SN74CBTLV1G125-Q1 low-voltage single FET bus switch

1 Features

- AEC-Q100 Qualified for Automotive Applications
  - Device Temperature Grade 1: –40°C to +125°C, T_A
- 5-Ω Switch Connection Between Two Ports
- Rail-to-Rail Switching on Data I/O Ports
- I_{off} Supports Partial-Power-Down Mode Operation

2 Applications

- Ventilator

3 Description

The SN74CBTLV1G125 features a single high-speed line switch. The switch is disabled when the output-enable ($\overline{OE}$) input is high.

This device is fully specified for partial-power-down applications using I_{off}. The I_{off} feature ensures that damaging current will not backflow through the device when it is powered down. The device has isolation during power off.

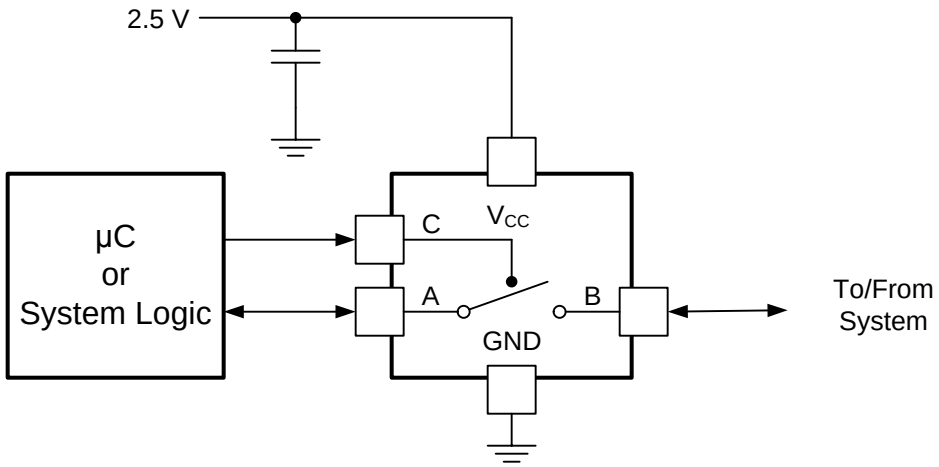
To ensure the high-impedance state during power up or power down, $\overline{OE}$ should be tied to V_{CC} through a pullup resistor; the minimum value of the resistor is determined by the current-sinking capability of the driver.

Device Information[1]

ORDER NUMBER	PACKAGE	BODY SIZE
SN74CBTLV1G125-Q1	SOT-23 (DBV) (5)	2.90 mm × 1.60 mm

(1) For all available packages, see the orderable addendum at the end of the datasheet.

Application Schematic



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4 Revision History

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

Changes from Revision A (December 2018) to Revision B **Page**

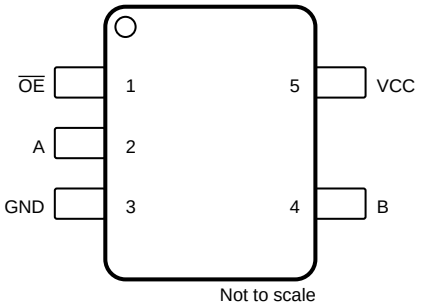
- Changed *Feature* From: Qualified for Automotive Applications To: AEC-Q100 Qualified for Automotive Applications ... 1
- Changed the *ESD Ratings* table notes ... 4
- Changed the T_A MAX value From: 85°C To 125°C in the *Recommended Operating Conditions* ... 4

Changes from Original (August 2009) to Revision A **Page**

- Added *Application* list, *Device Information* table, *ESD Ratings* table, *Feature Description* section, *Device Functional Modes*, *Application and Implementation* section, *Power Supply Recommendations* section, *Layout section, Device and Documentation Support* section, and *Mechanical, Packaging, and Orderable Information* section ... 1

5 Pin Configuration and Functions

DBV Package
SOT-23 (5-Pin)
Top View



Not to scale

Pin Functions

PIN		I/O	DESCRIPTION
NAME	NO.		
$\overline{OE}$	1	I	Active low enable
A	2	I/O	Switch I/O
GND	3	-	Ground
B	4	I/O	Switch I/O
V_{CC}	5	-	Power Supply

6 Specifications

6.1 Absolute Maximum Ratings

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

			MIN	MAX	UNIT
V_{CC}	Supply voltage range		–0.5	4.6	V
V_I	Input voltage range(2)		–0.5	4.6	V
	Continuous channel current			128	mA
I_{IK}	Input clamp current	$V_{I/O} < 0$		–50	mA
T_{stg}	Storage temperature range		–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 clamp-current ratings are observed.

6.2 ESD Ratings

			VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human-body model (HBM), per AEC Q100-002(1) HBM ESD Classification Level 2	±2000	V
		Charged-device model (CDM), per AEC Q100-011 CDM ESD Classification Level C5	±1000	

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

6.3 Recommended Operating Conditions

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

			MIN	MAX	UNIT
V_{CC}	Supply voltage		2.3	3.6	V
V_{IH}	High-level control input voltage	V_{CC} = 2.3 V to 2.7 V	1.7		V
		V_{CC} = 2.7 V to 3.6 V	2		
V_{IL}	Low-level control input voltage	V_{CC} = 2.3 V to 2.7 V		0.7	V
		V_{CC} = 2.7 V to 3.6 V		0.8	
T_A	Operating free-air temperature		–40	125	°C

(1) All unused control 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*, literature number SCBA004.

6.4 Thermal Information

THERMAL METRIC(1)		SN74CBTLV1G125-Q1 SOT-23 (DBV) 5 PINS	UNIT
$R_{\theta JA}$	Junction-to-ambient thermal resistance	249.2	°C/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	174.2	°C/W
$R_{\theta JB}$	Junction-to-board thermal resistance	83.9	°C/W
ψ_{JT}	Junction-to-top characterization parameter	67.3	°C/W
ψ_{JB}	Junction-to-board characterization parameter	83.5	°C/W
$R_{\theta JC(bot)}$	Junction-to-case (bottom) thermal resistance	n/a	°C/W

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

6.5 Electrical Characteristics

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

PARAMETER		TEST CONDITIONS			MIN	TYP(1)	MAX	UNIT
V_{IK}		V_{CC} = 3 V, I_I = –18 mA					–1.2	V
I_I		V_{CC} = 3.6 V, V_I = V_{CC} or GND					±1	µA
I_{off}		V_{CC} = 0, V_I or V_O = 0 to 3.6 V, $\overline{OE}$ = 3.6 V					15	µA
		V_{CC} = 0, V_I or V_O = 0 to 3.6 V, $\overline{OE}$ = 0 V					100	
I_{CC}		V_{CC} = 3.6 V, V_I = V_{CC} or GND					10	µA
ΔI_{CC} (2)	Control inputs	V_{CC} = 3.6 V, One input at 3 V, Other inputs at V_{CC} or GND					300	µA
C_i	Control inputs	V_I = 3 V or 0				2.5		pF
$C_{io(OFF)}$		V_O = 3 V or 0, $\overline{OE}$ = V_{CC}				7		pF
r_{on} (3)		V_{CC} = 2.3 V, TYP at V_{CC} = 2.5 V	V_I = 0	I_I = 32 mA		7	10	Ω
				I_I = 24 mA		7	10	
			V_I = 1.7 V,	I_I = 15 mA		15	25	
		V_{CC} = 3 V	V_I = 0	I_I = 32 mA		5	7	
				I_I = 24 mA		5	7	
			V_I = 2.4 V,	I_I = 15 mA		10	15	

(1) All typical values are at V_{CC} = 3.3 V (unless otherwise noted), T_A = 25°C.
(2) This is the increase in supply current for each input that is at the specified TTL voltage level, rather than V_{CC} or GND.
(3) Measured by the voltage drop between A and B terminals at the indicated current through the switch. On-state resistance is determined by the lower of the voltages of the two (A or B) terminals.

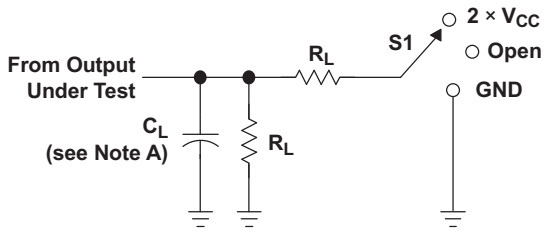
6.6 Switching Characteristics

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

PARAMETER	FROM (INPUT)	TO (OUTPUT)	V_{CC} = 2.5 V ± 0.2 V		V_{CC} = 3.3 V ± 0.3 V		UNIT
			MIN	MAX	MIN	MAX	
t_{pd} (1)	A or B	B or A		0.15		0.25	ns
t_{en}	$\overline{OE}$	A or B	0.5	8	0.5	7.5	ns
t_{dis}	$\overline{OE}$	A or B	0.5	8	0.5	7.5	ns

(1) The propagation delay is the calculated RC time constant of the typical on-state resistance of the switch and the specified load capacitance of 50 pF, when driven by an ideal voltage source (zero output impedance).

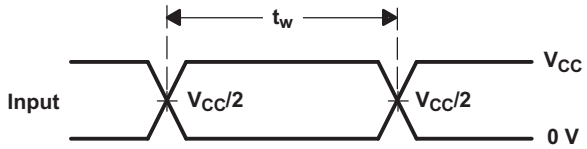
7 Parameter Measurement Information



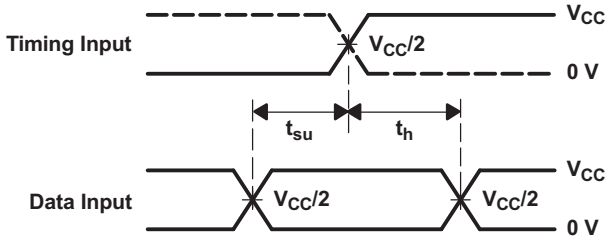
LOAD CIRCUIT

TEST	S1
t_{PLH}/t_{PHL} t_{PLZ}/t_{PZL} t_{PHZ}/t_{PZH}	Open 2 × V_{CC} GND

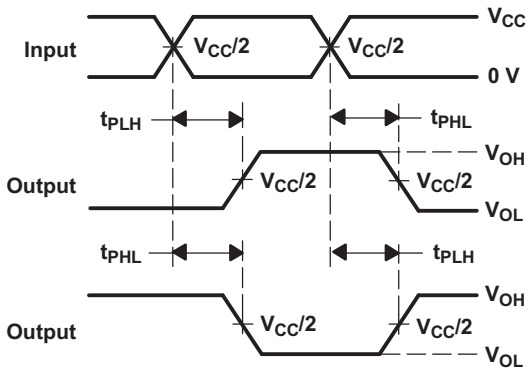
V_{CC}	C_L	R_L	V_D
2.5 V ±0.2 V	30 pF	500 Ω	0.15 V
3.3 V ±0.3 V	50 pF	500 Ω	0.3 V



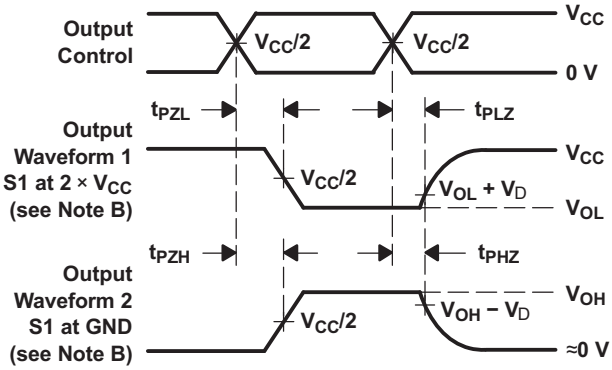
VOLTAGE WAVEFORMS
PULSE DURATION



VOLTAGE WAVEFORMS
SETUP AND HOLD TIMES



VOLTAGE WAVEFORMS
PROPAGATION DELAY TIMES
INVERTING AND NONINVERTING OUTPUTS



VOLTAGE WAVEFORMS
ENABLE AND DISABLE TIMES
LOW- AND HIGH-LEVEL ENABLING

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 ≤ 10 MHz, Z_O = 50 Ω, t_r ≤ 2 ns, t_f ≤ 2 ns.

D. The outputs are measured one at a time, with one 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_{PLH} and t_{PHL} are the same as t_{pd}.

H. All parameters and waveforms are not applicable to all devices.

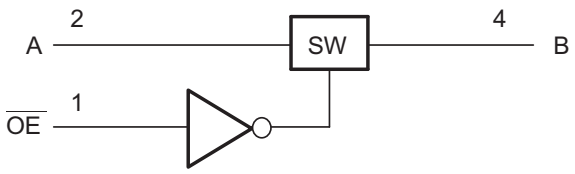
Figure 1. Load Circuit and Voltage Waveforms

8 Detailed Description

8.1 Overview

The SN74CBTLV1G125 device is a 1-channel 1:1 high-speed FET switch. The low ON-state resistance of the switch allows connections to be made with minimal propagation delay. The ($\overline{OE}$) pin is an active low logic control pin that controls the data flow. The FET is disabled when the output-enable ($\overline{OE}$) input is high. This device is fully specified for partial-power-down applications using I_{off}. The I_{off} feature ensures that damaging current will not backflow through the device when it is powered down. The device has isolation during power off. To ensure the high-impedance state during power up or power down, OE should be tied to VCC through a pullup resistor; the minimum value of the resistor is determined by the current-sinking capability of the driver.

8.2 Functional Block Diagram



8.3 Feature Description

The SN74CBTLV1G125 features 5-Ω switch connection between ports, allowing for low signal loss across the switch. Rail-to-rail switching on data I/O allows for full voltage swing outputs. I_{off} supports partial-power-down mode operation, protecting the chip from voltages at output ports when it is not powered on.

8.4 Device Functional Modes

Table 1 shows the functional modes of SN74CBTLV1G125.

Table 1. Function Table

INPUT $\overline{OE}$	FUNCTION
L	A port = B port
H	Disconnect

9 Application and Implementation

NOTE

Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

9.1 Application Information

The SN74CBTLV1G125 can be used to switch a signal path. The switch is bidirectional, so the A and B pins can be used as either inputs or outputs. This switch is typically used when there is one signal path that needs to be isolated at certain times.

9.2 Typical Application

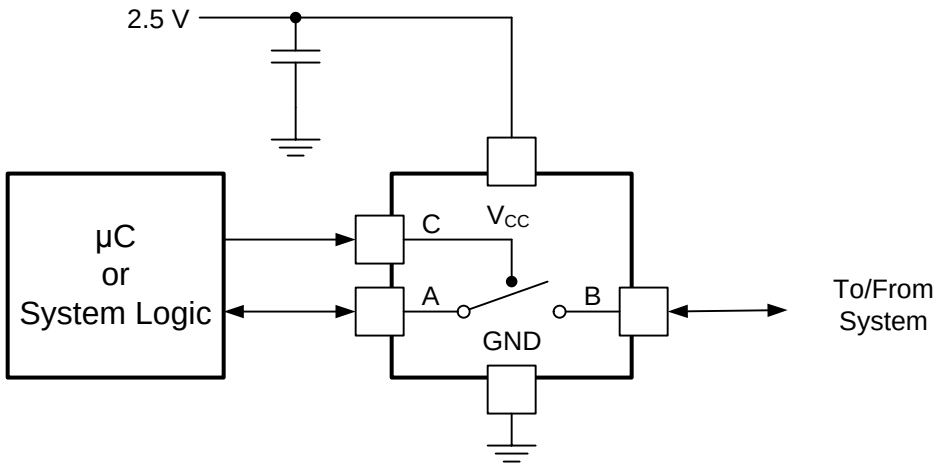


Figure 2. Typical Application

9.2.1 Design Requirements

The SN74CBTLV1G125 device can be properly operated without any external components. TI recommends pulling up the digital control pin (OE) to VCC or pulling down to GND to avoid undesired switch positions that could result from the floating pin. A floating digital pin could cause excess current consumption refer to Implications of Slow or Floating CMOS Inputs.

9.2.2 Detailed Design Procedure

When $\overline{OE}$ is high, the active bus. This means that there is a low impedance path between the A and B pins. The 0.1-µF capacitor on VCC is a decoupling capacitor and should be placed as close as possible to the device.

10 Power Supply Recommendations

The power supply can be any voltage between the minimum and maximum supply voltage rating listed in the Recommended Operating Conditions table. Each VCC terminal should have a good bypass capacitor to prevent power disturbance. For devices with a single supply, a 0.1-μF bypass capacitor is recommended. If multiple pins are labeled VCC, then a 0.01-μF or 0.022-μF capacitor is recommended for each VCC because the VCC pins are tied together internally. For devices with dual supply pins operating at different voltages, for example VCC and VDD, a 0.1-μF bypass capacitor is recommended for each supply pin. To reject different frequencies of noise, use multiple bypass capacitors in parallel. Capacitors with values of 0.1 μF and 1 μF are commonly used in parallel. The bypass capacitor should be installed as close to the power terminal as possible for best results.

11 Layout

11.1 Layout Guidelines

Reflections and matching are closely related to the loop antenna theory but are different enough to be discussed separately from the theory. When a PCB trace turns a corner at a 90° angle, a reflection can occur. A reflection occurs primarily because of the change of width of the trace. At the apex of the turn, the trace width increases to 1.414 times the width. This increase upsets the transmission-line characteristics, especially the distributed capacitance and self–inductance of the trace which results in the reflection. Not all PCB traces can be straight, and therefore; some traces must turn corners. Figure 3 shows progressively better techniques of rounding corners. Only the last example (BEST) maintains constant trace width and minimizes reflections.

11.2 Layout Example

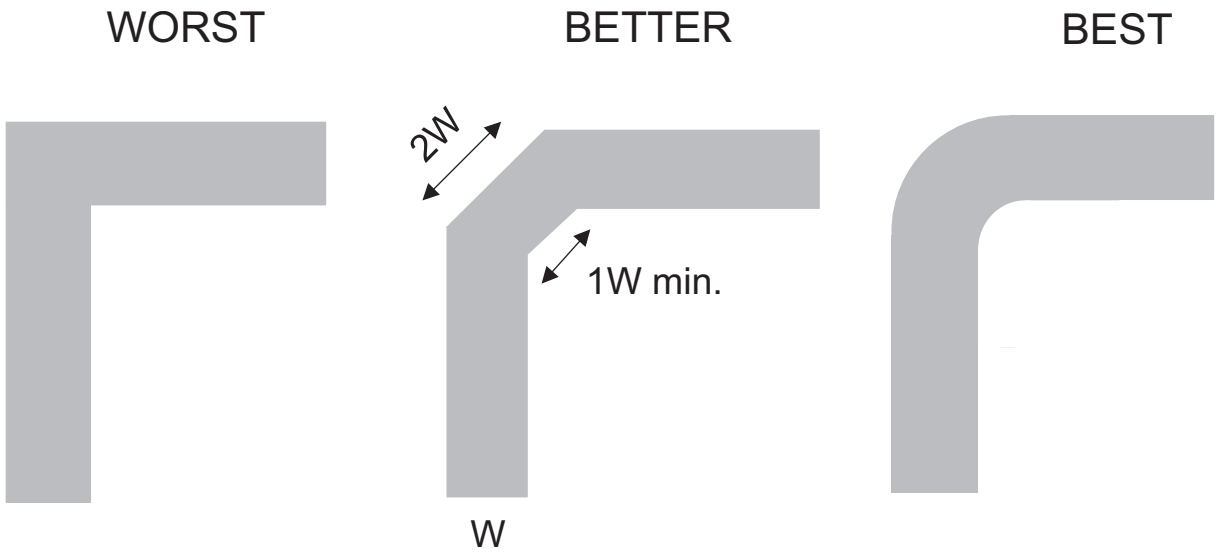


Figure 3. Example Layout

12 Device and Documentation Support

12.1 Device Support

12.2 Receiving Notification of Documentation Updates

To receive notification of documentation updates, navigate to the device product folder on ti.com. In the upper right corner, click on *Alert me* to register and receive a weekly digest of any product information that has changed. For change details, review the revision history included in any revised document.

12.3 Community Resources

The following links connect to TI community resources. Linked contents are 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.

TI E2E™ Online Community ***TI's Engineer-to-Engineer (E2E) Community.*** Created to foster collaboration among engineers. At e2e.ti.com, you can ask questions, share knowledge, explore ideas and help solve problems with fellow engineers.

Design Support ***TI's Design Support*** Quickly find helpful E2E forums along with design support tools and contact information for technical support.

12.4 Trademarks

E2E is a trademark of Texas Instruments.

12.5 Electrostatic Discharge Caution

This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

12.6 Glossary

SLYZ022 — *TI Glossary*.

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

13 Mechanical, Packaging, and Orderable Information

The following pages include mechanical, packaging, and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the left-hand navigation.

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
74CBTLV1G125DBVRQ1	ACTIVE	SOT-23	DBV	5	3000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	VCTO	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 <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm 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.

OTHER QUALIFIED VERSIONS OF SN74CBTLV1G125-Q1 :

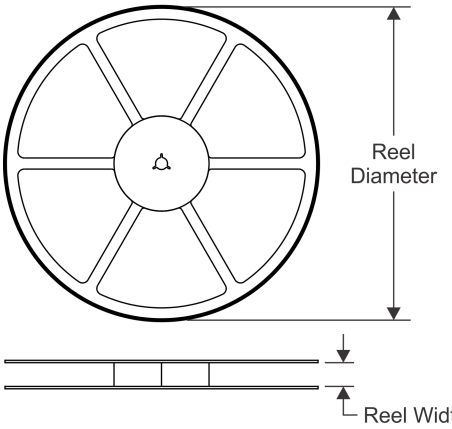
- Catalog: SN74CBTLV1G125

NOTE: Qualified Version Definitions:

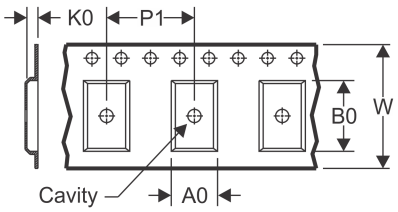
- Catalog - TI's standard catalog product

TAPE AND REEL INFORMATION

REEL DIMENSIONS

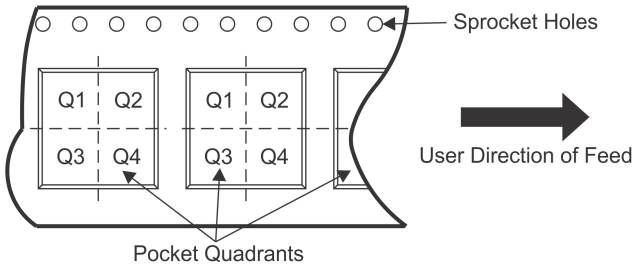


TAPE DIMENSIONS



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

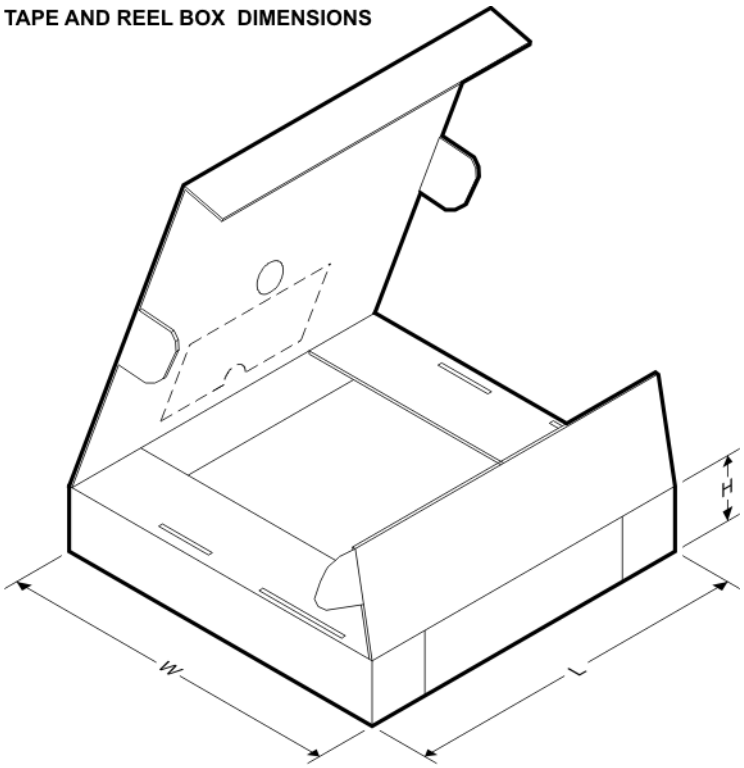
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
74CBTLV1G125DBVRQ1	SOT-23	DBV	5	3000	179.0	8.4	3.2	3.2	1.4	4.0	8.0	Q3

TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

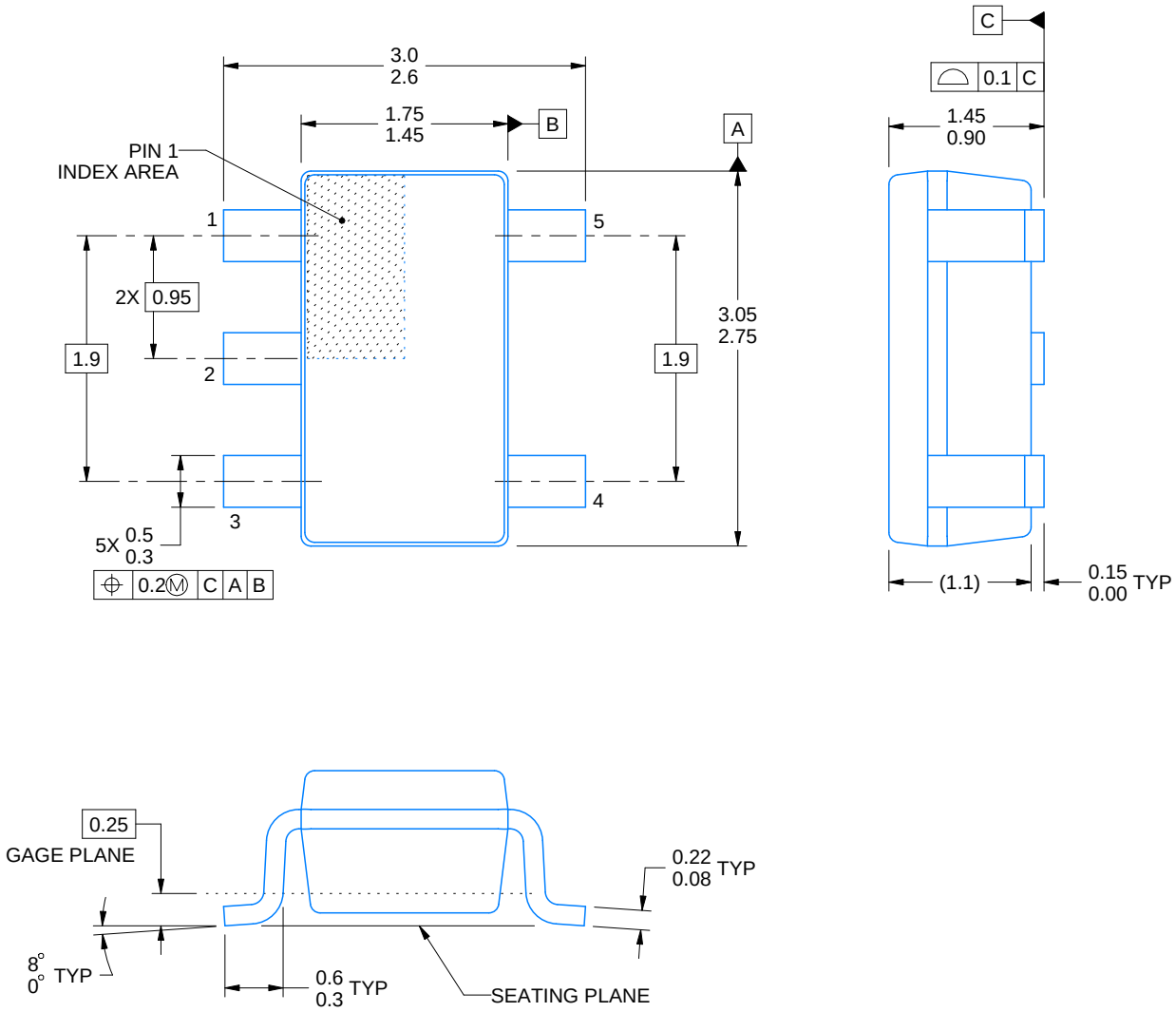
Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
74CBTLV1G125DBVRQ1	SOT-23	DBV	5	3000	200.0	183.0	25.0

PACKAGE OUTLINE

DBV0005A

SOT-23 - 1.45 mm max height

SMALL OUTLINE TRANSISTOR



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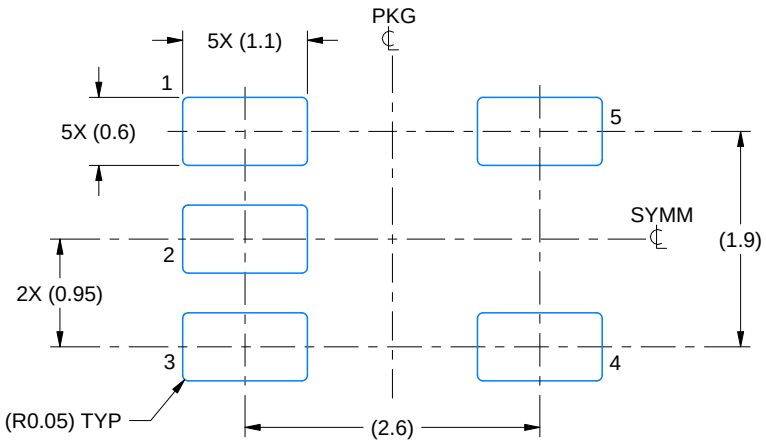
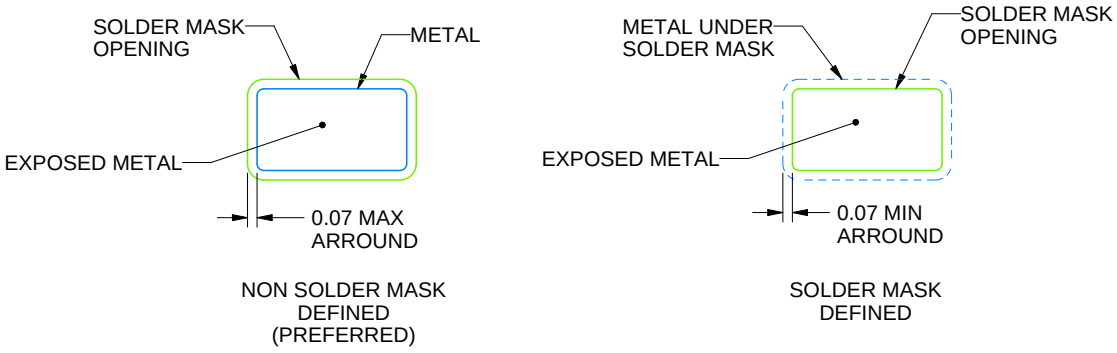
NOTES:

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. Refernce JEDEC MO-178.
4. Body dimensions do not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.25 mm per side.



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:15X



SOLDER MASK DETAILS

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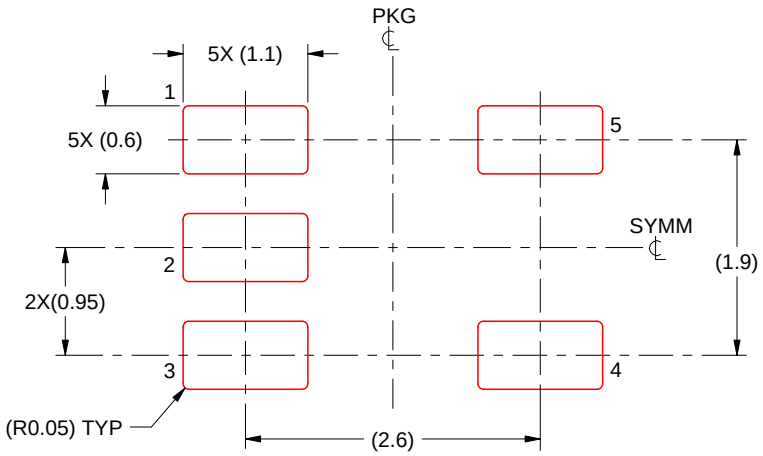
NOTES: (continued)

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



SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE:15X

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NOTES: (continued)

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

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