

FEATURES

- Member of the Texas Instruments Widebus™ Family
- EPIC™ (Enhanced-Performance Implanted CMOS) Submicron Process
- Output Ports Have Equivalent 26-Ω Series Resistors, So No External Resistors Are Required
- ESD Protection Exceeds 2000 V Per MIL-STD-883, Method 3015; Exceeds 200 V Using Machine Model (C = 200 pF, R = 0)
- Latch-Up Performance Exceeds 250 mA Per JESD 17
- Bus Hold on Data Inputs Eliminates the Need for External Pullup/Pulldown Resistors
- Package Options Include Plastic 300-mil Shrink Small-Outline (DL) and Thin Shrink Small-Outline (DGG) Packages

NOTE: For tape-and-reel order entry, the DGGR package is abbreviated to GR.

DESCRIPTION

This 20-bit flip-flop is designed for low-voltage 1.65-V to 3.6-V V_{CC} operation.

The 20 flip-flops of the SN74ALVCH162721 are edge-triggered D-type flip-flops with qualified clock storage. On the positive transition of the clock (CLK) input, the device provides true data at the Q outputs if the clock-enable ($\overline{CLKEN}$) input is low. If $\overline{CLKEN}$ is high, no data is stored.

A buffered output-enable ($\overline{OE}$) input places the 20 outputs in either a normal logic state (high or low level) or the high-impedance state. In the high-impedance state, the outputs neither load nor drive the bus lines significantly. The high-impedance state and increased drive provide the capability to drive bus lines without interface or pullup components. $\overline{OE}$ does not affect the internal operation of the flip-flops. Old data can be retained or new data can be entered while the outputs are in the high-impedance state.

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.

Active bus-hold circuitry is provided to hold unused or floating data inputs at a valid logic level.

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

The SN74ALVCH162721 is characterized for operation from -40°C to 85°C.

**DGG OR DL PACKAGE
(TOP VIEW)**

$\overline{OE}$	1	56	CLK
Q1	2	55	D1
Q2	3	54	D2
GND	4	53	GND
Q3	5	52	D3
Q4	6	51	D4
V_{CC}	7	50	V_{CC}
Q5	8	49	D5
Q6	9	48	D6
Q7	10	47	D7
GND	11	46	GND
Q8	12	45	D8
Q9	13	44	D9
Q10	14	43	D10
Q11	15	42	D11
Q12	16	41	D12
Q13	17	40	D13
GND	18	39	GND
Q14	19	38	D14
Q15	20	37	D15
Q16	21	36	D16
V_{CC}	22	35	V_{CC}
Q17	23	34	D17
Q18	24	33	D18
GND	25	32	GND
Q19	26	31	D19
Q20	27	30	D20
NC	28	29	$\overline{CLKEN}$

NC – No internal connection



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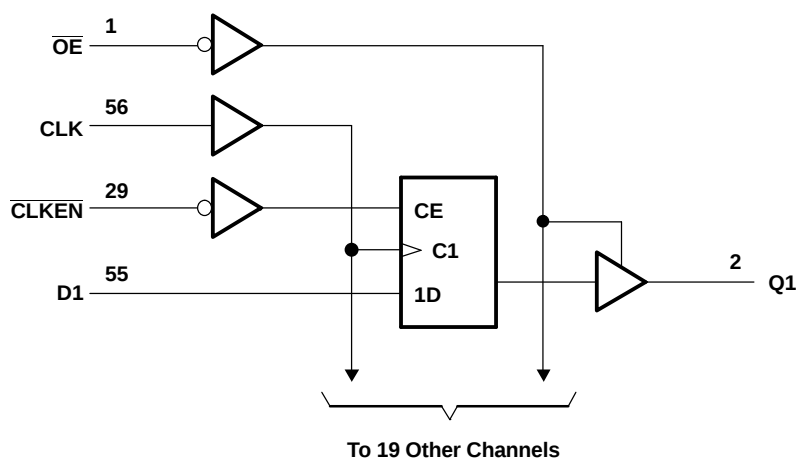
SN74ALVCH162721
3.3-V 20-BIT FLIP-FLOP
WITH 3-STATE OUTPUTS

SCES055G–DECEMBER 1995–REVISED SEPTEMBER 2004

FUNCTION TABLE
(each flip-flop)

INPUTS				OUTPUT Q
$\overline{OE}$	$\overline{CLKEN}$	CLK	D	
L	H	X	X	Q_0
L	L	$\uparrow$	H	H
L	L	$\uparrow$	L	L
L	L	L or H	X	Q_0
H	X	X	X	Z

LOGIC DIAGRAM (POSITIVE LOGIC)



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 ⁽²⁾	-0.5	4.6	V
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	81	°C/W
		DL package	74	°C/W
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.

RECOMMENDED OPERATING CONDITIONS⁽¹⁾

		MIN	MAX	UNIT
V_{CC}	Supply voltage	1.65	3.6	V
V_{IH}	High-level input voltage	$V_{CC} = 1.65 \text{ V to } 1.95 \text{ V}$	$0.65 \times V_{CC}$	V
		$V_{CC} = 2.3 \text{ V to } 2.7 \text{ V}$	1.7	
		$V_{CC} = 2.7 \text{ V to } 3.6 \text{ V}$	2	
V_{IL}	Low-level input voltage	$V_{CC} = 1.65 \text{ V to } 1.95 \text{ V}$	$0.35 \times V_{CC}$	V
		$V_{CC} = 2.3 \text{ V to } 2.7 \text{ V}$	0.7	
		$V_{CC} = 2.7 \text{ V to } 3.6 \text{ V}$	0.8	
V_I	Input voltage	0	V_{CC}	V
V_O	Output voltage	0	V_{CC}	V
I_{OH}	High-level output current	$V_{CC} = 1.65 \text{ V}$	-2	mA
		$V_{CC} = 2.3 \text{ V}$	-6	
		$V_{CC} = 2.7 \text{ V}$	-8	
		$V_{CC} = 3 \text{ V}$	-12	
I_{OL}	Low-level output current	$V_{CC} = 1.65 \text{ V}$	2	mA
		$V_{CC} = 2.3 \text{ V}$	6	
		$V_{CC} = 2.7 \text{ V}$	8	
		$V_{CC} = 3 \text{ V}$	12	
$\Delta t/\Delta v$	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.

SN74ALVCH162721
3.3-V 20-BIT FLIP-FLOP
WITH 3-STATE OUTPUTS

SCES055G–DECEMBER 1995–REVISED SEPTEMBER 2004

ELECTRICAL CHARACTERISTICS

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

PARAMETER	TEST CONDITIONS	V _{CC}	MIN TYP ⁽¹⁾ MAX	UNIT
V _{OH}	I _{OH} = -100 μA	1.65 V to 3.6 V	V _{CC} - 0.2	V
	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}	I _{OL} = 100 μA	1.65 V to 3.6 V	0.2	V
	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	μA
I _{I(hold)}	V _I = 0.58 V	1.65 V	25	μA
	V _I = 1.07 V	1.65 V	-25	
	V _I = 0.7 V	2.3 V	45	
	V _I = 1.7 V	2.3 V	-45	
	V _I = 0.8 V	3 V	75	
	V _I = 2 V	3 V	-75	
	V _I = 0 to 3.6 V ⁽²⁾	3.6 V	±500	
I _{OZ}	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	V _I = V _{CC} or GND	3.3 V	3.5	pF
C _o	V _O = V _{CC} or GND	3.3 V	7	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.

TIMING REQUIREMENTS

over recommended operating free-air temperature range (unless otherwise noted) (see Figure 1 through Figure 3)

			V _{CC} = 1.8 V		V _{CC} = 2.5 V ± 0.2 V		V _{CC} = 2.7 V		V _{CC} = 3.3 V ± 0.3 V		UNIT
			MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
f _{clock}	Clock frequency		(1)		150		150		150		MHz
t _w	Pulse duration, CLK high or low		(1)		3.3		3.3		3.3		ns
t _{su}	Setup time	Data before CLK↑	(1)		4		3.6		3.1		ns
		$\overline{\text{CLKEN}}$ before CLK↑	(1)		3.4		3.1		2.7		
t _h	Hold time	Data after CLK↑	(1)		0		0		0		ns
		$\overline{\text{CLKEN}}$ after CLK↑	(1)		0		0		0		

(1) This information was not available at the time of publication.

SWITCHING CHARACTERISTICS

over recommended operating free-air temperature range (unless otherwise noted) (see Figure 1 through Figure 3)

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
			MIN	TYP	MIN	MAX	MIN	MAX	MIN	MAX	
$f_{\max}$			(1)		150		150		150		MHz
t_{pd}	CLK	Q		(1)	1	6.7	6.2		1	5.3	ns
t_{en}	$\overline{OE}$	Q		(1)	1	7.2	7		1	5.8	ns
t_{dis}	$\overline{OE}$	Q		(1)	1	6.3	5.4		1	5	ns

(1) This information was not available at the time of publication.

OPERATING CHARACTERISTICS

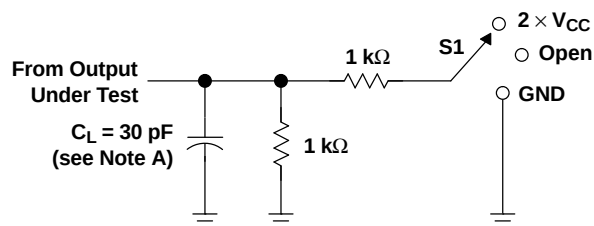
$T_A = 25^\circ\text{C}$

PARAMETER			TEST CONDITIONS	V _{CC} = 1.8 V	V _{CC} = 2.5 V	V _{CC} = 3.3 V	UNIT
				TYP	TYP	TYP	
C _{pd} Power dissipation capacitance	Outputs enabled	C _L = 50 pF, f = 10 MHz	(1)	55	59	pF	
	Outputs disabled		(1)	46	49		

(1) This information was not available at the time of publication.

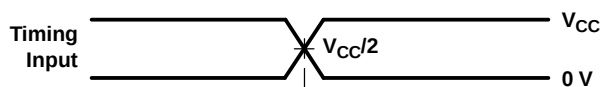
PARAMETER MEASUREMENT INFORMATION

$V_{CC} = 1.8 \text{ V}$

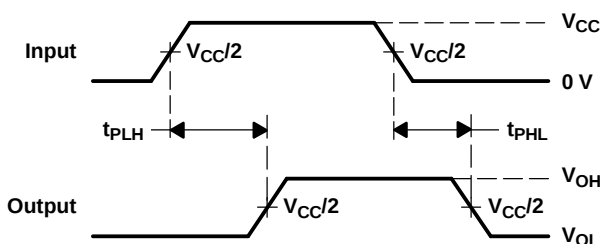


LOAD CIRCUIT

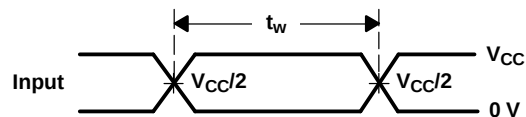
TEST	S1
t_{pd}	Open
t_{PLZ}/t_{PZL}	2 $\times V_{CC}$
t_{PHZ}/t_{PZH}	GND



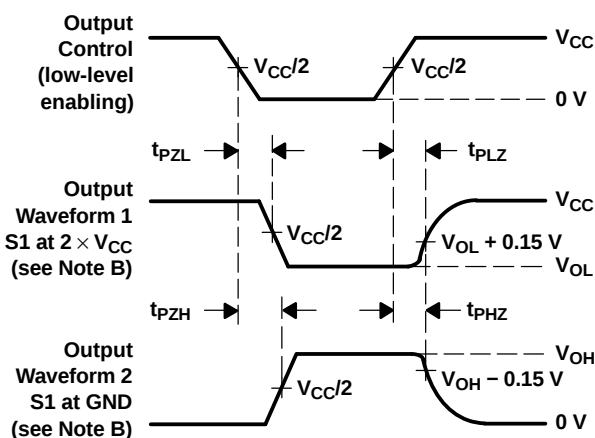
VOLTAGE WAVEFORMS
SETUP AND HOLD TIMES



VOLTAGE WAVEFORMS
PROPAGATION DELAY TIMES



VOLTAGE WAVEFORMS
PULSE DURATION



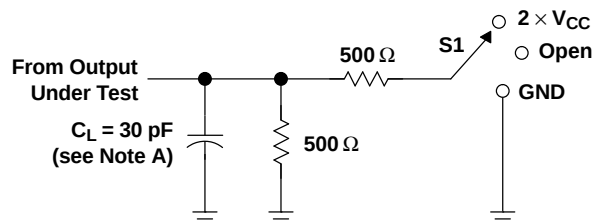
VOLTAGE WAVEFORMS
ENABLE AND DISABLE TIMES

- 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: $PRR \leq 10 \text{ MHz}$, $Z_O = 50 \Omega$, $t_r \leq 2 \text{ ns}$, $t_f \leq 2 \text{ ns}$.
 - 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} .

Figure 1. Load Circuit and Voltage Waveforms

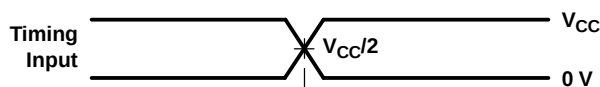
PARAMETER MEASUREMENT INFORMATION

$$V_{CC} = 2.5 \text{ V} \pm 0.2 \text{ V}$$

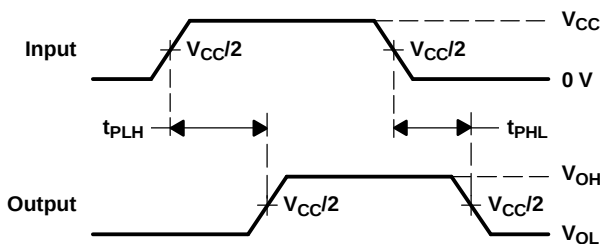


LOAD CIRCUIT

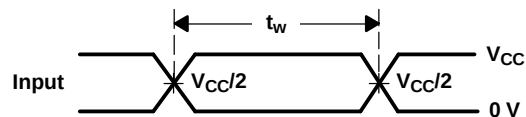
TEST	S1
t_{pd}	Open
t_{PLZ}/t_{PZL}	$2 \times V_{CC}$
t_{PHZ}/t_{PZH}	GND



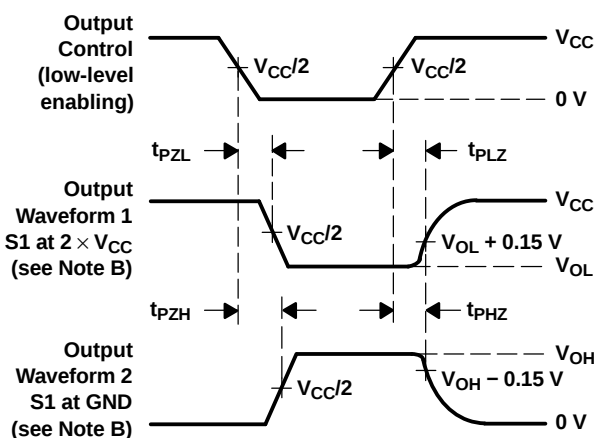
VOLTAGE WAVEFORMS
SETUP AND HOLD TIMES



VOLTAGE WAVEFORMS
PROPAGATION DELAY TIMES



VOLTAGE WAVEFORMS
PULSE DURATION



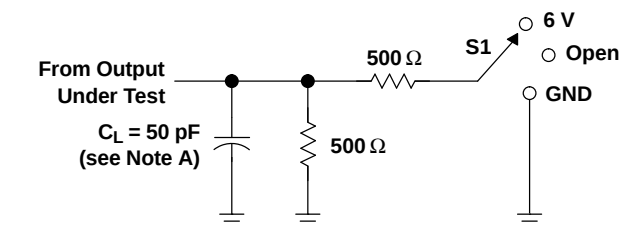
VOLTAGE WAVEFORMS
ENABLE AND DISABLE TIMES

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 - 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} .

Figure 2. Load Circuit and Voltage Waveforms

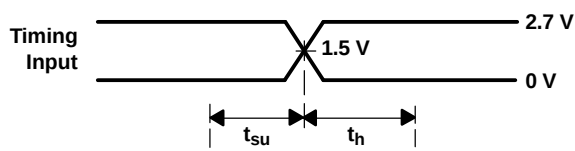
PARAMETER MEASUREMENT INFORMATION

$V_{CC} = 2.7\text{ V}$ AND $3.3\text{ V} \pm 0.3\text{ V}$

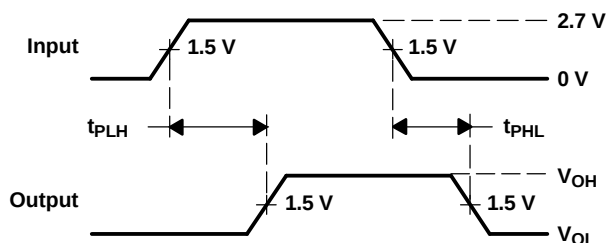


LOAD CIRCUIT

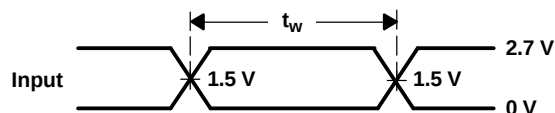
TEST	S1
t_{pd}	Open
t_{PLZ}/t_{PZL}	6 V
t_{PHZ}/t_{PZH}	GND



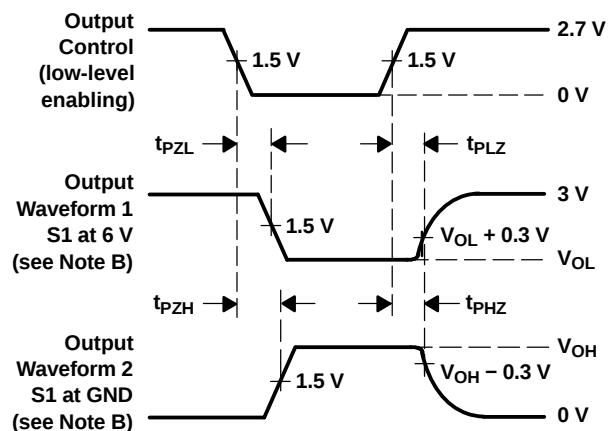
VOLTAGE WAVEFORMS
SETUP AND HOLD TIMES



VOLTAGE WAVEFORMS
PROPAGATION DELAY TIMES



VOLTAGE WAVEFORMS
PULSE DURATION



VOLTAGE WAVEFORMS
ENABLE AND DISABLE TIMES

- NOTES:
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 - 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: $PRR \leq 10\text{ MHz}$, $Z_O = 50\text{ }\Omega$, $t_r \leq 2.5\text{ ns}$, $t_f \leq 2.5\text{ ns}$.
 - 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} .

Figure 3. 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
SN74ALVCH162721DLR	ACTIVE	SSOP	DL	56	1000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	ALVCH162721	Samples
SN74ALVCH162721GR	ACTIVE	TSSOP	DGG	56	2000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	ALVCH162721	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.

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TAPE AND REEL INFORMATION
REEL DIMENSIONS

TAPE DIMENSIONS

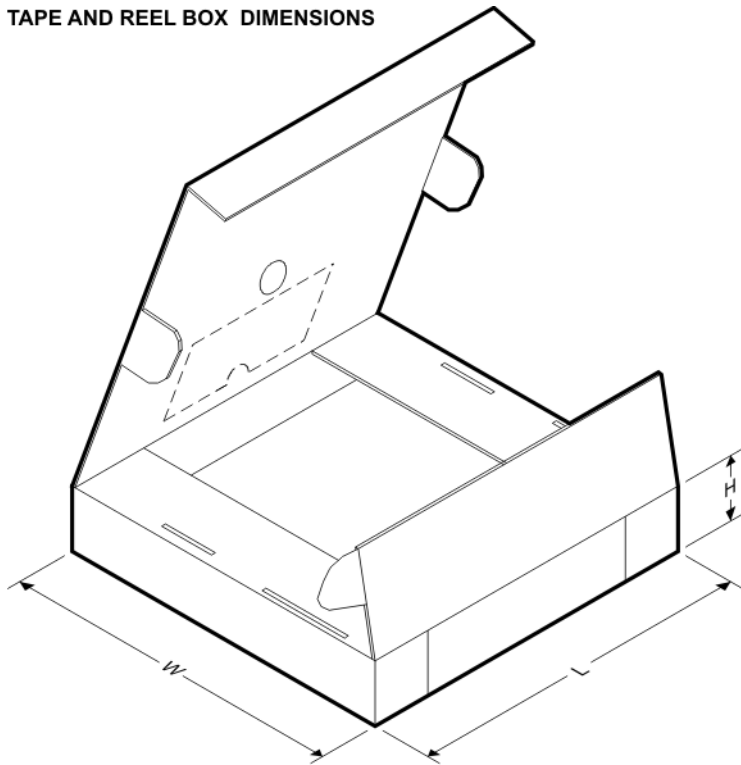

A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

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
SN74ALVCH162721DLR	SSOP	DL	56	1000	330.0	32.4	11.35	18.67	3.1	16.0	32.0	Q1
SN74ALVCH162721GR	TSSOP	DGG	56	2000	330.0	24.4	8.6	15.6	1.8	12.0	24.0	Q1

TAPE AND REEL BOX DIMENSIONS

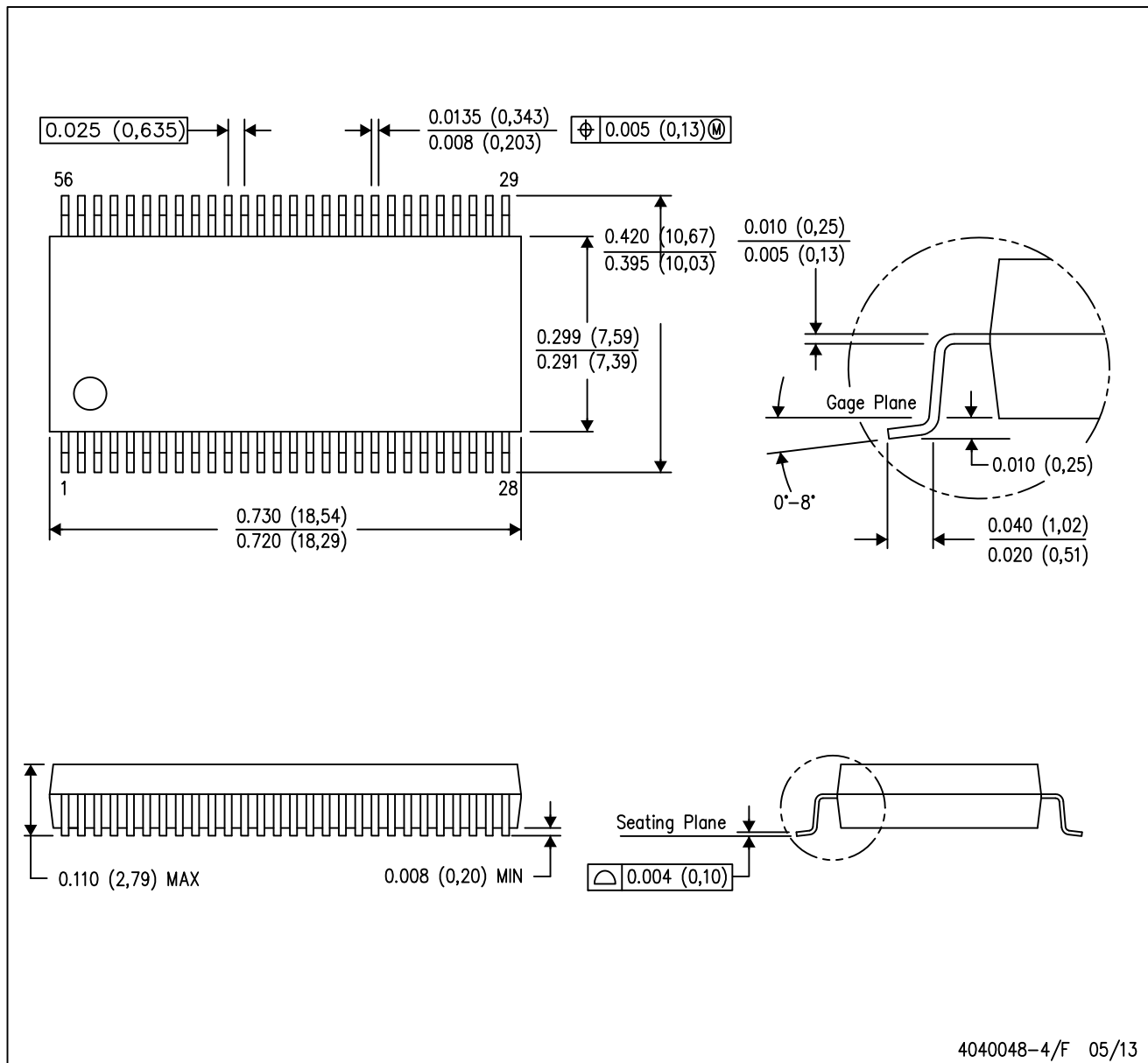


*All dimensions are nominal

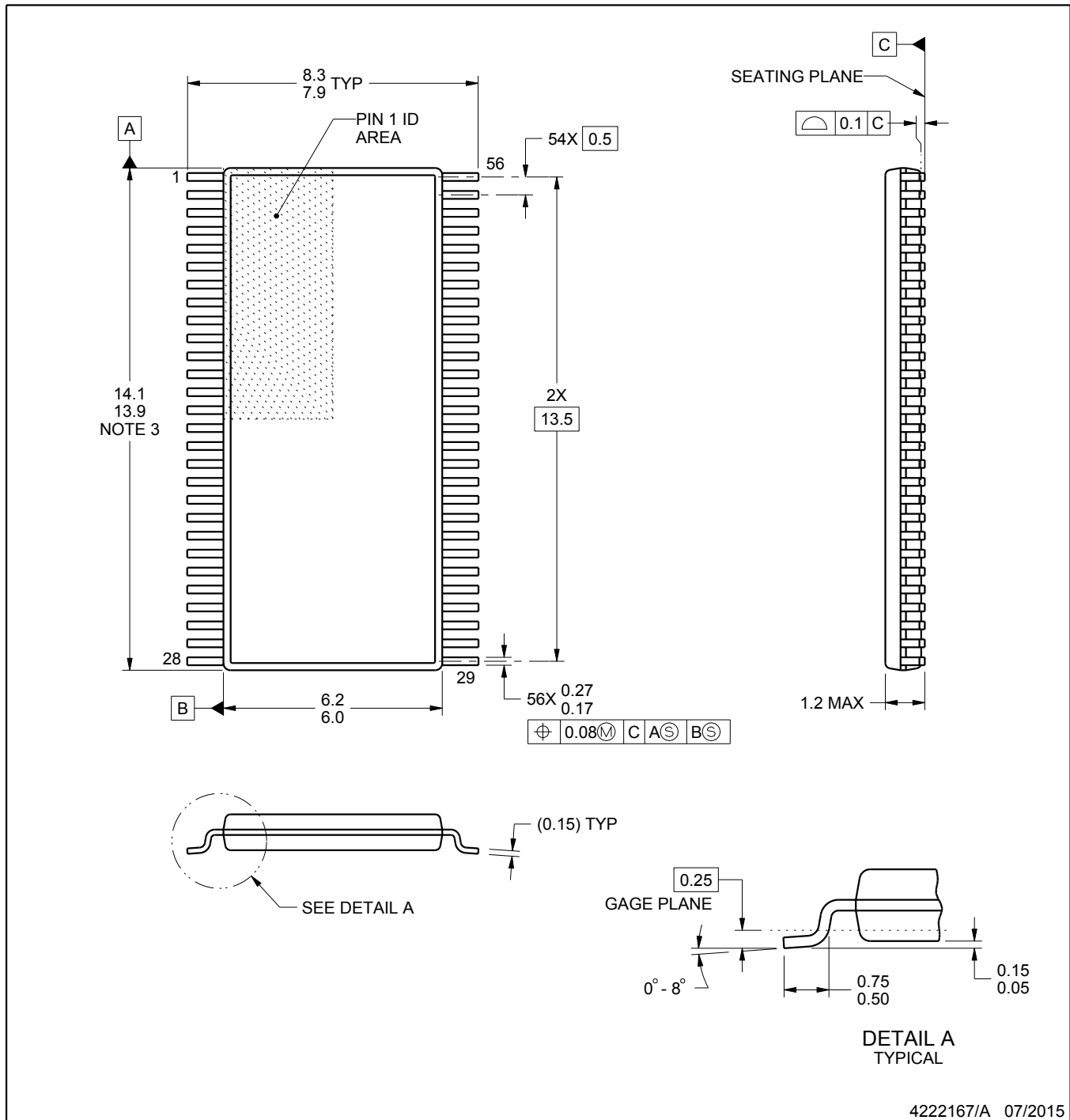
Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
SN74ALVCH162721DLR	SSOP	DL	56	1000	367.0	367.0	55.0
SN74ALVCH162721GR	TSSOP	DGG	56	2000	367.0	367.0	45.0

DL (R-PDSO-G56)

PLASTIC SMALL-OUTLINE PACKAGE



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



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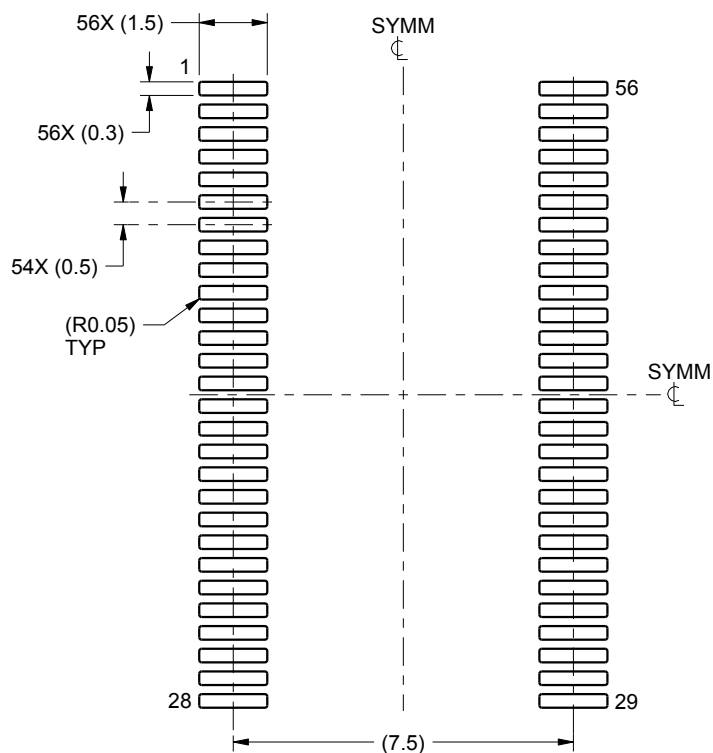
NOTES:

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. 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. Reference JEDEC registration MO-153.

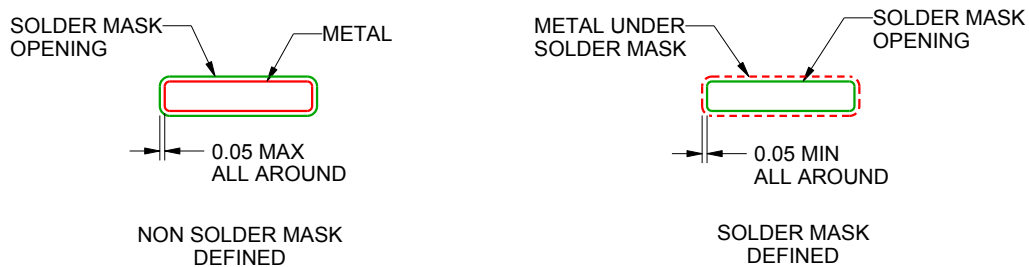
DGG0056A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



LAND PATTERN EXAMPLE
SCALE:6X



SOLDER MASK DETAILS

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NOTES: (continued)

5. Publication IPC-7351 may have alternate designs.

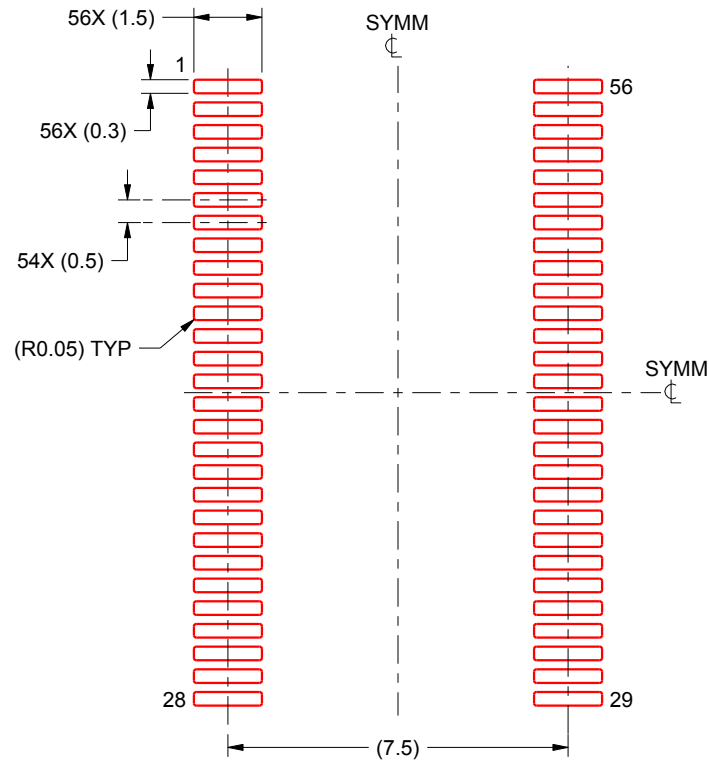
6. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

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

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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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