

FEATURES

- Member of the Texas Instruments Widebus™ Family
- Operates From 1.65 V to 3.6 V
- Max t_{pd} of 4.8 ns at 3.3 V
- ± 24 -mA Output Drive at 3.3 V
- B-Port Outputs Have Equivalent 26- Ω Series Resistors, So No External Resistors Are Required
- Bus Hold on Data Inputs Eliminates the Need for External Pullup/Pulldown Resistors
- Latch-Up Performance Exceeds 250 mA Per JESD 17
- ESD Protection Exceeds JESD 22
 - 2000-V Human-Body Model (A114-A)
 - 200-V Machine Model (A115-A)

DESCRIPTION/ORDERING INFORMATION

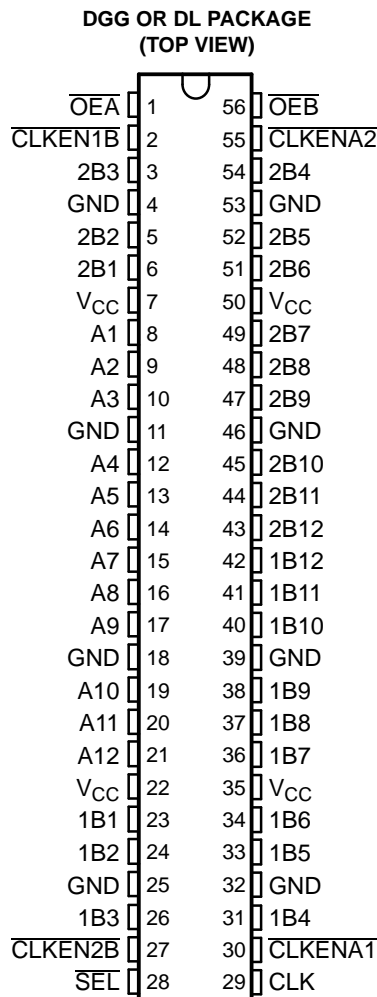
This 12-bit to 24-bit registered bus exchanger is designed for 1.65-V to 3.6-V V_{CC} operation.

The SN74ALVCH162268 is used for applications in which data must be transferred from a narrow high-speed bus to a wide, lower-frequency bus.

The device provides synchronous data exchange between the two ports. Data is stored in the internal registers on the low-to-high transition of the clock (CLK) input when the appropriate clock-enable (CLKEN) inputs are low. The select (SEL) line is synchronous with CLK and selects 1B or 2B input data for the A outputs.

For data transfer in the A-to-B direction, a two-stage pipeline is provided in the A-to-1B path, with a single storage register in the A-to-2B path. Proper control of these inputs allows two sequential 12-bit words to be presented synchronously as a 24-bit word on the B port. Data flow is controlled by the active-low output enables (\overline{OEA} , \overline{OEB}). These control terminals are registered, so bus direction changes are synchronous with CLK.

The B outputs, which are designed to sink up to 12 mA, include equivalent 26- Ω resistors to reduce overshoot and undershoot.



ORDERING INFORMATION

T_A	PACKAGE ⁽¹⁾		ORDERABLE PART NUMBER	TOP-SIDE MARKING
-40°C to 85°C	SSOP - DL	Tube	SN74ALVCH162268DL	ALVCH162268
		Tape and reel	SN74ALVCH162268DLR	
	TSSOP - DGG	Tape and reel	SN74ALVCH162268GR	ALVCH162268
	VFBGA - GQL	Tape and reel	SN74ALVCH162268KR	VH2268
VFBGA - ZQL (Pb-free)	74ALVCH162268ZQLR			

(1) Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at www.ti.com/sc/package.



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

Widebus is a trademark of Texas Instruments.

SN74ALVCH162268
12-BIT TO 24-BIT REGISTERED BUS EXCHANGER
WITH 3-STATE OUTPUTS

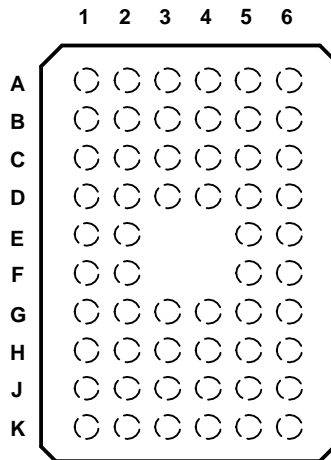
SCES018L–AUGUST 1995–REVISED SEPTEMBER 2004

DESCRIPTION/ORDERING INFORMATION (CONTINUED)

To ensure the high-impedance state during power up or power down, a clock pulse should be applied as soon as possible, and \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. Due to \overline{OE} being routed through a register, the active state of the outputs cannot be determined prior to the arrival of the first clock pulse.

Active bus-hold circuitry holds unused or undriven inputs at a valid logic state. Use of pullup or pulldown resistors with the bus-hold circuitry is not recommended.

GQL OR ZQL PACKAGE
(TOP VIEW)



TERMINAL ASSIGNMENTS

	1	2	3	4	5	6
A	2B3	$\overline{CLKEN1B}$	$\overline{OE\overline{A}}$	$\overline{OE\overline{B}}$	$\overline{CLKENA2}$	2B4
B	2B1	2B2	GND	GND	2B5	2B6
C	A2	A1	V_{CC}	V_{CC}	2B7	2B8
D	A4	A3	GND	GND	2B9	2B10
E	A6	A5			2B11	2B12
F	A7	A8			1B11	1B12
G	A9	A10	GND	GND	1B9	1B10
H	A11	A12	V_{CC}	V_{CC}	1B7	1B8
J	1B1	1B2	GND	GND	1B5	1B6
K	1B3	$\overline{CLKEN2B}$	\overline{SEL}	CLK	$\overline{CLKENA1}$	1B4

FUNCTION TABLES

OUTPUT ENABLE

INPUTS			OUTPUTS	
CLK	$\overline{OE\bar{A}}$	$\overline{OE\bar{B}}$	A	1B, 2B
↑	H	H	Z	Z
↑	H	L	Z	Active
↑	L	H	Active	Z
↑	L	L	Active	Active

A-TO-B STORAGE ($\overline{OE\bar{B}} = L$)

INPUTS				OUTPUTS	
$\overline{CLKEN\bar{A}1}$	$\overline{CLKEN\bar{A}2}$	CLK	A	1B	2B
H	H	X	X	1B ₀ ⁽¹⁾	2B ₀ ⁽¹⁾
L	L	↑	L	L ⁽²⁾	X
L	L	↑	H	H ⁽²⁾	X
X	L	↑	L	X	L
X	L	↑	H	X	H

- (1) Output level before the indicated steady-state input conditions were established
(2) Two CLK edges are needed to propagate data.

B-TO-A STORAGE ($\overline{OE\bar{A}} = L$)

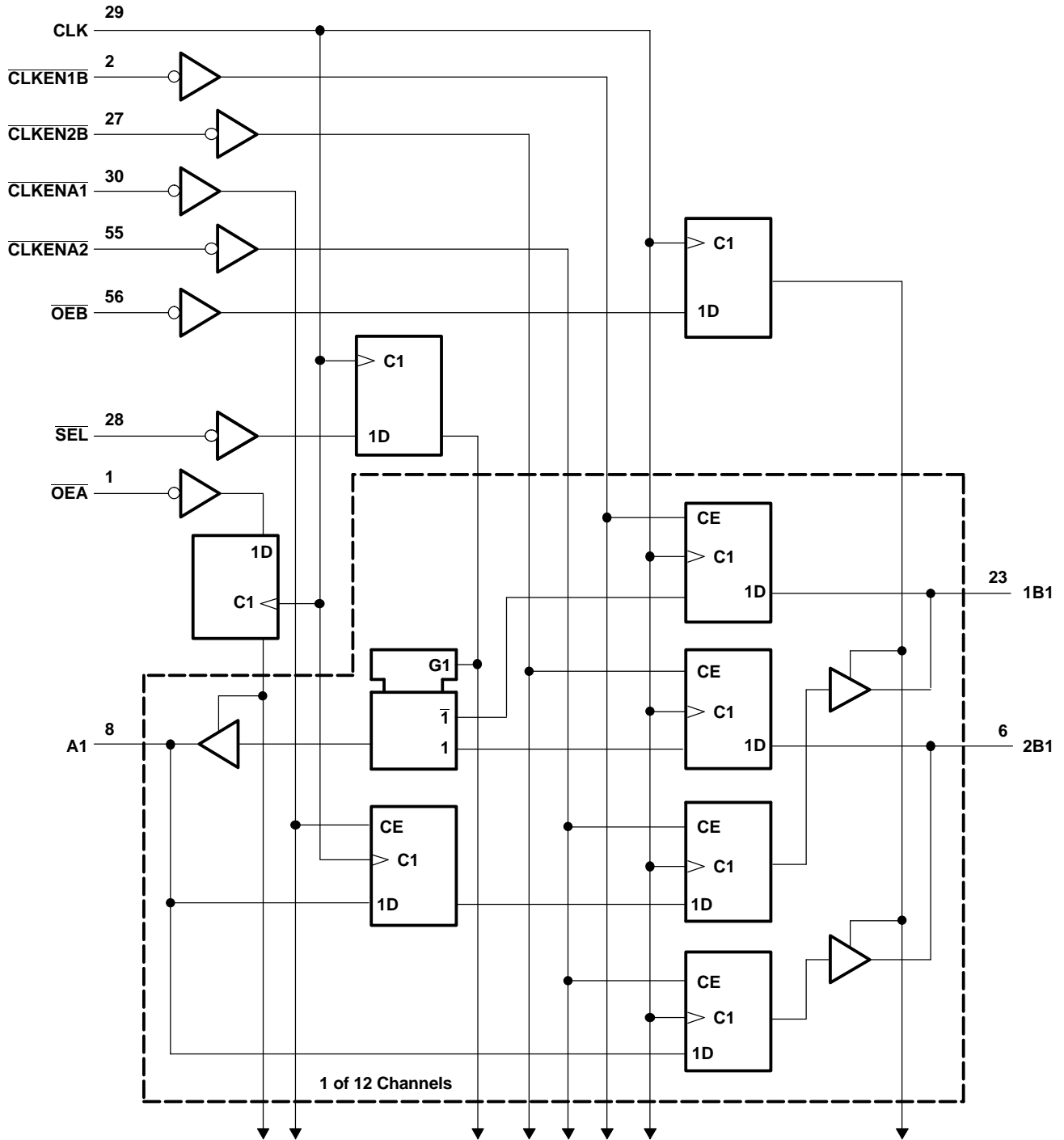
INPUTS						OUTPUT
$\overline{CLKEN\bar{1}B}$	$\overline{CLKEN\bar{2}B}$	CLK	\overline{SEL}	1B	2B	A
H	X	X	H	X	X	A ₀ ⁽¹⁾
X	H	X	L	X	X	A ₀ ⁽¹⁾
L	L	↑	H	L	X	L
L	L	↑	H	H	X	H
X	L	↑	L	X	L	L
X	L	↑	L	X	H	H

- (1) Output level before the indicated steady-state input conditions were established

SN74ALVCH162268
12-BIT TO 24-BIT REGISTERED BUS EXCHANGER
WITH 3-STATE OUTPUTS

SCES018L—AUGUST 1995—REVISED SEPTEMBER 2004

LOGIC DIAGRAM (POSITIVE LOGIC)



Pin numbers shown are for the DGG and DL packages.

ABSOLUTE MAXIMUM RATINGS⁽¹⁾

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

		MIN	MAX	UNIT
V _{CC}	Supply voltage range	-0.5	4.6	V
V _I	Input voltage range	Except I/O ports ⁽²⁾		V
		-0.5	V _{CC} + 0.5	
V _O	Output voltage range ⁽²⁾⁽³⁾	-0.5	V _{CC} + 0.5	V
I _{IK}	Input clamp current	V _I < 0		-50 mA
I _{OK}	Output clamp current	V _O < 0		-50 mA
I _O	Continuous output current			±50 mA
	Continuous current through each V _{CC} or GND			±100 mA
θ _{JA}	Package thermal impedance ⁽⁴⁾	DGG package		64 °C/W
		DL package		56
		GQL/ZQL package		42
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 negative-voltage and output voltage ratings may be exceeded if the input and output current ratings are observed.
- (3) This value is limited to 4.6 V, maximum.
- (4) The package thermal impedance is calculated in accordance with JESD 51-7.

SN74ALVCH162268
12-BIT TO 24-BIT REGISTERED BUS EXCHANGER
WITH 3-STATE OUTPUTS

SCES018L–AUGUST 1995–REVISED SEPTEMBER 2004

RECOMMENDED OPERATING CONDITIONS⁽¹⁾

		MIN	MAX	UNIT
V _{CC}	Supply voltage	1.65	3.6	V
V _{IH}	High-level input voltage	V _{CC} = 1.65 V to 1.95 V	0.65 × V _{CC}	V
		V _{CC} = 2.3 V to 2.7 V	1.7	
		V _{CC} = 2.7 V to 3.6 V	2	
V _{IL}	Low-level input voltage	V _{CC} = 1.65 V to 1.95 V	0.35 × V _{CC}	V
		V _{CC} = 2.3 V to 2.7 V	0.7	
		V _{CC} = 2.7 V to 3.6 V	0.8	
V _I	Input voltage	0	V _{CC}	V
V _O	Output voltage	0	V _{CC}	V
I _{OH}	High-level output current (A port)	V _{CC} = 1.65 V	-4	mA
		V _{CC} = 2.3 V	-12	
		V _{CC} = 2.7 V	-12	
		V _{CC} = 3 V	-24	
	High-level output current (B port)	V _{CC} = 1.65 V	-2	
		V _{CC} = 2.3 V	-6	
		V _{CC} = 2.7 V	-8	
		V _{CC} = 3 V	-12	
I _{OL}	Low-level output current (A port)	V _{CC} = 1.65 V	4	mA
		V _{CC} = 2.3 V	12	
		V _{CC} = 2.7 V	12	
		V _{CC} = 3 V	24	
	Low-level output current (B port)	V _{CC} = 1.65 V	2	
		V _{CC} = 2.3 V	6	
		V _{CC} = 2.7 V	8	
		V _{CC} = 3 V	12	
Δt/Δv	Input transition rise or fall rate		10	ns/V
T _A	Operating free-air temperature	-40	85	°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.

ELECTRICAL CHARACTERISTICS

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

PARAMETER		TEST CONDITIONS	V _{CC}	MIN	TYP ⁽¹⁾	MAX	UNIT
V _{OH}	A port	I _{OH} = -100 μA	1.65 V to 3.6 V	V _{CC} - 0.2			V
		I _{OH} = -4 mA	1.65 V	1.2			
		I _{OH} = -6 mA	2.3 V	2			
		I _{OH} = -12 mA	2.3 V	1.7			
			2.7 V	2.2			
			3 V	2.4			
	I _{OH} = -24 mA	3 V	2				
	B port	I _{OH} = -100 μA	1.65 V to 3.6 V	V _{CC} - 0.2			
		I _{OH} = -2 mA	1.65 V	1.2			
		I _{OH} = -4 mA	2.3 V	1.9			
		I _{OH} = -6 mA	2.3 V	1.7			
			3 V	2.4			
		I _{OH} = -8 mA	2.7 V	2			
	I _{OH} = -12 mA	3 V	2				
V _{OL}	A port	I _{OL} = 100 μA	1.65 V to 3.6 V			0.2	V
		I _{OL} = 4 mA	1.65 V			0.45	
		I _{OL} = 6 mA	2.3 V			0.4	
		I _{OL} = 12 mA	2.3 V			0.7	
			2.7 V			0.4	
		I _{OL} = 24 mA	3 V			0.55	
	B port	I _{OL} = 100 μA	1.65 V to 3.6 V			0.2	
		I _{OL} = 2 mA	1.65 V			0.45	
		I _{OL} = 4 mA	2.3 V			0.4	
		I _{OL} = 6 mA	2.3 V			0.55	
			3 V			0.55	
		I _{OL} = 8 mA	2.7 V			0.6	
	I _{OL} = 12 mA	3 V			0.8		
	I _I	V _I = V _{CC} or GND	3.6 V			±5	
I _{I(hold)}	V _I = 0.58 V	1.65 V	25		μA		
	V _I = 1.07 V		-25				
	V _I = 0.7 V	2.3 V	45				
	V _I = 1.7 V		-45				
	V _I = 0.8 V	3 V	75				
	V _I = 2 V		-75				
	V _I = 0 to 3.6 V ⁽²⁾		±500				
I _{OZ} ⁽³⁾	V _O = V _{CC} or GND	3.6 V			±10	μA	
I _{CC}	V _I = V _{CC} or GND, I _O = 0	3.6 V			40	μA	
ΔI _{CC}	One input at V _{CC} - 0.6 V, Other inputs at V _{CC} or GND	3 V to 3.6 V			750	μA	
C _i	Control inputs	V _I = V _{CC} or GND	3.3 V	3.5		pF	
C _{io}	A or B ports	V _O = V _{CC} or GND	3.3 V	9		pF	

 (1) All typical values are at V_{CC} = 3.3 V, T_A = 25°C.

(2) This is the bus-hold maximum dynamic current. It is the minimum overdrive current required to switch the input from one state to another.

 (3) For I/O ports, the parameter I_{OZ} includes the input leakage current.

SN74ALVCH162268

12-BIT TO 24-BIT REGISTERED BUS EXCHANGER WITH 3-STATE OUTPUTS

SCES018L–AUGUST 1995–REVISED SEPTEMBER 2004

TIMING REQUIREMENTS

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

		$V_{CC} = 2.5\text{ V} \pm 0.2\text{ V}$		$V_{CC} = 2.7\text{ V}$		$V_{CC} = 3.3\text{ V} \pm 0.3\text{ V}$		UNIT
		MIN	MAX	MIN	MAX	MIN	MAX	
f_{clock}	Clock frequency	120		125		150		MHz
t_w	Pulse duration, CLK high or low	3.3		3.3		3.3		ns
t_{su}	Setup time	A data before CLK \uparrow	4.5	4	3.4			ns
		B data before CLK \uparrow	0.8	1.2	1			
		$\overline{\text{SEL}}$ before CLK \uparrow	1.4	1.6	1.3			
		$\overline{\text{CLKENA1}}$ or $\overline{\text{CLKENA2}}$ before CLK \uparrow	3.6	3.4	2.8			
		$\overline{\text{CLKEN1B}}$ or $\overline{\text{CLKEN2B}}$ before CLK \uparrow	3.2	3	2.5			
		$\overline{\text{OE}}$ before CLK \uparrow	4.2	3.9	3.2			
t_h	Hold time	A data after CLK \uparrow	0	0	0.2			ns
		B data after CLK \uparrow	1.3	1.2	1.3			
		$\overline{\text{SEL}}$ after CLK \uparrow	1	1	1			
		$\overline{\text{CLKENA1}}$ or $\overline{\text{CLKENA2}}$ after CLK \uparrow	0.1	0.1	0.4			
		$\overline{\text{CLKEN1B}}$ or $\overline{\text{CLKEN2B}}$ after CLK \uparrow	0.1	0	0.5			
		$\overline{\text{OE}}$ after CLK \uparrow	0	0	0.2			

SWITCHING CHARACTERISTICS

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

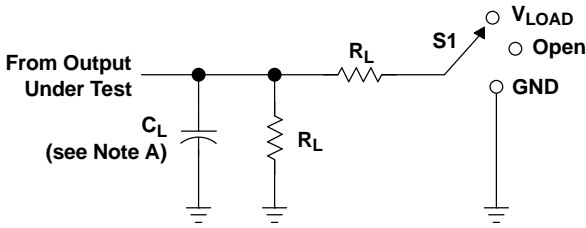
PARAMETER	FROM (INPUT)	TO (OUTPUT)	$V_{CC} = 1.8\text{ V}$	$V_{CC} = 2.5\text{ V} \pm 0.2\text{ V}$		$V_{CC} = 2.7\text{ V}$		$V_{CC} = 3.3\text{ V} \pm 0.3\text{ V}$		UNIT
			TYP	MIN	MAX	MIN	MAX	MIN	MAX	
f_{max}				120		125		150		MHz
t_{pd}	CLK	B	8	1.6	6.1	5.9	1.8	5.4	ns	
		A (1B)	8	1.6	5.8	5.4	1.7	4.8		
		A (2B)	8	1.6	5.8	5.3	1.8	4.8		
		A ($\overline{\text{SEL}}$)	11	2.5	7.3	6.5	2.4	5.8		
t_{en}	CLK	B	12	2.7	7.2	6.8	2.6	6.1	ns	
		A	9	2	6.2	5.6	1.8	5.1		
t_{dis}	CLK	B	10	2.8	7.2	6.1	2.5	5.9	ns	
		A	9	2	6.5	5.4	2.1	5		

OPERATING CHARACTERISTICS

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

PARAMETER		TEST CONDITIONS	$V_{CC} = 2.5\text{ V}$	$V_{CC} = 3.3\text{ V}$	UNIT
			TYP	TYP	
C_{pd}	Power dissipation capacitance	$C_L = 50\text{ pF}$, $f = 10\text{ MHz}$	87	120	pF
	Outputs disabled		80.5	118	

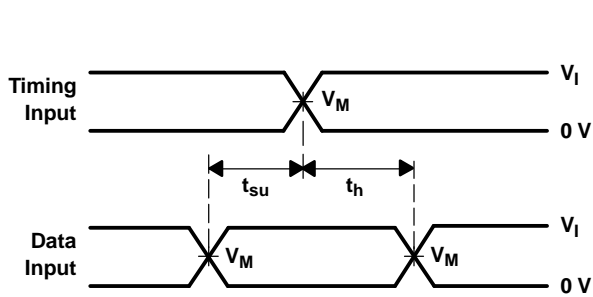
PARAMETER MEASUREMENT INFORMATION



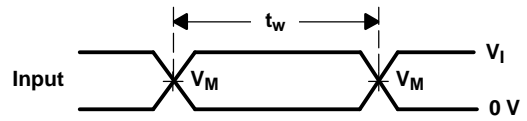
LOAD CIRCUIT

TEST	S1
t_{pd} t_{PLZ}/t_{PZL} t_{PHZ}/t_{PZH}	Open V_{LOAD} GND

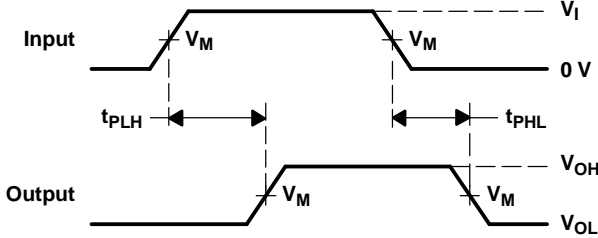
V_{CC}	INPUT		V_M	V_{LOAD}	C_L	R_L	V_{Δ}
	V_I	t_r/t_f					
$1.8 V \pm 0.15 V$	V_{CC}	$\leq 2 \text{ ns}$	$V_{CC}/2$	$2 \times V_{CC}$	30 pF	1 k Ω	0.15 V
$2.5 V \pm 0.2 V$	V_{CC}	$\leq 2 \text{ ns}$	$V_{CC}/2$	$2 \times V_{CC}$	30 pF	500 Ω	0.15 V
2.7 V	2.7 V	$\leq 2.5 \text{ ns}$	1.5 V	6 V	50 pF	500 Ω	0.3 V
$3.3 V \pm 0.3 V$	2.7 V	$\leq 2.5 \text{ ns}$	1.5 V	6 V	50 pF	500 Ω	0.3 V



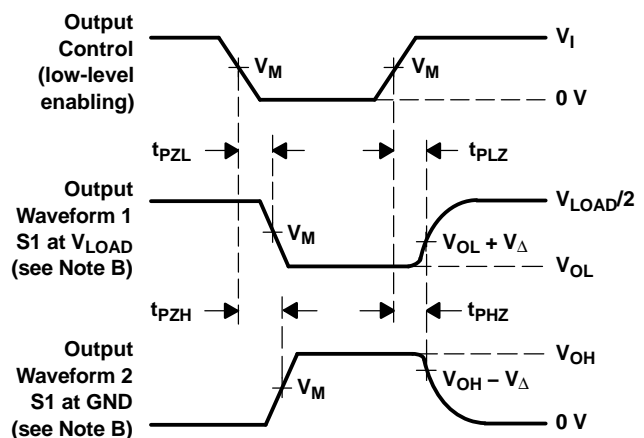
VOLTAGE WAVEFORMS
SETUP AND HOLD TIMES



VOLTAGE WAVEFORMS
PULSE DURATION



VOLTAGE WAVEFORMS
PROPAGATION DELAY TIMES



VOLTAGE WAVEFORMS
ENABLE AND DISABLE TIMES

- NOTES:
- C_L includes probe and jig capacitance.
 - 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.
 - All input pulses are supplied by generators having the following characteristics: $PRR \leq 10 \text{ MHz}$, $Z_O = 50 \Omega$.
 - The outputs are measured one at a time, with one transition per measurement.
 - t_{PLZ} and t_{PHZ} are the same as t_{dis} .
 - t_{PZL} and t_{PZH} are the same as t_{en} .
 - t_{PLH} and t_{PHL} are the same as t_{pd} .
 - All parameters and waveforms are not applicable to all devices.

Figure 1. Load Circuit and Voltage Waveforms

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
SN74ALVCH162268DL	ACTIVE	SSOP	DL	56	20	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	ALVCH162268	Samples
SN74ALVCH162268GR	ACTIVE	TSSOP	DGG	56	2000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	ALVCH162268	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.

Important Information and Disclaimer:The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

TAPE AND REEL INFORMATION

QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE


*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
SN74ALVCH162268GR	TSSOP	DGG	56	2000	330.0	24.4	8.6	15.6	1.8	12.0	24.0	Q1

TAPE AND REEL BOX DIMENSIONS


*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
SN74ALVCH162268GR	TSSOP	DGG	56	2000	367.0	367.0	45.0

TUBE


*All dimensions are nominal

Device	Package Name	Package Type	Pins	SPQ	L (mm)	W (mm)	T (μm)	B (mm)
SN74ALVCH162268DL	DL	SSOP	56	20	473.7	14.24	5110	7.87

MECHANICAL DATA

DL (R-PDSO-G56)

PLASTIC SMALL-OUTLINE PACKAGE



- NOTES:
- All linear dimensions are in inches (millimeters).
 - This drawing is subject to change without notice.
 - Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0,15).
 - Falls within JEDEC MO-118

PowerPAD is a trademark of Texas Instruments.

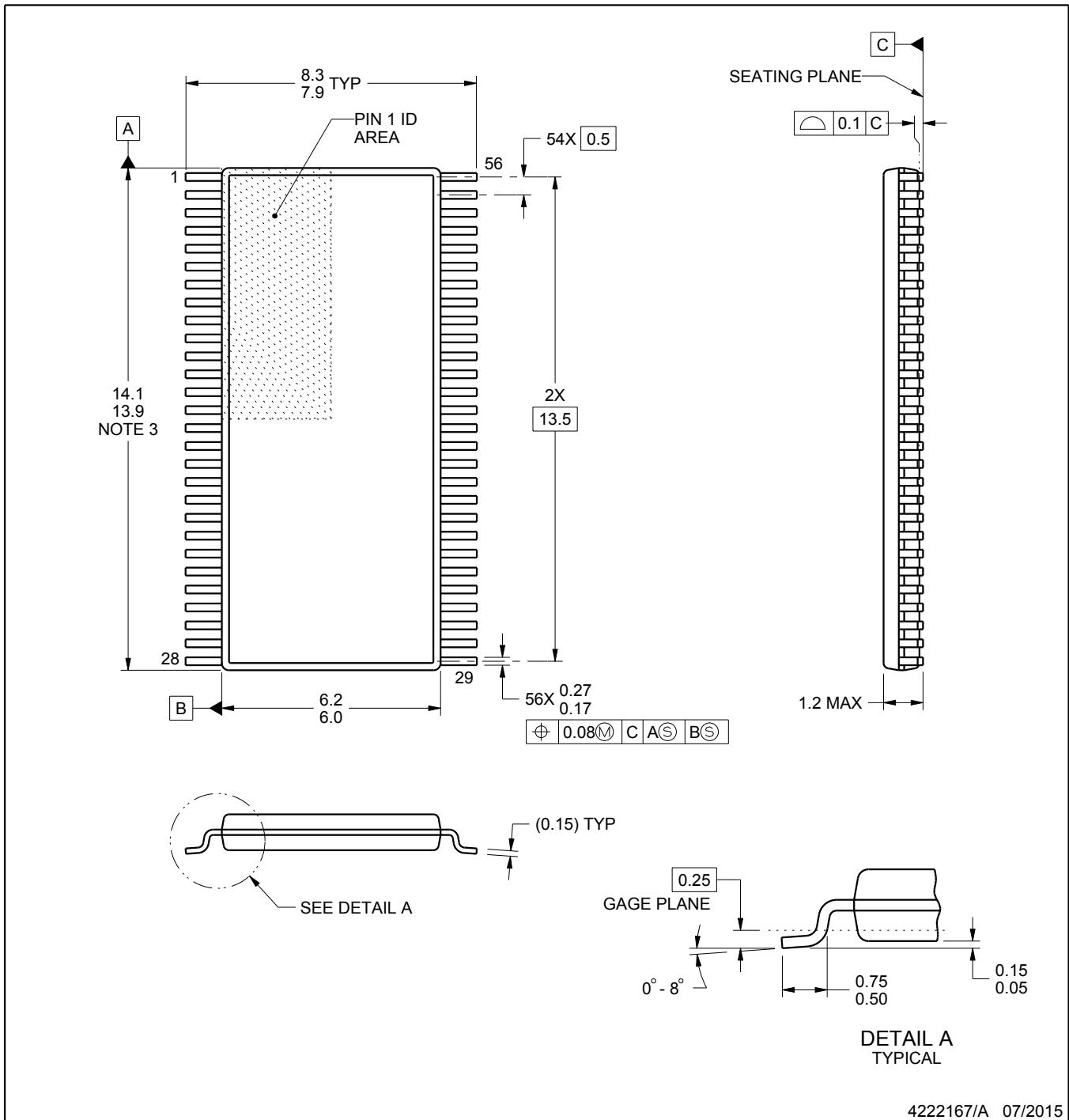
DGG0056A



PACKAGE OUTLINE

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



4222167/A 07/2015

NOTES:

- All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
- This drawing is subject to change without notice.
- This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.
- Reference JEDEC registration MO-153.

EXAMPLE BOARD LAYOUT

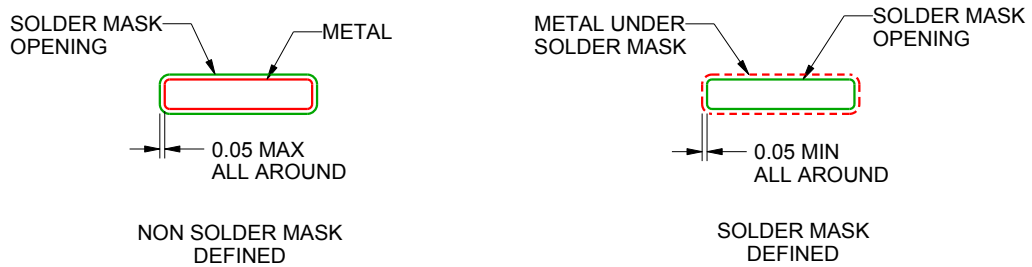
DGG0056A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



LAND PATTERN EXAMPLE
SCALE:6X



SOLDER MASK DETAILS

4222167/A 07/2015

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.

EXAMPLE STENCIL DESIGN

DGG0056A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



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

4222167/A 07/2015

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.

IMPORTANT NOTICE AND DISCLAIMER

TI PROVIDES TECHNICAL AND RELIABILITY DATA (INCLUDING DATA SHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES "AS IS" AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS AND IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, regulatory or other requirements.

These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you will fully indemnify TI and its representatives against, any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

TI's products are provided subject to [TI's Terms of Sale](#) or other applicable terms available either on [ti.com](#) or provided in conjunction with such TI products. TI's provision of these resources does not expand or otherwise alter TI's applicable warranties or warranty disclaimers for TI products.

TI objects to and rejects any additional or different terms you may have proposed.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2022, Texas Instruments Incorporated