SN74LVC1G06B-Q1 Automotive Single 1.1V to 5.5V Inverter Buffer/Driver With Open-Drain Output

1 Features

- AEC-Q100 qualified for automotive applications:
  - Device temperature grade 1: -40°C to +125°C
  - Device HBM ESD classification level 2
  - Device CDM ESD classification level C4B
- Operating range from 1.1V to 5.5V
- Over-voltage tolerant inputs support up to 5.5V independent of V_{CC}
- Open-drain outputs support 5.5V independent of V_{CC}
- Supports partial-power-down with back drive protection (I_{off})
- High open-drain output drive strength:
  - 32mA at 5V
  - 24mA at 3.3V
  - 8mA at 2.5V
  - 4mA at 1.8V
- Maximum propagation delay of 2.6ns at 5V; 50pF
- Latch-up performance exceeds 100mA per JESD78 and AEC-Q100-004

2 Applications

- Drive an indicator LED
- Level-shift Using Open-Drain Outputs

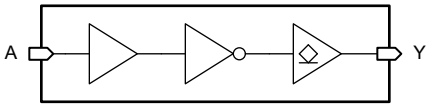
3 Description

The SN74LVC1G06B-Q1 device is a single inverter with open-drain output. The SN74LVC1G06B-Q1 device performs the Boolean function $Y = \overline{A}$ in positive logic.

Package Information

PART NUMBER	PACKAGE(1)	PACKAGE SIZE(2)	BODY SIZE(3)
SN74LVC1G06B-Q1	DTX (X2SON, 5)	1.1mm × 0.85mm	1.1mm × 0.85mm

(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.



Logic Diagram

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4 Pin Configuration and Functions

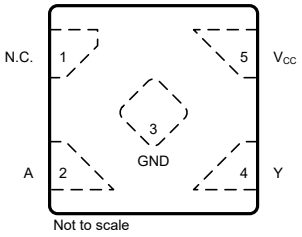


Figure 4-1. DTX Package5-PIN X2SONTop View

Table 4-1. Pin Functions

PIN		TYPE(1)	DESCRIPTION
NAME	NO.		
A	2	I	Input
GND	3	G	Ground
N.C.	1	-	No internal connection
V_{CC}	5	P	Power supply
Y	4	O	Output

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

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5 Specifications

5.1 Absolute Maximum Ratings

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

			MIN	MAX	UNIT
V_{CC}	Supply voltage range		-0.5	6.5	V
V_I	Input voltage range(2)		-0.5	6.5	V
V_O	Output voltage range - High Impedance(2)		-0.5	6.5	V
I_{IK}	Input diode clamp current	V_I < -0.5V		-50	mA
I_{OK}	Output diode clamp current	V_O < -0.5V		-50	mA
I_O	Continuous output current			50	mA
	Continuous current through V_{CC} or GND			±100	mA
T_J	Junction temperature			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 negative voltage ratings may be exceeded if the input and output current ratings are observed.

5.2 ESD Ratings

			VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human body model (HBM), per AEC Q100-002 HBM ESD Classification Level 2(1)	±2000	V
		Charged device model (CDM), per AEC Q100-011 CDM ESD Classification Level C4B	±1000	

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

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5.3 Recommended Operating Conditions

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

Specifications	Description	Condition	MIN	MAX	UNIT
V_{CC}	Supply voltage		1.1	5.5	V
V_I	Input voltage		0	5.5	V
V_O	Output voltage - High Impedance		0	5.5	
I_{OL}(1)	Low-level output current	V_{CC} = 1.2V		1	mA
		V_{CC} = 1.5V		4	
		V_{CC} = 1.8V		6	
		V_{CC} = 2.5V		16	
		V_{CC} = 3.3V		32	
		V_{CC} = 5V		50	
V_{IH}	High-level input voltage	V_{CC} = 1.1V to 1.95V	0.65x V_{CC}		V
		V_{CC} = 2.3V to 2.7V	1.7		
		V_{CC} = 3.0V to 3.6V	2		
		V_{CC} = 4.5V to 5.5V	0.7x V_{CC}		
V_{IL}	Low-Level input voltage	V_{CC} = 1.1V to 1.95V		0.35x V_{CC}	V
		V_{CC} = 2.3V to 2.7V		0.7	
		V_{CC} = 3.0V to 3.6V		0.8	
		V_{CC} = 4.5V to 5.5V		0.3x V_{CC}	
Δt/Δv	Input transition rise or fall rate	V_{CC} = 1.1V to 2.7V		20	ns/V
		V_{CC} = 3.3V ± 0.3V		10	
		V_{CC} = 5V ± 0.5V		5	
T_A	Operating free-air temperature		-40	125	°C

(1) Recommended maximum output current for continuous operation; see *Electrical Characteristics* for test current values to maintain V_{OH} and V_{OL} specifications. Operating with average output current greater than 32mA may impact device reliability and shorten the device lifetime.

5.4 Thermal Information

PACKAGE	PINS	THERMAL METRIC(1)						UNIT
		$R_{\theta JA}$	$R_{\theta JC(top)}$	$R_{\theta JB}$	Ψ_{JT}	Ψ_{JB}	$R_{\theta JC(bot)}$	
DTX (X2SON, 5)	5	393.6	103.2	331.8	69.8	331.9	179.9	°C/W

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

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5.5 Electrical Characteristics

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

PARAMETER	TEST CONDITIONS	V_{CC}	-40°C to 125°C			UNIT
			MIN	TYP	MAX	
V_{OL}	I_{OL}= 100µA	1.1V to 5.5V			0.2	V
	I_{OL}= 4mA	1.65V			0.45	
	I_{OL}= 8mA	2.3V			0.3	
	I_{OL}= 12mA	2.7V			0.4	
	I_{OL}= 16mA	3V			0.4	
	I_{OL}= 24mA	3V			0.55	
	I_{OL}= 32mA	4.5V			0.55	
I_I	V_I = V_{CC} or GND	V_{CC} = 0V to 5.5V		±0.01	±5	µA
I_{OFF}	V_I or V_O = V_{CC}	V_{CC} = 0V		±0.1	±10	µA
I_{OZ}	V_O = V_{CC} or GND	5.5V		±0.1	±15	µA
I_{CC}	V_I = V_{CC} or GND, I_O = 0	V_{CC} = 1.1V to 5.5V		0.01	10	µA
ΔI_{CC}	One input at V_{CC} - 0.6V, other inputs at V_{CC} or GND	3.0V to 5.5V			500	µA
C_I	V_I = V_{CC} or GND	3.3V		3.5		pF
C_O	V_O = V_{CC} or GND	3.3V		6.3		pF

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5.6 Switching Characteristics

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	V_{CC}	-40°C to 125°C			UNIT
					MIN	TYP	MAX	
t_{pd}	A	Y	C_L = 15pF	1.2V ± 0.1V			28.7	ns
				1.5V ± 0.12V			6.8	
				1.8V ± 0.15V			4.8	
				2.5V ± 0.2V			3.1	
				3.3V ± 0.3V			2.4	
				5.0V ± 0.5V			2	
			C_L = 30pF	1.8V ± 0.15V			5.9	
				2.5V ± 0.2V			3.8	
			C_L = 50pF	3.3V ± 0.3V			3.5	
				5.0V ± 0.5V			2.6	
C_{pd}			f = 10MHz	1.8V		2		pF
				2.5V		2		
				3.3V		2		
				5.0V		3		

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5.7 Typical Characteristics

T_A = 25°C (unless otherwise noted)

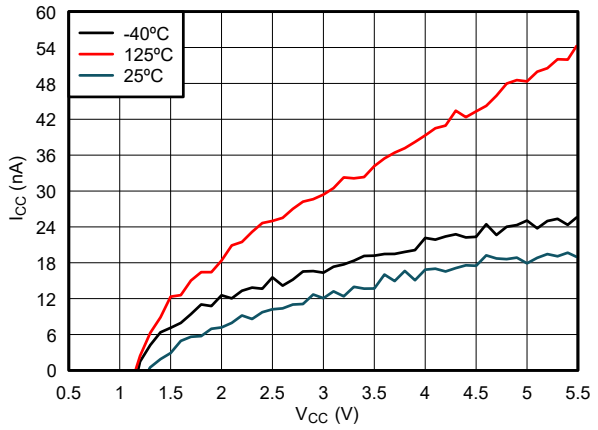


Figure 5-1. Supply Current Across Supply Voltage and Temperature

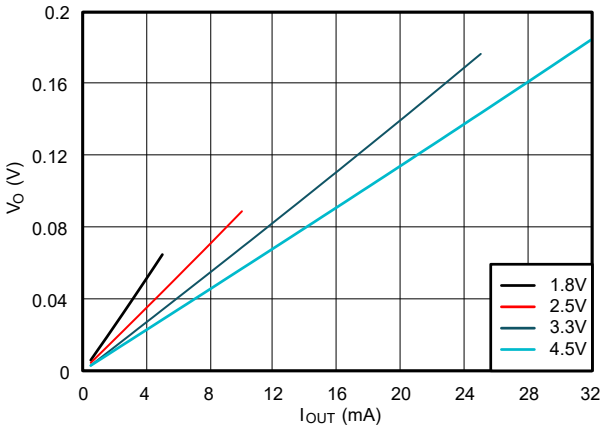


Figure 5-2. Output Voltage vs Current in LOW State

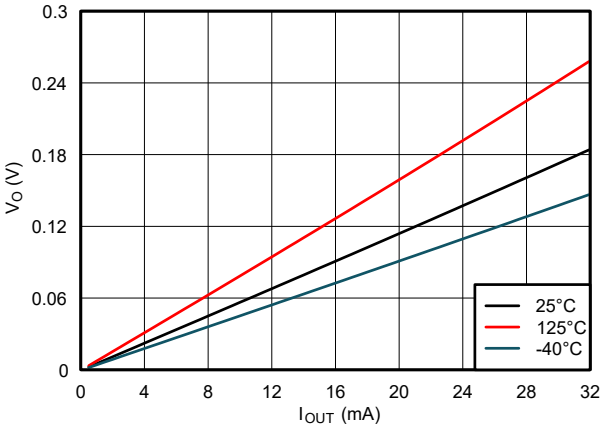


Figure 5-3. Output Voltage vs Current in LOW State; 4.5V Supply

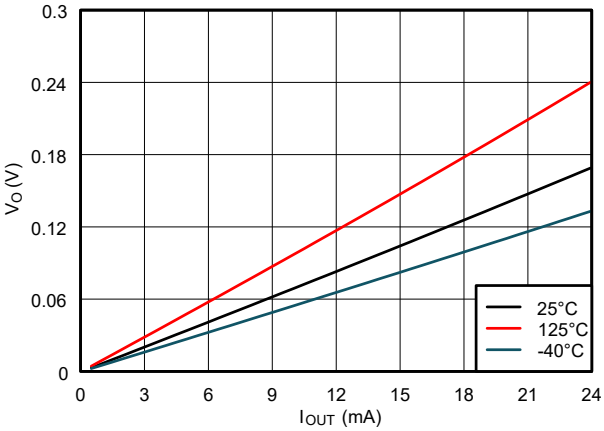


Figure 5-4. Output Voltage vs Current in LOW State; 3.3V Supply

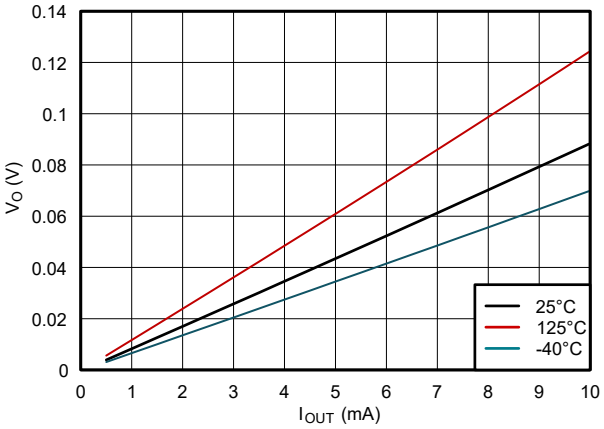


Figure 5-5. Output Voltage vs Current in LOW State; 2.5V Supply

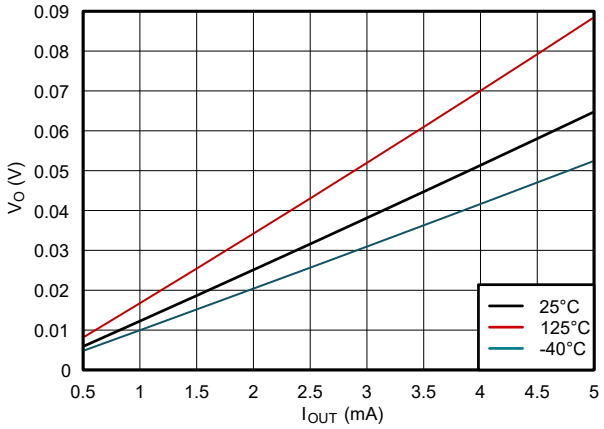


Figure 5-6. Output Voltage vs Current in LOW State; 1.8V Supply

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6 Parameter Measurement Information

Phase relationships between waveforms are chosen arbitrarily for the examples listed in the following table. Generators with the following characteristics supply all input pulses : PRR ≤ 1MHz, Z_O = 50Ω, t_t ≤ 2.5ns.

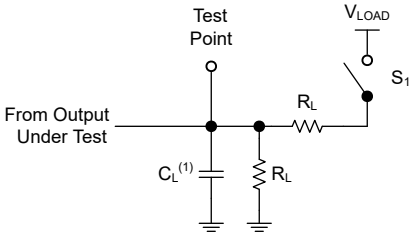
The outputs are measured individually with one input transition per measurement.

Table 6-1. Open-Drain Outputs

TEST	S1
t_{PLZ}, t_{PZL}	CLOSED

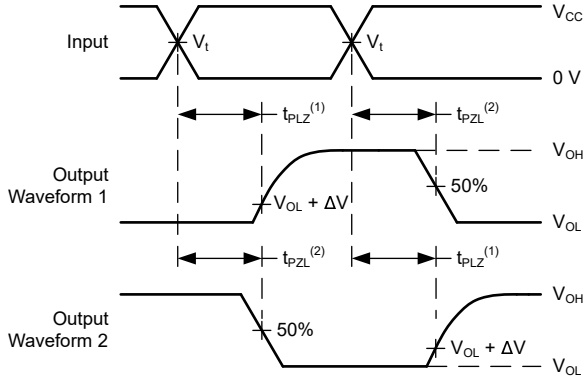
Table 6-2. 3-State or Open-Drain Outputs

V_{CC}	V_t	R_L	C_L	ΔV	V_{LOAD}
1.2V ± 0.1V	$V_{CC}/2$	2kΩ	15pF	0.1V	$2×V_{CC}$
1.5V ± 0.12V	$V_{CC}/2$	2kΩ	15pF	0.1V	$2×V_{CC}$
1.8V ± 0.15V	$V_{CC}/2$	1kΩ	15pF/30pF	0.15V	$2×V_{CC}$
2.5V ± 0.2V	$V_{CC}/2$	500Ω	15pF/30pF	0.15V	$2×V_{CC}$
3.3V ± 0.3V	1.5V	500Ω	15pF/50pF	0.3V	6V
5.0V ± 0.5V	1.5V	500Ω	15pF/50pF	0.3V	6V



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

Figure 6-1. Load Circuit for Open-Drain Outputs



(1) t_{PLZ} is the same as t_{dis}.
(2) t_{PZL} is the same as t_{en}.

Figure 6-2. Voltage Waveforms Propagation Delays

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7 Detailed Description

7.1 Overview

The SN74LVC1G06B-Q1 device contains one open-drain inverter.

7.2 Functional Block Diagram

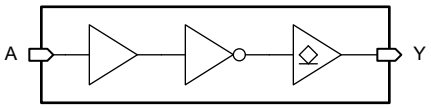


Figure 7-1. Logic Diagram (Positive Logic)

7.3 Feature Description

7.3.1 Open-Drain CMOS Outputs

Open-drain outputs are included in SN74LVC1G06B-Q1. Open-drain outputs can only drive the output low. When in the high logical state, outputs are in a high-impedance state, meaning outputs 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 SN74LVC1G06B-Q1 and is dependent on external factors.

Because of the high-impedance state, an external pull-up resistor is required to define a logic high. Without a pull-up resistor, the output floats and has an undefined logic level. The resistor value depends on factors like parasitic capacitance and power consumption; typically, a 10kΩ resistor is suitable.

The drive capability of SN74LVC1G06B-Q1 can create fast edges into light loads, so consider routing and load conditions to prevent ringing. Additionally, outputs can drive higher currents than SN74LVC1G06B-Q1 is designed to handle continuously. Limit the device output power to avoid damage due to overcurrent. Follow the electrical and thermal limits defined in the *Absolute Maximum Ratings* at all times. See the *Recommended Operating Conditions* table for the maximum output voltage that can be externally connected to SN74LVC1G06B-Q1.

Leave unused open-drain CMOS outputs disconnected.

7.3.2 Partial Power Down (I_{off})

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

7.3.3 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 ÷ 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 results in excessive power consumption and can cause oscillations. See more details in *Implications of Slow or Floating CMOS Inputs*.

Do not leave standard CMOS inputs floating at any time during operation. Terminate unused inputs at V_{CC} or GND. If a system does not always drive an input, consider adding a pull-up or pull-down resistor to provide a valid input voltage. The resistor value depends on multiple factors; a 10kΩ resistor, however, is recommended and typically meets all requirements.

7.3.4 Clamp Diode Structure

Figure 7-2 shows the inputs and outputs to this device have negative clamping diodes only.

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CAUTION

Voltages beyond the values specified in the *Absolute Maximum Ratings* table can cause damage to the device. The input and output voltage ratings can be exceeded if the input and output clamp-current ratings are observed.

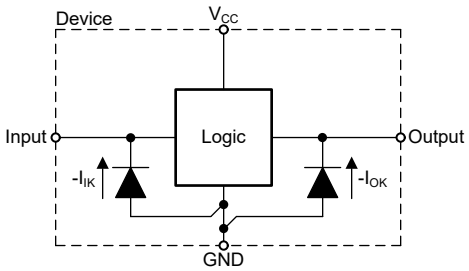


Figure 7-2. Electrical Placement of Clamping Diodes for Each Input and Output

7.3.5 Over-Voltage Tolerant Inputs

The SN74LVC1G06B-Q1 includes over-voltage tolerant inputs. The input pins support high-state input voltages larger than the supply voltage by utilizing an input protection circuit that does not include a standard positive clamp diode. See *Recommended Operating Conditions* for the recommended input voltage.

CAUTION

Do not exceed the maximum input voltage range provided in *Absolute Maximum Ratings*. Exceeding the maximum input voltage range rating can cause immediate and permanent damage to the device.

7.4 Device Functional Modes

Function Table lists the functional modes of the SN74LVC1G06B-Q1.

Table 7-1. Function Table

INPUT A(1)	OUTPUT Y(2)
L	Z
H	L

(1) H = High voltage level, L = Low voltage level
(2) L = Driving low, 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 SN74LVC1G06B-Q1 can be used in an LED application. Figure 8-1 shows a simple LED driver application.

8.2 Typical Application

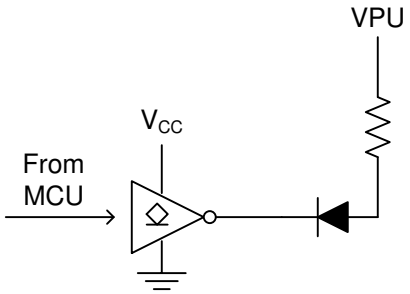


Figure 8-1. Typical Application Diagram

8.2.1 Design Requirements

8.2.1.1 Power Considerations

Verify that the desired supply voltage is within the range specified in the *Electrical Characteristics*. The supply voltage sets the device electrical characteristics, as described in the *Electrical Characteristics* section.

The positive voltage supply must be capable of sourcing current equal to the maximum static supply current, I_{CC}, listed in the *Electrical Characteristics*, and any transient current required for switching.

The ground must be capable of sinking current equal to the total current to be sunk by all outputs of the SN74LVC1G06B-Q1 plus the maximum supply current, I_{CC}, listed in the *Electrical Characteristics*, and any transient current required for switching. The logic device can only sink as much current that can be sunk into the ground connection. Verify that the maximum total current through GND listed in the *Absolute Maximum Ratings* is not exceeded.

The SN74LVC1G06B-Q1 can drive a load with a total capacitance less than or equal to 50pF while still meeting all of the datasheet specifications. Larger capacitive loads can be applied; however, TI recommends adding a series resistor between the output and capacitor to prevent excessive current.

The SN74LVC1G06B-Q1 can drive a load with total resistance described by $R_L \geq V_O / I_O$, with the output voltage and current defined in the *Electrical Characteristics* table with V_{OL}. When outputting in the HIGH state, the output voltage in the equation is defined as the difference between the measured output voltage and the supply voltage at the V_{CC} pin.

Total power consumption can be calculated using the information provided in the *CMOS Power Consumption and Cpd Calculation application note*.

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

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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 $V_{IL(max)}$ 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 the inputs can be connected with a pullup or pulldown resistor if the input is used sometimes, but not always. A pullup resistor is used for a default state of HIGH, and a pulldown resistor is used for a default state of LOW. The drive current of the controller, leakage current into the SN74LVC1G06B-Q1 (as specified in the *Electrical Characteristics*), and the desired input transition rate limits the resistor size. A 10kΩ resistor value is often used due to these factors.

The SN74LVC1G06B-Q1 has CMOS inputs and thus requires fast input transitions to operate correctly, as defined in the Electrical Characteristics table. Slow input transitions can cause oscillations, additional power consumption, and reduction in device reliability.

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

8.2.1.3 Output Considerations

The ground voltage is used to produce the output LOW voltage. Sinking current into the output increases the output voltage as specified by the V_{OL} specification in the *Electrical Characteristics*.

Open-drain outputs can be connected together directly to produce a wired-AND configuration or 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.

8.2.1.4 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. Verify that the capacitive load at the output is ≤ 50pF. Low load capacitance can be accomplished by providing short, appropriately sized traces from the SN74LVC1G06B-Q1 to the receiving device.
3. Verify that the resistive load at the output is larger than (V_{CC} / $I_{O(max)}$)Ω. Never violate the maximum output current from the *Absolute Maximum Ratings*. 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; however, the power consumption and thermal increase can be calculated using the steps provided in the *CMOS Power Consumption and Cpd Calculation application note*.

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8.2.2 Application Curves

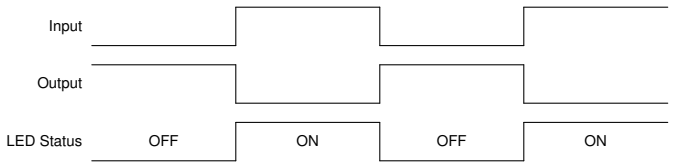


Figure 8-2. Application Curve

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 must have a good bypass capacitor to prevent power disturbance.

A 0.1µF capacitor is recommended for this device. A design can use multiple bypass capacitors in parallel to reject different frequencies of noise. The 0.1µF and 1µF capacitors are commonly used in parallel. The bypass capacitor must be installed as close to the power terminal as possible for best results.

8.4 Layout

8.4.1 Layout Guidelines

- Bypass capacitor placement
  - Place near the positive supply terminal of the device
  - Provide an electrically short ground return path
  - Use wide traces to minimize impedance
  - Keep the device, capacitors, and traces on the same side of the board whenever possible
- Signal trace geometry
  - 8mil to 12mil trace width
  - Lengths less than 12cm to minimize transmission line effects
  - Avoid 90° corners for signal traces
  - Use an unbroken ground plane below signal traces
  - Flood fill areas around signal traces with ground
  - Parallel traces must be separated by at least 3x dielectric thickness
  - For traces longer than 12cm
    - Use impedance controlled traces
    - Source-terminate using a series damping resistor near the output
    - Avoid branches; buffer each signal that must branch separately

8.4.2 Layout Example

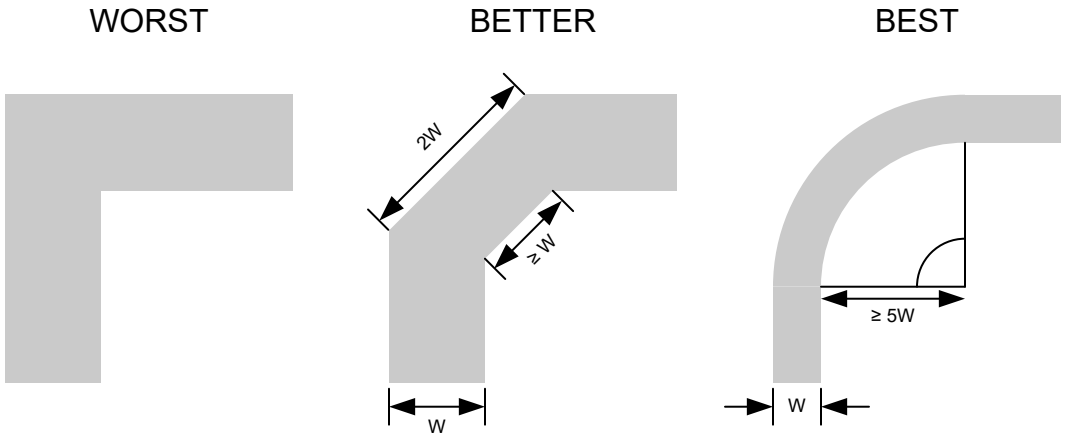


Figure 8-3. Example Trace Corners for Improved Signal Integrity

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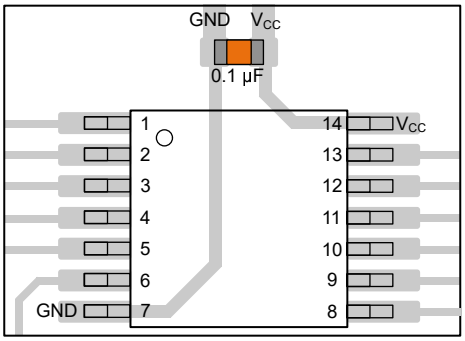


Figure 8-4. Example Bypass Capacitor Placement for TSSOP and Similar Packages

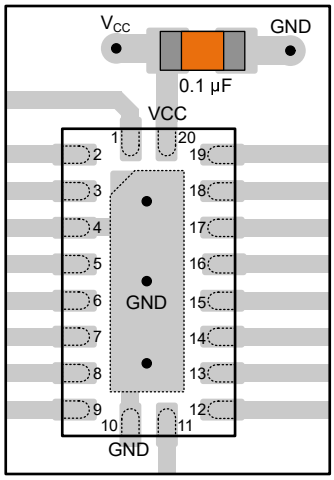


Figure 8-5. Example Bypass Capacitor Placement for WQFN and Similar Packages

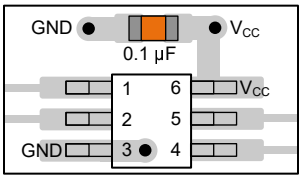


Figure 8-6. Example Bypass Capacitor Placement for SOT, SC70 and Similar Packages

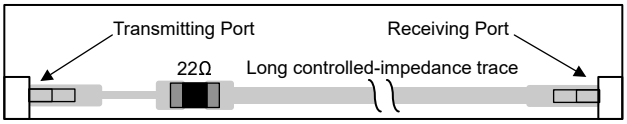


Figure 8-7. Example Damping Resistor Placement for Improved Signal Integrity

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, *CMOS Power Consumption and C_{pd} Calculation* application note
- Texas Instruments, *Designing With Logic* application note
- Texas Instruments, *Implications of Slow or Floating CMOS Inputs* application brief
- Texas Instruments, *Logic in Live-Insertion Applications With a Focus on GTLP* application note
- Texas Instruments, *Semiconductor and IC Package Thermal Metrics* application note
- Texas Instruments, *Texas Instruments General Quality Guidelines*
- Texas Instruments, *Thermal Characteristics of SLL Packages and Devices* application note
- Texas Instruments, *Understanding Schmitt Triggers* application brief

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.

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.

9.4 Trademarks

TI E2E™ is a trademark of Texas Instruments.
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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.

DATE	REVISION	NOTES
September 2026	*	Initial Release

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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.

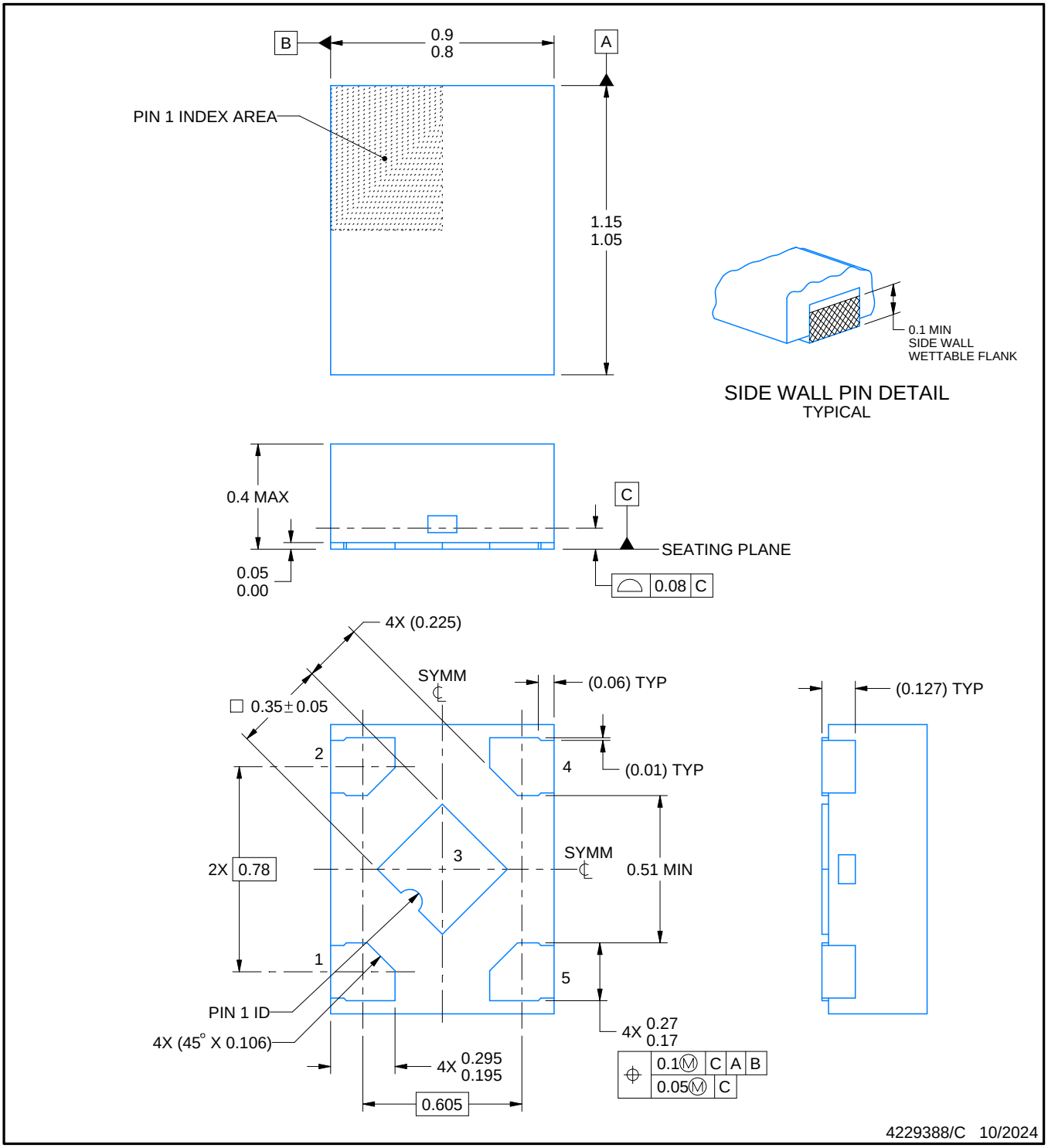
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PACKAGE OUTLINE

DTX0005A

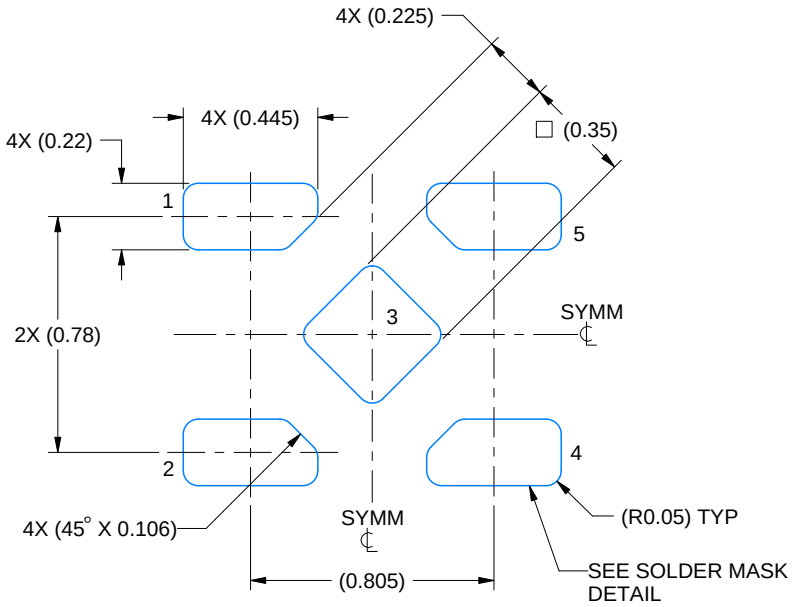
X2SON - 0.4 mm max height

PLASTIC SMALL OUTLINE - NO LEAD

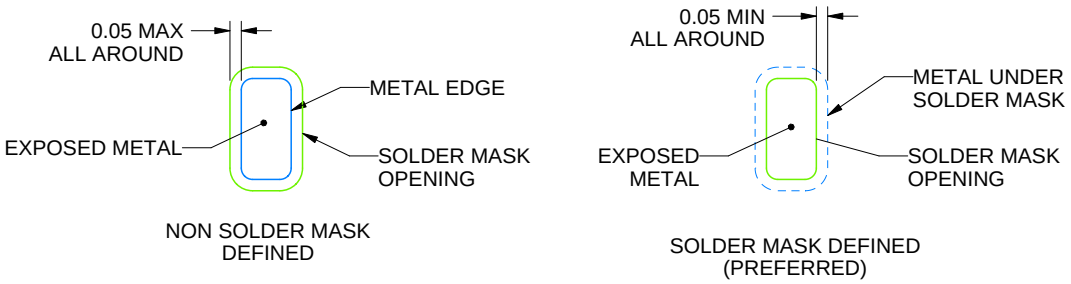


NOTES:

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



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE: 40X

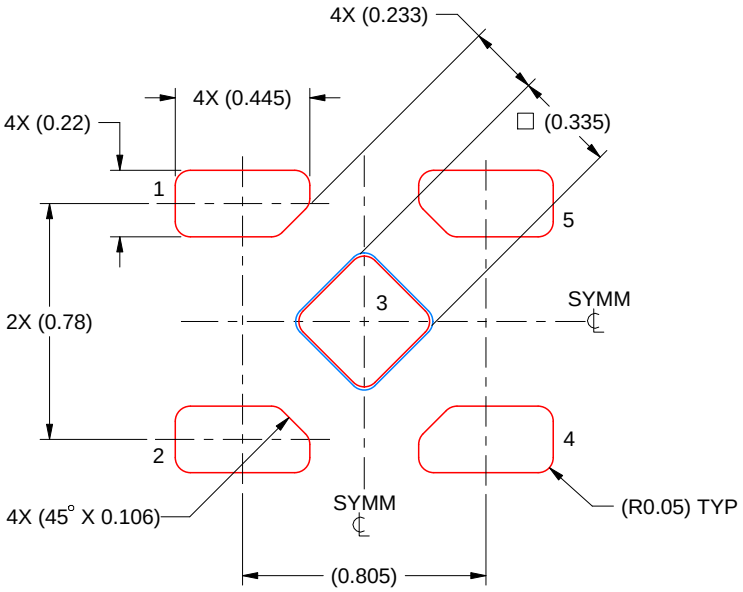


SOLDER MASK DETAILS

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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).



SOLDER PASTE EXAMPLE
BASED ON 0.1 mm THICK STENCIL
SCALE: 40X

PRINTED SOLDER PASTE COVERAGE BY AREA UNDER PACKAGE
PAD 5: 92%

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NOTES: (continued)

5. 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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