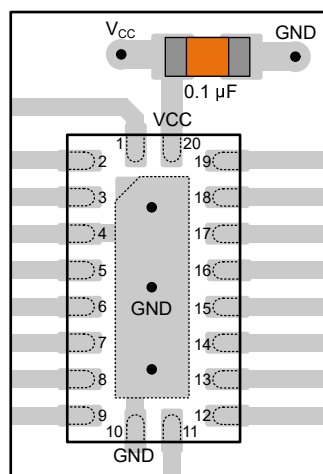


Figure 8-5. Example bypass capacitor placement for WQFN and similar packages

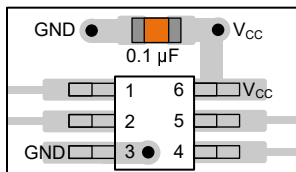


Figure 8-6. Example bypass capacitor placement for SOT, SC70 and similar packages

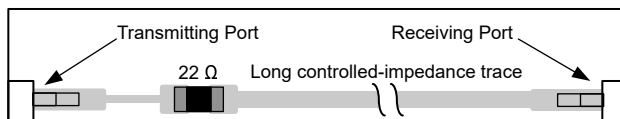


Figure 8-7. Example damping resistor placement for improved signal integrity

9 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.

9.1 Documentation Support

9.1.1 Related Documentation

For related documentation see the following:

- Texas Instruments, [HCMOS Design Considerations application report](#) (SCLA007)
- Texas Instruments, [CMOS Power Consumption and \$C_{pd}\$ Calculation application report](#) (SDYA009)
- Texas Instruments, [Designing With Logic application report](#)

9.2 Receiving Notification of Documentation Updates

To receive notification of documentation updates, navigate to the device product folder on [ti.com](#). Click on *Notifications* 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.

9.3 Support Resources

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

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9.4 Trademarks

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9.5 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.

9.6 Glossary

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

10 Revision History

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

Changes from Revision A (October 2021) to Revision B (August 2024) Page

- | | |
|---|---|
| • Added DGS package to <i>Device Information</i> table, <i>Pin Configuration and Functions</i> section, and <i>Thermal Information</i> table..... | 1 |
|---|---|

Changes from Revision * (July 2021) to Revision A (October 2021) Page

- | | |
|---|---|
| • Changed data sheet from advance information to production data..... | 1 |
|---|---|

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 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)
SN74HCS240DGSR	Active	Production	VSSOP (DGS) 20	5000 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	HS240
SN74HCS240DGSR.A	Active	Production	VSSOP (DGS) 20	5000 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	HS240
SN74HCS240RKSR	Active	Production	VQFN (RKS) 20	3000 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	HCS240
SN74HCS240RKSR.A	Active	Production	VQFN (RKS) 20	3000 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	HCS240

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

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

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

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

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

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

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

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OTHER QUALIFIED VERSIONS OF SN74HCS240 :

- Automotive : [SN74HCS240-Q1](#)

NOTE: Qualified Version Definitions:

- Automotive - Q100 devices qualified for high-reliability automotive applications targeting zero defects

TAPE AND REEL INFORMATION



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
SN74HCS240DGSR	VSSOP	DGS	20	5000	330.0	16.4	5.4	5.4	1.45	8.0	16.0	Q1
SN74HCS240RKSR	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)
SN74HCS240DGSR	VSSOP	DGS	20	5000	353.0	353.0	32.0
SN74HCS240RKSR	VQFN	RKS	20	3000	210.0	185.0	35.0



4226367/A 10/2020

NOTES:

PowerPAD is a trademark of Texas Instruments.

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. No JEDEC registration as of September 2020.
5. Features may differ or may not be present.

EXAMPLE BOARD LAYOUT

DGS0020A

VSSOP - 1.1 mm max height

SMALL OUTLINE PACKAGE



4226367/A 10/2020

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.
8. This package is designed to be soldered to a thermal pad on the board. For more information, see Texas Instruments literature numbers SLMA002 (www.ti.com/lit/slma002) and SLMA004 (www.ti.com/lit/slma004).
9. Size of metal pad may vary due to creepage requirement.
10. Vias are optional depending on application, refer to device data sheet. It is recommended that vias under paste be filled, plugged or tented.

EXAMPLE STENCIL DESIGN

DGS0020A

VSSOP - 1.1 mm max height

SMALL OUTLINE PACKAGE



SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE: 16X

4226367/A 10/2020

NOTES: (continued)

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

GENERIC PACKAGE VIEW

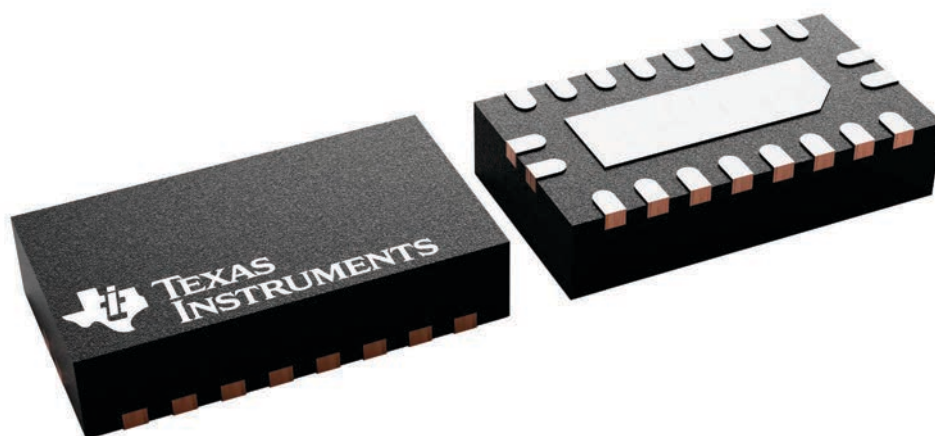
RKS 20

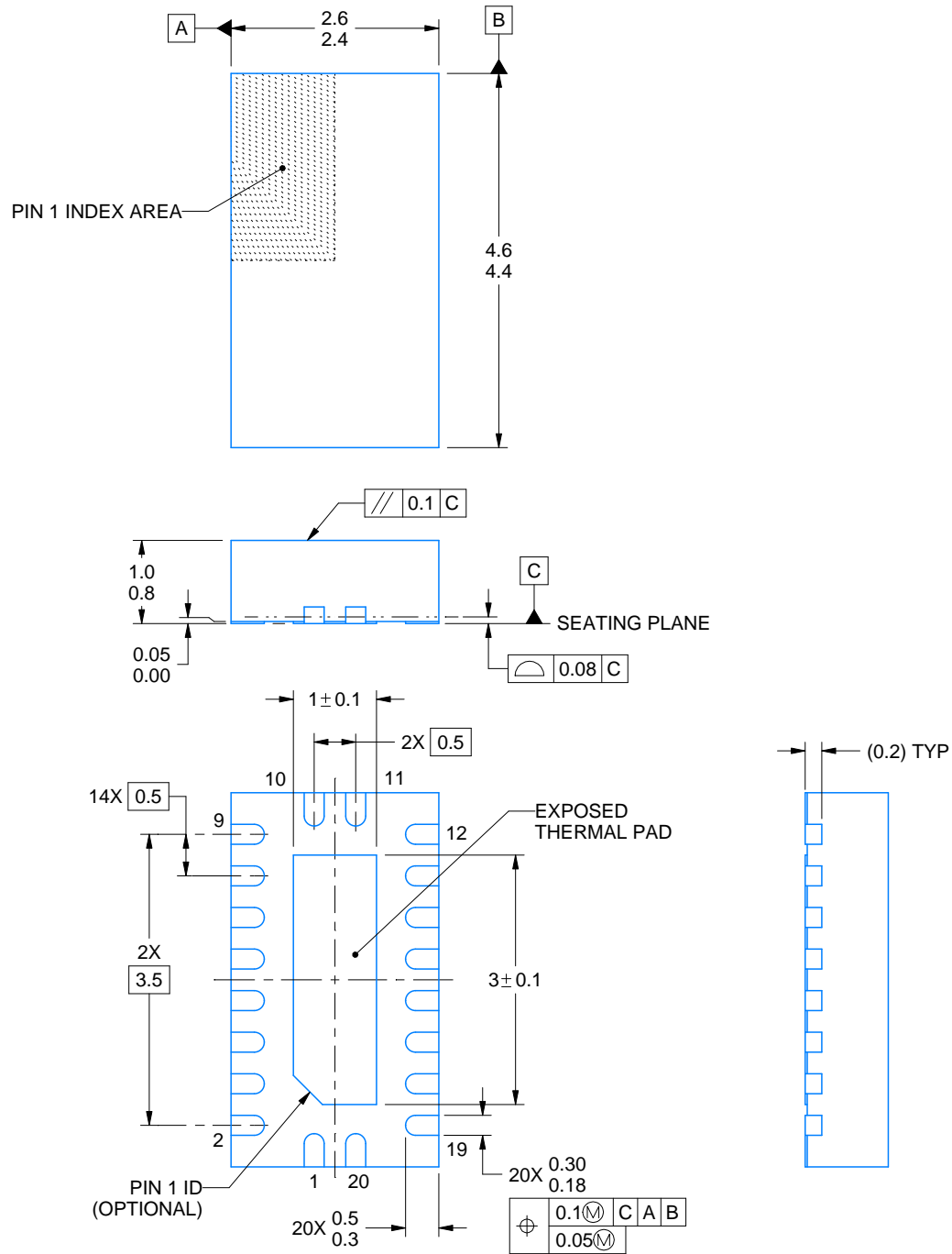
VQFN - 1 mm max height

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.





4222490/B 02/2021

NOTES:

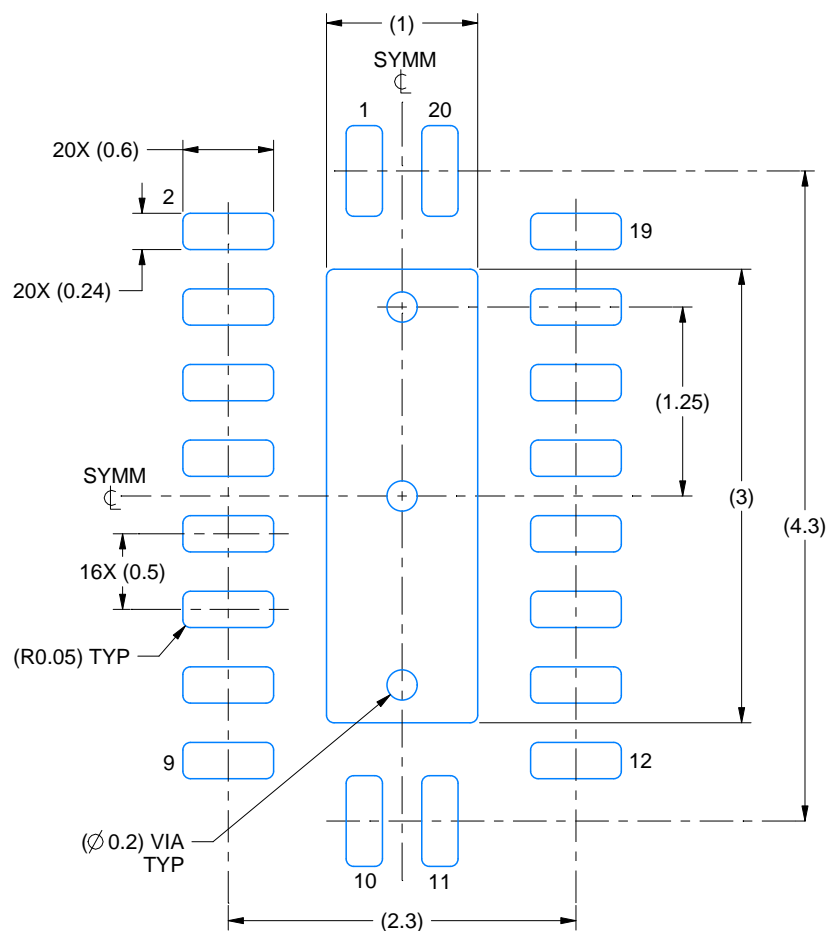
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. The package thermal pad must be soldered to the printed circuit board for thermal and mechanical performance.

EXAMPLE BOARD LAYOUT

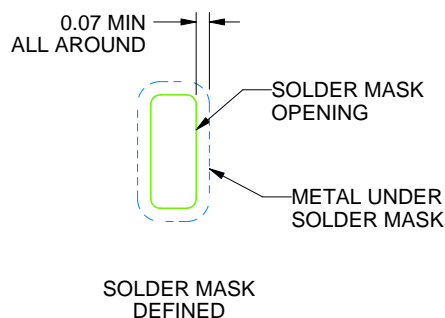
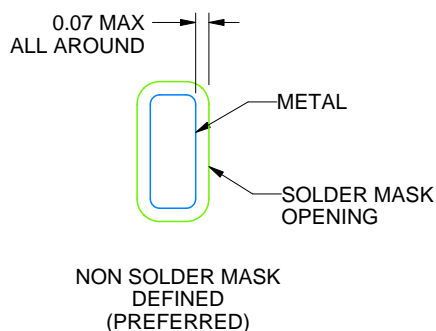
RKS0020A

VQFN - 1 mm max height

PLASTIC QUAD FLATPACK - NO LEAD



LAND PATTERN EXAMPLE
SCALE:20X



SOLDER MASK DETAILS

4222490/B 02/2021

NOTES: (continued)

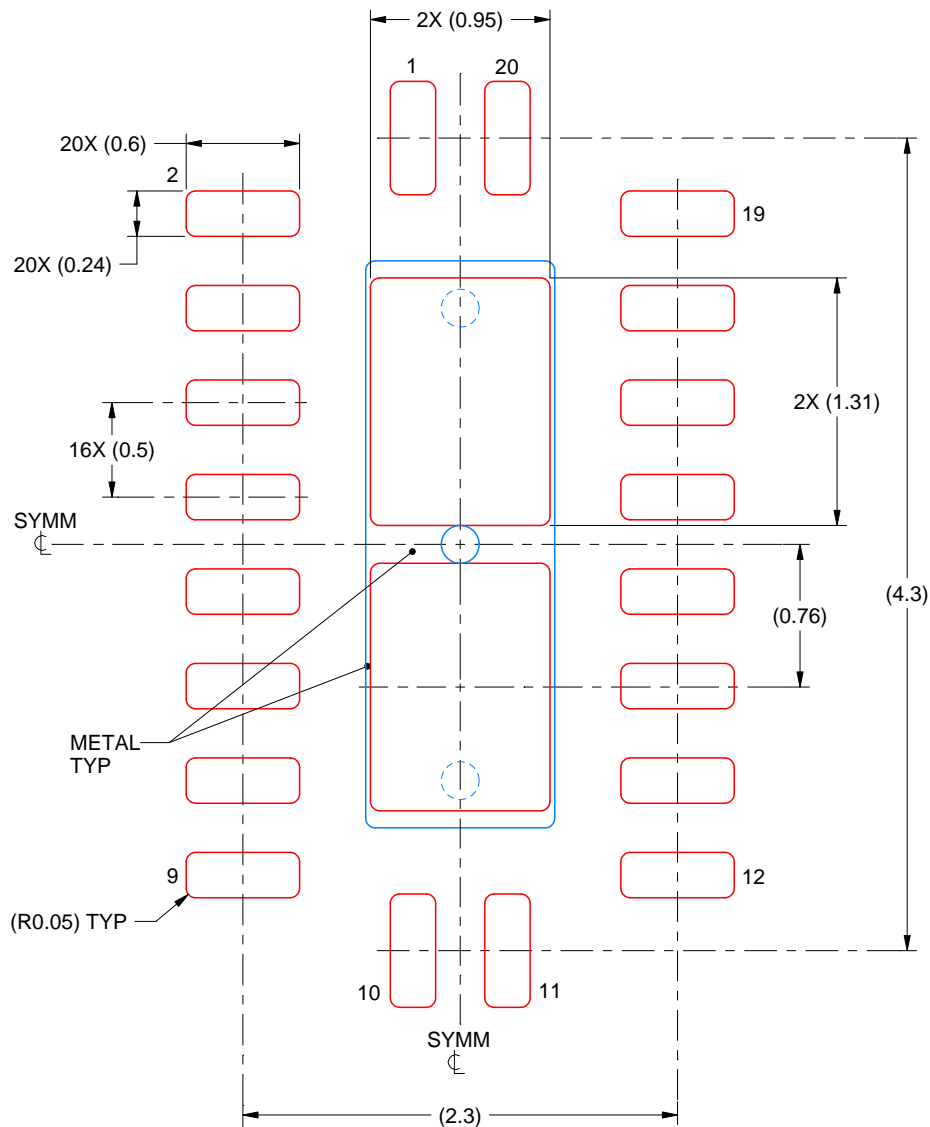
4. This package is designed to be soldered to a thermal pad on the board. For more information, see Texas Instruments literature number SLUA271 (www.ti.com/lit/sluea271).
5. Vias are optional depending on application, refer to device data sheet. If some or all are implemented, recommended via locations 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.

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