

# SN74CBT16214C

## 12-BIT 1-OF-3 FET MULTIPLEXER/DEMULTIPLEXER

### 5-V BUS SWITCH WITH –2-V UNDERSHOOT PROTECTION

SCDS121B – JUNE 2003 – REVISED OCTOBER 2003

- Member of the Texas Instruments Widebus™ Family
- Undershoot Protection for Off-Isolation on A and B Ports Up To –2 V
- Bidirectional Data Flow, With Near-Zero Propagation Delay
- Low ON-State Resistance ( $r_{on}$ ) Characteristics ( $r_{on} = 3 \Omega$  Typical)
- Low Input/Output Capacitance Minimizes Loading and Signal Distortion ( $C_{io(OFF)} = 5.5 \text{ pF}$  Typical)
- Data and Control Inputs Provide Undershoot Clamp Diodes
- Low Power Consumption ( $I_{CC} = 3 \mu\text{A}$  Max)
- $V_{CC}$  Operating Range From 4 V to 5.5 V
- Data I/Os Support 0 to 5-V Signaling Levels (0.8-V, 1.2-V, 1.5-V, 1.8-V, 2.5-V, 3.3-V, 5-V)
- Control Inputs Can Be Driven by TTL or 5-V/3.3-V CMOS Outputs
- $I_{off}$  Supports Partial-Power-Down Mode Operation
- Latch-Up Performance Exceeds 100 mA Per JESD 78, Class II
- ESD Performance Tested Per JESD 22
  - 2000-V Human-Body Model (A114-B, Class II)
  - 1000-V Charged-Device Model (C101)
- Supports Both Digital and Analog Applications: PCI Interface, Bus Isolation, Low-Distortion Signal Gating

DGG OR DL PACKAGE  
(TOP VIEW)

S0	1	56	S1
1A	2	55	S2
1B3	3	54	1B1
2A	4	53	1B2
2B3	5	52	2B1
3A	6	51	2B2
3B3	7	50	3B1
GND	8	49	GND
4A	9	48	3B2
4B3	10	47	4B1
5A	11	46	4B2
5B3	12	45	5B1
6A	13	44	5B2
6B3	14	43	6B1
7A	15	42	6B2
7B3	16	41	7B1
$V_{CC}$	17	40	7B2
8A	18	39	8B1
GND	19	38	GND
8B3	20	37	8B2
9A	21	36	9B1
9B3	22	35	9B2
10A	23	34	10B1
10B3	24	33	10B2
11A	25	32	11B1
11B3	26	31	11B2
12A	27	30	12B1
12B3	28	29	12B2

#### description/ordering information

#### ORDERING INFORMATION

$T_A$	PACKAGE†		ORDERABLE PART NUMBER	TOP-SIDE MARKING
–40°C to 85°C	SSOP – DL	Tube	SN74CBT16214CDL	CBT16214C
		Tape and reel	SN74CBT16214CDLR	
	TSSOP – DGG	Tube	SN74CBT16214CDGG	CBT16214C
		Tape and reel	SN74CBT16214CDGGR	

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



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#### description/ordering information (continued)

The SN74CBT16214C is a high-speed TTL-compatible FET multiplexer/demultiplexer with low ON-state resistance ( $r_{ON}$ ), allowing for minimal propagation delay. Active Undershoot-Protection Circuitry on the A and B ports of the SN74CBT16214C provides protection for undershoot up to –2 V by sensing an undershoot event and ensuring that the switch remains in the proper OFF state.

The SN74CBT16214C is a 12-bit 1-of-3 multiplexer/demultiplexer. The select (S0, S1, S2) inputs control the data path of each multiplexer/demultiplexer. When the multiplexer/demultiplexer is enabled, the A port is connected to the B port, allowing bidirectional data flow between ports. When the multiplexer/demultiplexer is disabled, a high-impedance state exists between the A and B ports.

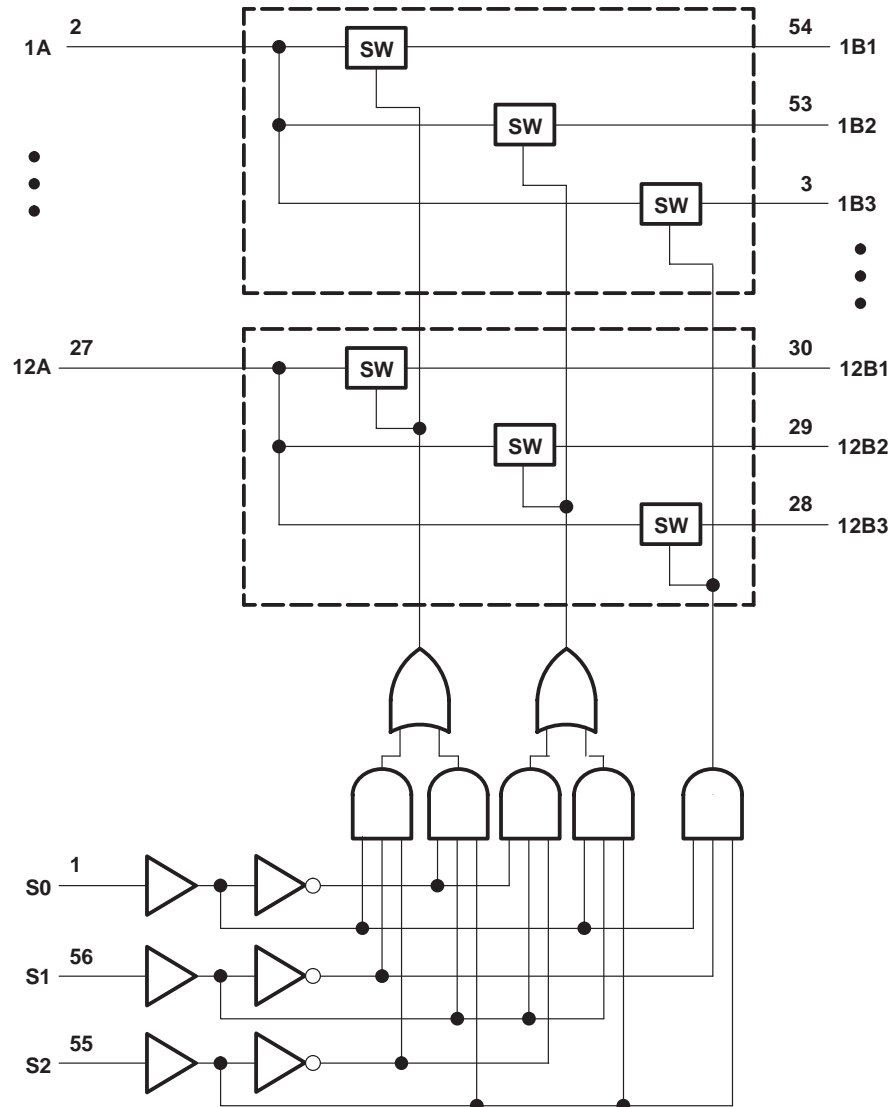
This device is fully specified for partial-power-down applications using  $I_{OFF}$ . The  $I_{OFF}$  feature ensures that damaging current will not backflow through the device when it is powered down. The device has isolation during power off.

To ensure the high-impedance state during power up or power down, each select input should be tied to GND through a pulldown resistor; the minimum value of the resistor is determined by the current-sourcing capability of the driver.

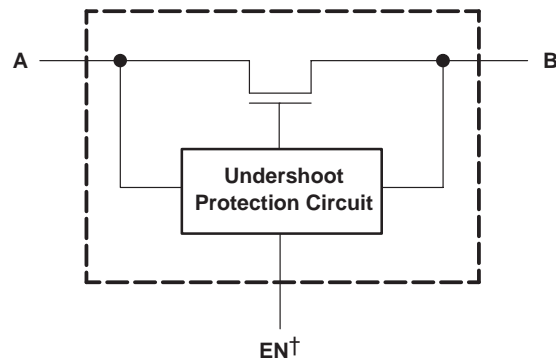
FUNCTION TABLE

INPUTS			INPUT/OUTPUT A	FUNCTION
S2	S1	S0		
L	L	L	Z	Disconnect
L	L	H	B1	A port = B1 port
L	H	L	B2	A port = B2 port
L	H	H	Z	Disconnect
H	L	L	Z	Disconnect
H	L	H	B3	A port = B3 port
H	H	L	B1	A port = B1 port
H	H	H	B2	A port = B2 port

logic diagram (positive logic)



simplified schematic, each FET switch (SW)



$^\dagger$  EN is the internal enable signal applied to the switch.

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### 5-V BUS SWITCH WITH –2-V UNDERSHOOT PROTECTION

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#### absolute maximum ratings over operating free-air temperature range (unless otherwise noted)<sup>†</sup>

Supply voltage range, $V_{CC}$	–0.5 V to 7 V
Control input voltage range, $V_{IN}$ (see Notes 1 and 2)	–0.5 V to 7 V
Switch I/O voltage range, $V_{I/O}$ (see Notes 1, 2, and 3)	–0.5 V to 7 V
Control input clamp current, $I_{IK}$ ( $V_{IN} < 0$ )	–50 mA
I/O port clamp current, $I_{I/OK}$ ( $V_{I/O} < 0$ )	–50 mA
ON-state switch current, $I_{I/O}$ (see Note 4)	±128 mA
Continuous current through $V_{CC}$ or GND terminals	±100 mA
Package thermal impedance, $\theta_{JA}$ (see Note 5): DGG package	64°C/W
DL package	56°C/W
Storage temperature range, $T_{stg}$	–65°C to 150°C

<sup>†</sup> 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.

- NOTES:
1. All voltages are with respect to ground unless otherwise specified.
  2. The input and output voltage ratings may be exceeded if the input and output clamp-current ratings are observed.
  3.  $V_I$  and  $V_O$  are used to denote specific conditions for  $V_{I/O}$ .
  4.  $I_I$  and  $I_O$  are used to denote specific conditions for  $I_{I/O}$ .
  5. The package thermal impedance is calculated in accordance with JESD 51-7.

#### recommended operating conditions (see Note 6)

	MIN	MAX	UNIT
$V_{CC}$ Supply voltage	4	5.5	V
$V_{IH}$ High-level control input voltage	2	5.5	V
$V_{IL}$ Low-level control input voltage	0	0.8	V
$V_{I/O}$ Data input/output voltage	0	5.5	V
$T_A$ Operating free-air temperature	–40	85	°C

NOTE 6: 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.

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

PARAMETER		TEST CONDITIONS		MIN	TYP†	MAX	UNIT
V <sub>IK</sub>	Control inputs	V <sub>CC</sub> = 4.5 V,	I <sub>IN</sub> = –18 mA			–1.8	V
V <sub>IKU</sub>	Data inputs	V <sub>CC</sub> = 5 V,	0 mA > I <sub>I</sub> ≥ –50 mA, V <sub>IN</sub> = V <sub>CC</sub> or GND, Switch OFF			–2	V
I <sub>IN</sub>	Control inputs	V <sub>CC</sub> = 5.5 V,	V <sub>IN</sub> = V <sub>CC</sub> or GND			±1	μA
I <sub>OZ</sub> ‡		V <sub>CC</sub> = 5.5 V,	V <sub>O</sub> = 0 to 5.5 V, V <sub>I</sub> = 0, Switch OFF, V <sub>IN</sub> = V <sub>CC</sub> or GND			±10	μA
I <sub>off</sub>		V <sub>CC</sub> = 0,	V <sub>O</sub> = 0 to 5.5 V, V <sub>I</sub> = 0			10	μA
I <sub>CC</sub>		V <sub>CC</sub> = 5.5 V,	I <sub>I/O</sub> = 0, V <sub>IN</sub> = V <sub>CC</sub> or GND, Switch ON or OFF			3	μA
ΔI <sub>CC</sub> §	Control inputs	V <sub>CC</sub> = 5.5 V,	One input at 3.4 V, Other inputs at V <sub>CC</sub> or GND			2.5	mA
C <sub>in</sub>	Control inputs	V <sub>IN</sub> = 3 V or 0			3.5		pF
C <sub>io</sub> (OFF)	A port	V <sub>I/O</sub> = 3 V or 0, Switch OFF, V <sub>IN</sub> = V <sub>CC</sub> or GND			10		pF
	B port				5.5		pF
C <sub>io</sub> (ON)		V <sub>I/O</sub> = 3 V or 0, Switch ON, V <sub>IN</sub> = V <sub>CC</sub> or GND			18		pF
r <sub>on</sub> ¶		V <sub>CC</sub> = 4 V, TYP at V <sub>CC</sub> = 4 V	V <sub>I</sub> = 2.4 V, I <sub>O</sub> = –15 mA		8	12	Ω
		V <sub>CC</sub> = 4.5 V	V <sub>I</sub> = 0, I <sub>O</sub> = 64 mA		3	6	
			I <sub>O</sub> = 30 mA		3	6	
			V <sub>I</sub> = 2.4 V, I <sub>O</sub> = –15 mA		5	10	

V<sub>IN</sub> and I<sub>IN</sub> refer to control inputs. V<sub>I</sub>, V<sub>O</sub>, I<sub>I</sub>, and I<sub>O</sub> refer to data pins.

† All typical values are at V<sub>CC</sub> = 5 V (unless otherwise noted), T<sub>A</sub> = 25°C.

‡ For I/O ports, the parameter I<sub>OZ</sub> includes the input leakage current.

§ This is the increase in supply current for each input that is at the specified voltage level, rather than V<sub>CC</sub> or GND.

¶ Measured by the voltage drop between the 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.

**switching characteristics over recommended operating free-air temperature range, C<sub>L</sub> = 50 pF (unless otherwise noted) (see Figure 3)**

PARAMETER	FROM (INPUT)	TO (OUTPUT)	V <sub>CC</sub> = 4 V		V <sub>CC</sub> = 5 V ± 0.5 V		UNIT
			MIN	MAX	MIN	MAX	
t <sub>pd</sub> #	A or B	B or A		0.24		0.15	ns
t <sub>pd</sub> (s)	S	A		6.7	1.5	6.3	ns
t <sub>en</sub>	S	B		7.2	1.5	6.6	ns
t <sub>dis</sub>	S	B		7.5	1.5	7.3	ns

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

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undershoot characteristics (see Figures 1 and 2)

PARAMETER	TEST CONDITIONS	MIN	TYP†	MAX	UNIT
V <sub>OUTU</sub>	V <sub>CC</sub> = 5.5 V, Switch OFF, V <sub>IN</sub> = V <sub>CC</sub> or GND	2	V <sub>OH</sub> –0.3		V

† All typical values are at V<sub>CC</sub> = 5 V (unless otherwise noted), T<sub>A</sub> = 25°C.

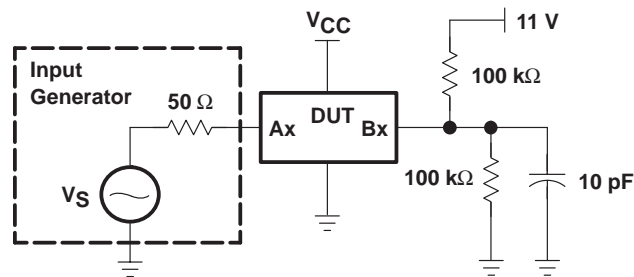


Figure 1. Device Test Setup

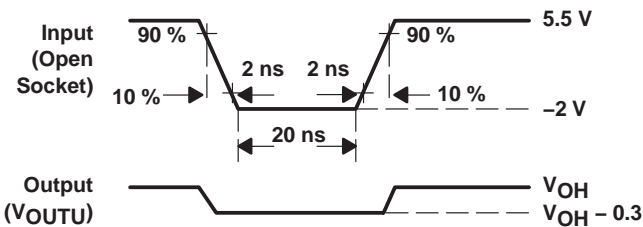
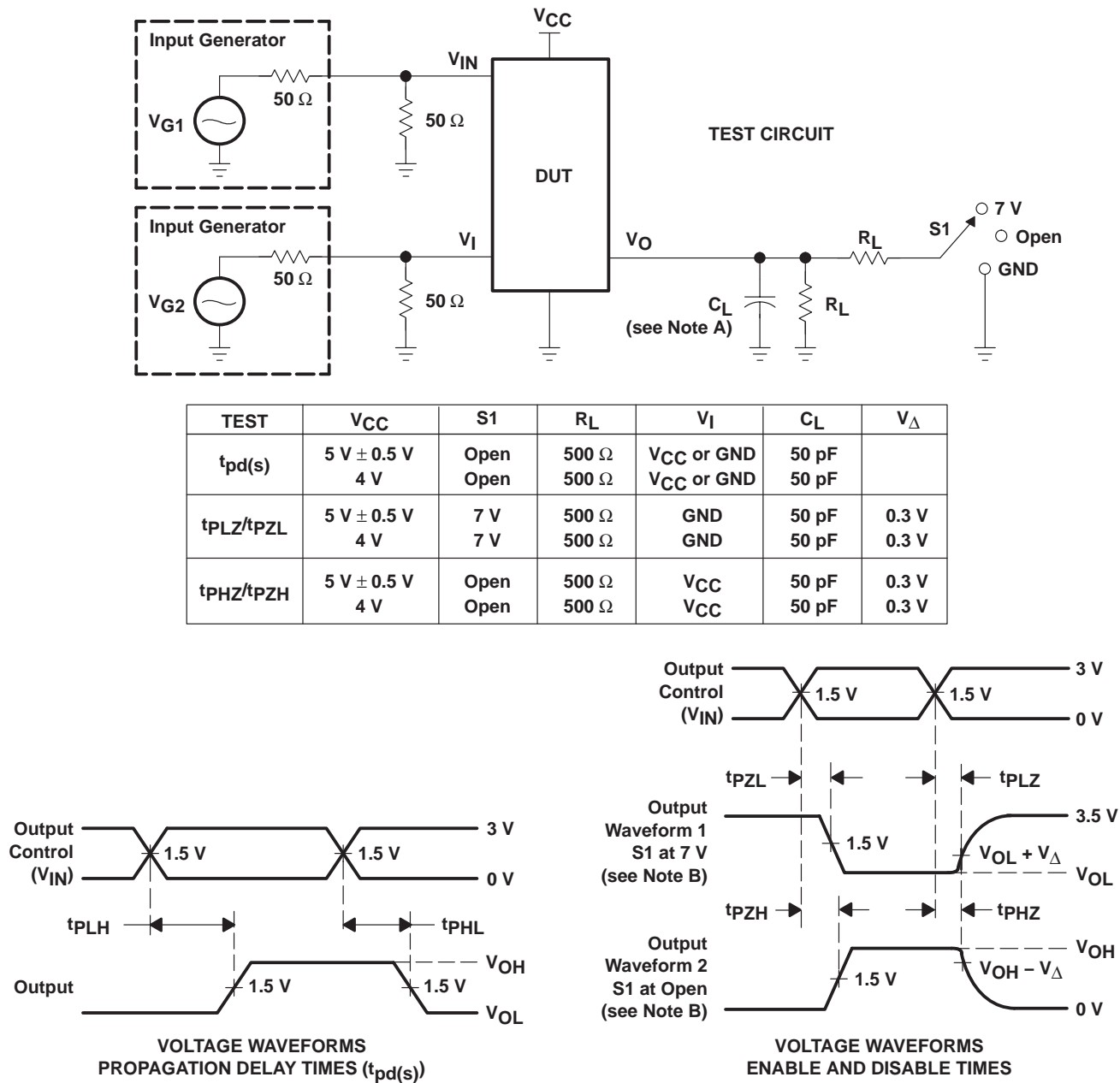


Figure 2. Transient Input Voltage (V<sub>I</sub>) and Output Voltage (V<sub>OUTU</sub>) Waveforms (Switch OFF)

### PARAMETER MEASUREMENT INFORMATION



- NOTES:
- A. C<sub>L</sub> 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<sub>O</sub> = 50 Ω, t<sub>r</sub> ≤ 2.5 ns, t<sub>f</sub> ≤ 2.5 ns.
  - D. The outputs are measured one at a time with one transition per measurement.
  - E. t<sub>PLZ</sub> and t<sub>PHZ</sub> are the same as t<sub>dis</sub>.
  - F. t<sub>PZL</sub> and t<sub>PZH</sub> are the same as t<sub>en</sub>.
  - G. t<sub>PLH</sub> and t<sub>PHL</sub> are the same as t<sub>pd</sub>(s). The t<sub>pd</sub> propagation delay is the calculated RC time constant of the typical ON-state resistance of the switch and the specified load capacitance, when driven by an ideal voltage source (zero output impedance).
  - H. All parameters and waveforms are not applicable to all devices.

**Figure 3. Test 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
74CBT16214CDGGRE4	ACTIVE	TSSOP	DGG	56	2000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	CBT16214C	<a href="#">Samples</a>
SN74CBT16214CDGGR	ACTIVE	TSSOP	DGG	56	2000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	CBT16214C	<a href="#">Samples</a>
SN74CBT16214CDL	ACTIVE	SSOP	DL	56	20	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	CBT16214C	<a href="#">Samples</a>
SN74CBT16214CDLR	ACTIVE	SSOP	DL	56	1000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	CBT16214C	<a href="#">Samples</a>
SN74CBT16214CDLRG4	ACTIVE	SSOP	DL	56	1000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	CBT16214C	<a href="#">Samples</a>

(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.

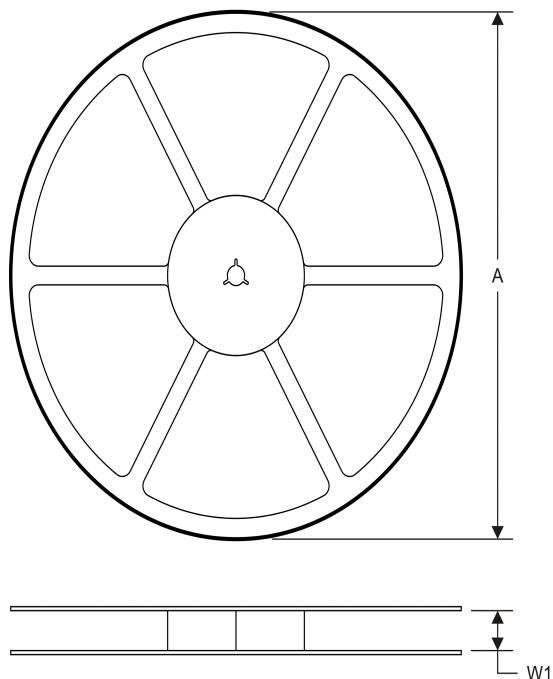
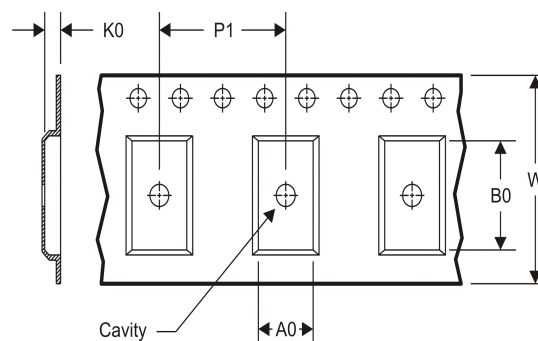
(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(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
SN74CBT16214CDGGR	TSSOP	DGG	56	2000	330.0	24.4	8.6	15.6	1.8	12.0	24.0	Q1
SN74CBT16214CDLR	SSOP	DL	56	1000	330.0	32.4	11.35	18.67	3.1	16.0	32.0	Q1

## TAPE AND REEL BOX DIMENSIONS

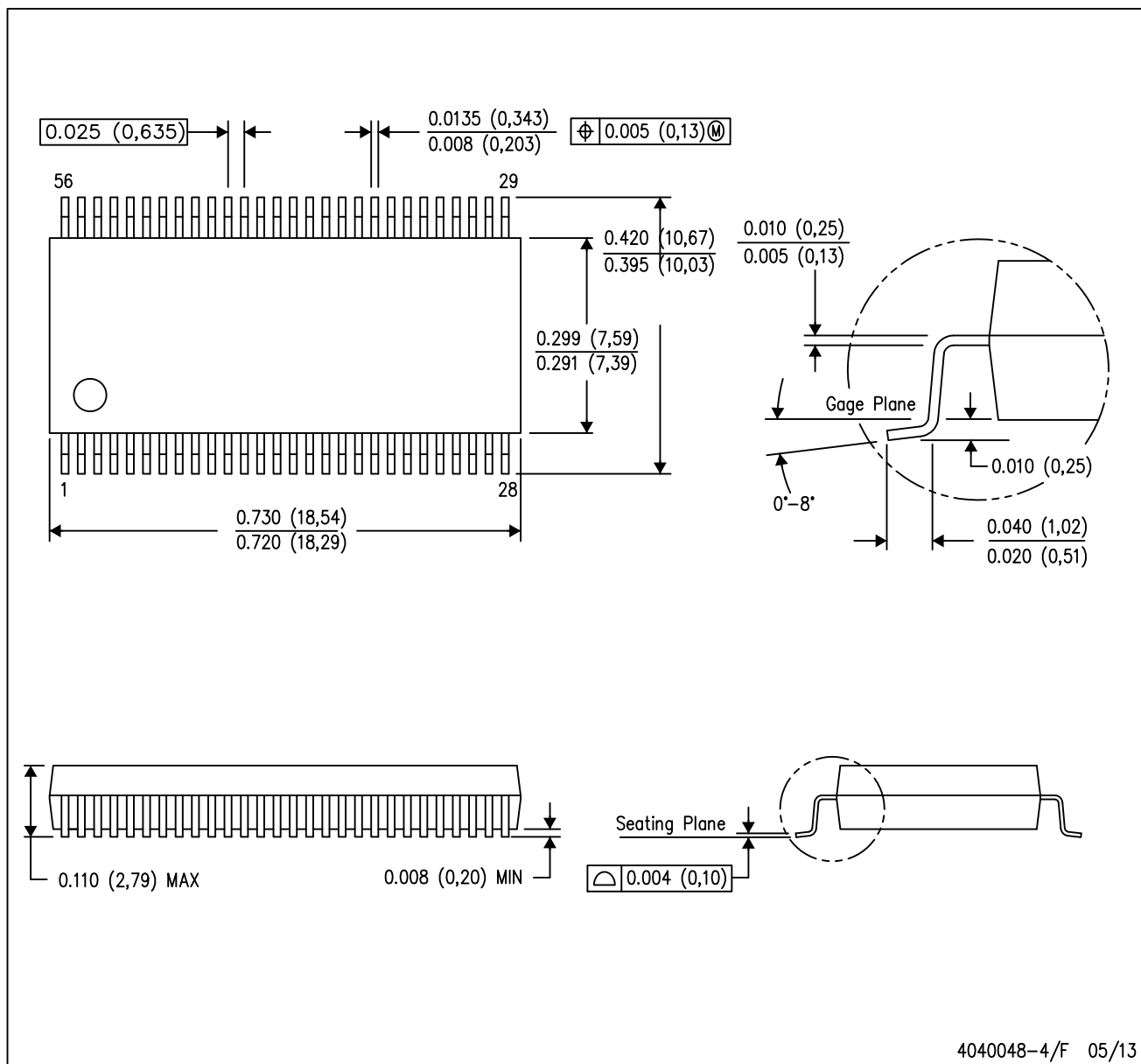


\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
SN74CBT16214CDGGR	TSSOP	DGG	56	2000	367.0	367.0	45.0
SN74CBT16214CDLR	SSOP	DL	56	1000	367.0	367.0	55.0

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

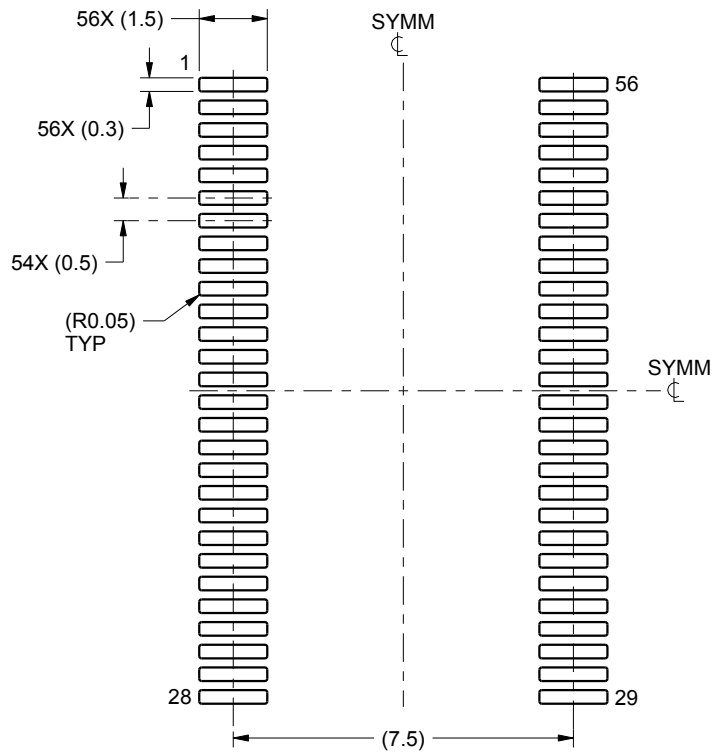


# EXAMPLE BOARD LAYOUT

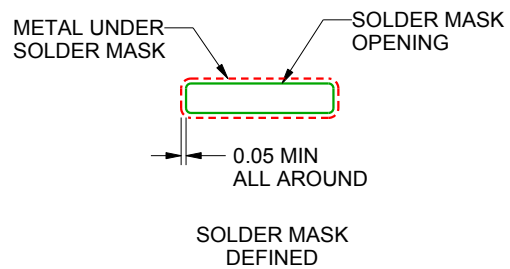
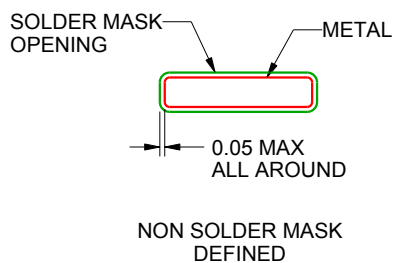
DGG0056A

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.

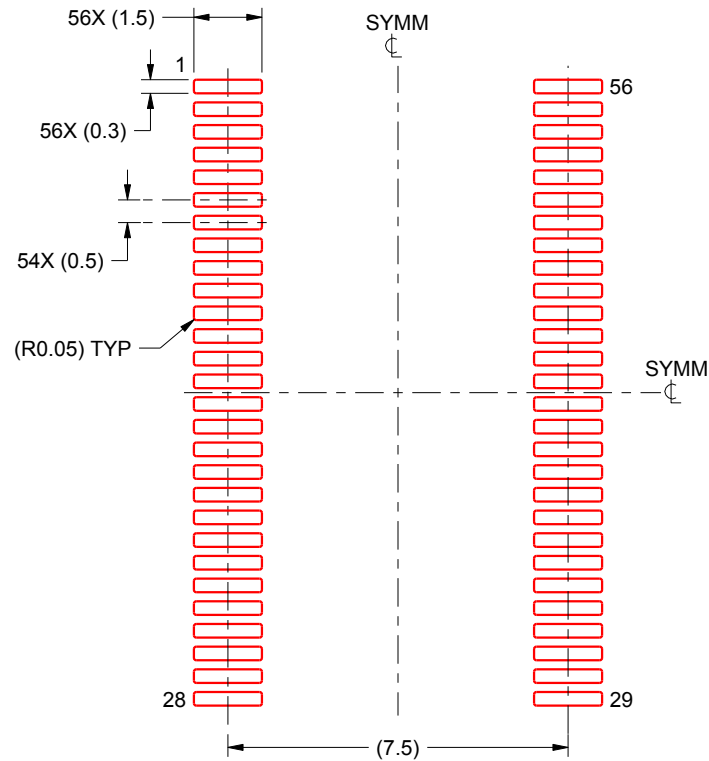
6. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

# 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.

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