

## CDCS504-Q1 Clock Buffer and Clock Multiplier

### 1 Features

- Qualified for Automotive Applications
- AEC-Q100 Test Guidance With the Following Results:
  - Device Temperature Grade 2:  $-40^{\circ}\text{C}$  to  $105^{\circ}\text{C}$  Ambient Operating Temperature Range
  - Device HBM ESD Classification Level H2
  - Device CDM ESD Classification Level C3B
- Part of a Family of Easy-to-Use Clock Generator Devices
- Clock Multiplier With Selectable Output Frequency
- Frequency Multiplication Selectable Between x1 or x4 With One External Control Pin
- Output Disable Through Control Pin
- Single 3.3-V Device Power Supply
- Wide Temperature Range:  $-40^{\circ}\text{C}$  to  $105^{\circ}\text{C}$
- Low Space Consumption 8-Pin TSSOP Package
- Create a Custom Design Using the CDCS504-Q1 With the [WEBENCH® Power Designer](#)

### 2 Applications

Automotive Applications Requiring Clock Multiplication

### 3 Description

The CDCS504-Q1 device is a LVCMOS input clock buffer with selectable frequency multiplication.

The CDCS504-Q1 has an output enable pin.

The device accepts a 3.3-V LVCMOS signal at the input.

The input signal is processed by a phased-locked loop (PLL), whose output frequency is either equal to the input frequency or multiplied by the factor of four.

By this, the device can generate output frequencies between 2 MHz and 108 MHz.

A separate control pin can be used to enable or disable the output. The CDCS504-Q1 device operates in a 3.3-V environment.

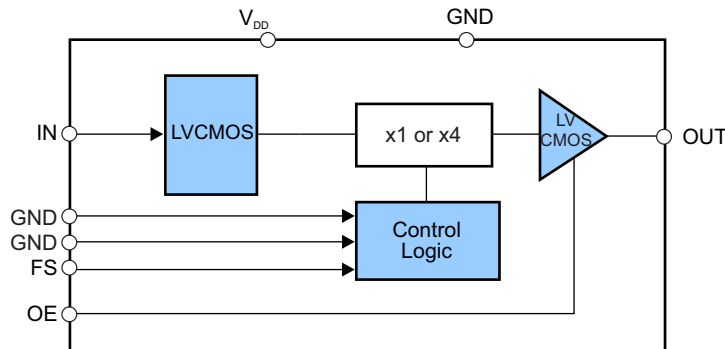
It is characterized for operation from  $-40^{\circ}\text{C}$  to  $105^{\circ}\text{C}$  and is available in an 8-pin TSSOP package.

#### Device Information<sup>(1)</sup>

PART NUMBER	PACKAGE	BODY SIZE (NOM)
CDCS504-Q1	TSSOP (8)	3.00 mm x 4.40 mm

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

#### Block Diagram



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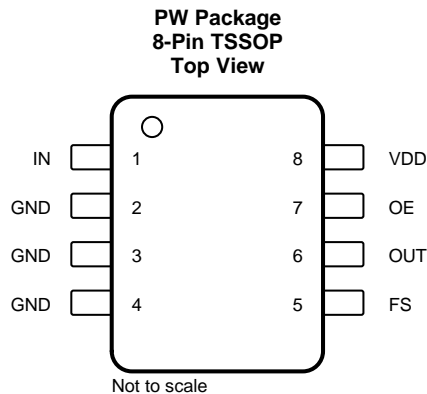
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## 4 Revision History

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

DATE	REVISION	NOTES
April 2017	*	Initial release.

## 5 Pin Configuration and Functions



### Pin Functions

PIN		TYPE	DESCRIPTION
NAME	NO.		
FS	5	I	Frequency multiplication selection, internal pullup
GND	2, 3, 4	Ground	Ground
IN	1	I	LVC MOS clock input
OE	7	I	Output enable, internal pullup
OUT	6	O	LVC MOS clock output
VDD	8	Power	3.3-V power supply

## 6 Specifications

### 6.1 Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted)<sup>(1)</sup>

		MIN	MAX	UNIT
V <sub>DD</sub>	Supply voltage	−0.5	4.6	V
V <sub>IN</sub>	Input voltage	−0.5	4.6	V
V <sub>out</sub>	Output voltage	−0.5	4.6	V
I <sub>IN</sub>	Input current (V <sub>I</sub> < 0, V <sub>I</sub> > V <sub>DD</sub> )		20	mA
I <sub>out</sub>	Continuous output current		50	mA
T <sub>J</sub>	Maximum junction temperature		125	°C
T <sub>stg</sub>	Storage temperature	−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.

### 6.2 ESD Ratings

		VALUE	UNIT
V <sub>(ESD)</sub>	Electrostatic discharge	Human-body model (HBM), per AEC Q100-002 <sup>(1)</sup>	V
		Charged-device model (CDM), per AEC Q100-011	

- (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

			MIN	NOM	MAX	UNIT
V <sub>DD</sub>	Supply voltage		3		3.6	V
f <sub>IN</sub>	Input frequency	FS = 0	2		27	MHz
		FS = 1	2		27	
V <sub>IL</sub>	Low-level input voltage LVCMOS				0.3 × V <sub>DD</sub>	V
V <sub>IH</sub>	High-level input voltage LVCMOS		0.7 × V <sub>DD</sub>			V
V <sub>I</sub>	Input voltage threshold LVCMOS			0.5 × V <sub>DD</sub>		V
C <sub>L</sub>	Output load test LVCMOS				15	pF
I <sub>OH</sub> /I <sub>OL</sub>	Output current				±12	mA
T <sub>A</sub>	Operating free-air temperature		–40		105	°C

### 6.4 Thermal Information

over operating free-air temperature range (unless otherwise noted)<sup>(1)</sup>

THERMAL METRIC <sup>(2)</sup>			CDCS504-Q1	UNIT	
			PW (TSSOP)		
			8 PINS		
R <sub>θJA</sub>	Junction-to-ambient thermal resistance		179.9	°C/W	
		High K	Thermal Airflow (CFM) 0		149
			Thermal Airflow (CFM) 150		142
			Thermal Airflow (CFM) 250		138
			Thermal Airflow (CFM) 500		132
	Low K	Thermal Airflow (CFM) 0	230		
		Thermal Airflow (CFM) 150	185		
		Thermal Airflow (CFM) 250	170		
		Thermal Airflow (CFM) 500	150		
R <sub>θJC(top)</sub>	Junction-to-case (top) thermal resistance		64.9	°C/W	
		High K	65		
		Low K	69		
R <sub>θJB</sub>	Junction-to-board thermal resistance		108.7	°C/W	
Ψ <sub>JT</sub>	Junction-to-top characterization parameter		9	°C/W	
Ψ <sub>JB</sub>	Junction-to-board characterization parameter		107	°C/W	
R <sub>θJC(bot)</sub>	Junction-to-case (bottom) thermal resistance		n/a	°C/W	

(1) The package thermal impedance is calculated in accordance with JESD 51 and JEDEC2S2P (high-k board).

(2) For more information about traditional and new thermal metrics, see the [Semiconductor and IC Package Thermal Metrics](#) application report.

### 6.5 Electrical Characteristics – Device Characteristics

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

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
I <sub>DD</sub>	Device supply current	f <sub>in</sub> = 3.072 MHz; FS = 1		24		mA
f <sub>OUT</sub>	Output frequency	FS = 0	2		27	MHz
		FS = 1	8		108	
I <sub>IH</sub>	LVCMOS input current	V <sub>I</sub> = V <sub>DD</sub> ; V <sub>DD</sub> = 3.6 V			10	μA
I <sub>IL</sub>	LVCMOS input current	V <sub>I</sub> = 0 V; V <sub>DD</sub> = 3.6 V			–10	μA
V <sub>OH</sub>	LVCMOS high-level output voltage	I <sub>OH</sub> = –0.1 mA	2.9			V
		I <sub>OH</sub> = –8 mA	2.4			
		I <sub>OH</sub> = –12 mA	2.2			

## Electrical Characteristics – Device Characteristics (continued)

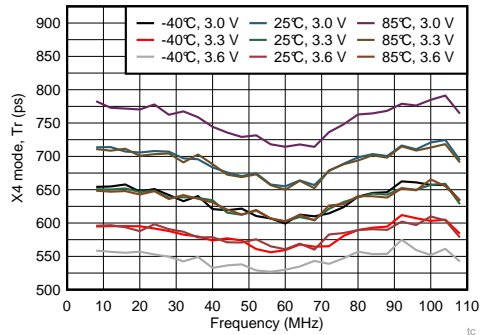
over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{OL}$ LVCMOS low-level output voltage	$I_{OL} = 0.1 \text{ mA}$			0.1	V
	$I_{OL} = 8 \text{ mA}$			0.5	
	$I_{OL} = 12 \text{ mA}$			0.8	
$I_{OZ}$ High-impedance-state output current	OE = Low	-2		2	$\mu\text{A}$
$t_{JIT(C-C)}$ Cycle to cycle jitter <sup>(1)</sup>	$f_{out} = 11.264 \text{ MHz}$ ; FS = 1, 10000 Cycles		144		ps
$t_r$ Rise time <sup>(1)</sup>	20%–80%		0.65		ns
$t_f$ Fall time <sup>(1)</sup>	20%–80%		0.55		ns
$O_{dc}$ Output duty cycle <sup>(2)</sup>		45%		55%	

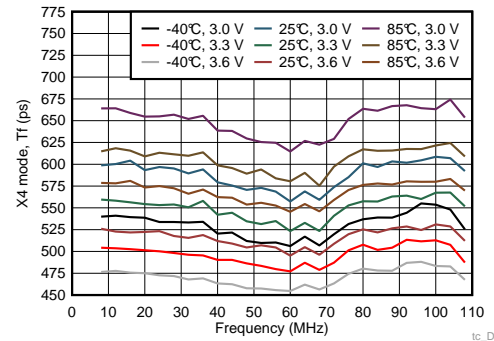
(1) Measured with Test Load, see Figure 4.

(2) Not production tested.

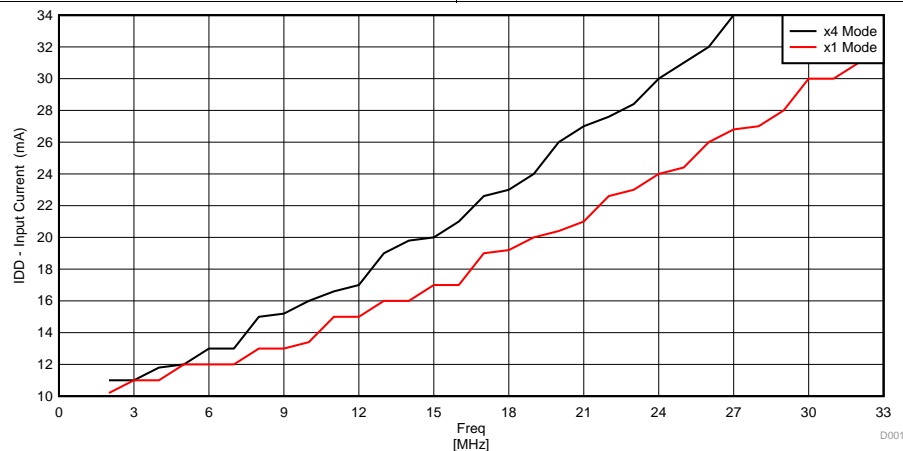
## 6.6 Typical Characteristics



**Figure 1. Typical  $T_r$  vs Output Frequency, VDD, Temperature in X4 Mode**



**Figure 2. Typical  $T_f$  vs Output Frequency, VDD, Temperature in X4 Mode**

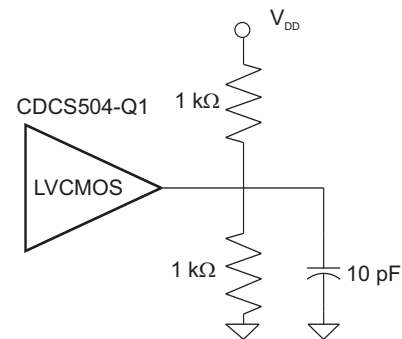


$V_{CC} = 3.3 \text{ V}$ , output loaded with test load

**Figure 3.  $I_{DD}$  vs Input Frequency**

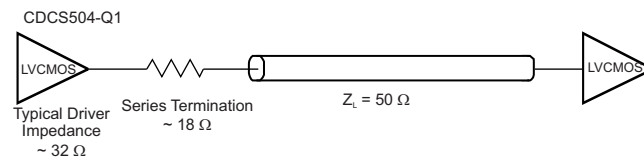
## 7 Parameter Measurement Information

### 7.1 Measurement Circuits



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**Figure 4. Test Load**



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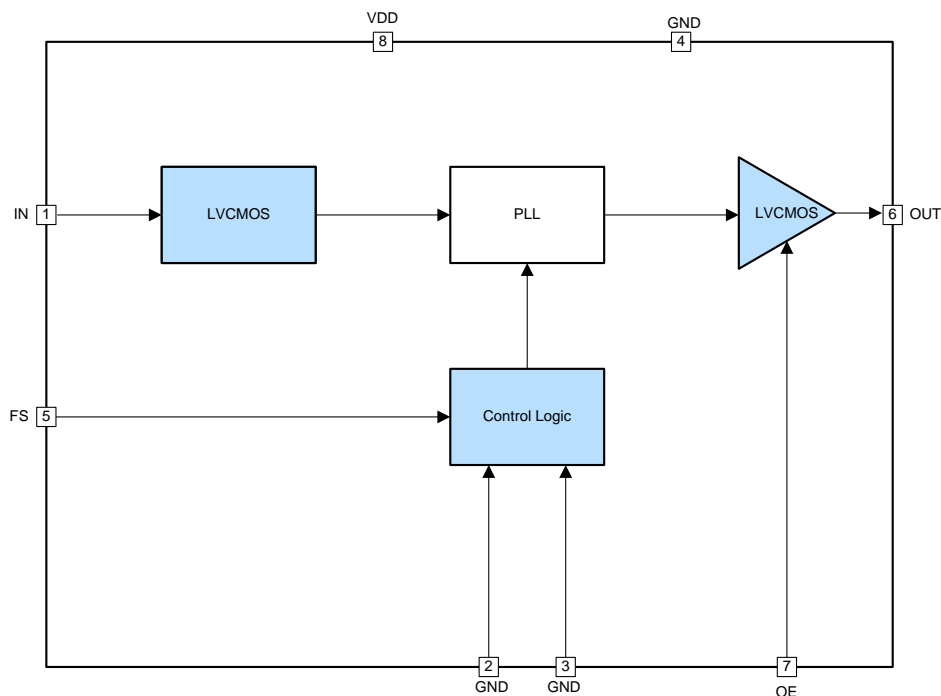
**Figure 5. Load for 50-Ω Board Environment**

## 8 Detailed Description

### 8.1 Overview

The CDCS504-Q1 is a LVCMOS clock buffer (x1 mode) or quadrupler (x4 mode). It integrates an internal PLL and generates a LVCMOS clock frequency range from 2 MHz to 108 MHz.

### 8.2 Functional Block Diagram



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### 8.3 Feature Description

The CDCS504-Q1 is qualified for automotive applications with AEC-Q100 test, which could support wide temperature range from  $-40^{\circ}\text{C}$  to  $105^{\circ}\text{C}$ . The device is easy to use, only need single 3.3-V power supply. The output enable or disable mode, along with frequency multiplication, could be controlled by external controls pins.

### 8.4 Device Functional Modes

When pin 7 OE is in low, the CDCS504-Q1 outputs 3-state. When pin 7 OE is set in high, the device would output clocks, output frequency depends on pin 5 FS status. FS = high enables frequency  $\times 4$  mode. FS = low makes output frequency equal to input frequency. If no input clock is provided, it is recommended to set OE = low in order to avoid random clock pulses from the internal PLL at the outputs.

**Table 1. Function Table**

OE	FS	$f_{\text{OUT}}/f_{\text{IN}}$	$f_{\text{OUT}}$ at $f_{\text{IN}} = 27 \text{ MHz}$
0	x	x	3-state
1	0	1	27 MHz
1	1	4	108 MHz

## 9 Application and Implementation

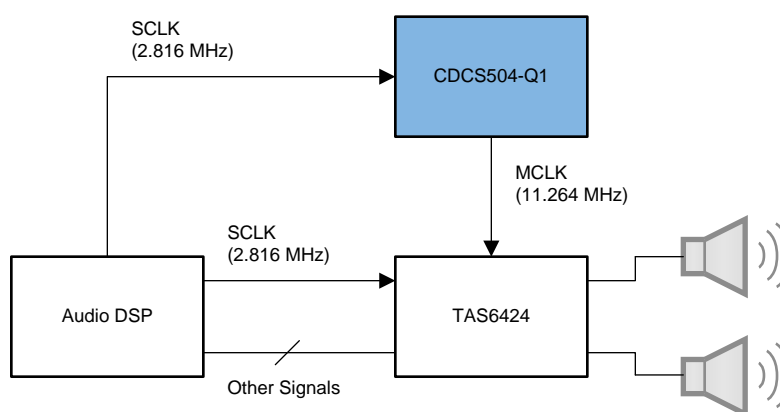
### NOTE

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 CDCS504-Q1 is a clock buffer or multiplier for automotive amplifiers and infotainment. It is fit for the TAS6424-Q1, a four-channel, class-D, digital-input audio-amplifier, when the applications are without available MCLK. See [Figure 6](#) for more details.

### 9.2 Typical Application



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**Figure 6. Clock for Automotive Amplifiers**

#### 9.2.1 Design Requirements

The CDCS504-Q1 is supplied with a single-power 3.3 V. The device supports minimum input frequency to 2 MHz. For maximum input frequency, it is 32 MHz in  $\times 1$  mode, and 27 MHz in  $\times 4$  mode. The input clock is LVCMOS type and should satisfy requirements in the [Recommended Operating Conditions](#).

#### 9.2.2 Detailed Design Procedure

In some applications, the clock input for CDCS504-Q1 is not always presented. In case there is an unexpected clock output without clock input, TI recommends setting OE pin to low. When it gets clock input ready, set OE pin to high to get expected clock output. If the other application presents continuous clock input for CDCS504-Q1, the OE pin could be floated, internal pullup brings output enable, or an external pullup circuits could be used fixedly.

##### 9.2.2.1 Custom Design With WEBENCH® Tools

[Click here](#) to create a custom design using the CDCS504-Q1 device with the WEBENCH® Power Designer.

1. Start by entering the input voltage ( $V_{IN}$ ), output voltage ( $V_{OUT}$ ), and output current ( $I_{OUT}$ ) requirements.
2. Optimize the design for key parameters such as efficiency, footprint, and cost using the optimizer dial.
3. Compare the generated design with other possible solutions from Texas Instruments.

The WEBENCH Power Designer provides a customized schematic along with a list of materials with real-time pricing and component availability.



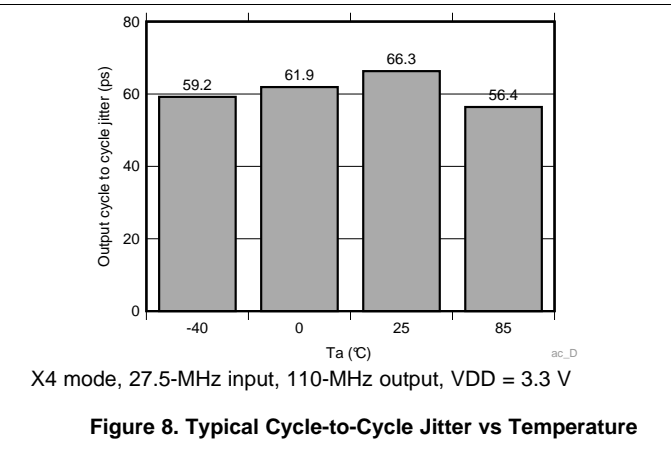
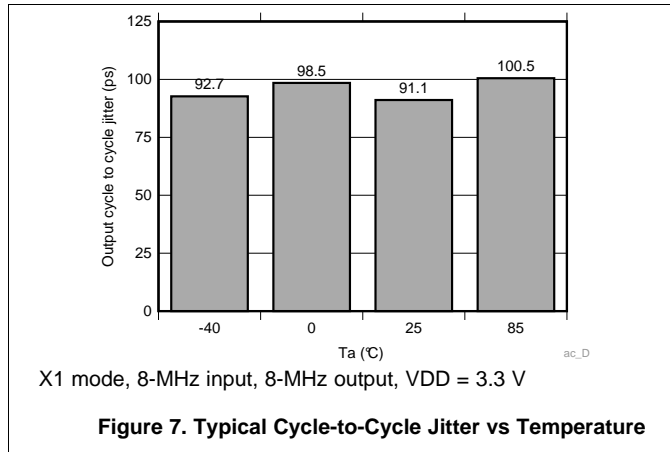
## Typical Application (continued)

In most cases, these actions are available:

- Run electrical simulations to see important waveforms and circuit performance
- Run thermal simulations to understand board thermal performance
- Export customized schematic and layout into popular CAD formats
- Print PDF reports for the design, and share the design with colleagues

Get more information about WEBENCH tools at [www.ti.com/WEBENCH](http://www.ti.com/WEBENCH).

### 9.2.3 Application Curves



## 10 Power Supply Recommendations

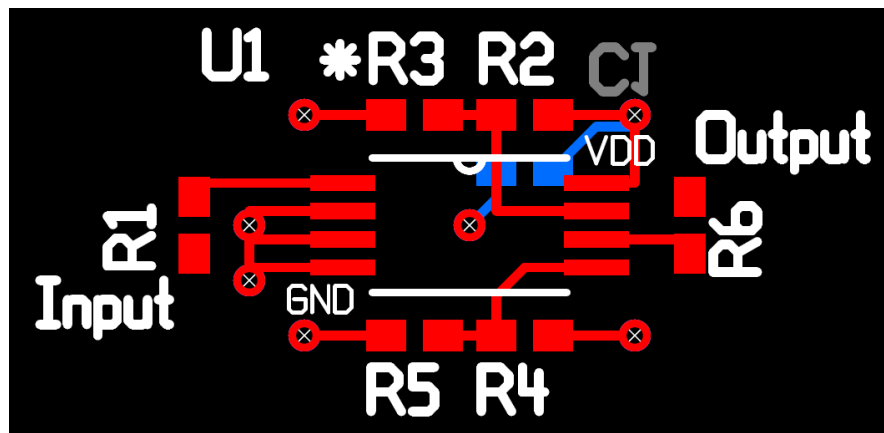
The CDCS504-Q1 requires a 3.3-V supply.

## 11 Layout

## 11.1 Layout Guidelines

The CDCS504-Q1 only has typical 20-mA supply current, so there is no thermal design challenge. A 0.01- $\mu$ F capacitor may be placed close to VDD pin as a bypass capacitor.

## 11.2 Layout Example



### Figure 9. Layout Example

## 12 Device And Documentation Support

### 12.1 Device Support

#### 12.1.1 Development Support

##### 12.1.1.1 Custom Design With WEBENCH® Tools

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- Export customized schematic and layout into popular CAD formats
- Print PDF reports for the design, and share the design with colleagues

Get more information about WEBENCH tools at [www.ti.com/WEBENCH](http://www.ti.com/WEBENCH).

### 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.

WEBENCH is a registered trademark of Texas Instruments.

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### 12.5 Electrostatic Discharge Caution



These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

### 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/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
CDCS504TPWRQ1	ACTIVE	TSSOP	PW	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR	-40 to 105	CS504Q	<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/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

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**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
CDCS504TPWRQ1	TSSOP	PW	8	2000	330.0	12.4	7.0	3.6	1.6	8.0	12.0	Q1

## TAPE AND REEL BOX DIMENSIONS



\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
CDCS504TPWRQ1	TSSOP	PW	8	2000	367.0	367.0	35.0

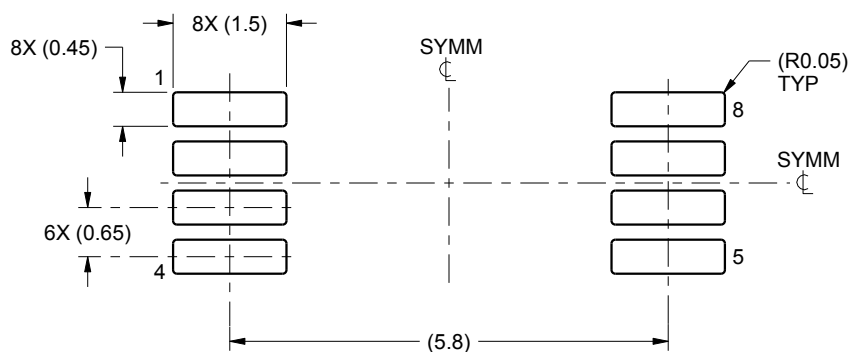


# EXAMPLE BOARD LAYOUT

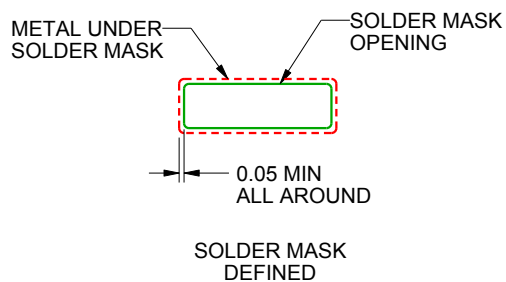
PW0008A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



LAND PATTERN EXAMPLE  
SCALE:10X



SOLDER MASK DETAILS  
NOT TO SCALE

4221848/A 02/2015

NOTES: (continued)

6. Publication IPC-7351 may have alternate designs.

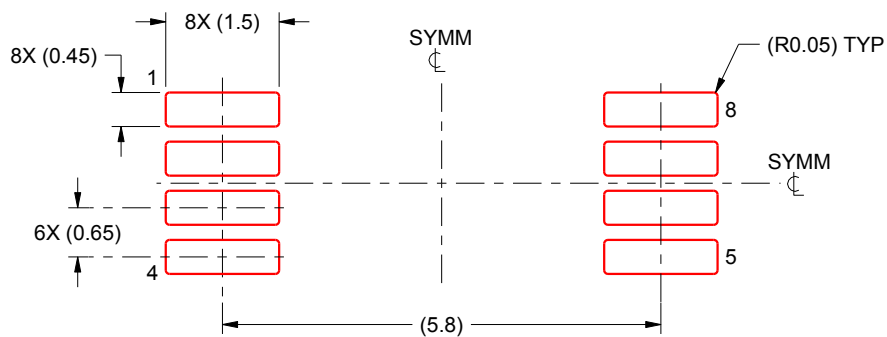
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.



**PW0008A**

## TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



SOLDER PASTE EXAMPLE  
BASED ON 0.125 mm THICK STENCIL  
SCALE:10X

4221848/A 02/2015

NOTES: (continued)

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

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